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Comparative Study of Various Methods of Fetal Weight Estimation At Term Pregnancy

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ABSTRACT:

Aim: *To assess the fetal weight in term pregnancies by various methods like Abdominal girth x Symphysiofundal height (Insler's formula), Johnson's formula and Hadlocks formula using USG.*

Objective: *To correlate these three methods of estimation of fetal weight with the actual birth weight of the baby after delivery.*

Materials and Methods: *The study was conducted in 100 women with full term pregnancy. These patients who were selected from antenatal clinics and maternity wards had their last fetal weight estimation done within one week of delivery. The study was conducted over a period of one year. Patients in whom delivery was anticipated within 1 week were included in this study and those who did not deliver within 1 week of fetal weight estimation were excluded from the study. The duration of gestation was calculated according to Naegale's rule or by first trimester scan report. A comparative evaluation of fetal weight estimation in term pregnancy using Abdominal girth x Symphysio fundal height (Insler's formula), Johnson's , and Hadlock's formula using ultrasonography was done. The fetal weight estimated by the above three methods was compared with actual weight of baby after birth. Data collected for age, parity, actual birth weight, mean birth weight by different methods was organized, interpreted and analyzed using appropriate statistical methods. P value of < 0.05 was considered significant.*

Results: *Results of the correlation analysis showed that there is a significant relationship between estimated and actual birth weight for all the methods. The major finding from this study is that ultrasonographic estimation of* *foetal weight is as accurate as the clinical method of estimation within the normal birth weight range.*

Conclusion: *Estimation of birth weight clearly has a role in management of labour and delivery in a term pregnancy. Of the three clinical formulae studied, USG*

Key Words: *Pre natal Fetal Weight, Ultrasonography, Birth weight, Estimated fetal weight, Actual Birth Weight*

INTRODUCTION

Accurate prenatal estimation of fetal weight (EFW) in late pregnancy and labour is extremely useful in the management of labour and delivery, permitting obstetricians to make decisions about instrumental vaginal delivery, trial of labour after caesarean delivery and elective caesarean section for patients suspected of having a macrosomic fetus,An accurate diagnosis of macrosomia for patients with gestational diabetes can reduce perinatal morbidity as it may assist the physician and staff in deciding the appropriate route of delivery to prepare for shoulder dystocia or to prevent a traumatic injury.Correct EFW values are also important when intrauterine growth is restricted and in preterm labour.EFW can be done by mothers (if they are parous), by clinicians using Leopold manoeuvres or by ultrasound.

In the 1970s, the use of ultrasound to estimate fetal weight gained popularity because of the perceived ability to standardize and reproduce measurements , although the technique can be challenging, depending on the mother's physique, uterine anomalies or amniotic fluid index .

Clinical EFW has been shown to accurately predict birth weight. Our study aimed to evaluate Fetal Weight by comparing the accuracy of clinical methods and ultrasound EFW in term women.

METHODOLOGY

Patients in whom delivery was anticipated within 1 week were included in this study and those who did not deliver within 1 week of fetal weight estimation were excluded from the study.Detailed obstetric and menstrual history was taken.The duration of gestation was calculated according to Naegale's rule or by first trimester scan report. Significant antenatal history such as history of antepartum haemorrhage, hypertensive disorders, diabetes mellitus, cardiac disease, anaemia and tuberculosis were noted.

1. **Fetal weight estimation(EFW) by Abdominal Girth (AG) (Symphysio Fundal Height) SFH - (Insler's Formula)**

EFW (wt in gms) = AG (cms) x SFH (cms)

After emptying the bladder, patient should lie supine with legs flat on the bed i.e, extended both at hip and knee. Abdominal girth is measured at the level of umbilicus and expressed in cms. After correction of dextro rotation, Mc Donald's measurements of height of the fundus from upper edge of symphysis pubis following the curvature of abdomen were taken in centimeter tape. The upper hand was placed firmly against the top of the fundus, with the measuring tape pressing between the index and middle fingers readings were taken from the perpendicular intersection of the tape with the fingers.

2 Fetal weight estimation by simplified Johnson's formula

As mentioned in previous method Mc Donald's measurement of symphysis fundal height is done. Fetal weight was estimated as follows:

Fetal weight (gms) = (Mc Donald's measurement -13) x 135, When presenting part was at 'minus' station

= (McDonald's measurement -12) x 155, when presenting part was at 'zero' station

= (Mc Donald's measurement – 11) x 155, when presenting part was at plus station

If women weighed more than 91 kgs, 1 cms was subtracted from fundal weight.

3 Fetal weight estimation by Hadlock's formula using ultrasonography

Sonographic examination was done in all patients using 3.5 MHz convex assay and linear assay transverse (Transverse Sumen's Sonoline SL grey scale model with M&B mode for simultaneous imaging and calculating fetal heart rate). After biparietal diameter (BPD) abdominal circumference (AC) and femur length (FL) were measured in centimeters, the sonography machine calculated fetal weight by formula.

$\text{Log } 10 (\text{EFW}) = 1.4787 - 0.003343 \text{ AC} \times \text{FL} + 0.001837 \text{ BPD}^2 + 0.0458 \text{ AC} + 0.158\text{FL}$

BIPARIETAL DIAMETER MEASUREMENT

The biparietal diameter was measured at right angles to the longitudinal axis of the elliptical skull at a level at which a clear midline echo and easily discernible lateral ventricle could be visualized. At this level, the transverse scan also should show cavum septum pellucidum and the thalamus. BPD was measured from the outer table of anterior skull to the inner table of the posterior skull.

ABDOMINAL CIRCUMFERENCE MEASUREMENT

The measurement of the fetal abdominal circumference was made from a transverse axial image of the fetal abdomen at the level of the liver.A major landmark in this section is the umbilical portion of the left portal vein deep in the liver, with the fetal stomach representing a secondary landmark. Though this circumference could be traced along its outer margin with a map measurer or electronic digitizer, it was preferred to calculate the circumference using the anteroposterior and transverse diameters measured outer to outer. The circumference then equaled (D1 + D2) x 1.57. Great care was taken when obtaining this measurement to be certain that the image was not inclined side to side or front to back. Excessive pressure with the transducer was avoided because it would distort the shape of the abdomen. In some cases, when the shape of the abdomen was distorted because of uterine factors (eg: decreased amniotic fluid volume, narrow maternal anteroposterior diameter, myometrial contraction), the circumference was traced directly with a map measure or electronic digitizer.

FEMUR LENGTH MEASUREMENT

The shaft of the femur is the easiest fetal long bone to visualize and measure. Femur length measurement was obtained from the greater trochanter to the lateral condyle. The head of the femur and the distal femoral epiphysis when present , was not included in the measurement. The measurement ends of the bone were blunt and not pointed. The fetal weight was calculated using the formula

$\log_{10}(EFW) = 1.4787 - 0.003343\,AC \times FL + 0.001837\,BPD^2 + 0.0458\,AC + 0.158FL$

Predicted estimated fetal weight by each method was compared with respective neonatal actual birth weight using electronic calibrated weighing machine in SAGAR hospital which showed the accurate birth weight. The difference was 50 gms and the same was added to arrive to the actual birth weight of the babies.

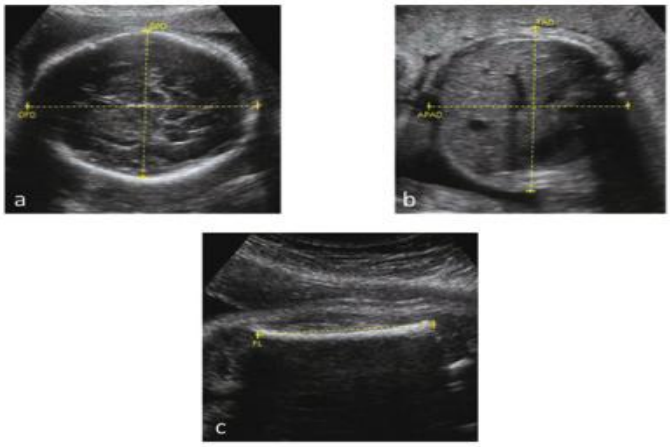

Figure 1 - Ultrasound images demonstrating the transverse section of the fetal head (A), abdomen (B) and femur length (C). Markers are placed depicting measurements of the biparietal (BPD), occipitofrontal (OFD), antero-posterior (APAD) and transverse abdominal (TAD) diameters and femur diaphysis length (FL).

RESULTS

Statistical analysis of the difference between calculated estimated fetal weight and actual birth weight was done in all methods using one way ANOVA for comparison of multiple groups where $P < 0.05$ is significant. Pearson's correlation coefficient to know if there is a significant relationship between estimated and actual birth weight for all the methods.

Birth weight estimation accuracy was compared with parity and age of the mother. The relative observations were recorded.

DISTRIBUTION OF CASES ACCORDING TO THE AGE

Mean age ± SD 28.52±2.60

Range 22-35yrs

The maternal age distribution was in the range of 22-35 years

Mean age ± SD being 28.52 years ± 2.60.

The maximum numbers of cases studied were in the age group 26-35 years closely followed by age group 31-35 years.

Table 1: Age Wise Distribution

Age Group in years	No. of Cases
≤ 20	0
21-25	10
26-30	73
31-35	17
Total	100

Distribution of Cases According To Actual Birth Weight

Mean B Wt.: ±SD 3083.78± 447.03

Range 2060 – 4020 gm.

The actual birth weight of babies was between 2060 gm – 4020 gm. The mean birth weight range was 3083± 447.03 gm.

The majority of babies were in the range of 3001-3500 gm

Table 2: Distribution Of Cases According To Actual Birth Weight

Birth weight group(grams) 1	No of cases
2001-2500	11
2501-3000	34
3001-3500	37
3501-4000	17
4001-4500	1
Total	100

Table 4: Mean Birth Weight By Different Methods

ANOVA- single factor F = 0.85, P > 0.01 Not significan

	Mean weight ±SD	Range
Actual birth weight	3083.78±447.03	2060-4020
AG X SFH	3028.63±399.80	2100-4010
USG	3079.94±370.05	2346-4000
Johnson's	3009.95±383.62	2000-4024

Clinically this much mean difference may not be significant but statistically it is significant. The mean actual birth weight was 3083.78±447.03 gm. The mean estimated birth weight by AG X SFH formula was3028.63±399.80. The mean estimated birth weight by Hadlock's formula was 3079.94±370.05. The mean estimated birth weight by Johnson's formula was 3009.95±383.62.

Table 2: Average Error And Percentage Error In Each Method

	AG X SFH	USG	Johnson's
Average error (gms)	310.06	291.50	323.50
% error	13.20%	12.01%	12.75%

ANOVA- single factor. F = 31.333, P < 0.05 Significant ,

NS : Not significant

All other comparisons are significant.

The average error in gms by AG x SFH formula was 310.06 gm and percentage error was 13.20%.

The average error in gms and percentage error for Hadlock's formula was 291.50 gm and 12.01% respectively.

The average error in gms and percentage error for Johnson's formula was 323.50 gms. and 12.75% respectively.

By one way ANOVA, F = 22.89, P <0.05 significant.

		Mean difference	P Value
Actual Wt – AGxSFH	3083.78-3029.63	55.15	> 0.05 NS
Actual Wt-USG	3083.78-3079	58.03	> 0.05NS
Actual Wt-johnsons	3083-3009.95	58.91	> 0.05NS

The difference between Hadlock's formula and AG x SFH formula is not statistically significant. Whereas the difference between Johnson's formulas compared with Hadlock's is statistically significant.

The average error in various fetal groups was least with Hadlock's formula closely followed by AG x SFH formula. The average error in various fetal groups was maximum with Johnson's formula.

Table 3: Mean Birth Weight By Different Methods

	Mean weight ±SD	Range
Actual birth weight	3083.78±447.03	2060-4020
AG X SFH	3028.63±399.80	2100-4010
USG	3079.94±370.05	2346-4000
Johnson's	3009.95±383.62	2000-4024

ANOVA- single factor F = 0.85, P > 0.01 Not significant

Table 3: Average Error In Various Fetal Weight Groups By Different Methods.

Methods	Birth Weight (gms)					
	2001-2500 n = 11	2501-3000 n= 34	3001-3500 n = 37	3501-4000 n = 17	4001-4500 n = 1	All cases n = 100
	Average error (gms)					
AGXSFH	749.69	733.09	463.67	510.09	671.89	480.803
USG	500	257.89	171.89	312.68	0	243.3976
Johnsons	343	355.55	305.55	371.19	574.39	335.436

Percentage Error By Different Methods (Table 3)

Using AG x SFH, formula prediction of birth weight in 73% of cases was within 10% of actual birth weight.

Using ultrasonography prediction of birth weight in 73% of cases was within 10% as compared to 56% by Johnson's formula

Table 3: Percentage Error Among Different Groups

Percentage error	AGXSFH	USG	Johnson's
Up to 5%	36%	35%	23%
Up to 10%	73%	73%	56%
Up to 15%	90%	88%	72%
Up to 20%	96%	93%	87%
Up to 25%	99%	97%	94%
Up to 30%	100%	99%	99%
Up to 35%		100%	98%
Up to 40%			100%

Table 9: Number of Cases with over and under Estimate of Birth Weight by Different Methods

Method	Over estimation No. of cases	Under estimation No. of cases	Total
AGXSFH	50	50	100
USG	30	70	100
Johnson's	40	60	100

The number of under and over estimation in all the fetal weight groups for all the methods was calculated. AG x SFH formula, Johnson's formula and Hadlock's formula had a tendency to under estimate the Fetal weight.In birth weight range of 3501-4000 gms all methods had a tendency to underestimate the fetal weight

Table 5 : Prediction of Birth weight by various methods and Standard Deviations of Predicted Error

Method	Pearson r	P Value	Estimating Actual Weight Equation	Standard deviation(gms)
AGXSFH	0.98	<0.01	B.Wt = 1.10 (AG x SFH) - 233.09	379.65
USG	0.86	<0.01	B.Wt = 1.04 (USG) - 124.04	389.33
Johnsons	0.93	<0.01	B.Wt = 1.08 (Johnson)- 168.47	430.04

* Pearson's correlation coefficient

<0.01= Significant

Results of the correlation analysis showed that There is a significant relationship between estimated and actual birth weight for all the methods.

The relationship was used to prelist the actual birth weight by using estimated fetal weight. Predicted birth weight using regression equation for each of the methods was presented in this table.

The standard deviation indicates how much variation can be expected in the predicted birth weight by each method. Less variation was found in AG x SF (± 379.65gm) followed AG x SFH by (±389.33) and highest variation in Johnson's.

DISCUSSION

It is routine obstetric practice to estimate fetal weight by measuring the symphysio-fundal height at each antenatal visit and to refer on for a sonographic estimation if it varies from the normal range for the gestation. Estimation of fetal weight by palpation of the abdomen is rarely done in clinical practice as we have come to rely heavily on ultrasonography, which is usually readily available.

Generally studies have shown that clinical estimates of fetal weight are atleast as accurate as ultrasound late in the third trimester and intra partum.The problem with reliance on ultrasound estimates of fetal weight is that it has inherent inaccuracies, with large intra- and inter observer variability.

Birth weight is a key variable affecting fetal and neonatal morbidity, Estimation of fetal weight is of paramount importance in the management of labor and delivery,

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 foetuses and multiple births. Comparing prospectively two clinical and two sonographic methods of predicting birth weight prior to induction of labor at term we found that clinical estimates appear to be at least as accurate as ultrasonographic ones.

However, ultrasound performs better at the most clinically relevant function of estimating fetal weight, i.e. predicting

the low or high-birth-weight fetus.Humphries et al. showed that the accuracies of birth weight estimation, both clinical and ultrasound, were still relatively low. Some studiesshowed the ultrasound EFW was the best method for EFW,

especially in preterm foetuses, but other studies, such as ours, did not conclude any gross difference between these

methods .Other studies have reported limited accuracy of ultrasound EFW at term, particularly in macrosomic fetuses.The advantage of using ultrasound for EFW has been questioned. Baum et al[1]. Concluded that ultrasound offered no advantage over clinical estimates of fetal weight at term. Our results are supported by previous studies that indicate that ultrasound EFW offers advantage over clinician's EFW when performed during late pregnancy or labour. An EFW should be recorded in the assessment of all patients who are at term and again when they are in labour, with full awareness of the limitations of the methods for making such estimates.

During last decade, estimated fetal weight has been incorporated into the standard routine antepartum evaluation of high risk pregnancies and deliveries. A lot of work has been done to find out accurate methods of estimation of fetal size and weight in utero. Accurate prediction of foetal weight has been of great interest in obstetrics. As foetal weight cannot be measured directly, it must be estimated from foetal and maternal anatomical characteristics. Many workers have used different methods to achieve this. Of the various methods, the most-commonly used are the clinical and ultrasonographic methods. Only a few studies have compared the accuracy of foetal weight by clinical and ultrasonic measurements.

Despite the differences in study design, our findings are in consonance with those reported by others that the accuracy of clinical estimation of birth-weight is similar if not better than that of ultrasonic estimation. The studies by Hendrix *et al*[2]. and Raman *et al.* showed that clinical estimation was significantly more accurate than sonographic prediction. Similar results as obtained by Sharma N *et al* [3]. and Titapant *et al* [4]. who observed that ultrasonic estimation was more accurate only when there is low birth-weight, but

in their own studies, both the methods underestimated birth-weight by more than 400g.Watson *et al.* found no significant difference between the two methods even at extremes of birth-weight at term. Furthermore, Nahum and Stanislaw found that the use of ultrasonography was generally no more accurate than prediction that is based solely on quantitative assessment of maternal and pregnancy specific characteristics.Johnstone *et al.* also found clinical

examination to be as predictive as ultrasound measurement in assessing foetal macrosomia in a diabetic population.

Chauhan *et al* [5]., in their comparison of accuracy of the two methods, observed no benefit in obtaining a sonographic estimate,because its accuracy is no better than that of the clinical method, except when there is low birth-weight (<2,500 g) when ultrasound yields a better prediction. They, however, concluded that an estimate of birth-weight is associated with a wide range of actual birth-weight, making obstetric decision based on such prediction to be likely associated with unnecessary intervention.

Our correlation coefficient for ultrasound estimation (0.74) is comparable with that of Uotila *et al.* in their comparison of ultrasonic estimation. Further studies are, however, necessary to improve the accuracy of foetal weight and to determine if estimationof foetal weight prediction near delivery actually improves outcome and how applicable these methods can be to situations that alter birth-weight such as premature rupture of membranes and obesity that were excluded in the present study.In the present study comparative evaluation of estimation of fetal weight in term pregnancy was done by various clinical methods and ultrasonography.

A study by Dawn et al[6] had included the clinical estimation by Dawn's formula, Dare et al [7] had included clinical estimation by Insler's formula for estimation of fetal weight.All other studies included various clinical and ultrasonographic methods of fetal weight estimation. In the present study both clinical and ultrasonographic methods of fetal weight estimation were included. Inclusion and exclusion criteria were similar to Bhandary Amritha et al[8].

Comparison of Methods Used For Fetal Weight Estimation:

Studies	Methods	
	Clinical	Ultrasonography
Shripad Hebbar et al11	-	+
Sherman et al10	+	+
Titapant et al 4	+	+
Dawn et al 6	+	-
Dare et al 7	+	-
Bhandary Amritha et al 8	+	+
A.S. Shittu et al12	+	+
Tiwari et al 9	+	+
Hebbar Shripad	+	+
Present study 2011	-	+

The mean maternal age (in years) in present study was year 28.52.The maximum numbers of cases studied were in the age group 26-30 years.The total number of primigravida was 58 and multigravida was 42.The actual birth weight of babies was between 2060 gm – 4020 gm. The mean birth weight range was 3059 ± 403.34 gm.The majority of babies were in the range of 3000-4000 gm.Three measures of accuracy were used in our statistical analysis in the number of estimates within ±10% of actual birth weight, mean percentage error, and mean average error. Interestingly, the mean percentage error can be misleading because it is the sum of positive and negative deviations from actual birth weight, thus artificially reducing the difference between actual birth weight and estimated birth weight. It is a measure of systematic error in each method and not variation from birth weight. Dare et al[7] found a percentage error between the actual and estimated weight to be 20.1% by AG x SFH method.In the present study the percentage error was 12.01 % for USG method.

Bhandary Amritha et al[8] found the average error in various fetal weight groups by AG x SFH was 224.37 gms which was least when compared to other methods. It was 299.11 gms by Hadlock's method and higher for the other two methods.

In present study the average error is 291.50gms, it was least by Hadlock's and by AG x SFH method it was 310.06gm.The difference in average error between Hadlock's formula and AG x SFH is not statistically significant.Average error in birth weight range of 3001-3500 gm was least with Hadlock's 171.98gm.While the average error in birth weight range 2001-2500 gm was least with Johnson's 343gm.Tiwari and Sood[9] in their study showed an average error of 364.96 gm, 224.82 gm 327.28 grams and 198.6 gms by applying clinical method (abdominal palpation for clinical assessment of fetal weight), Dawn's, Johnson's and Warsof's ultrasound method respectively. Bhandary Amritha et al[8] reported that maximum error was least by AG x SFH (i.e. 534.2gm) and maximum by Dawn's formula (i.e., 915.8gm). Present study showed similar results with maximum error being least by USG. Sherman et al[10] reported that rates of estimates within 10% of birth weight were not statistically significant in clinical and USG method (72% and 69% respectively)

Bhandary Amritha et al[8] reported that rates of estimates within10% of birth weights was not statistically

significant in AG x SFH method and USG method (67% and 62% respectively).In present study clinical estimation by AG x SFH (Insler's formula) and USG method are equally good for estimation of birth weight within 10% and the difference is not statistically significant. The major finding from this study is that ultrasonographic estimation of foetal weight is as accurate as the clinical method of estimation within the normal birth weight range.Although, while, our ultrasonic method underestimated, the clinical method overestimated fetal weight.

Studies	AG x SFH	USG	Johnson	Dawn's
Sherman et al10	72% (by abdominal palpation)	69%	-	-
Bhandary Amritha et al 8	67%	62%	41%	32.5%
Shittu et al12	70%	68%	-	-
Present study	73 %	73%	56%	-

Observation from this study implies that there is clearly a role for ultrasonic estimation of birth weight as a diagnostic tool, suggesting that ultrasonic estimation is sufficient to manage labour and delivery in a term pregnancy. The role for ultrasonographic estimation appears that, when clinically estimated weight suggests weight less than < 2500 g, subsequent sonographic estimation would yield a better prediction and would be further necessary to assess such fetuses for congenital malformation, presentation, placental location ,station and to do the biophysical profile to determine the well-being of the fetus.

The above findings have important implication for developed countries but in developing countries like ours where there is lack of technologically advanced ultrasound machines capable of doing sophisticated functions such as foetal weight but has an experienced clinician who could perform this function equally well.

Further studies are, however, necessary to improve the accuracy of foetal weight and to determine if estimation of foetal weight prediction near delivery actually improves outcome and how applicable these methods can be in situations that alter birth weight such as obesity that excluded in the present study.

CONCLUSION

An EFW should be recorded in the assessment of all patients who are at term and again when they are in labour, with full awareness of the limitations of the methods for making such estimates.

Estimation of birth weight clearly has a role in management of labour and delivery in a term pregnancy.of the three clinical formulae studied, USG (Hadlock's formula) has better predictable results in fetal weight estimation, compared to other two formulae. A modern method for assessing fetal weight involves the use of fetal measurements obtained by ultrasonography. The advantage of this technique is that it relies on linear and/or planar measurement of in-utero fetal dimensions that are definable objectively and should be reproducible. Early expectation that this method might provide an objective standard for identifying fetuses of abnormal size for gestational age was recently undermined by prospective studies that showed sonographic estimates of fetal weight to be no better than clinical estimation of fetal weight.

Several technical limitations of the sonographic method are maternal obesity, oligohydramnios and anterior placentation. It also requires costly sonographic equipment and specially trained personnel. Thus, based on this study, hadlock's formula can be of great value in developed countries.The problem with reliance on ultrasound estimates of fetal weight is that it has inherent inaccuracies, with large intra and inter observer variability. But in developing country like ours, where ultrasound is not available in many health care delivery systems specially in periphery AG x SFH is easy, cost effective, simple and can be used even by midwives.

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