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Original Article

Comparison of Various Methods for Assessing Estimated Fetal Weight

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Abstract

Introduction: Accurate estimation of fetal weight (EFW) is of paramount importance in the management of labor and in predicting the baby's survival outside the uterus. The perinatal and maternal outcomes grossly depend on the fetal weight at term gestation and management of diabetic and post-cesarean pregnancies is greatly influenced by the accurate EFW.

Aim: This study aims to compare various methods used to assess EFW at term pregnancy.

Materials and Methods: A prospective comparative study was carried out at Sree Balaji Medical College and Hospital, Chromepet, from August 2018 to February 2020. The formulas used in this study are Johnson's formula, Dare's formula, and Hadlock-4 formula using ultrasound (USG).

Results: Analysis show that USG was relatively effective in anticipating weight at birth and was found to be effective by 2% over Dare's formula and nearly 4% by Johnson's formula. Dare's formula is the better predictor of low birth weight (LBW) with the maximum area under the curve among the three methods. The cutoff values for predicting LBW using Dare's formula, USG, and Johnson's formula were 2607 g, 2740 g, and 2867.5 g, respectively.

Conclusion: This study concluded that antenatal fetal weight could be estimated with considerable exactness using Dare's and Hadlock's formulas. However, the accuracy of Johnson's formula was less than Dare's formula and Hadlock's formula (ultrasonography).

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

INTRODUCTION

Birth weight is the main determining factor for the survival of a newborn. Obstetricians should have a conception regarding estimation of fetal weight (EFW) to decide on the mode and place of delivery to optimize the neonatal outcome. Both excessive and low birth weights (LBWs) are associated with an increased risk of maternal and neonatal complications during labor and puerperium. This study compares EFW using different formulas (clinical and ultrasonological) with actual weight at birth, which is in use over a long time.[1]

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Over the past decade, EFW has been incorporated in the standard routine antepartum evaluation of high-risk pregnancies and deliveries. For example, management of diabetes complicating pregnancy, vaginal birth after cesarean section, and vaginal breech delivery will be greatly swayed by EFW.[2]

Accurate evaluation of fetal weight is important in preventing problems of prematurity, fetopelvic disproportion, labor induction in high-risk pregnancies, and to detect IUGR. Ultrasonography has transformed obstetrics by its application in fetal medicine as a good medium for estimating birth weight and gestational age (GA). However, clinical examinations and measurements have a place.[3]

As per the existing literature, there is no truly exact technique to evaluate fetal weight. Until the 1980s, clinical methods (abdominal palpation and pelvimetry) were used to EFW. The advent of ultrasonography and its widespread

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use over the past 3 decades made a belief that ultrasound (USG) is more reliable than other methods.[4]

Precise assessment of fetal weight will be used in planning mode delivery, level of hospital care, and survival of the newborn.

Aim

This study aims to compare various methods used to assess EFW at term pregnancy.

MATERIALS AND METHODS

A prospective comparative study was carried out at Sree Balaji Medical College and Hospital, Chromepet.

Inclusion Criteria

- Pregnant women admitted at term (37 completed weeks–40 weeks) for planned delivery either by cesarean section or by labor induction
- Singleton pregnancy, with GA, confirmed by dates and ultrasonography done before 22 weeks.

Exclusion Criteria

The following criteria were excluded from the study:

- Multifetal gestation
- Polyhydramnios/oligohydramnios
- Abnormal lie
- Preterm labor
- Fetal malformations
- Antepartum hemorrhage
- Eclampsia
- Obese patients (body mass index >30)
- Fibroid/ovarian tumors complicating pregnancy.

Two hundred cases of randomly selected term pregnancies were included in the study.

Clinical Formulas

Dare's formula

Fetal weight (g) = SFH (cm) × AG (cm)

Johnson's formula

EFW (g) = (Mac Donald's measurement-×)*155; × = 13 when presenting part is not engaged; × = 12 when presenting part is at "0" station; × = 11 when presenting part is at "+1" station

Ultrasonography: Hadlock's formula

With the patient's consent, she was asked to empty her bladder and lie in a supine position with her knees semi-flexed. On palpating per abdominally, the fundus of the uterus was marked by the left index and middle finger. With the help of a flexible non-elastic, standard sewing tape, the distance from the middle of the upper border of the symphysis pubis to the marking on the fundus was measured to give symphysial fundal height (SFH) or MacDonald's measurement in cm. Measurement was made using the tape reverse side up to forestall any bias.

Similarly, abdominal girth (AG) was measured at the umbilical level without applying unnecessary strain to fix the tape all over the abdomen to give AG in cm. Cervical changes (dilatation, effacement, and position of the cervix) and the magnitude of descent of the presenting part into the maternal pelvis are assessed by pelvic examination.

"Station is minus if the lower part of the presenting part is above the ischial spine. The station is zero when the presenting part is at the level of the ischial spine. The station is plus when the presenting part is beneath the ischial spine." Both the SFH and AG and station of presenting part were recorded on the individual pro forma sheet and then used to ascertain EFW by the formulas suggested by Johnson and Toshach and Dare *et al*.

Hadlock's USG formula

Measurement of abdominal circumference (AC)

AC was measured in a plane perpendicular to the long axis of the fetus's spine, which contains a profile of a portion of the umbilical part of the umbilical vein as its enter the substance of the fetal liver. This reference plane is caudal, to the plane that includes the fetal heart and cephalad to plane, which includes the upper poles ofthe kidneys. In addition, two perpendicular diameters are made from the outer to outer margin of the fetal abdomen since subcutaneous tissue is added in the measurements.

AC is calculated from the formula:
AC = (D1 + D2) * 1.57414. D1 – Anterior-posterior distance across. D2 – Traverse diameter

Measurement of borderline personality disorder (BPD)

BPD is calibrated from the outer margin of the proximal skull to the inner margin of the distal skull (outer to the inner table). The biparietal diameter was measured at cavum septum pellucidum and the thalamo basal complex. In the equivalent plane, the lateral panel of the anterior horn of the lateral ventricle is seen lateral and anterior to cavum septum pellucidum and MCA, pulsating at the level of the insula, which is seen lateral and posterior to cavum septum pellucidum. The shape of the fetal head obtained at this section was oval and symmetrical.

Measurement of head circumference (HC)

HC is the primary measurement of fetal head growth and is more shape independent than the BPD. The measurement is made from the same axial image used to calibrate BPD. Therefore, a reliable HC estimate was calibrated using the shortest and longest axis of fetal head measured outer to outer calipers, with following formula; HC = (D1+D2)*1.57. D1 – Anterior-posterior diameter. D2 – Transverse diameter.

Measurement of femur length (FL)

Considering its size and ease of measurement, femur length is generally preferred over other long bones. FL is calibrated with the transducer aligned along the longitudinal axis of the bone with the beam exactly 90°to the shaft. The measurement of femur length is from the greater trochanter to the lateral condyle of the femur. The head of the femur is not included. The average growth of FL is slightly <2 mm/week.

These three variables were applied to Hadlock formula:

Log10 BW = 1.5662 0.108 (HC) + 0.0468 (AC) + 0.1719 (FL) + 0.00034 (HC) 2–0.003685 (AC*FL)

Where AC=Abdominal circumference. FL=Femur length. HC=Head circumference. BW=Birth weight.

Patients were followed up to delivery. Soon after the delivery, the baby is weighed and the weight is noted. Then, using the clinical and USG formulas, a comparative analysis was done with the actual birth weight of the baby. Statistical work was performed using Chi-square test and Pearson's correlation. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 200 pregnant women were included in the study. The mean age of the participants was 26.1 (2.1) years, with a minimum of 19 years and a maximum of 30 years. More than half (56.5%) of the pregnant women were primigravida. Period of gestation was 38–39 weeks in 42.5% of the participants followed by 39–40 weeks which was observed in 30.5% of the participant [Table 1].

The mean expected weight was 2678.6 ± 373.9 g, 2771.4 ± 345.5 g, and 756.5 ± 429.9 g by Dare's formula, Johnson's formula, and USG, respectively [Table 2].

There was a very strong positive correlation between the expected fetal weight estimated by Dare's formula and the newborn's birth weight (r = 0.829; $P < 0.001$) [Figure 1].

Table 1: Distribution of patients characteristics

Variables	Frequency (*n*)	Percentage
Age group (years)		
15–20	3	1.50
21–25	73	36.50
26–30	124	62.00
Parity		
Primi	113	56.50
Multi	87	43.50
Period of gestation (weeks)		
37–38	32	16.00
38–39	85	42.50
39–40	61	30.50
40–41	22	11.00

Table 2: Comparison of EFWs of various methods with actual birth weight

Variables	Dare's formula (g)	Johnson's formula (g)	USG (g)	Actual birth weight (g)
Mean±SD	2678.6±373.9	2771.4±345.5	2756.5±429.9	2594.9±369.7
Median (IQR)	2717 (2460–2944)	2790 (2635–2945)	2780 (2460–3100)	2600 (2300–2800)
Minimum	1316	1240	1440	1400
Maximum	3468	3565	3710	3500

EFWs: Estimation of fetal weights, USG: Ultrasound

Table 3: Mean simple error, mean absolute error, and the mean absolute error percentage between the different methods

Variables	Simple error (g) (Mean±SD)	Absolute error (g) (Mean±SD)	Absolute error percentage (Mean±SE)
Dare's formula	83.6±217.8	189.6±135.4	9.4±0.34
Johnson's formula	176.5±279.1	275.5±181.2	11.3±0.61
USG	161.6±217.4	243.1±118.8	7.5±0.39

Table 4: Absolute error percentage related to various methods

Absolute error percentage	Dare's formula *n* (%)	Johnson's formula *n* (%)	USG *n* (%)
≤10	133 (66.5)	109 (54.5)	112 (56.0)
11–15	47 (23.5)	32 (16.0)	66 (33.0)
>15	20 (10.0)	59 (29.5)	22 (11.0)

USG: Ultrasound

Table 5: AUC of different methods in predicting LBW

Method	AUC	95% CI	*P*-value	Cutoff value (grams)	Sensitivity	Specificity
Dare's formula	0.948	0.921–0.975	<0.001	2607	83.7	90.4
Ultrasound	0.938	0.905–0.971	<0.001	2740	94.2	89.5
Johnson's formula	0.846	0.793–0.898	<0.001	2867.5	88.4	64.9

LBW: Low birth weight, AUC: Area under the curve

There was a strong positive correlation between the expected fetal weight estimated by Johnson's formula and the newborn's birth weight (r = 0.697; $P < 0.001$) [Figure 2].

There was a very strong positive correlation between the expected fetal weight estimated by USG and the newborn's birth weight (r = 0.863; $P < 0.001$) [Figure 3].

The mean accuracy of Dare's formula, Johnson's formula, and USG had a mean absolute error percentage of 9.4%, 11.3%, and 7.5%, respectively. Thus, it shows that USG was relatively effective in predicting the birth weight and it was found to be effective by 2% over Dare's formula and nearly 4% by Johnson's formula [Table 3].

Estimations with the error of <10% of absolute birth weight were most with Dare's formula (66.5%) followed by USG (56.0%). On the other hand, Johnson's formula had the least number of such cases (54.5%). Similarly, an error of >15% was more with Johnson's formula (29.5%) [Table 4].

The absolute error percentage for Johnson's formula to detect LBW was significantly higher when compared to other methods. However, there was no difference in the error plots for normal weight babies [Figure 4].

The three methods were good in predicting the LBW of the newborn and it was found to be statistically significant ($P <$ 0.001). However, Dare's formula was found to be a better predictor of LBW with the maximum AUC among the three methods. The cutoff values for predicting LBW using Dare's formula, USG, and Johnson's formula were 2607 g, 2740 g, and 2867.5 g, respectively [Table 5 and Figure 5].

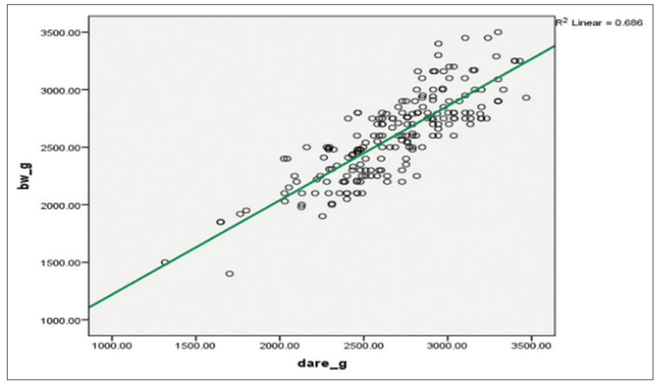

Figure 1: Correlation between the estimated fetal weight by Dare's formula and actual birth weight of the baby

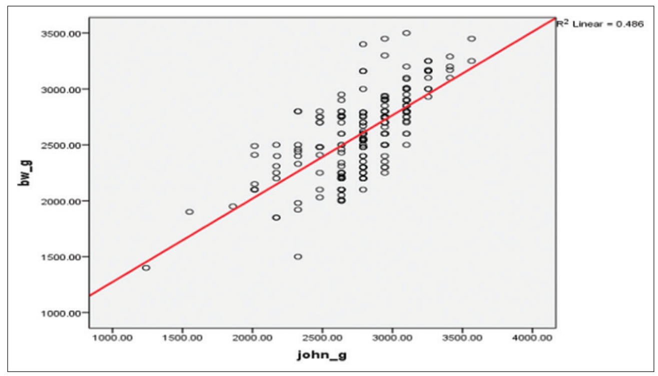

Figure 2: Correlation between the estimation of fetal weight by Johnson's formula and the birth weight of the baby

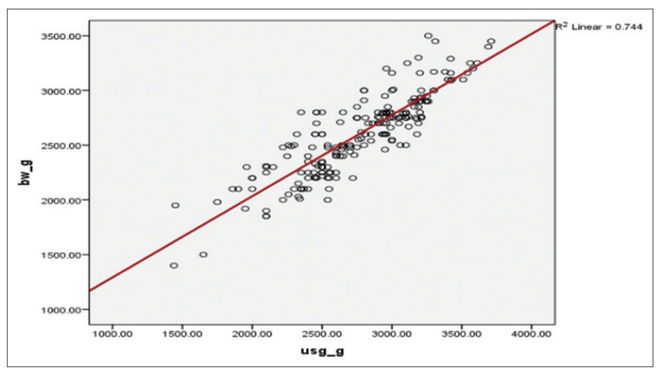

Figure 3: Correlation between the estimation of fetal weight by Hadlock's formula and the birth weight of the baby

DISCUSSION

The exact prediction of the weight of a fetus is of great interest in obstetrics. As *in utero* fetal weight cannot be measured directly, during the antenatal period, it is assessed using fetal and maternal anatomical features. Antenatal estimation of the weight of the fetus is one of the vital components in deciding the mode of delivery, and also their measurement is more useful, especially in breech presentation and macrosomic babies.[5] Clinicians frequently assess fetal weight when examining parturient at term. This helps predict CPD when labor progress is poor or gives early warning of possible shoulder dystocia.[6] In experienced hands, intrapartum clinical EFW is as good as USG-based predictions. "Mean birth weight of the babies in the study was 2.65 ± 0.35 kg which was lesser when compared to the studies conducted by Torloni *et al.* (2008).[7] 3.36 ± 0.54 kg. This is due to the maximum number of distribution of study population among 2500–3000 g."

In their publication in 1954, Johnsons and Toshachreported that of 200 cases, 68% of birth weight was within 353 g.[8] In our study, on using the same formula, 70% of the estimates were within this range, similar to the original study. In 1990, Dare *et al.* proposed a simpler formula for clinical EFW, which consisted of multiplying

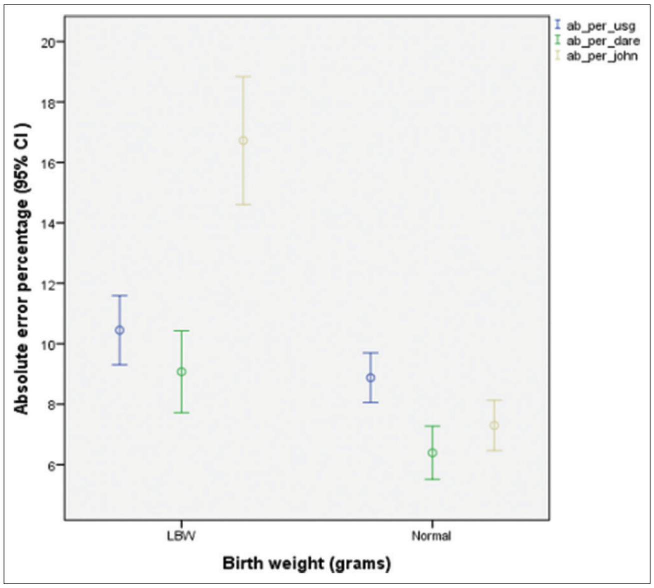

Figure 4: Absolute error percentage between different methods for predicting low birth weight

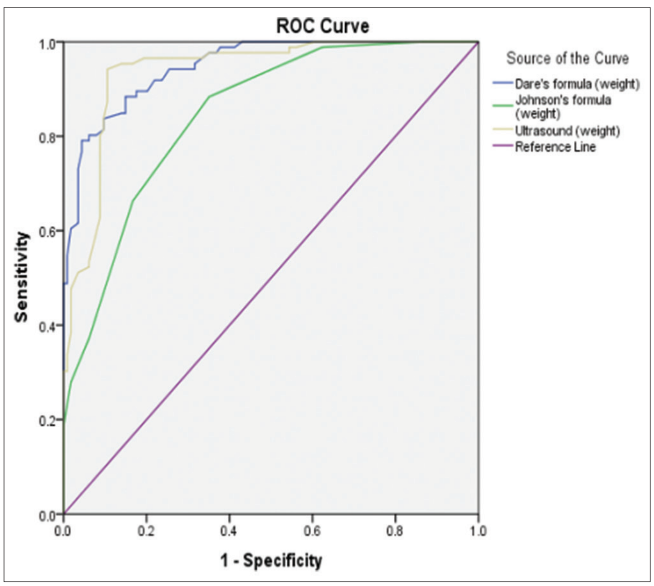

Figure 5: Receiver operator characteristic curve: Efficacy of different methods in predicting low birth weight

SFH × AG. In their original paper, Dare *et al*. applied this method on 498 full-term patients and obtained a strong correlation with the clinical estimates and actual birth weight (r = 0.742).[9] In our study, the correlation coefficient of Dare's formula was r = 0.82 of Johnson's formula (r = 0.69) and USG (r = 0.863). Dare's formula is a bit accurate, but Hadlock's formula has more accuracy when compared to other formulas, which is statistically significant.

In our country, India, clinical EFW will be more useful, which reduces the economic burden due to injudicious usage of sonographic investigations and should be limited only to cases with other indications.[10]

The mean absolute % error reflects the variability noted regardless of their direction and, as such, is a much more accurate predictor of differences from actual birth weight. Hence, the variation between predicted birth weight and real birth weight is best expressed by mean absolute percentage error for practical purposes. In our study, the mean absolute % error is 9.4 ± 0.34, 11.3 ± 0.61, and 7.5 ± 0.39 for Dare's formula, Johnson's formula, and USG-Hadlock's formula, respectively, which clearly shows that USG formula is more accurate in EFW. Comparing correlation coefficient for several methods in our study with the actual birth weight was 0.82, 0.697, and 0.863 for Dare's formula, Johnson's formula, and USG-Hadlock's formula, respectively. This, in consonance with several investigators, Dare's formula is the best for estimating weight in reference birthweight range of 2.5 kg–<3 kg and that below 1.9 kg Dare's formula is the best alternative for a low-resource setting.

When the clinical method is compared with USG for estimating the LBW babies alone, it is evident that Dare's formula was a better predictor of LBW with maximum AUC among the three methods.

CONCLUSION

This study concluded that antenatal fetal weight could be estimated with considerable exactness using Dare's and Hadlock's formulas. However, the accuracy of Johnson's formula was less than Dare's formula and Hadlock's formula (ultrasonography).

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