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Original Research Article

Comparative Study between Clinical Methods and Ultrasound Examination in the Estimation of Fetal Weight

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ABSTRACT

Introduction: Fetal weight estimation is considered one of the most significant criteria for perinatal mortality and morbidity assessment. It is very important for the prevention of prematurity, evaluation of pelvic disproportion before induction of labor and detection of labor and detection of intrauterine growth restriction. For estimation of fetal growth, two different routine methods are commonly used clinical examination and ultrasonography.
Materials and methods: The study was performed to determine the fetal weight in term pregnancy using abdominal girth x symphysis fundal height (Insler's formula), Johnson's formula and Hadlock's formula using ultrasonography. All the measurements were taken and the results were compared to the actual birth weight.
Results: Out of 200 participants, 98 underwent full term vaginal delivery (FTND) and 102 participants underwent lower segment cesarean section (LSCS) which was reported to be high in the present study i.e. 51%. The mean birth weights by two methods symphysis-fundal height * Abdominal girth (AG) and actual birth weight were statistically insignificant in the present study. It was also found that, the mean birth weights by Johnson's formula and Hadlock's formula with actual birth weight are statistically significant.
Conclusion: Of the three clinical formula's studied; Insler's formula has better predictable results in fetal weight estimation, compared to Johnson's and Hadlock's formula. Clinical estimation of birth weight clearly has a role in management of labor and delivery in a term pregnancy. It was concluded from the study was sonographic examination is more accurate in assessing fetal growth and estimating fetal weight than clinical examination.

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

INTRODUCTION

The perinatal and maternal outcome grossly depends upon the fetal weight at term gestation. Fetal weight in conjunction with gestational age is an important indicator of pregnancy outcome. Accurate estimation of fetal weight is of paramount importance in the management of labor and delivery. During the last decade, estimated fetal weight has been incorporated into standard routine antepartum evaluation of high-risk pregnancies and deliveries. Also,

when dealing with anticipated preterm delivery, perinatal counseling on the likelihood of survival, the intervention to be undertaken to postpone preterm delivery, optimal route of delivery, or the level of hospital where delivery should occur may be based wholly or in part on the estimation of expected birth weight. [1-3] Categorization of fetal weight into either small or large for gestational age may lead to timed obstetric interventions that collectively represent a significant departure from routine antenatal care. As far as the independent extra uterine existence and optimum survival of the fetus is concerned, undoubtedly, birth weight is considered one of the most significant criteria for perinatal mortality and morbidity assessment. It is very important for the prevention of prematurity, evaluation of pelvic disproportion before induction of labor and detection of labor and detection of intrauterine growth restriction. [4,5]

The fetus had been virtually inaccessible to the observation until the development of diagnostic ultrasound. The main difficulty in assessing fetal growth is inaccessibility of the fetus to the outside world. Generally for measuring the fetal growth two different routine methods are commonly used clinical examination and ultrasonography. Low cost clinical methods for measuring fetal growth are worth considering for estimation of fetal weight in primary health centers or centers where ultrasonography machines are not available. The clinical examination of fetal weight involves measurement of symphysis-fundal height and abdominal girth at the level of the umbilicus. Ultrasonography involves measurement of multiple fetal biometric parameters, after which fetal weight is computed by the ultrasound scanner using a regression algorithm. But ultrasonography has proven itself to be simple, important and non-invasive diagnostic tool to measure fetal weight. The ultrasound method is, however believed to be more accurate than the clinical method, hence >20% of all pregnant women now undergo a third-trimester ultrasound examination specifically for the assessment of fetal growth and fetal weight estimation. [6,7]

The main objective of the present study, is to assess the fetal weight in term pregnancy by using clinical assessment methods and ultrasonography and to compare evaluation methods after knowing the actual birth weight of the baby.

METHODOLOGY

This study was conducted with a total sample size of 200 mothers who fulfilled the inclusion criteria. It is a prospective study conducted by the Dept. of Radio diagnosis in collaboration with Dept. of Obstetrics and Gynecology, GIMSR, Visakhapatnam during the period March 2016 to August 2017. These mothers were selected from antenatal and maternity wards, which had their last USG done within one week prior to delivery. The mothers were explained about the ethical consideration of the study and were asked to sign the consent form once they understood the contents completely and if the age is less than 18years, consent was taken from the parents/guardian. The study was performed to determine the fetal weight in term pregnancy using abdominal girth x symphysis fundal height (Insler's formula), Johnson's formula and Hadlock's formula using ultrasonography. [8,9] All the measurements were taken and the results were compared to the actual birth weight. Approval of the institutional ethics committee was sought.

Inclusion criteria:

- Patients with term pregnancy
- Singleton pregnancy
- USG EFW within a week prior to delivery
- Cephalic presentation

Exclusion criteria:

- Patients with multiple gestations
- Malpresentations
- Poly or oligohydramnios
- Fibroids or adenexal masses
- Known fetal malformations

- Obesity

Procedure: Mothers included in the study were from all the socioeconomic classes. Detailed obstetric and menstrual history was taken for the correct duration of gestational age, which was calculated by Naegele's rule or by first trimester USG report. Mothers in whom delivery was anticipated within1 week were included in the study. And those who did not deliver within 1 week of fetal estimation were excluded from the study. Significant antenatal history such as history of antepartum hemorrhage, hypertensive disorders, diabetes mellitus, cardiac disease, anemia and tuberculosis were noted.

Fetal weight estimation by was done by using Insler's formula:

After emptying the bladder, the patient made to lie in supine with legs flat on the bed i.e. extended both at hip and knee. The abdominal girth was measured at the umbilicus and expressed in cms. After correction of dextrorotation, McDonald's measurement of the of the height of the fundus from the upper edge of the symphysis pubis following the curvature of the abdomen was taken with a centimeter tape the upper hand was placed firmly on top of the fundus, with the measuring tape pressing between the index and middle finger readings were taken from perpendicular intersection of the of the tape with the fingers. The measurement was made using the tape reverse side up so as tom forestall any bias.

Abdominal girth or AG x symphysis fundal height or SFH (Insler's formula) and EFW (weight in grams) = AG (cms) x SFH (cms)

Fetal weight estimation by simplified Johnson's formula:

As mentioned in the previous method McDonald's measurement of the Symphysis fundal height is done, which is the distance from height of fundus to the upper edge of the pubic symphysis. Station of presenting part was assessed by abdominal examination. Fetal weight was estimated by as follows:

Table 1: Fetal weight estimation by simplified Johnson's formula

Fetal weight (in gms.) = (McDonald's Measurement - X) x 155
Where'X' denotes the station of head
X=13, when presenting part is at 'minus' station
X=12, when presenting part is at '0' station
X=11, when presenting part is at ' plus' station

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).After biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL) were measured in centimeters, the sonography machine calculated fetal by Hadlock's formula.BPD diameter is measured using real time scanner; linear array Dynamic imaging equipment yields the most accurate results of BPD measurement.

Log10 (EFW) = 1.4787 - 0.003343 AC x FL + 0.001837 BPD2 + 0.458 AC + 0.158 FL

The following criteria should be met while obtaining the BPD measurement. Skull tables should be symmetrically opposed and of equal thickness creating an oval shape. There should be a midline echogenic falxcerebri. The third ventricle, thalamus and middle cerebral arteries should be seen. It should be lie parallel to and slightly above the canthomeatal line. The BPD IS difficult to obtain when the head is engaged or high floating and in breech presentation with an anterior placenta overlapping it. The relationship between BPD and gestational age is given as: Gestational age (weeks) = (BPD^2) +2, upto 5 completed months= BPD x 4 +2, after 5 completed months.

Table2:Accuracy of prediction of gestational age by BPD

Gestational age (weeks)	Variation in gestational age (days)
16	± 7
17 – 26	± 10 – 11
2 28	± 14
29 – 40	± 21

The standard error in measurement of the BPD is 2 to 3mm and the rate of growth of BPD begins to fall off slightly less than 2mm /wk in the last trimester of

pregnancy. Hence the accuracy of prediction of the gestational age from BPD falls with increasing gestational age. Cephalic index is a stringent criterion for accurate measurement of the BPD. It is calculated by the following formula:

Cephalic index = BPD /Occipitofrontal diameter x 100

Cephalic index remains constant throughout the pregnancy and thus can be used to check the accuracy of BPD measurement. Femur length: Femur is the easiest fetal bone to measure, useful in the assessment of gestational age. The method is however useful when the BPD can't be obtained when deeply engaged or high floating head anencephaly, collapse of the cranial bones. The average growth of the femur is slightly less than 2mm/wk. Femur length measurement was obtained from greater trochanter to the lateral condyle. The head of the femur and distal femoral epiphysis, when present are not included in the measurement. The measured ends of the bone should be blunt and not pointed. Abdominal circumference (AC)is the outer margin of the abdominal circumference is outlined and the starting point is marked. The measurement of the fetal abdominal circumference was made from the axial image of the fetal abdomen at the level of the liver. In some cases, when the shape of the abdomen is distorted because of uterine factors (oligohydramnios, narrow maternal anteroposterior diameter, myometrial contraction), the circumference was traced directly with a map measurer or electronic digitizer. A major land mark of this section is the umbilical portion of the left portal vein deep in the liver, with fetal stomach serving as the secondary land mark. Though the 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 and the circumference than equaled (D1 +D2) x 1.57.

Great care was taken to ensure that the image was not inclined side to side or front to back. Excessive pressure with the transducer was avoided as it would distort the shape of the abdomen. The radiologist had no prior knowledge of the clinical estimate of the fetal weight. All the three estimates were documented into a chart. After delivery, the new born babies were weighed within 30mins of delivery on an electronic weighing scale and documented as well.

Statistical analysis: The results were analysed using SPPS software version no. 16, paired and unpaired t-test, Karl Pearson's correlation coefficient and One-way ANOVA tests. Karl Pearson's correlation coefficient was used to know there is a significant correlation between estimated and actual birth weight for all the methods.

Table 3: Fetal measurements at various gestational ages

Gestational age (weeks)	BPD (mm)	HC (mm)	AC (mm)	FL (mm)
14	2.8	9.6	8.1	1.6
16	3.6	12.4	10.5	2.2
18	4.2	15.0	12.8	2.8
20	4.8	17.4	15.1	3.5
22	5.4	19.8	17.3	4.0
24	6.1	22.0	19.5	4.4
26	6.7	24.0	21.6	4.8
28	7.2	25.9	23.7	5.3
30	7.8	27.7	25.8	5.7
31	8.0	28.6	26.8	6.0
32	8.2	29.4	27.8	6.2
33	8.5	30.1	28.7	6.4
34	8.7	30.9	29.7	6.6
35	8.8	31.5	30.7	6.8
36	9.0	32.2	31.6	7.1
37	9.2	32.8	32.5	7.3
38	9.3	33.4	33.4	7.5
39	9.4	34.0	34.4	7.7
40	9.5	34.4	35.2	8.0

RESULTS

The maternal age distribution was in the range of 17-31Y and the maximum number of cases were reported in the age group of 21-30 Y. Out of 200 participants, 98 underwent full term vaginal delivery (FTND) and 102 participants underwent lower segment cesarean section (LSCS) which was reported to be high in the present study i.e. 51%.

From the Table-6 it was found that, the mean birth weights by two methods

symphysis-fundal height * Abdominal girth (AG) and actual birth weight were statistically insignificant (p=0.06) in the present study. From the Table-7 it was found that, the mean birth weights by Johnson's formula and actual birth weight were statistically significant (p=0.00005). Table-8 showed that, the measurement of birth weight by Hadlock's formula and actual birth weight are statistically significant (p=0.00001). By comparing the birth weight of symphysiofundal height * Abdominal girth (AG) method and Johnson's formula the results are statistically significant (p=0.000) and the mean difference was -337.14.On the other hand, by comparing the birth weight of symphysiofundal height * Abdominal girth (AG) method and Hadlock's formula the results are statistically insignificant (p=0.104) and the mean difference was -44.126. However comparing the results of birth weight determination by Johnson's formula and Hadlock's formula showed statistically significant ((p=0.00005). Since the p values were less than 0.05 by all the three methods they were statistically significant (Table-9). The correlation between symphysiofundal height* AG, Johnson's and Hadlock's formula methods with actual birth weight showed positive correlation and statistically significant (Table-10). By comparing the mean differences of various methods, the results were statistically significant except the actual birth weight with symphysiofundal height* AG were statistically insignificant (Table-11). By observing the average errors of birth weight determination (Figure-1) by various methods, the error rate is quite high with Johnson's formula method and low with symphysiofundal height* AG method (Table-12, Table-13).

Table 4: Distribution of participants by age groups

Age groups (Years)	No. of participants	% of participants
≤ 20	63	31.5
21-30	136	68.0
31 +	1	5.0
Total	200	100.0
Mean age	21.84	
Standard deviation	2.298	

Table 5: Distribution of participants by outcome

Outcome	No. of participants	% of participants
FTND	98	49.0
LSCS	102	51.0
Total	200	100.0

Table 6: Comparison of Symphysio-fundal height * AG and Actual birth weight by paired t test

Procedure	Mean	Mean difference	N	SD	SE	p-value
Symphysio-fundal height * AG	2959.01		200	331.490	23.44	
Actual birth weight	2902.89	56.12	200	412.275	29.15	0.06

Table 7: Comparison of Johnson's formula and Actual birth weight

Procedure	Mean	Mean difference	N	SD	SE	p-value
Johnson's formula	3296.15		200	404.252	28.58	
Actual birth weight	2902.89	393.26	200	412.275	29.15	0.00005

Table 8: Comparison of Hadlock's formula and Actual birth weight

Procedure	Mean	Mean difference	N	SD	SE	p-value
Hadlock's formula	3003.14		200	384.897	27.21	
Actual birth weight	2902.89	100.245	200	412.275	29.15	0.00001

Table 9: correlation between actual birth weight with others by Karl Pearson's correlation coefficient method

Actual birth weight	r value	symphysiofundal height * (AG)	Johnson's formula	Hadlock's formula
		0.379	0.351	0.701
	p value	0.000	0.000	0.000
	N	200	200	200

Table 10: correlation between symphysiofundal height * (AG) with Johnson's and Hadlock's formula and actual birth weight (ABW) by Karl Pearson's correlation coefficient method

symphysiofundal height * (AG)	r value	Johnson's formula	Hadlock's formula	ABW
		0.816	0439	0.379
	p value	0.000	0.000	0.000
	N	200	200	200

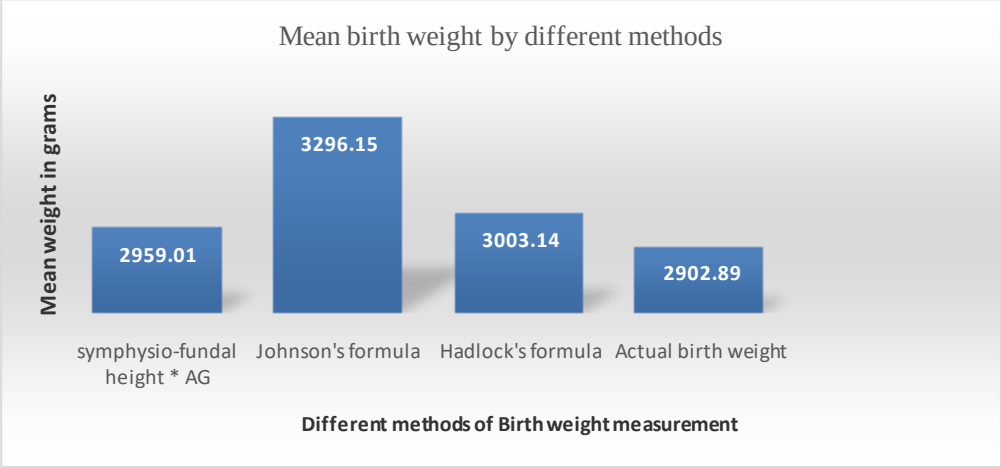

Figure 1: Mean birth weights by different methods

Table 11: Mean differences of different methods

Method	Mean difference	p value	Significance
ABW-SFH*AG	56.12	0.06	NS
ABW-Johnson's formula	393.26	0.00001	S
ABW-Hadlock'sformula	100.245	0.00005	S

Table 12: Average errors and percentage error in various methods

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

Table 13: Prediction of birth weight by various methods and standard deviation of prediction error

Method	Correlation coefficient	Prediction equation (Estimation of ABW)
SFH * AG	0.379	BW = 1509.3 + 0.47 (SFH)
Johnson's formula	0.351	BW = 1723.7 + 0.35 (Johnson)
Hadlock's formula	0.701	BW = 648.9 + 0.751 (Hadlock)
p = 0.00001		

DISCUSSION

The fetal weight estimation 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. Ultrasound is a painless, non- invasive, simple technique which gives information such as biophysical profile, gestational age, lie, position, presentation etc. and to ascertain the growth, timing and route of delivery as well as to detect any abnormality as fetal growth abnormality or genital problems. For determining the fetal growth ultrasound is considered to be more precise, whilst for normal clinical examination and above 4000g range and however some studies had found that both the clinical examination and ultrasonography showed somewhat similar level of accuracy but the ultrasound method is proved to be more accurate than the clinical methods. [10,11]

All studies included various clinical and ultrasonographic methods of fetal weight estimation, except study by Dawn *et al*. (1983) [12] had included the clinical estimation by Dawn's formula and Dare *et al*. (1990) [13] had included clinical estimation by Insler's formula for estimation of fetal weight. In the present study, both clinical and ultrasonographic methods of fetal weight estimation were included. The mean maternal age (in years) in the present study was 21.84 years. The maximum number of cases studied was in the age group 21-30years.Dare *et al*. (1990) found a percentage error between the actual and estimated weight to be 20.1% by AG x SFH method and in the current study the percentage error was 1.9% for AG x SFH method. [13]

Bhandary *et al*. (2004) [14] found the average error in various fetal weight groups

by AG x SFH was 224.37g which were least when compared to Johnson's and Hadlock's method and in the present study the average error in grams was least by SFH*AG formula which was 56.12g and by Hadlock's formula was 100.245g then followed by Johnson's formula, was 393.26g.The difference in average error between Hadlock's formula and AG x SFH is not statistically significant as p = 0.104.

Tiwari and Sood (1989) [15] showed an average error of 364.96g, 327.28g and 198.6g by SFH*AG, Johnson's and Hadlock's ultrasound method respectively. In the present study clinical estimation by AG x SFH (Insler's formula) and USG methods are equally good for estimation of birth weight within 10 % and the difference is not statistically significant.

In the present study, the mean birth weight by symphysiofundal height *abdominal girth was 2959.1±331.490 whereas mean birth weight by actual birth weight method ±SD was 2902.89±412.275. The 'p' value calculated to be 0.060, which is statistically not significant. This signifies that the difference between two methods is statistically significant, making Johnson's method less accurate for estimation of fetal weight as compared to actual birth weight. In the present study, the mean birth weight by Hadlock's formula was 3003.14± 384.897 whereas mean birth weight by actual birth weight method ±SD was 2902.89±412.275.The p-value calculated to be 0.0000* which is statistically significant. This signifies that the difference between the two methods is statistically significant, making Johnson's method less accurate for estimation of fetal weight as compared to actual birth weight.

By comparing the mean birth weight by Symphysio-fundal height* AG ± SD was 2959.01 ± 331.490 whereas mean birth weight by Johnson's formula ± SD was 3296.15±404.252.The 'p' value calculated to be 0.000 * which is statistically significant. This signifies that there is statistically significant difference in SFH*AG and Johnson's formula for estimation of fetal weight, SFH*AG being more actual birth weight. The mean birth weight by Jonson's formula ±SD was 3296.15±404.252 whereas mean birth weight by Hadlock's formula ± 3003.14 ± 384.897.The p- value calculated to be 0.000* which is statistically significant. This signifies that there is statistically significant difference in Johnson's and Hadlock's formula for estimation of fetal weight, making Hadlock's formula 2nd best method for estimation of fetal weight accurately after SFH*AG. Hence the results of our study are similar to many other studies that ultrasound technique, despite of the ongoing debates and controversies, plays a significant role in estimation of the fetal weight and still is a reliable source for diagnosis of fetal weight. The results of the present study found that if ultrasound technology and expertise are available, the focus should be on providing ultrasound training for fetal weight estimation, as most recent studies agree that ultrasound is the most accurate method. It should also be noted that, in recent studies, the accuracy of fetal weight estimated using ultrasound was higher than in studies conducted in the 1990s or even earlier. Ultrasound is now more accurate, as ultrasound technology has greatly improved in recent years.

CONCLUSION

Of the three clinical formula's studied, Insler's formula has better predictable results in fetal weight estimation, compared to Johnson's and Hadlock's formula. Clinical estimation of birth weight clearly has a role in management of labor and delivery in a term pregnancy. Diagnostic ultrasound is painless, non-invasive and has the potential to screen all the patients. The advantage of this technique is that it relies on linear and / or should be reproducible. Early expectation that this method might provide an objective standard for identifying fetuses of abnormal size for gestational age was recently determined by prospective studies that sonographic estimates of fetal weight is

better than clinical estimation of fetal weight. Finally it was concluded from the study was sonographic examination is more accurate in assessing fetal growth and estimating fetal weight than clinical examination. To improve the reliability of ultrasound, future studies are needed to develop new formulae to predict fetal weight more accurately and identify the threshold at which combining clinical fetal weight estimates with sonographic estimates could be useful to identify fetal macrosomia.

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