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Original Research Article

Utility of clinical methods and ultrasonography compared to actual birth weight in estimating the fetal birth weight

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ABSTRACT

Background: It is important to find out the most effective method for monitoring the growth of the fetus. The method should also identify the women with problematic pregnancy prone to IUGR so that early action can be taken to prevent adverse consequences.
Objective: To study the utility of clinical methods and ultrasonography compared to actual birth weight in estimating the fetal birth weight
Materials and Methods: A Hospital based Comparative Longitudinal Study was carried out among 200 antenatal women. Symphysio-Fundal Height (SFH) measurements and fetal weight was estimated by simplified Johnson's formula: McDonald's measurement for estimation of SFH was done i.e., distance from height of fundus to the upper edge of pubic symphysis.SFH at different weeks of gestation from 24 weeks until delivery was noted with a non-stretch centimeter tape. Fetal weight was estimated by Hadlock's formula using USG.
Results: Sensitivity of 74.55% and specificity of 95.17% was observed for Johnson's method while sensitivity of 90.91% and specificity of 98.62% by USG method. Mean difference between birth weights estimated by USG compared to actual birth weight was lesser (59.73 gm) compared to 418.96 gm by Johnson's method. Mean error by USG was less (127.86 gm) compared to Johnson's method (437.23 gm). Johnson's method was found to be have less percentage error overall, across the birth weight categories. Overestimation of actual birth weight by USG method was seen in 131 cases compared to 192 cases by Johnson's method.
Conclusion: Of the two methods studied for estimation of fetal weight, ultrasonographic method, i.e., Hadlock's formula has better predictable results in fetal weight estimation, compared to clinical method, i.e., Johnson's formula

1. Introduction

Fetal growth restriction (FGR, also called intrauterine growth restriction [IUGR]) is the term used to describe a fetus that has not reached its growth potential because of environmental factors. The origin of the problem may be fetal, placental, or maternal, with significant overlap among these entities. FGR is an adverse event in pregnancy, and the goal of antenatal monitoring is early detection of IUGR. This involves the correct determination of gestational age to differentiate FGR from a perceived restriction due to the wrong estimation of the gestational age. The use of USG studies to estimate fetal size, growth, and volume of liquor along with simple charting of fetal growth can help diagnose IUGR and guide the physician toward remedial measures. On USG, if the fetal weight is less than 10^{th} percentile for gestational age, it is called as FGR. This is the

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most common definition; however, other definitions using a variety of criteria have been proposed. When a small fetus is detected, it can be difficult to distinguish between the fetuses that are constitutionally small versus growth restricted. It is also difficult to identify the fetus that is not small but growth restricted relative to its genetic potential. Making the correct diagnosis is not always possible prenatally but is important prognostically and for estimating the risk for recurrence. The use of a percentile to define FGR is problematic because it does not distinguish among fetuses that are constitutionally small versus small because of a pathologic process.[1]

By comparison, a malnourished fetus whose estimated weight is slightly $>10^{th}$ percentile may be misclassified as appropriately grown and at low risk of adverse perinatal outcome, even though its weight may be far below its genetic potential. The term Small for gestational age (SGA) is used as it is not easy to estimate FGR. Foetuses with birth weight of less than 3^{rd} to 5^{th} percentile are prone to adverse effects and hence clinically more relevant.[2]

It has been estimated that about one third of the babies born in India are low birth weight (LBW) and thus constitutes 40% of the problem in the world. 75% of deaths during neonatal period and 50% of deaths during infancy are attributed to LBW. They are also exposed to the risk of increased morbidity.[3]

USG is considered as gold standard in detection of IUGR and also able to assess the wellbeing of the fetus in uterus. But this facility may not be available as it requires experts and handsome investment, especially in developing countries like India. Hence there is a need for simple clinical methods which are sensitive also in detecting IUGR. One such method is gravidogram.[4]

Observational studies using Fundal symphysis height (FSH) measurements have reported a wide range of sensitivities, 13 to 86% of small fetuses were detected.[5]Factors that may affect sensitivity include maternal BMI, bladder volume, parity, and ethnic group.[6] This technique appears to perform best when all of the measurements are obtained by the same clinician using the unmarked side of the tape (to reduce bias)[7] and plotted to reflect fetal growth for the individual patient ("customized"), rather than against a standardized norm.[8] This method is cheaper and can be used when USG is not available.[9]

Diagnostic value of this clinical method (fundal height measurement) is doubtful as most experienced obstetricians can also report less than 50% accuracy with this method.[10] Instead it has been recommended that symphysis-fundus measurements can be used and a variety of charts are also available for symphysis-fundus measurements (SFH).[5] Johnson et al were the first to develop the birth weight prediction formula using SFH with margin of error of 240 gm which was found in 68% of women and a margin of error of 375 gm which was found in 75% of the cases when the completed the study on 200 women.[11,12] Other studies confirmed the efficacy ranging from 61-72% of Johnson's formula.[13] One study from India identified the accuracy of Johnson's formula as 71%.[14] USG can also be not accurate at times due to factors like timing of USG for predicting birth weight.[15]

In 2000, Mongelli, Max; Gardosi, Jason[16] epidemiological and experimental studies show that abnormal fetal growth can lead to serious complications, including stillbirth, perinatal morbidity and disorders extending well beyond the neonatal period. Maternal characteristics such as weight, height, parity and ethnic group need to be adjusted for, and pathological factors such as smoking excluded, to establish appropriate standards and improve the distinction between what is normal and abnormal. Currently, the etiology of growth restriction is not well understood and preventative measures are ineffective. Elective delivery remains the principal management option, which emphasizes the need for better screening techniques for the timely detection of intrauterine growth failure.

Hence it is important to find out the most effective method for monitoring the growth of the fetus. The method should also identify the women with problematic pregnancy prone to IUGR so that early action can be taken to prevent adverse consequences. Hence present study was undertaken to study the utility of clinical methods and ultrasonography compared to actual birth weight in estimating the fetal birth weight.

2. Materials and Methods

A Hospital based Comparative Longitudinal Study was carried out from January 2018 to June 2019 (18 months) at Princess Esra Hospital, Shah-Ali-Banda Road, Moghalpura, Hyderabad among 200 antenatal women who attend the antenatal clinic during the study period and who satisfy the "inclusion criteria"

2.1. Inclusion criteria

1. All Antenatal women of GA 24 weeks & above with
   (a) Singleton Pregnancy,
   (b) Primi, Multigravida, Parous Gravida-2, Gravida-3 with two previous normal vaginal delivery/ LSCS.
   (c) Previous regular menstrual cycles.

2.2. Exclusion criteria

1. Antenatal women with
   (a) H/o Heart Diseases, Diabetes Mellitus, Chronic Pulmonary Diseases, Chronic Hypertension, Vasculopathy.
   (b) Fetal Malformations.

(c) Multiple Gestations.
(d) Pelvic masses i e , fibroid/ ovarian cysts complicating pregnancy.
(e) Women not sure of date.
(f) Late booking.

2.3. Methodology

Detailed history including Age, Parity, Literacy, Occupation, Socio-economic status, Past History, Family History, and Obstetric & Gynecological History was taken. Maternal Characteristics including Height, Pre-pregnancy weight, Weight-gain during Pregnancy, LMP were noted. Detailed Obstetric examination was done in all women.

Symphysio-Fundal Height (SFH) measurements and fetal weight was estimated by simplified Johnson's formula: McDonald's measurement for estimation of SFH was done i.e., distance from height of fundus to the upper edge of pubic symphysis.SFH at different weeks of gestation from 24 weeks until delivery was noted with a non-stretch centimeter tape. This gave the fetal growth in weeks of Pregnancy. A curve was plotted based on the mean SFH measurements, wherein the readings were arranged according to the 10th, 50th and 90th percentiles. At least five readings were taken for each patient and plotted on a graph and fetuses falling below 10th percentile for the gestational age on the graph were considered as SGAfetuses.SFH measurements just before delivery (within a week) were taken for estimation of fetal weight by Johnson's formula and comparison was done with actual birthweight. EFW (gm) = 2600 + 115 (SFH cm – 30).[17]

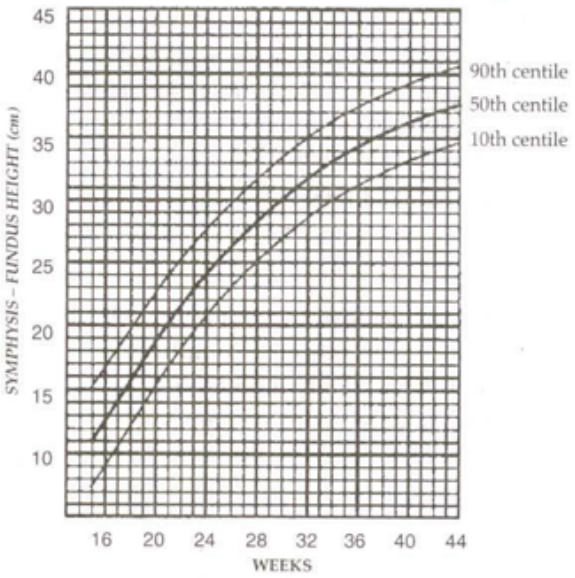

Fig. 1: Gravidogram

Fetal weight was estimated by Hadlock's formula using USG. Sonographic estimation was done with HD11 or HD15 PHILIPS, GE VOLUSON E10 or E8, GE LOGIQ P7 USG machines with 3.5 MHz convex probe. A booking Ultrasound was taken for all women in the study to confirm gestational age and to rule out fetal malformations, multiple gestations and uterine malformations. Routine USG were done after 24 weeks till delivery for detection of SGA babies (AC $<10^{th}$ percentile). A USG which was taken within one week of delivery was considered to calculate estimated fetal weight after measuring Biparietal Diameter (BPD), Abdominal Circumference (AC) and Femur Length (FL) in cm using Hadlock's formula by the USG machine as follows.

Log_{10} (EFW) = 1.4787 - 0.003343 x AC x FL + 0.001837 x BPD^2+ 0.0458 x AC + 0.15 x FL

"The actual birth weight of baby was determined by using electronic weighing machine and babies with birth weight less than 10^{th} percentile was considered as SGA babies according to the birth weight standards for South Indian babies".[18]

2.4. Statistical analysis

The sensitivity, specificity, positive predictive value and negative predictive value of gravidogram and USG in detection of SGA babies were calculated.

3. Results

Table 1 shows analysis of small for gestational age (SGA) infants by symphiso-fundal height (SFH) measurements. Out of 48 cases detected as SGA by SGH, 41 were true SGA giving a sensitivity of 74.55%. Out of 152 cases detected as AGA by SFH, 138 were true AGA giving a specificity of 95.17%. Thus SFH is found to have good sensitivity and specificity.

Table 2 shows analysis of small for gestational age (SGA) infants by 3^{rd}trimester ultrasound. Out of 52 cases detected as SGA by USG, 50 were true SGA giving a sensitivity of 90.91%. Out of 148 cases detected as AGA by USG, 143 were true AGA giving a specificity of 98.62%. Thus USG is found to have better sensitivity and specificity.

Table 3 shows mean birth weight by different methods. The mean difference between birth weight estimated by USG compared to actual birth weight was 59.73 gm compared to 418.96 gm of mean difference between birth weight estimated by Johnson's method and actual birth weight.

Table 4 Shows error of measuring birth weight by each method. Mean error by USG was less (127.86 gm) compared to mean error by Johnson's method (437.23 gm). Johnson's method was found to be have less percentage error overall, across the birth weight categories and as per the percentage error.

Table 5 Shows number of cases with over and under estimation of birth weights by different methods.

Table 1: Analysis of small for gestational age (SGA) infants by symphiso-fundal height (SFH) measurements

SFH	True SGA	True AGA (appropriate for gestational age)	Total
Detected SGA	41	7	48
Detected AGA	14	138	152
Total	55	145	200
Sensitivity		74.55%	
specificity		95.17%	
False negative		25.45%	
False positive		4.83%	
Positive predictive value		85.42%	
Negative predictive value		90.79%	

Table 2: Analysis of small for gestational age (SGA) infants by 3^{rd} trimester ultrasound

USG method	True SGA	True AGA	Total
Detected SGA	50	2	52
Detected AGA	5	143	148
Total	55	145	200
Sensitivity		90.91%	
Specificity		98.62%	
False negative		9.09%	
False positive		1.38%	
Positive predictive value		96.15%	
Negative predictive value		96.62%	

Table 3: Mean birth weight and error by different methods

Method	Mean birth weight (gm)	Mean difference	P value
Actual birth weight	2971.27+414.76	–	–
USG	3031.61+61	–	–
Johnson's	3390.23+299.98	–	–
Actual birth weight – USG (Hadlock's)	2971.27 – 3031.23	59.73	0.1279
Actual birth weight – Johnson's	2971.27 – 3390.27	-418.96	0.0001

Table 4: Error of measuring birth weight by each method

Variable		USG method	Johnson's method
Mean error		127.86	437.23
% standard error of mean		7.034	14.06
As per Birth weight (gm)	2000-2499	160	652
	2500-2999	196	526
	3000-3499	101	335
	> 3500	153	215
Percentage error	Up to 5%	149	15
	Up to 10%	192	77
	Up to 15%	193	115
	Up to 20%	197	143
	Up to 25%	199	167
	Up to 30%	200	181
	Up to 50%	–	200

Table 5: Number of cases with over and under estimation of birthweights by different methods

Method	Overestimation	Underestimation
USG	131	69
Johnson's	192	8

Overestimation of actual birth weight by USG method was only seen in 131 cases compared to 192 cases by Johnson's method; however USG tended to be underestimating the actual birth weight compared to Johnson's method.

4. Discussion

We found that Out of 48 cases detected as small for gestational age (SGA) by symphiso-fundal height (SFH), 41 were true SGA giving a sensitivity of 74.55%. Out of 152 cases detected as AGA by SFH, 138 were true AGA giving a specificity of 95.17%. Thus SFH is found to have good sensitivity and specificity. Mathai M et al[19] reported a sensitivity of 78% and a specificity of 88% for fundal height measurements. Grover V et al[20] noticed that for detection of small for date babies, symphysis-fundal height had a sensitivity of 80.8% with 93.5% specificity.

Out of 52 cases detected as SGA by USG, 50 were true SGA giving a sensitivity of 90.91%. Out of 148 cases detected as AGA by USG, 143 were true AGA giving a specificity of 98.62%. Thus USG is found to have better sensitivity and specificity in the present study. Baschat AA et al[21] showed a 98.1% of sensitivity for low abdominal circumference (AC) in the diagnosis of IUGR. There was a sensitivity of 85.7% for estimated fetal weight (EFW). Bhavani G et al[22] found a statistically significant agreement between USG-AC and USG-EFW with actual birth weight and the diagnostic accuracy of this method was found to be 80-95%.

We noticed that mean birth weight was 2971.27±414.761 gm which was lower than USG-EFW of 3031.612±371.1734 gm as well as that calculated by Johnson's formula of 3390.23±299.980 gm. Similar findings were reported by Alnakash AH et al[23] and Bhavani G et al[22] where both of the authors found that actual birth weight was lower than the estimated birth weight by either USG or by Johnson's formula.

The mean difference between the actual birth weight and by USG was narrow and not significant but the mean difference between the actual birth weight and Johnson's formula was wide and found to be statistically significant in the present study. The mean error by USG method was 127.86 gm while it was more with the Johnson's method i.e. 437.23 gm. Similar findings were reported by Tewari R et al[24] of mean error of 198.6 gm and 327.28 gm respectively by USG and Johnson's method while Alnakash AH et al[23] reported similar findings of mean error of 190.8 gm and 478.5 gm respectively by USG and Johnson's method.

Maximum error was noted as 768 gm by USG method and 1017 gm by Johnson's method in the birth weight group of 2000-2499 gm. Alnakash AH et al[23] in their study, Maximum error in USG was 1120 while it was 1485 by Johnson's method. Amritha BA et al[25] study showed a Maximum error was 774 by Hadlock's and 1135 by Johnson's formula.

Johnson's method was found to be have less percentage error overall, across the birth weight categories and as per the percentage error in the present study. Amritha BA et al[25] study showed similar results of percentage error of 62% by USG method compared to 41% by Johnson's method within 10% of birth weights.

In the present study, the average percentage error was 7.034% for Hadlock and 14.06% for Johnson method of estimation of fetal weight. Alnakash AH et al[23] in their study, the percentage error was 6.4% by USG and it was higher by Johnson's method 16.0% similar to the present study. Kathiriya D et al[26] study showed the mean percentage of error by USG was 14.36% for Hadlock EFW and 31% for Johnson formula.

5. Conclusion

Of the two methods studied for estimation of fetal weight, ultrasonographic method, i.e., Hadlock's formula has better predictable results in fetal weight estimation, compared to clinical method, i.e., Johnson's formula. Even then gravidogram is easily available, requires less expertise, simple and can be used in field. Hence its use can be recommended in the field conditions given a good sensitivity and specificity compared to actual birth weight.

6. Conflict of Interest

The authors declare that there is no conflict of interest.

7. Source of Funding

None.

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