Clinical versus sonological methods of fetal weight estimation at term pregnancy in a tertiary level hospital

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ABSTRACT

Introduction: Various clinical and sonological methods are used for estimation of fetal weight at term with varying accuracy.

Objectives: To compare clinical and sonological methods of fetal weight estimation at term.

Methodology: A prospective cross sectional study was conducted in the Department of Obstetrics and Gynaecology, Tribhuvan University Teaching Hospital, for a duration of one year. Women with term, singleton pregnancy admitted for delivery were enrolled. Fetal weight was estimated by two clinical methods -Insler-Bernstein's and Johnson's formulae as well as by ultrasonography using Hadlock's method. After delivery actual birth weight of newborns was compared with weights estimated by clinical and sonological methods. Frequency, percentage, mean, mean difference, standard deviation were calculated for descriptive analysis; for inferential statistics, p value was calculated by use of paired t test and association was calculated using the Pearson correlation coefficient.

Results: Total of 213 cases were enrolled. Difference of mean of weight estimated by sonological method compared to actual birth weight was statistically significant ($p < 0.001$) whereas there were no significant differences in mean values calculated by two clinical methods compared to actual birth weight (p =0.98 and 0.96). Insler-Bernstein's formula showed strongest positive linear correlation with the actual birth weight (r=0.76) among all three methods.

Conclusion: Estimation of fetal weight by clinical methods was more accurate compared to sonological method. Among the two clinical methods Insler-Bernstein's formula was closer to actual birth weight.

Keywords: Estimated Fetal Weight; Hadlock's method; Insler-Bernstein's formula; Johnson's formula

INTRODUCTION

Birth weight is a major determinant of morbidity and mortality in the first year of life.[1-3] Accurate estimation of the fetal weight in utero is essential for obstetrician in deciding the mode of delivery as well as anticipation and prevention of maternal and perinatal complications.[3] For estimation of fetal weight, various methods have been used such as clinical methods, x-ray of fetus in utero and ultrasound techniques.[4,5]

Clinical methods most commonly used are Insler-Bernstein's formula and Johnson's formula. These methods are easy and do not require any equipment. Several studies comparing the accuracy of these clinical methods have reported them as less accurate.[1,5-7] Others have agreed that clinical estimation of fetal weight can be quite accurate.[2,8,9]

Sonological methods are reliable alternatives in estimating the fetal weight, even though large imprecisions have been reported with sonological estimation as well.[10,11] However, these methods require

well-trained personnel and can be costly for a low resource setting.

This study was carried out to compare the estimated fetal weight (EFW) calculated at term pregnancy by clinical and sonological methods with the actual birth weight (ABW) taken immediately after birth and to determine the most near accurate method for estimation of fetal weight.

METHODOLOGY

This was a hospital based prospective cross sectional study conducted in Department of Obstetrics and Gynaecology, Tribhuvan University Teaching Hospital (TUTH), Kathmandu, from 1st May 2019 to 30th April 2020 for the total duration of one year. Ethical clearance for the study was taken from the Institutional Review Committee(IRC) of Institute of Medicine (IOM) [ref. no. 422(6-11)e²/075/76]. Written informed consents were obtained from the participants before recruitment into the study. The study population included women who came to labour room for delivery and met the inclusion criteria of singleton live fetus with cephalic presentation at gestational age 37 to 42 weeks and having a USG done within one week of admission. Patients with oligo/polyhydramnios, multiple gestation, malpresentation, anomalous fetus, intrauterine fetal death were excluded. Also, patients with co-existing fibroids, ovarian cysts, obesity (BMI > 29.5), gestational diabetes/overt diabetes and those with pregnancy induced hypertension or its related complications were also excluded. Non-probability convenient sampling was employed.

For sample size calculation effect size was calculated from difference in mean and standard deviation i.e. 0.17 with alfa error 0.05 and power (1- β) = 80%. Calculated sample size was 210 using (G-power 3.1)

Cases were enrolled from labour room daily based on inclusion and exclusion criteria of the study. Participants were explained about the study and were asked to sign the consent form. Patients were asked to lie supine on bed with legs flat after emptying the bladder. Abdominal girth(AG) was measured at the level of umbilicus and expressed in centimetres. After correction of dextrorotation, McDonald's measurement or Symphysiofundal height (SFH) was taken from the upper edge of the symphysis pubis following the curvature of the abdomen to the fundus with a non-elastic measuring tape. The measurement was made using the tape reverse side up so as to reduce bias.

Using Insler- Bernstein's formula estimated fetal weight was calculated as:

Estimated fetal weight (grams) = Symphysio fundal height (cm) SFH × Abdominal girth (cm) AG.[12]For Johnson's formula per vaginal examination was done at the time of admission to determine the head station of the fetus.

Using the Johnson's formula given by R.W. Johnson in the year 1957 estimated fetal weight was calculated as: Fetal weight in grams = (Fundal height in cms - N) × 155.[13]

N is a variable and its value changes according to level of head station.
when head station is at the level of ischial spines (zero station) N=12,
when head station above the level of ischial spine (minus station) N=13
and when below the level of ischial spines (plus station) N=11

Ultrasound was performed using C 2-5 transabdominal curvilinear probe on Philips HD 11 machine by senior radiologist. Biometry of fetus was taken using the following parameters; Bi-parietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femoral length (FL). Bi-parietal diameter was taken at the level where both thalami and cavum septum pellucidum was visualized. Measurement of bi-parietal diameter was taken from inner to outer table of the skull bones. Head circumference was measured in the same plane. Abdominal circumference was measured at the level of bifurcation of the hepatic vein into right and left branches. Femoral length was measured with the femur excluding the femoral head and the epiphysis along the vertical axis seen transversely. Expected fetal weight in grams was obtained using mediscan software device and Hadlock's formula.

Estimated fetal weight using Hadlock's formula by USG:

$\text{Log} 10 \text{ BW} = 1.5662 - 0.0108 \text{ (HC)} + 0.0468(AC) + 0.171 (FL) + 0.00034 (HC)10 - 0.003685 (AC \times FL).$[11]

Following delivery either vaginal or caesarean section, the birth weight was measured immediately using standard digital weighing machine in labour room. Information obtained was entered into master chart. IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA was used for processing and analysis of the data. Frequency, percentage, mean, mean difference, standard deviation were used for descriptive

analysis and the data were presented in figures and tables. For inferential statistics, p value was calculated by use of paired t test for continuous variables. P value of <0.05 was regarded as statistically significant.

The correlation between the two variables was calculated using Pearson correlation coefficient).

RESULTS

Total number of cases included in the study were 213. The gestational age at enrollment ranged from 37 to 41+1 weeks. Among the participants, 98 (46.01%) were multigravida and 115 (53.99%) were primigravida. The maternal age distribution was in the range of 18-38 years, with the mean age being 26.2 ± 4.37 years. Maximum number of cases 86 (40.38%) were in the age group of 25-29 years. Maximum number of new-borns 91 (43%) were in between 3000-3499 gms at the time of birth, with only five (2%) ≥ 4000 gms and six (3%) < 2500gms. The mean difference in weights estimated by Insler's, Johnson's and Hadlock's compared with ABW was 0.24gms, 0.89gms and 135.98gms respectively. Difference of mean of weight estimated by Hadlock's method as compared to actual birth weight was found to be statistically significant (p <0.001) whereas the difference in mean value calculated by Johnson's formula and Insler's formula compared to actual birth weight was not statistically significant (p= 0.98 and 0.96 respectively, Table 1).

Actual birth weights (ABW) of the newborns were divided into different weight categories. Estimated fetal weight calculated from three different methods were compared to ABW in the different weight categories. Insler- Bernstein's method for estimation of fetal weight, in weight range of 2500 grams to 3499 grams was more accurate than Johnson's and Hadlock's method. While Hadlock's method for estimation of fetal weight was more useful in big babies of weight range of 3500 grams and above. On the other hand, in smaller weight babies i.e. <2500 grams Johnson's formula was more useful (Table 2).

There was positive correlation between Insler's and Bernstein's estimation of fetal weight and ABW (r=0.76, Figure 1).

Johnson's fetal weight estimation and ABW shows positive linear correlation between, but strength of linear correlation is less than that of Insler-Bernstein's fetal weight estimation. (r=0.65, Figure 2).

Similarly, Hadlock's estimation of fetal weight and ABW also showed positive linear correlation between (r=0.61, Figure 3). Over-all Insler-Bernstein's method of fetal weight estimation showed strongest positive linear correlation with the actual birth weight (r=0.76) among all three methods.
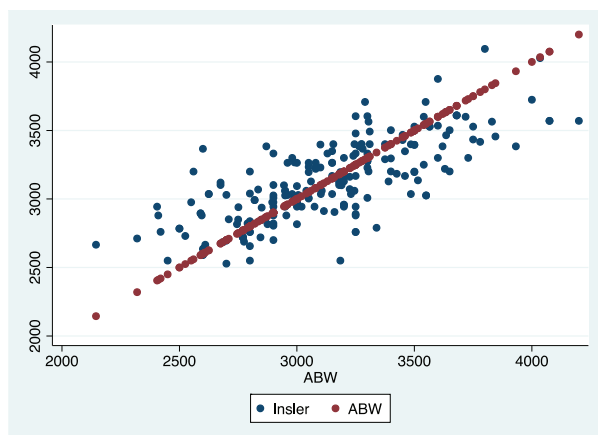
Table 1: Comparison of clinical and ultrasonological methods with Actual birth weight

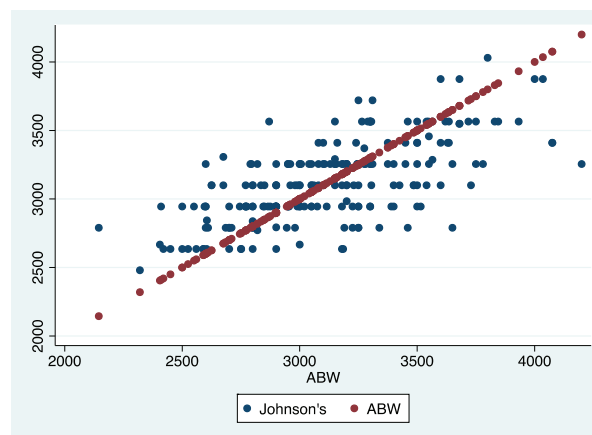| Procedure	Weight in grams (Mean ± SD)	Mean difference	p - value
Insler -Bernstein's	3123.97 ±300.91	0.24 gms	0.98
Actual birth weight	3123.73± 376.79		
Johnsons	3124.62± 294.75	0.89 gms	0.96
Actual Birth Weight	3123.73± 376.79		
Hadlock estimation	3259.71± 412.81	135.98 gms	<0.001*
Actual Birth Weight	3123.73± 376.79		

p value significant at <0.05, *= paired t test

Table 2: Mean difference in various fetal weight groups by different methods

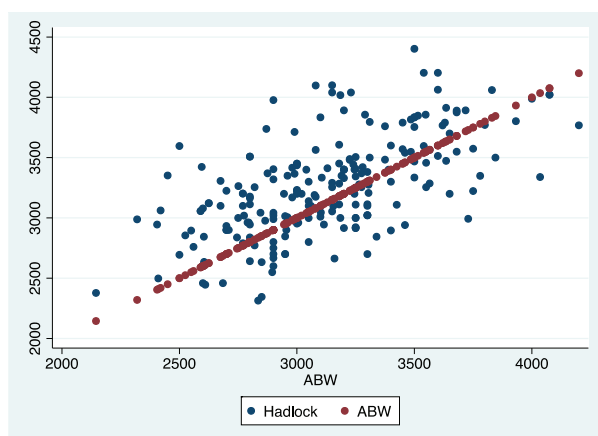|		Birth weights				
	Methods	<2500gms	2500-2999gms	3000-3499 gms	3500-3999 gms	≥ 4000gms
Mean difference from ABW	Insler-Bernstein's	394 gms	162 gms	165 gms	355 gms	424 gms
	Johnson's	298 gms	197 gms	199 gms	285 gms	514 gms
	Hadlock's	521 gms	317 gms	245 gms	270 gms	142 gms

Figure 1: Correlation of actual birth weight vs Insler-Bernstein's formula (in grams)

Figure 2: Correlation of actual birth weight vs Johnson's formula (in grams)

Figure 3: Correlation of actual birth weight vs Hadlock's formula (in grams)

DISCUSSION

Fetal weight estimation in-utero has become vital especially for the prevention of prematurity, evaluation of cephalo-pelvic disproportion, decision for mode of delivery, induction of labor at term and in detection of intrauterine growth restriction.[14] A lot of research has been done to find out accurate methods for estimation of fetal weight in utero including x-ray of fetus in utero, clinical methods like external measurement of uterus and ultrasound techniques.[9,12,15] However most accurate method for estimation of fetal weight is still debatable.

Obstetricians routinely estimate fetal growth by measuring the symphysiofundal height at each antenatal visit. Sonographic estimation is preferred if it varies from the normal range for the gestation. Earlier it was expected that ultrasonography might provide an objective standard for identifying fetuses of abnormal size for their gestational age. However, it was recently undermined by prospective studies that showed sonographic estimates of fetal weight to be no better than clinical methods for estimating fetal weight. [9,16,17]

Several studies have been conducted in past comparing the efficacy of different clinical and sonological methods of fetal weight estimation at term but no such study was done in our institute till date. In this study both clinical and sonological methods of fetal weight estimation were compared with ABW of newborns.

In the present study, the average error in fetal weight estimation was least by Insler- Bernstein's formula which was only 0.24 grams as compared to ABW followed by Johnson's formula (0.89 grams) and Hadlock's formula (135.98 grams). Similar result was observed in studies by Amritha et al.,[6] and Aruna et al.,[4] where average error by Insler- Bernstein's was least when compared to Johnson's and Hadlock's method.

The difference of mean estimated fetal weight estimated by Insler -Bernstein's formula compared to ABW as well as the mean difference of Johnson's and ABW was found to be statistically insignificant (p=0.98 and p = 0.96) but the difference of mean of Hadlock's and ABW was found to be statistically significant (p <0.001). This result suggests that clinical method for estimation of fetal weight may be more accurate in comparison to sonographic (Hadlock's) method for estimation of fetal weight. Similar study done by Aruna et al., showed the predictive value of Insler's and Bernstein's better than Johnson's and Hadlock's method.[4] In comparison to the current study, study by Sowjanya et al., showed equal predictive value for both Johnson's and Hadlock's methods for estimation of fetal weight.[14] This disparity could be due to difference in sample size between studies. Other reason could be

observer variations.

Baum et al., found no advantage of sonographic method of estimation of fetal weight over clinical method.[8] Another study done by Hendrix et al., showed that estimation of fetal weight using clinical method was significantly more accurate than sonographic method.[18] This was even agreed by Sherman et al.[2] Titapant et al., observed that sonographic method for estimation of fetal weight was more accurate only when there was low birth weight.[9]

Correlation analysis of all these methods have also been done with ABW using Karl Pearson correlation coefficient. Both the clinical methods, Insler- Bernstein's (SFH × AG) and Johnson's formula as well as the sonological method i.e., Hadlock's formula showed positive correlation with ABW. Among all three methods Insler- Bernstein's formula showed strongest positive linear correlation (r=0.76) with ABW. In contrast to current study other studies done by Sowjanya et al., and Ramaiah et al.showed that Hadlock's method had stronger correlation with ABW.[14,19] This correlation analysis in the current study shows that Insler- Bernstein's method is more sensitive to the changes in the ABW than the Hadlock's method.

In this study comparing the average error calculated in different weight groups showed that Insler- Bernstein's method for estimation of fetal weight, in weight range of 2500 grams to 3499 grams was more accurate than Johnson's and Hadlock's method. While Hadlock's method for estimation of fetal weight was more useful in big babies of weight range of 3500 grams and above. On the other hand, in smaller weight babies i.e. <2500 grams Johnson's formula was more useful. This result obtained in the current study was similar to study by Sowjanya et al.[14]

Results obtained in the present study are supported by studies mentioned above that indicate that sonographic method for estimation of fetal weight offers no advantage over clinical methods when performed during late pregnancy or in early stage of labour. However, plenty of other studies concluded that sonographic evaluation

was better for overweight patients as well as for babies with extremes of weight.[20-22] Some other studies even showed sonographic methods to be equivalent or even better than clinical methods for estimation of fetal weight at term gestation.[6,14] Unlike the current study, only a few studies have compared both the clinical methods (Insler-Bernstein's and Johnson's methods) so result might have varied.

Clinician reliability in estimation of fetal weight using ultrasonography has made clinician machine dependent, as a result of which clinician are discouraged to use their clinical skills for determination of the estimated fetal weight. Clinical method like Insler and Bernstein's formula, which is easy, quick and reliable can be of great value in a country like ours, where ultrasound may not be available at many health care delivery systems. A quick clinical method of fetal weight determination in utero is also beneficial in peripheral centers to decide regarding referral to higher centers. It can even be used by medical officers and paramedics who are the main manpower in rural health care centers. This study would encourage young clinicians to use their clinical skills for estimating fetal weight rather than completely depending upon ultrasonographic reports in decision making regarding mode of delivery and timely referral to higher centers

The limitation of the study was the relatively small sample size and short duration of study. A larger sample size would be advisable to draw more valid inferences to a large population. Obese patients and cases with high-risk pregnancies were excluded in the study. In these groups ultrasonological methods for estimation of fetal weight might be more accurate.

CONCLUSION
In our study, fetal weight estimation by clinical methods was found to be more accurate compared to sonological method. Weight estimation by Insler-Bernstein's formula was closer to actual birth weight as compared to Johnson's formula.

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