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Estimation of Foetal Weight by Ultrasonography and Neonate at Birth

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Abstract

Background: Ultrasonography intervention in delivery is highly sensitive and primary important for further tests of foetal well-being. **Objective:** The purpose of the present study was to observe the correlation of estimated foetal weight with neonatal birth weight. **Methodology:** This was a cross-sectional study on patients at the Labour Ward of Department of Obstetrics and Gynaecology at Sir Salimullah Medical College and Mitford Hospiptal, Dhaka, Bangladesh for six months. The women were selected who had normal pregnancy with early ultrasounographic examination for confirmation of gestational age, singleton live foetus, ultrasound examination for pregnancy profile done within 3 days before delivery. A sonographic foetal weight was estimated by using measurements of foetal body parts-biparietal diameter, abdominal circumference and femoral length. To measure the femur length, first a projection was made that shows a transverse section of one of the long bones, then scan at 900 to this to obtain a longitudinal section. **Results:** A total number of 100 patients were recruited for this study. The mean (±SD) sonographically estimated foetal weight was 3074±534gm with ranged from 2100 to 4100 gm. The mean (±SD) neonatal birth weight was 2978±466 gm with ranged from 2500 to 3800 gm ($p<0.05$). Sonographically estimated foetal weight less than 3000 g were correlated with neonatal birth weight. Out of the 100 cases 57(57.0%) cases had less than 3000 g estimated foetal weight and 43(43.0%) cases had 3000 g or more than 3000gm estimated foetal weight Sonographically. Among the 57 cases, which were less than 3000 g by Sonographically, 41 cases were less than 3000 g and 16 cases were found 3000 g or more than 3000 g in neonatal birth weight. **Conclusion:** Ultrasonography has definite value in the diagnosis of estimated foetal weight and can be regarded as a sensitive and specific imaging modality for pre-operative discrimination of the pregnant women. *[Journal of National Institute of Neurosciences Bangladesh, January 2023;9(1):42-47]*

Keywords: Foetal weight; symphysiofundal height; neonatal birth weight

Introduction

Knowledge of expected birth weight is attractive to clinicians as it is an important variable affecting perinatal mortality. Foetal weight estimation is thought to be helpful in predicting foetal survival and making management decisions in the very low birth weight group less than 1000g[1] and in managing the delivery of the large baby, where complications may occur[2]. The most successful early approach was a simple correlation between abdominal circumference (AC) and birth weight[3]. Numerous further attempts have combined measurements in regression equations or volumetric formulae, with varying degrees of accuracy.

Using three-dimensional (3D) ultrasound it is now

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possible to generate volume data sets of the foetus. The field of view of 3D ultrasound is currently limited so that in the second and third trimesters it is not possible to image the whole foetus in one data set. There is prior evidence, however, that foetal limb cross-sectional measurements and volumes may be valuable in estimating foetal weight[4-5]. Several groups have developed formulae relating the volume of one or more foetal body parts to foetal weight[6-8] all achieved random errors (SD) of approximately 6.0% to 7.0%, a marginal improvement on the cross-sectional methods. In the management of delivery, EFW must be accurate to within a few percent in all cases. Thresholds may be used to determine the mode of delivery; where errors often exceed 10% these thresholds have no value. In the prediction of low birth weight for the purposes of intervention well in advance of delivery, high sensitivity is of primary importance where further tests of foetal well-being, such as Doppler ultrasound[9], are available. Reducing random errors will increase specificity and make diagnosis more cost-effective. There is a variation in systematic and random errors between methods and between centers.

There are local factors influencing random errors, such as the study population, the observers, measurement protocols, the equipment or a combination of these variables. A number of authors have analyzed these factors and questioned the validity of formulae. There is conflicting evidence regarding the influence of amniotic fluid volume[10-12]. One would expect maternal adiposity and amniotic fluid volume to affect the accuracy of individual measurements as these factors both affect image quality. It is possible that these effects are masked by other, larger sources of error. Operator experience is important in producing accurate foetal weight estimates. Predanic et al[13] demonstrated the learning curve in estimating foetal weight; there were significant improvements in accuracy amongst residents in training up to 24 months, where the best performance was achieved. Even with experience, there are interobserver differences in measurements.

Gull et al[14] showed that averaging the results of two examiners reduced the mean absolute error in EFW by approximately 17% (from 6.1% to 5.1%). Dudley and Potter[15] developed a strategy for improving the quality of foetal measurements. Images of each head and AC measurement made were collected continuously and a sequential sample audited against widely accepted quality criteria. Sonographers were provided with feedback on the number of satisfactory measurements and on the quality criteria not met. Recognition of quality criteria improved and, with coaching, the proportion of images meeting all quality criteria increased. The audit was extended to a further five centers to determine whether quality varied significantly[16]. This study established that there was considerable variability in measurement quality between centers and that performance could be improved. There were differences of up to 18 mm between AC measurements made on optimal and suboptimal images on the same patient.

A number of authors have questioned the validity of EFW formulae on the grounds of the variability of foetal body composition and relative proportions, mathematical and physical quality. The use of volume as the basis for weight estimation has been validated using magnetic resonance imaging. Uotila et al[17] reported a better correlation between MRI EFW and birth weight than ultrasound EFW and birth weight. Jackson et al19 questioned the regression equation approach on the grounds of the confounding effects of skewness, kurtosis, outliers and the repeated use of variables on the outcome of regression. They provided an alternative, volumetric equation, with smaller mean absolute errors (7.2% cf. 7.9%) than the method of Hadlock et al[18]. The purpose of the present study was to observe the correlation of estimated foetal weight with neonatal birth weight.

Methodology

Study Population and Setting: This was a cross-sectional study in the Department of Obstetrics and Gynaecology at Sir Salimullah Medical College and Mitford, Dhaka, Bangladesh for six months. The patients who were fulfilled the criteria like within 36 to 40 weeks of gestation were selected for the study who. The women having normal pregnancy with early ultrasonography examination for confirmation of gestational age. Ultrasound examination for pregnancy profile was done within 3 days before delivery. The study population were excluded who had Twin pregnancy or multiple pregnancy or any gross foetal anomaly.

Study Procedure: A sonographic foetal weight was estimated by using measurements of foetal body parts-biparietal diameter, abdominal circumference and femoral length. BPD is the widest diameter of the skull. It was determined at the level of the paired thalami, Interrupted by the midline echo from the falx cerebri and cavum septum pellucidum. It was measured from leading edge to leading edge (outer to inner skull table). Foetal abdominal circumference was the length of the outer perimeter of the foetal abdomen, measured on transverse section at the level of the stomach and intrahepatic portion of the umbilical vein. To measure the femur length, first a projection was made that shows a transverse section of one of the long bones, then scan at 900 to this to obtain a longitudinal section. Measurements were making from one end of the bone to the other end. Hadlock's method uses BPD, AC and FL and is inbuilt in all ultrasound machines. Hadlock's formula was applied like Log1D (BW) =-1.5213+ 0.003343xACx FL+0.001837xBPD2+ 0.0458xAC+ 0.158x FL. After collecting all the necessary information regarding the study, data were collected in a pre-designed structured data collection sheets. Data was collected from primary source starting from the clinical history and transabdominal sonogram.

Statistical Analysis: All the relevant collected data was compiled on master chart first and Statistical analyses was done by computer software devised as the statistical package for social science (SPSS). Pearson's correlation coefficient test, paired-t test, chi- square test, validity test and others relevant statistical computing was be performed. The value will express as frequencies, percentage, mean± SD and ranges.

Ethics Approval and Consent to Participate: Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

Results

A total number of 100 patients were select for the study who within 36 to 40 weeks of gestation. The women having normal pregnancy with early ultrasonographic examination were select for the study who within 36 to 40 weeks of gestation. The women having normal pregnancy with early ultrasonographic examination were select for the study who within 36 to 40 weeks of gestation. It showed linear trend i.e. with the increase in patients symphysiofundal height there was an increase in mean foetal weight. The mean foetal weight was lowest 2.0±0.2 kg, when mother symphysiofundal height was 32 cm. and highest 2.81±0.19 kg when mother symphysiofundal height was 36 cm (Table 1).

Table 1: Relationship between Symphysiofundal Height (SFH) and Estimated Foetal Weight by Sonography

SFH (cm)	n	Estimated Foetal Weight (kg) (Mean± SD)
32	9	2.0±0.26
33	15	2.22±0.28
34	20	2.31±0.26
35	23	2.66±0.21
36	33	2.81±0.19

The mean (±SD) sonographically estimated foetal weight was 3074±534gm with ranged from 2100 to 4100 gm. The mean (±SD) neonatal birth weight was 2978±466 gm with ranged from 2500 to 3800 gm. The difference between sonographically estimated foetal weight and neonatal birth weight was statistically significant ($p<0.05$) (Table 2).

Table 2: Comparison between sonographically and neonatal birth weight (n=100)

	Sonographically Estimated Foetal Weight (gm)	Neonatal birth Weight (gm)	P value
Mean±SD	3074±534	2978±466	0.005
Range	2100 - 4100	2500 -3800	

Sonographically estimated foetal weight less than 3000 g were correlated with neonatal birth weight. Out of the 100 cases 57(57.0%) cases had less than 3000 g estimated foetal weight and 43(43.0%) cases had 3000 g or more than 3000 g estimated foetal weight sonographically. Among the 57 cases, which were less than 3000 g by sonographically, 41 cases were less than 3000 g and 16 cases were found 3000 g or more than 3000 g in neonatal birth weight. Whereas, 7 cases were found less than 3000 g in neonatal birth weight and 36 cases were found 3000 g or more than 3000 g among the 3000 g or more than 3000 g which were sonographically estimated. Therefore, 48(48.0%) cases were less than 3000 g and rest of the 52(52.0%) cases were found 3000 g or more than 3000 g in neonatal birth weight. (Table 3).

Table 3: Comparison of Sonographically Estimated Foetal Weight Less Than 3000 Gm With Neonatal Birth Weight

Sonographically estimated foetal Weight (gm)	Neonatal Birth Weight		Total
	BW<3000g	BW > 3000g	
BW< 3000g	41(True Positive)	16(False Positive)	57
BW>3000g	7(False Negative)	36(True Negative)	43
Total	**48**	**52**	**100**

Sonographically estimated foetal weight 3000g or more than 3000g were correlated with neonatal birth weight. Out of the 100 cases 43(43.0%) cases had 3000 g or more than 3000g estimated foetal weight and 57(57.0%) cases had less than 3000g estimated foetal weight sonographically. Among the 43 cases, which were 3000 g and more than 3000g by sonographically, 36 cases were 3000g or more than 3000g and 16 cases were found less than 3000 g in neonatal birth weight. Whereas, 16 cases were found 3000 g or more than 3000g in neonatal birth weight and 41 cases were found less than 3000 g among the less than 3000g which were sonographically estimated. Therefore, 52(52.0%) cases were 3000 g or more than 3000g and rest of the 48(48.0%) cases were found less than 3000g in neonatal birth weight (Table 4).

Table 4: Comparison of Sonographically Estimated Foetal Weight 3000g or More Than 3000gm With Neonatal Birth Weight

Sonographically estimated foetal Weight (gm)	Neonatal Birth Weight		Total
	BW<3000g	BW > 3000g	
BW< 3000g	36(True Positive)	7(False Positive)	43
BW>3000g	16(False Negative)	41(True Negative)	57
Total	**52**	**48**	**100**

The Ultrasonography diagnosis of estimated foetal weight were correlated with neonatal birth weight and the validity of test were confirmed by calculating sensitivity, specificity, accuracy positive and negative predictive values (Table 5).

Table 5: Validity of Ultrasonography as a Modality by Calculating Sensitivity, Specificity, Accuracy, Positive and Negative Predictive Value of Estimated Foetal Weight

Validity Test	BW< 3000g	BW> 3000g
Sensitivity	85.4%	69.2%
Specificity	69.2%	85.4%
Accuracy	77.0%	77.0%
Positive predictive value	71.9%	83.7%
Negative predictive value	83.7%	71.9%

Discussion

Ultrasonographic imaging is considered as an objective means for foetal weight estimation, the goals of this study were to determine the accuracy of foetal weight estimated from symphysis-fundal height to that of the ultrasonographically estimated foetal weight. To compare the accuracy of clinical and sonographic estimates of foetal weight made from the 20 weeks of gestation to the term period.

Approximate prediction of foetal weight is more important prior to induction of labour or elective caesarean section. On the other hand, foetal growth retardation is an alarming situation in pregnancy. Obstetrician wants to know the exact weight of the foetus, probable causes and types of IUGR and foetal biophysical profile in this condition for proper management of the patient.

Estimation of foetal weight in woman who present in early labour at term is important in some patients, a small infant may had foetal distress during labour if growth retardation or placental abnormalities are present[19] conversely, macrosomia (birth weight 4000 or more) diagnosed in early labour may herald desultory labour, midpelvic arrest, shoulder dystocia or a need for cesarean delivery. A prediction of foetal weight derived from sonographic measurements of foetal anatomy is generally considered more accurate than obtained by clinical examination at or before 34 weeks gestation. In any study a bivariate of factors influencing foetal weight's shows that maternal age, maternal weight, maternal height, MUAC maternal educational status,al family income etc. have a significant influence upon the foetal height.

This prospective study was carried out with an aim to compare the estimation of foetal weight by ultrasonography and neonatal weight of neonatal at birth, to observed the correlation of estimated foetal weight with neonatal birth weight, its validity by determining sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPP) and find any significant influence of maternal height, weight, body mass index (BMI), foetal sex on estimated foetal weight and neonatal birth weight. Among infant with a birth weight less than 2,500 grams, clinical EFW can predict correctly in 56.4% of cases (in comparison with Ultrasonographically estimated foetal weight) and foetal weight >2,500gms correctly in 94.8% of cases. From this study it shows that when the clinical estimate of foetal weight is less than 2,500 grams. It cannot replace the ultrasound estimation of foetal weight. Out of the 100 cases true positive cases were 41, as positive case was 16, false negative cases 7 and true negative years 36 in ultrasonogram for detection of estimated foetal weight<3000g. Sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were found for the detection of estimated foetal weight <3000g. The sensitivity of ultrasonogram was 85.4%, specificity was 69.2, accuracy was 77.0%, PPV was 71.9% and NPV was 83.7%, which is comparable with Peregrine et al[19] study, where they found 100.0%, specificity was 76.0, PPV was 33.3% and NPV was 100.0% ultrasonogram estimation of foetal weight in Hadlock formula,

Out of the 100 cases true positive cases were 36, false positive case was 7, false negative cases 16 and true negative cases 41 in ultrasonogram estimation of foetal weight >_3000g. The ultrasonogram had sensitivity 69.2%, specificity 85.4%, accuracy 77.0%, PPV 83.7% and NPV 71.9% for estimation of foetal weight >_3000g in this current study.

Conclusion

As the neonatal birth weight of the present study significantly correlated well with ultrasonography findings, and the validity tests are almost identical as observed by many investigators, it can be concluded that the ultrasonography is useful diagnostic modality in estimated foetal weight and it should be worthy to note here that ultrasonography can help the gynaecologists in the rational approach of patient management.

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Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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