



Accuracy of Ultrasound in fetal birth weight estimation in term pregnancies: Experience at tertiary care hospital of Quetta, Pakistan

Ameed Jesrani^{1*}, Pari Gul², Syeda Nuzhat Zehra³, Mahwash Mansoor⁴

^{1,3} Department of Radiology, Sindh Institute of Urology and Transplantation, Karachi, Pakistan

^{2,4} Department of Radiology, Bolan Medical Complex Hospital, Quetta, Pakistan

Abstract

Introduction: Ultrasound assessment of prenatal estimated fetal weight (EFW) determination in term pregnancies provides valuable information in the evaluation of fetal growth and planning mode of delivery.

Objective: The aim of this study was to assess the accuracy of ultrasound in estimation of fetal birth weight in term pregnancies at Bolan Medical Complex Hospital.

Methods: A prospective, Hospital based, cross sectional study was conducted from January 2019 to June 2019. Obstetric ultrasound was done on 470 term pregnancies to determine fetal weight that fulfill the inclusion criteria. Data was collected using questionnaire. The weights of the neonates were confirmed at the expected time of delivery from registration books. Summary statistics computed.

Results: Out of 470 pregnant mothers for fetal weight estimation, the accuracy of ultrasound fetal weight estimation within 10% of actual birth weight was 85.5%. The mean absolute error of estimated fetal weight was 226.67gm. The accuracy of weight estimation was seen to decline as the gestational age increased from 87.8% at 37 - 38 weeks, 82.6% at 39-40 weeks and 50% at 41-42 weeks. Overall ultrasound overestimated the fetal weight in those <2500gm and underestimated in those >4000gm.

Conclusion: The accuracy of ultrasound in estimation of fetal weight performed in term pregnancies was found to be higher in our study than that reported in other studies. More accurate results are shown in normal birth weight of fetuses and gestational age of earlier weeks of term pregnancies.

Keywords: fetal birth weight estimation, term pregnancy, Ultrasound

Introduction

Estimation of fetal weight (EFW) by evaluation of fetal growth on ultrasound has an important role in deciding mode of delivery in various obstetric units throughout world [1]. Increased risk of newborn complications is seen in low and excessive weight fetuses during labour and puerperium. Both preterm delivery and intrauterine growth restriction are found to be responsible for increased perinatal morbidity and mortality in low birth weight babies. Excessive weight at birth is reported to cause complications associated with vaginal delivery that include shoulder dystocia, brachial plexus injury, bone injuries and intrapartum asphyxia in fetuses while birth canal and pelvic floor injuries, increased rates of assisted per vaginal and caesarean sections as well as postpartum hemorrhage in mothers [2, 3, 4].

Fetal weight can be correlated with various parameters and formulas [5-8]. Many combinations of standardized fetal biometric parameters such as biparietal diameter (BPD), head circumference (HC), Abdominal circumference (AC) and femur length (FL) [9] were used in early 1980s to devise various such formulas such as Sheppard formula which includes BPD and AC and the Hadlock formula [10] using FL and AC which are widely accepted and in practice for estimation of fetal weight (EFW) because of their simpler usage and accuracy. These parameters are considered to be more accurate and simpler than others [11 -

13]. Two schools of thoughts are there to support accuracy of this parameter one is of Hadlock *et al.* [14] Rose and McCallum [15] which is in support for using all three parameters for more accurate results and other is of Woo and Wan [16] which suggests same predictive accuracy of using two parameters over three.

Comparative studies for estimation of fetal weight by using clinical and maternal calculations and its accuracy of these values with ultrasound have been done. Accuracy of ultrasound determined estimated fetal weight at in low risk population has strong correlation with birth weight with mean absolute percentage error of 6.7% [17] as shown by T. Prior *et al.* in his study. T. Ashrafganjooei compared three different methods of determining EFW which were clinical, maternal and sonographic EFW on 246 parous women which showed sensitivity values of predicting birth weights by ultrasound, clinical and maternal EFW of 17.6%, 11.8% and 6.3% with specificity of 93.5%, 99.6% and 98.0% respectively. This study also revealed no advantage of ultrasound EFW over clinical EFW measurement when performed during the late pregnancy and labor [18].

Fetal ultrasound using Hadlock's formula has error in estimation of fetal weight by about 290gm \pm 250gm as shown by a study conducted from January 2010 to February 2012 in Nepal. Error of estimation by more than 10% compared to actual weight was

seen in 40% of cases. Significant error of estimating fetal weight by ultrasound that lead to unnecessary obstetrical intervention^[19] was concluded in study. Between January 2012 and July 2012 a prospective validation study was done at General Hospital Ampara, Srilanka on 393 pregnancies at gestational age between 35 and 41 weeks showed all EFW formulas either under or overestimated birth weight in singleton pregnancies. Overestimation of fetal weight in low birth weight babies and underestimation of this in birth weight >3500g^[20] was seen with almost all formulas.

Another comparative study between accuracy of clinical and ultrasound EFW in predicting actual birth weight in 200 term pregnancies was done in Enugu, Southeastern Nigeria that showed overestimation of actual fetal weight by both of these methods. The proportion of the clinical estimated weights that were within 10% of the actual birth weight was significantly lower than that of ultrasound method for babies of all birth weights (35.0 vs 67.5%; $p < 0.001$) and for macrosomic babies (76 vs 100%, $p = 0.009$). For babies with normal birth weights (2.5-3.9 kg), ultrasound method error values were significantly lower than those of clinical method for both the mean percentage error (5.4 vs 19.6%; $p < 0.001$) and the mean absolute percentage error (9.97 vs 20.6%; $p < 0.001$)^[3].

Significant association between birth weight, gestational age and maternal weight were found in a prospective study carried out in Khartoum, Sudan in a total of 533 participants within 36 months of time which concluded that predicting fetal weight using the formula derived by Hadlock *et al.* is accurate and valid^[21].

High risk pregnancies such as those associated with intrauterine growth retardation, macrosomia and prematurity are associated with significant morbidity and mortality which can be reduced with accurate EFW. To the investigator's knowledge, there is no study done in Bolan Medical Complex Hospital which evaluated the accuracy of ultrasound in estimating fetal weight in term pregnancy. Therefore, this study could provide very important information about the accuracy of ultrasound in estimation of fetal weight, which helps to decrease maternal and child mortality and morbidity in term pregnancy. It also provides insight about factors which contribute to its accuracy and limitations.

Patients and methods

The study was conducted in the department of radiology, Bolan Medical Complex Hospital Quetta after approval from Ethical Review Committee and informed consent from patients. Consecutive sampling technique was applied and 470 ultrasound examinations of term pregnancies were recorded during 6 months period between January 2019 to June 2019. Term pregnant women those who visited Bolan Medical Complex Hospital for routine Antenatal clinic (ANC) follow up and those who came with labor and admitted to the obstetric ward were participated in the study. Pregnant mothers who are critically ill and cannot give informed consent and those mothers with still birth and other fetal anomalies were excluded.

All pregnant women who came to ANC visit and those who came with labor and admitted to obstetric ward were interviewed and ultrasound examination done by principal investigator using commercially available ultrasound systems (TOSHIBA; Germany) with curved transducers having frequency of 3.5 MHz were used. The machines used the Hadlock formula in fetal

weight estimation. The collected data filled in self-prepared data collection sheet / questionnaire/ which includes the socio-demographic characteristics and possible determinant variables for the accuracy of ultrasound (including gravidity, parity and last menstrual period) and ultrasound finding variables like gestational age by ultrasound, fetal presentation/lie, number of gestation, amniotic fluid amount, placental position and estimated fetal weight were included. Finally, the actual fetal weight collected by the principal investigator from the medical document records. The reports and findings were recorded.

Data completeness was checked on each data collection day by the principal investigator. Data clearance and cleaning was done before data entry. Data entered and analysed using SPSS 20 statistical software. The data was described using proportions and percentages, while appropriate graphic presentations besides measures of central tendency and measures of dispersion were used for further description. Socio-demographic and other independent variables were analyzed. Multivariate logistic regression model was employed to control for confounders. P-value <0.05 was considered statistically significant.

Results

A total of 470 term pregnant women were eligible to be incorporated in the analysis for the accuracy of ultrasound in fetal weight determination after the relevant ultrasound examination was done. The mean (\pm SD) age of the mothers was 27.08 (\pm 4.49) years with a range of 16 yrs - 40 years. Mean gravidity was 1.95 with a range of 1 - 6.

From the total sample of 470 term pregnant women who had obstetric ultrasound examinations; 85.53% was found to be accurate in estimation of fetal weight and the rest 14.46% of the examinations was inaccurate (figure 1).

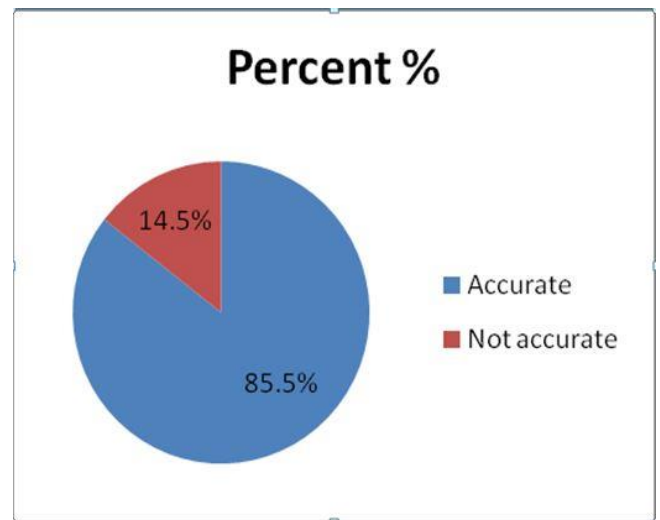


Fig 1: Accuracy of determination of fetal weight by ultrasound

The accuracy of weight estimation was seen to decline as the gestational age increased from 87.8% at 37 - 38 weeks, 82.6% at 39-40 weeks and 50% at 41-42 weeks.

From those evaluated at 37-38 weeks, 44 were not accurate and ultrasound overestimated 12 of them and underestimated 32 of them, of those at 39-40 weeks 16 were not accurate, all of them were underestimated and at 41-42 weeks 4 were not accurate and

all were underestimated.

Of 470 mothers examined in determining the accuracy of ultrasound on EFW, the weight difference between estimated fetal weight and actual fetal weight was analyzed and the mean weight difference was 226.67gm (the average difference between the estimated and actual fetal weight). The standard deviation is 196.75 (average difference among each observation) in range of 9gm up to 1193gm (the minimum and maximum difference among observations). This implies in average there was 226.67gm over or under estimated weight in the examination.

The proportion in the extent of the deviation in fetal weight away from expectation was with a mean value of 0.0741 (the proportion of difference between estimated and actual fetal weight differ by 7.4%) and standard deviation of 0.0716. The most accurate estimation had a 0.02% variation from the actual and the worst estimation had 45.7% variation from the actual weight. Generally the determination of fetal weight by ultrasound was accurate with an average of 7.4% difference between the expected and actual fetal weight. The deviation in weight at different weight categories showing that the mean difference in those >4000gm is (351.4gm) higher than the others, (292.55gm) in <2500gm and (214.93gm) in 2500-4000gm.

Among those with weight <2500gm 4 of them were not accurate and ultrasound overestimate the weight in both cases, in those 2500-4000 gm 52 of them were not accurate and among these 5 of them were overestimated and 42 of them underestimated and in those >4000 gm 10 were inaccurate and all of them were underestimated. Generally the accuracy of ultrasound fetal weight estimation is high when the fetal weight is in the range of 2500- 4000gm and low when the fetal weight is > 4000gm (Figure 2).

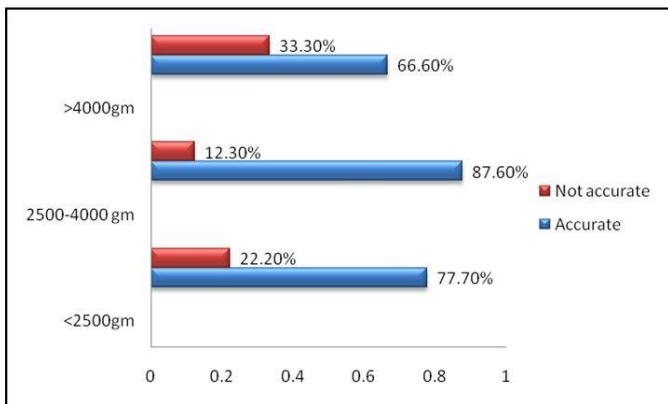


Fig 2: The Accuracy of fetal weight determination by ultrasound when the weight at delivery is less than 2500gm, between 2500gm & 4000gm or greater than 4000gm

In order to identify the major determinants in the accuracy of the fetal weight determination, the difference between expected fetal weight and weight at delivery was used as the indicator of the extent of accuracy of the result of the examination. This variable is supposed to be the dependent variable of our regression model. However, the difference between these two variables can be

either positive or negative. Since we are interested with the magnitude of the difference, only the extent of the difference was used as the dependent variable of our linear regression model. All the variables that are expected to influence the difference were used as independent variables.

The variables considered in this regression were found to be jointly non-significant to examine and Pseudo R2 is also 0.0952 which depicts that the listed variables which were used for this analysis do not explain the required result. This result clearly showed that the major determinant factors for accurate fetal weight determination are other factors out of the variables which we used in this study.

The individual significance test of the regression showed that 4 of the 20 stated variables were found to affect the probability of making accurate estimation of fetal weight, significantly at 1% and 10% levels of significance. These include fetal lie cephalic, fetal lie transverse and placental location anterior fundal and posterior fundal.

The result showed that fetal lies cephalic and transverse are likely to affect the correct estimation of fetal weight negatively. It is indicated that coefficient of fetal lie cephalic and transverse are negative having P-value of 0.085 and 0.097 respectively revealing that these are among the significant variables that can affect the probability of making accurate fetal weight determination, negatively at 10% level of significance. Placental location anterior fundal and posterior fundal influences the probability of making accurate determination negatively and significantly, having negative coefficient. It has P-value of 0.079 and 0.027, respectively, which showed it is significant at 10% level of significance (figure 3).

The rest of the variables remained insignificant to influence the accuracy of fetal weight determination by ultrasound.

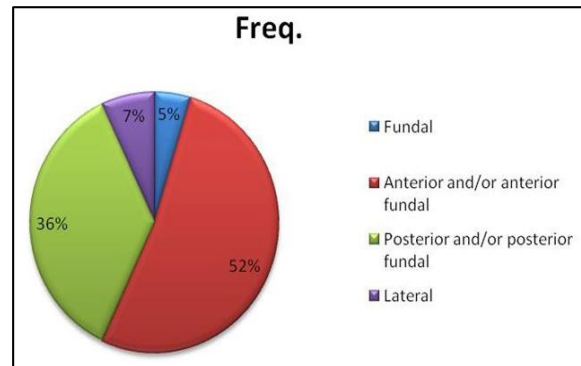


Fig 3: Placental Position by Ultrasound

Discussion

In the analysis for the study on accuracy of ultrasound in fetal weight estimation a total of 470 mothers were included. Estimated fetal weight was found to be accurate within 10% of the actual birth weight in 85.53% of the cases. This accuracy was higher in comparison with 72% in the study by Charles Njoku, 75% by Atalie and 68% by S. Shittu.

Ultrasound underestimated the fetal weight in cases where the

estimation was either greater or less than 10% of the actual birth weight, a finding similar with the study done by Charles Njoku and different from that of S. Kumarasiri and EO Ugwa *et al.* which showed overestimation. Most of the estimations done were prior from the time of delivery during which fetus would have gained weight and contributed to underestimation.

When comparing the estimated weight outcomes based on different stages of GA, the accuracy within 10% of ABW dropped as the GA increased (87.8% at 37-38 weeks, 82.6% at 39-40 weeks and 50% at 41-42 weeks). One reason for these results could be the larger number of sample size found in the category of 37-38 weeks and the small non representative sample size found in 41-42 weeks of gestation. The other possible reasons could be the decrement of AFI at term and engagement of the head as the GA increases making the correct measurement of fetal biometry difficult (especially BPD & HC).

The EFW and the actual birth weight were categorized into three groups in order to observe and compare any possible effect of weight categories on the accurate estimation of ultrasound which ranged between 2500-4000gms, those <2500grams and those >4000gms.

The highest accuracy of ultrasound estimation was in range of birth weight 2500-4000gms and lowest in birth weight <2500gms which was consistent with what S. Shittu *et al.* found in their study.

As previously reported by S Kumarasiri and T. Prior this study also showed that ultrasound overestimated low birth weight and underestimated high birth weight.

Weight difference less than or greater than 10% of actual fetal weight was defined as over or underestimation respectively. The sensitivity, specificity & positive predictive value of ultrasound to accurately estimate the fetal weight within 10% of the actual birth weight was found to be, in those < 2500gm it was 63.63%, 66.67% & 77.78% respectively, for those between 2500 & 4000gm it was 97.37%, 40.9% & 87.68% respectively and for those >4000gm it was 26.32%, 97.46% and 66.67% respectively.

Limitations

Some births occurred over a wide range of days after the last ultrasound examination and there was a gap in measurement of EFW and the date of delivery which underestimates the weight of the fetus. Fetal weight estimation was done by only one formula, Hadlock type but it would have been good to assess different formulas on ultrasound for fetal weight estimation.

Conclusion

In comparison with other studies our study revealed higher accuracy of ultrasound in estimation of fetal weight when performed on term pregnancies. More accurate results are shown in normal birth weight of fetuses and gestational age of earlier weeks of term pregnancies. Due attention should be given to over and under estimation of low birth weight and macrosomia respectively by sonographic weight estimation to avoid any under diagnosis leading to mismanagement.

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