Research Article

Sonographic Assessment of Fetal Weight at Term and its Correlation with Weight at Birth in Pakistani Population

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Abstract

Objective: To compare sonographic estimated fetal weight with actual birth fetal weight.

Back Ground: Prenatal estimation of fetal weight is very important to predict various pathological and physiological conditions. Ultrasound is the modality of choice to predict fetal weight that's why different formulas are designed to estimate fetal weight. However to what extant these formulas are applicable and accurately estimate fetal weight in our population? An effort is made in the form of this research to solve this question to some extent.

Methods: The study was designed for the evaluation of the relative accuracy of the sonographically estimated fetal weight at term while comparing with actual birth weight at birth, in healthy Pakistani pregnant ladies. Four hundred normal pregnant females were enrolled in this research voluntarily after written informed consent. The obstetrical sonographic examination was performed at term and followed the patient till caesarian section or prevaginal delivery. Only normal pregnant women with normal pregnancies and normal fetuses were included. Diabetic and hypertensive mothers and fetal chromosomal anomalies, macrosomic and microsomic fetuses were excluded. Before delivery at term fetal weight was calculated with ultrasound and after birth, the fetal weight was measured with weighing scale.

Result: The average of sonographically estimated fetal weight was 3187.60 g and actual fetal was calculated at birth, mean 3282.32 g. The difference between the means of actual fetal birth weight and estimated weight was 94.72g.

Conclusion: There was a strong correlation between actual birth weight and sonographically estimated fetal weight. But still ultrasound is unable to detect accurate fetal weight rather it estimate fetal weight while having some statistically acceptable variation.

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Keywords | Gestational Age; Obstetrical ultrasound; Estimated fetal weight; Actual Birth weight; Correlation; Sonography.

Introduction

Prenatal fetal weight determination is very important for the fetal wellbeing as well as for the management plane of delivery.[1] Fetal weight estimation is one of the most important predictors of fetal intrauterine growth restriction (IUGR).[2] Underweight fetuses are at increased risk for different pathological conditions such as respiratory distress syndrome, type 2 diabetes, Heart disease, stroke, kidney disease, gum disease, and nerves disease.[3] Ultrasound is a non-invasive, fast, safe, accurate, easily performable, and cost-effective imaging modality.[4] Ultrasonography has been used since long, for the diagnosis of different causes of pathological and physiological conditions, in this country. The above-mentioned characteristics of Ultrasonography make it an advantageous modality in the developing country such as Pakistan, where trained personnel are few and economic power for purchasing good quality and sophisticated imaging machines are limited.[5] The introduction of Ultrasonography in medical diagnosis has overcome a lot of diagnostic restrictions of x-radiation during pregnancy and has nearly eliminated fetal exposure to ionizing radiation.[6] In the field of obstetrics and gynecology, Ultrasonography has become firmly established that it is now capable of diagnosing many fetal structural abnormalities.[7] Ultrasonography is essential for assessing fetal weight, fetal wellbeing, and guiding physicians through the treatment plane of the fetus. It has gradually become an indispensable procedure and plays an important role in caring for every pregnant woman. It is now recognized that the use of diagnostic Ultrasonography in pregnancies improve patient management plane and pregnancy outcome.[8] However, with the routine ultrasonographic examinations, the overall improvement of perinatal outcome or decrease in morbidity or mortality is still controversial.[9]

Developments in obstetrical Ultrasonography lead to the creation of the new specialty of prenatal diagnosis which became concerned with the study of fetal congenital anomalies. Another important development in the 1980s was fetal biometry.[10] About two dozen measurements were developed to assess gestational age and fetal size.[11] The measurements that are still widely used today for fetal biometry are the biparietal diameter (BPD), the crown-rump length (CRL), the abdominal circumference (AC), the femur length (FL), the head circumference (HC), the anteroposterior trunk diameter (APTD), the transverse trunk diameter (TTD) and the fetal trunk cross-sectional area (FTA).[12]

Accurate fetal weight assessment by Ultrasonography is crucial, especially in the preterm births. Small for Gestational Age (SGA) fetuses are susceptible to stress during the childbirth.[13] Accurate identification of SGA fetuses allows for close monitoring and informed decision-making on pregnancy prolongation or surgical delivery.[14] Many studies that examined fetal weight with Ultrasonography had a poor methodology or statistical analysis. There remain variation in the actual birth weight and sonographically estimated fetal weight for different population due to variation of climatic factors effecting body habitus of the inhabitants.[15] This research is therefore an effort to check the applicability of sonographic estimated fetal weight in the population of Pakistan.

Methods

This cross-sectional study was conducted at Gilani Ultrasound Centre Ferozpur Road Lahore to apply the sonographic criteria for the estimation of fetal weight in our population. The study was completed in 18 months from 1st September 2015 to 1st March 2016. Four hundred normal pregnant women were included in the study after signing informed consent, voluntarily. This study was performed in accordance with the Declaration of Helsinki. This human study was approved by Technical Review committee (TRC) and Institutional Review Board (IRB). Systematic random sampling techniques were followed, and alternative individuals were selected for randomization purpose. Diabetic, hypertensive pregnant mothers, anomalous and abnormal babies were excluded from this study. Toshiba Xario with convex transducer 3-6Mhz was used. Sonographic Fetal weight was measured with the use of headlock method at term. Pregnancies were followed till delivery and actual weight was measured. Correlation of the sonographic estimated fetal weight and actual fetal weight was performed with Pearson's correlation coefficient with the help of Statistical Package of Social Sciences (SPSS 24, IBM, Armonk, NY, United States of America). Patient privacy was main-

tained throughout the examination. Standard, AIUM Obstetrical Ultrasound guidelines and examination techniques were observed during the examination. Patients were examined in supine positions with the application of appropriate amount and proper warm gel at body temperature. Throughout the examination the fetus was considered as an individual and proper examination of all the organs, and structures were performed. They were scanned fully (head, abdomen, limbs, heartbeats, orientation, presentation, position, amount of liquor, placenta position and maturity). The researcher measured the PBD in a good position (e.g. oval shape, equidistant), the A.C with good criteria (stomach in G-shape and aorta of the fetus should be visible) and FL with full extension. The measurement was taken by placing the curser outer to outer (Figures 1,2 and 3) . The estimation of the fetal weight was multifactorial and was calculated from the measurement of femur length, abdominal circumference, and biparietal diameter. The gestational age and fetal weight were calculated with the help of built-in equation and the actual fetal weight was registered in the labor room after delivery by the doctor. Comparison of the actual birth weight and sonographically estimated fetal weight was presented in the form of scattered plot and Pearson's correlation.

Results

With the objective of comparing sonographically estimated fetal weight with actual weight at birth, we included 400 normal pregnant females (free of hypertension, diabetes, uterine anomalies etc.) with normal pregnancies (free of pregnancy-related complications i.e. polyhydramnios, oligohydramnios, placentomegaly etc.) and normal fetuses (free of chromosomal anomalies, macro or microsomia etc.). Mean age of the patient was 27.36 ± 5.3 years (17-41 years). Parity was included as a variable in this study to compare it with fetal weight in addition to the main objective. Mean of the parity was calculated as 2.5 ± 1.7 (0-7). Mean biparietal Diameter was 93.32 ± 0.70 mm (91.50-95.20 mm). Mean femur length was 77.50 ± 0.97 mm (74.20-77.50.20 mm). Abdominal circumference is important for headlock formula, mean abdominal circumference was 324.74 ± 10.39 mm (300-350 mm). Mean gestational age was 38.25 ± 1.11 weeks (36-40 weeks). The mean of sonographically estimated fetal weight was 3187.60 ± 491.99 g (2358 -3915 g). Actual fetal was calculated at birth mean 3282.32 ± 497.63 g (2412-4000 g) as shown in table 1. A Significant linear correlation was found (p-value = 0.000 and R2 = 0.989) between the actual fetal weight at birth and sonographic estimated fetal weight (Table 2, Figure 4).

Table 1: *Descriptive Statistics of Different Variables Related to Fetus*

Variables	N	Min.	Max.	Mean	Std. Deviation
Age	400	17.00	41.00	27.36	5.30
Parity	400	1	7	2.5	1.7
Biparietal Diameter (BPD)	400	91.50	95.20	93.32	0.70
Femur Length (FL)	400	74.20	77.50	76.41	0.97
Abdominal Circumference (AC)	400	300.00	350.00	324.74	10.39
GA in weeks	400	36.00	40.00	38.25	1.11
Sonographic, Estimated Fetal Weight (EFW)	400	2358.00	3915.00	3187.60	491.99
Actual, Birth Weight	400	2412.00	4000.00	3182.32	497.63

Table 2: *Correlation of Sonographic EFW and Actual Birthweight.*

		Sonographic EFW	Actual Birth Weight
EFW	Pearson Correlation	1	.989**
	Sig. (2-tailed)		.000
	N	400	400

****. Correlation is significant at the 0.01 level (2-tailed).**

Figure 1: *Gestational age 37 Weeks and 4 Days, Sonographic Estimated Fetal Weight 3257g, and Actual Birth weight was 3264g, C-Section Delivery.*

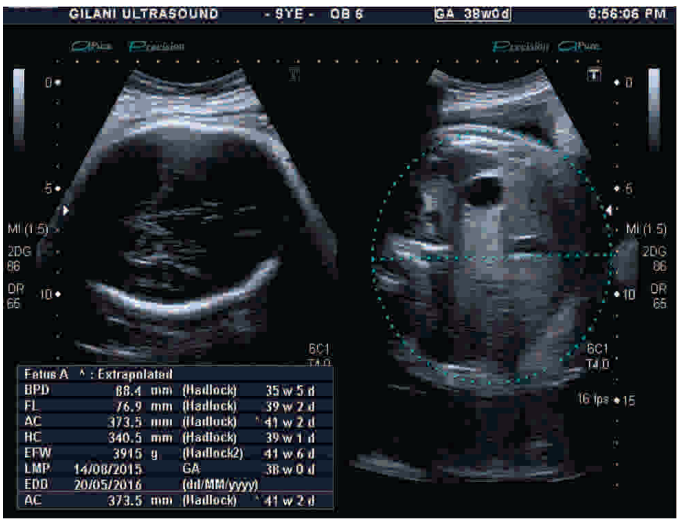

Figure 2: *Gestational age 38 weeks, Sonographic Estimated Fetal Weight 3915g, and Actual Birth Weight was 4000g, Pervaginal Delivery.*

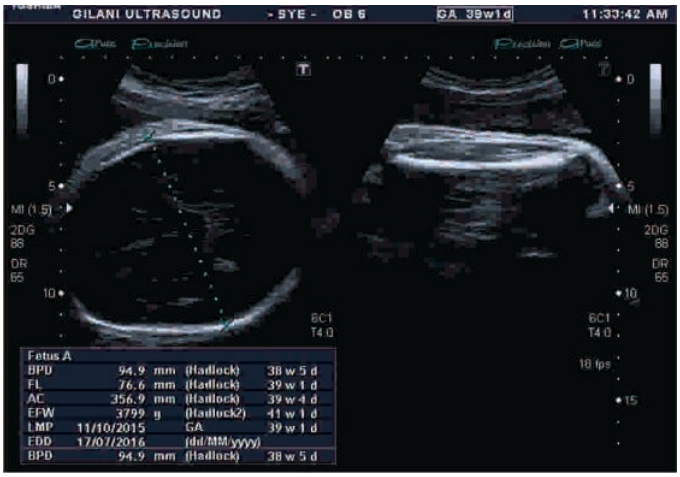

Figure 3: *Gestational Age 39 Weeks, and 1-Day, Sonographic Estimated Fetal Weight 3799g, and Actual Birth weight was 3757g, Pervaginal Delivery.*

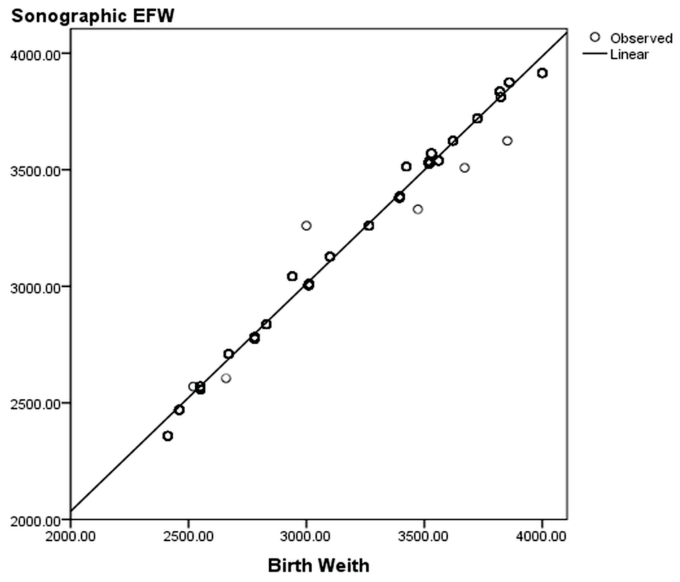

Figure 4: *Correlation between Sonographically Estimated and Actual Fetal Weights.*

Discussion

Estimation of prenatal fetal weight is not only important for the fetal welling but it is also important the delivery management plane. There are well-established criteria for calculating fetal weight, and all the ultrasound machines have built-in formula to calculate fetal weight from the various combinations of fetal biometry.[16,17] And previously a lot of data published in the literature from various countries of the world.[18] But As we know machine estimate fetal weight from the biometry of different fetal organs and structures (Figure 1,2,3). Demographically, all the individuals are not alike they vary in body habitus and morphology from each other. It was, therefore, a question arising, whether our machine estimates fetal weight accurately, in our population or not. While keeping in mind this question we performed this research to correlate sonographically estimated fetal weight with actual weight at birth. Four hundred normal pregnant women were voluntarily enrolled in this study. Ultrasound was performed at term, less than one week prior to either C-section or normal Pervaginal elective delivery. All the hypertensive, diabetic, Rh-incompatible and women with uterine anomalies were excluded from this study. All the macrosomic, microsomic and anomalous fetuses were excluded. The actual weight of the fetuses was measured at birth in labor room or gynecological operation theater. A study was conducted by Valent AM, et al with the aim to know the accuracy of sonographically estimated fetal weight in normal and diabetic pregnant women.[19] The mean of change in expected fetal weight in normal and diabetic individuals were 62 and 103 g and P-value = 0.04. But the signed percent error was observed 1.7% ± 9.8% and 2.6% ± 9.9%, in normal and diabetic mothers respectively, P- value was 0.15. There was a week correlation between the change in fetal weight in normal and diabetic mothers while comparing on linear regression, "R2" was 0.11 and "r" was 0.34 and non-DM pregnancies. Overall sensitivity for the estimation of fetal weight more than 4000g was poor. It was concluded that the biometric measurements of the fetus could be affected by diabetes with a change in thorax and abdomen diameter, but no clinically significant alterations in the accuracy of expected fetal weight when performed near delivery. In our study, we were checking for the accuracy of sonographically estimated fetal weight that's why we exclu-

ded diabetic pregnant women from our study. but in case of comparison of the estimated fetal weight with actual birth weight, our results agree with it.

A study conducted in Nigeria in 2015; by Eze CU, et al; with the same aim to evaluate sonographically estimated fetal weight with actual birth weight.[16] They included 282 pregnant women conveniently but we include four hundred women with systematic random sampling. They calculated mean of estimated and actual fetal weight at term as 3378±40g and 3393±60g respectively. There was about 100 to 150g difference between the mean weight of our study and the study mentioned above. It means demographically, fetal weight varies from each other. They observed 14.5% macrosomic and 15.2% macrosomic fetuses but we excluded both the groups to accurately check for the weight estimation model. They concluded that in the population of Nigeria, fetal weight estimated by ultrasound with Hadlock-3 weight estimation model can correlate with actual birth weight positively.

A prospective study is published in 2015, by Dimassi K, et al; with the aim to check the accuracy of sonographically estimated fetal weight.[20] For this purpose, they followed 500 singleton pregnancies. Fetal weight was estimated sonographically before birth and measured after birth. Both the weights were compared and median difference was found 200g, The linear logistic regression showed a very strong relation, R-value of 0.79 and p-value significant at 0.01 level. The results of our study also agree with it. Dimassi K, et al; prospectively performed ultrasound of 299 pregnant women at 37 or more weeks of gestation, in 2015, with the aim to check for inter-observer variability. He concluded that fetal weight estimated by residents in the delivery room were as accurate as those performed by experimented sonographers. Weissman A, et al; studded thirty-three triplet pregnancies to assess the accuracy of sonographically estimated fetal weight in triplet pregnancies.[21] The difference between sonographically estimated fetal weight and actual weight was compared. In 70% of individuals, the difference was less than 10%, it was 10-20% among 19% of pregnancies and less than 10% difference was found in 11% of pregnancies. In our study, we excluded multiple pregnancies.

With the development of ultrasonographic fetal measurements, numerous methods of fetal weight estimation have been evaluated. Many of these computer-generated equations such as the Campbell & Hadlock et al Rose & McCallum and the Sabbagha equation use head and abdominal measurements similar to the formulas used in this study. Obese patients, anterior location of the placenta and decreased amniotic fluid levels are factors that can affect the quality of sonographic examination and therefore, its accuracy. However, our data did not support these factors as limitations in assessing fetal weight. One way to compare the accuracy of two or more ultrasonographic fetal weight estimation methods is to perform the estimations concurrently on the same patient and then compare the error for the methods. Another way is to calculate the percentage of estimated weights that are within 10 % of actual fetal birth weight, the formula with more estimates that are within 10 % of actual fetal birth weight was being considered more accurate. The present study was designed to evaluate the relative accuracy and the effect of various fetal parameters on three sonographic methods of estimating fetal weight. The effect of birth weight on accuracy was Zed by selecting a population with an expected narrow birth weight range. All examinations were carried out by a single investigator, thus eliminating interobserver variation as a confounding variable. The mean error for each of the three methods was comparable to other published reports. The comparison of mean error among the methods and the percentage of fetuses estimated within 10 % of actual birth weight revealed that the Aoki formula was slightly more accurate than either Aloka or Shephard's formula. This agrees with the findings of Chien et al who estimated fetal weight using the Aoki, Campbell, Shephard and Campbell formulas. They suggested that the high accuracy for the estimation of fetal weight obtain by the use of the Aoki formula. Probably due to the uses three fetal biometric variables (BPD, AC, and FL) rather than two variables (M & AC) as in the Shephard's formula or one variable (AC) as in the Campbell formula.[22]

Our result is also comparable to other published reports. For example, using BM and two dimensions of the abdominal diameter (AC) which was averaged, Benacerraf et al stated that 74 % of their estimates were within plus or minus 10 % of the actual birth

weight in a sample of thirteen hundred pregnant women. This is lower than our result which showed that the estimated weights were within 10% of actual birth weight. The large sample size in that study compared with our 400 subjects may have contributed to the differences that exist between the two results. Our result is also in agreement with the findings of Shamley et al who analyzed four equations for estimation of fetal weight (Hadlock, Shephard, Rose and Sabagha and found that 70 79 % of their weight predictions were within 10 % of actual fetal weight. Our study demonstrated that fetal weight can be estimated accurately and reliably by Ultrasonography at term using any of the three formulas. However, as the head is frequently engaged during the first stage of labor, BPD could not often be measured accurately in patients in active labor. In such patients, formulas using another standard sonographic measurement, such as femur length (FL) are advised for estimation of fetal weight.[23]

This problem did not affect our study because all subjects with ruptured membranes were excluded from selection into the study population. The percentage of estimates within 10% of the actual birth weight was significantly higher among those who were estimated by Aoki's formula followed closely by Shephard's formula. Furthermore, the Aoki equation presented the smallest mean difference between fetal weight estimated by Ultrasonography and actual birth weight compared with the two other equations. Our study also found that the Aoki and the Shephard equations tended to underestimate fetal weight whereas the Aloka equation tended to overestimate. This finding is in agreement with that of Chien et al who found a high level of validity for fetal weight estimated by the Aoki and Shephard formulas. In our study, the ability of all three equations to detect birth weights over 3800 grams was very poor. This confirms Hadlock's observation about the limited sensitivity of sonographic equations to identify the macrosomic fetus. All three equations were able to rule out most suspected small for gestational age.[24]

Conclusion

Estimated fetal weight based on multiple fetal parameters give reliable and clinically useful information for most pregnant ladies. Although there remains acceptable variation between the actual birth weight and sonographically estimated fetal weight.

Ethical Approval: Given
Conflict of Interest: None
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