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ORIGINAL ARTICLE

TO COMPARE THE ACCURACY OF PREDICTED BIRTH WEIGHT BY ULTRASONOGRAPHIC MEASUREMENTS OBTAINED JUST BEFORE AND AT TERM

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ABSTRACT: BACKGROUND: Fetal weight measurement by ultrasonographic methods can be considered as an important modality for antenatal prediction of fetal weight (preferable single USG should be done at 34-36.9wks) to rule out various complications of pregnancy such as macrosomia, IUGR etc which enable us to be prepared for the delivery of the baby and prevent any further dreaded complications resulting out of these conditions including shoulder dystocia, severely compromised baby **AIM:** To compare the accuracy of predicted birth weight by ultrasonographic measurements obtained just before and at term. **METHOD:** The study was performed in a tertiary care Hospital in West Bengal between 1st July 2012 to 30th June 2013 on 100 Pregnant women attending Antenatal Clinic (34-36.9 wks) with a live singleton pregnancy, all women underwent ultrasound examination twice(< 37 weeks/ > 37 weeks). The estimated fetal weight calculated using Hadlock's formula. Data were then compared for each pair of sonograms from the same patient using a paired t test. P value of **<0.05** was considered statistically significant. RESULTS: The study included 100 patients undergoing 200 sonograms. The mean absolute error of the predicted birth weight was smaller for period 1 (34-36.9 wks) than for period 2 (≥ 37 wks) (152 ± 125g compared with 193.5 ± 121g, P=0.0001). The overall mean absolute percent errors in predicting birth weight were 5.6 ± 4.7 (Period 1) & 7.6 ± 4.3 (Period 2) for IUGR and 5.4 ± 3.9 (Period 1) & 6 ± 3 (Period 2) for Macrosomia. Averaging data from both gestational periods did not improve the prediction of birth weight. Our study did not show any correlation between latency and the accuracy of birth weight predictions. **CONCLUSION:** This study indicates that serial sonograms in the late third trimester do not improve the ability to predict birth weight, even in abnormally grown fetuses. So, a single sonogram between 34 and 37 weeks' gestation is recommended for prediction of birth weight.

KEYWORDS: Antenatal Birth Weight Prediction, Ultrasound Estimation.

INTRODUCTION: Newborn with low birth weight and excessive birth weight, both are at increased risk of complications during labor and the puerperium.[1,2] The perinatal complications associated with low birth weight are mostly occurring due to fetal prematurity and intrauterine growth restriction.[2]

The macrosomic fetuses, are at increased risk of complications mainly during delivery, e.g. shoulder dystocia, brachial plexus injuries, bony injuries, and intrapartum asphyxia, as well as maternal risks such as: injury to the birth canal, pelvic floor damage, and postpartum hemorrhage. So, it would be extremely useful if we could accurately estimate the birth weight prenatally. There are a few options available for this, of which tactile assessment of fetal size & weight is the oldest technique. This technique is referred to as clinical palpation or Leopold manoeuvre.

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The pros of this method are that it is convenient and virtually costless; but the cons are that it is a subjective method and associated with notable predictive errors.[3,4,5]

Another widely available method is the obstetric ultrasonographic assessment. The sonologist uses the fetal biometric measurements and put them into standard formulas to predict fetal weight. This method has been presumed to be more accurate than clinical methods for estimating fetal weight. Ultrasonographic measurements have been studies extensively and they found to have a mean absolute error ranging 6-15%[6] for birth weight prediction.

The effects of fetal growth on the estimation of weight is an important concern, therefore most of the studies have performed ultrasound either in early labor or within the preceding week. But even this approach has several flaws, like- at such advanced gestation, the fetal head sinks into the pelvis and becomes fixed, making it difficult to accurately take the measurements.[7]

So, taking the fetal measurements remote from term and extrapolating them to get the estimated birth weight is the best available option. The gestation- adjusted projection method, proposed by Mongelli and Gardosi[8] for predicting fetal weight from sonographic measurements is now being widely studied.

This technique is based on the assumption that normal fetuses do not cross percentiles on growth curves. This implies that:

$$\frac{\text{Estimated Fetal Weight by U/S}}{\text{Median Fetal Weight at Gestational Age of U/S}} = \frac{\text{Birth Weight at Delivery}}{\text{Median Fetal Weight at Gestational Age at Delivery}}$$

Fig. 1: Projected weight at delivery by ultrasound

The purpose of this study was to determine that which is the best time to perform a remote ultrasound for predicting fetal birth weight, whether just before term (Period 1, 34.0 –36 wk 6 days' gestation) or at term (period 2, 37 weeks' gestation or greater).

MATERIALS & METHODS: The study was performed in a tertiary care Hospital in West Bengal, India. The institute caters a huge area, mostly rural with annual delivery more than 20000 per year. The study was done between 1st July 2012 to 30th June 2013.

100 Pregnant women, with confirmed gestational age of 34 –36 wk 6 days with a live singleton pregnancy, who attended the Ante-natal OPD in The Department of Obstetrics & Gynaecology, R G Kar Medical College & Hospital, were included in the study. All women underwent ultrasound examination twice (Once before 37 weeks' gestation and once at or after 37 weeks' gestation).

All ultrasound examinations were performed by the same sonologist to eliminate observer bias. The biparietal diameter, head circumference, abdominal circumference, and femur length had been measured with standard ultrasound machines and fetal weights were calculated using Hadlock's formula.[9]

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Patient records were specifically checked for the risk factors of intra uterine growth restriction or macrosomia.

Now the birth weights were predicted from each sonogram using the gestation-adjusted projection method and Brenner's median fetal [10] weights (50th percentile) for gestational age. First, the estimated fetal weight and the median fetal weight for the gestational age at that sonogram were put in the formula in Fig-1. As we now knew the exact time of delivery, we put the median fetal weight at the time of delivery in the formula in Fig-1, so we get the predicted birth weight at the time of delivery. Now the difference between the predicted & actual birth weight was calculated. A positive value means that, it has overestimated the birth weight & negative value means underestimation (The signed error).

The absolute error in birth weight prediction was calculated by ignoring the positive or negative signs. Percent errors (signed and absolute) were obtained by dividing the error in prediction by the actual birth weight. Data were then compared for each pair of sonograms from the same patient using a paired t test. This allowed each patient to serve as her own control.

The percentage of predicted birth weights within 5%, 10%, and 15% of the actual birth weight were also calculated by Chi square test. The average of the predicted birth weights for each fetus were compared with each prediction alone, using paired t tests.

The effects of latency until delivery and actual birth weight on the accuracy of birth weight prediction were assessed using Independent variable t test. Since this method required independence among observations, data from period-1 and period 2 were analyzed separately.

A P value of <0.05 was considered statistically significant. Using an alpha=0.05 and beta= 0.80, minimum 24 patients would be required to detect a 200 g difference in the predicted birth weight.

RESULT ANALYSIS: The study population consisted of 100 patients undergoing 200 ultrasound examinations. The overall demographic characteristics of the patients and their infants are given in Table 1.

Characteristic	Mean (Average) ± SD	Range
Maternal age (y)*	21.78 ± 3.72	18-37
Gravida*	1.46 ± 0.77	1 – 4
Gestational age at delivery (wk)*	39.9 ± 1.01	37.3 – 41.3
Birth weight*(g)	2814.5 ± 530.5	1900 – 4500

Table 1: Maternal and Infant Demographics:

*Mean (average)

The women at risk for macrosomia (n 18) had: maternal diabetes, increased fundal height, history of macrosomia; and women at risk for growth restriction (n 17) had: underlying maternal disease, lagging fundal height, oligohydramnios, placental abnormality.

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Birth weight error	Period 1	Period 2	P value	X^2	df
± 5%	54%	41%	0.07*	3.38	1
± 10%	81%	77%	0.49*	0.43	1
± 15%	98%	95%	0.25*	1.3	1

Table 2: Percentage of Correct Birth Weight Predictions-(n=100)

* Chi-square test.

The table 2 shows: there were no differences in birth weight predictions within 5%, 10%, or 15% of the actual birth weight in both the ultrasounds.

Mean errors in prediction	Period 1 (34.0 –36.9 wk)	Period 2 (37.0 wk and beyond)	P value
Birth weight (g)	33 ± 195	39 ± 226	P=0.7* T=-0.38
Absolute birth weight (g)	152 ± 125	193.5 ± 121	P=0.0001* T=-0.4
Percent errors	0.83 ± 7	1.1 ± 8.11	P=0.65* T=-0.45
Absolute percent errors	5.3 ± 4.5	6.8 ± 4.5	P=0.0001* T=-4.5

Table 3: Mean Errors in Birth Weight Prediction.

* Paired sample t test, two-tailed P value.

The mean predicted birth weight errors, absolute birth weight errors, percent errors, and absolute percent errors for the entire study population are shown in Table 3. The absolute gestation-adjusted projection predicted birth weights from period 1 were superior to those from period 2 and the results were statistically significant (P=0.0001).

Again similar results were found, when we separated the study population by indications for serial sonogram (Table 5).

Fetuses at risk for growth restriction IUGR (n =17)			
Mean errors in prediction	**Period 1**	**Period 2**	P*
Birth weight (g)	-14 ± 167	19 ± 200	0.15
Absolute birth weight (g)	126 ± 106	169 ± 98.5	0.02
Percent errors	-0.5± 7.4	0.9 ± 9	0.18
Absolute percent errors	5.6 ± 4.7	7.6 ± 4.3	0.02
Fetuses at risk for Macrosomia (n =18)			
Birth weight (g)	158 ± 205	159 ± 210	0.99
Absolute birth weight (g)	203.5 ±156	230 ± 121	0.51
Percent errors	4 ± 5.5	4 ± 5.6	0.97
Absolute percent errors	5.4 ± 3.9	6 ± 3	0.5

Table 4: Mean Errors in Birth Weight Prediction by Indication for Sonogram

*Paired sample t test, two-tailed P value.

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Interestingly, sonograms performed after 37 weeks were more likely to overestimate the birth weight of fetuses at risk for macrosomia and underestimate the birth weight of fetuses at risk for growth restriction than studies performed between 34 and 36.9 weeks. However, these differences were not statistically significant.

Similarly, the effect of using the information from both scans to predict birth weight accurately is shown in Table 6 & 7. Averaging birth weight predictions from both sonograms did not improve the accuracy of the predicted birth weight over that from period 1 but was superior to the prediction from period 2.

The latency until delivery was not significantly correlated with the absolute percent errors of gestation-adjusted projection-predicted birth weights during period 1 or period 2.

Similarly, there was no correlation in the accuracy of birth weight prediction with actual birth weight for period 1 and period 2.

Mean errors in prediction	Mean errors in prediction	Average of both predictions	P value	T value
Birth weight (g)	33 ± 195	32 ± 211	P=0.97*	T=-0.04
Absolute birth weight (g)	152 ± 125	173 ± 124	P=0.17*	T=1.38
Percent errors	0.8 ± 7	0.8 ± 7.5	P=1*	T=0.001
Absolute percent errors	5.3 ± 4.5	6 ± 4.5	P=0.21*	T=1.27

Table 5: Effect of Averaging Information from Both Sonograms on Prediction of Birth Weight- 34.0 –36.9 (wk)

* Paired sample t test, two-tailed P value.

Mean errors in prediction	Mean errors in prediction	Average of both predictions	P value	T value
Birth weight (g)	39 ± 226	32 ± 211	P=0.79*	T= -0.26
Absolute birth weight (g)	193.5 ± 121	173 ± 124	P=0.18*	T= -1.36
Percent errors	1.1 ± 8.11	0.8 ± 7.5	P=0.75*	T= -0.32
Absolute percent errors	7 ± 4.5	6 ± 4.5	P=0.07*	T= -1.8

Table 6: Effect of Averaging Information from both Sonograms - for ≥37.0 wk

* Paired sample t test, two-tailed P value.

The latency between Ultrasound & delivery in all cases of Period 2 were <35 days. But in period 1 ultrasound the latency period ranges between 0-49 days (Table 8). Our study did not show any correlation between latency and the accuracy of birth weight predictions, the absolute percent error in sonograms performed with latency ≤35 days were similar to those sonograms with latency >35 days.

Latency	n	Mean absolute percent error	*P= 0.248
>35 days	35	4.64 ± 4.703	df= 98
≤35 days	65	5.73 ± 4.327	T= -1.163

Table 7: The mean absolute percent error and latency between ultrasound & delivery in period 1:

*Independent sample t-test, two-tailed P value

DISCUSSION: This study identifies, that by applying the gestation-adjusted projection method on the date of delivery, using the data obtained from an ultrasound examination at 34 to 36wk 6 days, birth weight can be predicted with a mean absolute percent error of only 5.3%.

Spinnato et al[11] initially proposed a mathematic model for the prediction of birth weight from ultrasound examinations remote from delivery. The model, utilizing multiple linear regressions and incorporating lapse time, was developed using 245 patients who delivered within 35 days of a complete fetal biometric ultrasound examination and whose newborns weighed 1000–5000 g. The model was then validated on an additional 167 cases, confirming an 8.5% mean absolute error, which was superior to the previously described static methods of Hadlock et al[9] Shepard et al[12] and Ott et al[13]; those methods did not take latency until delivery into account. Of note, although macrosomic or growth restricted fetuses were not studied specifically, they were also not excluded from the study.

Subsequently, Mongelli and Gardosi[8] evaluated 276 low-risk pregnancies that delivered within 35 days of the last ultrasound examination. The gestation-adjusted projection method was compared with Spinnato's method[11] for predicting birth weight. A mean absolute error of 9.93% was found for the gestation-adjusted projection method, which was significantly lower than the 11.98% error calculated using the Spinnato method on this data set. There are two possible limitations to the use of the gestation-adjusted projection method:

1) First, the gestation-adjusted projection method, as originally described, was only applied when the latency between sonographic measurements and delivery was 35 days or less. This was because the gestation-adjusted projection method was being compared with the Spinnato[11] method, which reported unacceptable deterioration of accuracy when latency exceeded 35 days. However, our data included sonograms performed between 0 and 49 days before delivery. Since Mongelli and Gardosi reported no significant correlation between the prediction errors and latency interval, our assumption was that this increase in latency would not significantly affect our results.

This assumption was supported by our data, which did not show a correlation between latency and the accuracy of birth weight predictions, the absolute percent error in sonograms performed with latency ≤35 days was 5.73, as compared to 4.64 for sonograms with latency >35 days, these differences are not statistically significant (P value > 0.2).

2) The second limitation in applying the gestation adjusted projection is the inclusion of fetuses with suspected growth abnormalities (Macrosomia and growth restriction). These patients are precisely the population for whom predicting birth weight may be critical. Since the theoretic basis of the gestation adjusted projection method is that normal fetuses do not cross fetal weight percentiles, including fetuses that are not growing normally could certainly affect the

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accuracy of this method. However, when the fetuses with suspected Macrosomia or growth restriction were looked at separately, the overall mean absolute percent errors in predicting birth weight were 5.6 ± 4.7 (Period 1) & 7.6 ± 4.3 (Period 2) for IUGR and 5.4 ± 3.9 (Period 1) & 6 ± 3 (Period 2) for Macrosomia. These are certainly within the acceptable range of prediction errors, indicating these fetuses did not cross weight percentiles during the gestational age period studied (after 34 weeks).

Eva k. Pressman et al[14]. studied 138 patients with singleton pregnancies undergoing 276 sonograms, between 34.0 and 36.9 weeks' gestation (period 1) and at 37 weeks and beyond (period 2). The mean absolute error of the predicted birth weight was smaller for period 1 than for period 2. They concluded that, sonograms between 34.0 and 36.9 weeks' gestation allow for more accurate prediction of birth weight than sonograms later in gestation, though these differences are small and not clinically significant.

In our study, we also found similar results, indicates that serial sonograms in the late third trimester do not improve the ability to predict birth weight, even in abnormally grown fetuses. A single sonogram between 34 and 37 weeks' gestation is recommended for prediction of birth weight. This fact is also supported by The American College of Obstetricians and Gynaecologists.

The use of multiple ultrasonographic examinations in predicting birth weight was examined by Hedriana and Moore.[15] That study revealed a slight improvement in birth weight prediction if the average of fetal weight percentiles of serial third-trimester observations was used, particularly in the fetuses with abnormal growth.

Bajracharya J et al[16] have done a retrospective observational hospital based study at Kathmandu from January 2010 to February 2012, including a total 150 women with full term singleton pregnancy leading to live birth and found that, fetal ultrasound using Hadlock's formula has error in estimation of fetal weight by about 290 gm ± 250 gm. In 40% of the cases, there is an error of estimation by more than 10% compared to actual weight. Due to the significant error was seen while estimating fetal weight by ultrasound; they concluded that, depending only on the fetal ultrasound for the estimation of fetal weight can lead to unnecessary obstetrical intervention. It is thus necessary to correlate the ultrasound findings with clinical examination.

In our study we found that, sonograms performed before 37 weeks were more likely to overestimate the birth weight of fetuses at risk for macrosomia and underestimate the birth weight of fetuses at risk for growth restriction than studies performed after 37 weeks, though the data are not statistically significant.

Gail Best et al.[17] studied patients with singleton pregnancies who had diabetes. The patients underwent sonograms between 34.0 weeks and 36.9 weeks. A total of 133 diabetic women and 1690 controls were included in the study and found that Prediction of birth weight using the gestation-adjusted projection method is as accurate in diabetic women as in controls. This fact is also supported by American College of Obstetricians and Gynaecologists (Obstet Gynecol 2002; 99: 740–4.© 2002 ACOG).

In our study we found that fetuses at risk of Macrosomia the mean absolute percent error was 5.4 ± 3.9 (Period 1) & 6 ± 3 (Period 2) which is comparable with the overall results of 5.3 ± 4.5 (Period 1) & 6.8 ± 4.5 (Period 2), indicating that the prediction of birth weight using the gestation-adjusted projection method is, as accurate in patients having risk factors for Macrosomia (e.g. Diabetes), as in low-risk patients.

Patrick f. et al[18] conducted a prospective observational study whereby all ultrasonic biometric measurements were done by a single observer. Fifty pregnant women at term had ultrasonic measurement of various fetal biometric parameters performed within a week of delivery. Fetal weight was estimated by the use of four reported methods (Aoki, Campbell, Shepard, and Hadlock formulas).They found The adjusted estimated fetal weight obtained from all four formulas tended to be lower than measured birth weight. The smallest mean difference was obtained with the Shepard and Aoki formulas, whereas the Campbell and Hadlock formulas produced larger mean differences. They concluded that the validity of ultrasonic estimation of fetal weight at term with all four formulas was high. In our study we only used the Hadlock formula for estimation of birth weight.

CONCLUSION: Sonograms between 34 wk and 36 wk 6 days, gestation allow for more accurate prediction of birth weight than sonograms later in gestation.

This study indicates that serial sonograms in the late third trimester do not improve the ability to predict birth weight, even in abnormally grown fetuses.

So, a single sonogram between 34 and 37 weeks' gestation is recommended for prediction of birth weight.

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