Accuracy of Clinical and Sonographic Estimations of Fetal Weight at Term at the Federal Teaching Hospital, Gombe Nigeria

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ABSTRACT

Background: Accurate estimation of fetal weight is important in making appropriate management decision. For example, the decision on the mode of delivery of suspected cases of fetal macrosomia, maternal diabetes, vaginal birth after caesarean section and breech deliveries, is largely dependent on estimation of fetal weight. It is also used by the obstetricians in counselling pregnant women on the timing of delivery of intrauterine growth restricted fetuses. There are inconsistent reports from the clinical and ultrasonographic fetal weight estimation methods.

Aim: The aim of the study was to estimate the fetal weight using both clinical and sonographic methods and to determine their accuracy by comparing them with actual birth weight.

Methods and Materials: This was a prospective cross-sectional comparative study. One hundred and twenty-two pregnant women who were admitted for delivery within 36 hours were consecutively recruited. The birth weights of the fetuses were estimated using Dare’s clinical formula and Hadlock’s ultrasound formula. The women were followed up till delivery and the birth weight of the neonates were taken within 20 minutes of delivery.

Results: In the entire study group, the clinical method overestimated the birth weight by an average of 241 g while sonographic method underestimated the birth weight by an average of 50 g. The mean of the absolute percentage error was higher in the clinical method compared with the sonographic method (11.06% vs. 8.85%; P value = 0.008). The proportions of the estimates within the 10% of the actual birth weight were higher with sonographic estimation compared with the clinical estimation (64.8% vs. 46.7%; p-value = 0.240).

Conclusion: Ultrasound is a better predictor of the actual birth weight and should be used where fetal weight is critical in decision making.

Keywords: Accuracy, Clinical and Sonographic, Estimation Fetal Weight, Gombe.

1. Introduction

Estimation of fetal weight is an important part of antepartum and intrapartum care of pregnant women. It becomes particularly important in diagnosis and management of suspected cases of fetal macrosomia and intrauterine growth restriction because of adverse pregnancy outcomes associated with such pregnancies [1], [2]. For macrosomic babies, vaginal delivery has been shown to be associated with maternal complications such as primary postpartum haemorrhage from uterine atony, cervical and perineal lacerations and increasing risk of operative deliveries [3], [4]. Fetal complications include shoulder dystocia, birth injuries, perinatal asphyxia, and fetal death. To minimize all these complications, American College of Obstetricians and Gynaecologists (ACOG) recommends elective caesarean delivery for estimated fetal weight ≥4.5 kg in pregnant women with diabetes and ≥5.0 kg in pregnancy without diabetes [5]. Accurate estimation
of fetal weight will reduce performance of unnecessary caesarean sections and potential morbidity and mortality.

Fetal weight estimation compared with percentile gestational age specific weight normogram is useful in assessing fetal growth in both uncomplicated and complicated pregnancies [1], [2]. It is one of the cardinal steps in timing the delivery of intratuerine growth restricted fetuses and for prognosis on their survival [6].

In addition to the diagnosis and management of suspected fetal macrosomia and intratuerine growth restricted fetuses, estimation of fetal weight is critical in deciding the mode of delivery of pregnancy complicated with diabetes, vaginal birth after caesarean section, and breech presentation [7]–[9]. In all these cases, estimation of fetal weights may indicate the need for elective caesarean delivery or intensive monitoring of labour should vaginal delivery is allowed.

Various methods of estimating fetal weight have been described in the literature. These methods include maternal perception of fetal weight, clinical palpation using Leopold manoeuvre, use of clinical formulas and fetal biometry with ultrasound.

Maternal perception of fetal weight by parous women and clinical palpation using Leopold manoeuvre have been used with varying degree of accuracy [10], [11]. These two methods are not standardized and non-reproducible. Standardized tool of estimating fetal weight using clinical formulas and sonographic methods have been described to improve accuracy and enhance reproducibility.

The clinical methods widely used are Johnson’s method, Dawn’s rule and Dare’s formula. These clinical methods are simple, cheap, easy to teach and non-invasive. They are, however, influenced by maternal obesity, abnormal fetal lie/presentation, polyhydramnios, oligohydramnios, uterine fibroids and adnexal masses coexisting with the pregnancy.

Sonographic estimation of fetal weight involves the use of one or combination of fetal biometry to automatically generate fetal weight. In addition to estimation of fetal weight, ultrasound has added advantages of diagnosing those pregnancy conditions that influence clinical fetal weight estimation. The ultrasound machines are expensive and require specially trained personnel. There is also erratic electricity supply in the developing countries. Thus, clinical weight estimation is still relevant in our low resource settings.

There are inconsistent results in the accuracy of fetal weight estimation using clinical and ultrasonographic methods. In general, some studies showed no difference in measure of accuracy between the two methods [12], [13] while others found that ultrasound method was superior to clinical methods [14]–[16]. In contrast, a study reported that clinical method as a better predictor of birth weight [17]. For birth weight ≥4.0 kg, sonographic method did better than clinical method [15] while another study showed no difference in measure of accuracy between the two methods [13]. For birth weight ≤2.5 kg, sonographic method was reported to be a better predictor of the actual birth weight and that whenever clinical method is used in this case, a subsequent sonographic method is recommended [13], [15]. Because of these conflicting reports in the literature, it is necessary to assess the accuracy of these two methods of fetal weight estimation in our setting so that our decision will henceforth be evidence based.

The aim of this study was to estimate the fetal weight using both clinical and sonographic methods and to determine their accuracy by comparing them with actual birth weight.

2. Materials and Method

2.1. Study Site

This was a collaborative study between Departments of Obstetrics and Gynaecology and Radiology of the Federal Teaching Hospital, Gombe. The hospital is a tertiary health centre located in the state capital. It manages referral cases from primary and secondary health care centres within the state and neighbouring states. In addition, undergraduate and postgraduate students are trained in this facility. The study was conducted between November 18, 2017 and August 6, 2018.

2.2. Study Design

This was a prospective cross-sectional comparative study.

2.3. Study Population

All women who were admitted for delivery within 36 hours were counselled for the study. Consecutive patients who consented and met the inclusion criteria were recruited until the desired sample size was reached.

2.4. Inclusion Criteria

The inclusion criteria were; Pregnant women with singleton fetus at term whose fetuses were in longitudinal lie and cephalic presentation and pregnant women who were admitted for elective delivery within the next 36 hours.

2.5. Exclusion Criteria

Women who refused to consent, who were established, whose fetuses were in abnormal lie/presentation, and those with ruptured membranes, polyhydramnios, and oligohydramnios were excluded from the study. Women with complications requiring emergency delivery, such as antepartum haemorrhage, pre-eclampsia/eclampsia, weight >90 kg and those who delivered malformed fetuses were also excluded from the study.

2.6. Sample Size Determination

Sample size was calculated using the formula [18]:

$$\text{Sample size} = \frac{Z^2 \times \text{SD}^2}{d^2}$$

Z = constant = 1.96 using confidence limit of 95%
SD = standard deviation from the previous study [12]
Clinical ± 633 grams, Ultrasound ± 441 grams
Mean ± 537
D = absolute error or precision limit put at 100 grams
n = \(1.96^2 \times \frac{537^2}{100^2}\)
= 111
Sample size was approximately 122 with 10% attrition or non-responder rate.
2.7. Sampling Technique
Non-probability convenient sampling method was used.

2.8. Standardization of Procedure

2.8.1. Clinical Fetal Weight Estimation by Dare’s Method

The clinical fetal weight estimation was done by the researchers assisted by two other senior registrars with a flexible tape measure calibrated in centimeters. The pregnant woman was asked to empty her bladder and placed in supine position. The highest point of uterine fundus was located by palpation downward from the xiphisternum with the ulnar border of the hand. The tape measure which was reverse side-up to forestall any bias was placed at this point with a finger, the midpoint of the upper border of the pubic symphysis was then located with a finger. The tape measure was then drawn downward to obtain symphysio-fundal height (SFH) to the nearest centimeters.

The abdominal circumference (AC) was determined by placing a tape measure reverse side-up transversely at the umbilicus with a finger. This was then run transversely to the back of the patient to meet at the same point on the umbilicus. The product of SFH and AC at the umbilicus gave the estimated fetal weight in grams.

2.8.2. Sonographic Estimation of Fetal Weight

Estimation of fetal weight by ultrasound was done independently by two senior residents at the radiologic department assisted by additional two registrars who have been scanning consistently for more than one year. An abdominal sector 3.5 MHz transducer in Philips Ultrasound machine developed in Korea was used. This machine estimates fetal weight with an in-built BPD, AC and FL. The sonologists have no prior knowledge of estimated fetal weight by clinical method.

The patient was asked to lie supine on an examination couch and the abdomen was exposed from the xiphisternum to the pubic symphysis. Ultrasonic gel was then applied to the abdomen. Sequential scan for the BPD, AC and FL described below were done and the fetal weights were automatically displayed by the machine.

2.8.2.1. BPD Measurement

A transverse scan of fetal skull showing a midline echo due to reflection by the falx cerebri was taken [19], [20]. At this point, thalamus and cavum septum pellucidum were also showed at the midline echo [19], [20]. The BPD was then taken by placing a cursor to the right angle of the midline echo from the outer to the inner aspects of the two temporoparietal bones.

2.8.2.2. AC Measurement

A transverse scan of the fetal abdomen showing the liver, stomach and the left portion of the umbilical vein were captured [19], [20]. A cursor of the tract ball was then placed at the outermost aspect of the fetal abdomen at the level of the fetal liver and traced it round the fetal abdomen [19], [20].

2.8.2.3. FL Measurement

From the transverse section of the fetal abdomen, the transducer was moved caudally until the fetal iliac bones were seen and at this point, part of fetal femur was also demonstrated [19], [20]. A slight rotation and angulation of the transducer allowed the full length of the femur to be seen [20]. A properly visualized femur should have a clear distal margins and acoustic shadowing may be seen projecting downward from the bone [20]. The measurement was then taken from blunt end to blunt end parallel to the shaft [19], [20].

The ultrasound scan automatically estimated fetal weight from the BPD, AC and FL measurement.

2.8.3. Actual Birth Weight

The actual birth weights of the newborn were determined by weighing the neonates within 20 minutes of the delivery by the trained midwives or doctors in the labour ward who had no prior knowledge of both clinical and sonographic estimation of fetal weights. A standard analogue weighing scale corrected for zero error was used. The babies were weighed by placing supine on a tray without clothing and feeding.

2.9. Data Analysis

Information from the proforma form was entered into the data base created by SPSS version 20 and analyzed. The accuracy of each method of estimation of fetal weight was determined using the mean error, percentage error and absolute percentage error. The mean error represents the sum of the positive (overestimation) and negative deviation (underestimation) from the actual birth weight. The mean percentage error is the percentage of the sum of positive and negative deviations from the actual birth weight. It thus reduces the difference between the actual birth weight and does not show variation from the birth weight. The pair t-test was used to determine the difference in the mean percentage error. The mean absolute percentage errors however, reflect the variability noted irrespective of their direction. Therefore, it is much more accurate predictor of differences from the actual birth weight. This was also used in previous studies [13]–[15]. The mean of the absolute percentage error was not normal distributed and the Wilcoxon signed-rank test (non-parametric) was used to determine the differences between the two methods and p-value of <0.05 was considered statistically significant.

The proportions of the estimates within the 10% of the absolute error of each method were also determined and differences were tested using chi-square.

Each of these errors was determined for entire study group and three strata of birth weight viz: <2.5 kg, 2.5–3.9 kg and ≥4.0 kg.

2.10. Ethical Consideration

Ethical clearance was obtained from Research and Ethics Committee of the Federal Teaching Hospital, Gombe.
TABLE I: Sociodemographic Characteristics of the Study Population

<table>
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<tr>
<th>Variables</th>
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<tr>
<td><strong>Age (years)</strong></td>
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<tr>
<td>15–24</td>
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<td>25–39</td>
<td>89</td>
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<td>≥40</td>
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<tr>
<td>Hausa</td>
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<td>18.9</td>
</tr>
<tr>
<td>Tangale</td>
<td>13</td>
<td>10.7</td>
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<tr>
<td>Waja</td>
<td>7</td>
<td>5.7</td>
</tr>
<tr>
<td>Tera</td>
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<td>Others</td>
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<tr>
<td><strong>Religion</strong></td>
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<tr>
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<tr>
<td>≥5</td>
<td>8</td>
<td>6.6</td>
</tr>
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</table>

3. RESULTS

Table I showed the socio-demographic characteristic of the study population. Majority of the women (73.0%) were between 25 and 39 years and the mean age of the women was 29.4 years ± 6.1. The major ethnic group was Fulani (32.8%). Most of the women (69.7%) were muslim. Majority of them (43.4%) had tertiary level of education while more than half of them (52.5%) were housewife. The mean parity was 2.0 ± 1.7. The mean gestational age of the fetuses was 39 weeks ± 1.3. Mean birth weight of the babies was 3136 g ± 478. Majority of the babies (86.1%) had their birth weights between 2500–3999 g while 9 (7.4%) and 8 (6.5%) had their birth weights <2500 g and ≥4000 g, respectively.

Table II showed the measure of accuracy of both clinical and ultrasound method compared with the actual birth weight. In the entire study group, the clinical fetal weight estimation overestimated birth weight while the ultrasound method underestimated birth weight by averages of 241 g and 50 g respectively. The mean of the absolute percentage errors using sonographic method was 8.85% while it was 11.06% with clinical methods (p-value = 0.008). The estimated birth weights that were within 10% of the actual birth weight were 46.7% and 64.8% by clinical and ultrasound methods respectively (p-value = 0.240).

In the normal birth weight stratum (birth weight 2500–3999 g), the clinical method overestimated the birth weight by an average of 269 g while the sonographic method underestimated the birth weight by an average of 35 g. The mean of the absolute percentage error was significantly higher by the clinical method compared with the sonographic method (11.45% vs. 8.93%; p-value = 0.007). The proportions of the estimates that were within 10% of the actual birth weight were higher for ultrasonic method compared with the clinical method and this was not statistically significant (61.9% vs. 44.8%; p-value = 0.441).

In the macrosomic fetuses (birth weight ≥4000 g), the clinical and sonographic methods underestimated the birth weight by 97 g and 418 g, respectively. The mean of the absolute percentage errors was higher for sonographic method compared with the clinical method (9.70% vs. 6.18%; p-value = 0.263). The estimates within the 10% of the actual birth weight were not significantly different between the two methods (75% for both methods, p-value = 0.464).

For babies whose birth weights were less than 2500 g, both clinical and sonographic overestimated the birth weights by 219 g and 104 g, respectively. The mean of the absolute percentage errors was however lower in the ultrasound method compared with the clinical method (7.22% vs. 10.80%; p-value = 0.066). The proportion of the estimates that were within 10% of the actual birth weights was not significantly different between the two methods (44.4% for clinical method and 88.9% for ultrasound method, p-value = 0.556).

4. DISCUSSION

In contemporary obstetrics, estimation of fetal weight is crucial in the care of pregnant women. The accurate estimation of fetal weight will reduce unnecessary interventions. Various studies were designed to determine the best predictor of birth weight between the clinical and ultrasound methods and the findings have been inconsistent. These inconsistent findings aroused our interest in this study so that our decision will be evidence based.

In this study, Dare’s clinical method overestimated the fetal weight while Hadlock’s ultrasound formula underestimated the fetal weight by averages of 241 g and 50 g, respectively. This is in consonance with the findings by Njoku et al. in Calabar where the clinical method overestimated the actual birth weight by 299 g and the sonographic method underestimated the birth weight by 101 g [12]. However, both methods have been found to overestimate the actual birth weight by Ugwu and his associates in Enugu [15]. Because the clinical method is simple and easy to teach, the overestimation may be beneficial in primary health care as it can serve as a low threshold for referral to secondary and tertiary health care centres.

It was also observed that in the entire study group, the mean of the absolute percentage errors was significantly lower in the ultrasonographic estimation of fetal weight as compared to the clinical method (8.85% vs. 11.06%; p-value = 0.008). It can be inferred from this that the fetal weight estimations by the ultrasound are better predictor of the actual birth weight. This was also observed by other researchers [14]–[16] while others found no statistically significant difference in the absolute percentage errors between the two methods [12], [13]. These inconsistent
findings may be related to difference in the sample size and population.

For birth weight <2500 g, both methods significantly overestimated the birth weight. The mean of absolute percentage error was however lower in the ultrasound estimation as compared with the clinical method but this was not significant (7.22% vs. 10.80% p-value, 0.066). The findings by Shittu and associates in Ile-ife (12.6% for the ultrasound method and 16.1% for the clinical method; p-value = 0.063) are in agreement with ours. Similar findings were reported by other researchers [14], [15]. In this study, the mean of absolute percentage errors among the macrosomic babies was not statistically different between the two methods even though both methods underestimated the birth weights. However, in a similar study in Enugu, the mean of absolute percentage error among macrosomic babies was higher with the sonographic method compared to the clinical method (11.1% vs. 2.8%; p-value < 0.001) [14]. The findings in the low birth weight and macrosomic groups may need to be interpreted with caution because the number of these fetuses seen in these studies may be too low to make adequate inferences. It is not surprising as these studies were not designed for solely for these groups of fetuses. Therefore, a study with adequate sample size for these birth weight strata is suggested.

The proportions of the estimates within 10% of actual birth weight were not statistically significant different in all birth weight strata between the two methods in this study. This also reiterates the utility of clinical fetal weight estimation in our resource-constraints setting.

The strength of this study is its prospective nature which reduced errors from the recall and the incomplete information. The fetal weights were independently estimated by the radiologist blinded to initial clinical estimation thereby reducing bias. The timing between the estimation of fetal weight and delivery was within 36 hours. This might have also reduced the errors from the potential fetal weight gain after the estimation. The birth weights of the babies were also determined by personnel blinded to both clinical and ultrasound estimation of fetal weight.

5. Conclusion

In conclusion, ultrasound is a better predictor of birth weight and should be used when the facility is available. Clinical estimation of the fetal weight via Dare’s formula clearly has a role in a resource-constraints setting of ours. It should be taught routinely to staff in the Primary Health Care settings where the majority of the pregnant women are seen. The fact that the method overestimated the fetal weight may serve as a low threshold for a referral to secondary and tertiary health care centres. The women will be assessed further in these centres using ultrasound method in addition.

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Conflict of Interest

There is no conflict of interest.
REFERENCES


