How Accurate it is to Predict Macrosomia by Three Ultrasound Formulas

AHMED SOLIMAN, M.D.*; AMAL HANFY, M.D.*; HAITHAM TORKY, M.D.*; AMR OSSAMA, M.D.** and AHMED MOUSTAPHA, M.D.*,***.
The Departments of Obstetrics & Gynecology*, Radiology**, Faculty of Medicine, Cairo University and Obstetrics & Gynecology Department, Benha University, Egypt***

Abstract

Objective: To evaluate the accuracy of three different ultrasound formulas in estimation of fetal weight in suspected macrosomia early in labour.

Design: A prospective clinical trial.

Setting: Department of Obstetrics & Gynecology, Cairo University.

Participants: Pregnant females presenting in early labour with clinical impression of macrosomia were examined by ultrasound and those with abdominal circumference more or equal to 35cm were selected for the study.

Interventions: Every woman was considered as herself control and fetal weight was calculated using Campbell & Wilkin, Hadlock et al. and Shepard et al., formulas. The expected fetal weight was then compared by the real fetal weight.

Results: There is no difference between different formulas for estimation of fetal weight in suspected macrosomic babies as proved by different statistical methods. There was a good correlation between the expected fetal weight estimated by different formulas with the real fetal weight.

Conclusion: Prediction of macrosomia early in labour provides reliable data that can help in decision making with reasonable accuracy of different formulas.

Key Words: Ultrasound formulas – Predict macrosomia.

Introduction

ACCURATE estimation of birth weight in the macrosomic fetus is critical in the clinical management of labor. Birth trauma, perinatal asphyxia, and maternal morbidity are increased in patients with fetal macrosomia who are vaginally delivered [1].

As fetal weight cannot be measured directly, it must be estimated from other anatomic parameters.

A variety of formulas based on fetal anthropometric measurements primarily on head; abdomen and limb measurements have been published [2] and have a wide range of predictive accuracy [3].

The accuracy of a formula to predict birth weight of a particular population may be enhanced if it is generated from a sample of fetuses representative of that population [4]. Different populations manifest different prevalence of macrosomia [5]. In the present study, we wished to investigate which formulas could be of choice in prediction of macrosomia during intrapartum care.

Material and Methods

The present study was conducted in Kasr El-Aini Hospital, Department of Obstetrics and Gynecology, Cairo University during 2010. This study enrolled pregnant females early in labour. All were singleton, cephalic presentation with no major congenital anomalies between 37 and 42 weeks of gestation with clinical impression of large sized baby using abdominal girth as a screening measure.

The due date for each patient was established previously by the 1st day of her last menstrual period (LMP) or prior ultrasound examination in 1st trimester.

All participants were subjected to a single ultrasonographic examination, of these 35 cases were selected whose abdominal circumference (AC) > 35cm to predict fetal macrosomia [6]. The ultrasound scan was performed with a real time ultrasound Piomedical 240 scanner 3.5 MHz convex array transducer Piomedical equipment BV, the Netherlands.

After application of enough gel to the probe, positioning of the probe over the abdomen and
adjusting the gain to obtain the best image, complete ultrasonographic examination for each patient was done focusing on abdominal circumference (AC), biparietal diameter (BPD), femur length (FL).

AC was measured in a view that included the following features: The outline is circular, short length of umbilical vein centrally placed between the lateral abdominal walls and a third of the way along an imaginary line drawn from the anterior wall to the fetal spine, with the stomach usually visualized as a transonic area in the left side of the abdomen.

The BPD was recorded as the maximum diameter of a transverse section of the fetal skull at the parietal eminences with the following features: A short midline, the cavum septum pellucidum and the thalami.

The measurement of the FL was made from the center of the “U”-shape at each end of the bone. This represents the length of the metaphysis. The measurements were obtained from three separate images of the same femur.

Every patient was examined as her own self control comparing real fetal weight with the estimated fetal weight. Data were obtained and collected till the end of the study, then analysis of the expected fetal weight was done in a separate data sheet without considering the real fetal weight, to minimize the risk of bias.

The same observer did all scans. Three equation formulas have been used to estimate the fetal weight: Campbell & Wilkin [6], Hadlock et al. [7] and Shepard et al. [8]. These equations were selected, as they were the most widely used in our hospital. The errors in predicting fetal weight using these formulas were expressed as a percentage of actual birth weight by means of the following method:

\[
\text{Error (\%)} = \frac{\text{Predicted weight} - \text{actual weight}}{\text{actual weight}} \times 100
\]

Statistical methods:
The data obtained by the background variables of the studied group, the ultrasonographic measurements of BPD, FL and AC, the ultrasonographic estimation of the fetal weight and the real fetal weight were analyzed statistically using different statistical methods. Correlation between the RFW and the different equations in the study was done using the Pearson product-moment (linear) correlation coefficient (\(r\)). A probability values (p-value) less than 0.05 was considered significant.

Using table 2 X 2 for true +ve, false +ve, false ve and true ve values derived from different formulas and real fetal weight, the sensitivity, specificity, positive and negative predictive values, and Likelihood ratios were generated to estimate the accuracy of different formulas.

Linear regression and polynomial curves were plotted to represent the correlation between the RFW and the different estimated fetal weights using the 3 equations.

All statistical calculations were done using computer programs Microsoft Excel version 5 and SPSS statistical program version 7.5.

Results
The age of our participants ranged between 18 to 40 years with a mean of 32.6 years. Most of them were multiparas-only one was primigravida-and all were at fullterm ranging between 37-42 weeks with mean of 39.5 weeks. Estimated fetal weight using different equations showed slight difference between different equations (Table 1).

The accuracy of the three formulas was estimated (Table 2). Using the correlation coefficient, the estimated fetal weight by Campbell and Wilkin, Hadlock et al. and Shepard et al., equations showed a strong correlation with the real fetal weight (\(r\): 0.676, 0.618 and 0.36 respectively; \(p<0.001\)).

The percent of error for different equations ranges between 5-10%. The mean of the percent of error using Campbell equation was 4.8, while that of Hadlock et al., was 7.3 and that of Shepard et al., was 6.3 (Table 3). However, it should be noted that fallacies of the equations increased with increased fetal weight.

Fig. (1) shows the scattered distribution of our cases using linear regression analysis of the estimated fetal weight by different equations and the real fetal weight. Using polynomial regression analysis, we could extend a trendline in a chart forward or backward beyond the actual data to show a trend (Fig. 2).

Table (2): Estimated fetal weight using Campbell & Wilkin, Hadlock et al. and Shepard et al., equation.

<table>
<thead>
<tr>
<th>Estimated fetal weight</th>
<th>Campbell &amp; Wilkin</th>
<th>Hadlock et al.</th>
<th>Shepard et al.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.055</td>
<td>4.202</td>
<td>4.110</td>
</tr>
<tr>
<td>SD</td>
<td>0.297</td>
<td>0.682</td>
<td>0.279</td>
</tr>
<tr>
<td>Median</td>
<td>4.072</td>
<td>4.050</td>
<td>4.080</td>
</tr>
<tr>
<td>SE</td>
<td>0.053</td>
<td>0.115</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Table (2): Accuracy of different formulas in estimating fetal weight of suspected macrosomic babies.

<table>
<thead>
<tr>
<th>Item</th>
<th>Equation type</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>(+)ve PV</th>
<th>(-)ve PV</th>
<th>(+)ve Likelihood ratio</th>
<th>(-)ve Likelihood ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Campbell</td>
<td>88%</td>
<td>100%</td>
<td>100%</td>
<td>76%</td>
<td>9.6</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Hadlock</td>
<td>88%</td>
<td>100%</td>
<td>100%</td>
<td>76%</td>
<td>9.11</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Shepard et al.</td>
<td>90%</td>
<td>90%</td>
<td>66%</td>
<td>83%</td>
<td>10</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Table (3): Percent error of each equation.

<table>
<thead>
<tr>
<th>Equation type</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campbell eq.</td>
<td>21.35</td>
<td>4.88</td>
<td>7.7</td>
<td>0.844</td>
</tr>
<tr>
<td>Hadlock eq.</td>
<td>38.1</td>
<td>7.36</td>
<td>9.23</td>
<td>1.56</td>
</tr>
<tr>
<td>Shepard eq.</td>
<td>26.67</td>
<td>6.33</td>
<td>6.67</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Fig. (1): Linear regression correlation between real fetal weight and expected fetal weight by the 3 formulas.

Discussion

Most studies of sonographic estimation of fetal weight were performed during the antepartum period, and it is difficult to speculate on their accuracy during labor [4]. In the present study, analysis of the raw data was done estimating fetal weight by different available formulas: Campbell [6], Hadlock [7] and Shepard et al. [8] trying to find out which will be the most accurate in estimating fetal weight in suspected macrosomia during labour.

We chose these three formulas in particular as we believe they involve BPD, AC, and FDL which
are likely to be most consistent and more appropriate to be measured during labour. Three of the five major body components (brain, trunk, skeleton, muscle, and fat) are represented in such weight estimation formulas.

Comparing it with the actual fetal weight, estimated fetal weight formulas tend to be accurate within 10-15% of the actual weight [9].

In the era of evidence base medicine, the sensitivity and specificity of a diagnostic tool are of limited use when applying diagnostic tests in clinical practice [10]. Many centers all over the world are now adopting the positive and negative predictive values as they are related to the prevalence of the condition (macrosomia in the present study). However, statisticians are now urging that the positive and negative likelihood ratios are even more important as they provide an explicit tool for updating diagnostic probabilities according to test results [10]. In the present study, we tried to detect the accuracy of formulas for fetal weight in prediction of macrosomia during labour in different directions. After correlation coefficient, we applied sensitivity, specificity, +ve pv, –ve pv, +ve LR and –ve LR. There was no difference between different equations for the above parameters confirming that all equations had more or less have the same accuracy.

On comparing the sensitivity, specificity and +ve predictive value reported in our study with those in the medical literature, we can consider our figures higher. This can be explained by our population study’s main selection criteria of AC = 35 cm.

Linear regression correlation has been proved to be a strong statistical method for detection of the relation between two independent variables. In the present study, linear regression for different formulas showed concentrated scattered plotting around the regression line (Fig. 1). This demonstrates the strong predictability of different equations for estimation of fetal weight. Moreover, polynomial regression curve was done to test the trend of accuracy of these equations as the error in estimation of fetal weight can be greatest at the extremes of birth weight when the estimates are most crucial in decision making [4]. The polynomial regression curve showed a weak correlation between real fetal weight and estimated fetal weight using Shepard et al., equation ($r^2$: 0.133) and a fair correlation between the real fetal weight and estimated fetal weight using both Campbell and Hadlock et al., equations ($r^2$: 0.542 and 0.529 respectively) (Fig. 2).

These results confirm the hypothesis that different formulas can identify large fetuses. However the mean percent of error was not the same for different formulas. This means that all these equations are more or less similar in their accuracy for correlating the real fetal weight. However, it seems that Campbell & Wilkin and Hadlock et al., equations tend to be more correlated with the real fetal weight than Shepard et al., although there is no statistically significant difference. This difference may be elicited statistically with large sample size than in the present study.

Keeping the real fetal weight as the gold standard for comparison, Campbell & Wilkin which used AC alone was as accurate as other formulas using combined parameters. Thus, for an easy practical rapid way of intrapartum estimation of fetal weight in suspected macrosomia, we may recommend to use Campbell & Wilkin formula. One limitation of our study, is its small sample size. However, we can assume that this sample although small is representative of the entire population of mothers with large size baby.

In conclusion, ultrasound examination for suspected macrosomia early in labour is a valuable tool to accurately estimate fetal weight with no significant difference in using different formulas.

References
