ULTRASOUND DIAGNOSIS OF FETAL MACROSOMIA

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Abstract: Fetal macrosomia is associated with an increased risk of maternal and fetal obstetrical complications. Since the incidence of fetal macrosomia is increasing in the last decades, the antepartum diagnosis is required for decreasing the perinatal morbidity and mortality. Ultrasound fetal weight estimation over 4000 grams is difficult, existing different indexes and formulas which present variable degrees of sensitivity and specificity and the errors are higher when the fetal weight is higher. In conclusion, the role of ultrasonography in the antepartum diagnosis of fetal macrosomia has to be related to the clinical situation, for each case, and the population specific growth curves must be taken into account.

Rezumat: Macrosomia fetală este asociată cu o creștere a complicațiilor obstetricalice atât materne cât și fetale. Având în vedere că incidența acesteia est e în creștere în ultimele decenii, este necesar ca diagnosticul antepartum să fie stabilit pentru a scădea morbiditatea și mortalitatea perinatală. Estimarea ecografică a greutății fetale peste 4000 grame este dificilă, existând diferențe indicii și formule care prezintă sensibilitate și specificitate variabile, iar erorile sunt cu atât mai mari cu cât greutatea fetală este mai crescută. În concluzie, aportul ecografiei în diagnosticarea antepartum a fătului macrosom trebuie integrat în contextul clinic, în fiecare caz în parte și trebuie să se țină cont de curbele de creştere specifice fiecărei populaţii.

Birth weight has an ascending tendency in the last two decades and the fetal macrosomia is frequently associated with more obstetrical complications, requiring a correct antepartum diagnosis in order to establish the birth conduct.(1-4)

Fetal macrosomia is defined as the fetal growth above the 90th percentile or with 2 standard deviations above the statistic average birth weight specific for the gestational age and for the ethnic characters or as a fetal weight above 4000 grams. An estimation of a fetal weight above 90th percentile at a certain gestational age requires a number of investigations in order to find the etiology (constitution, genetics or metabolism).

Fetal macrosomia can be symmetric or asymmetric. Symmetric macrosomia (global) is represented by the proportional growth of all of fetal parameters circumference in relation to the average values specific to the gestational age (head, abdominal circumference and weight are above 90th percentile). Asymmetric macrosomia is seen in diabetic pregnancies where the abdominal and the thigh circumference are above the normal limits, but the head and the femur circumference are in normal limits.

The incidence of macrosomia depends on the geographical region. In the Scandinavian countries the incidence is 20% (5), in the USA 9.2% (6), in Taiwan about 1-2% (7) and in Thailand only 1% (6). In Romania, the percentage of births with macrosoms fetuses is between 6-8%.(4,8)

The risk factors for macrosomia that should be antenatally taken into consideration are pregestational or gestational maternal diabetes, overweight, the accelerated weight increase during pregnancy, race, ethnic group, previous births of macrosoms babies and masculine gender.(4,9)

The women who give birth of macrosoms foetuses are predisposed to caesarean section or instrumental delivery, prolonged labour, perineal and uterine lacerations, haemorrhages and anaemia, and the newborn can suffer perinatal asphyxia, meconium aspiration and obstetrical trauma (shoulder distocia, collarbone or humerus fracture, facial or brachial plexus palsies). The risks are increased when the birth weight is over 4500 grams.

The diagnosis of fetal macrosomia can be clinical (with an error of ± 500 grams) and by ultrasound, in order to decide the birth conduct. We recommend that before the ultrasound examination is made, the risk factors for macrosomia to be searched, knowing that the accuracy of fetal weight estimation in macrosomia is underestimated, having the positive predictive value of 38-67%.(10)

For the estimation of fetal weight by ultrasound examination, the usual fetal biometry is required, which can be used single or in different formulas and the comparison with the population based growth curves is needed.

The biparietal diameter (BPD) and the head circumference (HC) are measured in transverse section of the fetal cephalic extremity, meeting the following criteria: the biparietal diameter (BPD) and the head circumference (HC) are measured in transverse section of the fetal cephalic extremity, meeting the following criteria: the section has to be symmetrical and slightly oval with the visualization of the middle line, the thalami and the cavity of the septum pellucidum should be present and without the visualization of the cerebellum.(11,12) The BPD measuring is made perpendicularly on the middle line, the calipers being placed on the outer aspect of the proximal and distal skull

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surface, this being commonly described as an "outer to outer" measurement.

The measurement of the abdominal circumference (AC) is made on a circular section where the landmarks required are the stomach and the sinus of the portal vein, and the reins should not be seen.(11,12) The fetal abdomen is easily distorted by compressions and the changes of the round shape are the common cause of measurement errors.

The correct measurement of the femur length (FL) is made after the visualization of the extremities of the bone, its angle with the horizontal line being less than 45°.(11,12) The estimation of the fetal weight using a single ultrasound parameter introduced in a mathematic formula is inferior than by using multiple ultrasound parameters. Thus, using only the BPD in some formulas present, after some studies, a sensibility of 68,8% and a specificity of 74,3% for predicting the weight over 4000 grams.(13) Other authors (Rosati) have found a sensibility of only 45% and a specificity of 74,3%.(14)

The abdominal circumference has been used for the first time for the estimation of fetal weight in 1975 by Campbell and Wilkin.(15) There are numerous studies that have used this method for the ultrasound diagnosis of macromomia because the abdominal subcutaneous tissue and the size of the liver are measured and these are the main factors in determining the fetal weight.(16) The abdominal circumference higher than 350 mm has a sensibility of 87,5% and a specificity of 84,74% for predicting the fetal weight over 4000 grams (17), but some other authors have reported a sensibility of 89% and a specificity of 93%.(18) An abdominal circumference higher than 370 mm can predict fetal macrosomia with a sensitivity of 77% and a specificity of 75% (18) and a value that is higher to 380 mm has the accuracy in predicting a fetal weight over 4500 grams only of 37%.(19)

The estimation of fetal weight using as a parameter the femur length has no advantages, having a sensibility of only 51% and a specificity of 86% in predicting the fetal macrosomia.(14) The femur length greater than 70 mm has a sensibility of 68,8% and a specificity of 74,5%.(13)

There are many formulas used to estimate the fetal weight, the most used being the Hadlock’s (1985) and the Shepard’s formulas (1982). The first one has many variants, using the 4 fetal parameters in different combinations, when the second one uses only the BPD and AC. In his study, Sokol uses the Hadlock IV formula (HC, AC, FL) and records a sensitivity of 85,7% and a specificity of 95%.(20) By using only AC and FL (Hadlock II formula), Smith proves that the sensitivity of the formula decreases when the fetal weight grows. So, the sensitivity is 94% in fetuses over 4000 grams, 88% in those over 4250 grams, 44% in those over 4500 grams and only 6% in fetuses over 4750 grams.(21) By using the same formula, Peregrine founds a sensitivity of 40% and a specificity of 94% in screening fetuses over 4000 grams.(22) Shepard’s formula has poor results in predicting macrosomic fetuses in non diabetic pregnancies, with a sensitivity of only 48% and a specificity of 92%.(22,23)

The comparison of the accuracy of the formulas used in the estimation of fetal weight in several studies is difficult because of the different methods used, the different definitions of macrosomia and the time variables between the ultrasound estimation and control (birth weight). Coombs compares 31 formulas of ultrasonographic estimation of fetal weight and concludes that the results obtained are similar and have a limited value in predicting macrosomia. The best result was obtained by using Ott’s formula (1986), which has the sensitivity of 45%. (24) The same author founds an error of 20% in predicting a fetal weight of 4500 grams (so, the real weight can be between 3600 and 5400 grams). (25) Another review (2005) compares 16 complex formulas and the abdominal circumference in the estimation of fetal weight. The conclusion is that the two techniques are comparable in ultrasound prediction of a fetus with a weight over 4000 grams. (25) The accuracy of the prediction increases with the number of the examinations, but decreases with the increase of the fetus dimensions. (26,27)

Table no. 1. Estimation of fetal weight (FW) formulas (27)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Formula</th>
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<tbody>
<tr>
<td><strong>Campbell</strong></td>
<td>( FW = 0,332*\text{BPD} - 0,193*\text{BPD}^2 + 0,036*\text{BPD} + 0,002*\text{BPD} )</td>
</tr>
<tr>
<td></td>
<td>( \log_{10}FW = -4,564 + 0,282*\text{AC} - 0,00331AC^2 ) (kg, cm)</td>
</tr>
<tr>
<td><strong>Hadlock I</strong></td>
<td>( \log_{10}FW = 1,3596 + 0,0064*\text{HC} + 0,0424*\text{AC} - 0,174* \text{FL} + 0,00061*\text{BPD} ) AC - 0,00386<em>AC</em>FL (g, cm)</td>
</tr>
<tr>
<td><strong>Hadlock II</strong></td>
<td>( \log_{10}FW = 1,304 + 0,05281*\text{AC} - 0,1938* \text{FL} - 0,004*\text{AC} - 0,05281*\text{FL} ) (g, cm)</td>
</tr>
<tr>
<td><strong>Hadlock III</strong></td>
<td>( \log_{10}FW = 1,335 - 0,0034*\text{AC} + 0,0316*\text{BPD} + 0,0457*\text{AC} + 0,1623* \text{FL} ) (g, cm)</td>
</tr>
<tr>
<td><strong>Hadlock IV</strong></td>
<td>( \log_{10}FW = 1,326 - 0,00326*\text{AC} + 0,0107*\text{HC} + 0,0438*\text{AC} + 0,158* \text{FL} ) (g, cm)</td>
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<tr>
<td><strong>Shepard</strong></td>
<td>( \log_{10}FW = 1,7492 + 0,166*\text{BPD} + 0,046*\text{AC} - 0,002546*\text{AC} - 0,0008582*\text{HC} + 1,2594*\text{FL} ) (kg, cm)</td>
</tr>
<tr>
<td><strong>Ott</strong></td>
<td>( \log_{10}FW = 2,0661 + 0,04355*\text{HC} + 0,55394*\text{AC} - 0,0008852*\text{HC} + 1,2594*\text{FL} ) (kg, cm)</td>
</tr>
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Because of the inconstant results obtained in the estimation of fetal weight over 4000 grams, some authors have tried, in practice, the measurement of fetal soft tissues for the diagnosis of macrosomia.

The thickness of the subcutaneous tissue measurement on standard abdominal section has a sensitivity of 100% and a specificity of 42% in the diagnosis of macrosomia, if this measure is of 8 mm. If the thickness is greater, the sensitivity decreases and the specificity increases, so a measure of 13 mm has a sensitivity of 45% and a specificity of 99%. The conclusion is that this parameter is useful in the exclusion of macrosomia.(28)

Another studied ultrasound parameter is the measurement of the subcutaneous tissue of the arm on an axial section under the humeral head, from the skin surface and the external part of the bone. This parameter has a sensitivity of 88% and a specificity of 75% in the ultrasound diagnosis of macrosomia.(29) Also, the subcutaneous tissue has been measured at the shoulder level and on an axial section, at the shoulder level. A thickness greater than 12 mm has a sensitivity of 83% and a specificity of 90% in the detection of the fetal macrosomia in diabetes pregnancies.(30)

Abramwicz has used the cheek-to-cheek diameter in a new formula besides the BPD and the AC and he has obtained an average error of 4,14%, mentioning that this diameter can be realized only in 70% of the cases on a coronal section of the fetal face passing through the superior lip and nose.(31) In another study, Kerrick has proven the positive correlation between the cheek-to-cheek diameter and the abdominal circumference with the fetal weight in macrosomia, although in the diabetic pregnancies only the abdominal circumference is correlated with the fetal weight over 4000 grams. (32)

Because there is no 100% specific method for the diagnosis of macrosomia, there are authors who tried to estimate
integration of Romanian research in the context. Growth population specific curves should be taken into account. correlated with the clinical diagnosis, and in every case, the resonance imaging (fMRI) in the estimation of fetal weight in normal weight fetuses, so more studies are necessary to prove if the 3D ultrasoundography is reliable in the diagnosis of macrosomia. In conclusion, the results obtained in the diagnosis of macrosomia are discordant, where the small studies having good results, and the large ones being disappointing. We wait the results of the tridimensional ultrasoundography and fetal magnetic resonance imaging (fMRI) in the estimation of fetal weight in macrosomia. Until then, the results of ultrasoundography have to be correlated with the clinical diagnosis, and in every case, the growth population specific curves should be taken into account. Research made within the POSDRU/88/1.5/S/60370 project “Integration of Romanian research in the context of European research-doctoral scholarships” co-financed by the European Social Fund through the Sectoral Operational Program - Human Resources Development 2007-2013.

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