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Possibility of Ultrasound Diagnostics of Fetal Macrosomia

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1. Summary

The term “fetal macrosomia” is used to describe a newborn who’s much larger than average. A baby who is diagnosed as having fetal macrosomia weighs more than 8 pounds, 13 ounces [4000 grams], regardless of his or her gestational age. About 9% of babies worldwide weigh more than 8 pounds, 13 ounces. Risks associated with fetal macrosomia increase greatly when birth weight is more than 9 pounds, 15 ounces [4500 grams] [1]. Fetal macrosomia may complicate vaginal delivery and can put the baby at risk of injury during birth. Fetal macrosomia also puts the baby at increased risk of health problems after birth. Recently it is possible to observe increase of macrosomic fetus delivery incidence. In presence it represents 10% of all deliveries. Despite major progress in obstetrics over the last decades, the delivery of large fetuses remains a source of anxiety among caregivers because these pregnancies are at increased risk of several perinatal complications. This review offers information of possibilities of ultrasound diagnosis of fetal macrosomia, even detecting fetal macrosomia is difficult to do during pregnancy [2]. But while fetal macrosomia is unpredictable, promoting good health and a healthy pregnancy can help prevent it [3].

2. Definition and Classification of Macrosomic Fetus

The term “macrosomia” defies newborn with weight over 4000 grams and higher than 90. percentile for it’s gestational age [including factors as race, socio-economic conditions and geographic conditions] or +2 SD of average delivery weight according to gestational age. Among other characteristics are that “big fetus” has excessively strong and thick cranial bones, thick head, thin cranial sutures and narrowed fontanels. Macrosomia and hypertrophy are synonyms. From the clinical practice it is possible to classify the newborn according to the symmetry of body weight layout, into proportionally large, when the excessive layout is symmetric on the whole organism, and into disproportionally large, when hypertrophy affects selective organ or more organs. The disproportionally large newborns usually suffer developed organic problem [hydrocephalus, meningoencephalocele, teratomas, hernias], and occure also in women with decompensated or undiagnosed gestational diabetes mellitus, where hypertrophy affects mostly thoracal area [4].

3. Causes and Risks of Fetal Macrosomia

Among risk factors are: hereditary occurrence, environment, ethnicity, parity of woman, diabetes mellitus or glucose intolerance of woman, post-term pregnancies [gestational age over 41 weeks], maternal obesity or excessive weight gain during pregnancy [BMI >30], maternal age, male fetus, medication during pregnancy and excessive amount of amniotic fluid [over 60.percentile for gestational age] [5].

4. Complications During and After Delivery

-Injury to the birth canal, genital tract or perineum

-Heavy bleeding or postpartum hemorrhage

-Uterine rupture

-Longer labor, especially during the pushing phase

-Changes in baby's heart rate during labor

-Shoulder dystocia of baby

-Bone fractures in the baby

-Brachial plexus injury

-Brain damage

-High red blood cell count, which increases baby's risk of jaundice

-Low blood sugar

-Breathing problems [3]

5. Risk of Fetal Hypertrophy

Macrosomia is defined by high percentage of maternal and fetal mortality and morbidity.

1. Maternal macrosomia: higher percentage of deliveries per Caesarean section, complications in natural vaginal delivery [prolonged delivery, vacuumextraction, forceps, larger injuries, postpartum haemorrage with need of blood transfusion].

2. Neonatal macrosomia: risk of shoulder dystocia is 10-times higher in baby's with birth weight over 4000 grams, brachial plexus injuries are 20-times more often in babies with birth weight over 4500 grams.

3. Fetal macrosomia: twice as high risk of giving still birth in mothers with decompensated diabetes

6. Diagnostics of Macrosomic Fetus

There isn't any precise method to predict fetal macrosomia. Aspexia of pregnant woman isn't the method of prediction, but it can be an impulse to suggest FM. Next step has low sensitivity and specificity and that is evaluating the risk factors, but it has only information validity. However ultrasound can estimate fetus's weight within about 10% it still stays the most precise method of diagnostics [6].

7. Ultrasound Diagnostics of Fetal Macrosomia

Ultrasound biometry is based on measuring three main bioparametres: biparietal diameter [BPD], abdominal circumference [AC] and femur length [FL]. Positive prediction ranges around 50-60%. Average mistake in estimating weight in fetal weight more than 4000 grams is around 300 – 400 grams [6].

8. Biometric Parameters

Modern ultrasound methods increase possibility of predicting macrosomic fetus as soon as the I.trimester according to measurement crown-rump length [CRL]. During the pregnancy there is possibility to observe the growth of fetus according to classical biometric parameters, their combination and ratio. Hackmon et.al included into their study 20 post-term macrosomic newborns with fetal weight >4250 grams, 67 newborns with fetal weight between 2500 – 3800 grams, when the second one was as a control group. Term of the delivery was estimated either according to the last menstrual period [in women with regular cycles], according to CRL in early pregnancy or according to the day of conception. The pregnancies with unsure estimated date of birth were excluded. Another exclusionary criteria were multiple pregnancies, maternal hypertension or proteinuria, subchorionic hematoma, genetic or congenital malformations. All pregnant women underwent screening for nuchal translucency [NTS] within the range of 11-14 weeks of gestation. There was association detected between delivery weight [expressed as ratio between actual and estimated fetal weight], and difference between measured and estimated fetal biometry in time of measuring NTS [expressed as equivalent of growth days]. Statistical analysis included Student t-test and simple regression. Fetal biometry I time of measuring NTS was statistically higher in macrosomic newborns comparing with the control group [2,65 ± 2,06 days comparing to 0,68 ± 1,4 days, p = 0,001]. In macrosomic newborns there was significant correlation detected between range of macrosomia, and discrepancy between estimated and excessive birth weight in time of measuring NTS [R^2 = 0,44, p = 0,0015]. Sex of the baby didn't have any significant impact on fetal biometry in early stage of pregnancy [7] (Table -1).

Table 1: Fetal growth parameters

Standard biometric parameters	Crown-rump length (CRL) in I.trimester, Cheek-to-cheek diameter (CCD); Biparietal diameter (BPD); Abdominal circumference (AC); Femur length (FL)
Supplementary parametres	Thickness of abdominal subcutaneous fat
	Cross-section through umbilical cord
Index parametres (monitoring proporcional growth of fetus)	Ratio HC/AC
Volume of amniotic fluid (mathematical pattern)	Pattern log, EFW – estimated fetal weight

9. Prognosis of Fetal Macrosomia In II.Trimester

Thorsell et.al. were trying to prove estimated relationship between larger fetus in proper gestational age in early pregnancy, and fetal macrosomia, in retrospective study of 19377 single pregnancies in 16.-20.gestational week in years 1998-2004 in Sweden. The results found out higher risk of fetal macrosomia happening in fetuses which were ≥ 7 days then estimated weight according to last menstrual period. In this case the risk was higher around 59%, that the baby will have birth weight ≥ 4500 grams. This finding points out the fact, that measuring of fetus in early pregnancy is not only important reason to estimate the gestational age, but also it is important reason to estimate the fetal growth [6].

10. Biparietal Diameter [BPD]

BPD is the parameter used to determine the gestational age, and also to estimate intrauterine growth and estimate fetal weight. Measuring of BPD can be wrong in cases where there are changes in shape of fetal head in latest weeks of pregnancy in malpresentations, and in pregnancies complicated by preterm rupture of membranes Biparietal diameter is not accurate in dolichocephaly and brachycephaly. Therefore in these cases it is suggested the cephalic index [8]. Cephalic [also cranial] index is ratio of length and width of fetal cranium. If the cranium is exactly the same length and width, the cephalic index is 100. If the width of cranium is only 70% of it's length we call it dolichocephaly with cephalic index 70. Cephalic index up to 75 is called dolichocephaly, from 75 to 80 it's called mesocephalic and from 80 higher it's called brachycephaly. Growth of biparietal diameter of fetal cranium [in millimeters] depends on gestational age is shown in (Table 2).

Table 2: BPD growth according to gestational age

Gestational week	Biparietal diameter (mm)
12 – 16	21 – 35
Up to 22	39 - 55
Up to 28	58 - 69
Up to 34	74 - 86
Up to 40	88 - 97
41	98
42	100

11. Abdominal Circumference [AC]

Biparietal diameter, circumference of head and length of femur don't show the acceleration in growth according to higher income of insulin. Statistically significant growth acceleration shows only circumference of waist – abdominal circumference, where there is an accumulation of fat tissue [7]. AC is the most sensitive ultrasound biometric factor which reflects growth acceleration. The reason is also growth of fetal liver. The growth approximately 1,2 centimeters per week is warning sign for possible detection of babies with higher weight [sensitivity 83,8%, specificity 85,4%, positive predictive value 78,8%, but negative predictive value up to 89%]. Abdominal circumference > 35 cm can identify 90% of macrosomic fetuses, when there is a risk of shoulder dystocia. Observation detected significant growth of AC from 32.gestational week. The ratio femur length/abdominal circumference [FL/AC ratio] detected macrosomia with accuracy of 82% [4]. The growth of abdominal circumference [in mm] according to gestational age is shown in (Table 3).

Abramovicz et.al. focused on measurements of cheek-to-cheek length and ratio of length cheek-to-cheek/biparietal distance in ultrasound detection of abnormal fetal growth in 87 fetuses with estimated weight over 90.percentile. The analysis showed that middle length of cheek-to-cheek distance is in these fetuses significantly higher. In diabetic women was the ratio cheek-to-cheek/biparietal diameter higher then in mothers who didn't have gestational diabetes mellitus. According to the results is the length cheek-to-cheek and ratio of length cheek-to-cheek/biparietal diameter an innovative ultrasound method, which is influenced by pathophysiologic mechanism of fetal macrosomia [9].

Table 3: AC growth according to gestational age

Gestational week	Abdominal circumference
Dec-16	56 - 105
Up to 22	117 - 175
Up to 28	129 - 240
Up to 34	250 - 299
Up to 40	309 - 354
41	362
42	371

12. Volume of Amniotic Fluid

Volume of AF can be increased [polyhydramnion] in cases of congenital anomalies, diabetes and fetal hydrops. It can also be decreased [oligohydramnion] in cases of fetal renal failure, postterm pregnancies, intrauterine growth retardation or some other congenital anomalies. The volume of amniotic fluid is often evaluated subjectively according to experience of the caregiver. The only rule is, that in case of polyhydramnion, none of the fetal shoulder don't get in contact with uteral wall at the same time. Semiquantitative method of determining the volume of amniotic fluid is measurement of index of amniotic fluid [AFI]. If the AFI in the largest quadrant is at least 2 centimetres, that doesn't mean it is oligohydramnion. The more accurate determination of the volume of amniotic fluid includes measuring in all four uterine quadrants. If their summary is less than 7, that is a sign of oligohydramnion. In case that summary of all quadrants is more than 25, this leads us to the diagnosis of polyhydramnion. Retrospective study in 2008 included 3115 women, who gave birth within 7 days from last ultrasound measuring. Predictive value of macrosomia was 71%, if the AFI was ≥ 20 and estimated fetal weight was more than 4000 grams [5].

13. Mathematical Model

New formula for optimalisation of more accurate detection of estimated fetal weight was gained in 4-year study [2003 – 2006] and included 424 pregnancies mostly of Caucasian rase. There were excluded multiple pregnancies, fetuses who died intrauterine and also fetuses with signs of structural or chromosomal abnormalities. There had been also considered parameters like weight of mother and classical biometric parametres.

logeEFW = 7,6377445039 + 0,0002951035 x maternal weight + 0,000394964 x head circumference + 0,0048698624 x femur length. According to this model 77,9% was in deviation ± 5%, 97,1% in deviation ± 10% and 100% fell into the deviation of 15 -20% of estimated fetal weight [10].

14. Thickness of Abdominal and Subcutaneous Fat

In the study there was measured thickness of fat in 300 fetuses in range of 37.-42. Gestational week, where average time between measuring and delivery was 11 days. The results showed that the thickness of subcutaneous fat in macrosomic fetuses was significantly higher than in fetuses with normal size according to gestational age [12,0 ± 1,4 mm compared to 6,6 ± 1,6 mm], which significantly proved positive correlation between the thickness of abdominal subcutaneous fat and the size of fetus [11].

15. The Thickness of Cross Section of Umbilical Cord as a Predictor of Fetal Macrosomia

Measuring of umbilical cord cross section [UCCS] is still in consideration as a possible predictor of macrosomia. The goal of the study, which included 1026 women, was to get the information, if the thickness of the UCCS can be a predictor of delivery of macrosomic fetus. These women were in 34 week of pregnancy and gave birth within 4 weeks from the last ultrasound measuring of thickness of UCCS, umbilical veins and Warthol substance roast in loose fold of umbilical cord. In these cases the fetal biometric parameters [BPD, AC, FL] were 95.percentile for gestational age. 53 [5,2%] of newborns had birth weight over 4000 grams and 22 newborns [2,1%] had birth weight over 4500 grams. The thickness of UCCS was significantly higher in newborns with birth weight over 4000 grams or 4500 grams [54,7%] over those with regular birth weight [8,7%]. The study shows that ultrasound measurement of the thickness of umbilical cord cross section can increase predictive value of delivery of macrosomic fetus [12].

16. Conclusion

Over the last decades there has been increased number or deliveries of macrosomic fetuses, but there also has been expansion of methods of early diagnostics of these kinds of pregnancies. The only complication stays estimating fetal weight, which is most accurate after delivery by weighing the newborn. Therefore all the ultrasound studies are retrospective. In reality there is no need of prediction of such cases, but estimating possible complications, which occur during deliveries of such fetuses. Estimating of fetal weight, anamnesis, progress of delivery, fetal and maternal anatomy, this all belong to complex, which should lead to precautions. Until now there aren't strategies of management unified, which would lead to reducing risks of deliveries of macrosomic fetuses. The choice of way or method of leading delivery differs in these cases. Caesarean section puts mother into risk, and neither can we prevent all injuries of fetus during CS. The most common reason of delivering pregnancy of macrosomic fetus by Caesarean section is cephalo-pelvic disproportion. Not even induction of delivery in these cases brought significant improvement of possible complications. It seems that elective induction of delivery increases number of Caesarean sections. Macrosomia remains usual complication of pregnancy, and followed delivery, it's prediction is unfortunately not accurate, and there are not known steps, which would lead to prevention of complications of macrosomic fetuses during delivery.

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