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REVIEWS

Sonographic Placental Aspects in Fetal Growth Restriction

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Abstract

Fetal growth restriction (FGR) is a complication diagnosed in about 10% of pregnancies and is associated with significant perinatal mortality and morbidity. Both the diagnosis and the correct management of cases of intrauterine growth restriction remain a challenge of modern obstetrics. A normal placental development is essential for a proper intrauterine physical and neurological growth of the fetus throughout pregnancy. Various pathophysiological situations may reflect in abnormal placental development linked with severe pregnancy disorders. In this paper we aim to exemplify sonographic aspects in various placental pathology associated with FGR along with the recommended management. Placental insufficiency is the most common risk factor for FGR and it cannot be directly measured and objectified, remaining a diagnostic of exclusion. The risk for perinatal adverse outcomes in placenta accreta spectrum cases is increased trough the pathological implantation especially in depth. In pregnancies complicated with placental insufficiency, secondary macroscopic lesions can be noted, as parabasal and intervillous thrombosis, hematomas, extensive fibrin deposits and infarcts areas. Even if, over time, multiple studies have targeted methods of preventing intrauterine growth restriction through actions on the mother, the effectiveness of no treatment has been demonstrated.

Keywords: fetal growth restriction, placental insufficiency, placental lacunae.

Rezumat

Restricția de creștere intrauterină (RCIU) este o complicație diagnosticată în aproximativ 10% din sarcini și este asociată cu o mortalitate și morbiditate perinatală semnificativă. Atât diagnosticul, cât și conduita terapeutica corecta a cazurilor de restricție de creștere intrauterină rămân o provocare a obstetricii moderne. O dezvoltare placentară normală este esențială pentru o creștere fizică și neurologică intrauterină adecvată pe tot parcursul sarcinii. Diverse situații fiziopatologice se pot reflecta în dezvoltarea placentară anormală asociată cu complicații severe. În această lucrare ne propunem să exemplificăm aspectele ecografice în diverse patologii placentare asociate cu RCIU împreună cu managementul recomandat. Insuficiența placentară este cel mai frecvent factor de risc pentru RCIU și nu poate fi măsurată și obiectivată direct, rămânând astfel un diagnostic de excludere. Riscul unui prognostic perinatal nevaforabil în cazurile cu spectrul placentei accreta este crescut prin implantarea patologică mai ales în profunzime. În sarcinile complicate cu insuficiență placentară se pot observa leziuni macroscopice secundare, precum tromboza parabazală și interviloasă, hematoame, depozite extinse de fibrină și zone de infarct. Chiar dacă, de-a lungul timpului, mai multe studii au vizat metode de prevenție a RCIU prin acțiuni asupra mamei, nu a fost demonstrată eficacitatea unei conduite.

Cuvinte cheie: restricție de creștere intrauterină, insuficiență placentară, lacune placentare.

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INTRODUCTION

Fetal growth restriction is a complication diagnosed in about 10% of pregnancies and is associated with significant perinatal mortality and morbidity. It remains a pathology without antenatal treatment where prenatal diagnosis and fetal surveillance are the only option in decreasing stillbirth rates. If FGR is not diagnosed prenatally, the risk of intrauterine demise is eightfold increased[1]. An estimated fetal weight < 10th percentile is the definition for FGR. This sole criterion is not specific as it does not differentiate between the pathological fetal growth and a constitutional small fetus. The International Society of Obstetricians and Gynecologists (ISUOG) includes in the definition of fetal growth restriction abnormal pulsatility index of the uterine artery and umbilical artery (> 95th percentile) along with estimated fetal weight or abdominal circumference < 3rd percentile[2].

Both the diagnosis and the correct management of cases of intrauterine growth restriction remain a challenge of modern obstetrics. Variable diagnostic criteria, variable monitoring methods as well as the uncertainty of the impact of various factors at each gestational age make this statement real; the challenge of the obstetrician being represented by the precise diagnosis with the correct assessment of the gestational age and according to these parameters the synchronization of the moment of birth with the best foreseeable neonatal prognosis. Iatrogenic prematurity superimposed on cases with intrauterine growth restriction, due to uncertainty in the assessment of fetal status, significantly increase the mortality and morbidity associated with these cases.

The postnatal impact of FGR is not to be ignored. Among preterm birth that is preferred in some cases in order to prevent in utero demise, the infants with FGR have a difficult transition at delivery when adding hypoxic stress due to uterine contractions. Impaired thermocoagulation, hypoglycemia, hypocalcemia, hyperbilirubinemia, polycythemia and hyperviscosity, feeding difficulties and impaired immune function are common complications in intrauterine growth restricted babies that require a close follow up in the neonatal period and after discharge[3].

Successful implantation of a genetically normal embryo with normal placentation into a healthy maternal organism will most likely result in the birth of a healthy fetus. Affecting any of these factors exponentially negatively influences the prognosis of a pregnancy[4]. Thus, the pathogenesis of intrauterine growth restriction turns out to be multifactorial, and the qualification of the etiological factor and the identification of an underlying pathology are essential steps in the management of grafted cases of this condition. The factors that dictate fetal growth are genetic, maternal and placental. In 5-20% of cases with FGR a genetic abnormality is present as aneuploidy, disomy, single gene mutation duplications or partial deletions. If a symmetric FGR is diagnosed prior 20 weeks of gestation the cause is almost for certainly an aneuploidy[5]. Chromosomal mosaicism is identified postpartum in approximatively 10% of idiopathic FGR cases. In about 10% of cases the cause is a fetal infection like cytomegalovirus or toxoplasmosis[6].

The main maternal factors are medical and obstetrical condition that include preeclampsia, pregestational diabetes, hypertension, autoimmune disorders, cardiac pathology, exposure to teratogens, poor nutritional status and, in the majority of cases, constitution[7].

A normal placental development is essential for a proper intrauterine physical and neurological growth of the fetus throughout the pregnancy. Various pathophysiological situation may reflect in abnormal placental development linked with severe pregnancy disorders.

In this paper we aim to exemplify sonographic aspects in various placental pathology associated with FGR along with the recommended management.

PLACENTAL INSUFFICIENCY

Disproportionately, placental insufficiency is the most common risk factor for FGR and it can not be directly measured and objectified and remains a diagnostic of exclusion and reflects poor placental function. Intrauterine fetal growth is dependent on placental passage of nutrients from the maternal circulation, which requires normal bidirectional transplacental transport and normal umbilical perfusion. Approximately 70% of glucose and 45% of maternal oxygen are used by the placenta, thus delivery of nutrients and oxygen to the fetus is dependent on uterine perfusion, feto-placental exchange zone, and increased hemoglobin affinity for oxygen[8]. Any disruption of this process culminates with fetal acidosis as a consequence of decompensated fetal hypoxemia.

Relative hypoxia is a consequence of a reduced blood flow into the intervillous space when there is a lack of

normal physiological adaptation of spiral arteries to pregnancy. In uncomplicated pregnancies, the fetoplacental system has a continuous expansion proportional with gestation advancing[9]. Objectively, the fetoplacental arterial impedance has a progressive decline and the umbilical blood flow present a gradual rise, respectively the umbilical Doppler indices have a downward trend (Figure 1,2,3).

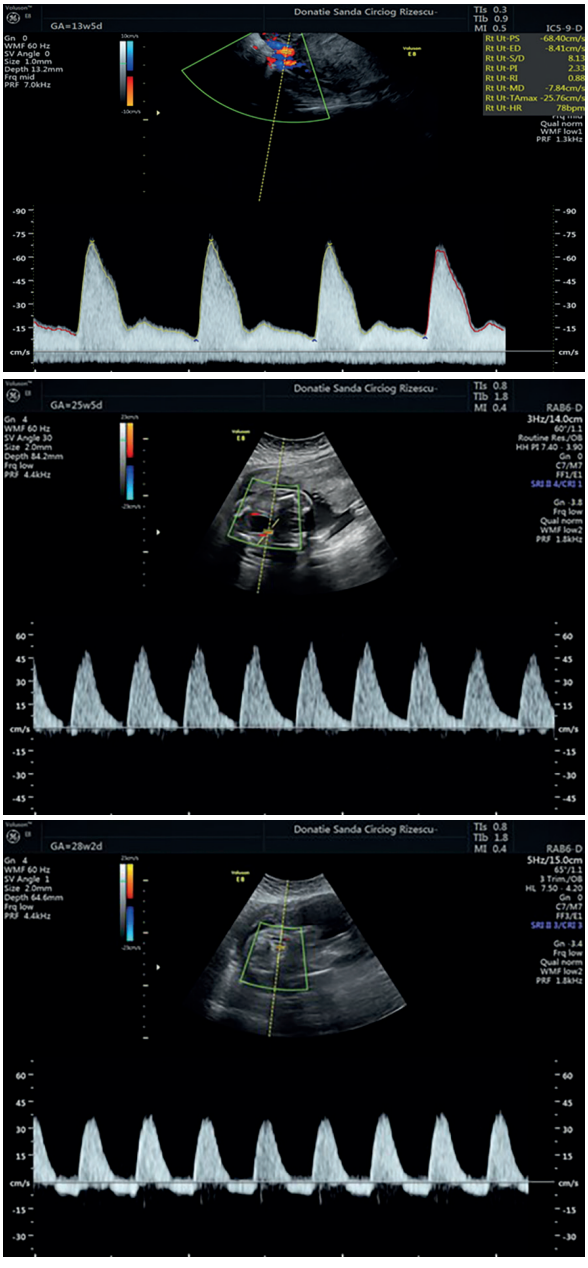
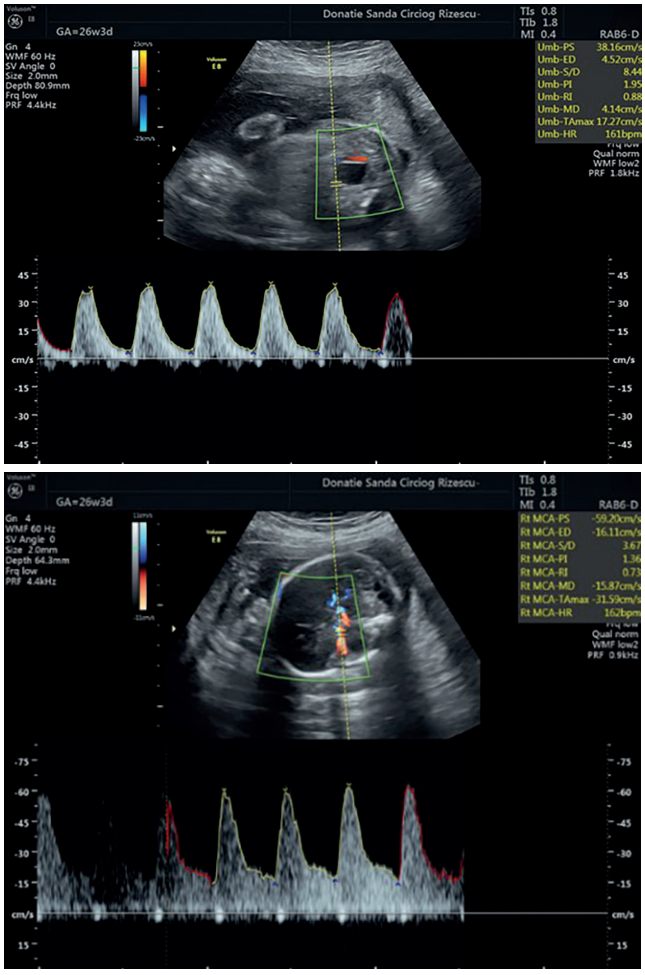


Figure 1, 2, 3. Protodiastolic notch identified at the level of the uterine arteries with increased PI in a 25 years primigravida (1). At 25 weeks of gestation absent end diastolic flow in umbilical artery is noted and fetus with FGR (2). At 28 weeks of gestation reversed diastolic flow (3).

In growth restricted fetuses, due to chronic placental insufficiency, the umbilical artery end-diastolic flow is reduced accompanied by compensatory hemodynamic response in fetuses. The first sign observed in FGR is a decrease of end-diastolic flow velocity and rise of uterine artery Doppler indices. In the next phase, blood flow is redistributed to the vital organs, which reflects in a decreased cerebroplacental ratio. The worsening of fetal status is indicated by the growth of fetoplacental impedance, respectively absent end-diastolic flow or reversed[10]. This context predicts an acute deterioration. An imminent adverse fetal outcome is indicated by absence or reversal of the ductus venosus arterial (a) wave[11] (Figure 4,5,6).



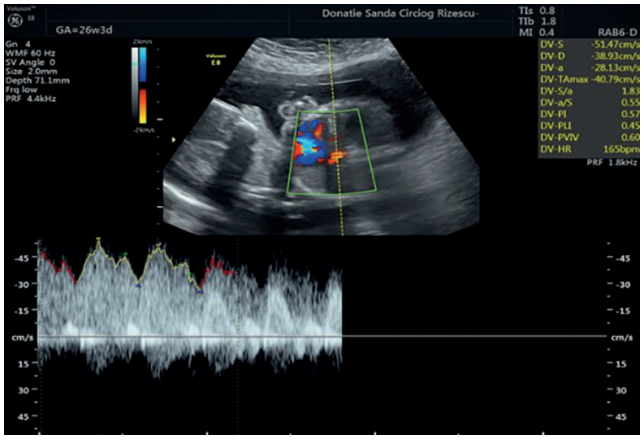


Figure 4, 5, 6. Abnormal cerebral-placental ratio in a 26 weeks of gestation fetus. Umbilical artery PI>99 percentile, MCA PI- 3rd percentile, ductus venosus 43rd percentile-normal.

Prenatal care in such cases include fetal surveillance with sonographic assessment of fetal weight at every two weeks. If a downfall in the estimated fetal weight percentile is noted then the risk for perinatal morbidity and mortality is increased[12].

The recommendation of Doppler indices measurements of the uterine and middle cerebral artery along with biophysical profile in FGR is to be performed weekly if it falls within normal limits (uterine artery pulsatility index (PI) ≤95th and middle cerebral artery PI ≥5th percentile). A more frequent evaluation, twice a week, is necessary if the uterine artery PI>95th and middle cerebral artery PI<5th percentile but the amniotic fluid is normal and a normal heart variability is noted on non-stress test (NST). The hospital admission in considered if other associated conditions are present, like chronic hypertension, preeclampsia or oligohydramnios with subsequent individualized care[13].

Daily biophysical profile with NST at every 6 hours and Doppler measurements at every 48 hours is the recommended management for admitted patience with absent or reversed diastolic flow of the uterine artery.

Absent or reversed ductus venosus end-wave is not an indication for delivery but is a factor to consider in decision making.

PLACENTA ACCRETA SPECTRUM

Placenta accreta spectrum (PAS) is a term that describes abnormal trophoblast invasion in the myometrium. It is a life-threatening condition as the attempt to remove the placenta leads to massive hemorrhage. The pathogenesis mainly lies on the existence of a defective decidualization area due to a preexisting endometrial-myometrial interface damaging.

The latest classification of PAS, according to The International Federation of Gynecology and Obstetrics [FIGO] Placenta Accreta Spectrum Disorders Diagnosis and Management Expert Consensus Panel is:

Grade 1 – placenta adherent or creta
Grade 2 – increta
Grade 3 – percreta with the subcategorization:
- subtype 3a – limited to the uterine serosa
- subtype 3b – urinary bladder invasion (Figure 7)
- subtype 3c – invasion of other pelvic tissue/organs

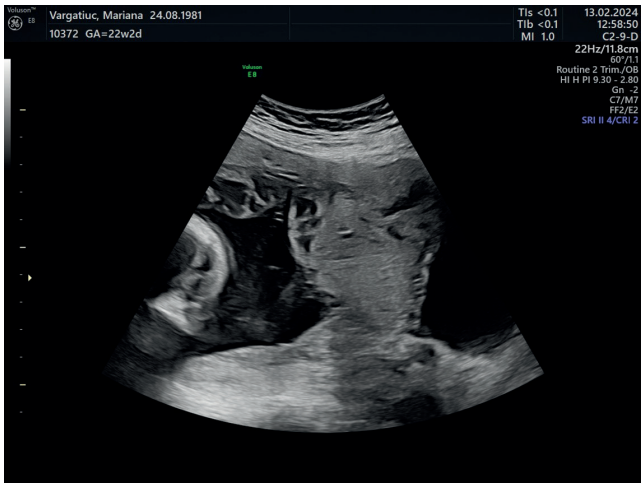


Figure 7. Anormal placental invasion at 22 weeks of gestation, with urinary bladder invasion and placental bulking. Subsequent abnormal development with FGR; EFW- 5 percentile at 35 weeks of gestation.

The risk for perinatal adverse outcome in PAS cases is increased trough the pathological implantation of the placenta without an appropriate placental implantation, especially in depth, fact that is critical for a normal fetal growth[14]. According to the studied published until now, a higher grade of placental invasion does not result in worse neonatal outcome (Figure 8). Also, studies on placenta previa with no abnormal invasion, showed that placenta previa associates with congenital anomalies, perinatal mortality and preterm delivery but

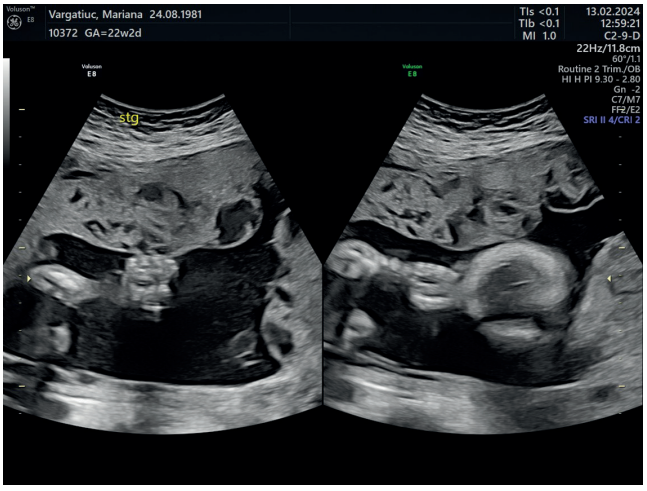


Figure 8. Grade 3 placental lacunae 23 weeks of gestation with normal fetal development throughout pregnancy

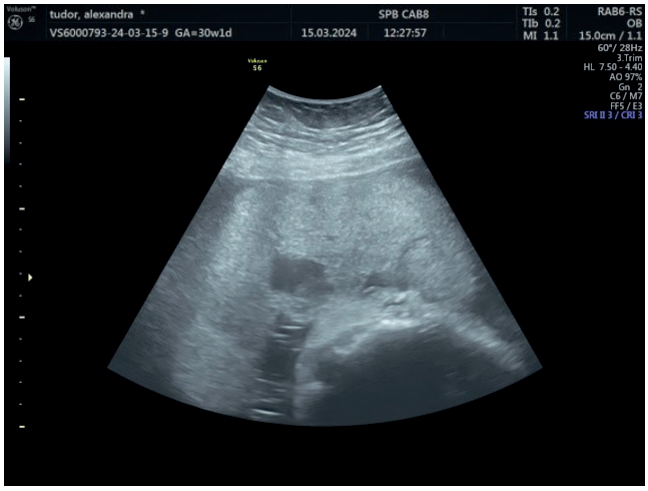


Figure 9. Voluminous central placental lacunae at the level of the umbilical cord insertion in a 30 weeks gravida with normal fetal growth until this point.

it has no statistically significant link with fetal growth restriction[15].

PLACENTAL LACUNAE

Placental villous-free areas low appear echogenic on sonography and filled with various velocity maternal blood and can impact the uteroplacental and fetal circulation[16]. The reported incidence of placental lacunae ranges from 2% to 71%.[17] According to the sonographic appearance, four grades of placental lacunae were described as follows[18]:

Grade 0 - none is identified
Grade 1- one to three small lacunae
Grade 2 - four to six lacunae or more irregular
Grade 3 - more than 6 large and irregular

In pregnancies complicated with placental insufficiency, secondary macroscopic lesions can be noted, as parabasal and intervillous thrombosis, hematomas, extensive fibrin deposits and infarcts areas[19] (Figure 8). There are several studies published on the pregnancy outcome in patients with placental lacunae[20,21] with contradictory results but with a common conclusion point, respectively that the presence of placental lake associates a higher incidence of maternal hypertensive disease, low umbilical cord pH and FGR. Also, the hypoechoic placental areas can indicate intervillous space thrombosis and can be an indicator for a pro-thrombotic maternal state (Figure 9). In cases of placenta previa, the presence of placental lacunae has a positive predictive rate for PAS of about 80%[22]. The development mechanism in these cases is not completely understood but inappropriate placentation associated with the high blood flow rate in PAS cases are though to cause mechanical disruption of the placenta.

CONCLUSION

The essential point in FGR is early diagnosis based on sonographic measurements. The placenta is the maternal-fetal organ that begins to develop at implantation of the blastocyst and assures the nutrition of the fetus and other developmentally crucial functions. The diagnosis of FGR is one of certainty if the estimated fetal weight is<3th percentile in correctly dated pregnancies. Recommendations of monitoring trough Doppler measurements have the goal to maintain the pregnancy in a safe area as long as possible and to reduce the likelihood of stillbirth. Even if, over time, multiple studies have targeted methods of preventing intrauterine growth restriction through actions on the mother, the effectiveness of no treatment has been demonstrated.

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