American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Growth Disturbances–Risk of Intrauterine Growth Restriction**

Variant 1: **Risk of IUGR justifies evaluation.**

Radiologic Procedure	Rating	Comments	RRL*
Risk Factor for IUGR			
Size smaller than dates by LMP or prior US	9		None
Maternal hypertension or pre-eclampsia	8	Other maternal conditions known to predispose to IUGR, such as systemic lupus erythematosus, and prior pregnancy history of small-for-gestational-age babies, may also be indications for IUGR evaluation.	None
Poor maternal weight gain	8		None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Growth Disturbances–Risk of Intrauterine Growth Restriction**

Variant 2: **Risk of IUGR initial evaluation.**

Radiologic Procedure	Rating	Comments	RRL*
Obstetrical US			
US pregnant uterus fetal measurement and (if prior scan) growth	9		None
US pregnant uterus assess amniotic fluid	9	Oligohydramnios is a risk factor for fetal morbidity or mortality.	None
US pregnant uterus anatomic survey	9	Fetal anomalies may indicate an underlying syndromic cause, such as aneuploidy, for the growth restriction.	None
US pregnant uterus fetal activity patterns	7		None
US pregnant uterus biophysical profile	4	BPP, Doppler, and other tests are not, in general, indicated for the initial assessment to determine if there is (probable) IUGR, but if the first scan is done at a stage of potential viability (when delivery of the fetus would be considered as an option) and IUGR is suspected by the findings, these tests may be useful and should be applied as in the following tables. (BPP components: 1) fetal heart-rate reactivity, 2) fetal breathing movements, 3) fetal movement, 4) fetal tone, and 5) assessment of amniotic fluid volume.)	None
Doppler Evaluation		BPP, Doppler, and other tests are not, in general, indicated for the initial assessment to determine if there is (probable) IUGR, but if the first scan is done at a stage of potential viability and IUGR is suspected by the findings, these tests may be useful and should be applied as in the following tables. A variety of fetal and maternal blood vessels have been evaluated by Doppler wave-form analysis to assess the risk of adverse perinatal outcome. The most commonly interrogated vessels are the umbilical arteries.	
US pregnant uterus umbilical arteries	4		None
US pregnant uterus cerebral to uterine artery ratio	3		None
US pregnant uterus cerebral arteries	3		None
US pregnant uterus uterine arteries	3		None

Other			
US pregnant uterus nonstress test/fetal heart rate monitoring	2	A variety of fetal and maternal blood vessels have been evaluated by Doppler wave-form analysis to assess the risk of adverse perinatal outcome. The most commonly interrogated vessels are the umbilical arteries.	None
US pregnant uterus fetal movement counts (daily)	2		None
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Clinical Condition: **Growth Disturbances–Risk of Intrauterine Growth Restriction**

Variant 3: **Small fetus, low or low normal fluid, follow-up studies.**

Radiologic Procedure	Rating	Comments	RRL*
Follow-up US			
US pregnant uterus every 4 weeks	9	The maximum reasonable interval for a follow-up growth scan when there is evidence of IUGR is 4 weeks, but as the pregnancy enters the third trimester and approaches the time of possible (urgent) delivery, shorter scanning intervals may be indicated.	None
US pregnant uterus every 3 weeks	8		None
US pregnant uterus every 2 weeks	7		None
US pregnant uterus biophysical profile	8	Some form of surveillance for fetal well-being is indicated. The BPP, or selected component tests of the BPP, generally including a marker of acute condition (eg, breathing activity or heart rate reactivity), and amniotic fluid volume as a marker of more chronic status, are the most frequent primary formal tests of fetal status. Tests for fetal well-being are generally done once or twice weekly, but in severe situations may be indicated more frequently. (BPP components: 1) fetal heart-rate reactivity, 2) fetal breathing movements, 3) fetal movement, 4) fetal tone, and 5) assessment of amniotic fluid volume.)	None
US pregnant uterus with Doppler	8	Doppler may provide important ancillary data to the BPP, but is not, in general, a stand-alone test.	None
US pregnant uterus heart rate monitoring	8	Heart-rate monitoring, if reactive, may obviate the need for the complete BPP, but periodic surveillance of the amniotic fluid volume is still indicated as well.	None
US pregnant uterus fetal movement counts (daily)	8	Daily fetal movement counting by the mother is an important adjunct to periodic formal testing of fetal well-being.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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Variant 4: **Very small fetus, normal fluid, follow-up studies.**

Radiologic Procedure	Rating	Comments	RRL*
Follow-up US		The smaller the fetus, the greater is the concern for life-threatening compromise. The interval of growth assessment should diminish both as the fetal size estimate drops from 10% to 5% and below and as the pregnancy advances into the third trimester and toward possible (urgent) delivery. It is uncommon for a fetus to be significantly growth restricted due to uteroplacental insufficiency and still have normal amniotic fluid volume. Inaccurate dating is the most common cause for this combination, and can be confirmed by follow-up scans for growth. Fetal aneuploidy may also present in this fashion. See below.	
US pregnant uterus every 3 weeks	9		None
US pregnant uterus every 4 weeks	8		None
US pregnant uterus every 2 weeks	8		None
US pregnant uterus biophysical profile	9	Testing for fetal well-being is indicated from the point of potential viability onward. The primary testing should be by the BPP or selected component tests of the BPP. (BPP components: 1) fetal heart-rate reactivity, 2) fetal breathing movements, 3) fetal movement, 4) fetal tone, and 5) assessment of amniotic fluid volume.)	None
US pregnant uterus with Doppler	8	Doppler may provide important ancillary data to the BPP.	None
US pregnant uterus heart rate monitoring	8	Heart-rate monitoring, if reactive, may obviate the need for the complete BPP.	None
US pregnant uterus fetal movement counts (daily)	8		None
Karyotyping (amniocentesis or cordocentesis)	6	Presence of normal amniotic fluid volume may indicate that fetal growth restriction is caused by something other than uteroplacental insufficiency. A fetus with aneuploidy, especially trisomy 13, trisomy 18, or triploidy, may have severe, symmetrical, early-onset IUGR.	None
Rating Scale: **1=Least appropriate, 9=Most appropriate**			***Relative Radiation Level**

Clinical Condition: **Growth Disturbances–Risk of Intrauterine Growth Restriction**

Variant 5: **Normal sized fetus, low or absent fluid, follow-up studies.**

Radiologic Procedure	Rating	Comments	RRL*
Follow-up US		Absence or reduction of amniotic fluid is a risk factor for fetal morbidity/mortality, even with a normally grown fetus, due to possible umbilical cord compression. Periodic assessment of fetal growth is indicated. Low or absent fluid with a normal size fetus may indicate premature rupture of membranes or a fetal urinary tract abnormality. Evaluation for these possibilities is also indicated.	
US pregnant uterus every 2 weeks	9		None
US pregnant uterus every 3 weeks	6		None
US pregnant uterus every 4 weeks	5		None
US pregnant uterus biophysical profile	9	Some form of surveillance for fetal well-being is indicated. The BPP, or selected component tests of the BPP, generally including a marker of acute condition (eg, breathing activity or heart rate reactivity), and amniotic fluid volume as a marker of more chronic status, are the most frequent primary formal tests of fetal status. Tests for fetal well-being are generally done once or twice weekly, but in severe situations may be indicated more frequently. (BPP components: 1) fetal heart-rate reactivity, 2) fetal breathing movements, 3) fetal movement, 4) fetal tone, and 5) assessment of amniotic fluid volume.)	None
US pregnant uterus with Doppler	8	Doppler may provide important ancillary data to the BPP, but is not, in general, a stand-alone test.	None
US pregnant uterus heart rate monitoring	8	Heart-rate monitoring, if reactive, may obviate the need for the complete BPP, but periodic surveillance of the amniotic fluid volume is still indicated, as well.	None
US pregnant uterus fetal movement counts (daily)	8	Daily fetal movement counting by the mother is an important adjunct to periodic formal testing of fetal well-being.	None
Karyotyping (amniocentesis or cordocentesis)	3	There is a low probability of aneuploidy presenting with a normally grown fetus and oligohydramnios.	None
Rating Scale: **1=Least appropriate, 9=Most appropriate**			***Relative Radiation Level**

Expert Panel on Women's Imaging: Carolyn Zelop, MD[1]; Arthur C. Fleischer, MD[2]; Rochelle F. Andreotti, MD[3]; Teresita L. Angtuaco, MD[4]; Mindy M. Horrow, MD[5]; Susanna In-Sun Lee, MD, PhD[6]; Marcia C. Javitt, MD[7]; Anna S. Lev-Toaff, MD[8]; Leslie M. Scoutt, MD.[9]

Summary of Literature Review

Intrauterine growth restriction (IUGR) is an important complication of pregnancy. It can be associated with significant risks of perinatal morbidity and mortality. One of the primary mechanisms of IUGR is uteroplacental insufficiency, which may occur in a variety of maternal or placental conditions. The major concern in IUGR is not the small size of the fetus, per se, but the possibility of life-threatening fetal compromise.

When clinically suspected, IUGR can be confirmed as probably present by sonographic fetal measurements and weight estimation, but both false-negative and false-positive cases can be anticipated. Findings that should prompt an ultrasound (US) examination include: maternal size smaller than dates or otherwise anticipated from a prior US, poor maternal weight gain, maternal hypertension, or pre-eclampsia. Other maternal conditions such as lupus erythematosus or a history of previous birth of a growth-restricted infant may also warrant evaluation.

The greater the risk of IUGR based on the clinical findings, the greater is the positive predictive value of US, but the likelihood of IUGR also increases even when US predicts a normal weight [1]. Estimated fetal weight and abdominal circumference are equivalently better than the ratio between femur length and abdominal circumference in predicting IUGR, and biometry performed within 2 weeks of delivery is more predictive than when performed at 26-34 weeks [2]. Dashe et al [3] found that among small-for-gestational-age (SGA) fetuses with no anatomic abnormalities, only those that were asymmetric (abdomen small in proportion to head) were associated with increased pregnancy-induced maternal hypertension before 32 weeks and cesarean delivery for abnormal heart rate patterns when compared with those of fetuses average for gestational age (AGA). Additionally, asymmetric SGA fetuses sustained more adverse neonatal composite outcomes compared to symmetric SGA or AGA fetuses.

Once a probability of IUGR has been established, and uteroplacental insufficiency is considered to be a likely mechanism based on US findings and clinical setting, there are a series of possible therapeutic interventions that can be used to improve fetal growth and try to prevent fetal compromise. Assessment of fetal well-being is essential to the management of such pregnancies. This testing is aimed at determining if there is life-threatening fetal compromise, and whether urgent premature delivery would offer a better chance of survival and avoidance of morbidity than would continued exposure to an increasingly hostile intrauterine environment [4,5].

Periodic fetal biometry, evaluation of amniotic fluid volume, use of the biophysical profile (BPP) or a selected subset of its component tests, Doppler ultrasound, fetal heart-rate monitoring, and fetal movement counting can all contribute to the determination of fetal compensation or compromise. It is beyond the scope of this guideline to compare these methods and rate the relative effectiveness of the many individual parameters testable alone or in various combinations. Instead, the guideline ranks the relative utility of these broad categories of fetal assessment once a risk of IUGR and potential fetal compromise has been established.

The biophysical profile has been and remains the mainstay of fetal well-being evaluation. It consists of four parameters variably sensitive to the acute exposure of the fetus to hypoxemia: fetal breathing movements, fetal limb and body movements, fetal tone, and amniotic fluid volume as an indicator of chronic hypoxemia. The nonstress test (NST), which is sometimes included with the BPP as a fifth component, can be used alone as a test of acute status, but it is often coupled with amniotic fluid measurement, a valuable reflection of fetal hypoxemic exposure over the previous week. Alternatively, the four sonographic BPP components can be used without the NST. Scores of 8-10 on the BPP are strong indicators of a well-compensated fetus, but there are many false positives when the fetus fails one or two of the acute marker tests [6]. Reduced amniotic fluid volume is an important predictor of intrapartum fetal distress, much of which is attributable to umbilical cord compression events, and the fluid volume should be periodically checked in pregnancies suspected to have IUGR [7]. Testing strategies usually evaluate one or more of the acute status parameters at least weekly, and often twice weekly, from the point of potential postnatal viability onward. Amniotic fluid is usually assessed weekly, but more often if it is approaching severely low levels. Daily or even more frequent testing by BPP or NST may be indicated in critical situations.

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Extensive research on Doppler analysis of uterine, umbilical, and various intrafetal vessels confirms a strong correlation between high-resistance arterial wave form patterns (eg, low, absent, or reversed diastolic flow in the umbilical artery) and subsequent IUGR, hypoxemic fetal morbidity, and mortality [8]. The correlation is greatest in high-risk pregnancies but insufficiently predictive in general, low-risk populations to be useful as a primary screening test [9,10].

Some have argued that since Doppler appears to be applicable primarily in a population already defined as high risk, the clinical decisions as to when a fetus is compromised and requires emergent delivery will be based on the BPP and heart-rate monitoring, making the Doppler superfluous. A recently published meta-analysis of 20 controlled trials of Doppler ultrasonography, however, found "compelling evidence" that knowledge of the Doppler findings improved perinatal outcome in high-risk pregnancies, reducing antenatal admissions, inductions of labor, and cesarean sections for fetal distress, and reducing the odds of perinatal death by 38% [11].

Studies correlating Doppler findings with the BPP, amniotic fluid volume, NST, US fetal weight estimates, and maternal blood pressure have shown that predictabilities of IUGR and fetal compromise are, to some extent, additive [12-16]. Doppler waveform abnormalities may precede clinical recognition of less-than-expected abdominal enlargement, with abnormal BPP an even later finding [17]. A review by Morris et al [18] summarizes many of these concepts about the sonographic assessment of IUGR. Dubinsky et al [19] found that decreased amniotic fluid and abnormal umbilical cord arterial Doppler waveforms were independent predictors of poor neonatal outcomes. A retrospective study by Ott [20] found that SGA singleton pregnancies with abnormal umbilical artery blood flow patterns had higher cesarean section rates for fetal nonreassuring status, increased neonatal intensive care unit stays, and increased neonatal morbidity. Those SGA fetuses with normal umbilical Doppler patterns were unassociated with these complications, suggesting that these were constitutionally small babies rather than being growth-restricted [19]. In addition to arterial Doppler, the fetal venous system can also be interrogated as a surrogate for forward cardiac blood flow [21]. In a recent study of fetuses with early-onset placental dysfunction, Baschat et al [22] demonstrated that ductus venous Doppler parameters emerge as the primary cardiovascular factor in predicting neonatal outcome.

An additional test of value in IUGR and other high-risk pregnancies is daily (or even more frequent) fetal movement counting by the mother. Frequent and vigorous fetal movements are evidence of well-being, providing reassurance to the mother, while diminishing fetal activity can provide an early warning of a deteriorating fetal status. The testing is easy and inexpensive but provides benefit in addition to the formal fetal surveillance protocols.

The specific variant conditions included in this Appropriateness Criteria require several additional comments.

A fetus small for dates compared with an earlier US study in which amniotic fluid volume was low or low normal, is the typical setting in which uteroplacental insufficiency is the most likely mechanism for IUGR. Repeat US for biometry is indicated, with the frequency adjusted by the severity of the growth restriction and the gestational age. Mild growth lag prior to 28-30 weeks can be remeasured in 4 weeks, while severe IUGR after 33 weeks may be best remeasured in 2 weeks. Some formal testing protocol for fetal well-being should be initiated on a weekly or twice-weekly schedule. Daily fetal movement counts are indicated.

IUGR caused by uteroplacental insufficiency is unusual when a normal amniotic fluid volume is present with a small or very small fetus. A first consideration should be the possibility of inaccurate dating of the pregnancy. This can be confirmed by follow-up US biometry that demonstrates appropriate interval growth of the fetal measurement parameters for the number of weeks intervening between the first and second examination. With a symmetrically very small fetus for dates, however, particularly if detected in the second or even first trimester the possibility of aneuploidy, especially trisomy 18, trisomy 13, and triploidy, must be considered [23]. Needless to say, the presence of fetal anomalies will raise the concern for chromosomal abnormality considerably. Diagnosis is generally accomplished by amniocentesis, but if a rapid karyotype is needed (eg, to avoid a cesarean section for fetal compromise of a fetus with a lethal condition) cordocentesis or placental biopsy can often provide an answer in 48-72 hours.

When there is low or absent amniotic fluid with a normally grown fetus, causes of oligohydramnios other than IUGR must be considered. These include obstruction or nonfunction of the fetal urinary tract, premature rupture of membranes, and tocolysis of preterm labor by nonsteriodals. Regardless of its etiology, oligohydramnios is an important risk factor for perinatal morbidity and mortality, due largely to umbilical cord compression but also, in cases of early and long-standing oligohydramnios, to the possible occurrence of pulmonary hypoplasia. Close monitoring of fetal condition is indicated along with periodic imaging evaluation of the fetus to check growth and chest configuration for degree of lung compression.

In summary, intrauterine growth restriction, with its inherent risks of fetal morbidity and mortality from the

hypoxemia of inadequate uteroplacental function, must be considered a major abnormality of pregnancy. When it is suspected on the basis of clinical and sonographic findings, urgent management decisions may be necessary, including the possibility of emergent preterm delivery. A protocol of frequent fetal surveillance is indicated to guide patient management and the timing of delivery.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations	
Relative Radiation Level	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

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Appendix 1.

Entry Criteria
• Size smaller than dates by last menstrual period (LMP) or prior sonogram
• Poor maternal weight gain
• Maternal hypertension or pre-eclampsia
Comment
• Entry criteria apply individually to any one or more fetuses of a multiple pregnancy
• Use multiple pregnancy guidelines
Initial Evaluation: Obstetrical Sonogram
• Scan for size and dates and determine interval growth if there has been a previous scan
• Evaluate amniotic fluid volume (qualitative, largest pocket AP diameter, amniotic fluid index)
• Note fetal activity patterns
• Survey anatomy

Appendix 2. Guideline: Growth Disturbances/Growth Restriction

Outcomes				
Normal size Normal fluid	Small size Normal fluid	Small size Asymmetrical Symmetrical Fluid low normal or low	Very small size Normal fluid	Normal size Low or absent fluid
↓	↓	↓	↓	↓
Normal	Inaccurate dates	Growth restriction	Possible aneuploidy and/or growth restriction	Urinary tract Abnormal rupture of membranes
Additional Studies				
↓	↓	↓	↓	↓
None	None	Biophysical profile Nonstress test Doppler flow studies	Detailed anatomic survey Karyotype-amniocentesis Cordocentesis Biophysical profile Nonstress test Doppler flow studies	Detailed anatomic survey Clinical exam for leaking fluid Amnioinfusion with dye to check for leakage and to improve anatomic survey
Follow-up Studies				
↓	↓	↓	↓	↓ ↓
None	Same	US scan for growth ≤27 wk – f/u in 4 wks 28-32 wk – f/u in 3 wks ≥33 wk – f/u in 2 wks plus BPP, NST, Doppler Fetal movement counting	Same	Urinary non-function Clinical manage-ment PROM Clinical manage-ment