

American College of Radiology ACR Appropriateness Criteria®

Clinical Condition: Second and Third Trimester Bleeding

Variant 1: No other signs or symptoms.

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transabdominal	9	If cervix and placenta are not visualized transabdominally, attempt transvaginal or transperineal US.	O
US pregnant uterus transvaginal	8	If transabdominal US is inconclusive. If there is evidence of ruptured membranes or open cervix with bulging amniotic sac at or below the external os, transvaginal US is contraindicated.	O
US pregnant uterus transperineal	8	If transabdominal US is inconclusive and there is clinical concern about performing transvaginal US, transperineal US is an alternative approach.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: Internal cervical os not visible by transabdominal ultrasound.

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transvaginal	9	If cervix appears completely open, do not use transvaginal US. Transperineal US is still safe in this setting.	O
US pregnant uterus transperineal	9		O
US pregnant uterus repeat transabdominal	4		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 3: Placenta previa diagnosed before 32 weeks.

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transabdominal	9	If cervix and placenta are not visualized transabdominally, attempt transvaginal or transperineal US.	O
US pregnant uterus transvaginal	8	If transabdominal US is inconclusive. If there is evidence of ruptured membranes or open cervix with bulging amniotic sac at or below the external os, transvaginal US is contraindicated.	O
US pregnant uterus transperineal	7	If transabdominal US is inconclusive and there is clinical concern about performing transvaginal US, transperineal US is an alternative approach.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Second and Third Trimester Bleeding**Variant 4:** Uterine contractions, pain, >20 weeks.

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transabdominal	9		O
US pregnant uterus transvaginal	8	If transabdominal US is inconclusive. If there is evidence of ruptured membranes or open cervix with bulging amniotic sac at or below the external os, transvaginal US is contraindicated.	O
US pregnant uterus transperineal	7	If transabdominal US is inconclusive and there is clinical concern about performing transvaginal US, transperineal US is an alternative approach.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 5: Persistent low lying placenta.

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transabdominal	9		O
US pregnant uterus transvaginal with Doppler	8	Color and spectral Doppler US to exclude vasa previa if transabdominal US is inconclusive.	O
US pregnant uterus transperineal	7	If there is clinical concern about using transvaginal US, transperineal US can be used as an alternative.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 6: Placenta previa, history of caesarean delivery.

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transabdominal with Doppler	9		O
US pregnant uterus transvaginal with Doppler	8	Color and spectral Doppler.	O
US pregnant uterus transperineal	7	If there is clinical concern about using transvaginal US, transperineal US can be used as an alternative.	O
MRI pelvis without contrast	7	As an adjunct to US and for preoperative planning.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

SECOND AND THIRD TRIMESTER BLEEDING

Expert Panel on Women's Imaging: Ann E. Podrasky, MD¹; Rochelle F. Andreotti, MD²; Susanna I. Lee MD, PhD³; Sandra O. DeJesus Allison, MD⁴; Genevieve L. Bennett, MD⁵; Douglas L. Brown, MD⁶; Phyllis Glanc, MD⁷; Mindy M. Horrow, MD⁸; Marcia C. Javitt, MD⁹; Anna S. Lev-Toaff, MD¹⁰; Leslie M. Scoutt, MD¹¹; Carolyn M. Zelop, MD.¹²

Summary of Literature Review

Vaginal bleeding in the second and third trimester usually prompts ultrasound (US) evaluation, and the sonographic findings can be critical in guiding emergent obstetrical management. Investigation of the cause of bleeding includes clinical data as to the amount of bleeding, any associated pain, and assessment of fetal well-being. Potentially serious etiologies include placenta previa, placental abruption, and vasa previa. Preterm labor may also be accompanied by bleeding as the cervix begins to dilate and cervical veins bleed, although usually bleeding is less severe. Less severe bleeding can also be due to marginal sinus separation. Placenta accreta, when present, is often associated with placenta previa; however, the bleeding is typically intrapartum or immediately postpartum.

If the bleeding is severe in late pregnancy and there are signs of fetal distress, urgent delivery is required, even if the cause is not found by imaging [1]. When no cause of bleeding is found even after delivery, it is often presumed to be due to slight marginal sinus separation.

Placenta Previa

Placenta previa classically presents with painless bleeding near the end of the second trimester or some time after. Placenta previa is defined as placental implantation that overlies or is very close to the internal os. Traditionally, there are four types: 1) complete previa — covers the internal os; 2) partial previa — partially covering; 3) marginal — placental edge going to the internal os; and 4) low-lying — to within 2 cm of the internal os. Some prefer to broaden these categories to complete versus marginal (<2 cm) [2]. If the placental edge is <2 cm from the internal os, one should measure the placental edge to

internal os distance [3]. Clinical management (caesarean delivery) is the same for complete, marginal, or low-lying previa, given that as the cervix dilates, the low-lying placenta can become a partial previa with placenta uncovered and has a high risk of bleeding.

US will reliably exclude placenta previa if the lower placental edge is shown to lie >2 cm away from the internal cervical os. This is most often accomplished by transabdominal examination of the cervix and lower uterine segment with the bladder moderately full; but the bladder should not be so full as to artificially elongate the cervix [4]. Screening to rule out placenta previa should be done as part of the second trimester anatomic survey examination [5]. Although it is more common to perform US for fetal anatomic evaluation at 18-20 weeks, scanning at 20-23 weeks was shown to decrease the number of false positives by one study [6]. If the pertinent placental and cervical anatomy is not seen due to an empty bladder or is obscured by the fetal head, by hematoma, by a suspected lower uterine segment contraction, or, as noted above, by an overly full bladder, transperineal scanning or more commonly transvaginal scanning [7] with the bladder empty will almost always result in the correct diagnosis. Since there can be more technical pitfalls with the transperineal method [8], transvaginal scanning is the preferred method in suspicious cases. Transvaginal US is considered safe in patients with previa, even in those who present with vaginal bleeding [9].

Placenta previa diagnosed in the second trimester frequently does not persist until term. It is diagnosed in 1%-6% of pregnancies in mid-trimester, but the incidence at term is much lower, approximately 0.14%-0.3% [10]. Those previas that are incomplete (partial, marginal, low-lying) do not have true attachment across the internal cervical os and often resolve later in gestation. The reasons for this apparent placental "migration" are thought to be: 1) growth or elongation of the lower uterine segment [1] and 2) trophoblastic invasion causing the placental tissue to grow in better-perfused areas of the uterus and to atrophy in less well-vascularized areas such as the lower uterine segment [11].

If the placenta is overlapping or reaching the internal os on the anatomic survey scan, a follow-up should be done in the third trimester. The persistence of previa to term is more likely when diagnosed later in gestation [12]. At any point in gestation if the placenta covers the cervix and is fully implanted on both the anterior and posterior walls of the lower uterine segment, placenta location is unlikely to change. An overlap of >15 mm seen on the initial scan at 18-23 weeks has been shown to have a high likelihood of resulting in caesarean delivery [13]. Importantly, patients with a history of caesarean delivery are more likely to have previa and are also less likely to have resolution of previa by delivery [14].

A diagnostic pitfall for previa which can occur is opposed myometrial contractions of the lower uterine segment,

¹Principal Author, Baptist Hospital of Miami/South Miami Center for Women and Infants, Miami, Florida.

²Panel Chair, Vanderbilt University Medical Center, Nashville, Tennessee.

³Panel Vice-chair, Massachusetts General Hospital, Boston, Massachusetts.

⁴Georgetown University Hospital, Washington, District of Columbia.

⁵New York University Medical Center, New York, New York.

⁶Mayo Clinic, Rochester, Minnesota.

⁷Women's College Hospital, Toronto, Ontario, Canada.

⁸Albert Einstein Medical Center, Philadelphia, Pennsylvania.

⁹Walter Reed Army Medical Center, Washington, District of Columbia.

¹⁰Thomas Jefferson University Hospital, Philadelphia, Pennsylvania.

¹¹Yale University School of Medicine, New Haven, Connecticut.

¹²St. Francis Hospital and Medical Center, Hartford, Connecticut, American College of Obstetrics and Gynecology.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

which can be seen with any technique and may make the placenta appear lower or covering the internal os. Recognizing the rounded, thicker appearance of these contractions (>1.5 cm) without an interposed mucous plug is helpful and should prompt waiting for the contractions to resolve. Also it is important to recognize the placenta and cervix as 3-dimensional structures. The placental edge may lie off midline to the right or left of the scanning plane, so either a transverse image or video clip throughout the lower uterine segment is also helpful. Magnetic resonance imaging (MRI) is used only in rare instances when US is not completely conclusive in diagnosing a low-lying placenta or placenta previa.

Placental Abruption

Placental abruption is early placental detachment from the uterus with hemorrhage into the decidua basalis (subchorionic) layer. The incidence is 1% of pregnancies and has increased slightly over the last decade [15]. Risk factors include hypertension, pre-eclampsia, preterm rupture of membranes, cigarette smoking, cocaine abuse, and thrombophilias. Also, it is more common in patients with a history of prior caesarean section and those with placenta previa [14,16].

Eighty percent of cases present with bleeding with or without pain, most commonly in the third trimester. Abruption is generally regarded as a clinical diagnosis presenting as vaginal bleeding, uterine tenderness, and contractions. However, not all patients have the classic presentation, and US can be used to evaluate those cases that present atypically or those that do not exhibit fetal distress.

There are three types of abruption: marginal, retroplacental, and the least common type, preplacental. Retroplacental abruption is the most ominous since it disrupts the placental blood flow. It can also be concealed (ie, without vaginal bleeding) if it remains entirely behind the placenta. Preplacental abruption can cause compression at the placental cord insertion site. The echogenicity of the hematoma can vary with the age of the blood, causing variable sonographic visibility of the hematoma. While sometimes the hematoma is readily visible by US, in other cases only placental thickening is seen due to isoechogenicity of the hematoma to the placenta in acute abruption, or to poor definition of the hematoma as blood dissects into the placental tissue. In fact, one study found only 24% sensitivity of US for abruption [17]; therefore, the caveat that a normal US does not necessarily exclude abruption. However, those missed by US are usually small marginal abruptions.

The US appearance of placental abruption depends on the severity and, as noted, the echogenicity of the clot. The placenta with abruption may appear thickened or bulging and have heterogeneous echotexture with loss of the normal basal plate interface. However, if the hemorrhage is small or ill-defined with blood dissecting into the placenta, diagnosis can be problematic. Color Doppler evaluation is necessary since a retroplacental hematoma should have no vascularity within it. On the other hand, a retroplacental myometrial contraction which might mimic

a hematoma on gray-scale imaging will have normal myometrial vascularity with color Doppler imaging. In general, in a patient with second or third trimester bleeding, in the absence of a diagnosis of placenta previa by US, the management of the pregnancy depends on the clinical circumstances. In rare, non-acute instances where clinical or US findings are confusing, MRI may help better define the location of the placenta and the presence of abruption [18].

Vasa Previa

Vasa previa is a rare cause of bleeding, potentially disastrous in nature, and is associated with a high risk of fetal death or neurologic deficit due to fetal exsanguination [19]. It occurs when submembranous cord vessels (containing fetal blood) cross over the internal os. With vasa previa, as labor ensues, cervical dilatation will lead to fetal hemorrhage. The two scenarios in which vasa previa occurs are 1) velamentous insertion of the cord and 2) the presence of succenturiate lobe with interconnecting vessels between it and the main placenta traversing the internal os. Low-lying placenta is a risk factor in 80% of cases or can be seen when previous midtrimester previa appears to have resolved later in gestation [20]. Prenatal diagnosis of vasa previa is critical so that a caesarean section can be performed before the onset of labor and thus is associated with a significant increase in neonatal survival [21].

A high index of suspicion is needed, particularly in those patients with risk factors for vasa previa, which include: low-lying placenta, bilobed placenta, succenturiate lobe, multifetal pregnancy, and pregnancy resulting from in-vitro fertilization. Gray-scale transabdominal or transvaginal sonography may show linear vessel walls over the internal os; however, these can be unapparent and vasa previa generally requires color Doppler for accurate diagnosis [22]. In addition, spectral Doppler is needed to confirm fetal umbilical arterial waveform and fetal heart rate.

Demonstration of the umbilical cord inserting into the main placental mass is very helpful in excluding a vasa previa associated with a velamentous cord insertion. However, this does not exclude vasa previa in the situation of interconnecting vessels with succenturiate or bilobed placental variants. Also, funic (cord) presentation should be distinguished from vasa previa by demonstration of free-floating mobile cord as opposed to fixed cord vessels over the internal os. It should be noted that a marginal vein previa is not considered vasa previa, since it contains maternal blood with low venous pressure.

Placenta Accreta

Patients with placenta previa and a history of prior caesarean delivery are also at higher risk for placenta accreta or its variants (ie, increta, percreta). Placenta accreta results from a deficiency of the decidua basalis and results in abnormal penetration of placental tissue beyond the endometrial lining of the uterus. The increta variant is defined as chorionic villi invading the

myometrium, and percreta is penetration of chorionic villi through the uterus. Percreta can commonly involve the bladder in patients with prior caesarean deliveries. One retrospective study [23] found a nearly 10% risk of placenta accreta in patients with placenta previa, and the risk of accreta increased independently with higher numbers of prior caesarean deliveries, advanced maternal age and also with implantation over the caesarean scar. Accreta is thus more common with anterior or central previas; however, it may occur wherever the placenta forms and can occur at myomectomy uterine scars or at other areas at risk for abnormal placentation such as the uterine cornua or a rudimentary horn. Although previously thought to be a potential risk factor, prior uterine curettage was not associated with an increased risk of placenta accreta in patients within this same study [23]. The danger arises when the diagnosis of placenta accreta is unknown at delivery, as any attempt to remove the abnormally adherent placental tissue may result in uncontrollable bleeding, leading to emergency hysterectomy and high morbidity. Prenatal imaging diagnosis will help avoid complications, such that a planned caesarean delivery can be performed at 34-35 weeks, and options for safest management will have been explored preoperatively.

The US findings for accreta have been described as loss of the subplacental sonolucent space and intraplacental sonolucent vascular lakes at the site of accreta, with the latter finding having the highest positive predictive value [24]. Other findings described include thinning of the myometrium (<1 mm) [25] and increased vascularity on color Doppler at the placental-myometrial interface [26]. As the spectrum progresses, there will be interruption of the interface between the uterine wall and the bladder wall [27]. With placenta percreta, there will be focal disruption of the uterine serosa, extension of tissue outside the uterus, and loss of the bladder wall echogenic mucosal reflector. Large vessels can be seen extending into the bladder wall. US evaluation can be performed with transabdominal scanning, which is often improved by using a higher frequency transducer. Transvaginal scanning is also useful in those cases with a caesarean section scar in the lower uterine segment.

MRI has been useful as an adjunctive method to evaluate for placenta accreta [28]. The MRI findings for accreta include focal thinning or absence of the myometrium at the site of placental implantation, a nodular interface between the placenta and the uterus, a mass effect of the placenta on the uterus causing an outer bulge, heterogeneous signal intensity within the placenta, dark intraplacental bands on T2-weighted images, and the loss of the tissue plane between the placenta and bladder wall [29]. In one recent series comparing imaging findings to pathology [29], the accuracy of US was fairly high, with a sensitivity for placenta accreta at 77% and specificity of 96%. MRI performed somewhat better in their cases, with a sensitivity of 88% and specificity of 100%; however, gadolinium contrast was used for some of the cases in this series and gadolinium is not routinely used in clinical practice, especially since MRI features of placenta accreta

do not require contrast administration [30]. In those cases where US screening is suggestive of accreta, MRI can be complementary to describe morphology and the extent of involvement for preoperative planning [31]. Another recent retrospective study [29] compared US and MRI in a series of 32 patients. It yielded statistically similar sensitivities and specificities of US and MRI and found the two modalities to be complementary in situations when one of the imaging studies was inconclusive.

Safety Issues

Magnetic Resonance Imaging

Pelvic MRI has been in use for over 20 years with no evidence of adverse effects to the fetus in both clinical and laboratory investigations [32]. Nevertheless, safety concerns regarding potential heating effects of radiofrequency pulses and acoustic injury to the fetus when exposed directly to the magnetic field (eg, with abdominopelvic or lumbar spine MRI) have not been completely dispelled [33]. While no fetal harm has been reported with ≤ 1.5 -T scanning, little experience has been reported at higher field strengths. Guidelines on practice procedures for MR imaging of pregnant patients are outlined in ACR White Paper on MR Safety [34]. Gadolinium contrast agents administered to a pregnant woman cross the placenta and enter the fetal circulations, filtered via the fetal kidneys and excreted into the amniotic fluid where they may remain for an indeterminate time. In animals, fetal gadolinium exposure to repeated and higher doses than that used clinically has been reported to result in increased rates of intrauterine growth restriction and birth defects [35]. To date, no such adverse effects to the human fetus have been reported. Nevertheless, gadolinium contrast agents should be administered only after an in-depth risk-benefit analysis argues for an overwhelming benefit to the mother and child that outweighs the potential risks to the fetus from exposure to free gadolinium ions. Guidelines on practice procedures for gadolinium administration in pregnant patients are outlined in [ACR Manual on Contrast Media](#) [36].

Ultrasound

US is generally considered safe during pregnancy. As in any imaging procedure, the ALARA (as low as reasonably achievable) principle should be followed. Cardiac activity may be documented in real time, or M-mode imaging. Because of higher energy levels, pulsed and color Doppler of the embryo should be avoided if possible. Pulsed and color Doppler may be extremely useful for other first trimester issues, including retained products of conception and adnexal masses [37].

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. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). 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*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼☼	0.1-1 mSv	0.03-0.3 mSv
☼☼☼	1-10 mSv	0.3-3 mSv
☼☼☼☼	10-30 mSv	3-10 mSv
☼☼☼☼☼	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

References

- Sakornbut E, Leeman L, Fontaine P. Late pregnancy bleeding. *Am Fam Physician* 2007; 75(8):1199-1206.
- Bhide A, Thilaganathan B. Recent advances in the management of placenta previa. *Curr Opin Obstet Gynecol* 2004; 16(6):447-451.
- Oppenheimer LW, Farine D, Ritchie JW, Lewinsky RM, Telford J, Fairbanks LA. What is a low-lying placenta? *Am J Obstet Gynecol* 1991; 165(4 Pt 1):1036-1038.
- Hertzberg BS, Bowie JD, Carroll BA, Kliewer MA, Weber TM. Diagnosis of placenta previa during the third trimester: role of transperineal sonography. *AJR* 1992; 159(1):83-87.
- Olive EC, Roberts CL, Nassar N, Algert CS. Test characteristics of placental location screening by transabdominal ultrasound at 18-20 weeks. *Ultrasound Obstet Gynecol* 2006; 28(7):944-949.
- Becker RH, Vonk R, Mendé BC, Ragosch V, Entezami M. The relevance of placental location at 20-23 gestational weeks for prediction of placenta previa at delivery: evaluation of 8650 cases. *Ultrasound Obstet Gynecol* 2001; 17(6):496-501.
- Smith RS, Lauria MR, Comstock CH, et al. Transvaginal ultrasonography for all placentas that appear to be low-lying or over the internal cervical os. *Ultrasound Obstet Gynecol* 1997; 9(1):22-24.
- Hertzberg BS, Kliewer MA, Baumeister LA, McNally PB, Fazekas CK. Optimizing transperineal sonographic imaging of the cervix: the hip elevation technique. *J Ultrasound Med* 1994; 13(12):933-936; quiz 1009-1010.
- Timor-Tritsch IE, Monteagudo A. Diagnosis of placenta previa by transvaginal sonography. *Ann Med* 1993; 25(3):279-283.
- Chie I, Levine D. Sonography of the Lower Uterine Segment. *Ultrasound Clinics* 2006; 1(2):303-319.
- Predanic M, Perni SC, Baergen RN, Jean-Pierre C, Chasen ST, Chervenak FA. A sonographic assessment of different patterns of placenta previa "migration" in the third trimester of pregnancy. *J Ultrasound Med* 2005; 24(6):773-780.
- Dashe JS, McIntire DD, Ramus RM, Santos-Ramos R, Twickler DM. Persistence of placenta previa according to gestational age at ultrasound detection. *Obstet Gynecol* 2002; 99(5 Pt 1):692-697.
- Taipale P, Hillesmaa V, Ylostalo P. Transvaginal ultrasonography at 18-23 weeks in predicting placenta previa at delivery. *Ultrasound Obstet Gynecol* 1998; 12(6):422-425.
- Getahun D, Oyelese Y, Salihu HM, Ananth CV. Previous cesarean delivery and risks of placenta previa and placental abruption. *Obstet Gynecol* 2006; 107(4):771-778.
- Ananth CV, Oyelese Y, Yeo L, Pradhan A, Vintzileos AM. Placental abruption in the United States, 1979 through 2001: temporal trends and potential determinants. *Am J Obstet Gynecol* 2005; 192(1):191-198.
- Oyelese Y, Ananth CV. Placental abruption. *Obstet Gynecol* 2006; 108(4):1005-1016.
- Glantz C, Purnell L. Clinical utility of sonography in the diagnosis and treatment of placental abruption. *J Ultrasound Med* 2002; 21(8):837-840.
- Kay HH, Spritzer CE. Preliminary experience with magnetic resonance imaging in patients with third-trimester bleeding. *Obstet Gynecol* 1991; 78(3 Pt 1):424-429.
- Oyelese KO, Turner M, Lees C, Campbell S. Vasa previa: an avoidable obstetric tragedy. *Obstet Gynecol Surv* 1999; 54(2):138-145.
- Francois K, Mayer S, Harris C, Perlow JH. Association of vasa previa at delivery with a history of second-trimester placenta previa. *J Reprod Med* 2003; 48(10):771-774.
- Oyelese Y, Catanzarite V, Prefumo F, et al. Vasa previa: the impact of prenatal diagnosis on outcomes. *Obstet Gynecol* 2004; 103(5 Pt 1):937-942.
- Oyelese Y, Smulian JC. Placenta previa, placenta accreta, and vasa previa. *Obstet Gynecol* 2006; 107(4):927-941.
- Miller DA, Chollet JA, Goodwin TM. Clinical risk factors for placenta previa-placenta accreta. *Am J Obstet Gynecol* 1997; 177(1):210-214.
- Comstock CH, Love JJ, Jr., Bronsteen RA, et al. Sonographic detection of placenta accreta in the second and third trimesters of pregnancy. *Am J Obstet Gynecol* 2004; 190(4):1135-1140.
- Comstock CH. Antenatal diagnosis of placenta accreta: a review. *Ultrasound Obstet Gynecol* 2005; 26(1):89-96.
- Chou MM, Ho ES, Lee YH. Prenatal diagnosis of placenta previa accreta by transabdominal color Doppler ultrasound. *Ultrasound Obstet Gynecol* 2000; 15(1):28-35.
- Finberg HJ, Williams JW. Placenta accreta: prospective sonographic diagnosis in patients with placenta previa and prior cesarean section. *J Ultrasound Med* 1992; 11(7):333-343.
- Levine D, Hulka CA, Ludmir J, Li W, Edelman RR. Placenta accreta: evaluation with color Doppler US, power Doppler US, and MR imaging. *Radiology* 1997; 205(3):773-776.
- Dwyer BK, Belogolovkin V, Tran L, et al. Prenatal diagnosis of placenta accreta: sonography or magnetic resonance imaging? *J Ultrasound Med* 2008; 27(9):1275-1281.
- Lax A, Prince MR, Mennitt KW, Schwebach JR, Budorick NE. The value of specific MRI features in the evaluation of suspected placental invasion. *Magn Reson Imaging* 2007; 25(1):87-93.
- Palacios Jaraquemada JM, Bruno CH. Magnetic resonance imaging in 300 cases of placenta accreta: surgical correlation of new findings. *Acta Obstet Gynecol Scand* 2005; 84(8):716-724.
- Shellock FG, Crues JV. MR procedures: biologic effects, safety, and patient care. *Radiology* 2004; 232(3):635-652.
- De Wilde JP, Rivers AW, Price DL. A review of the current use of magnetic resonance imaging in pregnancy and safety implications for the fetus. *Prog Biophys Mol Biol* 2005; 87(2-3):335-353.
- Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document for safe MR practices: 2007. *AJR* 2007; 188(6):1447-1474.
- OMNISCAN® package insert: Nycomed Imaging A.S. Princeton, NJ.

36. American College of Radiology. *Manual on Contrast Media*. Available at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx.

37. Bly S, Van den Hof MC. Obstetric ultrasound biological effects and safety. *J Obstet Gynaecol Can* 2005; 27(6):572-580.

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.