# 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 | Ensure visualization of placenta, inferior placental margin, and cervix from internal to external os. Bladder should not be over-filled. | O |
| US pregnant uterus transvaginal | 8 | This is performed if transabdominal US is inconclusive. If there is an open cervix with bulging amniotic sac at or below the external os, transvaginal US is contraindicated. This is usually not performed if there are ruptured membranes due to the potential risk of chorioamnionitis. | O |
| US pregnant uterus transperineal | 7 | This is an alternative to the transvaginal approach if there is an open cervix with bulging amniotic sac, ruptured membranes with possible risk of chorioamnionitis, or if transvaginal US declined. Procedure requires technical expertise to near the level of accuracy achieved with the transvaginal technique. | 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:** **Cervix or internal cervical os not well seen by transabdominal ultrasound.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US pregnant uterus transvaginal | 9 | If the cervix appears completely open, do not use transvaginal US. Transperineal US is still safe to use in this setting. | O |
| US pregnant uterus transperineal | 7 | This alternative to the transvaginal approach is used if there is an open cervix with bulging amniotic sac, ruptured membranes with possible risk of chorioamnionitis, or if transvaginal US declined. Procedure requires technical expertise to near the level of accuracy achieved with the transvaginal technique. | 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** |

**Clinical Condition:** **Second and Third Trimester Bleeding**

**Variant 3:** **Placenta previa diagnosed on prior US.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US pregnant uterus transabdominal | 9 | If the cervix, specifically internal cervical os and inferior placental margin, is not visualized transabdominally, perform transvaginal or transperineal US. | O |
| US pregnant uterus transvaginal | 8 | Perform if transabdominal US is inconclusive. If there is an open cervix with bulging amniotic sac at or below the external os, transvaginal US is contraindicated. Procedure is usually not performed if there are ruptured membranes due to risk of chorioamnionitis. | O |
| US pregnant uterus transperineal | 7 | This is an alternative to the transvaginal approach if there is an open cervix with bulging amniotic sac, ruptured membranes with possible risk of chorioamnionitis, or if transvaginal US is declined. Procedure requires technical expertise to near the level of accuracy achieved with the transvaginal technique. | O |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Variant 4:** **Persistent low lying-placenta.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US pregnant uterus transabdominal | 9 | Evaluate placental cord insertion. | O |
| US pregnant uterus transvaginal with Doppler | 8 | Use color and spectral Doppler US to exclude vasa previa if transabdominal US is inconclusive. | O |
| US pregnant uterus transperineal | 7 | This is an alternative to the transvaginal approach if there is an open cervix with bulging amniotic sac, ruptured membranes with possible risk of chorioamnionitis, or if transvaginal US declined. Procedure requires technical expertise to near level of accuracy achieved with the transvaginal technique. | 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 5:** **Placenta previa and history of Caesarean section.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US pregnant uterus transabdominal with Doppler | 9 | Presence of placental lacunae should raise concern for placenta accreta. | O |
| US pregnant uterus transvaginal with Doppler | 8 | Use 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 IV contrast | 7 | Use as an adjunct when there are suspicious sonographic findings of possible placenta accreta. Useful for preoperative planning. | O |
| MRI pelvis without and with IV contrast | 3 | | 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:** **Uterine contractions and pain.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US pregnant uterus transabdominal | 9 | Evaluate placenta and cervix. | O |
| US pregnant uterus transvaginal | 8 | Use if transabdominal US is inconclusive. If there is an open cervix with bulging amniotic sac at or below the external os, transvaginal US is contraindicated. Procedure is usually not performed if there are ruptured membranes. | O |
| US pregnant uterus transperineal | 7 | This is an alternative to the transvaginal approach if there is an open cervix with bulging amniotic sac, ruptured membranes with possible risk of chorioamnionitis, or if transvaginal US declined. This procedure requires technical expertise to near the level of accuracy achieved with the transvaginal technique. | 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

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## Summary of Literature Review

### Introduction/Background

Physicians frequently order an ultrasound (US) evaluation when a pregnant patient develops vaginal bleeding. In the second and third trimesters, bleeding can be a result of abnormal placentation, such that sonographic findings are often crucial in guiding emergent obstetrical management. Initial clinical data to obtain include the amount of bleeding, the presence and severity of associated pain, and subjective assessment of fetal movements. Potentially serious etiologies during the second and third trimesters include placenta previa, placenta accreta, placental abruption, and vasa previa. When placenta accreta occurs, it is most commonly associated with placenta previa. However, the highest risk of life-threatening bleeding from accreta typically occurs intrapartum or immediately postpartum, eg, with attempted placental removal. Light vaginal bleeding or bloody vaginal discharge ("bloody show") can accompany preterm labor and cervical incompetence as the cervix begins to dilate and cervical veins bleed; however, contractions or pain are likely the more predominant symptoms [1]. In the second trimester, mild bleeding can result from a small marginal separation at the edge of the placenta that does not expand [2]. Uncommon causes of bleeding in the second or third trimester include cervical infection or neoplasm. Lastly, uterine rupture, a rare emergency situation presenting as bleeding and severe pain in late pregnancy, can occur in patients who have had prior Caesarean sections and uterine surgery.

Various reports have addressed the clinical significance of second- and third-trimester vaginal bleeding. In a recent clinical study, a single episode of light vaginal bleeding in the midsecond trimester did not significantly alter pregnancy outcome, but an episode of heavy bleeding had a favorable outcome in 67% of nonprevia cases and 35% of previa cases [3]. Another study demonstrated no increase in the risk of preterm birth or preterm membrane rupture from a single bleeding episode. Multiple bleeding episodes, however, increased the risk of preterm complications 2-fold in a study cohort of white women [4], although this was not shown to be true in the African American patients. Positive sonographic findings, such as intrauterine clot, membrane separation, or placenta previa, at the time of bleeding yield a 2-fold increase in perinatal morbidity and mortality [5]. Also, any bleeding prior to 20 weeks can indicate an increased risk of placental abruption, particularly if it is associated with morphologic abnormalities of the placenta, umbilical cord, or membranes [6]. In another study, unexplained bleeding with a negative US examination after 20 weeks was correlated with risk of preterm delivery, neonatal intensive care, and reduced birth weight [7]. Finally, a recent statistical study using transvaginal US found a higher risk of preterm delivery among patients in their second trimester who had a history of vaginal bleeding and a short cervix[8].

Late-pregnancy bleeding can be associated with significant maternal and fetal risks [9], including uteroplacental insufficiency, preterm birth, and severe maternal hemorrhage. Emergent US is used to determine the specific cause of bleeding. However, if the bleeding is severe and there are signs of fetal distress, urgent delivery is required even if the imaging found no anatomic placental or cervical cause. Causes of myometrial damage, such as Caesarean section deliveries and prior uterine surgical procedures, are noteworthy because of the increasing prevalence of placenta previa and accreta thought to be associated with the rise in Caesarean section rates in the

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past 20 years. The risk of abnormal placentation increases in patients with each successive Caesarean section [10]. Accurate antenatal diagnosis of placental abnormalities provides the opportunity to develop a multidisciplinary delivery plan to obtain the best maternal and neonatal outcomes.

**Placenta Previa**

Placenta previa classically presents with painless bleeding near the end of the second trimester or during the third trimester. It is defined as placental implantation that overlies or is very close to the internal cervical os. The incidence is 2.8/1,000 in singleton pregnancies and 3.9/1,000 in twin pregnancies [11]. The main risk factors for placenta previa include age over 30, multiparity, prior Caesarean sections, and prior abortions [12]. Higher parity and number of Caesarean sections create a synergistic effect that increases the likelihood of previa [13].

Placenta previa has been traditionally categorized into 4 types: (1) complete previa—covers the internal os (may be central or asymmetric over the 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 [14]. If the placental edge is <2 cm from the internal os, one should measure the placental edge to the internal os distance [15]. Current recommendations are to report the distance either from the internal os or from the overlap of the placenta over the internal os [16]. Historically, a Caesarean section has been performed for complete, partial, or marginal previa. It may also be needed for a persistent low-lying placenta because the inferior edge of the placenta can become uncovered as the cervix dilates, leading to vaginal bleeding analogous to a partial previa. However, there are recent considerations for vaginal delivery in cases of low-lying placentae without excessive vaginal bleeding [17].

US reliably excludes placenta previa if the lower placental edge is >2 cm away from the internal cervical os. This is usually evaluated by transabdominal examination of the cervix and lower uterine segment with the bladder moderately full; however, the bladder should not be so full as to artificially elongate the cervix. Screening to rule out placenta previa should be part of the second-trimester anatomic examination [18]. One study found that scanning at 20 to 23 weeks decreased the number of false positives [19]; however, most practitioners perform the anatomic survey at 18 to 20 weeks to allow for counseling and additional testing as needed. Transvaginal scanning [20] is the preferred method for evaluating potential previa if the pertinent placental and cervical anatomy are not visible for various reasons, eg, an empty bladder, obscuration by the fetal head, hematoma, obesity, lower uterine segment contraction, or an overly full bladder. Transvaginal US is considered to be safe for patients who have previa, including those who present with vaginal bleeding [21]. Transperineal US [22,23] can be used as an alternative if there is a contraindication to transvaginal US, such as an incompetent cervix with a bulging amniotic sac or suspected preterm premature rupture of membranes. Transperineal US has been shown to have good accuracy when there is sufficient technical expertise to clearly demonstrate accurate cervical landmarks [24].

Placenta previa diagnosed in the second trimester frequently does not persist until term. Although it has been diagnosed in 1% to 6% of pregnancies in midtrimester, the incidence of previa at term is much lower, approximately 0.14% to 0.3% [25]. The persistence of a previa to term is more likely when it is diagnosed later in gestation [26]. If previa or a low-lying placenta is diagnosed on the midtrimester anatomic survey scan, a follow-up US should be performed in the third trimester. Many cases in which the placenta extends just over or to the internal cervical os resolve later in gestation. The reasons for this apparent placental "migration" are thought to be (1) growth or elongation of the lower uterine segment and (2) trophotropism, causing the placental tissue to develop in better-perfused areas of the uterus and to atrophy in less well-vascularized areas, such as the lower-uterine segment [27]. When the placenta fully covers the cervix and is implanted on both the anterior and posterior walls of the lower-uterine segment, by an overlap of >15 mm as seen on the initial scan at 18 to 23 weeks, there is a high likelihood of resultant delivery by Caesarean section [28]. Oppenheimer et al [29] examined the rate of placental "migration" after 29 weeks in patients who have previa or a low-lying placenta with an internal os overlap of -20 mm to 20 mm. Although their sample size was small, analysis of their data indicated that a placental migration rate of <1 mm/week, as measured at 4-week intervals, predicted the necessity for a Caesarean section. In a more recent study, Vergani et al [17] evaluated patients having a placental edge-internal os distance <20 mm from the internal os; in a subgroup with an os distance of 11 mm to 20 mm, 69% delivered vaginally. Those in the <10-mm subgroup were managed by Caesarean section 75% of the time and experienced a higher postpartum hemorrhage rate. As noted, patients with a prior history of Caesarean section(s) are more likely to have previa and are less likely to have resolution of previa by delivery [30].

A major pitfall in diagnosing placenta previa is myometrial contraction in the lower uterine segment. A contraction can simulate the inferior placenta, or opposing anterior and posterior contractions can simulate the

walls of the upper cervix. In both instances, the true internal os is obscured, causing the placenta to appear lower and to cover the internal os [25]. Although any technique—transabdominal, transperineal, or transvaginal—can be used to detect these false appearances, transvaginal US is considered to be the most accurate; therefore, one must be able to recognize the most accurate depiction. Rather than the cylindric appearance of the actual cervix, these contractions have a rounded, thicker, or "heaped up" appearance without an interposed mucous plug, which can produce an overestimation of the cervical length. It is useful to wait for the contractions to resolve and reimage the cervix. Also it is important to consider the placenta and cervix as 3-D structures. The placental edge may lie off midline to the right or left of the scanning plane; thus, either a transverse image or video clip throughout the lower uterine segment is also helpful. Use of 3- or 4-D grayscale to diagnose placenta previa has been suggested, but no studies have been reported to date. Three-dimensional US has been used primarily to evaluate placental vasculature in previa and suspected accreta [31] or vasa previa. Magnetic resonance imaging (MRI) has been used as an adjunct to US in cases of previa and primarily in cases of suspected accreta.

**Placenta Accreta**

In the last several decades, placenta accreta, defined as placenta abnormally adherent to the uterus, has become a more prevalent obstetrical problem, primarily due to the increase in the rate of Caesarean section deliveries [10]. One retrospective study [32] found a nearly 10% risk of placenta accreta in patients who have placenta previa. Patients with placenta previa and multiple prior Caesarean section deliveries have the highest risk for placenta accreta, eg, up to 40% with 3 prior Caesarean sections [33]. Advanced maternal age and multiparity are other risk factors [32], and placenta accreta has been linked to Asherman's syndrome and fibroids [34]. The incidence of placenta accreta was recently reported as 1 in 533 deliveries [10]. Histologically, there is a deficiency of the decidua basalis layer (also known as Nitabuch's layer) that results in abnormal penetration of placental tissue beyond the endometrial lining of the uterus. Placenta increta is a variant form, defined as chorionic villi invading the myometrium, and percreta is the penetration of chorionic villi through the uterus. Percreta is the most problematic and can invade adjacent tissues, such as the bladder wall. The accreta spectrum is more common with anterior or central previas; however, it can occur at any placental site, myomectomy sites, or other areas at risk for abnormal placentation, such as the uterine cornua or a rudimentary horn. One study linked placenta accreta with elevated serum markers, in particular maternal serum alpha-fetoprotein, in the second trimester, [35]; another study reported this elevated marker in previa but not in accreta [36].

If it is not diagnosed before delivery, placenta accreta can be a very dangerous condition, most commonly manifesting in the third stage of labor. Attempted removal of the abnormally adherent placental tissue during this stage may result in massive, uncontrollable bleeding and lead to emergency hysterectomy and attendant high morbidity and mortality. Other complications could include disseminated intravascular coagulation, adult respiratory distress syndrome, renal failure, and death. Antenatal imaging diagnosis is a basis for antenatal consultation, such as gynecologic oncology, anesthesiology, interventional radiology, and neonatology. Two studies showed decreased maternal hemorrhagic morbidity with a planned Caesarean section hysterectomy, with no significant increase in neonatal morbidity [37,38]. One of the studies reported a scheduled delivery at 34 to 35 weeks with steroid administration to promote lung maturity [38]. Optimal obstetrical management at delivery includes operative and blood-volume support strategies, and the best outcomes are obtained with a scheduled Caesarean section hysterectomy and no attempt to remove the placenta. Although there have been contradictory reports, 1 case-control series [39] supported the prophylactic use of iliac occlusive balloons by interventional radiology to control maternal bleeding. Interventional radiology techniques may be used on a case-by-case basis.

US is the initial imaging modality of choice for suspected placenta accreta. Sonographic indicators, such as the presence of placental lacunes [40], can occur as early as 15 weeks. More commonly, screening anatomy US is performed at 18 to 20 weeks. If the patient has placenta previa or a low-lying placenta and a prior Caesarean section, the examiner should suspect the presence of placenta accreta. To optimize detail of the lower uterine segment, a higher-frequency transducer is often used to survey the uterine and placental morphology transabdominally. It is recommended to supplement this with transvaginal scanning to evaluate the anterior lower uterine segment myometrium, placenta, and myometrial-placental interface [41].

Numerous studies have reported using sonographic grayscale and color Doppler findings to diagnose placenta accreta. Twickler et al [42] described the presence of vascular lacunes in the placenta and myometrial thinning <1 mm as positive findings in their 9 patients. In another study, Yang et al [43] used a system first established by Finburg et al [44] for grading the number of lacunes. Yang et al showed a sensitivity of 100% for grade 2+ (4-6) lacunes, with a higher incidence of obstetric complications in these patients, and the severity of accreta increased

with the number of lacunes. Comstock et al [40] observed lacunes in a majority of their accreta patients in scans at 15 to 20 weeks. The more irregular and larger lacunes with turbulent flow defined as venous velocity >15 cm/s [45] are associated with placenta accreta. There is a spectrum of sonographic findings that includes obliteration or complete loss of the normal retroplacental hypoechoic zone, localized thinning of the myometrium to <1 mm, vessels bridging the placental-uterine border, and intraplacental sonolucent vascular lakes [46]. One study stated that the presence of multiple criteria yields a higher positive-predictive value [47]. Another finding was increased vascularity on color Doppler at the placental-myometrial interface [48-50]. As the accreta spectrum progresses, there will be an interruption of the interface between the uterine and bladder walls [49-51]. With placenta percreta, there will be a focal disruption of the uterine serosa, focal bulge with tissue extension outside the uterus, and loss of the bladder wall layers, with large vessels extending into the bladder wall. Comstock [49] reviewed the value of color Doppler for evaluating placental lacunes and placental vascular sinuses traversing the uterine wall. A more recent report [51] touted the value of 3-D color Doppler angiography and multiple specific color Doppler criteria to aid in diagnosis. The single most useful diagnostic criterion was "numerous coherent vessels" involved the placental base, defined as inseparable cotyledon (fetal villous) and intervillous (maternal) circulations with extreme hypervascularity fusing into a huge vascular complex involving the placental base. These authors diagnosed this in 38 of 39 patients who had placenta accreta. In summary, placental lacunes and abnormal color Doppler imaging patterns were the most helpful US markers [52].

In many cases, sonography can be sufficiently accurate for diagnosing placenta accreta, particularly in anterior previa at the Caesarean section scar. MRI may be helpful for evaluating posterior placenta accreta [53]. The literature supports using MRI to confirm a diagnosis and better depict the overall topography, particularly if there is percreta and invasion of adjacent structures [54]. Several MRI findings for accreta have been described, including (1) focal thinning or absence of the myometrium at the site of placental implantation, (2) a nodular interface between the placenta and the uterus, (3) a mass effect of the placenta on the uterus, causing an outer bulge, (4) heterogeneous signal intensity within the placenta, (5) dark intraplacental bands on T2-weighted images, and (6) loss of the tissue plane between the placenta and bladder wall [52,55]. One series compared imaging findings to pathology [56] and reported good accuracy of US, sensitivity for placenta accreta at 77%, and specificity of 96%; MRI accuracy was better, with a corresponding sensitivity of 88% and specificity of 100%. However, these data are less clinically useful because gadolinium contrast, which is not commonly used with pregnancy, was administered in some cases. Two recent publications focused on the presence of multiple dark intraplacental bands, which measured >6 mm wide in 1 study [57]. In a small number of cases, penetrating and/or bizarre tortuous vessels and heterogeneity of the placenta were also reported [57]. The second study quantitated the bands by calculating their total volume [58].

Another retrospective study [56], which compared US and MRI in 32 patients, yielded statistically similar sensitivities and specificities (93% and 71% for US, respectively, and 80% and 65% for MRI, respectively), with a lower specificity for each modality than had been reported previously. The 2 modalities were complementary when one of the imaging studies was inconclusive; there were no cases in which both studies were inconclusive. Warshak et al [50] also advised a 2-stage protocol starting with US and followed by MRI. In summary, US can be diagnostic for placenta accreta, but MRI is often very helpful in confirming a diagnosis and describing more completely the morphology and extent of involvement for predelivery planning. Further, it is important to recognize the potential for false-negative imaging and plan prudently for intrapartum maternal hemorrhage in cases of high clinical suspicion [59].

**Placental Abruption**

Placental abruption is the premature separation of a normally implanted placenta from the uterus, with hemorrhage into the decidua basalis (subchorionic) layer. The incidence has increased slightly (1% of pregnancies) in the past decade [60]. Risk factors include hypertension, pre-eclampsia, preterm rupture of membranes, cigarette smoking, cocaine abuse, thrombophilias, and abdominal trauma. Also, it is more common in patients who have had a prior Caesarean section and those who have placenta previa [30,61].

Abruption is generally regarded as a clinical diagnosis presenting as vaginal bleeding, uterine tenderness, and contractions and can lead to consumptive coagulopathy in severe cases. Eighty percent of cases present in the third trimester with bleeding and with or without pain. US can be used in an emergency situation to help confirm the diagnosis, but an inconclusive study should not delay delivery, particularly if there are signs of fetal distress. In patients who present atypically, US examination of the placenta is indicated.

The 3 types of abruption are marginal, retroplacental, and—the least common—preplacental. Retroplacental abruption is the most ominous because it disrupts the placental blood flow. It can be "nonconcealed," (presenting with vaginal bleeding) or "concealed" (without vaginal bleeding) if it remains entirely behind the placenta. In their series, Glantz et al [62] found only 24% sensitivity of US for detecting abruption; therefore, they warned that a normal US does not necessarily exclude abruption. A false-negative diagnosis can occur if the blood egresses completely from the uterus; thus, no hematoma will be evident at the time of the US examination. Smaller marginal abruptions might also be missed.

With US, the abrupted placenta appears to be thickened, usually with rounded bulging, and is heterogeneous in echotexture, which causes loss of the normal basal plate interface. The echogenicity of the hematoma can vary from echogenic or isoechoic to sonolucent based on the age of the blood, causing variable sonographic visibility of the hematoma. However, if the hemorrhage is small or ill-defined with blood dissecting into the placenta, diagnosis can sometimes be problematic. Color Doppler is useful in detecting the hemorrhage because a retroplacental hematoma should not have vascularity within it. On the other hand, a retroplacental myometrial contraction, which might mimic a hematoma on grayscale imaging, will appear to have normal myometrial vascularity with color Doppler imaging. Although it is easier to diagnose a larger retroplacental hematoma, a larger hematoma can contribute to an adverse perinatal outcome. A hematoma >50 ml by volume or >50% placental detachment has a poorer fetal prognosis. Based primarily on clinical presentation but also on imaging findings, a prompt delivery should be performed.

Hematomas caused by preplacental abruptions can also be problematic, as there can be other diagnostic considerations, such as subchorionic maternal venous lakes, subchorionic thrombohematomas, or subchorionic fibrin deposition. The "jello" indicator, ie, the mobility or softness of a hematoma evident with gentle probing, is helpful in diagnosing an acute to subacute hematoma. Preplacental abruption can cause compression at the placental cord insertion site, which can produce abnormal umbilical cord Doppler examinations and attendant fetal compromise.

Ultrasound is the imaging modality of choice, but abruption can be subacute, which can confuse US findings. MRI can diagnose abruption and define the size and location of the periplacental hematoma [63]. In a recent study of 19 cases, a T-1 gradient echo sequence and a diffusion-weighted sequence were used to identify placental abruption in 95% of the cases [64].

**Vasa Previa**

Vasa previa is a rare cause of second- and third-trimester vaginal bleeding and is associated with a high risk of fetal death or neurologic deficit due to fetal exsanguination [65]. The incidence is 1 in 2,500 deliveries. It occurs when umbilical vessels (containing fetal blood) traverse the fetal membranes in the lower uterine segment in front of the presenting part and cross over the internal cervical os unprotected by the placental or umbilical cord. With vasa previa, cervical dilation will lead to fetal hemorrhage, with rapid depletion of the fetal blood volume as labor ensues. Vasa previa occurs in 2 scenarios: (1) type 1, ie, velamentous insertion of the cord, and (2) type 2, ie, succenturiate lobe, with interconnecting vessels between it and the main placenta traversing the internal os, or bilobed placenta, with interconnecting vessels over the os. Diagnosis of vasa previa is critical so that a Caesarean section can be performed before the onset of labor; thus, it is associated with a significant increase in neonatal survival. If vasa previa is not diagnosed prenatally, the mortality in the largest series of combined data is 56% [66]. If diagnosed prenatally, then >96% survive.

The reported risk factors [67] for vasa previa are low-lying placenta, bilobed placenta, succenturiate lobe, multifetal pregnancy, and pregnancy resulting from *in vitro* fertilization. Vasa previa has been associated with midtrimester placenta previa in 69% of cases [68]. If the placenta is low-lying, the patient should be further evaluated for the cord insertion site. If transabdominal imaging does not clearly and convincingly demonstrate the internal cervical os, transvaginal sonography should be performed to exclude vasa previa, especially among those with any of the previously noted risk factors for vasa previa.

Grayscale sonography can show linear vessel walls over the internal os; however, color (or power) Doppler is needed for an accurate diagnosis [65], preferably via transvaginal sonography. In addition, spectral Doppler is useful for confirming a fetal umbilical arterial waveform and fetal heart rate within the overlying vessels. Cord (or funic) presentation is usually readily distinguished from vasa previa by a free-floating mobile cord as opposed to fixed-cord intramembranous vessels over the internal os. A marginal-vein previa is not considered vasa previa because it contains maternal blood with only low-velocity venous flow.

A sonographic demonstration of the umbilical cord inserting centrally into the main placental mass is very helpful in excluding a vasa previa associated with a velamentous cord insertion. A feasibility study of sonographic imaging using color Doppler and transvaginal imaging showed that 99% of the placental cord insertion sites could be imaged in minimal additional time [69]. Sepulveda had similar results for detecting velamentous cord insertion and advised routine evaluations at 18 to 20 weeks to screen for potential abnormal cord insertion and exclude the possibility of vasa previa [70]. However, imaging the placental cord insertion into the main placental mass does not exclude type 2 vasa previa from interconnecting vessels with succenturiate or bilobed placental variants. Furthermore, a case report showed that an initially low-lying placenta with central cord insertion resolved later in the pregnancy; however, follow-up examinations showed that velamentous vessels overlaid the internal cervical os until delivery, a finding consistent with proven vasa previa [71]. These authors used 3-D US and 3-D power Doppler angiography to provide a map for surgical incision into the uterus to avoid lacerating these vessels. Other investigators have used both surface-rendering and 3-D multiplanar reconstruction in the coronal plane to diagnose vasa previa [72,73]. If a 3-D image is not available, a dynamic clip in the sagittal plane can also be used. MRI was recently used in an uncertain case in which hemorrhage over the internal os between bilobed placentas was distinguishable from the placenta [74].

With the proper antenatal diagnosis of vasa previa, delivery planning can be optimized at approximately 35 to 36 weeks. It should be noted that in vasa previa, amniocentesis for lung maturity may not be indicated because it can cause membrane rupture and lead to bleeding from the intramembranous vessels. The obstetrician can confirm the exact position of the fetal vessels that will be encountered during the Caesarean section. A collaborative effort of physicians and caregivers at a facility skilled in high-risk deliveries and neonatal resuscitation has been shown to greatly improve outcomes with vasa previa.

**Summary**

- Vaginal bleeding in the second or third trimester can be associated with increased risks to the mother and fetus, or both, depending on the severity, number of episodes, and cause of bleeding, as determined by US.
- The primary imaging method is transabdominal US supplemented by transvaginal US. Transvaginal US may be needed for visualization of the cervix and internal os and when there is a risk of preterm labor. In some cases, transperineal US is appropriate.
- Placenta previa is best described by the distance of the placental edge to the internal os and should be re-evaluated during pregnancy for a potential resolution depending on the degree of attachment to the opposing wall.
- Prior Caesarean sections can increase the risk of placental accreta. Multiple sonographic findings, including intraplacental lacunes, increased vascularity, myometrial thinning, and focal placental bulge can lead to an accurate diagnosis of placenta accreta. MRI improves diagnostic confidence based on additional findings of dark intraplacental bands and heterogeneity of the placenta, along with the overall morphologic depiction of the placenta and adjacent structures. Moreover, MRI is also useful for multidisciplinary planning for delivery.
- Placental abruption is generally considered a clinical diagnosis, but emergency use of US is appropriate for diagnosing the sonographic findings of abruption, such as placental thickening, heterogeneity, and a periplacental hematoma.
- Vasa previa is a serious risk that needs to be recognized and requires a planned Caesarean section. It occurs with the velamentous insertion of the umbilical cord over the internal cervical os or, in cases of an accessory placental lobe (succenturiate lobe), with interconnecting vessels. Ultrasound is usually sufficient, although MRI has also been used.

**Safety Considerations in Pregnant Patients**

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR-SPR Practice Guideline for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI)
- ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation
- ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound
- ACR Manual on Contrast Media

- ACR Guidance Document for Safe MR Practices

**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 "Varies". | | |

**Supporting Documents**

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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