The placenta is often overlooked in the routine evaluation of a normal gestation, receiving attention only when an abnormality is detected. Although uncommon, abnormalities of the placenta are important to recognize owing to the potential for maternal and fetal morbidity and mortality. Pathologic conditions of the placenta include placental causes of hemorrhage, gestational trophoblastic disease, retained products of conception, nontrophoblastic placental tumors, metastases, and cystic lesions. Sonography remains the imaging modality of choice for evaluation of the placenta. Magnetic resonance (MR) imaging can be of added diagnostic value when further characterization is required, particularly in the setting of invasive placental processes such as placenta accreta and gestational trophoblastic disease. Computed tomography (CT) has a limited role in the evaluation of placental disease owing to limited tissue characterization, compared with that of MR imaging, and the radiation risk to the fetus; this risk often outweighs the benefit. The primary role for CT is in the evaluation of trauma and gestational trophoblastic disease, for which it allows characterization of the primary lesion and distant metastases.
Introduction

The placenta is named for its appearance (Greek plakos, meaning “flat cake”) and is responsible for the nutritive, respiratory, and excretory functions of the fetus. The placenta is often overlooked in the routine evaluation of a normal gestation, receiving attention only when an abnormality is detected.

In this article, we present the imaging characteristics of the normal and abnormal placenta. After reviewing the embryologic features and multimodality evaluation of the placenta, we describe normal placental anatomy and morphology, including twin gestations. Finally, we discuss pathologic conditions of the placenta, including placental causes of hemorrhage, gestational trophoblastic disease, retained products of conception (RPOC), nontrophoblastic placental tumors, metastases, and cystic lesions.

Embryologic Features

Both fetal and maternal components contribute to the structure of the placenta. The villi of the chorion frondosum are fetal in origin and contain arterial plexuses supplied by the umbilical artery. These chorionic villi protrude into the intervillous space, where they are bathed in maternal blood (1,2).

The maternal portion of the placenta is composed of the decidua placentalis, which lines the intervillous space. Fetal trophoblastic invasion of the endometrium induces decidual changes. Maternal decidual septa separate groups of villi within the intervillous space.

Multimodality Evaluation of the Placenta

Imaging in the antepartum period should be performed with minimal risk to both the mother and developing fetus. As a result, noninvasive techniques such as ultrasonography (US) and magnetic resonance (MR) imaging that do not use ionizing radiation are preferred.

US is the mainstay of placental imaging in the antepartum period (3). At sonography, the placenta is uniformly of intermediate echogenicity, with a deep hypoechoic band at the interface between the myometrium and basilar decidual layer (Fig 1). Color and power Doppler techniques permit direct visualization of placentation, allowing assessment of both the uteroplacental and fetoplacental circulations. Poor vascularity secondary to uterine scarring or large fibroids can lead to atrophy of the chorionic villi and corresponding compromise of fetal circulation. Both three-dimensional and four-dimensional (or real-time three-dimensional) US are emerging sonographic techniques that may ultimately be of value in placental volume measurements or vascular imaging (3).

MR imaging is the other dominant imaging modality in the antepartum period. MR imaging may be superior to US in some settings owing to improved soft-tissue contrast and wider field of view; however, it is limited by cost, patient claustrophobia, and limited availability of both imaging unit technology and skilled image interpretation (4). Although MR imaging uses no ionizing radiation, the safety of MR imaging during pregnancy remains uncertain. Tissue heating during pregnancy related to radiofrequency fields used by MR imaging units is of primary concern and has been variably addressed in the literature by means of animal and human studies, including the use of modern SSFSE imaging and echo-planar imaging (5). MR imaging sequences with high temporal resolution and good contrast-to-noise ratios, such as SSFSE and steady-state free-precession gradient-echo sequences, have made antepartum imaging of the placenta possible (6).

To minimize the deposition of radiofrequency energy in the pregnant patient and optimize temporal resolution, a 256 × 160 matrix is used with a partial-phase field of view of 0.70–0.75 in applicable rectangular geometries, such as the axial plane. At our institution, SSFSE imaging is performed in multiple orthogonal planes initially with T2-weighted spin-echo and T1-weighted gradient-echo imaging performed subsequently, as directed by the interpreting radiologist. Some studies have also investigated the value of pre- and postcontrast T1-weighted spoiled gradient-echo sequences, although the use of intravenous gadolinium contrast material remains controversial in the antepartum period (6,7). At MR imaging, the placenta appears as an intermediate-
Figure 1. Normal placenta. (a) US image shows a placenta (P) that is relatively homogeneous in echotexture. The retroplacental clear space is hypoechoic (arrowheads). (b) Sagittal single-shot fast spin-echo (SSFSE) T2-weighted MR image shows a placenta (P) with intermediate signal intensity. The dark line represents the retroplacental clear space (arrowheads).

Table 1

<table>
<thead>
<tr>
<th>Shape of Placenta</th>
<th>Definition</th>
<th>Significance</th>
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<tbody>
<tr>
<td>Succenturiate (Fig 2a)</td>
<td>An additional lobule separate from the main bulk of the placenta</td>
<td>Rupture of vessels connecting the two components; retention of the accessory lobe with resultant postpartum hemorrhage</td>
</tr>
<tr>
<td>Bilobed (Fig 3a)</td>
<td>Placenta with two relatively even-sized lobes connected by a thin bridge of placental tissue</td>
<td>No known risk</td>
</tr>
<tr>
<td>Circumvallate (Fig 4a)</td>
<td>Chorionic plate smaller than the basal plate with associated rolled placental edges</td>
<td>Placental abruption and hemorrhage</td>
</tr>
<tr>
<td>Placenta membranacea (Fig 5)</td>
<td>Thin membranous structure circumferentially occupying the entire periphery of the chorion</td>
<td>Placenta previa, as a portion of the placenta completely covers the internal cervical os</td>
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signal-intensity soft-tissue structure along the margin of the uterus. The myometrial-decidual interface is visible as a low-signal-intensity line deep to the placenta (Fig 1).

**Normal Imaging Appearance and Variants**

Typically, the placenta is located along the anterior or posterior uterine wall, extending onto the lateral walls. Although usually discoid, the placenta can be variable in morphology. Variant placental shapes include bilobed, succenturiate, circumvallate, and placenta membranacea (Table 1) (Figs 2–5). The umbilical cord typically inserts centrally, but eccentric and velamentous (outside the placental margin) insertions also occur (Fig 6).
Figure 2. Succenturiate placenta. (a) Diagram shows a placenta with a succenturiate lobe. (b) US image shows a placenta (P) with a succenturiate lobe (S). The main body of the placenta is located along the posterior uterine wall. A second soft-tissue structure of the same echogenicity but located anteriorly is the succenturiate lobe. (c) Sagittal SSFSE MR image shows a normal placenta (P) with a succenturiate lobe (S). The main body of the placenta is located along the posterior uterine wall. A second soft-tissue structure with similar signal intensity is seen along the anterior uterine wall and represents the succenturiate lobe.

Eccentric insertions are cord insertions that are less than 1 cm from the placental edge. These are distinguished from a velamentous insertion, where the umbilical cord inserts on the chorioamniotic membranes rather than on the placental mass.

Figure 3. Bilobed placenta. (a) Diagram shows a bilobed placenta. (b) US image shows a bilobed placenta. The two lobes of the placenta (P1 and P2) are separated by a thin bridge of placental tissue that covers the internal os. In this case, the umbilical cord (arrowhead) inserts into the bridge of tissue.

This membranous insertion results in a variable segment of the umbilical vessels running between the amnion and the chorion, unprotected by Wharton jelly.

Placental size is expressed in terms of thickness in the midportion of the organ and should be between 2 and 4 cm. Placental thinning has
been described in systemic vascular and hematologic diseases that result in microinfarctions. Thicker placentas (>4 cm) are seen in fetal hydrops, antepartum infections, maternal diabetes, and maternal anemia. Placental thickening can be simulated by myometrial contractions and underlying fibroids.

The overall appearance of the placenta changes during the course of pregnancy, with the progressive development of calcifications. A grading system to describe these changes has been proposed; however, its clinical significance has been called into question, as progression through the various stages is not observed in all pregnancies (8–11) and a lack of progression through the various grades appears to have no clinical significance. That being said, early maturation of the placenta increases the risk of adverse fetal outcomes.
Figure 7. Chorioamniotic separation. Transverse (a) and sagittal (b) images from obstetric US performed at 20 weeks gestation show a free-floating membrane (arrowheads) surrounding the fetus (F). This membrane is the amnion, which is completely separated from the underlying chorion; there is even separation (arrow) over the surface of the placenta (P). This was a sporadic case of chorioamniotic separation that caused no complications. The fetus was carried to term and was found to be normal at birth.

The placental and fetal membranes (chorion and amnion, respectively) are separate early in gestation, accounting for the appearance of the amniotic sac. After approximately 14 weeks gestation, these membranes fuse and are no longer separately distinguishable (12). In rare cases, chorioamniotic separation can occur later in gestation. This can be focal or extensive, with the amniotic membrane becoming either free floating or adherent to the fetus. Extensive cases pose a risk to the fetus, with increased rates of both preterm delivery and the development of amniotic bands (12).

Chorioamniotic separation is most commonly related to prior intervention such as amniocentesis or surgery but can occur sporadically. Sporadic cases have been associated with increased rates of underlying fetal chromosomal and developmental abnormalities (12).

Chorioamniotic separation is usually detected with US and is visible as a free-floating or adherent membrane surrounding the fetus (Fig 7). Separation can extend throughout the entire uterine cavity and over the surface of the placenta.

Twin Gestations

Twins occur in up to 2.5% of all pregnancies and are at increased risk for adverse outcome. The increase in perinatal complications is correlated with placental chorionicity, with a higher rate of morbidity and mortality seen in monochorionic than dichorionic gestations (13). Twin-to-twin transfusion syndrome and twin reverse arterial perfusion sequence—which are related to abnormal arterial and venous communications within the placental mass—as well as fetal demise with potential risk to the surviving twin are complications unique to monochorionic gestations.

Monozygotic twins (30% of twins) result from the mitotic division of a zygote originating from the fertilization of one ovum by one sperm. In monozygotic pregnancies, chorionicity depends on the timing of zygotic division. Early division results in a monochorionic gestation, while later division results in a dichorionic gestation.

Dizygotic twins result when two sperm fertilize two distinct ova simultaneously. Dizygotic twins are always dichorionic. Opposite-sex twins must be dizygotic and therefore dichorionic. Identical-sex twins with a monochorionic placenta are monozygotic, but identical-sex twins with a dichorionic placenta require further analysis to determine zygosity.

US is capable of demonstrating chorionicity with a high degree of specificity and sensitivity (14,15). Clear distinction of two placentas may be difficult, particularly if the two sites of blastocyst implantation are close. In these cases, the twin peak sign and T sign can be helpful in defining chorionicity. The twin peak sign, visible in the late first and early second trimester, is a
Figures 8, 9. (8) Twin peak sign in dichorionic-diamniotic twin gestations. (a) US image of an early twin gestation shows the separate placentas converging at the insertion of the amniotic membrane (arrowhead), forming the so-called twin peak that is characteristic of a dichorionic-diamniotic gestation. (b) Sagittal SSFSE MR image shows similar findings, with the twin peak (a) formed by the two placentas. Arrowhead = intertwin membrane. (9) T sign in a monochorionic-diamniotic twin gestation. US image of an early twin gestation shows the amniotic membrane (arrowhead) separating the amniotic sacs of twins A and B. The membrane has a flat interface with the single placenta (P).

triangular projection of placental tissue extending up the intertwin membrane (opposed amnions) in dichorionic-diamniotic twinning (16) (Fig 8). The T sign is a 90° intersection of the intertwin membrane with the single placenta in a monochorionic-diamniotic gestation (Fig 9).

The thickness of the intertwin membrane can also be helpful in distinguishing chorionicity. Dichorionic gestations have a thicker membrane (≥2 mm vs ~1 mm) owing to the presence of two layers of amnion and two layers of chorion, in comparison with only two layers of thin amnion in cases of monochorionic placentation. Finally, in early gestations, the number of yolk sacs corresponds to the number of amnions. In cases where only a single placenta is visible, the presence of two yolk sacs confirms a dichorionic gestation. Using a combination of the described findings, Carroll et al (17) correctly identified chorionicity in 149 of 150 twin gestations.
Placental Hematoma

Placental hematomas can occur on the fetal (preplacental or subchorionic) side (Fig 10) or maternal (retroplacental) side or be centered within the placenta. At US, placental hematomas appear as well-circumscribed masses with echogenicity that varies according to chronicity. They are hypoechoic or anechoic in the acute phase, heterogeneously echogenic in the subacute phase, and anechoic in the chronic phase. Doppler interrogation should reveal absence of internal blood flow; this finding allows differentiation of hematomas from other placental masses (20). The role of MR imaging in the diagnosis of placental hematoma is not well defined (21), but placental hematomas appear as well-circumscribed masses with echogenicity that varies according to chronicity. They are hypoechogenic or anechoic in the acute phase, heterogeneously echogenic in the subacute phase, and anechoic in the chronic phase. Doppler interrogation should reveal absence of internal blood flow; this finding allows differentiation of hematomas from other placental masses (20). The role of MR imaging in the diagnosis of placental hematoma is not well defined (21), but placental hematomas can be expected to follow the signal intensity progression seen with hemorrhage elsewhere in the body (Fig 10).

Placental Abruption

Placental abruption represents premature separation of the placenta from the uterine wall. Al-

Figure 10. Placental hematoma. (a) US image shows a rounded collection of mixed-echogenicity material (arrowheads) deep to the chorion along the lateral margin of the placenta. There is no internal Doppler signal to suggest blood flow. This appearance is consistent with a subchorionic hematoma. (b) Axial T2-weighted SSFSE MR image shows a low-signal-intensity mass (H) along the margin of the placenta (P). (c) Axial T1-weighted MR image shows the predominantly intermediate-signal-intensity mass with internal areas of increased signal intensity (arrow). The signal intensity characteristics and the location of the mass are consistent with a subchorionic hematoma with hemorrhage of varying age.
though rare (<1% of pregnancies), third-trimester abruption is associated with an increased risk of preterm delivery and fetal death (22) (Fig 11). US is frequently performed to confirm the presence of abruption and assess the extent of subchorionic or retroplacental hematoma (Fig 11). The presence of blood in large enough volumes to be visible sonographically indicates retained hemorrhage that may remain symptomatic. False-negative results can occur when blood dissects out from beneath the placenta and drains through the cervix. In a study of 149 patients clinically suspected to have placental abruption, only 17 (11%) had sonographic evidence of abruption, but 32 (21%) had confirmed abruption at delivery (23).

CT is often the examination performed in cases of trauma, as it allows evaluation of both the pregnancy and the maternal anatomy. The placenta is variable in appearance throughout

Figure 11. Placental abruption. (a, b) Computed tomographic (CT) images show placental abruption after a motor vehicle collision at 40 weeks gestation. The amniotic fluid is high in attenuation because of hemorrhage (arrow in a), making the devascularized placenta difficult to identify. Careful inspection reveals an anterior and right lateral placenta (arrowheads in b), which has only slightly higher attenuation than the amniotic fluid. (c) Comparison CT image, obtained in a woman with pelvic fractures after trauma, shows amniotic fluid (F) with the attenuation of simple fluid and a normally enhancing placenta (P) with much higher attenuation. No retroplacental hemorrhage is seen, a finding consistent with lack of abruption. (d) US image shows placental abruption in another patient. A crescentic collection of predominantly hypoechoic fluid lifts the edge of the placenta (P) away from the underlying myometrium (M). The fluid collection contains layering high-attenuation material (arrowhead), a finding consistent with blood.
pregnancy. In the second trimester, the placenta is more heterogeneous in appearance, with the cotyledons appearing as rounded areas of low attenuation surrounded by enhancing placental tissue (24). The placenta can maintain this appearance throughout the pregnancy or become more homogeneously enhancing as the pregnancy progresses (24). The CT appearance of placental abruption is variable. It sometimes appears as an area of nonenhancement of the placenta related to devascularization; other times, it appears as high-attenuation material related to hemorrhage deep to the placenta or within the amniotic fluid (24) (Fig 11).

**Placenta Previa**

Placenta previa refers to abnormal implantation of the placenta in the lower uterine segment, overlying or near the internal cervical os. Normally, the lower placental edge should be at least 2 cm from the margin of the internal cervical os. The relationship of the placenta to the internal os changes throughout the course of pregnancy as the uterus enlarges. The diagnosis of placenta previa should not be made before 15 weeks gestation, and low-lying or marginal placental positioning should be reevaluated later in gestation to confirm placental position before delivery.

Placenta previa can be subdivided according to the position of the placenta relative to the internal cervical os (Table 2) (Fig 12). Although transvaginal sonography is the imaging standard for making this diagnosis, the position of the placenta is usually demonstrable with transabdominal imaging. Transvaginal or translabial approaches may be required to accurately demonstrate the location of the placenta, particularly in posteriorly located placentas (25–27). However, transvaginal imaging should be undertaken with care in advanced pregnancies, as it can lead to premature rupture of membranes or to infection when the membranes have already ruptured. In the appropriate clinical setting, the absence of sonographic confirmation of placenta previa does not exclude the diagnosis.

MR imaging allows identification of the position of the placenta (Fig 12). However, it has been demonstrated to be less specific than color Doppler flow imaging in the diagnosis of placenta previa (28).

**Vasa Previa**

Vasa previa refers to the presence of abnormal fetal vessels within the amniotic membranes that cross the internal cervical os. These vessels are unsupported by Wharton jelly or placental tissue and are at risk of rupture when the supporting membranes rupture; such vessels are also at risk of direct injury during labor. Rupture of these vessels can lead to catastrophic fetal hemorrhage.

In cases of vasa previa, the abnormal vessels either connect a velamentous cord insertion with the main body of the placenta or connect portions of a bilobed placenta or a placenta with a succenturiate lobe (29). Given this association, vasa previa needs to be excluded in patients with variant placental morphology. The diagnosis of

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<th>Table 2</th>
<th>Subtypes of Placenta Previa</th>
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<tr>
<td>Placenta Previa Subtype</td>
<td>Description</td>
</tr>
<tr>
<td>Low-lying previa</td>
<td>Lower placental margin is within 2 cm of the internal cervical os</td>
</tr>
<tr>
<td>Marginal previa</td>
<td>Placenta extends to the edge of the internal os but does not cover it</td>
</tr>
<tr>
<td>Complete previa</td>
<td>Placenta covers the internal os</td>
</tr>
<tr>
<td>Central previa</td>
<td>Central placenta is implanted directly over the internal os</td>
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**Teaching Point**
Figure 12. Spectrum of placenta previa. (a) Transvaginal US image obtained at 27 weeks gestation shows a posterior placenta ($P$) without previa. The most caudal tip of the placenta is nearly 5 cm (cursors) from the internal cervical os. Distances greater than 2 cm are considered normal. (b) Transvaginal US image obtained at 20 weeks gestation shows a low-lying placenta ($P$). The placental margin comes to within 0.7 cm of the internal cervical os. (c) Transvaginal US image obtained at 19 weeks gestation shows marginal placenta previa. The placental tip ($T$) is located immediately at the internal cervical os ($O$) but does not cover it. $P$ = body of the placenta. (d) Transvaginal US image obtained at 19 weeks gestation shows complete placenta previa. The placenta ($P$) entirely covers the internal cervical os ($O$). (e, f) Transabdominal US image obtained at 18 weeks gestation (e) and sagittal SSFSE MR image obtained at 29 weeks gestation (f) show central placenta previa. The placenta ($P$) entirely covers the internal cervical os ($O$ in e). In the case shown in the US image, the umbilical cord ($C$ in e) inserts immediately above the os. $C$ in f = uterine cervix.
vasa previa is made with Doppler US, which demonstrates vascular flow within vessels overlying the internal cervical os (Fig 13). Occasionally, transvaginal US is required to confirm the presence of these aberrant vessels. Marginal sinus previa, where prominent maternal vessels are appreciated at the edge of the placenta, can mimic vasa previa at color flow imaging.

As with placenta previa, patients with vasa previa diagnosed in the second trimester should be reevaluated later in gestation. The vasa previa can resolve as the uterus enlarges and the relationship of the placenta to the internal os changes.

**Placenta Accreta, Increta, and Percreta**

During the process of placental development and implantation, a defect in the normal decidua basalis from prior surgery or instrumentation allows abnormal adherence or penetration of the chorionic villi to or into the uterine wall (6). The extent of adherence to and invasion of the placental tissue varies: Superficial invasion of the basalis layer is termed *placenta accreta* (approximately 75% of cases); deeper invasion of the myometrium is termed *placenta increta*; and even deeper invasion involving the serosa or adjacent pelvic organs is termed *placenta percreta* (6) (Fig 14). This abnormal adherence of the placenta to the uterus can result in catastrophic intrapartum hemorrhage at the time of placental delivery, often necessitating emergent hysterectomy (30).

The prevalence of placenta accreta has increased more than 10-fold in the past 30 years to approximately 1 in 2500 deliveries (7,31). This increase appears to relate to the increasing rate of uterine surgery (curettage or cesarean delivery), which results in a decidual defect that allows abnormal placental ingrowth (1,8). The combination of placenta previa and prior instrumentation has been identified as a significant synergistic combination for the development of placenta accreta, with rates as high as 50%–67% in patients with the combination of more than two prior cesarean deliveries and a placenta previa (7,32,33).

Given the significant morbidity and mortality associated with placenta accreta, antepartum diagnosis is important to allow the obstetrician to properly prepare for management of associated complications (6,34).

Gray-scale US and Doppler imaging have been shown to be effective imaging strategies for the detection of placenta accreta when applied to a clinically high-risk population, such as those with prior uterine surgery or placenta previa (6,35). Sonographic features of placenta accreta include loss of the normal retroplacental clear space, anomalies of the bladder-myometrium interface, prominent placental lacunae, and increased vascularity at the interface of the uterus and bladder (7,34,35). Of these various sonographic features, the presence of prominent placental lacunae has the highest positive predictive value (36). Lacunae are characterized by ill-defined margins, irregular shape, and turbulent flow.

The overall sensitivity and specificity of US for the diagnosis of placenta accreta have been reported to be 77%–93% and 71%–96%, respectively (7,34). The use of transvaginal Doppler US has been shown to be particularly useful in suspected lower uterine segment disease (30). Given these results and the widespread availability of US, this modality is still recommended as the primary imaging modality for the evaluation of suspected placenta accreta.
The use of MR imaging in the antepartum diagnosis of placenta accreta is relatively nascent. MR imaging is most useful in cases where the sono- graphic findings are equivocal or when the placenta has a posterior location (35). Some authors have suggested that, given the significant morbidity and mortality, the use of intravenous gadolinium contrast material is indicated in these cases. Their assertion is that gadolinium contrast material adds specificity to the diagnosis, as the margin between the placenta and the myometrium is more clearly delineated on postcontrast images (7).

MR imaging features considered diagnostic of placenta accreta include abnormal uterine bulging, heterogeneous placental signal intensity on T2-weighted images, and the presence of dark intraplacental bands related to lacunae on T2-weighted images (35) (Fig 14). The overall sensitivity and specificity of MR imaging have been given as 80%–88% and 65%–100%, respectively (7,34). These rates are relatively similar to those cited for US, and several studies have reported...
most common clinical presentations for this group of disorders. Other clinical signs and symptoms include rapid uterine enlargement, excessive uterine size for gestational age, and hyperemesis gravidarum or preeclampsia that occurs in the early second trimester. The common feature for this group of disorders is the abnormal proliferation of trophoblastic tissue with excessive production of β–human chorionic gonadotropin (β-hCG) (37).

Gestational Trophoblastic Disease
Gestational trophoblastic disease encompasses hydatidiform moles, invasive moles, and choriocarcinoma. First-trimester bleeding is one of the

no significant differences in the overall accuracy of MR imaging versus sonography (7,33,34). However, there has been one study in which the sonographically determined depth of suspected placental invasion was reclassified with MR imaging in 30% of patients, leading to changes in the peripartum clinical management (10).

Given the difficulty in making an accurate antepartum diagnosis of placenta accreta, many authors recommend a two-stage approach to optimize diagnostic yield, beginning with US in patients with clinical risk factors and then proceeding to MR imaging for equivocal cases (7,35). That being said, this diagnosis can be difficult to make even with the advanced tissue characterization available with MR imaging.

**Figure 15.** Complete mole. (a) Longitudinal US image of the uterus shows distention of the uterine cavity by echogenic material (M). The echogenic material has the classically described snowstorm appearance of a complete mole. The normal hypoechoic myometrium (U) can be seen at the periphery. C = internal cervical os. (b) US image shows a multicystic structure within the uterus, a finding consistent with a complete mole. No identifiable fetal tissue was present. Molar tissue can be variable in morphology. (c) CT image of a patient with a β-hCG level of 620,000 mIU/mL shows a predominantly low-attenuation mass in the uterus with heterogeneous foci of internal enhancement. Pathologic examination demonstrated a complete mole without myometrial invasion. The multicystic structure posterior to and to the right of the uterus is an enlarged ovary with theca lutein cysts. CT can be used to assess for invasion by gestational trophoblastic disease.
Hydatidiform Mole

Hydatidiform moles occur in 1 of every 1000–2000 pregnancies and are classified into two major types—complete and partial—with distinctive histologic and genetic features (38). The complete hydatidiform mole is the most common form of gestational trophoblastic disease. Complete moles result from fertilization of an empty ovum with subsequent duplication of the paternal chromosomes. Thus, most complete moles (approximately 90%) have a 46,XX karyotype with a minority having a 46,XY karyotype. This chromosomal anomaly causes early loss of the embryo and proliferation of the trophoblastic tissue. At pathologic analysis, the trophoblastic tissue appears as a complex multicystic mass, classically described as a “cluster of grapes” (37).

At US, complete moles appear as a heterogeneous echogenic endometrial mass with multiple variable-sized small anechoic cysts, giving the appearance of a “snowstorm” (Fig 15). There is no identifiable fetal tissue. At color Doppler interrogation, increased vascularity with low-resistance waveforms can be identified in the spiral arteries of the uterus. Theca lutein cysts are present in fewer than 50% of complete moles and are caused by hyperstimulation of the ovaries due to excessive production of β-hCG by abnormal trophoblastic tissue.

Partial hydatidiform moles are much less common and result from fertilization of a normal ovum by two sperm. This results in a chromosomal composition of 69,XXX or 69,XXY. At pathologic analysis, partial moles appear as focal trophoblastic hyperplasia interspersed with villous hydrops. Fetal tissue is present, which is often complicated by severe symmetric growth restriction, multiple structural anomalies, and oligohydramnios. At sonography, partial moles appear similar to complete moles but are differentiated by the presence of fetal tissue (Fig 16). Distinction between the two forms can be difficult but is of limited clinical significance, as the management is similar.

MR imaging is typically not used in routine evaluation of hydatidiform moles; however, it may be used to determine if there is extension of molar tissue to the myometrium or outside the uterus. MR imaging findings are frequently nonspecific and can mimic the features of RPOC. Moles appear as heterogeneous tissue distending the uterine cavity, with predominantly low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and avid enhancement on postcontrast images. Focal areas of hemorrhage and cystic spaces may also be seen (39). In cases of partial moles, abnormal fetal tissue is often appreciated. It is important to identify the normal myometrium, which appears as a hypointense layer surrounding the molar tissue, as this aids in differentiation from invasive disease (39).

Figure 16. Partial mole. US image shows echogenic material filling the majority of the uterine cavity. Adjacent to this material is a gestational sac containing an embryo (arrowhead). These findings were due to a pathologically proved partial mole. The differential diagnosis for this appearance includes a large subchorionic hemorrhage. These two entities can be distinguished on the basis of the β-hCG level and the presence of vascular flow within the molar tissue. No flow would be expected in a hemorrhage.
Invasive Mole and Choriocarcinoma

Invasive moles represent deep growth of the abnormal tissue into and beyond the myometrium, sometimes with penetration into the peritoneum and parametrium (Fig 17). Owing to their aggressive growth characteristics, invasive moles are considered locally invasive nonmetastasizing neoplasms. Choriocarcinomas are similar to invasive moles but are capable of metastasizing, frequently manifesting with lung and pelvic metastases. Approximately 50% of choriocarcinomas arise after a molar pregnancy, 25% arise after abortion, and 25% arise after a normal pregnancy.

Invasive moles and choriocarcinomas are largely indistinguishable at imaging. At sonography, both appear as heterogeneous, echogenic, hypervascular masses. Areas of intraslesion necrosis and hemorrhage can be seen within choriocarcinoma. The hypervascular nature of these tumors can be helpful in detection of myometrial invasion, although this is not always detectable.

Choriocarcinoma is one case in which CT is used to evaluate placental disease, as there is no danger of fetal irradiation. However, the appearance of the primary tumor is nonspecific, manifesting as heterogeneous predominantly hypoattenuating intrauterine tissue. CT is particularly useful for staging choriocarcinoma by allowing detection of distant metastases (Fig 18).

Although rarely used, MR imaging can have a role in demonstrating myometrial and parametrial invasion. Choriocarcinoma is usually seen as an intrauterine mass with heterogeneous high signal intensity on T2-weighted images and marked enhancement on postcontrast images, findings that reflect the high vascularity of the tumor (Fig 18). Tumor vascularity can also be reflected by focal signal voids on T1- and T2-weighted images. Myometrial invasion is visible as high-signal-intensity foci within the myometrium, which demonstrate enhancement on postcontrast images. Enhancing parametrial soft tissue is characteristic of local spread (40–43). MR imaging can also help detect metastatic disease, particularly within the pelvic organs and lymph nodes.
Retained Products of Conception

The diagnosis of RPOC is suspected when routine examination of the placenta at delivery reveals an incomplete placenta or when a pregnant patient presents with vaginal bleeding in the first trimester and abnormal material is appreciated within the uterine canal. US is typically the imaging modality employed when RPOC are suspected. Transvaginal imaging is reportedly more sensitive and specific than transabdominal imaging (44,45).

At sonography, the appearance of RPOC is frequently nonspecific owing to similarity with the appearance of intrauterine thrombi. When identified, RPOC are visible as heterogeneously echogenic material within the uterine canal (Fig 19). Color Doppler imaging can be helpful in differentiating RPOC from intraluminal thrombus, as viable RPOC can have internal blood flow, which is often of low resistance and best appreciated at the endometrial-myometrial interface. Blood flow may not be detectable in cases of nonviable RPOC, which can thus be difficult to distinguish from thrombus.

Figure 18. Choriocarcinoma. (a) Sagittal T2-weighted MR image shows a mass of heterogeneous signal intensity (white arrowheads) in the uterine fundus; the mass invades into the posterior uterine wall. The internal foci of low signal intensity (black arrowhead) are flow voids, which are suggestive of marked vascularity. (b) Contrast-enhanced T1-weighted MR image shows avid enhancement of the mass (white arrowheads). The low-signal-intensity flow voids are seen in the posterior uterine wall, and the mass has central low signal intensity (black arrowhead), which represents necrosis. The mass was a pathologically proved choriocarcinoma. (c) Contrast-enhanced CT image obtained 2 years later shows a low-attenuation lesion in the liver (arrowhead), a finding consistent with metastatic disease. There were also metastases in the pancreatic head and lungs.
Figure 19. RPOC. (a, b) Transverse gray-scale (a) and power Doppler (b) US images show echogenic material in a fluid-filled distended endometrial canal (arrowheads). There is no evidence of internal vascularity. In a patient with vaginal bleeding and a history of pregnancy, these findings are consistent with RPOC. (c, d) Sagittal T2-weighted (c) and contrast-enhanced spoiled gradient-recalled acquisition in the steady state (d) MR images, obtained in another patient, show a mass in the uterine fundus (arrowheads) that invades the myometrium. The mass has heterogeneous signal intensity on the T2-weighted image and is isointense on the T1-weighted image with uniform enhancement, findings consistent with RPOC.

At MR imaging, RPOC typically appear as heterogeneous-signal-intensity masses on T1- and T2-weighted images (Fig 19). Variable enhancement is observed on postcontrast images. Unfortunately, MR imaging findings are frequently nonspecific and may overlap with those of gestational trophoblastic disease. Serum $\beta$-hCG levels are important to distinguish between the two entities, as values are usually normal or only mildly elevated with RPOC.

Nonthrophoblastic Placental Tumors
Nonthrophoblastic placental tumors are quite rare. Chorioangiomas are the most common, occurring in less than 1% of pregnancies (46,47). Placental teratomas are extremely rare and are similar in appearance to chorioangiomas, but are differentiated by the presence of calcifications (46).

Chorioangiomas are essentially hemangiomas of the fetal portion of the placenta, supplied by the fetal circulation (46,48). Although the vast majority are small and of no clinical significance, large (>5 cm) or multiple lesions (so-called chorioangiomatosis) stress the fetal circulation and
can be associated with complications such as hydrops, thrombocytopenia, intrauterine growth retardation, and an overall increase in antepartum mortality (46,48,49).

Given that the vast majority of chorioangiomas are incidentally identified, the sonographic characteristics are best described. These lesions appear as well-circumscribed, rounded, hypoechoic or mixed-echogenicity masses protruding from the fetal side of the placenta (46,50). Most are located near the cord insertion, and Doppler imaging reveals substantial vascularity or a large feeding vessel (46–48) (Fig 20).

MR imaging is used only as an adjunct for further evaluation in equivocal cases. Chorioangiomas are isointense on T1-weighted images with increased signal intensity on T2-weighted images (51). Focal areas of increased signal intensity on T1- and T2-weighted images correspond to intralesion hemorrhage.

**Metastases**

Cancer occurs during pregnancy at a rate of approximately 1 in 1000 patients. However, involvement of the placenta by metastatic disease is extremely rare, with fewer than 100 cases reported in the literature, to our knowledge (52). Placental metastases are believed to arise due to hematologic dissemination of tumor cells, which lodge in the intervillous space of the placenta (53–55).

Melanoma is by far the most common tumor to involve the placenta, followed by leukemia-lymphoma, lung cancer, breast cancer, sarcoma, gynecologic tumors, and gastric tumors; there have also been case reports of other miscellaneous primaries (54–56). The imaging appearance of metastases to the placenta is not well described. Findings can be expected to include focal lesions with altered echogenicity or signal intensity relative to that of the normal placenta.

**Cystic Lesions**

The vast majority of hypoechoic foci in the placenta represent intervillous space thrombi or decidual septal cysts, commonly referred to as placental lakes (46,57,58). The term **placental lakes** may also refer to intervillous vascular spaces that appear hypoechoic and demonstrate low-velocity laminar flow on color Doppler images.

Intervillous space thrombi form due to focal fetal hemorrhages that rapidly thrombose in the maternal blood pool of the intervillous space (57). Decidual septal cysts are related to focal degeneration within the maternal decidual septa (46). Most intervillous space thrombi and decidual septal cysts are visible as hypoechoic foci smaller than 1–2 cm and are of limited clinical significance (Fig 21). Lesions larger than 3 cm are usually also of limited significance but may be indicative of underlying placental disease (57).

True placental cysts occur on the fetal surface of the placenta, typically near the cord insertion, and appear to develop at subchorionic foci of...
fibrin deposition (59, 60). The majority are simple with internal echogenicity identical to that of amniotic fluid (Fig 21). The prevalence of placental cysts is thought to be in the range of 2%–7%, but most are small and go unnoticed. Complications related to cysts are uncommon, with rare reports of intrauterine growth retardation (59).

**Conclusions**

Although uncommon, abnormalities of the placentas are important to recognize owing to the potential for maternal and fetal morbidity and mortality. Sonography remains the dominant imaging modality for evaluation of the placenta. MR imaging is useful for further evaluation when increased tissue characterization is of value, particularly in the setting of invasive placental processes such as placenta accreta and gestational trophoblastic disease. CT has a limited role in the evaluation of placental disease owing to the radiation risk to the fetus. The primary role for CT is in the evaluation of trauma and gestational trophoblastic disease, for which it allows characterization of the primary lesion and distant metastases.

**References**


Imaging of the Placenta: A Multimodality Pictorial Review

Khaled M. Elsayes, M.D., et al

Imaging in the antepartum period should be performed with minimal risk to both the mother and developing fetus.

US is capable of demonstrating chorionicity with a high degree of specificity and sensitivity (14,15).

Normally, the lower placental edge should be at least 2 cm from the margin of the internal cervical os.

Gray-scale US and Doppler imaging have been shown to be effective imaging strategies for the detection of placenta accreta when applied to a clinically high-risk population, such as those with prior uterine surgery or placenta previa (6,35).

MR imaging findings are frequently nonspecific and can mimic the features of RPOC.
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