Ectopic Pregnancy

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The differential diagnosis in a pregnant patient who presents with pain and bleeding in the first trimester includes normal early pregnancy, spontaneous abortion, molar pregnancy, and ectopic pregnancy. Knowledge of the sonographic appearance of these entities is helpful at arriving at the correct diagnosis. When no intrauterine pregnancy is visualized, careful attention to the adnexa is crucial for finding an extraovarian mass, since the fallopian tube is the most common location for ectopic pregnancy. This review describes and illustrates the sonographic findings of ectopic pregnancy.

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When a woman in her reproductive years presents to the emergency room with pain and vaginal bleeding, one of the first questions to ask is: “Is there any way you could be pregnant?” The differential diagnosis in a pregnant patient who presents with pain and bleeding in the first trimester includes normal early pregnancy, spontaneous abortion, ectopic pregnancy, and molar pregnancy. Sonography is the imaging method of choice in these patients. One of the first questions to be answered by means of sonography is: “Is there a gestational sac?” If there is a gestational sac, it is crucial to determine “Is there a gestational sac?” If there is a gestational sac, even when complicated, is unlikely to be an ectopic pregnancy since ovarian ectopic pregnancies are extremely rare.

Sonography is used not only to diagnose ectopic pregnancy but also to triage patients into the most appropriate surgical or nonsurgical management, to guide for percutaneous treatments of ectopic pregnancy, and to follow-up patients when medical or expectant management protocols are used. This review describes and illustrates the sonographic findings of ectopic pregnancy.

**Essentials**
- The most common location of ectopic pregnancy is in the fallopian tube; if an extraovarian mass is present in a pregnant patient with pain and bleeding, and no intrauterine gestational sac is seen, the diagnosis of ectopic pregnancy should be considered until proved otherwise.
- Since heterotopic pregnancies are common in the in vitro fertilization population, particular care should be taken to assess the adnexa in these patients, even if an intrauterine pregnancy is documented.
- If the patient is clinically unstable, differentiating between a ruptured ectopic and a ruptured hemorrhagic corpus luteum is unimportant, since in either case laparotomy is indicated; if a large amount of free fluid is noted in the pelvis and/or abdomen, perform the remainder of the sonographic evaluation as expeditiously as possible so that the patient can be appropriately treated.
- The size of the ectopic pregnancy, presence of cardiac activity, and presence of free fluid are important features in triaging patients to surgery, medical treatment, or expectant management.

**Serum β-Human Chorionic Gonadotropin**

Serum β-human chorionic gonadotropin (hCG) is a more sensitive test for assessment of pregnancy than is urine β-hCG. A negative serum β-hCG result essentially excludes the diagnosis of a live pregnancy, although a chronic ectopic pregnancy may be present. Radioimmunoassays are widely available and become positive at approximately 23 days after the last menstrual period (LMP) (9 days after conception). This is before the first missed menstrual period and before a gestational sac can be seen with transvaginal sonography.

It is important to know what β-hCG standard is used in the laboratory at your institution. Most institutions now use the third international standard (IS) or the international reference preparation (IRP). However, much of the literature on β-hCG in early pregnancy was written by using the second IS. Correlation between IRP and the second IS can be performed by multiplying by a factor of 1.8 (second IS × 1.8 = IRP). In this review the β-hCG levels are corrected to IRP values. In general, an intrauterine gestational sac should be seen when the β-hCG value is greater than 2000 mIU/mL (IRP). This value is a guideline and not an absolute, since not all normal intrauterine pregnancies (IUPs) will be visualized with this level of β-hCG (1).

**Technique**

The sonographic examination is initiated transabdominally. Views are obtained of the uterus and adnexal regions in the sagittal and transverse orientations. Care should be taken to scan above and below the ovaries to assess for an extraovarian mass. Free fluid (if present) is documented in the pelvis (Fig 1). Cases have been reported of ectopic pregnancies visualized transabdominally that were missed with vaginal scanning alone (2,3), especially in patients with pelvic masses, such as leiomyomas (3). Views of the kidneys should be obtained to assess for a large amount of hemoperitoneum (Fig 2). Free fluid can also be visualized with views of the pericolic gutters, perihpatic region, and perispinal region. If a large amount of free fluid is visualized, scanning should be performed expeditiously, in order to have the potentially hemodynamically unstable patient appropriately treated as soon as possible.

In almost all cases of early pregnancy, a transvaginal examination will be needed to better assess for an early intrauterine or extrauterine gestational sac. Transvaginal examination can be deferred in rare cases where there is obvious hemoperitoneum and the patient is unstable and where the ectopic pregnancy is clearly diagnosed transabdominally. Transvaginal examination can also be deferred if there is a clear IUP, the ovaries are well visualized, there is no extraovarian adnexal mass, and there is no free fluid.

Transvaginal scanning allows for im-
proved visualization of the endometrial contents and typically allows for better visualization of the adnexal region. Views are initially obtained of the uterus in the sagittal and transverse planes, with high-resolution images acquired of the endometrial cavity to assess for small gestational sacs. Attention is then turned to the adnexal regions. When assessing for an ectopic pregnancy it is important to document the ovaries and then scan between the ovaries and the uterus since the most common location of ectopic pregnancy is within the tubes. Since a tubal mass can be located above, below, medial, or lateral to the ovaries, careful attention should be paid to the entire adnexal region. Note that the location of the corpus luteum is not helpful in directing the examination because contralateral implantation occurs in up to one-third of cases (4).

When scanning, it can be helpful to perform a gentle bimanual examination by using the probe and a hand on the patient’s abdominal wall to move a questionable mass. If the mass moves separately from the ovary it is highly likely to be a tubal ectopic pregnancy, whereas if it moves with the ovary it is likely to be a corpus luteum cyst.

If an ectopic pregnancy is visualized, it should be measured in three dimensions, since the maximum diameter of the ectopic pregnancy can affect the mode of treatment.

After examining the adnexa transvaginally it is important to assess the cul-de-sac for any free fluid (Figs 1, 3).

Who Is “at Risk” for Ectopic Pregnancy

Any woman capable of being pregnant can have an ectopic pregnancy. However, there are certain populations that are at increased risk. These include women with prior ectopic pregnancy, tubal disease, or intrauterine device (in the event of pregnancy, the intrauterine device typically prevents implantation in the uterus) and those women undergoing infertility treatment (Fig 4). Diagnoses of ectopic pregnancy have increased in recent years because of increased sensitivity of radioimmunoassay for β-hCG, improved detection with transvaginal sonography, and increased use of infertility treatments. In 1992, ectopic pregnancies accounted for approximately 2% of reported pregnancies (5). In the in vitro fertilization population this risk can be as high as 4.5% (6).

The Pregnant Patient with Pain and Bleeding

The classic triad of findings in ectopic pregnancy is pain, bleeding, and an adnexal mass. However, this triad is present only in about 43% of patients (7). Even when the triad is present, other causes of the pain and bleeding may be present. Normal early pregnancy can be associated with pain, either due to ligamentous laxity or due to a growing hemorrhagic corpus luteum cyst. Normal pregnancies with bleeding can be associated with pain, as can a spontaneous abortion in progress. While molar pregnancies are not classically associated with pain, they can cause pain secondary to the enlarging uterus and ovarian theca lutein cysts. Knowledge of the appearance of these entities is necessary in the assessment of patients at risk for ectopic pregnancy.

Normal Early Pregnancy and Heterotopic Pregnancy

It is important to recognize the sonographic findings of normal early IUP, since the presence of an IUP dramatically decreases the likelihood that an ectopic pregnancy is also present. The earliest sonographic finding of an IUP is the intradecidual sign (Fig 5), which is visualized at about 41⁄2 menstrual weeks (e.g., 41⁄2 weeks after the LMP). The intradecidual sign is a small fluid collec-
tion surrounded by an echogenic ring that is eccentrically located within the endometrium, just beneath the endometrial stripe (8). To establish that the intradecidual sac is present, it should be visualized in two planes and not have a changing appearance (9). The echogenic ring around the sac is important, because decidual cysts are common in ectopic pregnancy and can be present in normal early pregnancy (Fig 6).

One problem with use of the intradecidual sign in early pregnancy is the variable accuracy that has been reported with this finding. Läing et al (10) found that the intradecidual sign had a sensitivity and specificity of 48% and 66%, respectively. However, in a study by Chiang et al (9), sensitivity and specificity of the intradecidual sign were found to be 60%–68% and 97%–100%, respectively. Because of the possibility that a decidual cyst could be mistaken for a very early IUP, the prudent course is to follow-up symptomatic patients (eg, pregnant patients with pain and bleeding) with an evaluation of hCG level, with sonography, or with both.

Slightly later in pregnancy, at about 5 weeks, the double decidual sac sign is visualized. The double decidual sac sign is caused by the inner rim of chronic villi surrounded by a thin crescent of fluid in the endometrial cavity, which in turn is surrounded by the outer echogenic rim of the decidua vera. This sign is highly reliable for the diagnosis of an intrauterine gestational sac. However, there is only a short window of time between visualization of the intradecidual sign and visualization of a yolk sac (a definitive sign of IUP), so the double decidual sac sign has limited value.

At about 5½ weeks the yolk sac is visualized within the gestational sac. If a patient is pregnant and bleeding and any of these signs of early IUP are seen, typically the patient will be followed up clinically with either a serum β-hCG test or follow-up sonography until cardiac activity is documented in the embryo, establishing that it is a live pregnancy.

Although the presence of an intrauterine gestational sac dramatically decreases the likelihood of an ectopic pregnancy, it is still important to per-

![Figure 4](a): Live ectopic pregnancy in patient undergoing ovulation induction 3 weeks after stated LMP. (a) Transverse transabdominal view shows an enlarged 11-cm ovary (calipers) with multiple cysts. (b) Transverse transabdominal view shows an echogenic ring-like mass (arrow) outside the uterus (UT). Other images showed this to be separate from the ovary. (c) Transvaginal view shows an embryo (calipers). (d) M-mode view demonstrates cardiac activity, as shown by the heart rate on the lower half of the image (arrowheads). Note that age by stated LMP was 3 weeks, but presence of cardiac activity and embryonic size is consistent with 6 weeks.

![Figure 5](a): Intradecidual sign in normal early pregnancy. Sagittal transvaginal view of the uterus (calipers) shows a small echogenic ring (arrowhead) eccentrically located in the endometrium, abutting and slightly displacing the midline endometrial stripe (arrows).

![Figure 6](a): Decidual cysts. Sagittal transvaginal scan of the uterus shows four small fluid collections (arrows). At the time of the study, the β-hCG value was 736 mIU/mL; follow-up evaluation showed a normal IUP. ff = free fluid.
form a careful assessment of the adnexa, since heterotopic pregnancies (combined intra- and extrauterine pregnancies) can occur (Fig 7). The risk for heterotopic pregnancies ranges between one in 30,000 and one in 2,100 (11–14). The one in 30,000 number was obtained by multiplying the incidence of ectopic pregnancy and dizygotic twinning (13). However, the incidence of heterotopic pregnancies is increasing, especially in women undergoing ovulation induction, in whom the risk for heterotopic pregnancy is as high as 1%–3% (15). This high incidence results from the high prevalence of tubal damage among patients undergoing in vitro fertilization and the use of superovulation and multiple embryo transfer, which predispose patients to the condition. This 1%–3% value is important to remember, since it is similar to the risk of ectopic pregnancy in the general population. Since heterotopic pregnancies are common within the in vitro fertilization population, particular care should be taken to assess the adnexa in these patients, even if an IUP is documented.

**Abnormal Early IUP**

Spontaneous abortions (Fig 8) are common in pregnant patients with pain and bleeding. Criteria to diagnose a failed IUP at sonography should be sufficiently generous to allow for follow-up of any potential viable pregnancy but not unnecessarily follow-up clear nonviable pregnancies. In our laboratory we use the following thresholds at transvaginal sonography for diagnosis of a nonviable pregnancy:

1. Nonvisualization of a yolk sac by the time the mean sac diameter is 13 mm
2. Nonvisualization of an embryo by the time the mean sac diameter is 18 mm
3. Nonvisualization of cardiac activity by the time the embryo is 5 mm in length

These values are higher than those reported in the literature (8-mm mean sac diameter for visualization of a yolk sac and 16-mm mean sac diameter for visualization of an embryo [16]) in order to ensure that our specificity for diagnosis of a nonviable pregnancy is 100%. One of the difficult tasks in evaluating for ectopic pregnancy is distinguishing an abnormal IUP from the pseudogestational sac of ectopic pregnancy. If an intrauterine gestational sac is visualized with a diameter of 13 mm without a yolk sac and the β-hCG level is not rising normally, a dilation and curettage procedure can be performed. This will confirm the presence of an abnormal IUP if chorionic villi are present and thereby effectively eliminate the risk for ectopic pregnancy. If villi are not detected, the patient is still at risk for ectopic pregnancy. If the patient is stable, interval change in β-hCG levels can be monitored.

Molar pregnancy (Fig 9) is another possibility in pregnant patients with
pain and bleeding. Late in the first trimester, the classic findings of an enlarged uterus with multiple small cysts will be visualized. However, earlier in pregnancy the appearance may be similar to a normal IUP or a hematoma within a gestational sac. Correlation with β-hCG values and follow-up sonography is helpful in these cases. A β-hCG value of more than 100 000 mIU/mL with a heterogeneous appearance to the endometrium with multiple small cystic spaces is suspicious for molar pregnancy.

**Free Fluid**

Fluid accumulates in the cul-de-sac (Fig 3), since this is the most dependent location in the pelvis. When fluid has a complex appearance with floating echoes, or a layering appearance, this is consistent with hemoperitoneum. As mentioned previously, when blood is present it is important to scan up by the kidneys to assess for the degree of hemoperitoneum (Fig 2). Hemoperitoneum in the pregnant patient can be due to either an ectopic pregnancy or a ruptured hemorrhagic corpus luteum cyst. If the patient is clinically unstable, differentiating between a ruptured ectopic pregnancy and a ruptured hemorrhagic corpus luteum is unimportant, since in either case laparotomy is indicated. If a large amount of free fluid in the pelvis and/or abdomen is noted, the remainder of the scan should be performed as expeditiously as possible so that the patient can be appropriately treated.

In unstable patients with demonstration of hemoperitoneum, the sonographic examination can be terminated without demonstrating an ectopic pregnancy. In the clinically stable patient, it is more important to carefully examine the adnexa to determine if an ectopic pregnancy is present. Echogenic fluid visualized in a patient with a positive β-hCG level has a positive predictive value of 86%–93% in the diagnosis of ectopic pregnancy (17). Note that at times, blood clot will be seen to surround the uterus, giving the uterus ill-defined margins.

**Endometrial Findings in Ectopic Pregnancy**

Decidual cysts (Fig 6) are thin-walled simple-appearing cysts, usually located at the junction of the endometrium and myometrium. They are associated with ectopic pregnancy (18) but are also seen with normal IUPs and in nonpregnant patients. These cysts are distinguished from the intradecidual sign in that they are usually multiple and do not have an echogenic rim. However, multiple cysts can be present, one of which can be an early intrauterine gestational sac; therefore, multiplicity cannot be used as a distinguishing feature. These cysts should be distinguished from the pseudosac of ectopic pregnancy (Fig 10).

The pseudosac, which is present in approximately 20% of patients with ectopic pregnancy (19), is a fluid collection within the endometrial cavity. Because the fluid contains blood and debris, it may have a very heterogeneous appearance. The pseudosac is distinguished from the decidual cysts and intradecidual sign in that a pseudosac is centrally located within the endometrial cavity. In addition, when scanning, this fluid can at times be seen to move.

When it is unclear if a fluid collection is an intradecidual sign, a decidual cyst, or a pseudosac, no suspicious adnexal mass is seen, and the patient is stable, it is reasonable to correlate with β-hCG findings and obtain a follow-up sonogram.
Ovarian Findings in Ectopic Pregnancy

Once the intrauterine contents have been assessed, it is important to carefully evaluate the adnexa. In the adnexa, the most common finding is the corpus luteum cyst (Fig 11). The corpus luteum cyst is a normal structure in pregnancy but can have a varied appearance, at times appearing similar to an ectopic pregnancy. It is important to remember that the corpus luteum cyst is located within the ovary or exophytic from the ovary, whereas ectopic pregnancies are most commonly located within the tube. An anechoic cyst is unlikely to be an ectopic pregnancy. Even a complex cyst in the ovary is much more likely to be the corpus luteum than an ectopic pregnancy because ovarian pregnancies represent less than 1% of all ectopic pregnancies (20). The wall of the corpus luteum is generally more hypoechoic than is the wall of an ectopic pregnancy. As mentioned previously, real-time scanning with gentle pressure on the vaginal probe and anterior abdominal wall can be used to demonstrate that a corpus luteum moves with the ovary, rather than separately from it (as would be expected from a tubal ectopic pregnancy). If the patient is clinically stable and has an adnexal mass of unclear origin, it is possible to perform serial β-hCG evaluation and follow-up sonography. A hemorrhagic corpus luteum cyst should rapidly change in appearance as the blood products within it evolve.

Tubal Findings in Ectopic Pregnancy

The most common location of ectopic pregnancy is in the fallopian tube, with 75%–80% in the ampullary portion, 10% in the isthmic portion, 5% in the fimbrial end, 2%–4% in the interstitial end (sometimes called cornual ectopic), and 0.5% in the ovary (20). Abdominal, cervical, and scar pregnancies are rare.

The most specific finding of an ectopic pregnancy is an extrauterine live embryo (100% specificity) (Fig 4). Because of the lack of sensitivity of this finding, most physicians use the criterion of an extraovarian adnexal mass. This may be (in decreasing order of specificity) a tubal ring with a yolk sac and embryo (Fig 4), a tubal ring with a yolk sac only (Fig 12), a tubal ring without central identifying features (Fig 13), or a complex adnexal mass separate from the ovary (Fig 14). Most of the enlargement of the fallopian tube is caused by bleeding into the wall and lumen rather than from the products of conception. In these cases, the adnexa may demonstrate only an amorphous appearance.

Color Doppler Assessment

Radiology residents are commonly taught to suspect ectopic pregnancy at color Doppler imaging when the “ring of fire” is visualized, owing to the low-impedance high diastolic flow seen in pregnancy that can surround the tubal ring of an ectopic pregnancy. However, a hypervascular ring (Figs 13, 15) around a mass in the pelvis is more likely to be visualized around the corpus luteum than an ectopic pregnancy. This is because both corpus luteum cysts and ectopic pregnancies can be very vascular with low-impedance flow; however, corpus luteum cysts are much more common than ectopic pregnancies. Color Doppler imaging is most helpful when an ectopic pregnancy is not seen but is highly suspected. In that case color Doppler imaging can be used to help find a mass surrounded by bowel loops.

The “Negative” Pelvic Sonogram

At times, sonography will be performed to “rule out” ectopic pregnancy, and all of the anatomy will appear normal. The differential diagno-
sis in such a patient is normal early pregnancy, spontaneous abortion, and ectopic pregnancy. Including ectopic pregnancy in the differential diagnosis is important, since 15%–35% of ectopic pregnancies will not demonstrate an identifiable extrauterine mass at transvaginal sonography (17,21,22). Among patients with ectopic pregnancy, 5%–18% of cases are detected or confidently diagnosed only at repeat sonography (23). Therefore, in any pregnant patient in whom neither an IUP nor ectopic pregnancy is visualized, follow-up is needed, with evaluation of β-hCG level, sonography, or both. Intrauterine gestational sacs grow at a rate of 0.8 mm per day; therefore, follow-up sonography in 2–3 days will demonstrate growth in normal pregnancy. Ectopic pregnancies also grow, and hemorrhage, and therefore may become more apparent at follow-up.

Emergency Room Scanning for Ectopic Pregnancy

There are two questions that residents commonly ask regarding performance of pelvic sonography to rule out ectopic pregnancy in the emergency room: (a) “Do I need to know the β-hCG value before performing sonography?” (b) “The patient’s LMP was only 3 weeks ago. Why should I perform sonography, when ectopic pregnancy does not manifest until 5 weeks after the LMP?” These are important questions, which are addressed in the following discussion.

Do I Need to Know the β-hCG Value before Performing Sonography?

Since it is important to assess for intra- and extrauterine pregnancy in all pregnant patients presenting with pain and bleeding, and since ectopic pregnancy can be a life-threatening emergency, there is no need to wait for a β-hCG value before performing sonography. However, knowledge of the β-hCG value can be helpful in interpreting the study and determining what kind of follow-up should be performed. So, we do not delay performance of pelvic sonographic evaluations, since it is possible to diagnose intra- and extrauterine pregnancy without knowledge of the β-hCG value and to assess for potentially life-threatening hemoperitoneum. However, we do correlate the β-hCG findings with our final interpretation in cases in which a definite intra- or extrauterine pregnancy is not visualized.

If a patient presents to the emergency room with pain and bleeding and has a β-hCG value of 50 mIU/mL, we do not expect to visualize an IUP. If the study is normal, we give an impression that an intrauterine gestational sac is not expected to be visualized with a β-hCG value of this level, and the differential diagnosis is as follows: “very early pregnancy, spontaneous abortion, cannot exclude ectopic pregnancy.” If the β-hCG value is 2000 mIU/mL or greater and the study is normal, our interpretation is as follows: “A gestational sac is typically visualized sonographically with a β-hCG value at this level. The differential diagnosis is most likely spontaneous abortion or ectopic pregnancy, but we cannot totally exclude a normal very early IUP, and follow-up is recommended.” This follow-up will typically include serial testing of β-hCG levels to assess for doubling time, as well as follow-up sonography.

In the past, when an intrauterine gestation sac was not visualized and the β-hCG value was greater than 2000 mIU/mL, the patient went on to undergo laparoscopy to assess for ectopic pregnancy, a procedure that did not necessarily cause a spontaneous abortion when an IUP was present. Currently many patients are treated with methotrexate, which can cause loss of an intra- or extrauterine pregnancy. In a study of outpatients without an IUP visible at sonography, Mehta et al (1) found that 27% of patients had an IUP at follow-up, 40% had a spontaneous abortion, and 32% ultimately were diagnosed with ectopic pregnancy. When just those patients with a β-hCG value greater than 2000 mIU/mL were assessed, there were 51 cases in this study, 17 of which were eventually diagnosed as IUP. Of the cases eventually shown to be IUPs, one case was evaluated at night by a resident, who possibly had a lower level of experience and ability to detect an intraterine gestational sac; one case was of triplets, for which it was expected that the β-hCG value would be higher than is typically seen; in one case, the β-hCG value was 2150 mIU/mL, which is within range of error of the laboratory test; in six cases, there was a possible intradecidual sign but not enough to diagnose with confidence; and eight cases remain unexplained. This is important, because we do not want to use methotrexate to treat patients who have a potentially viable IUP. If the patient is clinically stable, it is reasonable to perform follow-up evaluation with both β-hCG testing and sonography in 48 hours.

The doubling time for a normal IUP is 2 days, with a range of 1.2–2.2 days (24). In 21% of ectopic pregnancies, the doubling time will mimic that of an IUP (25); however, in the majority of cases the doubling time is increased. If the β-hCG levels are rising abnormally (<60% increase over at least 48 hours and not steadily declining), the patient is presumed to have an ectopic pregnancy. Even small gestational sacs should grow 0.8 mm per day; therefore, repeat sonography performed in 2–3 days will show a definite change.
Tubal ectopic pregnancy usually becomes symptomatic at 5–6 weeks after the patient’s LMP. Other forms of ectopic pregnancy become symptomatic even later. Interstitial ectopic pregnancy tends to manifest at 8–10 weeks after the LMP, and abdominal ectopic pregnancy can present at term. However, it is extremely common for patient’s report of LMP to be incorrect in early pregnancy. In addition to inaccuracies of recollection of the LMP, patients can have a small amount of bleeding that they assume is a menstrual period, when instead it is implantation bleeding or bleeding secondary to an ectopic pregnancy. An example of this is given in Figure 4, where a patient with stated LMP of 3 weeks prior to the examination had a 6-week live ectopic pregnancy.

Unusual Forms of Ectopic Pregnancy

Rare forms of ectopic pregnancy include interstitial, cervical, abdominal, and scar pregnancies.

Interstitial ectopic pregnancy (sometimes called cornual pregnancy) is also important to recognize (Fig 16). These pregnancies represent 2%–4% of all ectopic pregnancies and are located in the interstitial portion of the tube, partially surrounded by myometrium. Interstitial ectopic pregnancies have a higher morbidity and mortality than other tubal ectopic pregnancies because of later presentation and the potential for massive hemorrhage (26). In this location, myometrium surrounds a portion of the expanding gestational sac, allowing it to enlarge painlessly for a relatively long time. The diagnosis is suggested when an IUP is visualized high in the fundus that is not surrounded in all planes by 5 mm of myometrium (27). The specificity of this 5 mm threshold has not been investigated.

Cervical pregnancies represent less than 1% of all ectopic pregnancies (28,29). A cervical ectopic pregnancy is centered in the cervix, enlarging the endocervical canal (Fig 17). At times the gestational sac extends into the lower uterine segment. This form of ectopic pregnancy can be distinguished from an abortion in progress by documentation of cardiac activity within the endocervical canal; this activity is present in live cervical ectopic pregnancies after 6 weeks gestational age and is only rarely seen in spontaneous abortions in progress. In addition, in cases of spontaneous abortion, the sac shape and location should change at serial imaging. Color Doppler imaging can be helpful in showing the hypervascular trophoblastic ring in the cervical region in cases of live cervical ectopic pregnancies.

Cervical ectopic pregnancies tend to bleed profusely if surgical procedures are performed, because of the large amount of fibrous tissue in the cervix. This propensity for life-threatening hemorrhage in the past frequently led to hysterectomy for treatment. Currently, conservative treatments are possible, including sonographically guided local injection of potassium chloride (30,31), systemic or local administration of meperidine, (30,32–34), or preoperative uterine artery embolization (30,35) before dilation and evacuation. These procedures are performed with the hope of preserving future reproductive potential.

Scar ectopic pregnancies are being increasingly reported (36). These are most common in the site of a prior cesarean section scar but can be seen in any scar in the uterus (37). Criteria used for diagnosis of a cesarean section scar pregnancy are an empty uterus, empty cervical canal, development of the sac in the anterior part of the lower uterine segment, and an ab-
sence of myometrium between the bladder wall and the gestational sac (Fig 18) (38).

Ovarian and abdominal ectopic pregnancies are rare. When studied at real-time, ovarian ectopic pregnancies move with respect to the ovary, not separately. Abdominal ectopic pregnancy typically develops in the ligaments of the ovary. It can then obtain blood supply from the omentum and abdominal organs. At times these pregnancies migrate out of the pelvis and are seen in the upper abdomen. Sonographically the pregnancy is seen separate from the uterus, adnexa, and ovaries. Treatment is by means of laparotomy or laparoscopy (Fig 7) (39). While abdominal pregnancy can result in a life-threatening emergency, especially when diagnosed late in gestation, it can also result in a live birth by means of laparotomy.

Management

Because ectopic pregnancy is now being diagnosed earlier and more frequently than in prior decades, management has shifted from emergency laparotomy to laparoscopy to even

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<tr>
<td></td>
<td>curettage procedures; also preserves</td>
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<tr>
<td></td>
<td>the uterus</td>
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<tr>
<td></td>
<td>Interstitial and scar ectopic pregnancy</td>
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<tr>
<td></td>
<td>to preserve uterus</td>
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<td></td>
<td>Heterotopic pregnancies to be least</td>
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<td></td>
<td>disruptive to intrauterine pregnancy</td>
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<tr>
<td><strong>Expectant management</strong></td>
<td>Clinically stable patient</td>
<td>May require other treatment if ectopic</td>
<td>86%</td>
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<td></td>
<td>Declining or stable β-hCG levels</td>
<td>pregnancy progresses</td>
<td></td>
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<td></td>
<td>Lower β-hCG levels associated with</td>
<td>Requires patient compliance for</td>
<td></td>
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<tr>
<td></td>
<td>best outcome (&lt;200 mIU/mL)</td>
<td>multiple return visits</td>
<td></td>
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<tr>
<td></td>
<td>Adnexal mass &lt; 4 cm</td>
<td>May take up to 147 days to resolve</td>
<td></td>
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<tr>
<td></td>
<td>Return for β-hCG values and sonography</td>
<td>completely</td>
<td></td>
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<td></td>
<td>at multiple intervals</td>
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</table>

Source.—References 34, 41–60.

* The 50 mg/m² single-dose regimen, without leucovorin, can be repeated on day 7 if the β-hCG value did not decline 15% between days 4 and 7, or as 1 mg/kg intramuscular (up to four doses with 0.1 mg/kg of leucovorin, with monitoring of β-hCG level on alternate days until it declines 15% from previous value).
more conservative management in select cases. Benefits of noninvasive approaches include preservation of fertility, decreased morbidity, and decreased cost (40). However, it should be realized that ectopic pregnancy is estimated to account for 9% of maternal deaths (5) and should still be considered potentially life-threatening, especially in unstable patients and those with large amounts of hemoperitoneum. The size of the ectopic pregnancy, presence of cardiac activity, and presence of free fluid are important features in triaging patients to surgery, medical treatment, or expectant management. The indications, limitations, and expected future fertility for various treatment methods are given in the Table. An illustration of transvaginal needle guidance for treatment of an ectopic pregnancy is shown in Figure 19.

**Methotrexate**

Methotrexate is a folate antagonist that is given intramuscularly for treatment of ectopic pregnancy. A common regimen for methotrexate is a 50 mg/m² dose that can be repeated on day 7 if the β-hCG value does not decline 15% between days 4 and 7. Sonography of patients treated with methotrexate is complicated, since most patients show a worsening appearance, with increased hemorrhage around the ectopic pregnancy (Fig 20). There may be an initial increase in the size of the tubal mass after methotrexate treatment, and an adnexal mass may be visible up to 3 months after treatment (41). The increase in tubal size and vascularity, in spite of the declining β-hCG level, represents a healing process and should not cause concern unless the patient is clinically unstable or has persistent symptoms (41). Sonography after methotrexate is indicated only in cases where rupture is suspected due to worsening abdominal pain, hemodynamic instability, or failure of β-hCG values to decline by at least 15% between days 4 and 7 or increasing or plateauing β-hCG levels after the first week of treatment (42).

**Expectant Management**

A risk of medical treatment in patients with unproved ectopic pregnancy is that some patients with either spontaneous abortion or very early IUP will be needlessly treated. In addition, many small ectopic pregnancies that previously went undiagnosed are now known to resolve spontaneously. These issues have led to increased expectant management of ectopic pregnancy, where stable patients with low β-hCG values are monitored with sequential β-hCG testing and sonography and not otherwise treated.

**Conclusion**

Sonography plays a central role in the diagnosis and management of ectopic pregnancy. If an extraovarian mass is present in a pregnant patient with pain and bleeding, and no intrauterine gestational sac is seen, the diagnosis of ectopic pregnancy should be considered until proved otherwise. Therapy is determined by a combination of clinical symptoms, sonographic findings, and serum β-hCG values. While an intrauterine gestational sac is typically seen when the β-hCG value is greater than 2000 mIU/mL (IRP), this value should be used as a guideline and not an absolute threshold. Since the fallopian tube is the most common location of ectopic pregnancy, care should be taken while scanning to search between the uterus and ovary for a tubal mass. Surgery is being performed less often for ectopic pregnancy since the alternative treatments of expectant management, methotrexate, and percutaneous injection are now available. With these conservative treatments, there is an increased role for sonography in patient follow-up.

**References**


