Imaging Unusual Pregnancy Implantations: Rare Ectopic Pregnancies and More

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OBJECTIVE. The purpose of this article is to review key clinical issues and imaging features of unusual pregnancy implantations. Examples from different imaging modalities are provided to increase interpreting physicians' familiarity with the appearance and potential complications of unusual ectopic, cesarean scar, heterotopic, and rudimentary horn pregnancies.

CONCLUSION. Abnormal pregnancy implantations are life-threatening. Interpreting physicians' familiarity with the appearance of unusual pregnancy implantations is critical for early identification and initiation of appropriate therapy.

When a female patient of reproductive age presents with a positive pregnancy test, pain, and vaginal bleeding, unusual pregnancy implantations must be considered. Ectopic pregnancies, or implantations of a fertilized egg outside the endometrial cavity, comprise 2% of all pregnancies [1] and are almost always nonviable. Although mortality rates have decreased over the past 3 decades, likely because of earlier recognition of ectopic pregnancy with improvements in laboratory assay sensitivity, ultrasound technology, and minimally invasive surgical options, ectopic pregnancies remain an important cause of mortality among women of reproductive age [1, 2]. Once a pregnancy is confirmed by the presence of β-HCG in serum or urine, transvaginal ultrasound is the imaging modality of choice for localization of early pregnancy. Ultrasound can detect intrauterine and ectopic pregnancies, as well as cesarean scar pregnancies and rudimentary horn pregnancies. Ultrasound can also detect embryonic cardiac activity. Transabdominal ultrasound allows a larger FOV that includes the upper abdomen. Free fluid in the Morison pouch or other sources of abdominal pain may be identified.

A single measurement of β-HCG does not reliably distinguish between an intrauterine and ectopic pregnancy or other unusually implanted pregnancy; however, correlation with serial β-HCG level measurements can be helpful for accurate interpretation of ultrasound findings. An intrauterine gestational sac is typically, but not always, visualized on transvaginal ultrasound when the β-HCG level is greater than 2000–3000 IU/L [3, 4]. Although an empty uterus and a β-HCG level less than 2000–3000 IU/L may represent an intrauterine pregnancy too early to visualize, ectopic pregnancy is in the differential diagnosis for any patient with a positive β-HCG test and an empty endometrial cavity. For β-HCG levels greater than 2000–3000 IU/L, the most likely diagnosis is a nonviable intrauterine pregnancy, but these levels should prompt a detailed search for an ectopic pregnancy, keeping in mind that a single β-HCG level measurement can be very misleading and that using β-HCG levels to guide management can lead to erroneous treatment of intrauterine pregnancies [4].

Approximately 95% of ectopic pregnancies occur in the noninterstitial fallopian tube [5] (Fig. 1). Ultrasound findings suggestive of a tubal ectopic pregnancy are well documented and include an empty uterus, free fluid (particularly if echogenic), an adnexal mass or ring separate from the ovary, the ring of fire sign (although this is also commonly seen around a corpus luteum cyst), and—the most specific finding—extrauterine embryonic cardiac activity [3]. Intrauterine fluid can be present with an ectopic pregnancy, although it conforms to the shape of the uterine cavity and does not have the typical smooth-walled appearance of a gestational sac [6]. A live intrauterine pregnancy does not exclude an ectopic pregnancy, particularly with assisted reproduction. Al-

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though the frequency of combined normally implanted intrauterine pregnancies and ectopic pregnancies (heterotopic pregnancies) in the general population ranges from 1/2100 to 1/30,000 pregnancies, the rate associated with assisted reproductive technology procedures is 1–3% [3].

Unusual pregnancy locations include the cervix, cesarean scars, the interstitial fallopian tube, the ovary, and the abdominal cavity. Because of their rarity, interpreting physicians may be unfamiliar with the imaging appearances of these unusual pregnancy sites. When an ectopic pregnancy is suspected and cannot be identified in the adnexa, a detailed ultrasound evaluation of the cervix, anterior lower uterine segment (if the patient has a history of cesarean delivery), cornua, ovaries, and cul-de-sac should be performed.

Cervical Ectopic Pregnancies

Frequency and Risk Factors

Cervical ectopic pregnancies comprise fewer than 1% of ectopic pregnancies [5]. Proposed risk factors include anatomic abnormalities, fibroids, prior endocervical canal instrumentation, Asherman syndrome, intrauterine device, and in vitro fertilization [7, 8].

Appearance and Differential Diagnosis

A cervical ectopic pregnancy (Fig. 2) may be misdiagnosed as a miscarriage in progress or as a nabothian cyst, although the latter typically occurs in groups and beneath the transformation zone. The hourglass uterus is an ultrasound sign of cervical ectopic pregnancy that describes a smaller-than-dates uterus with an enlarged cervix and narrowing at the internal os [9, 10]. A ballooned cervix and a closed internal os are also suggestive of cervical ectopic pregnancy [9]. The sliding sac sign is the movement of a gestational sac against the endocervical canal and can be seen in a miscarriage in progress but not a cervical ectopic pregnancy [11]. M-mode ultrasound can document cardiac activity, clearly differentiating a cervical ectopic pregnancy from a miscarriage in progress when present (Fig. 3). Doppler ultrasound may also show increased surrounding vascularity suggestive of ectopic pregnancy. In the stable patient, serial ultrasound may be helpful for clarification, though it should be limited to 2–3 days, at which point a conclusive diagnosis should be possible. Although it is rarely needed, MRI of cervical ectopic pregnancies can show the hourglass sign and a lobulated heterogeneous enhancing cervical mass with a T2-hypointense rim [12]. Of note, if a viable intrauterine pregnancy remains in the differential diagnosis, administration of gadolinium-based contrast agents should be avoided whenever possible.

Complications and Management

Surgical treatment is generally reserved for patients with hemodynamic instability. There are no consensus guidelines for optimal treatment of the stable patient with a cervical ectopic pregnancy. For stable patients, ultrasound-guided transvaginal or transabdominal local injection of potassium chloride (KCl) or methotrexate (MTX) with or without systemic MTX may be preferred because of the low risk of hemorrhage and to preserve future fertility [13]. Uterine artery ligation [14], uterine artery embolization [15], and mechanical tamponade [16] have been used as adjuncts to medical and surgical management to treat or minimize the risk of hemorrhage. Expectant management with serial ultrasound imaging may be reserved for stable low-risk patients with uncertain diagnosis and low or decreasing β-HCG levels. Expectant management in these cases should be limited to just a few days.

Cesarean Scar Pregnancies

Frequency and Risk Factors

Cesarean scar pregnancies comprise up to 6% of abnormal implantations in women with a history of cesarean delivery [17]. Scar pregnancies are reported with increasing frequency in the literature [18] reflecting increasing rates of cesarean deliveries.

Appearance and Differential Diagnosis

A cesarean scar pregnancy (Fig. 4) may be misdiagnosed as a low intrauterine pregnancy, cervical ectopic pregnancy, or miscarriage in progress. Scar pregnancies share a common histologic profile with early placenta accreta and may have similar pathogenesis by implanting where there is little or no intervening decidual layer so that trophoblastic tissue invades the surrounding scar and myometrium [19]. Cesarean scar pregnancies are sometimes referred to as cesarean scar ectopic pregnancies, and though they are implanted on a region of defective or absent decidua, they are implanted inside the uterus and thus are not ectopic pregnancies. Cesarean scar pregnancies tend to be located eccentrically in the anterior lower uterus just superior to the cervix. The eccentric anterior location can help differentiate a cesarean scar pregnancy from a low intrauterine pregnancy, and an empty cervix can help differentiate a cesarean scar pregnancy from a cervical ectopic pregnancy or miscarriage in progress. Cesarean scar pregnancies will show the absence of normal myometrium between the bladder and the gestational sac, differentiating them from cervicoisthmic pregnancies [20]. Transvaginal ultrasound is the imaging test of choice; however, physicians interpreting the examinations may have seen cesarean scar pregnancies rarely if ever. In these situations, MRI may be useful for problem solving when ultrasound is inconclusive in determining pregnancy location. MRI can show thinning of myometrium between the gestational sac and the bladder [21].

Complications and Management

Although there are case reports of full-term cesarean scar pregnancies, implantation in fibrous scar tissue rather than normal myometrium can lead to pregnancy failure, uterine rupture, hemorrhage, placenta previa, and morbidly adherent placenta [22]. Surgical intervention via laparotomy or laparoscopy is indicated for patients with hemodynamic instability. Although most centers still treat scar pregnancies as ectopic pregnancies given the substantial risks, other centers are changing how they treat these pregnancies. Michaels et al. [22] report that the possibility of delivering a live-born neonate is 62.5%, but this carries a 37.5% risk of hysterectomy due to placenta accreta. Thus, it may be appropriate to counsel patients on expectant management with the risk of complications of accreta versus surgical or medical management to minimize the chance of hysterectomy. For patients who undergo surgical or medical management, ultrasound-guided local injection of MTX or KCl, with or without systemic MTX, and hysteroscopic surgical excision were associated with the lowest complication rate in one review [18]. Uterine artery embolization can be used before dilatation and curettage to decrease the risk of hemorrhage [23]. If the diagnosis is uncertain, expectant management may be used for stable low-risk patients with low or decreasing β-HCG levels.

Interstitial Ectopic Pregnancies

Frequency and Risk Factors

Interstitial ectopic pregnancies implant in the proximal-most portion of the fallopian tube surrounded by myometrium. They comprise approximately 2% of all ectopic preg-

nancies [5, 24]. Possible risk factors for interstitial ectopic pregnancy include prior ectopic pregnancy, prior salpingectomy (particularly ipsilateral salpingectomy), uterine anomalies, use of assisted reproductive technologies, and pelvic inflammatory disease [25, 26].

Appearance and Differential Diagnosis

Interstitial pregnancies can be mistaken for normal intrauterine pregnancies, particularly normal intrauterine pregnancies located eccentrically in the uterine cavity. Interstitial ectopic pregnancies (Figs. 5 and 6) are eccentrically located lateral to the round ligament and tend to be surrounded by less than 5 mm of visible myometrium; normal intrauterine pregnancies will have at least 5 mm of surrounding myometrium on all sides and are medial to the round ligament [27]. The interstitial line sign is an ultrasound sign of interstitial pregnancy that describes an echogenic line extending from the superolateral endometrium to the center of the interstitial gestational sac [28], though it can be difficult to identify. Three-dimensional sonography is very helpful for differentiating interstitial pregnancies from normal intrauterine pregnancies. Three-dimensional ultrasound is the best way to show the entire uterine cavity and an overview of the cornua, showing that an interstitial ectopic pregnancy is implanted outside the uterine cavity but within the interstitial portion of the fallopian tube in the myometrium [29]. If 3D ultrasound is not available or if the sonographer or interpreting physician has limited experience with 3D ultrasound or interstitial ectopic pregnancies, MRI can confirm the diagnosis of interstitial pregnancy with surrounding myometrium and an intact junctional zone between the mass and the endometrial cavity [30].

Complications and Management

Because interstitial pregnancies are surrounded by myometrium, they can expand and present at later stages than other tubal pregnancies, potentially leading to catastrophic hemorrhage. The proximity of uterine and ovarian vessels to the cornua makes the risk of significant hemorrhage particularly high. Ruptured interstitial ectopic pregnancies will typically require laparotomy. Laparoscopy, hysteroscopic suction, and uterine artery embolization have been used successfully for nonruptured interstitial ectopic pregnancies [27]. For stable patients, medical treatment with systemic MTX or ultrasound-guided local injection of MTX or KCl can preserve future fertility; ultrasound-guided local injection of MTX or KCl alone allows continuation of a concomitant intrauterine pregnancy if present [13].

Ovarian Ectopic Pregnancies

Frequency and Risk Factors

Ovarian ectopic pregnancies (Fig. 7) comprise 1–3% of all ectopic pregnancies [5, 24, 31] and up to 6% of such pregnancies in association with assisted reproductive technology procedures [32].

Appearance and Differential Diagnosis

In the absence of a yolk sac or fetal pole, an ovarian ectopic pregnancy may be misdiagnosed as a corpus luteum cyst or ruptured hemorrhagic cyst. Both ovarian ectopic pregnancies and corpus luteum cysts can have marked peripheral vascularity (the ring of fire sign). Identification of a separate corpus luteum cyst can be helpful [33]. A wide echogenic ring with a small internal echolucent area has been described as a sign of an ovarian ectopic pregnancy, and the absence of this sign may be secondary to rupture [31]. Distal tubal ectopic pregnancies in close approximation to the ovary may be misdiagnosed as ovarian ectopic pregnancies. Free movement between the ovary and an adnexal mass on palpation (the sliding organs sign) [34] can be useful in separating intra- from extraovarian masses but is not helpful in distinguishing between ovarian ectopic pregnancies, corpus luteum cysts, and hemorrhagic ovarian cysts.

Complications and Management

Ovarian ectopic pregnancies are often treated surgically with oophorectomy or wedge resection [35] and may be diagnosed definitively only at surgery. By American Society for Reproductive Medicine committee opinion, MTX is not recommended as a first-line treatment of ovarian ectopic pregnancies [36].

Abdominal Ectopic Pregnancies

Frequency and Risk Factors

Abdominal ectopic pregnancies (Figs. 8 and 9) are intraperitoneal pregnancies excluding tubal and ovarian pregnancies. Intraligamentous pregnancy may be considered an extraperitoneal form of abdominal ectopic pregnancy. Abdominal ectopic pregnancies comprise approximately 1% of all ectopic pregnancies [5, 24, 37] and have a mortality rate of 5% [37]. They can result from extrusion of the gestation from the fimbrial end of the fallopian tube or rupture of a tubal ectopic pregnancy [38, 39]. Proposed risk factors are those of ectopic pregnancies in general and include tubal damage, pelvic inflammatory disease, endometriosis, and assisted reproduction [2, 40, 41].

Appearance and Differential Diagnosis

Early abdominal ectopic pregnancies may be misdiagnosed as tubal if located in the adnexa. They can present at advanced gestational age, even at term. A full-term abdominal ectopic pregnancy has been delivered by laparotomy [42]. Late-term abdominal pregnancies can resemble intrauterine pregnancies, rudimentary horn pregnancies, or uterine rupture. They may be associated with elevated maternal serum α-fetoprotein level, particularly when visceral implantation of the placenta is extensive [43]. Ultrasound findings seen in abdominal ectopic pregnancies include the absence of myometrial tissue continuing from the uterus around the gestational sac, abnormal placentation, oligohydramnios, and unusual fetal lie [42]. A misshapen gestational sac and flattened placenta may help distinguish an abdominal ectopic from a late-presenting tubal ectopic pregnancy, which is more likely to show a rounded gestational sac and crescentic placenta [44]. Careful sonographic evaluation of the myometrium can also help distinguish a late-presenting abdominal ectopic pregnancy from an intrauterine gestation. The embryo can implant on the omentum, serosa, or pouches surrounding the uterus and adnexa; the bowel; abdominal organs; the retroperitoneum; and the abdominal wall [45]. RBCs tagged with ^{99m}Tc have been used to locate the placenta in an intraabdominal pregnancy after nonvisualization using ultrasound and arteriography [46], and CT has been used to locate a pregnancy after negative laparoscopy [47]. MRI can confirm lack of myometrium around an abdominal ectopic pregnancy [48] and can clarify anatomic relationships, vascular supply, and placental adherence [49], which can help with preoperative planning and prediction of potential complications during or after medical or surgical treatment.

Complications and Management

As for ovarian ectopic pregnancies, MTX is not recommended as a first-line treatment of abdominal ectopic pregnancies by American Society for Reproductive Medicine committee opinion [36], but early gestations may be amenable to primary medical treatment

with local administration of MTX [45, 47], reserving surgery for patients for whom medical management fails. There are multiple case reports of successful treatment via laparoscopy [41, 50, 51]. In the setting of implantation on a vascular surface, laparotomy may be preferentially performed to allow rapid hemostasis. For all surgical approaches, careful consideration must be given to placental extraction or plan to leave in situ, and techniques such as placental blood supply ligation, preoperative arterial embolization, and MTX administration have been used to minimize the risk of hemorrhage [45, 52, 53].

Rudimentary Horn Pregnancies

Frequency and Risk Factors

Müllerian duct anomalies result from abnormal development of the paired müllerian ducts, which normally form the uterus, fallopian tubes, cervix, and proximal vagina during weeks 6–12 of embryogenesis. A unicornuate uterus results from the normal development of one müllerian duct and the failure of the contralateral müllerian duct to elongate normally between weeks 6 and 9 of embryogenesis. The prevalence of müllerian duct anomalies in the general population is about 5% [54]. Unicornuate uteri comprise 10–20% of müllerian duct anomalies [55]; approximately one-third of these are isolated unicornuate uteri with no rudimentary contralateral horn, approximately one-third have a rudimentary horn that does not contain any endometrium, and approximately one-third have a rudimentary horn that contains endometrium. The cavities of rudimentary horns that contain endometrium can communicate with the endometrium of the contralateral horn (approximately one-third of endometrium-containing rudimentary horns) or not (approximately two-thirds of endometrium-containing rudimentary horns) [56]. The frequency of rudimentary horn pregnancies has been reported at 1/76,000 and 1/100,000 pregnancies [57, 58]. Eighty-five percent of rudimentary horn pregnancies occur in noncommunicating rudimentary horns [59].

Appearance and Differential Diagnosis

An enlarging gravid rudimentary horn can make detailed anatomic evaluation difficult; rudimentary horn pregnancies can be mistaken for bicornuate uterus pregnancies [60], interstitial ectopic pregnancies [61], and abdominal ectopic pregnancies [62]. Early in the pregnancy, rudimentary horn pregnancies can be mistaken for noninterstitial tubal ectopic pregnancies [63]. Tsafrir et al. [64] proposed the following criteria for diagnosing rudimentary horn pregnancies by ultrasound: pseudopattern of an asymmetric bicornuate uterus, absent visual continuity between the cervical canal and the lumen of the pregnant horn, and the presence of myometrial tissue surrounding the gestational sac (Fig. 10). In a prospective observational study, Mavrelos et al. [63] reported that the critical sonographic finding was detection of a single interstitial tube in an empty uterus adjacent to the pregnancy, which could be identified in both early and advanced pregnancies. They also found that free mobility of a rudimentary horn pregnancy and a vascular pedicle joining the gestational sac to the unicornuate uterus were helpful signs [63]. Thin surrounding myometrium and placenta accreta, when present, are other clues to the presence of a rudimentary horn pregnancy [64]. Three-dimensional ultrasound is a reproducible method of diagnosing müllerian duct anomalies [65] and, because of its relative speed and low cost compared with MRI, may be the imaging test of choice for evaluating suspected müllerian duct anomalies. It can be helpful in characterizing the contour of the uterus and the presence of a rudimentary horn [56]. MRI is also highly accurate for diagnosing and characterizing müllerian duct anomalies [66] and can reveal the contour of the uterus, the unicornuate uterus's connection to the rudimentary horn, cavitary communication [64], and continuity of the rudimentary horn lumen with the cervix [67]. MRI can be helpful in evaluating for abnormal placentation, evaluating the vascular supply of the pregnancy [68], and in surgical planning [64].

Complications and Management

Rudimentary horn pregnancies have an increased risk of miscarriage, preterm labor, and uterine rupture [69], which can be life-threatening. Fifty percent of rudimentary horn pregnancies rupture, 80% before the third trimester [59]. The maternal mortality rate has improved dramatically over the past century and is currently less than 0.5% [59]. Placenta accreta and thinned myometrium predispose to uterine rupture [64], although varying amounts of myometrium in the rudimentary horn can accommodate the growing fetus often into the second and sometimes even the third trimester. When diagnosis is delayed, ruptured rudimentary horn pregnancies can present as abdominal ectopic pregnancies [70]. Rarely, an undiagnosed and unruptured rudimentary horn pregnancy continues to term and is delivered by cesarean section [71]. Treatment of rudimentary horn pregnancies has consisted of various surgical techniques to remove the pregnancy and the rudimentary horn to prevent future occurrences [64]. Case reports of attempted medical management exist, sometimes in cases of misdiagnosis [72], but the rudimentary horns are eventually excised [72, 73]. MRI can be helpful in predicting outcome and surgical morbidity; placenta accreta suggests poorer outcomes, which can help guide treatment planning [68].

Heterotopic Pregnancies

Frequency and Risk Factors

A heterotopic pregnancy is an intrauterine pregnancy plus one or more abnormally implanted pregnancies, including noninterstitial tubal ectopic pregnancies and the unusual implantation sites described in the previous sections. The frequency of a spontaneous heterotopic pregnancy in the general population ranges from 1/2100 to 1/30,000 pregnancies [3], with the 1/30,000 estimate based on a theoretic calculation [74]; the frequency associated with assisted reproductive technology procedures, however, is much higher at 1–3% [75]. The most important risk factor is a history of assisted reproduction, particularly when multiple embryos are transferred; another risk factor is a history of tubal disease [76]. Although most patients with heterotopic pregnancies will have at least one risk factor, nearly one-third of patients in one study had no risk factors [76].

Appearance and Differential Diagnosis

The appearance on ultrasound is that of a normal intrauterine pregnancy plus one or more abnormally implanted pregnancies. The abnormal implantation is most often a tubal ectopic pregnancy [76] (Fig. 11). Ectopic pregnancy may be eliminated from the differential diagnosis once an intrauterine gestation has been documented, but for patients with risk factors for heterotopic pregnancy, a detailed search for an additional implantation must be performed. In patients who have undergone ovarian hyperstimulation, enlarged ovaries can render the search for an ectopic pregnancy more difficult [77]. Depending on the location of the abnormally implanted pregnancy, the differential diagnosis may include a normal intrauterine pregnancy plus a nabothian cyst (cervical ectopic pregnancy), a corpus luteum or hemorrhagic ovarian cyst

(ovarian ectopic pregnancy), or two normal intrauterine gestations (interstitial ectopic or cesarean scar pregnancy).

Complications and Management

The complications of heterotopic pregnancies include all of the complications of ectopic pregnancies as well as a possible increased risk of miscarriage of the intrauterine pregnancy [78, 79]. Heterotopic pregnancies frequently present with hemodynamic instability [76], likely because the presence of an intrauterine pregnancy provides false reassurance and delays the diagnosis of abnormal implantation. Surgical intervention is indicated for patients with hemodynamic instability. Specific treatment of the abnormally implanted gestation will vary depending on its location, and stable patients have been managed using a variety of surgical methods [80, 81] or direct injection of KCl transvaginally or transabdominally [13]. Direct injection of hypertonic saline [82] or hyperosmolar glucose [83] into the ectopic gestation has also been used to treat heterotopic pregnancies and, like KCl, is not associated with fetal malformations [84]. Although local injection of MTX has been used to treat heterotopic pregnancies [85], systemic MTX cannot be used in patients who desire to continue the concurrent intrauterine pregnancy. For an asymptomatic patient with a known heterotopic pregnancy but no cardiac activity in the abnormally implanted gestation, expectant management with close clinical and sonographic monitoring has been performed with successful delivery of the intrauterine pregnancy [86].

Conclusion

Unusually located pregnancies present diagnostic challenges and are associated with high morbidity and mortality. The absence of a gestational sac in the uterus and adnexa should prompt a thorough evaluation of other potential sites of implantation, including the cervix, cesarean scar, interstitial fallopian tube, ovaries, cul-de-sac, and abdomen. In addition to diagnosing abnormal pregnancy locations, imaging can provide important information about anatomic relationships for surgical planning and can provide guidance for minimally invasive treatments.

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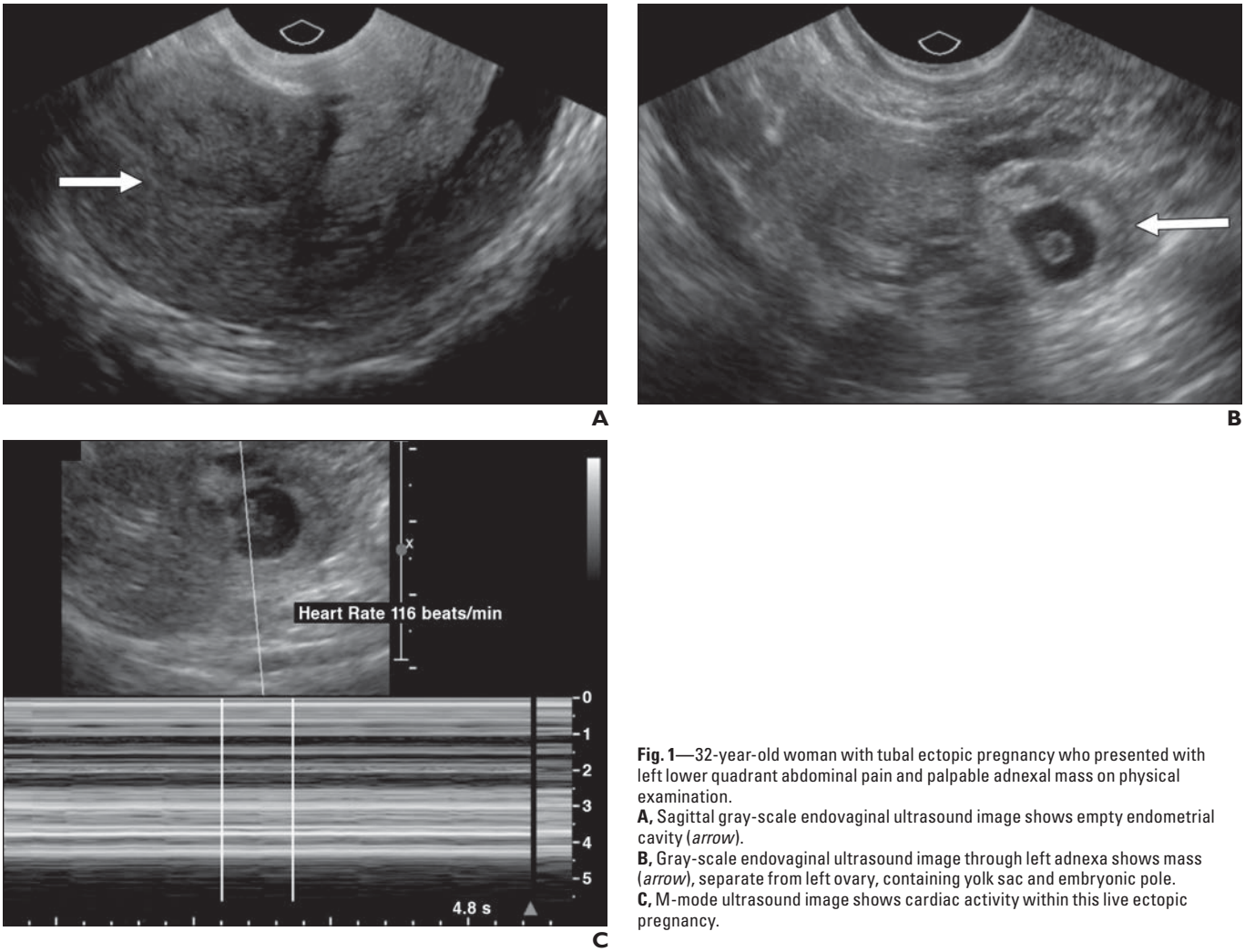


Fig. 1—32-year-old woman with tubal ectopic pregnancy who presented with left lower quadrant abdominal pain and palpable adnexal mass on physical examination.
A, Sagittal gray-scale endovaginal ultrasound image shows empty endometrial cavity (*arrow*).
B, Gray-scale endovaginal ultrasound image through left adnexa shows mass (*arrow*), separate from left ovary, containing yolk sac and embryonic pole.
C, M-mode ultrasound image shows cardiac activity within this live ectopic pregnancy.

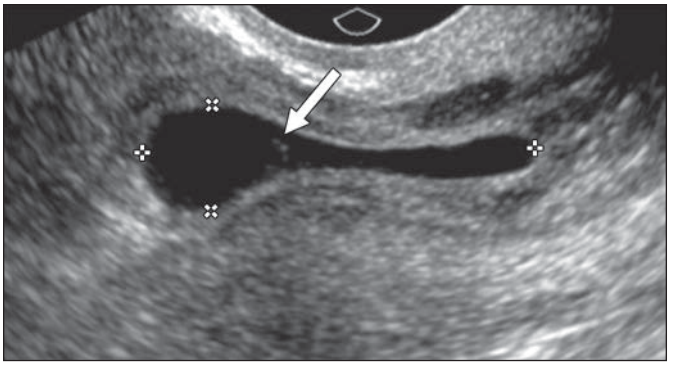
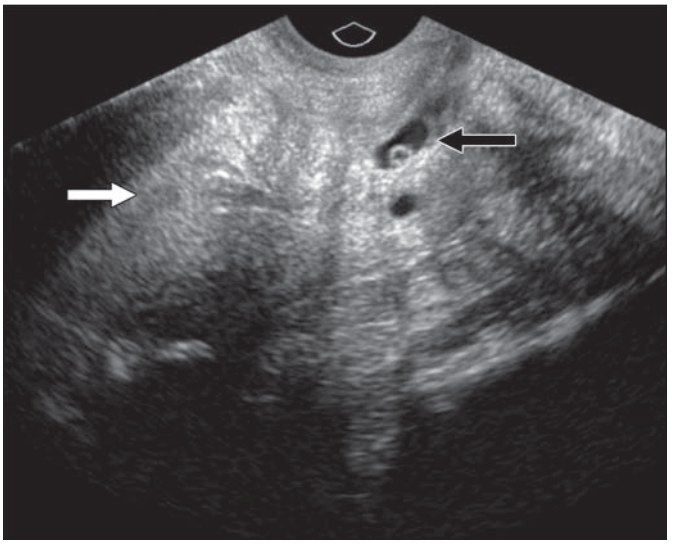


Fig. 2—39-year-old woman with suspected cervical ectopic pregnancy who presented with abnormally increasing β-HCG levels and pain. Sagittal gray-scale transvaginal ultrasound image shows hourglass-shaped gestational sac (within *calipers*) containing yolk sac (*arrow*) located in cervix. Differential diagnosis considerations include cervical ectopic pregnancy or miscarriage in progress. In this case, real-time imaging showed sac was not mobile within endocervical canal, favoring ectopic pregnancy over miscarriage in progress.



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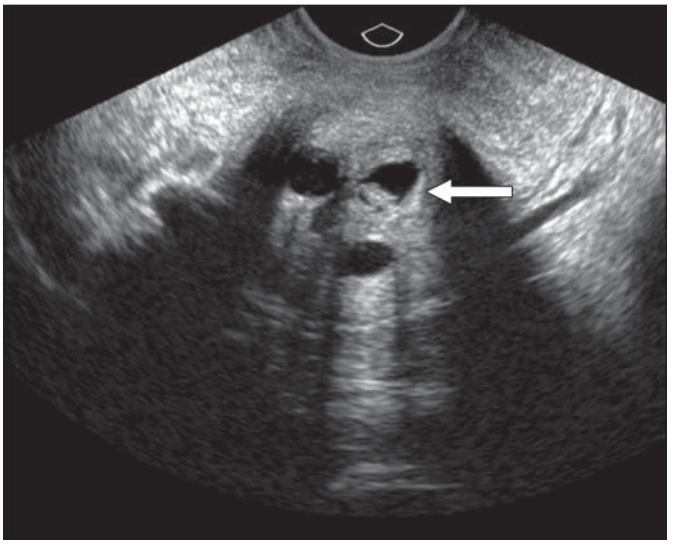

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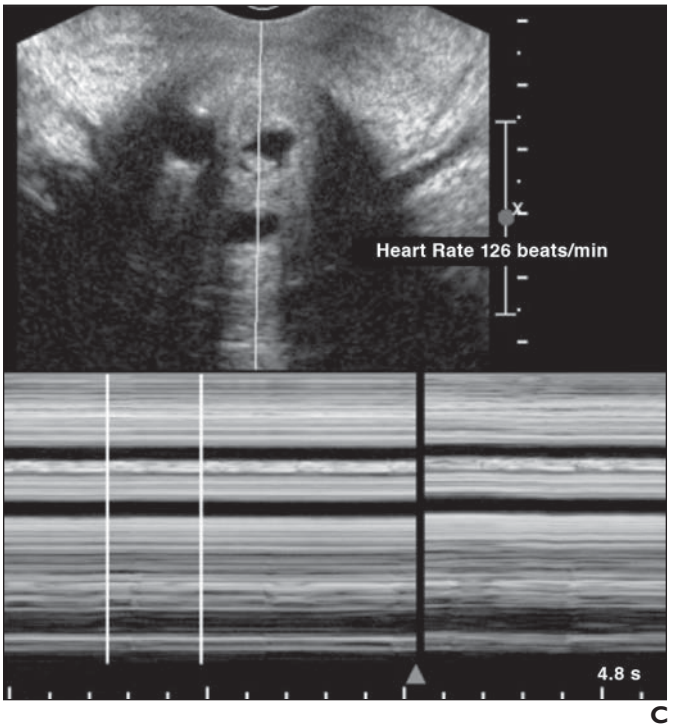

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Fig. 3—23-year-old woman with cervical ectopic pregnancy who presented with abnormally increasing β-HCG levels after receiving methotrexate treatment for presumed tubal ectopic pregnancy.
A, Sagittal gray-scale endovaginal ultrasound image shows normal endometrium (*white arrow*) and gestational sac with yolk sac and embryo within cervix (*black arrow*).
B, Transverse gray-scale endovaginal ultrasound image shows gestational sac (*arrow*) and surrounding nabothian cysts in cervix.
C, M-mode ultrasound image shows cardiac activity in this live cervical ectopic pregnancy.

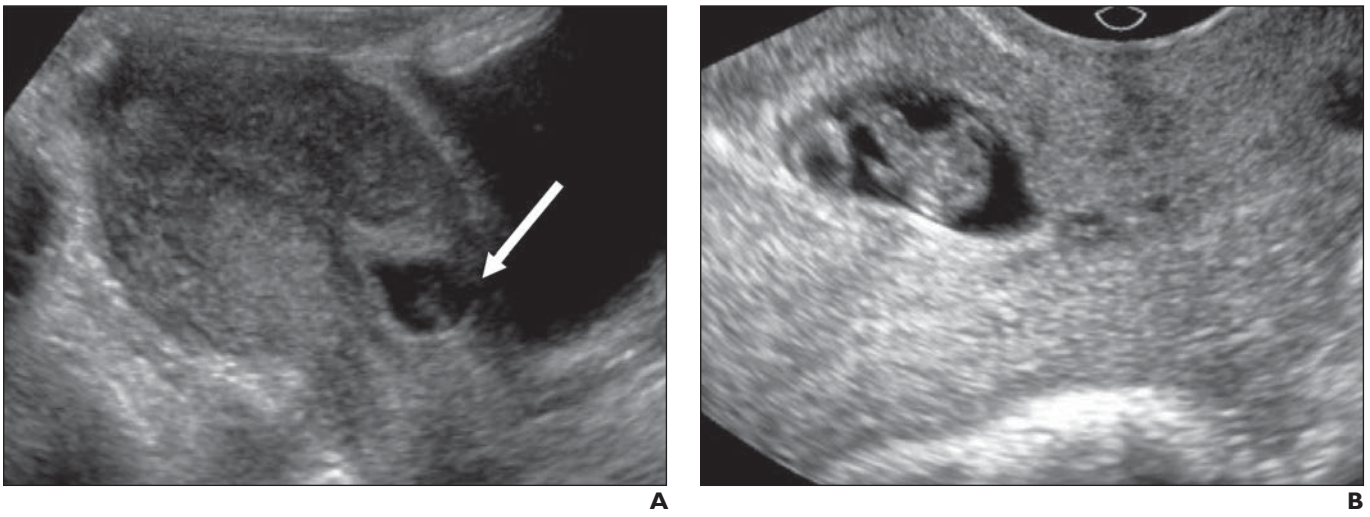

Fig. 4—39-year-old woman with cesarean section scar pregnancy.
A and **B,** Sagittal gray-scale transabdominal (**A**) and transvaginal (**B**) ultrasound images show eccentrically located gestational sac (*arrow*, **A**) low within anterior uterine wall, at expected site of cesarean section scar.
C, Unenhanced sagittal T2-weighted MR image shows mass (*arrow*) centered in myometrium at expected site of cesarean section scar. Patient was treated with intraoperative injection of methotrexate into gestational sac.

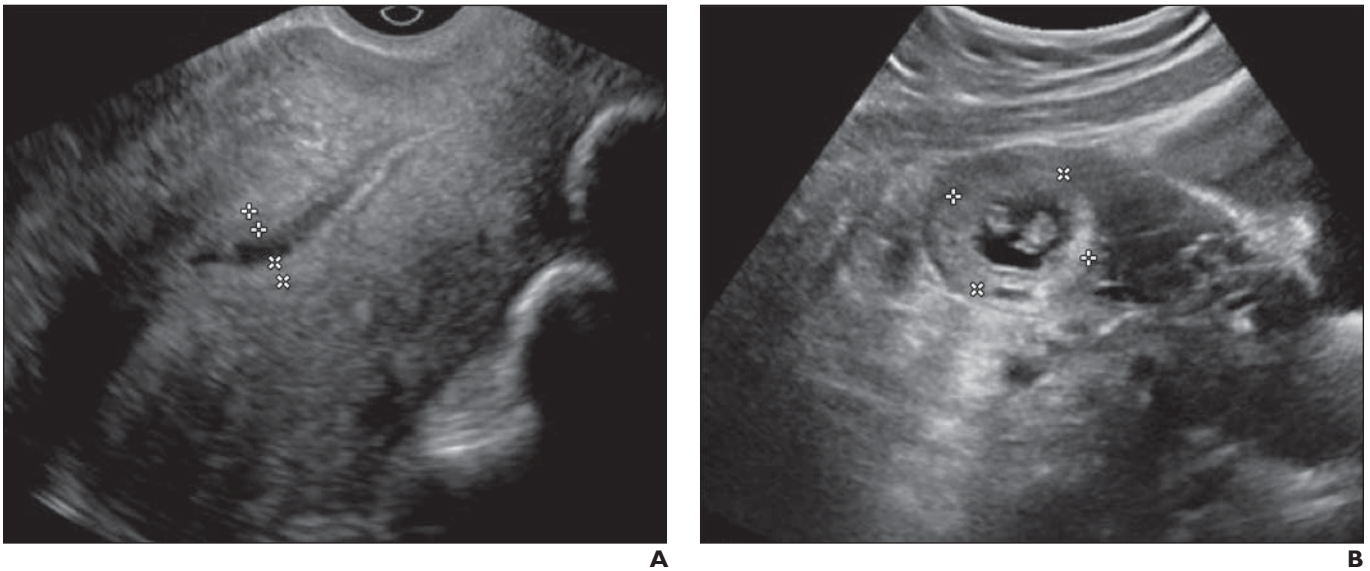

Fig. 5—36-year-old woman with interstitial ectopic pregnancy.
A, Sagittal gray-scale transvaginal ultrasound image of uterus shows no intrauterine pregnancy (endometrium marked with *calipers*).
B, Sagittal gray-scale transvaginal ultrasound image through right cornua shows exophytic mass (within *calipers*) with yolk sac and live embryo. No definite myometrium is visible surrounding gestational sac. Patient was treated with methotrexate.

(Fig. 5 continues on next page)

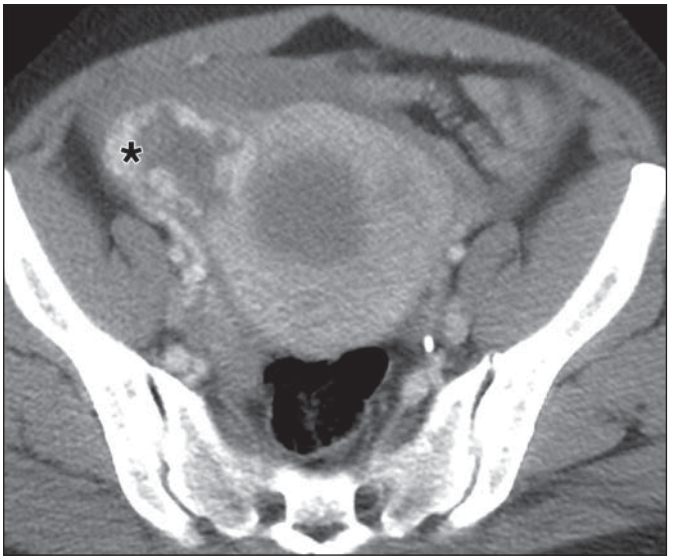

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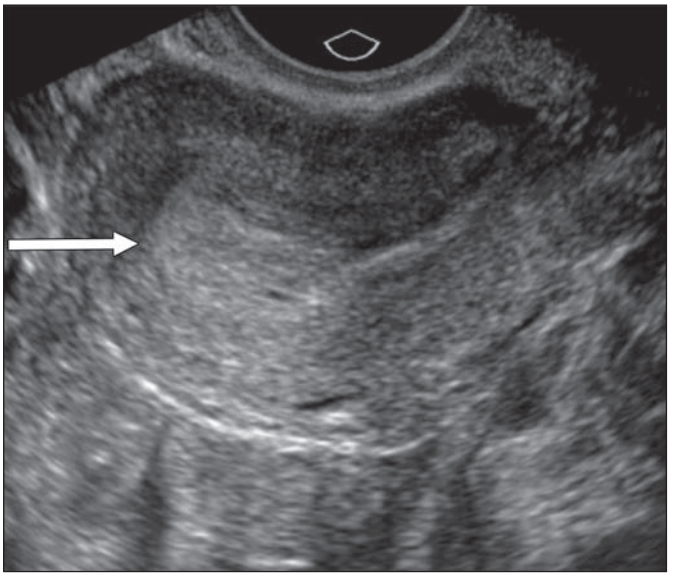
Fig. 5 (continued)—36-year-old woman with interstitial ectopic pregnancy.
C, Several days later, patient presented with increasing pain. Axial image from contrast-enhanced CT obtained at that time shows hemoperitoneum (*asterisk*) surrounding ruptured hypervascular interstitial ectopic pregnancy.



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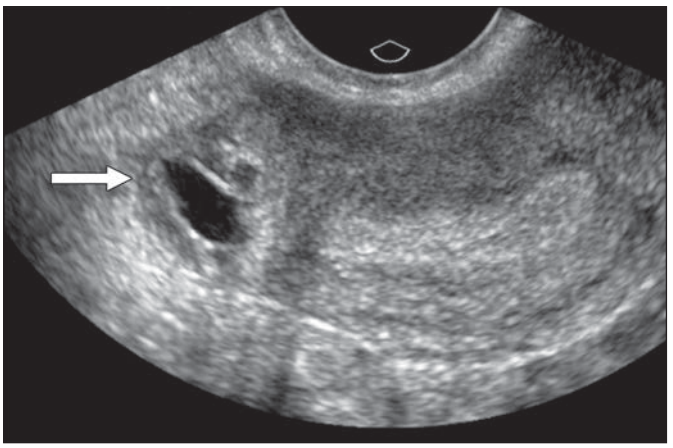

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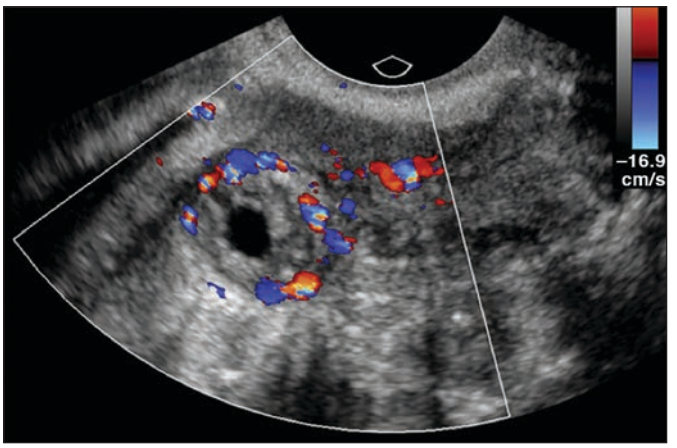

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Fig. 6—36-year-old woman with interstitial ectopic pregnancy.
A, Sagittal gray-scale transvaginal ultrasound image of uterus shows normal endometrium (*arrow*).
B, Transverse gray-scale transvaginal ultrasound image shows gestational sac in region of right cornua (*arrow*) without clear myometrium surrounding gestational sac.
C, Color Doppler transvaginal ultrasound image shows peripheral hypervascularity around this gestational sac. Diagnosis of interstitial ectopic pregnancy was made, and patient was treated surgically.

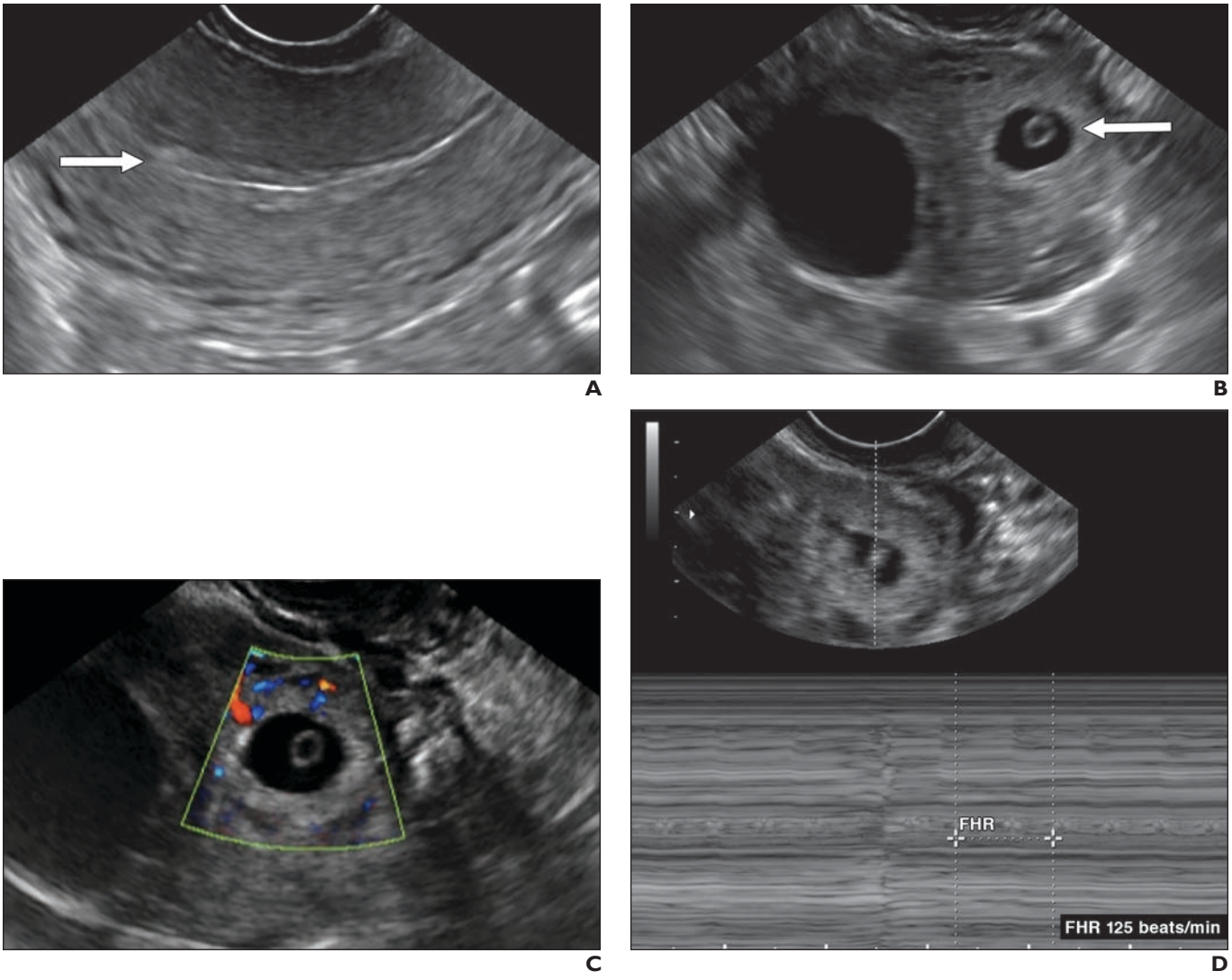

Fig. 7—37-year-old woman with intraovarian ectopic pregnancy who became pregnant via assisted reproductive technologies.
A, Sagittal gray-scale ultrasound image of uterus shows normal endometrium (*arrow*) and no intrauterine pregnancy.
B, Gray-scale ultrasound image of left ovary shows intraovarian gestational sac with yolk sac (*arrow*).
C, Color Doppler ultrasound image of intraovarian gestational sac shows peripheral hypervascularity.
D, M-mode ultrasound image shows cardiac activity in embryo. Real-time examination showed gestational sac and ovary could not be separated, which was diagnostic of intraovarian ectopic pregnancy. FHR = fetal heart rate.

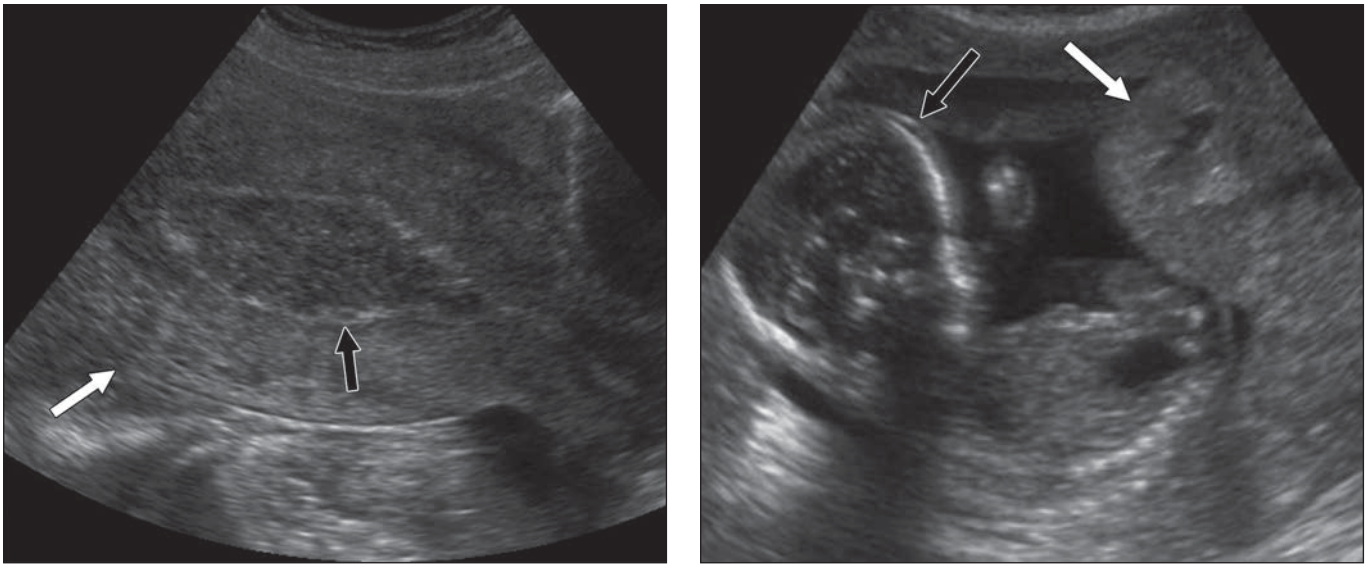

Fig. 8—38-year-old woman with abdominal ectopic pregnancy. (Reprinted from [87])
A, Transabdominal gray-scale ultrasound image shows uterus (*white arrow*) with empty uterine cavity (*black arrow*).
B, Sagittal transabdominal gray-scale ultrasound image shows uterine fundus (*white arrow*) and fetus superior to uterine fundus (*black arrow*) consistent with abdominal ectopic pregnancy.

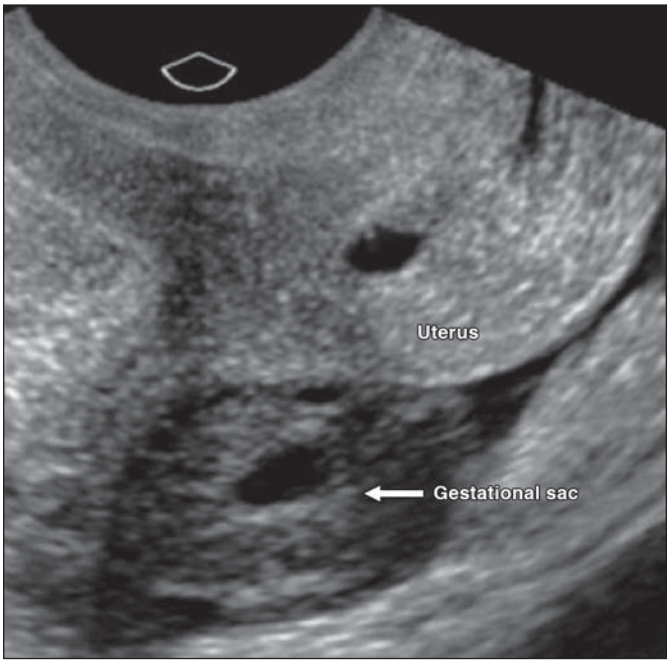

Fig. 9—25-year-old woman with abdominal ectopic pregnancy who presented with pain, bleeding, and abnormally increasing β-HCG levels. Transvaginal gray-scale ultrasound image through pelvis shows mass in cul-de-sac with adjacent free fluid. Intrauterine pregnancy was not present. Mass in cul-de-sac was confirmed to be abdominal ectopic pregnancy at surgery, because both fallopian tubes were normal. Early intraabominal ectopic pregnancies are generally not distinguishable from more common intratubal ectopic pregnancies.

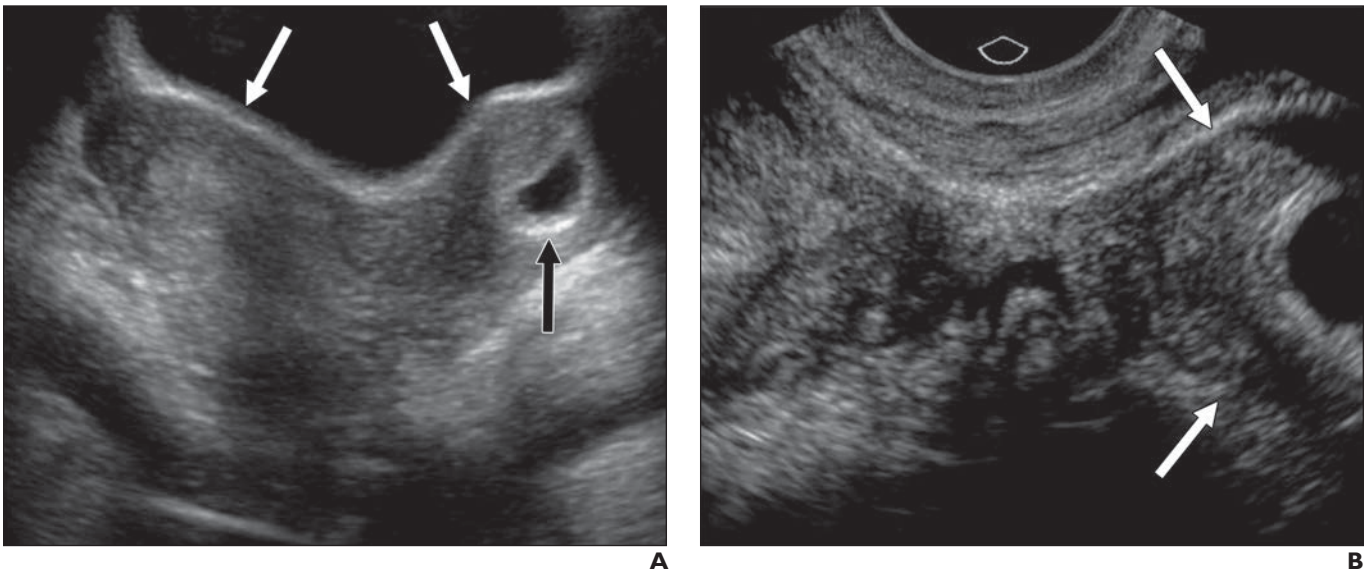

Fig. 10—27-year-old woman with rudimentary horn pregnancy who presented with pain and positive β-HCG level.
A, Transverse transabdominal gray-scale ultrasound image through uterus shows two uterine horns (*white arrows*) with saclike structure in left horn (*black arrow*), which appears asymmetrically smaller than right horn.
B, Transverse transvaginal gray-scale ultrasound image through uterus also shows these findings and shows myometrial tissue surrounding gestational sac (*arrows*) and no communication between two cavities. Real-time scanning showed no continuity between cervical canal and lumen of pregnant horn. Surgical resection confirmed unicornuate uterus with pregnancy in noncommunicating rudimentary horn.

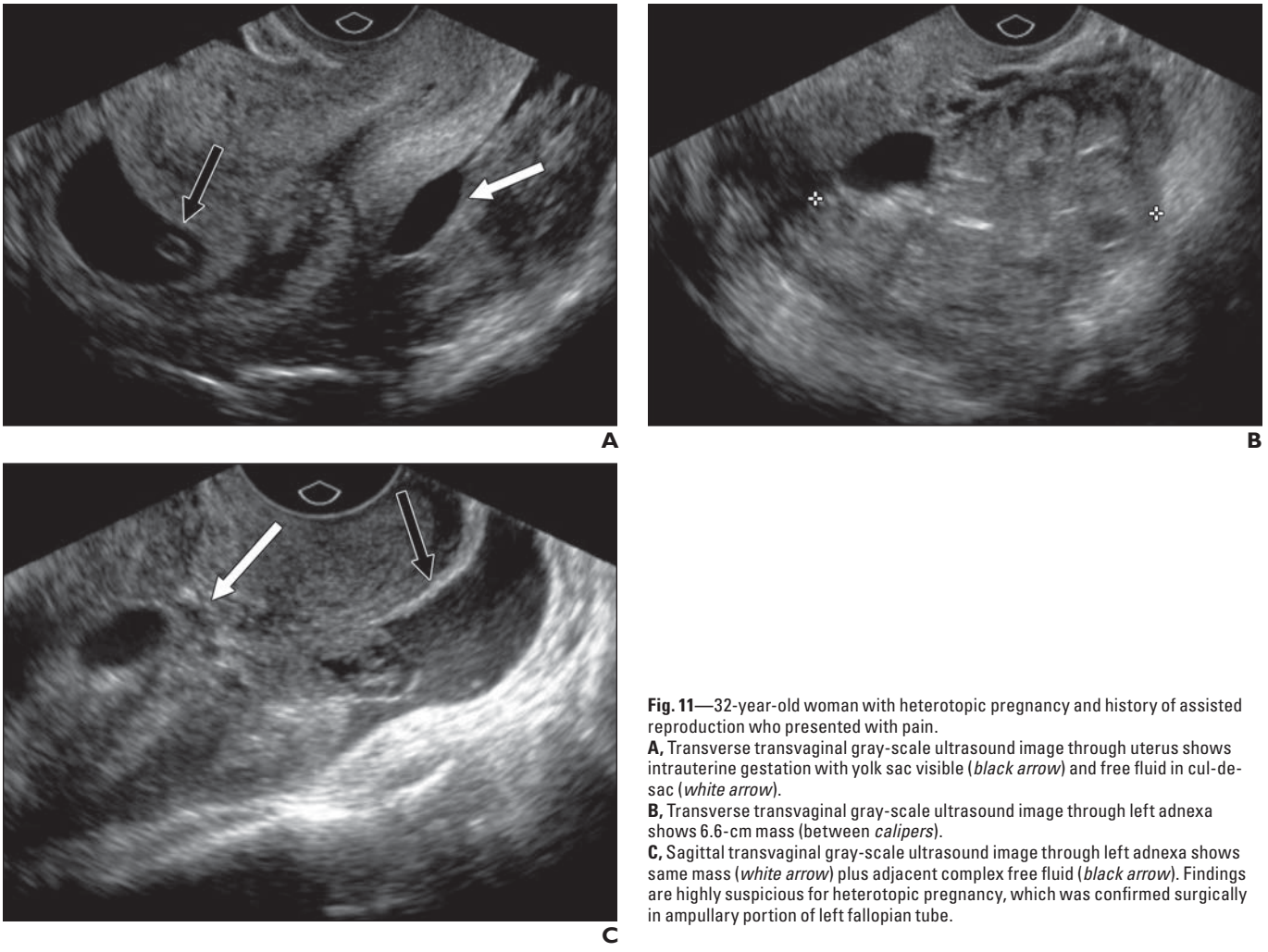

Fig. 11—32-year-old woman with heterotopic pregnancy and history of assisted reproduction who presented with pain.
A, Transverse transvaginal gray-scale ultrasound image through uterus shows intrauterine gestation with yolk sac visible (*black arrow*) and free fluid in cul-de-sac (*white arrow*).
B, Transverse transvaginal gray-scale ultrasound image through left adnexa shows 6.6-cm mass (between *calipers*).
C, Sagittal transvaginal gray-scale ultrasound image through left adnexa shows same mass (*white arrow*) plus adjacent complex free fluid (*black arrow*). Findings are highly suspicious for heterotopic pregnancy, which was confirmed surgically in ampullary portion of left fallopian tube.