ABSTRACT: Ectopic pregnancy (EP) has a variable and misleading clinical presentation contributing to the confusion with medical or other gynecological disorders.

The rapid recourse to diagnostic methods, human chorionic gonadotropin (β-hCG) titers and transvaginal ultrasonography, represents the best approach not only in the early diagnosis but also in the management and monitoring of patients with diagnosed EP. The purpose of this article is to provide a pictorial essay about EP and its multiple ultrasound (US) patterns. We present a large spectrum of EP aspects diagnosed on US and confirmed by pathology. We also review miscellaneous gynecologic diseases that may mimic EP on US. Although endovaginal US combined with quantitative (β-hCG) analysis is an excellent tool for identifying EP, it may be normal sometimes in early pregnancies. Knowledge of all these patterns is helpful in establishing an early correct diagnosis, therefore leading to elective and conservative management in stable patients and preventing tubal rupture or substantial hemorrhage.

INTRODUCTION

Ectopic pregnancy is a high-risk diagnosis that is increasing in frequency and is still commonly missed in the emergency department.

The recently increased incidence of ectopic pregnancy (EP) is related both to an increased numbers of patients at risk for the disease and to an earlier and more accurate diagnosis. Risk factors for EP are history of previous ectopic pregnancy or pelvic inflammatory disease with consequentially scarred fallopian tube, increased number of reconstructive tubal surgery, tubal ligation, and the use of intrauterine contraceptive device and assisted reproductive techniques [1].

Clinical presentation can be misleading; suspicion of the diagnosis is raised when a patient has a positive pregnancy test with the triad of pain, bleeding and adnexal mass. However, this clinical triad is present in only 45% of patients [2]. Almost all ectopic pregnancies are located in the tube: ampullary segment (80%), isthmic segment (12%), fimbrial end (5%), and cornual and interstitial segment (2%). Nontubal sites are uncommon and very susceptible to complications: abdominal (1.4%), ovarian (0.2%) and cervical (0.2%) [3-4].

The combined use of serum β-hCG testing and transvaginal sonography is the current noninvasive approach. Because of more sensitive laboratory tests and improved ultrasound resolution, EP may be detected at an earlier stage, thus contributing to conservative treatment.

This pictorial essay presents various sonographic patterns of EP, suggests an algorithm for didactic workup of EP (Figure 1) and describes the possible differential diagnoses.

DISCUSSION

The first goal of endovaginal ultrasound (US) in the patient suspected of harboring an EP is to rule out an intrauterine pregnancy. However, demonstration of a viable intrauterine pregnancy does not absolutely exclude the possibility of an EP. Rarely EP does occur synchronously with an intrauterine gestation (Figure 2). It is called heterotopic pregnancy and should especially be considered when the pregnancy is the result of an assisted reproductive technology. Heterotopic pregnancy is estimated to occur in 1/30,000 pregnancies in the general population, but it is likely to occur in 1-2.9% in patients with multiple risk factors who are undergoing infertility treatment [5-6]. Multiple EP may also occur (Figure 3).

If no intrauterine sac was seen, a careful evaluation of the adnexa, the cul-de-sac and Morrison’s pouch is important to detect an adnexal mass suggestive of EP, a pelvic hematoma, anechoic or echoic fluid that could represent either peritoneal fluid or blood.

The adnexal mass

Extrauterine gestational sac

An ectopic pregnancy can be diagnosed with confidence when an adnexal cystic mass containing a yolk sac and or a fetal pole, with or without cardiac activity is identified. This occurs in 8-34% [1, 7] of EP (Figure 4).
Pain, Bleeding, Delayed menses

β-hCG +

Endovaginal US

β-hCG –

EP excluded except in rare cases of early or chronic EP

Adnexal mass

Specific (gestational sac or tubal ring)

EP

Non specific

No adnexal mass and no intrauterine pregnancy

EP Intrauterine early pregnancy Spontaneous abortion

Intrauterine pregnancy

EP excluded except in rare cases of heterotopic pregnancies

Follow-up

FIGURE 1

Algorithm summarizing the clinical and radiologic workup when suspecting an ectopic pregnancy.

FIGURE 2

Heterotopic pregnancy in a 32-year-old woman.

a. Transabdominal ultrasound shows an intrauterine gestational sac containing a fetal pole (arrow) with cardiac activity on real time imaging.

b. Transabdominal ultrasound of the right adnexa demonstrates a large hematoma (arrowheads) containing a gestational sac (arrow) with echoic material within it.
This finding has a specificity of up to 100%. An extra-uterine gestational sac with a diameter of 4 cm or more is considered contraindication to medical treatment by methotrexate [8].

**Adnexal (or tubal) ring**

In the absence of a visualized yolk sac or fetal pole, the so-called tubal ring sign is the next most specific (40-78%) US finding for EP [1, 6, 9-10].

A tubal ring is a thick-walled adnexal cystic structure with an anechoic cystic center (representing an extra-uterine gestational sac in the fallopian tube), surrounded by a hyperechoic ring representing the trophoblastic tissue, and an external hypoechoic ring corresponding to the vessels, tube and/or hematoma (Figure 5).

It may be difficult to differentiate the tubal ring of an EP from an exophytic corpus luteal cyst (Figure 6). The most important sign is that the luteal cyst lies within the ovary, unlike EP (Figure 3). Frates et al. [10] reported that the wall of the adnexal ring is more echoic compared to the wall of the corpus luteal cyst. In Stein et al.’s

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**Figure 3.** Twin ectopic pregnancy in a 31-year-old woman. Transvaginal sonogram shows a 17 mm tubal ring (arrow). Adjacent to it, is a smaller tubal ring measuring 6 mm (arrow heads), surrounded by amorphous echoic material.

**Figure 4.** Ectopic pregnancy with cardiac activity in a 29-year-old woman.

- **a.** Transabdominal ultrasound shows an echoic ring (arrow) located between the uterus (u) and the right ovary (o).
- **b.** Transvaginal scan of the right adnexa reveals a fetal pole within the echoic tubal ring.
- **c.** M mode ultrasound displays cardiac activity.
- **d.** Echogenic free fluid (⁎) is present in the cul-de-sac corresponding to hemoperitoneum.
series [11], the wall of the ring was more echoic than the endometrium in 32% of cases, a feature that was absent in all the corpora luteal walls.

**Non-specific adnexal mass**

The identification of a non-specific, echoic homogeneous or heterogeneous adnexal mass located between the ovary and the uterus will correspond to a tubal hematoma (Figure 7) or hematosalpinx in 89-100% of the time [1] (Figure 8).

When US reveals a non-specific adnexal mass, correlation with the clinical history and β-hCG level is recommended to workout the diagnosis. In the appropriate clinical setting, the specificity may reach 92-99% [1].

**No adnexal mass**

Sometimes, an adnexal mass is not seen or is discovered only on follow-up examination. Associated findings (see below) may be the only sonographic signs of EP or could be seen in conjunction with an adnexal mass or tubal ring.

**Associated findings**

**Pelvic hematoma**

Pelvic hematoma appears as an echoic avascular mass on color Doppler (Figure 9). Transabdominal ultrasound is useful to demonstrate a large abdominal or pelvic mass outside the range of the endovaginal probe. A pelvic hematoma can also be present secondary to a ruptured hemorrhagic cyst (Figure 10).
FIGURE 7. Ectopic pregnancy in a 45-year-old patient experiencing left pelvic pain with a history of ovulation induction treatment and positive β-hCG test.

a & b. Transvaginal ultrasound of the right (a) and left (b) ovaries reveals enlargement of both ovaries which contain multiple follicles. The largest cross-sectional ovarian area measures 13.27 and 18.75 cm² respectively.

c. Transvaginal ultrasound of the left adnexa shows an enlarged tube (white arrow heads) containing heterogeneous material (arrow).

d. View of the pathologic specimen shows a clot that was extracted from the tube and contained some gestational materials on histology.

FIGURE 8. Ectopic pregnancy manifested as non-specific adnexal mass in a 26-year-old patient with metrorrhagia and pelvic pain. First ultrasound (not shown) revealed no intrauterine pregnancy but free fluid in the cul-de-sac.

a. 48 hours later, transvaginal ultrasound demonstrates a non-specific extra-ovarian mass (arrow) located between the uterus (u) and the left ovary (o). b. Color Doppler of the left extra-ovarian mass demonstrates no vascular flow within it.
Pelvic transabdominal ultrasound reveals ill-defined posterior margins of the uterus (a) displaced by a large heterogeneous pelvic mass consistent with a hematoma. There was no evidence of vascular flow on color Doppler (arrows).

Sagittal transvaginal ultrasound of the uterus shows a small amount of fluid in the endometrial cavity (white arrow) containing some echoic materials, simulating an intrauterine gestational sac.

Transverse transvaginal ultrasound of the left adnexa demonstrates an echogenic mass (arrow) within the hematoma, containing a central cystic structure (white arrow head) representing the ruptured gestational sac.


a. Transabdominal ultrasound shows free fluid in the Morrison pouch (white arrow).

b. Sagittal transvaginal ultrasound of the uterus shows a small amount of fluid in the endometrial cavity (white arrow) containing some echoic materials, simulating an intrauterine gestational sac.

d. Transverse transvaginal ultrasound of the left adnexa demonstrates an echogenic mass (arrow) within the hematoma, containing a central cystic structure (white arrow head) representing the ruptured gestational sac.


a. Transabdominal ultrasound shows an echoic amorphous mass surrounding the posterior and left aspect of the uterus (u), suggestive of diffuse pelvic hematoma.

b. Sagittal transvaginal ultrasound demonstrates an intrauterine gestational sac (white arrow).

c. Transverse transvaginal ultrasound of the left ovary shows a hyperechoic (white arrow heads) ring-like mass; its relationship with the ovary is difficult to assess given the presence of the large hematoma. There are some scattered echoic materials in its anechoic center, mimicking a yolk sac (arrow). During the examination, the echoic material within the ring faded. A diagnosis of ruptured corpus luteal cyst was made that was confirmed by laparoscopy. The patient was monitored later and demonstrated a live intrauterine pregnancy.
FIGURE 11
Subserosal pedunculated necrobiotic leiomyoma in a 37-year-old patient suspected of harboring heterotopic pregnancy.

a. Sagittal transvaginal view of the uterus shows an intrauterine gestational sac containing a yolk sac.
b. Transverse transvaginal ultrasound of the right adnexa demonstrates an echoic mass with hypoechoic center (white arrow), located between the uterus (u) and the ovary (o) mimicking an ectopic pregnancy.
c. Transvaginal ultrasound of the mass with and without Doppler demonstrates no evidence of vascular flow within the center of the mass (the external iliac vessels are labeled).
d. Laparoscopy revealed a pedunculated necrobiotic leiomyoma demonstrated in this pathologic specimen.
Peritoneal fluid

The presence of a specific sign of EP or a complex adnexal mass may be an isolated finding or combined with free peritoneal fluid. A small amount of fluid can be seen in both normal and abnormal pregnancies. However, large amounts of fluid occupying the Morrison’s pouch (Figure 9), or echoic fluid suggestive of blood, increase the likelihood of EP. The incidence of anechoic peritoneal fluid is 46-75% and echoic fluid is 56% [1].

Unusual ectopic pregnancies

Interstitial EP represents 2-3% of all EP. It occurs in the interstitial or intramural portion of the fallopian tube. It presents late in the first trimester, with a 20% risk of uterine rupture. On ultrasound, the gestational sac is located eccentrically within the uterine cavity. The “interstitial line sign” is a sensitive and specific sign used for the diagnosis. The interstitial line represents the two layers of the endometrium seen adjacent to the gestational sac but not surrounding it.

Cervical EP is rare (0.1%) and it may be difficult to differentiate it from isthmicocervical pregnancy or miscarriage.

Caesarean scar EP is extremely rare. It is the implantation of the gestational sac into a caesarean scar, usually located anteriorly at the level of the internal os and occurs after multiple caesarean sections [12].

Differential diagnoses

Other general or gynecological disorders can mimic EP such as appendicitis, salpingitis, ruptured corpus luteal cyst (Figure 10), adnexal torsion and pedunculated necrotic leiomyoma (Figure 11) [13-14].

Limitation of US and β-hCG

One should understand that, in rare cases of pregnancy, the β-hCG measurement is negative e.g. early pregnancy and chronic EP [1]. There is also a “gray” zone of β-hCG levels in which US is frequently indeterminate. A β-hCG of 1500-2000 mIU/mL (International Reference Preparation) is the level at which a gestational sac will be seen in most, but not all, normal early pregnancies [15-16]. In up to 26% of EP no intrauterine pregnancy nor an adnexal abnormality are detectable by endovaginal US [17]; however, an ectopic pregnancy cannot be excluded. In this case, clinical correlation, serial β-hCG levels and close ultrasound follow-up are of paramount importance when the patient is stable and reliable. Unstable patients should be treated as clinically indicated [1].

CONCLUSIONS

Transvaginal US has proven its value in the diagnosis of EP. The presence of a tubal ring or extrauterine gestational sac or adnexal mass correlated with the clinical history and the β-hCG level provide clues to the diagnosis of EP and allow the differentiation from other causes of adnexal masses in pregnant women. However, radiologists and clinicians should be aware of the pathologic conditions mimicking EP and of false negative results. This knowledge is useful in establishing an early accurate diagnosis of EP therefore allowing for conservative management.

REFERENCES