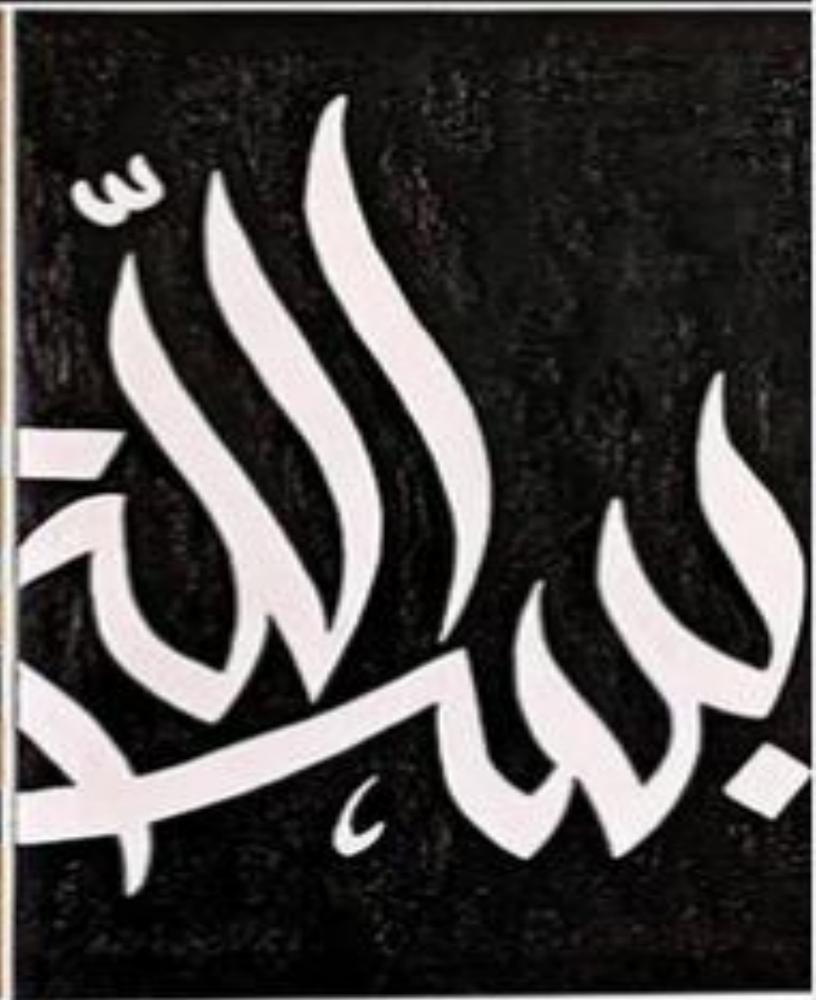
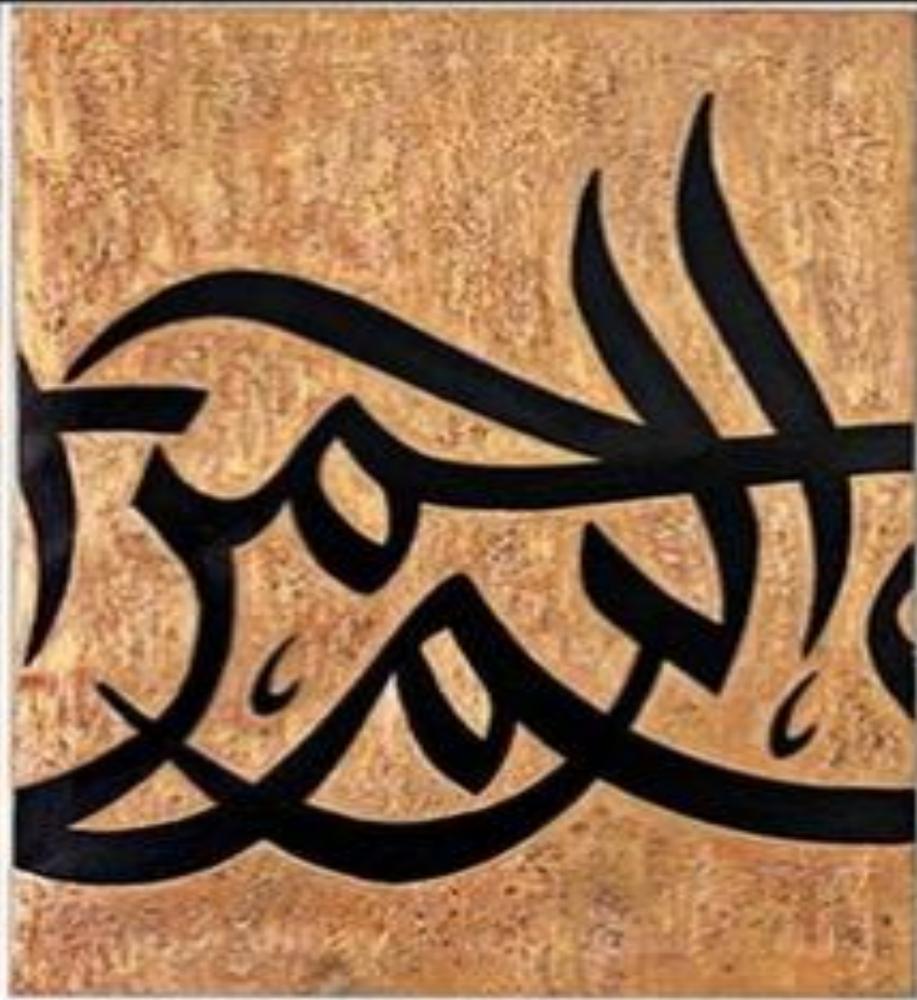




Ultrasound Findings in 1st Trimester Normal Pregnancy and Pregnancy Failure and complications

By: Hamideh Ebadat MD,Radiologist
Jahrom university of medical science





Introduction

- ▶ US imaging in early pregnancy should be primarily **Endovaginal**
- ▶ **Transabdominal** imaging used for:
 1. adnexal masses high in the pelvis
 2. documentation of the amount of free fluid
- ▶ Differential diagnosis in early US:
 - Viable intrauterine pregnancy (IUP)
 - Non-viable intrauterine pregnancy (IUP)
 - Ectopic pregnancy
 - IUP of uncertain viability
 - Pregnancy of unknown location



Normal Development of Early IUP between 4 and 8 Weeks of Gestational Age

Table 1: Timeline of Normal Early Pregnancy Development

Time Period	Developmental Milestone (Threshold)
Week 0	Patient has last menstrual period
Week 2	Conception occurs
Week 4.5–5.0	Gestational sac appears
Week 5.0–5.5	Yolk sac appears
Week 6.0	Embryo appears; cardiac pulsation begins, with a lower limit of 100 beats/min
Week 6.5–7.0	Amniotic membrane appears; cardiac pulsation lower limit is 120 beats/min
Week 7–8	Spine develops
Week 8	Head curvature separates from the body; four limb buds appear
Week 8.0–8.5	Intrinsic motion of the embryo occurs
Weeks 8–10	Rhombencephalon develops

4.5–5.0 weeks of gestational age

The intradecidual sign :

defined as an eccentrically located gestational sac within the echogenic decidua, with a relatively undisturbed collapsed uterine cavity visualized as a thin echogenic line, is highly suggestive of an IUP.



intra-decidual sign in a pregnant woman

double sac sign

consisting of two concentric echogenic rings surrounding the fluid collection and separated by a thin crescent of endometrial fluid, is a sign of definitive IUP.

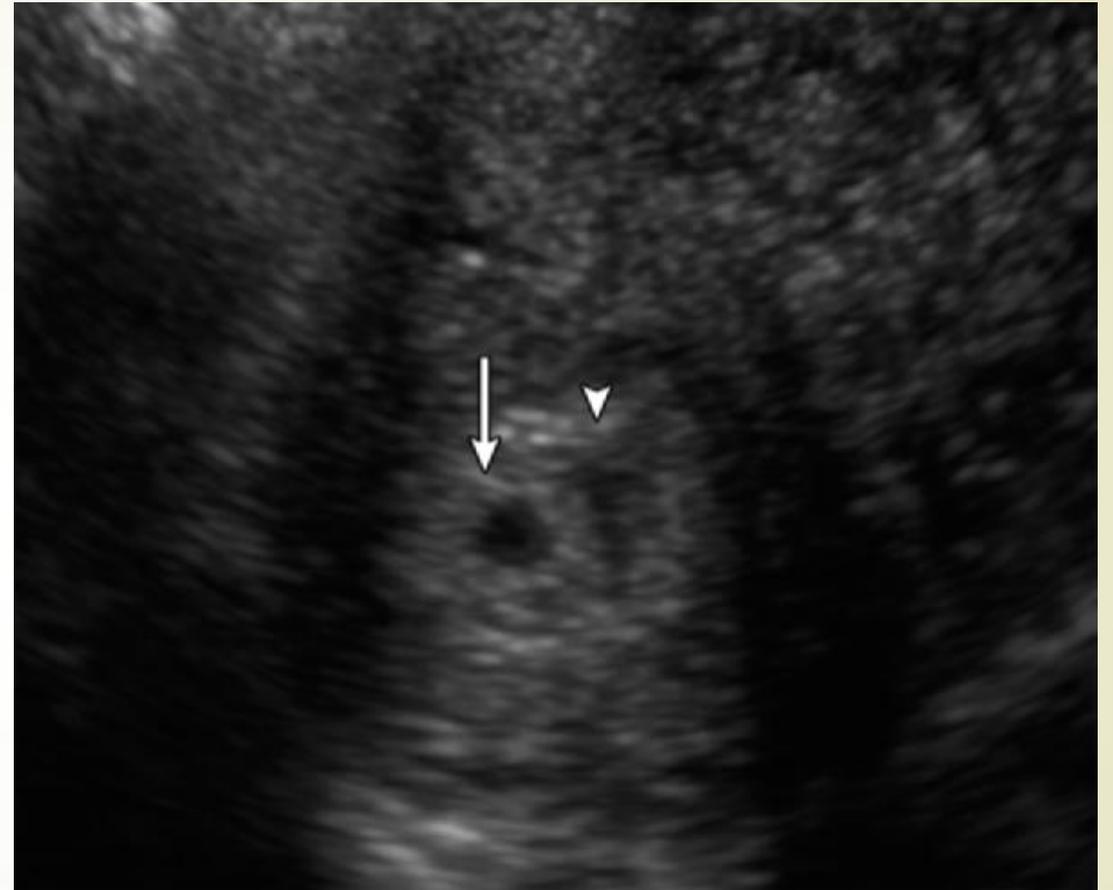
The outer echogenic ring:

decidua parietalis,

the inner ring :

decidua capsularis and chorion

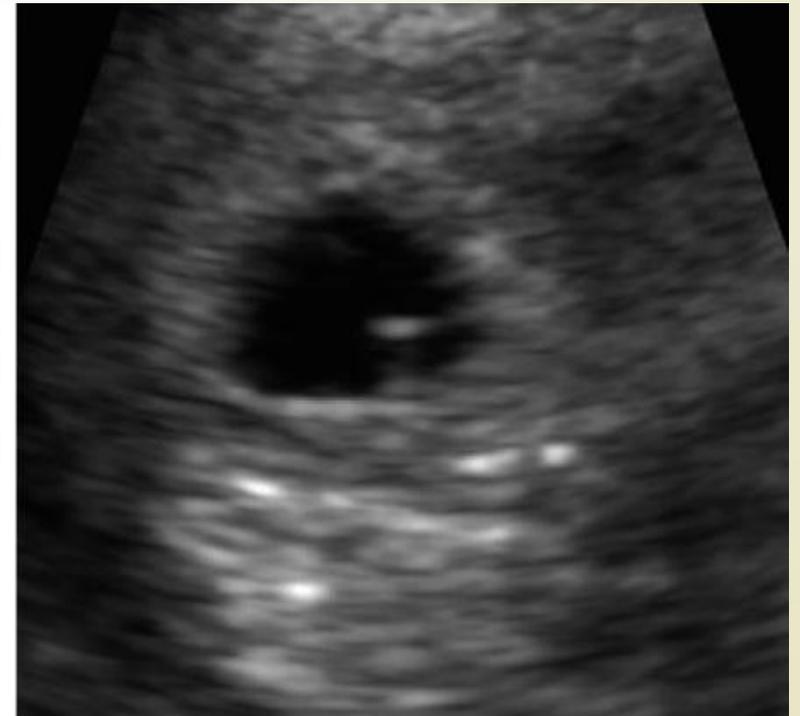
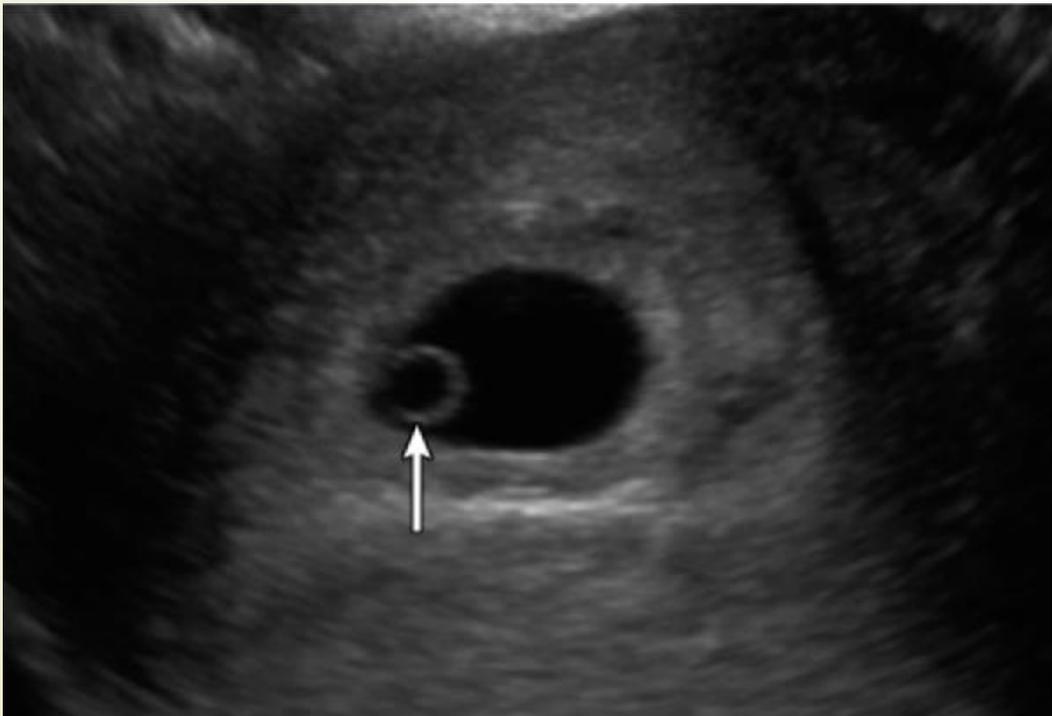
The intradecidual sign is visible before the double sac sign because in the intradecidual sign, the gestational sac is not large enough to deform the contour of the uterine cavity, while in the double sac sign, the gestational sac has grown large enough to protrude into the endometrial cavity .



5.0–5.5 weeks :

Yolk sac is the earliest intra gestational sac structure to be visualized at US.

round 3–5-mm structure, usually eccentrically located within the gestational sac.

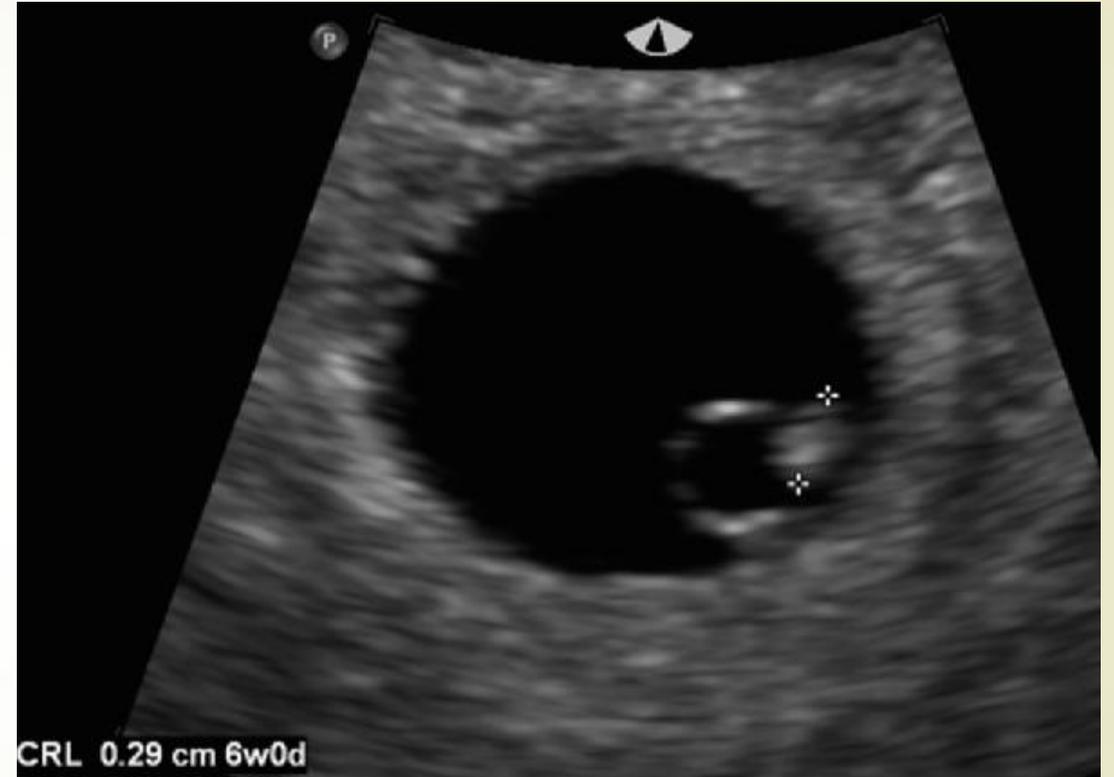


6 weeks of gestational age

embryo is visible .

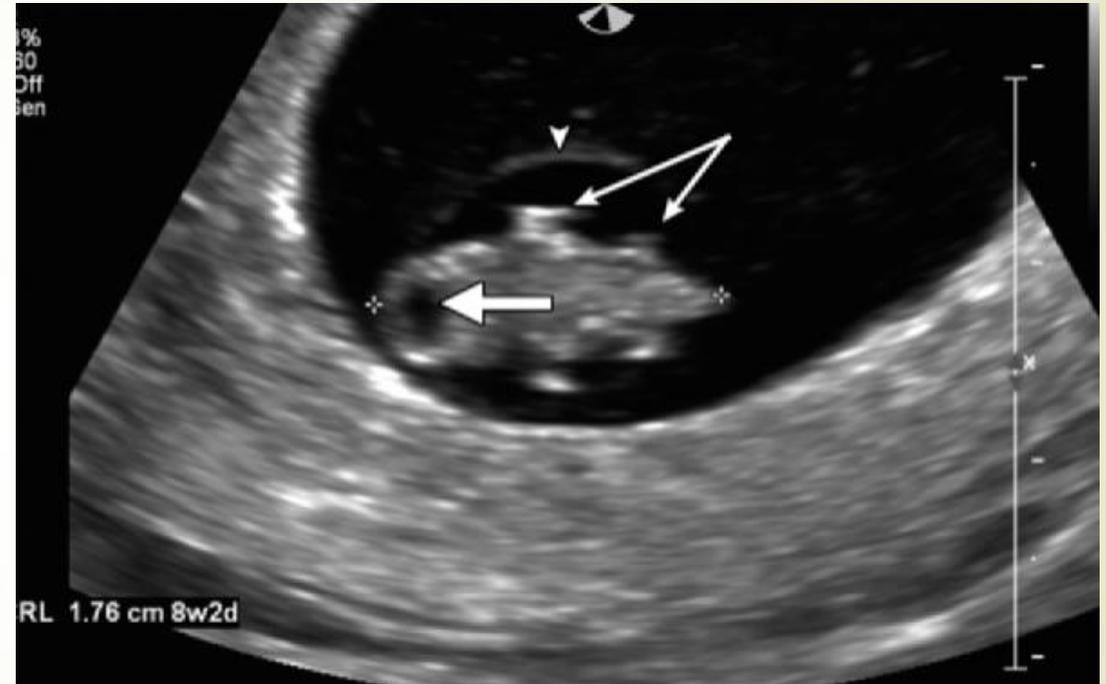
The length of the embryo is measured from the head (crown) to the buttocks (rump), hence the term crown-rump length (CRL) ,which is the most accurate measurement of gestational age through the first 12 weeks of pregnancy.

The embryo should be visualized when the MSD is at least 25 mm .



6.5 - 7 weeks of gestational age

- Visualization of amniotic membrane
- amniotic membrane is thinner than the yolk sac, and although it is seen more easily after 7 weeks, it can be seen as early as 6.5 weeks of gestational age.
- Between 6.5 and 10 weeks of gestation, a linear relationship exists between the diameter of the amniotic cavity and the CRL, with the mean diameter of the amnion 10% larger than that of the CRL.
- In normal gestation, the chorionic cavity, amniotic cavity, and CRL grow proportionally until the onset of fetal urine production at about 10 weeks.
- fusion of the amnion and chorion at 14–16 weeks



6 -7 weeks of GA

Ultrasound established measurement of **7 mm and larger as the CRL** at which **cardiac activity** should be present.

The embryonic heart rate accelerates over the first 6–8 weeks of gestation, with the lower limit of normality near 100 beats per minute at 6.2 weeks of gestation and 120 beats per minute at 6.3–7.0 weeks of gestation.



Table 2: US Findings Diagnostic of Pregnancy Failure

Finding	Imaging Appearance
Absent cardiac activity by the time the CRL is a certain size	CRL \geq 7 mm with no heartbeat
Absent embryo by the time the gestational sac is a certain size	MSD \geq 25 mm with no embryo
Absent embryo by a certain point in time; requires two US examinations	Absence of embryo with a heartbeat 2 or more weeks after US showed gestational sac without yolk sac Absence of embryo with a heartbeat 11 or more days after US showed gestational sac with yolk sac



- ▶ Endovaginal US image shows a nonviable IUP. An amorphous embryo (arrowhead) is seen with a CRL of 20 mm, projecting to a gestational age of 8 weeks 4 days, but there was no cardiac activity. These findings are consistent with a nonviable IUP because the CRL measures at least 7 mm. Note the irregular gestational sac contour (arrow), a sign of poor prognosis.

Endovaginal US image demonstrates a nonviable IUP. There is an empty gestational sac with an MSD of 29 mm.

Fine linear echogenic debris is noted in the sac, but there is no yolk sac or embryo. The estimated gestational age is 8 weeks 1 day. The findings are in keeping with nonviable IUP because the MSD measures at least 25 mm

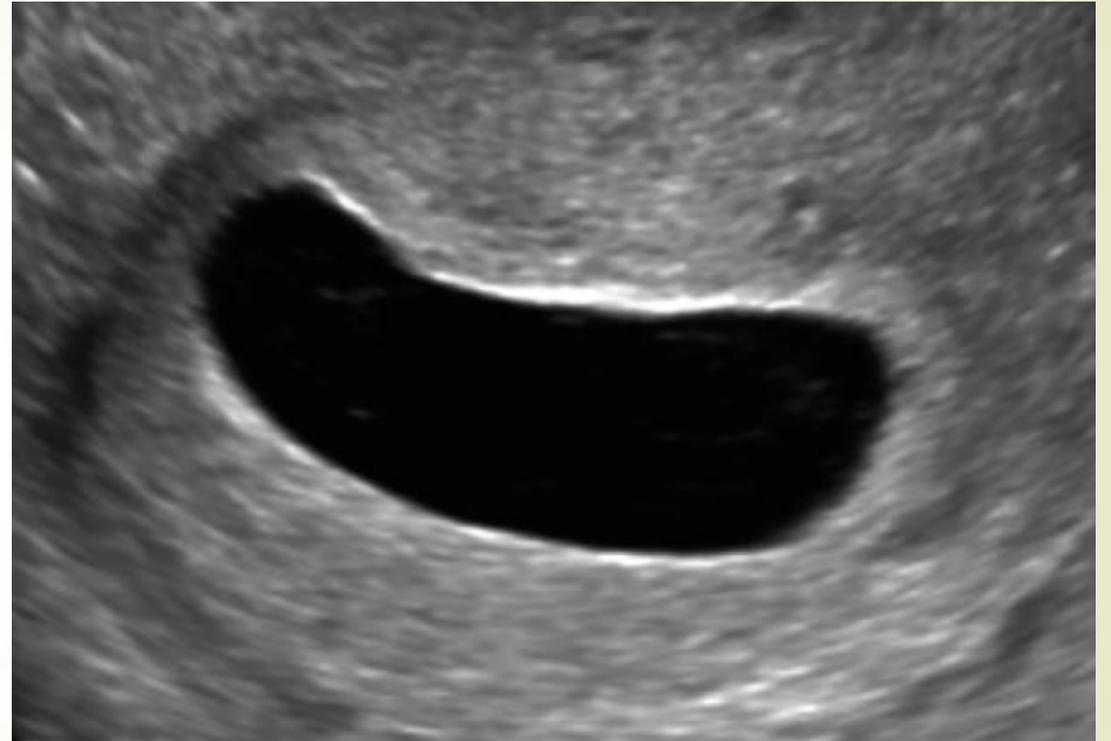


Table 3: US Findings Suspicious for, but Not Diagnostic of, Pregnancy Failure

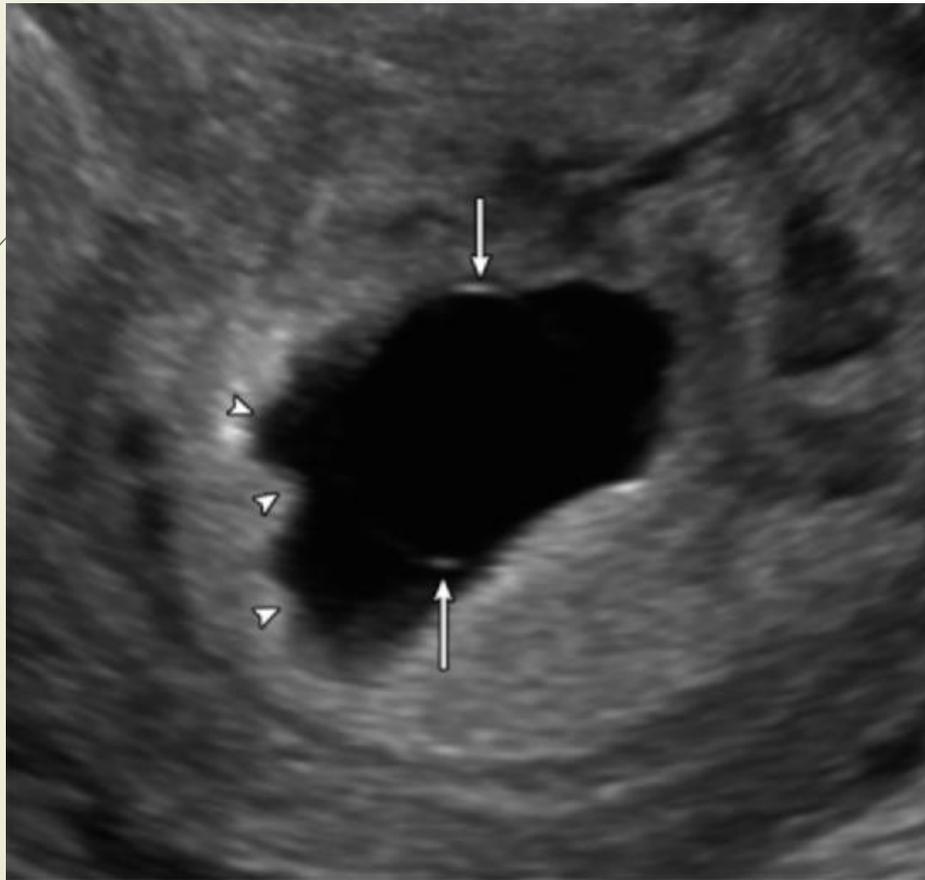
Finding	Imaging Appearance
Absent cardiac activity by the time the CRL is a certain size	CRL <7 mm with no heartbeat
Absent embryo by the time the gestational sac is a certain size	MSD of 16–24 mm with no embryo
Absent embryo by a certain point in time	Absence of embryo with a heartbeat 7–13 days after US showed gestational sac without yolk sac Absence of embryo with a heartbeat 7–10 days after US showed gestational sac with yolk sac Absence of embryo 6 or more weeks after last menstrual period
Morphology of gestational sac, amnion, and yolk sac	Empty amnion (amnion seen adjacent to yolk sac, with no visible embryo), enlarged yolk sac (>7 mm), small gestational sac in relation to size of embryo (<5-mm difference between MSD and CRL)

Table 4: US Indicators of Poor Prognosis in Early Pregnancy

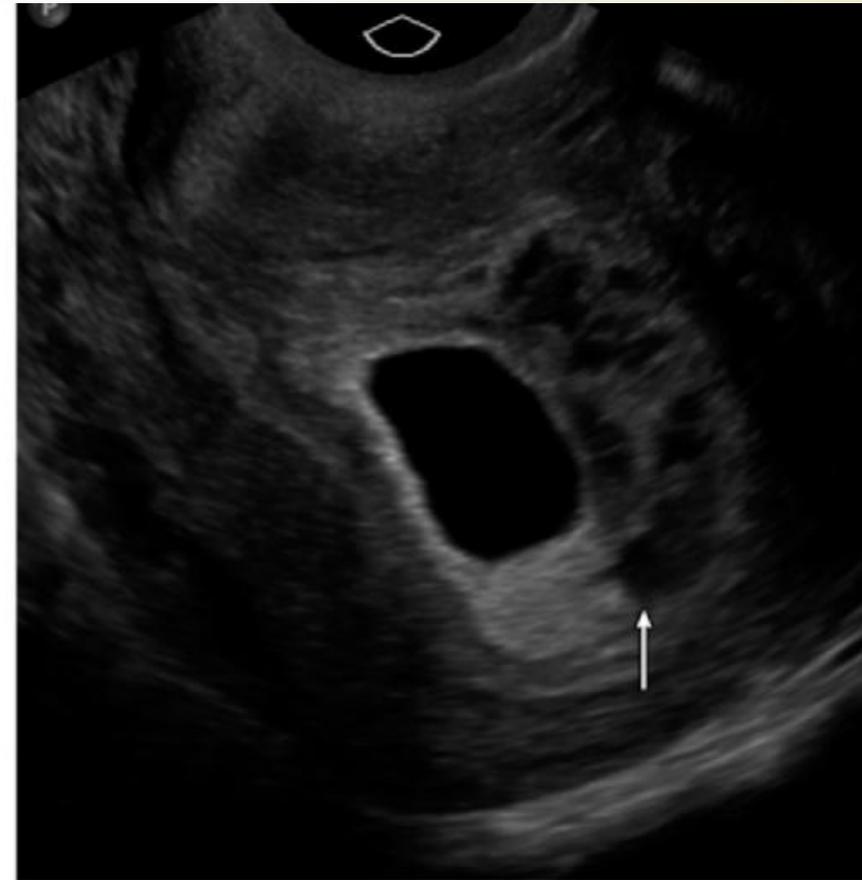
Feature	Imaging Appearance
Gestational sac	Irregular contour, low-lying position
Yolk sac	Calcified, larger than 7 mm
Amnion	Empty, enlarged, or expanded
Embryo	Amorphous shape
Cardiac activity	Bradycardia of 85 beats/min or less
Chorionic villi	Hydropic change
Subchorionic hemorrhage	Large, particularly if it encircles at least two-thirds of the gestational sac circumference

Endovaginal US images show findings suspicious for but not diagnostic of pregnancy failure at initial US and findings of nonviable IUP at follow-up US. (a) Initial findings are suspicious for pregnancy failure but not diagnostic.

There is **an irregular gestational sac** (arrowheads) with an MSD of 17 mm, an **enlarged empty amnion** (arrows), and no embryo or yolk sac. (b) Follow-up image obtained 10 days later shows a nonviable IUP. There is a lack of appropriate interval growth of the gestational sac and no embryo. Note **the hydroptic changes in the chorionic villi** (arrow). The MSD is 19 mm, projecting to a gestational age of 6 weeks 6 days.



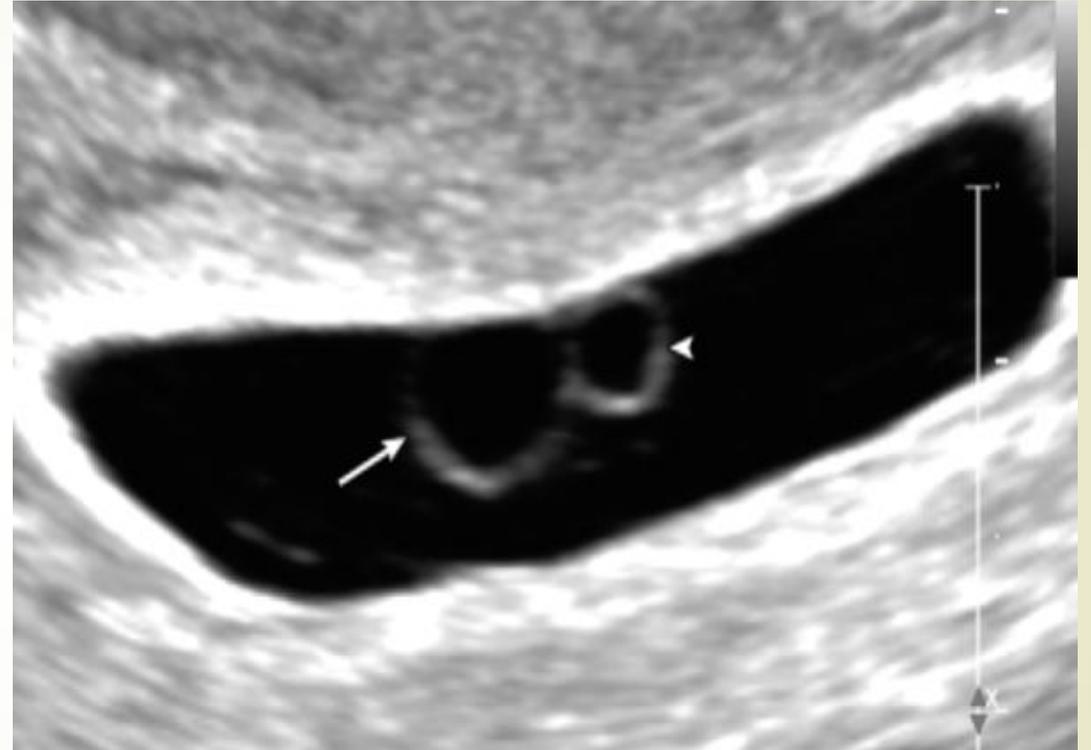
a.



b.

an “empty amnion,” a sign of poor prognosis.

An empty amnion (arrow) is seen adjacent to a normal yolk sac (arrowhead). The MSD is 2.2, projecting to an estimated gestational age of 7 weeks 2 days. An embryo should be present within the amnion in a normal IUP



an enlarged yolk sac, a sign of poor prognosis

An enlarged 7-mm yolk sac (arrow) is seen within an irregular gestational sac with an MSD of 10 mm, projecting to a gestational age of 5 weeks 5 days, and contains no embryo. Findings are suspicious for pregnancy failure but are not diagnostic



Initial image shows a gestational sac with an MSD of 14 mm, projecting to a gestational age of 6 weeks 1 day.

The sac contains an embryo with a CRL of 11 mm, projecting to a gestational age of 7 weeks 3 days.

The difference between the MSD and CRL is less than 5 mm, a sign of poor prognosis



calcified yolk sac

a calcified yolk sac (arrow), which is a sign of poor prognosis. There is also an enlarged amnion (arrowheads). The CRL (not shown) was 20 mm, projecting to an estimated gestational age of 8 weeks 5 days, and no cardiac activity was seen, findings consistent with a nonviable IUP.



Large subchorionic hemorrhage

A large hypoechoic collection (arrows) separates the chorion from the echogenic decidua and encircles almost one-half of the circumference of the gestational sac.

The risk of pregnancy loss is doubled in large hematomas, particularly when there is **encirclement of more than two-thirds of the chorionic circumference**





Pregnancy of Unknown Location

- ▶ Pregnancy of unknown location is the term given to the transient state of early pregnancy during which no definite IUP is visualized at US and the adnexa are normal—in other words, a “normal” pelvic US finding.

At this stage, the three main possibilities include:

- ▶ early IUP
 - ▶ occult ectopic pregnancy
 - ▶ completed spontaneous abortion.
- 

Endovaginal US images in a pregnant woman show a pregnancy of unknown location, with an IUP seen at follow-up US. (a) At initial US, the patient had a b-hCG level of 334 mIU/mL (334 IU/L) and demonstrated a normal endometrium, no intrauterine fluid collection, and normal adnexa—essentially “normal” pelvic US findings. The differential diagnosis was early IUP, occult ectopic pregnancy, or completed spontaneous abortion. (b) Follow-up image obtained 7 days later shows a rounded intrauterine fluid collection with intradecidual and double sac signs, findings that confirm IUP. The MSD is 6 mm, projecting to a gestational age of 5 weeks 1 day. The b-hCG level increased to 4410 mIU/mL (4410 IU/L)



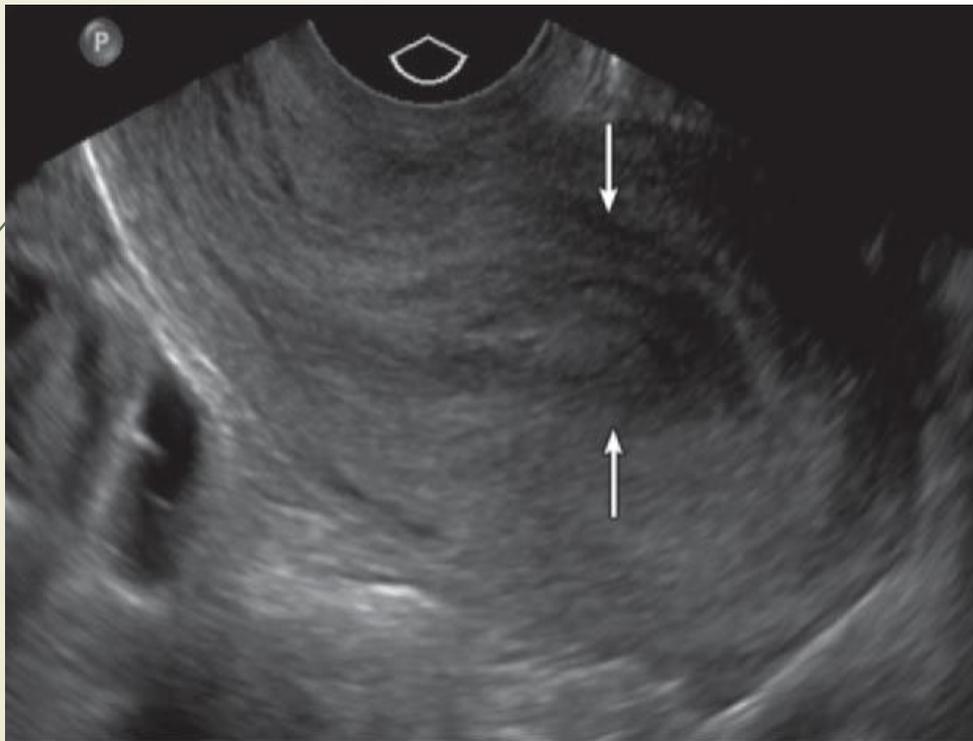
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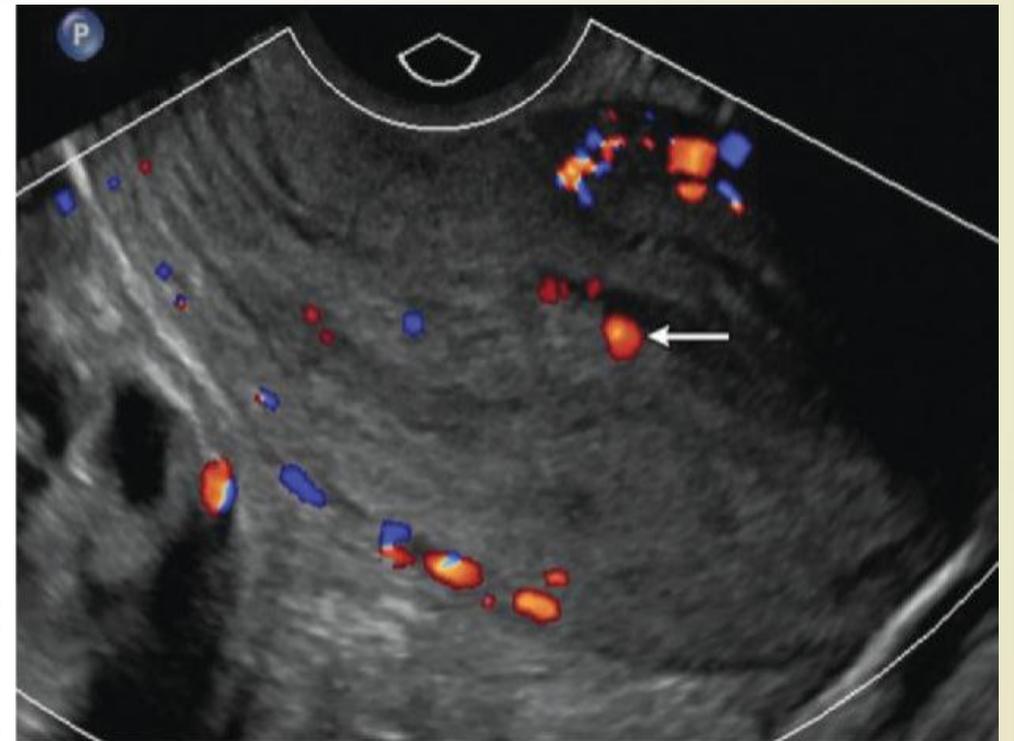
b.

Endovaginal US images in a pregnant woman with vaginal bleeding and a b-hCG level of 24,670 mIU/mL (24,670 IU/L)

show a pregnancy of unknown location, with findings favoring abortion in progress. (a) Image shows a retroverted uterus with an expanded uterine cavity (arrows) due to heterogeneous echogenic material that represents blood products. No gestational sac is identified. The adnexa are normal, with no blood seen in the pelvis. (b) Color Doppler US image shows focal trophoblastic flow at the endometrial-myometrial junction (arrow), a finding that suggests the pregnancy implantation site.



a.



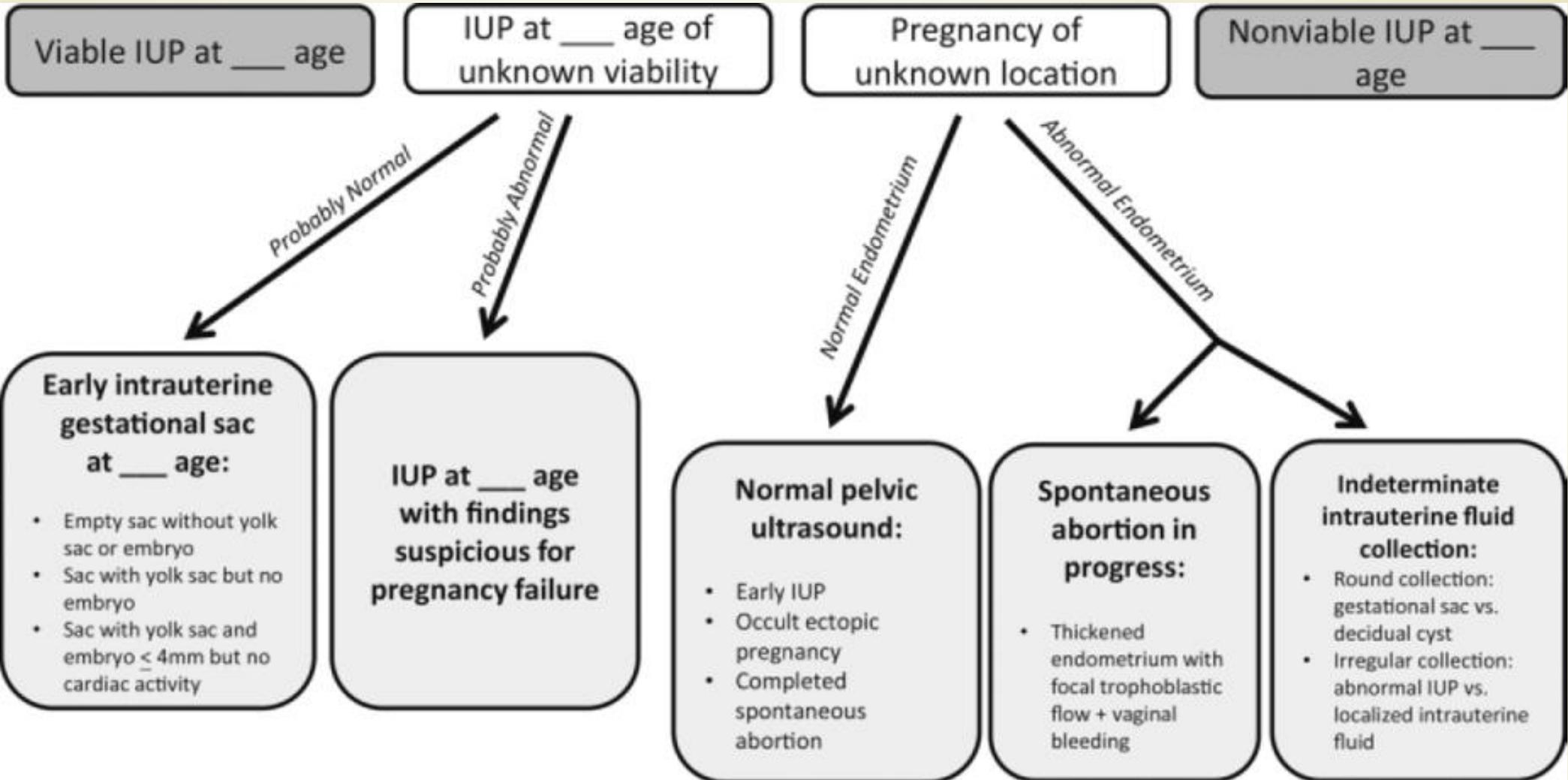
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IUP of unknown viability

IUP of unknown viability can apply to normal situations before development of an embryo that has cardiac activity including an empty sac, a sac with a yolk sac but no embryo, and a sac with a yolk sac and an embryo smaller than 4 mm but no cardiac activity.

A second category of unknown viability applies when there are findings suspicious for pregnancy failure (signs of poor prognosis).

follow-up US to confirm normal development of the pregnancy is recommended.



ViabIUP at ___ age

IUP at ___ age of unknown viability

Pregnancy of unknown location

Nonviable IUP at ___ age

Probably Normal

Probably Abnormal

Normal Endometrium

Abnormal Endometrium

Early intrauterine gestational sac at ___ age:

- Empty sac without yolk sac or embryo
- Sac with yolk sac but no embryo
- Sac with yolk sac and embryo < 4mm but no cardiac activity

IUP at ___ age with findings suspicious for pregnancy failure

Normal pelvic ultrasound:

- Early IUP
- Occult ectopic pregnancy
- Completed spontaneous abortion

Spontaneous abortion in progress:

- Thickened endometrium with focal trophoblastic flow + vaginal bleeding

Indeterminate intrauterine fluid collection:

- Round collection: gestational sac vs. decidual cyst
- Irregular collection: abnormal IUP vs. localized intrauterine fluid



Retained products of conception

- ▶ The term RPOC refers to intrauterine tissue of trophoblastic origin that develops after conception and persists after delivery or termination of pregnancy . The presence of chorionic villi on microscopy confirms the diagnosis of RPOC.
- ▶ The condition is seen more frequently after spontaneous abortion or termination of pregnancy than after vaginal or cesarean delivery.
- ▶ Patients with RPOC often present with postpartum hemorrhage (PPH), which is divided into primary and secondary types. Primary PPH is defined as blood loss greater than 500 mL in the first 24 hours, whereas secondary PPH is excessive blood loss between 24 hours and 6 weeks postpartum



US Diagnosis of RPOC

- ▶ Ultrasound is useful diagnostic tool for the triage of patient with PPH and is more accurate than clinical presentation alone for the diagnosis of RPOC.
- ▶ Combined gray-scale–color Doppler US is the first-line imaging modality for the diagnosis of suspected RPOC and allows real-time assessment of the uterine structures and blood flow.
- ▶ The sensitivity and specificity of US for the diagnosis of RPOC varies widely based on the diagnostic criteria and the clinical setting. However, more recent studies have defined more robust gray-scale and color Doppler US criteria with a high sensitivity and specificity for RPOC

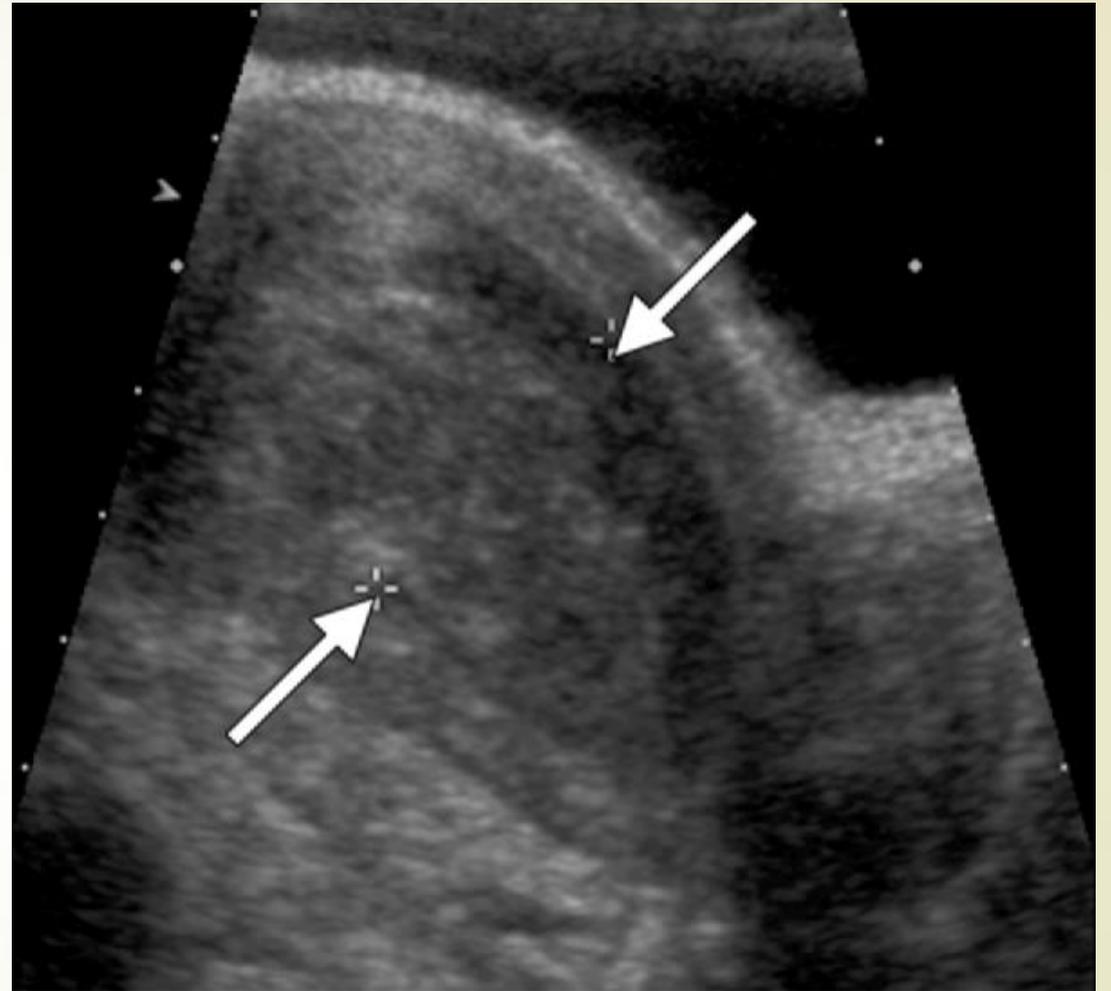


Gray-Scale US Findings of RPOC

- ▶ The most sensitive finding of RPOC at gray-scale US is a **thickened endometrial echo complex (EEC)** . The exact definition of “thickened” varies in the literature, ranging from **8 to 13 mm** . If a patient is clinically suspected of having RPOC, we use **10 mm** as the cut-off value, which has a reported sensitivity of over 80%.
- ▶ Another gray-scale US finding that increases the likelihood of RPOC is the presence of an **endometrial or intrauterine mass**.

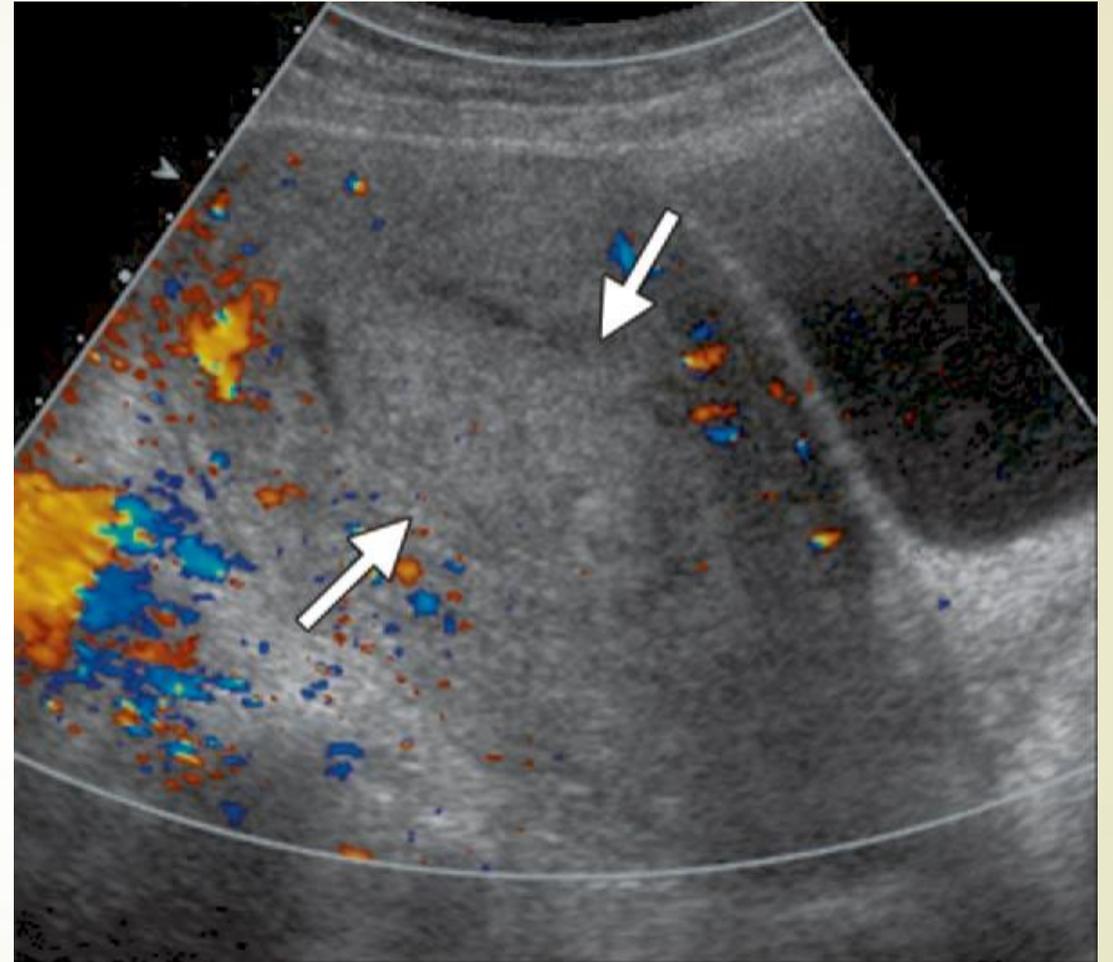
Pathologically proved RPOC with a thickened EEC in a 29-year-old postpartum woman.

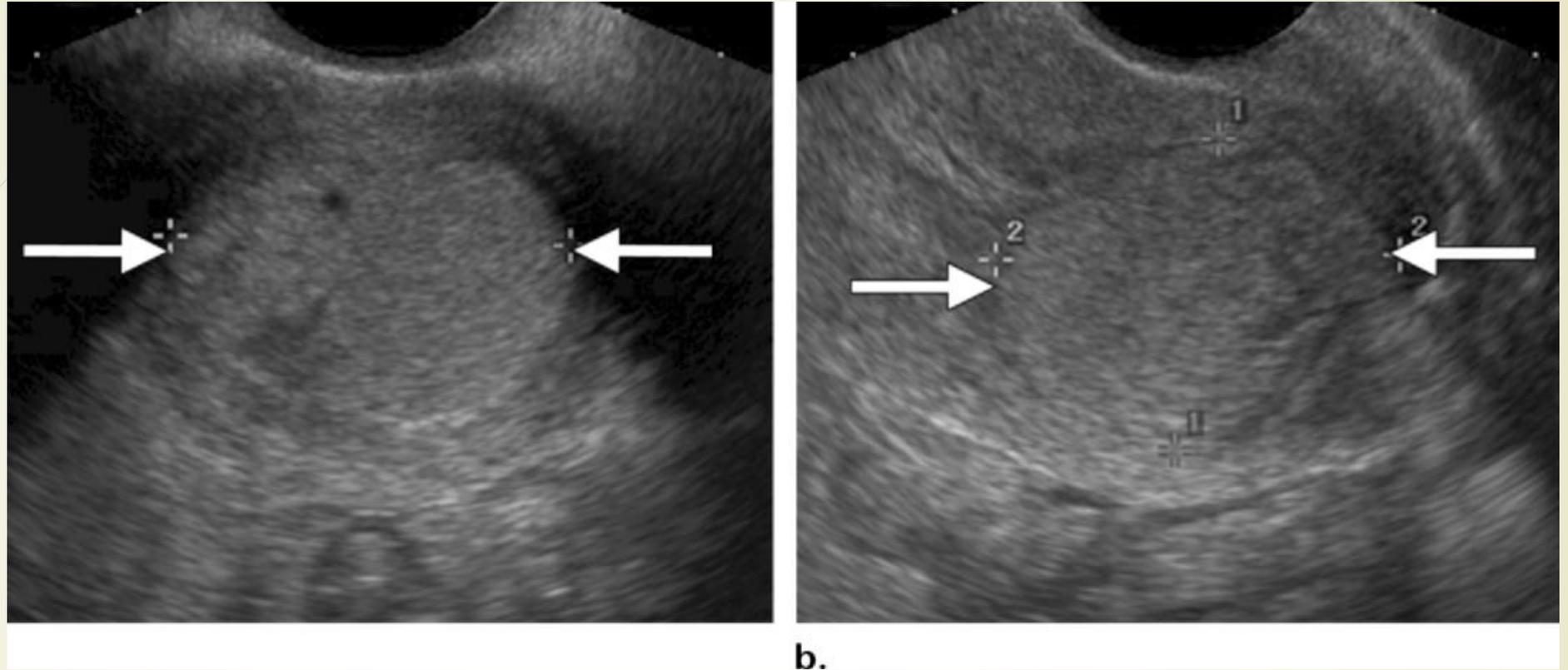
Longitudinal transabdominal gray-scale US image shows a markedly thickened (26-mm) EEC



Pathologically proved organizing blood clot with no RPOC in a 30-year-old woman with vaginal bleeding.

Longitudinal transabdominal color Doppler US image obtained 8 days postpartum shows an avascular, thickened (33-mm) EEC.

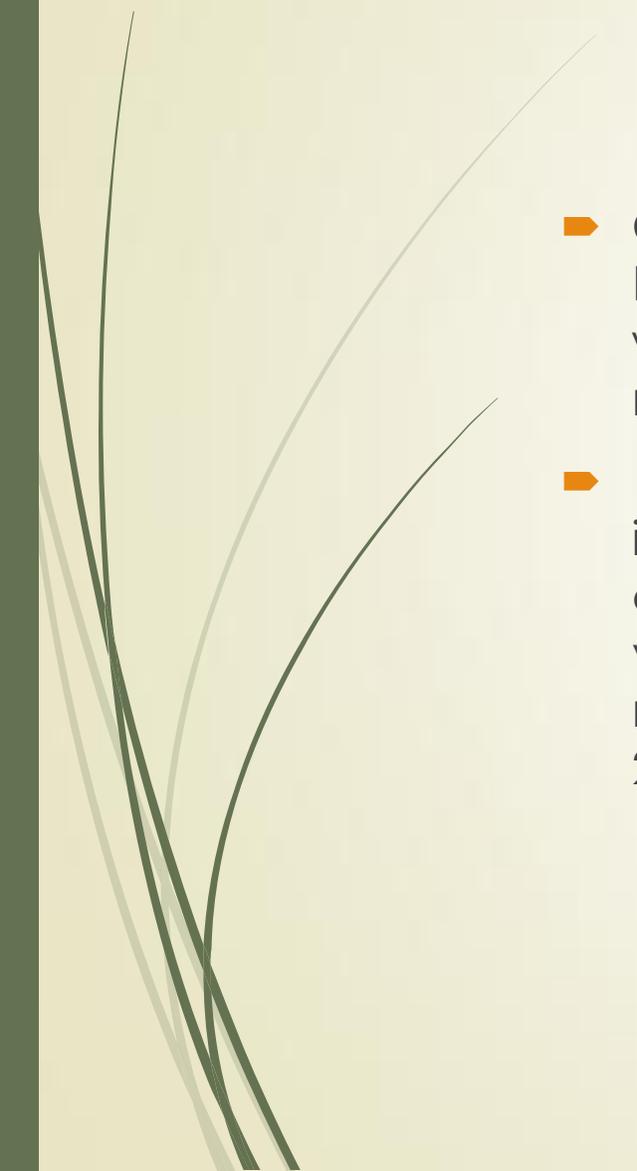


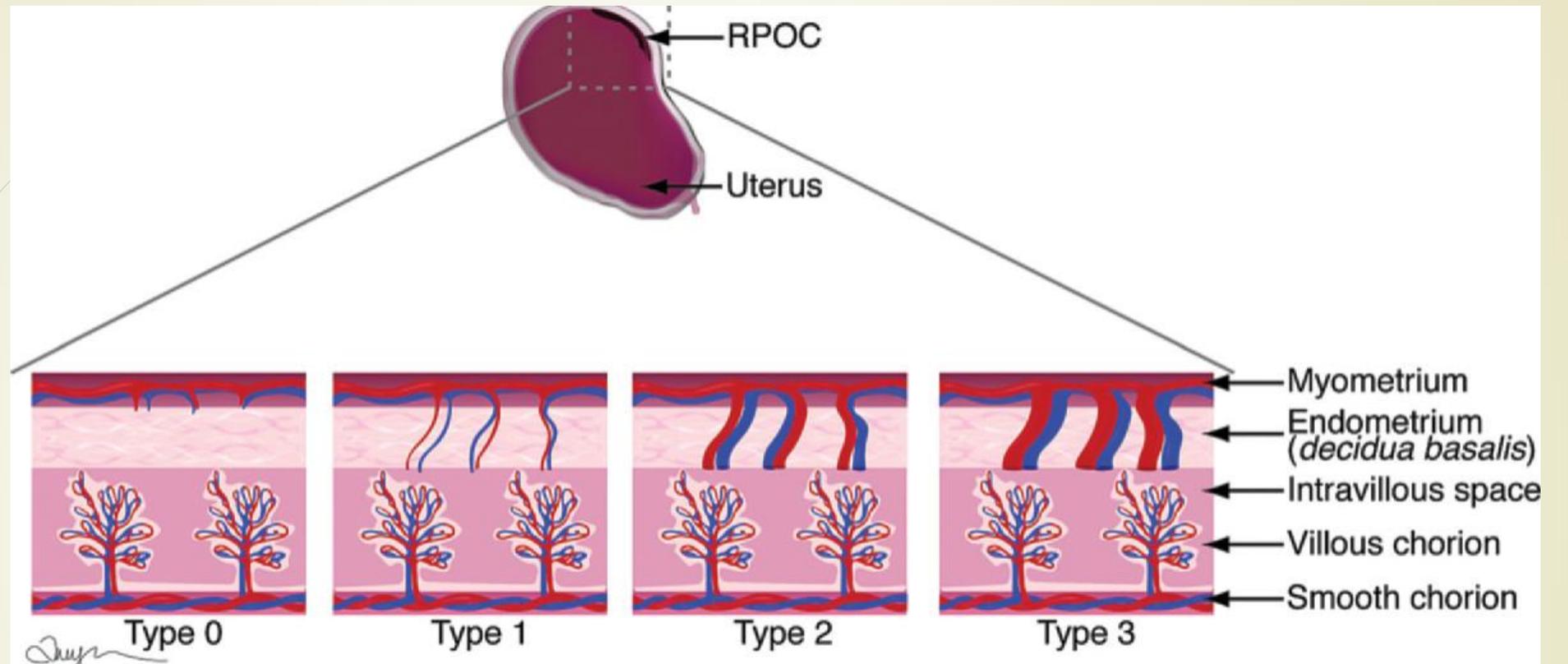


Pathologically proved RPOC in a 22-year-old woman with vaginal bleeding. Transverse (a) and longitudinal (b) endovaginal gray-scale US images of the uterus obtained 2 weeks postpartum clearly depict a $3.8 \times 1.8 \times 2.0$ -cm echogenic mass (arrows) in the lower uterine segment and cervix.



Color Doppler US Findings of RPOC

- ▶ Color Doppler US further enhances diagnostic confidence in identifying RPOC. For example, blood clots will appear avascular at color Doppler US, whereas the detection of vascularity in a thickened EEC or endometrial mass is likely to represent RPOC.
 - ▶ The degree of vascularity in a thickened EEC or endometrial mass can help increase diagnostic confidence for the presence of RPOC . To better describe the typical color Doppler US findings of RPOC, the degree of vascularity of the endometrial component can be compared with the myometrial vascularity in the same image section and graded as type 0, 1, 2, or 3.
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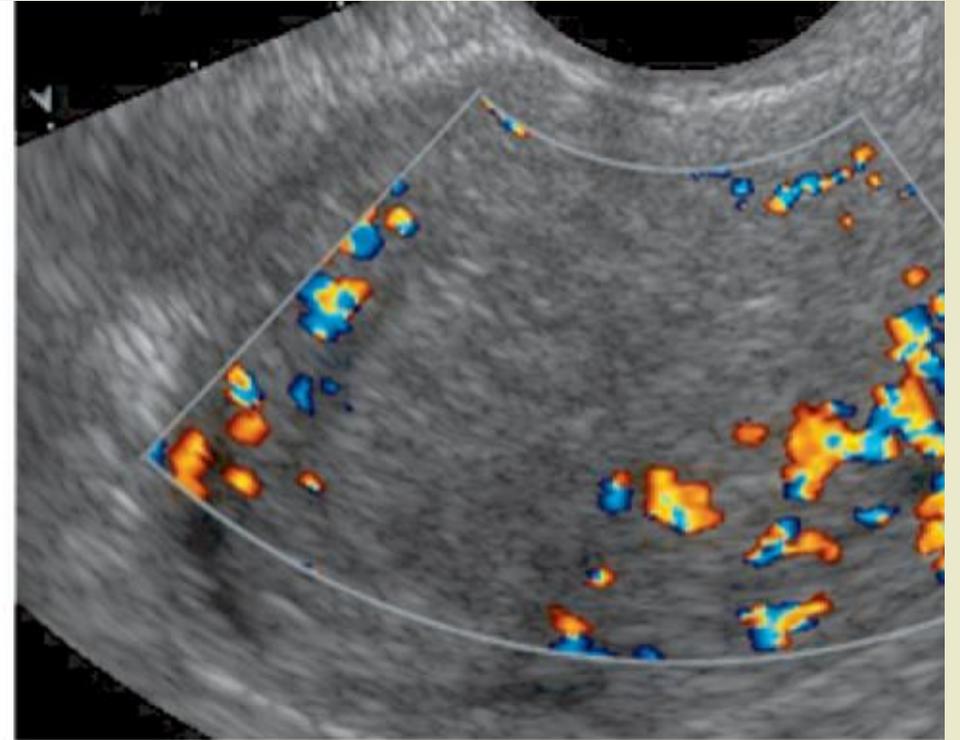
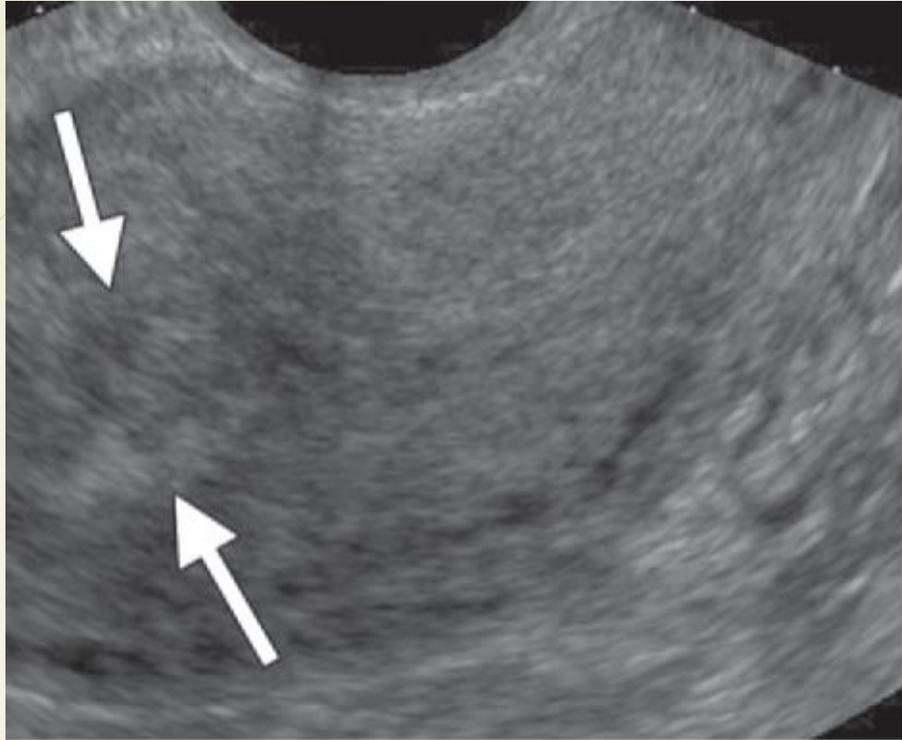


Drawings illustrate RPOC with various types of vascularity (types 0–3). The degree of vascularity is measured by comparing endometrial with myometrial blood flow at color Doppler US



Type 0 vascularity

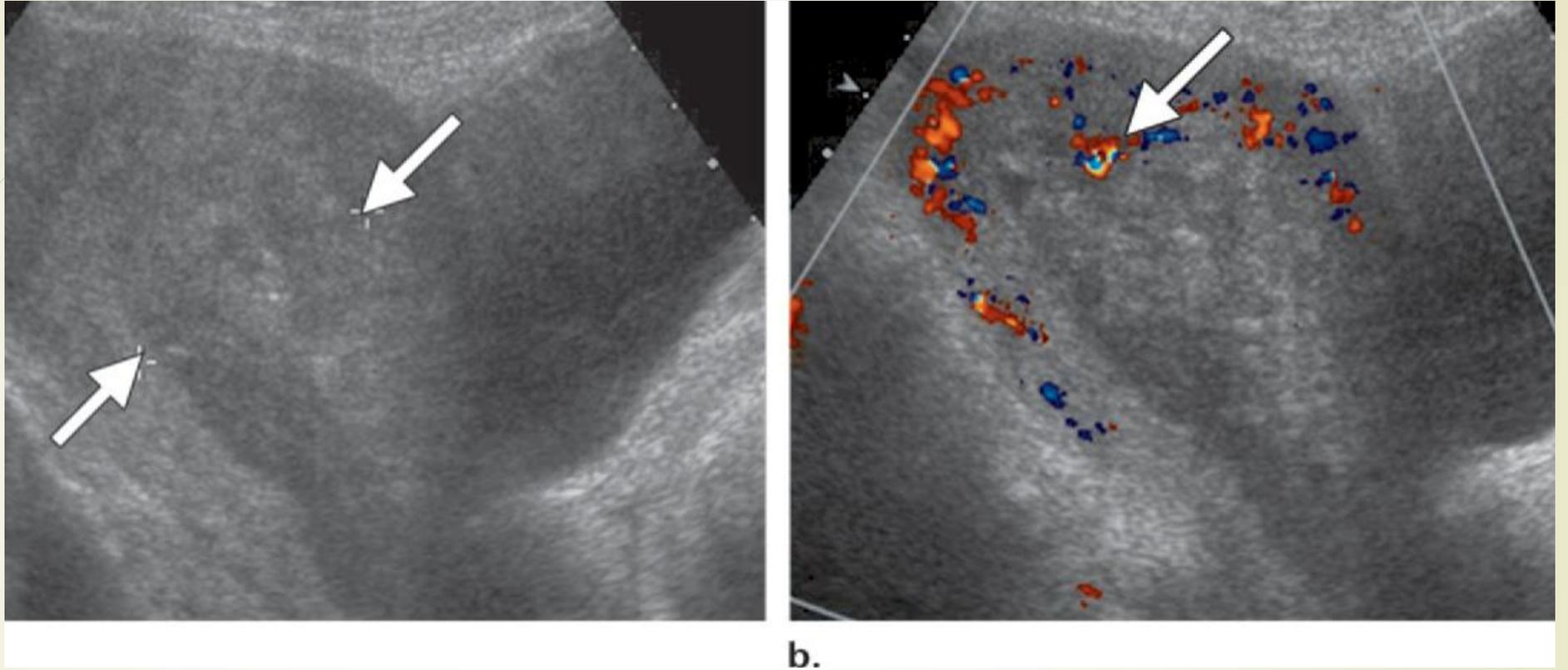
- ▶ defined as no detectable vascularity in a thickened EEC or mass, may represent either a blood clot or avascular RPOC . Although an avascular thickened endometrium could still represent RPOC, avascular RPOC will probably pass spontaneously without intervention and is unlikely to cause severe bleeding.
 - ▶ If any vascularity is detected in a thickened EEC or mass, the likelihood of RPOC increases substantially to a PPV of 96%.
- 



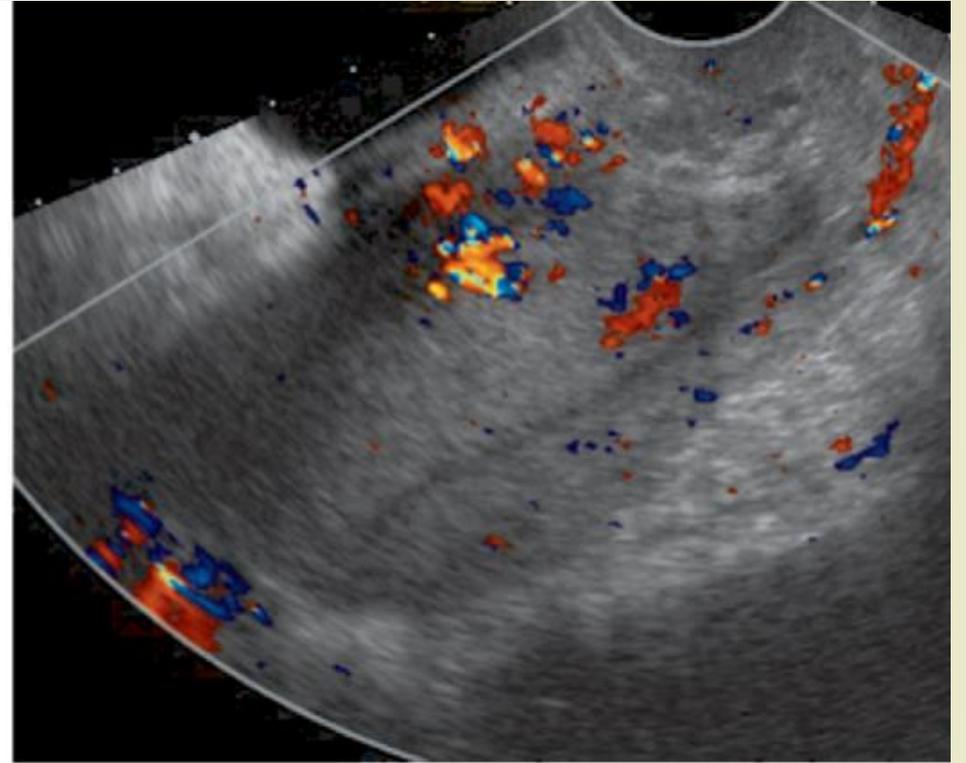
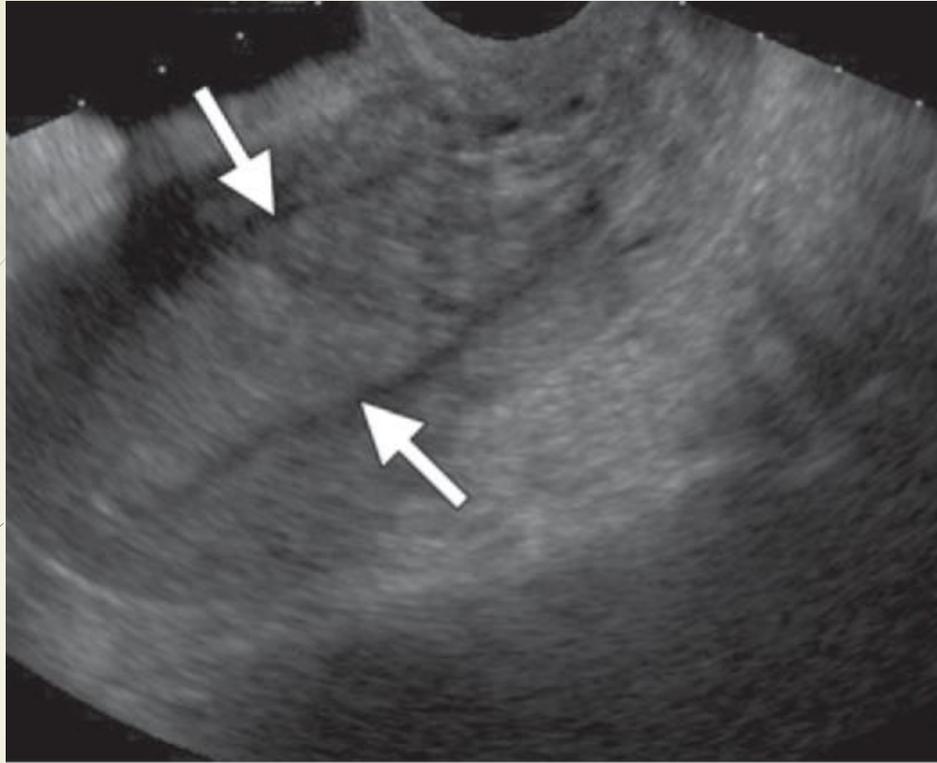
b.

Pathologically proved RPOC with type 0 vascularity in a 42-year-old woman with persistent bleeding 2 weeks after a miscarriage (22 weeks gestation). (a) Longitudinal endovaginal US image shows persistent thickening (28 mm) of the EEC (arrows) and distention of the endometrial canal by heterogeneous echogenic material. (b) Longitudinal color Doppler US image shows avascularity of the endometrium.

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- 
- ▶ type 1 or minimal vascularity (less than that of the myometrium), which has a PPV greater than 90%.
 - ▶ type 2 or moderate vascularity (nearly equal flow in the endometrium and myometrium), which has been shown to have a PPV of 100%.



Pathologically proved RPOC with type 1 vascularity in a 40-year-old woman with passing blood clots and an open cervical os. (a) Longitudinal transabdominal US image shows a thickened (39-mm) EEC (arrows). (b) Longitudinal color Doppler US image shows a small focus of color flow within the EEC



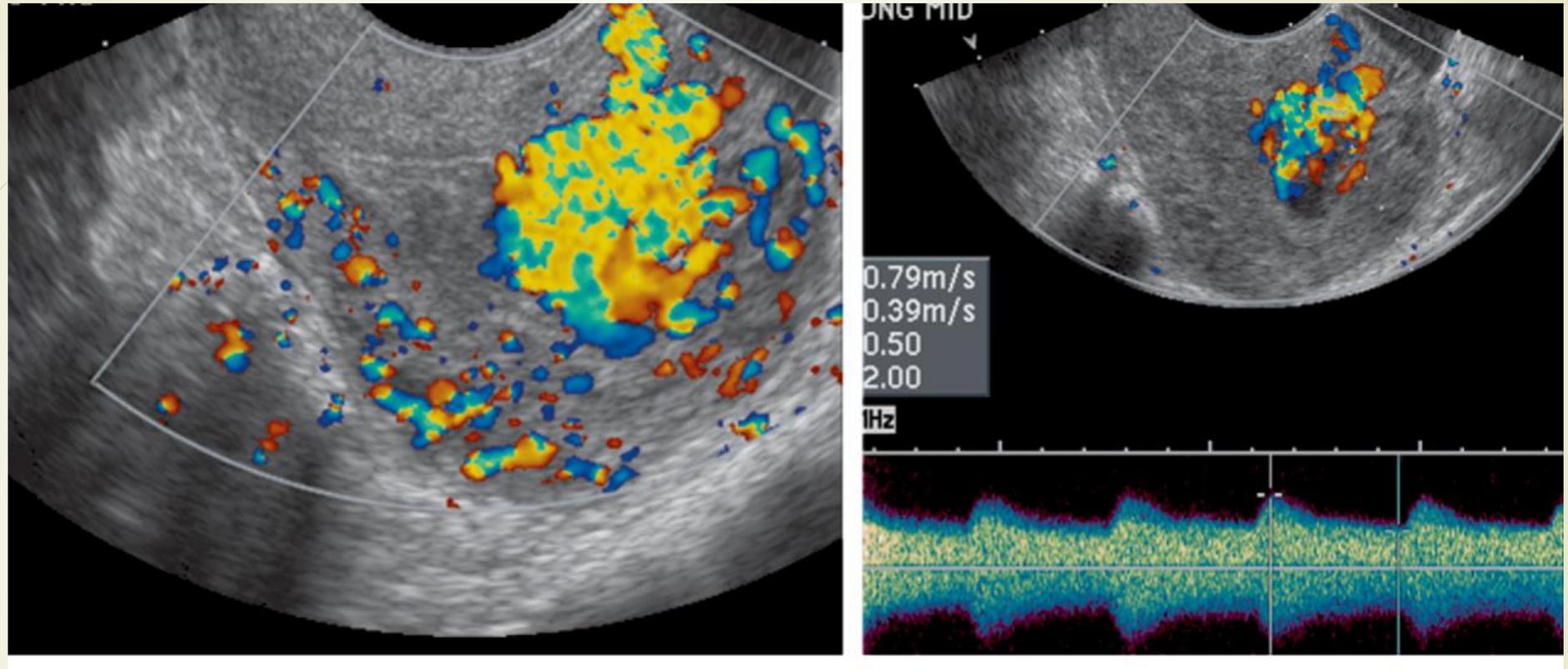
b.

Pathologically proved RPOC with type 2 vascularity in a 29-year-old woman (G2, P2) who had undergone a cesarean section 6 weeks earlier. (a) Longitudinal endovaginal gray-scale US image shows a large amount of echogenic material and a thickened EEC (arrows). (b) Longitudinal color Doppler US image obtained in the same area shows endometrial material with moderate vascularity similar to that of the adjacent myometrium.



type 3 vascularity

- ▶ or marked endometrial vascularity (greater than that of normal myometrium in the same image section), which also has a PPV of 100%. Of note, type 3 vascularity can be so robust that it mimics an AVM at color Doppler US.
- ▶ The arterial flow velocity of type 3 RPOC can be 100 cm/sec or higher, with a very low-resistance spectral waveform and large vessels occasionally being evident . **Vascularity should always be seen extending from the myometrium into the endometrium. If vascularity is isolated to the myometrium, other diagnoses besides RPOC should be considered .**



RPOC with type 3 vascularity in a 22-year-old woman with a 1-week history of vaginal bleeding who had had a miscarriage 2 months earlier. (a) Longitudinal endovaginal color Doppler US image shows a thickened EEC with marked vascularity involving both the endometrium and the myometrium. (b) Color Doppler US image with spectral waveform shows marked vascularity, with velocities of up to 79 cm/sec. This marked vascularity should not be mistakenly attributed to an arteriovenous malformation (AVM) given the clear extension of vascularity to the endometrium; the presence of marked vascularity should, however, be conveyed to the obstetrician



Pitfalls of RPOC



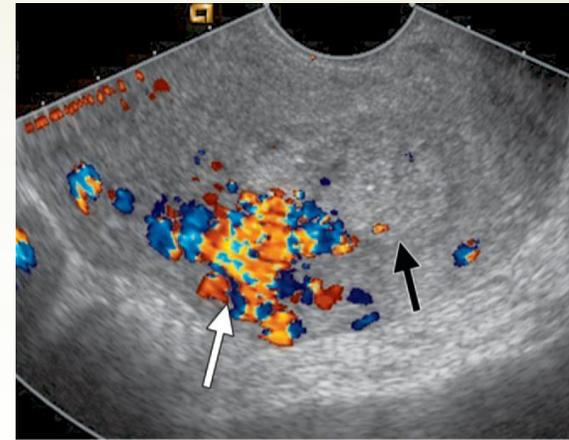


uterine AVMs

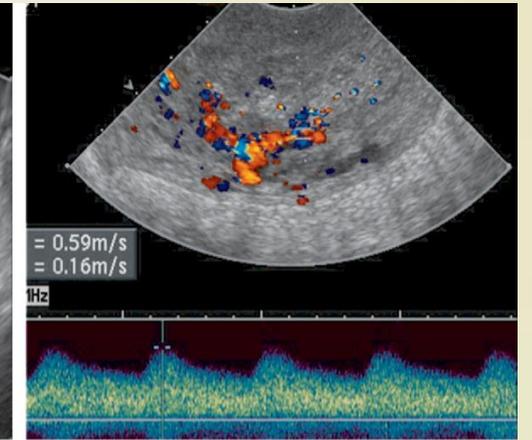
- ▶ Given the marked vascularity of type 3 Both AVMs and RPOC are persistent postpartum findings; however, RPOC can be distinguished from AVMs on the basis of the vascular endometrial component seen in RPOC, whereas **uterine AVMs primarily involve only the myometrium.**
- 

Presumed AVM in a 30-year-old woman who had undergone dilation and curettage 1 month earlier for RPOC after an uncomplicated normal spontaneous vaginal delivery with a sudden large volume of vaginal bleeding.

- (a) Longitudinal color Doppler US image shows marked vascularity isolated to the myometrium (white arrow) and clot in the endometrial cavity (black arrow).
- (b) Color Doppler US image with spectral waveform shows high-velocity, low-resistance flow.
- (b) Digital subtraction angiogram shows an early draining vein (arrow). The patient underwent embolization, with resolution of bleeding.



a.



b.

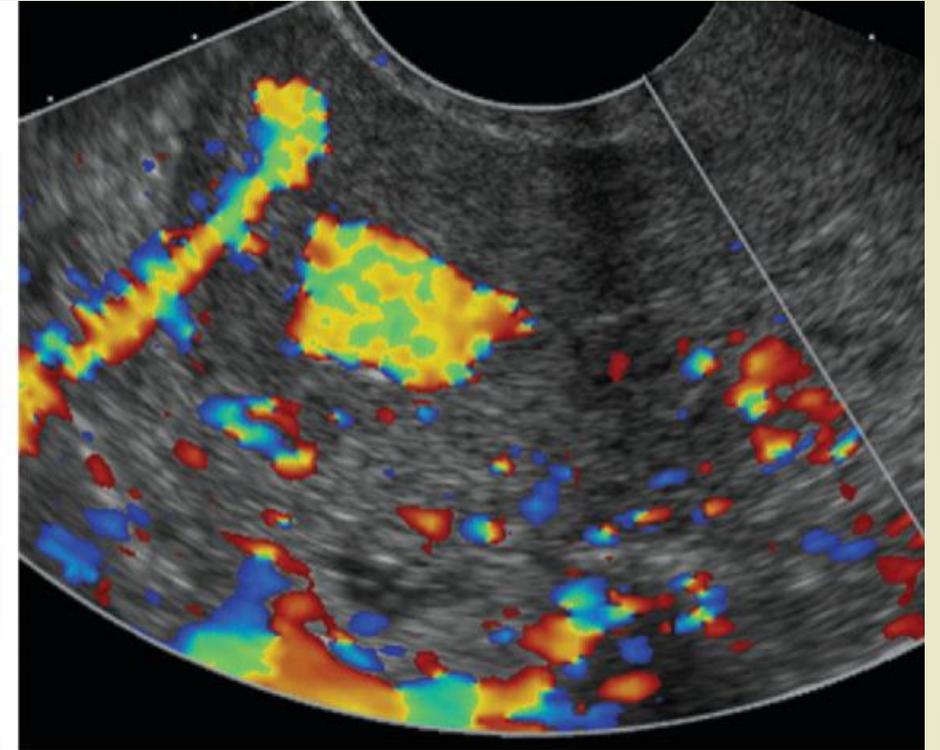
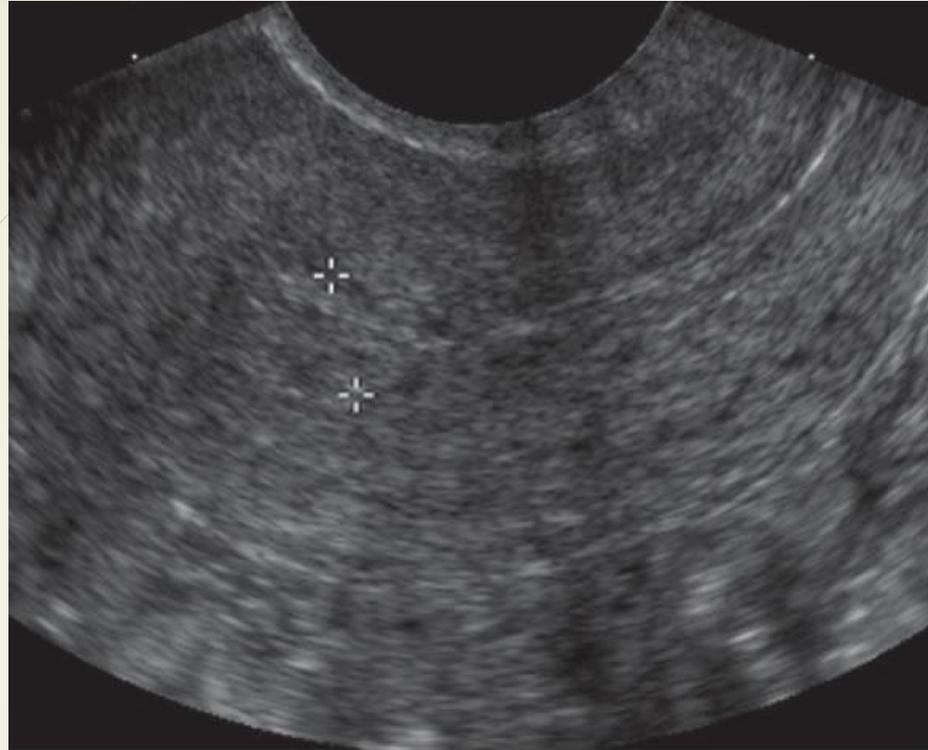


c.



endometrial polyp or submucosal fibroid

- ▶ Another potential mimic of RPOC is an underlying endometrial abnormality, such as an endometrial polyp or submucosal fibroid.
- 



b.

Pathologically proved vascular endometrial polyp in a 23-year-old woman with vaginal bleeding who had undergone medical termination of pregnancy 2 months earlier. (a) Longitudinal gray-scale US image shows an isoechoic mass with small cystic spaces (calipers) within the endometrium. (b) Longitudinal color Doppler US image shows marked vascularity within the mass. Pathologic analysis showed only fragments of weakly proliferative and decidualized endometrium, with no RPOC

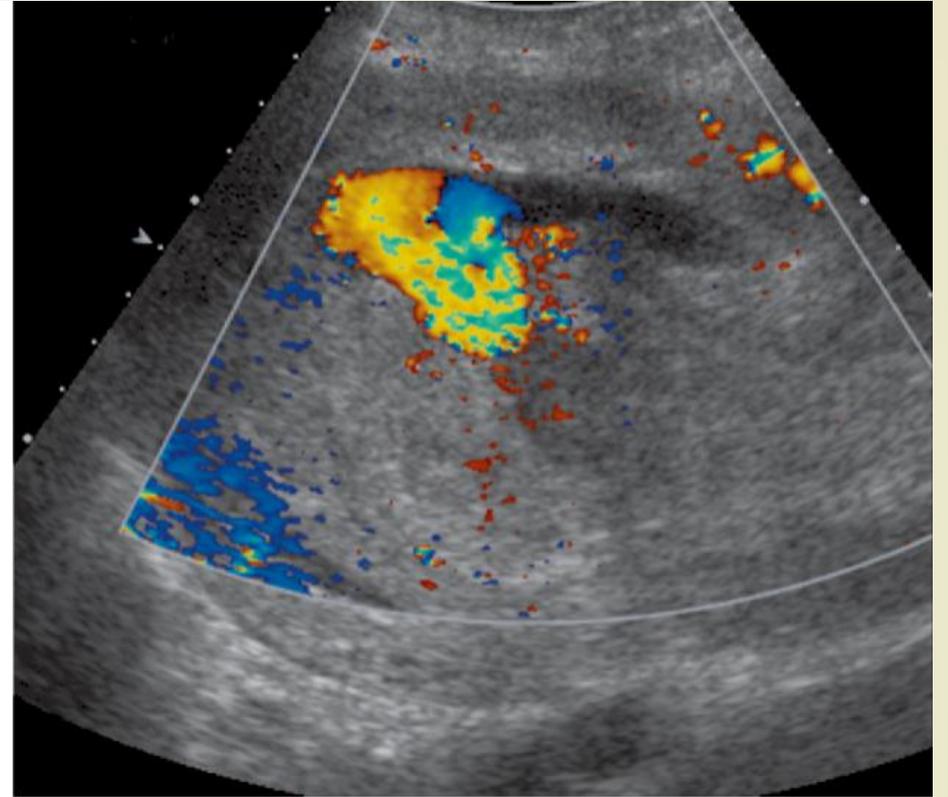
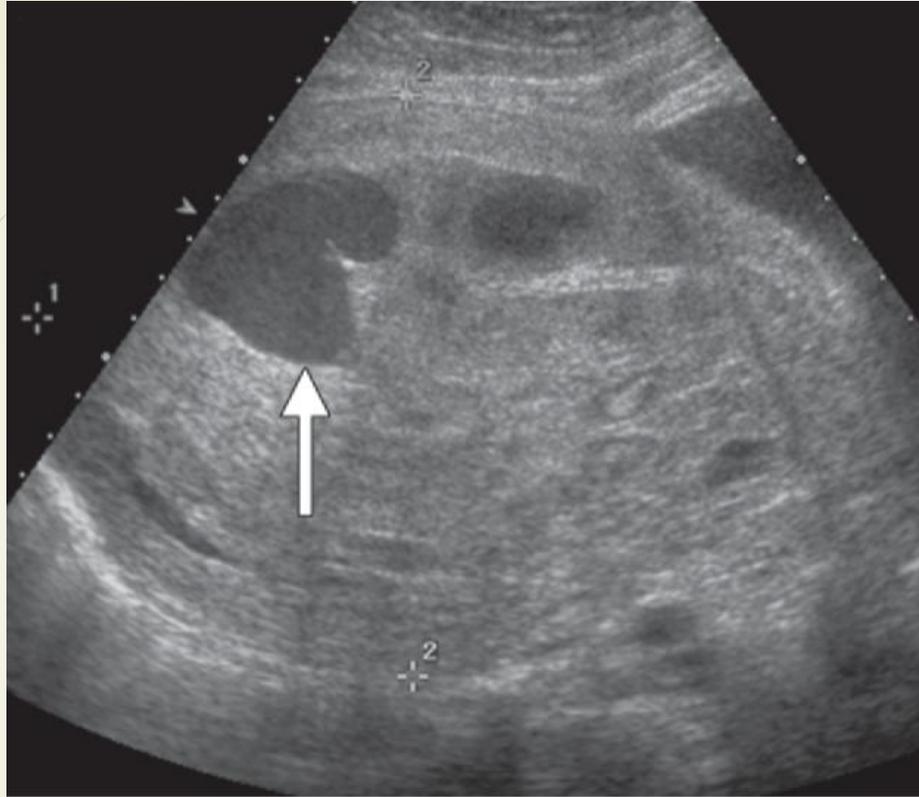


Sub involution of the placental implantation site

- ▶ Sub involution of the placental implantation site is an exceptionally rare postpartum condition in which the uterine vessels fail to involute following delivery .

The postpartum uterus may appear unusually large, with dilated myometrial vessels .

Although its exact cause is unknown, subinvolution of the placental implantation site is thought to be related to an abnormal immunologic recognition process similar to preeclampsia. Risk factors for subinvolution include atony, multiparity, cesarean section, uterine prolapse, uterine fibroids, endometritis, coagulopathies, and RPOC.



Pathologically proved subinvolution of the placental implantation site in a 36-year-old woman who had undergone a cesarean section for twins 1½ weeks earlier. (a) Longitudinal transabdominal US image shows an enlarged uterus with large, tubular hypoechoic areas (arrow) in the myometrium. (b) Longitudinal color Doppler US image demonstrates tubular hypoechoic areas representing large vessels within the myometrium. Pathologic analysis demonstrated ectasia of the uterine veins with subinvolution of the uteroplacental arteries and no evidence of RPOC.

از توجه شما سپاسگزارم

