

1st Trimester OB Ultrasound

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Indications/Goals:

- Primary objective is to identify an intrauterine pregnancy
- Secondary objectives are to detect extrauterine signs of an ectopic pregnancy, estimate the viability of an intrauterine pregnancy, and characterize other causes of pelvic pain and vaginal bleeding

Background:

- Modern qualitative urine tests for beta-human chorionic gonadotropin (B-hCG) have a threshold of about 20; they allow detection of pregnancy as early as 1 week post-conception
- The convention when referring to the age of a pregnancy is gestational age, which is the date from conception plus 2 weeks
- The hormone B-hCG is produced by the trophoblasts early in pregnancy
- Progesterone is produced by the corpus luteum in early pregnancy and serum levels remain relatively high during a normal pregnancy (serum levels generally lower in abnormal pregnancies)
- While spontaneous abortion rates in younger women (<36yo) after a heartbeat is identified by transvaginal or transabdominal ultrasound is quite low (in the 5% range), rates of loss after documented fetal heart tones have been reported as high as 30% in patients >40yo with “threatened AB”
- Importantly, a normal embryonic heart rate may be as low as 70-100 bpm during early gestation; 120-160 bpm by 9-10wks gestational age
- Embryos longer than 5mm with HR below 100 bpm have a survival rate of only 6%; <5mm may have slower HRs but less than 80 bpm is nearly always associated with embryonic demise
- At 10wks the embryo is now termed a fetus, since organogenesis is complete

Threatened, Complete, Incomplete, Inevitable, and Missed Miscarriages:

- About 70% of patients with abdominal pain or vaginal bleeding in the first trimester will have an IUP
- “**Threatened AB**” occurs in about 25% of early pregnancies; about 40-50% of these will eventually have pregnancy loss
- A “**completed**” spontaneous abortion can be diagnosed when all POC (products of conception) have been expelled; this may occur immediately or be delayed for days to weeks

- The term “**incomplete abortion**” is used when a pregnancy has failed but all of the POC have not been expelled from the uterus
- This includes embryonic demise, blighted ovum, and retained POC
- These patients may require D&C to removed POC
- “**Inevitable abortion**”: expulsion in progress; the cervical os is open
- About 25% of twin pregnancies diagnosed during the first trimester will become singleton pregnancies by the second trimester

Ectopic Pregnancy:

- **2%** of pregnancies
- In symptomatic patients presenting to the ED, incidence is much higher: **7-13%**
- Incidence has quadrupled over the last 20 years
- The current incidence of heterotopic pregnancy is probably greater than 1 per 8,000 pregnancies (incidence in IVF patients 1 per 100 pregnancies)
- **The history in early ectopic pregnancy is neither sensitive nor specific**
- RF for ectopic: PID, IUD, tubal ligation, increased maternal age, prior ectopic, and h/o infertility
- Most commonly occurs within the fallopian tubes; may also occur in interstitial locations (at the edge of the uterus adjacent to the tubes), cornual (in one horn of a bicornuate uterus), cervical, ovarian, and abdominal implantations
- Interstitial pregnancies may progress to 10-12wks gestation before rupture
- Fluid in the peritoneal cavity can be seen in the normal IUP, IUP with a ruptured corpus luteum cyst (CLC), or with a leaking or ruptured ectopic (echogenic material is particularly concerning for ectopic pregnancy)
- Free fluid in the posterior pelvic cul-de-sac is highly suggestive of ectopic pregnancy; only about 1/3 of ectopic pregnancies have no FF in the cul-de-sac
- Although a large amount of fluid predicts ectopic pregnancy, it is not a reliable indicator of tubal rupture
- Differential diagnosis of a complex adnexal mass: tubal hematoma, ectopic trophoblastic tissue, or distorted contents of an ectopic gestational sac
- A complex mass contains a mixture of cystic and solid components
- In normal pregnancies, the B-hCG rises by at least 50% every 2 days for the first 6-8 weeks of gestation; peaks ~ 100,000 in a normal pregnancy
- In ectopic pregnancy and embryonic demise, the expected increase in B-hCG is often less than expected, although in about 25% of ectopic pregnancies, the B-hCG rises normally for a time
- Low level beta does not predict a benign course (30-40% of ectopics with level <1000 will be ruptured at the time of diagnosis)
- 40% of ectopics present with a B-hCG less than 1000, 20% with level less than 500
- ***In other words, the B-hCG should not be used to determine whether an ultrasound is or is not done***

- Single-dose of IM methotrexate has success rate ~ 90%
- Failures with methotrexate: higher B-hCG levels, adnexal mass greater than 4cm, presence of embryonic cardiac activity, large amount of FF, and severe pain
- Patients with B-hCG level >1,000 and unclear or questionable sonographic findings should ideally be observed in the hospital

Molar Pregnancy:

- Chorionic villi proliferate in a disordered fashion, usually without the development of a fetus
- Clinical presentation is vaginal bleeding with a markedly elevated B-hCG
- Neoplastic gestational disease develops in about 15% of molar pregnancies after dilatation and curettage

Cysts in Pregnancy:

- Simple cysts appear as thin-walled, anechoic spheres; no loculations
- In **non**-pregnant patients, a cyst is physiologic until it reaches a diameter > 2.5cm
- Follicular cysts can range from 2.5cm to 14cm
- Masses less than 5cm can usually be managed conservatively
- Most common of these in the pregnancy patient are corpus luteum cysts (usually 1-10cm)
- Corpus luteum cysts result from reabsorption of the blood in the corpus hemorrhagicum
- In pregnancy, CLC can persist up to 16wks and reach a diameter of up to 13cm
- Cysts generally regress spontaneously prior to 18 weeks of gestation
- Cysts containing heterogeneic debris (internal echoes) are mainly hemorrhagic
- A theca lutein cyst is an exaggerated CLC that occurs in patients with very high B-hCG levels (hyperstimulation patients and Gestational Trophoblastic Disease patients)

Fibroids in Pregnancy:

- Uterine leiomyomas may enlarge during pregnancy due to increased estrogen levels
- Patients with multiple fibroids have a higher risk of bleeding, premature labor, malpresentation, and retained products

Other findings in Pregnancy:

- **Subchorionic hemorrhage**
 - Bleeding between the endometrium and chorionic membrane; it is a common finding late in the first trimester and is also known as “implantation hemorrhage”
 - Part of the chorionic membrane and placenta are separated from the decidua vera (the endometrium)
 - Those with large subchorionic hemorrhages may have a much higher rate of pregnancy loss
- **Dermoid cysts**
 - Most common complex mass seen in early pregnancy is a teratoma, or dermoid cyst (germ cells with the ovary and contain heterologous tissue like fat, skin, hair, and teeth)
- **Ovarian torsion**

- About 20% of cases of adnexal torsion occur during pregnancy; torsion rarely occurs in a normal size ovary
- Most patients with torsion have FF in the pelvic cul-de-sac, probably as a result of obstruction of venous and lymphatic drainage

Sono Anatomy and Pathology:

Basic Anatomy:

- The uterus is a thick-walled muscular structure that is about 6-7cm long and 3-4cm in transverse and AP diameters; shaped like an inverted pear
- When the uterus is in the normal anteflexed position, the longitudinal axes of the uterus and vagina create an angle of about 90 degrees
- Retroversion of the uterus occurs in about 10% of women; retroversion means that the body of the uterus bends posterior toward the rectosigmoid colon instead of toward the anterior abdominal wall
- The fallopian tubes enter the body of the uterus laterally, in an area called the cornua
- The fallopian tubes are not normally seen on pelvic ultrasound
- The posterior cul-de-sac, or “pouch of Douglas”, usually contains bowel loops, is the most dependent intraperitoneal organ
- Normal ovaries are about 2cm wide and 3cm long

1st Trimester Pregnancy Anatomy:

- Double decidual sac sign: 5-6wks gestational age; 2 rings: decidua capsularis (the inner ring, same as the chorionic ring) and the decidua vera (the outer ring), separated by a thin hypoechoic layer (which is the endometrial canal), all of which surround the gestation sac
- At 5-6 weeks EGA, a yolk sac becomes visible; it then shrinks and disappears by about 12 weeks
- Around 5-6 weeks, an embryo (“fetal pole”) also appears by transvaginal ultrasound at the border of the yolk sac; the normal embryo will grow rapidly, around 1mm per day
- Cardiac activity should be seen by the time the embryo is 5mm in length
- Pregnancy dating using mean sac diameter (MSD; average of X/Y/Z measurements) is only useful at 5-6 weeks
- Once the fetus has reached 13wks gestational age, BPD (biparietal diameter), HC (head circumference), AC (abdominal circumference), and FL (femur length) are used
- Gestational age determination by CRL is accurate to within 5-7 days
- BPD very accurate, especially before 20 weeks

Sono Findings:

Threatened, Complete, Incomplete, Inevitable, and Missed Miscarriages by Ultrasound:

- **Threatened:** IUP with closed os and vaginal bleeding
- **Complete:** Closed os with no POC per TVUS

- **Incomplete:** Echogenic debris in uterus; either embryonic demise, blighted ovum, or retained POC (patients with intrauterine echogenic material or a thickened midline strip (10mm wide or larger) after a SAB probably have retained products of conception)
- **Missed (IUFD):** IUP with CRL>5mm but no cardiac activity

Ectopic Pregnancy:

- After detecting fetal heart tones, to verify IUP must identify myometrium with a minimum 5mm rim surrounding the gestation
- Transvaginal sonography can establish a diagnosis of IUP or ectopic in 75% of patients at the time of their presentation
- When no IUP or ectopic is identified, then the exam is “indeterminate” and a formal U/S and Beta-hCG are obtained; diagnosis is either early pregnancy, ectopic, or miscarriage
- The discriminatory zone is the B-hCG level above which an IUP can be consistently visualized by pelvic sonography; however, this only refers to a double decidual sign, which, from our standpoint, is *not* a definitive sign of pregnancy
- Patients with a completely empty uterus and normal thin midline stripe had a 27% chance of an ectopic pregnancy and a 10% chance of an IUP; patients with intrauterine echogenic material had a 5% chance of ectopic pregnancy and none had an IUP
- When evaluating for ectopic, identify the ovaries and look at the adnexa for any mass concerning for extra-uterine gestational sac; free fluid should also be noted
- A live extrauterine embryo with cardiac activity can be seen with transvaginal sonography in about 15-20% of ectopic pregnancies
- The definition of “small amount” is fluid that is confined to the cul-de-sac and covering less than one-third of the inferior posterior uterus
- A tubal ring is nearly diagnostic of an ectopic; it is a concentric hypoechoic structure found in the adnexa (created by the trophoblast of the ectopic surrounding the chorionic sac and is equivalent to the gestational sac)—relatively thick and brightly echogenic wall
- A tubal ring produces a “ring of fire” on Doppler

Embryonic demise:

- Earliest finding is a gestational sac without a YS or embryo
- A YS usually seen when MSD is 8-10mm or greater
- A fetal pole should be seen when MSD is 16mm or greater (some use 20mm)
- Cardiac activity should be observed when fetal pole is measured at 5mm by transvaginal and 10mm by transabdominal ultrasound
- Abnormal YS: very small (<2mm between 8-12wks) or very large >6mm (between 5-12 weeks) is predictive of embryonic demise; shape of YS has no association
- Odd-shaped or grossly distorted *gestational sac* is reportedly a good indicator of pregnancy failure

Subchorionic hemorrhage:

- Acutely, may appear hyperechoic or isoechoic relative to the placenta
- Over time, becomes hypoechoic
- Appears as hypoechoic stripe around the chorionic membrane/placenta

Molar Pregnancy:

- Classic finding is the “grape-like” appearance
- Intrauterine echogenic mass containing diffuse small hypoechoic vesicles
- May be confused with an incomplete abortion

Cysts in Pregnancy:

- Simple cysts appear as thin-walled, anechoic spheres; no loculations
- A corpus luteum cyst is usually less than 5cm in diameter and appears as a thin-walled unilocular structure surrounded by normal ovarian parenchyma
- Hemorrhage into a CLC can cause the appearance of internal echogenic debris and septae

Fibroids in Pregnancy:

- Cause the uterus to sonographically appear heterogeneous and globular
- Discrete masses may be seen that distort normal uterine architecture
- Fibrotic changes and calcifications result in reflection of sound waves....and shadowing distal to the fibroid
- May limit transvaginal approach; transabdominal may be only means of evaluating the uterus

Sono Technique:

- Transabdominal view best with a full bladder, 3-5MHz transducer
- Transvaginal (endovaginal) view, typically using a 5-7.5 MHz transducer, is best with an empty bladder; a full bladder will straighten the angle between the uterus and the vagina, moving the body of the uterus away from the probe
- Some common dating techniques include mean sac diameter (MSD), crown-rump length (CRL), biparietal diameter (BPD), and femur length (FL):

- **MSD:**

- The average of three orthogonal measurements of the gestational sac: (length + width + depth)/3; this is only useful at 5-6 weeks, when there is a gestational sac but no embryo yet seen

- **CRL:**

- At ~ 5-6 weeks, an embryo becomes visible, and CRL should be used
- Measure the maximal embryo length, **excluding** the yolk sac
- CRL is accurate to within 5-7%

- **BPD:**

- Used at the end of the 1st trimester and during the second trimester

- It is the transverse measurement of the diameter of the skull at the level of the thalamus
- For measuring BPD, the calipers should be positioned from the leading edge of the skull (outer table) on the near side to the leading edge of the skull (inner table) on the far side
- Very accurate, especially prior to 20 weeks

Ovaries:

- Ovaries usually found just lateral and posterior to the body of the uterus, between the uterus and the lateral pelvic wall
- In their normal location, the ovaries are bound posteriorly by the internal iliac artery and superiorly by the external iliac vein
- Other texts describe the ovaries as lying anterior to the internal iliac veins and medial to the external iliac veins

Look For:

Sono Documentation:

- ***3 transverse views of the uterus: HI, MID, LO***
- ***1 longitudinal view of the uterus***
- ***1-2 videos scanning through all planes in a transverse and longitudinal orientation***
- ***2 orthogonal views of each ovary***
- ***Fetal heart rate in M-mode***
- ***Estimated gestation age (crown-rump length or biparietal diameter)***
- ***Identify any pathology: free fluid, ovarian cysts, fibroids, subchorionic hemorrhage, etc.***

Pitfalls:

- Scanning an empty bladder transabdominally or a full bladder transvaginally
- Failing to “talk” your patient through the TVUS exam, or handling the probe roughly
- Attributing an empty uterus to a very early IUP or a completed spontaneous AB
- Mistaking a pseudogestational sac for a gestational sac (occurs in up to 5-10% of ectopic pregnancies)
- Misidentifying an early IUP
- Failure to identify heterotopic pregnancy
- Missing ovaries due to failure to adjust depth, maintaining transverse plane

Pearls:

- To identify ovaries, look for your internal and external iliac veins (remember that they lie lateral/posterior to the uterine body, are bound posteriorly by the internal iliac artery and superiorly by the external iliac vein)
- Increase your depth when evaluating the ovaries
- If no gestational sac is seen on TAUS, there is a low likelihood you'll find any definitive sign of pregnancy on TVUS (proceed directly to formal radiology scan)