Brigham and Women's Hospital

Harvard Medical School

Brant and Helms Club Ultrasound

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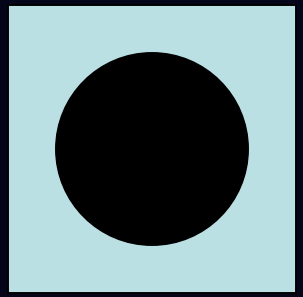
Objectives

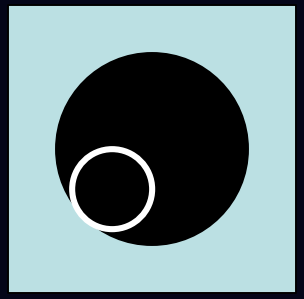
- Practical tips for the rotation
- Basic physics of ultrasound
- How to optimize ultrasound images
- Learn some normal anatomy on ultrasound and practice taking cases

Gestational Age

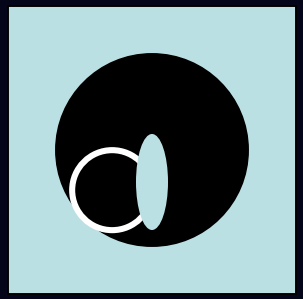
- 5.0 weeks
  - GS



- 5.5 weeks
  - GS + YS



- 6.0 weeks
  - GS + YS + embryo



Gestational Age

Table 2. Guidelines for Transvaginal Ultrasonographic Diagnosis of Pregnancy Failure in a Woman with an Intrauterine Pregnancy of Uncertain Viability.*

Findings Diagnostic of Pregnancy Failure	Findings Suspicious for, but Not Diagnostic of, Pregnancy Failure†
Crown–rump length of ≥7 mm and no heartbeat	Crown–rump length of <7 mm and no heartbeat
Mean sac diameter of ≥25 mm and no embryo	Mean sac diameter of 16–24 mm and no embryo
Absence of embryo with heartbeat ≥2 wk after a scan that showed a gestational sac without a yolk sac	Absence of embryo with heartbeat 7–13 days after a scan that showed a gestational sac without a yolk sac
Absence of embryo with heartbeat ≥11 days after a scan that showed a gestational sac with a yolk sac	Absence of embryo with heartbeat 7–10 days after a scan that showed a gestational sac with a yolk sac
	Absence of embryo ≥6 wk after last menstrual period
	Empty amnion (amnion seen adjacent to yolk sac, with no visible embryo)
	Enlarged yolk sac (>7 mm)
	Small gestational sac in relation to the size of the embryo (<5 mm difference between mean sac diameter and crown–rump length)

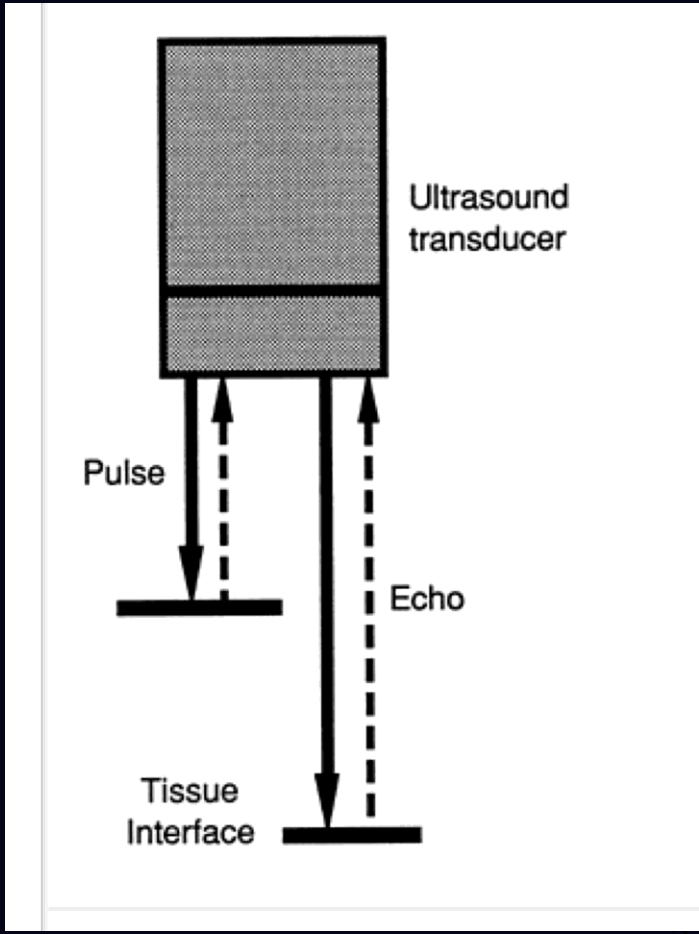
MEMORIZE THIS

Diagnostic Criteria for Nonviable Pregnancy Early in the First Trimester

Peter M. Doubilet, M.D., Ph.D., Carol B. Benson, M.D., Tom Bourne, M.B., B.S., Ph.D., and Michael Blaivas, M.D., for the Society of Radiologists in Ultrasound Multispecialty Panel on Early First Trimester Diagnosis of Miscarriage and Exclusion of a Viable Intrauterine Pregnancy*

Practical Ultrasound Physics

- Advantages: No ionizing radiation, real time, multiplanar capability, portable
- Use of sound wave at 1-20 MHz
- Pulse-echo technique
  - Determine the depth of each echo by measuring round trip time of flight



Practical Ultrasound Physics: Transducers

- Transducers
  - Higher frequency transducers (6-15 MHz) yield the greatest spatial resolution but limited penetration

    -Thyroid, breast, testes, infants, palpable lesions

  - Lower frequency transducers (1-5 MHz) yield better penetration but poorer resolution

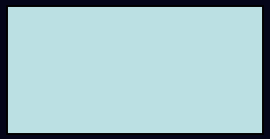
    -Abdominal, pelvic, obstetric

- Water-soluble gel

  -Ensure good contact and transmission

Practical Ultrasound Physics: Transducers

Linear-array

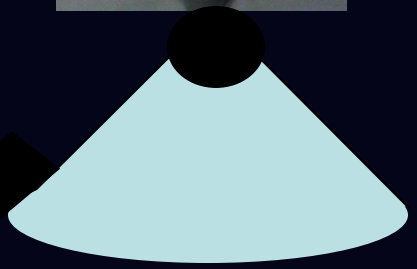


Thyroid

Curved-array

Abdomen

Endoluminal



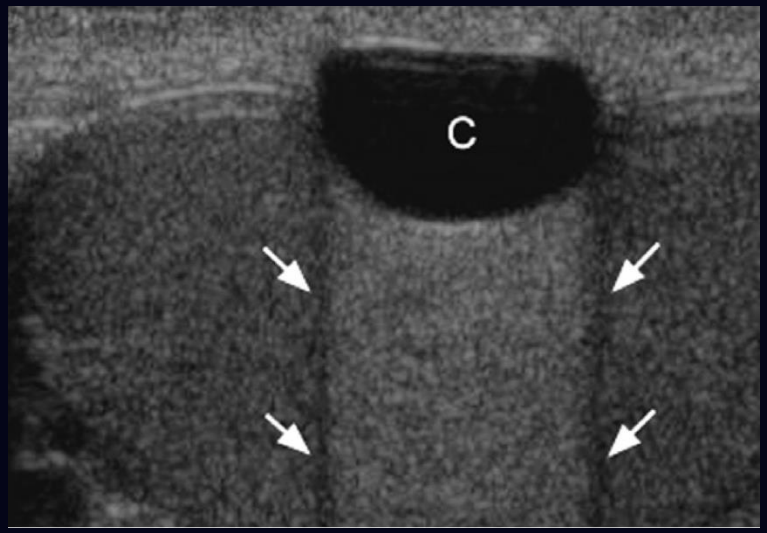
Trans-Vaginal

Sector

Between Ribs

Practical Ultrasound Physics: Artifacts

- Acoustic Enhancement
  - Fluid containing structures attenuate the sound much less than solid structures so that the strength of the sound pulse is greater after passing through fluid

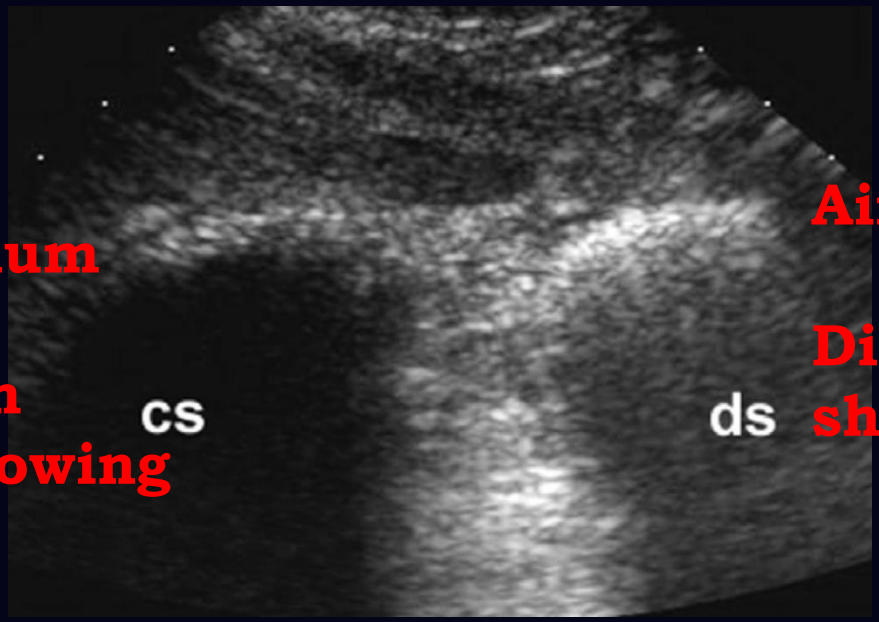


Testicular cyst

Cervical lymph node

Practical Ultrasound Physics: Artifacts

- Acoustic Shadowing
  - Energy of transmitted sound is decreased by reflection and/or absorption
  - At soft tissue/calcification interface -> absorption
  - At soft tissue/gas interface -> reflection

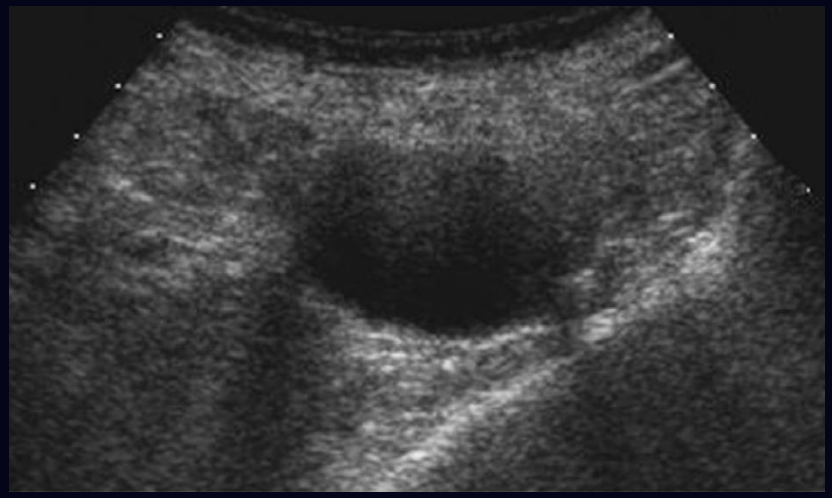


Left: Clean shadow due to gallbladder filled stones

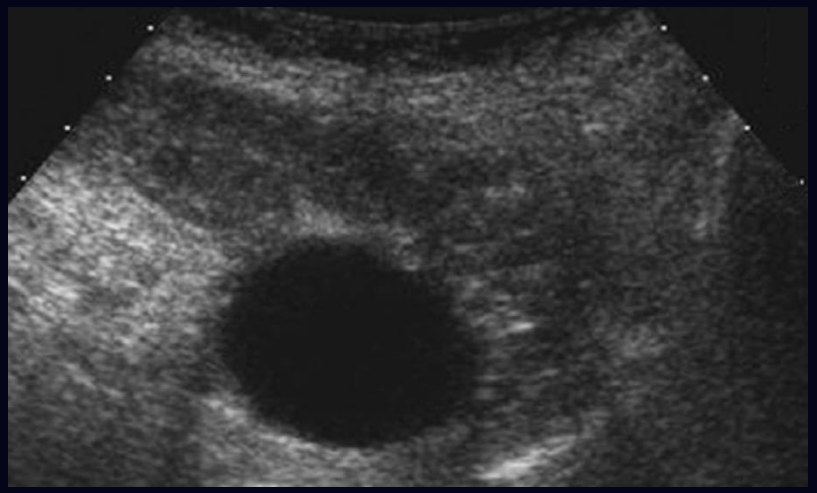
Right: Dirty shadow due to a gas-filled loop of bowel

Practical Ultrasound Physics: Artifacts

- Reverberation/Near field artifact
  - Sound reflects off interfaces in the near fields then reflects off the transducer itself and back into the body then interacts with the same interfaces multiple times



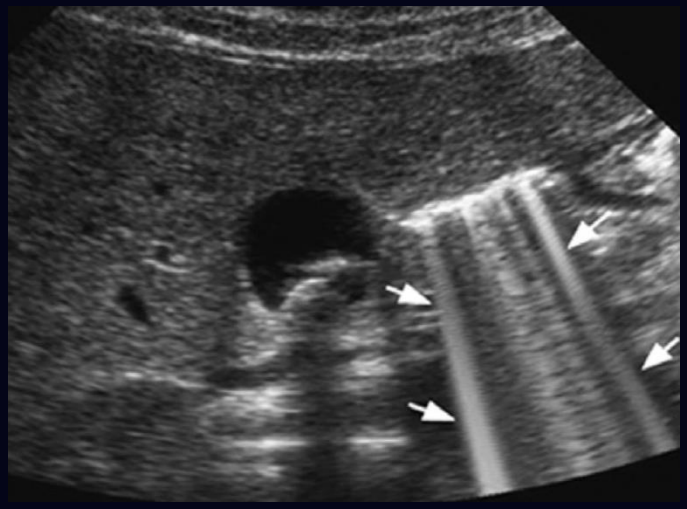
Near field reverberations in the superficial aspect of the ovarian cyst



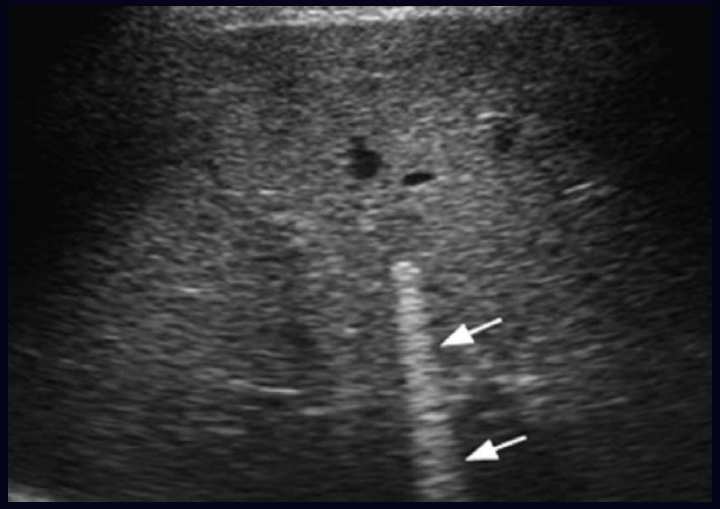
Near field reverberations resolved by repositioning the transducer so that the cyst is deeper

Practical Ultrasound Physics: Artifacts

- Ring-down Artifact
  - Occurs due to gas (less commonly metal)
  - Sound pulse excites the fluid trapped between gas bubbles and causes the fluid to resonate

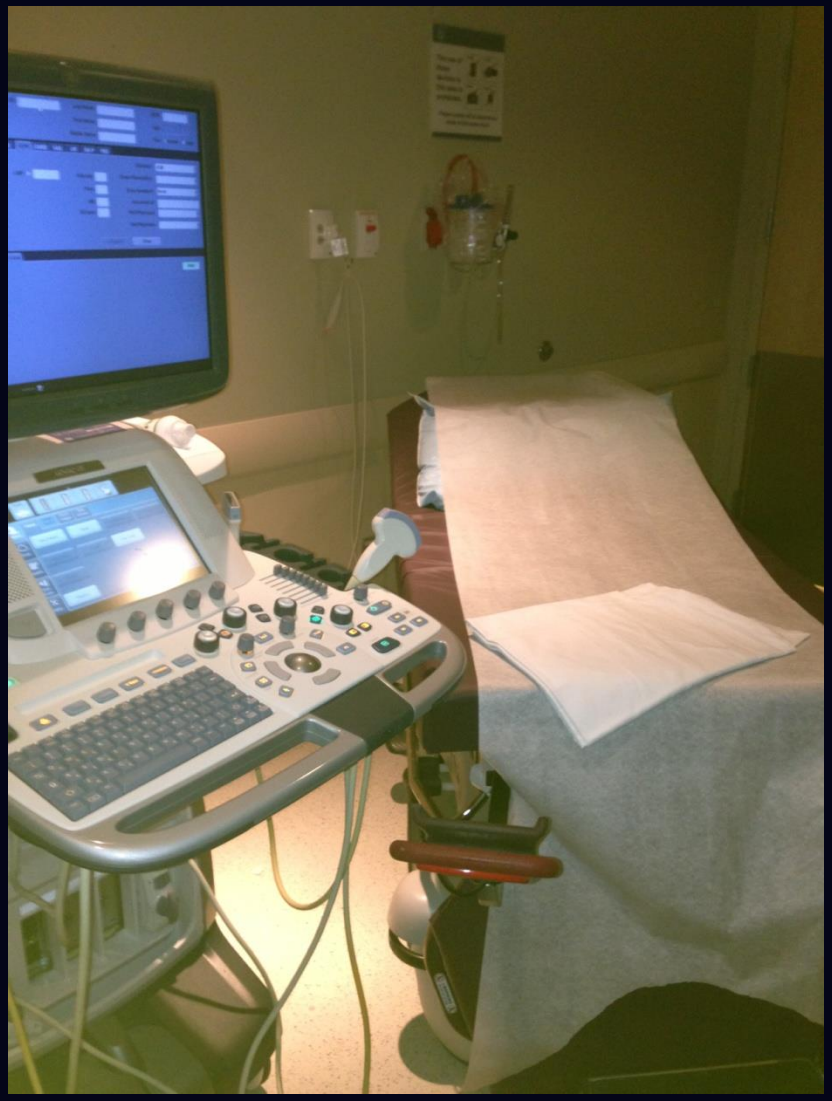


Ring-down artifact from a gas-filled loop of bowel



Ring-down artifact from a shotgut pellet embedded within the liver

Image Optimization: The US Machine



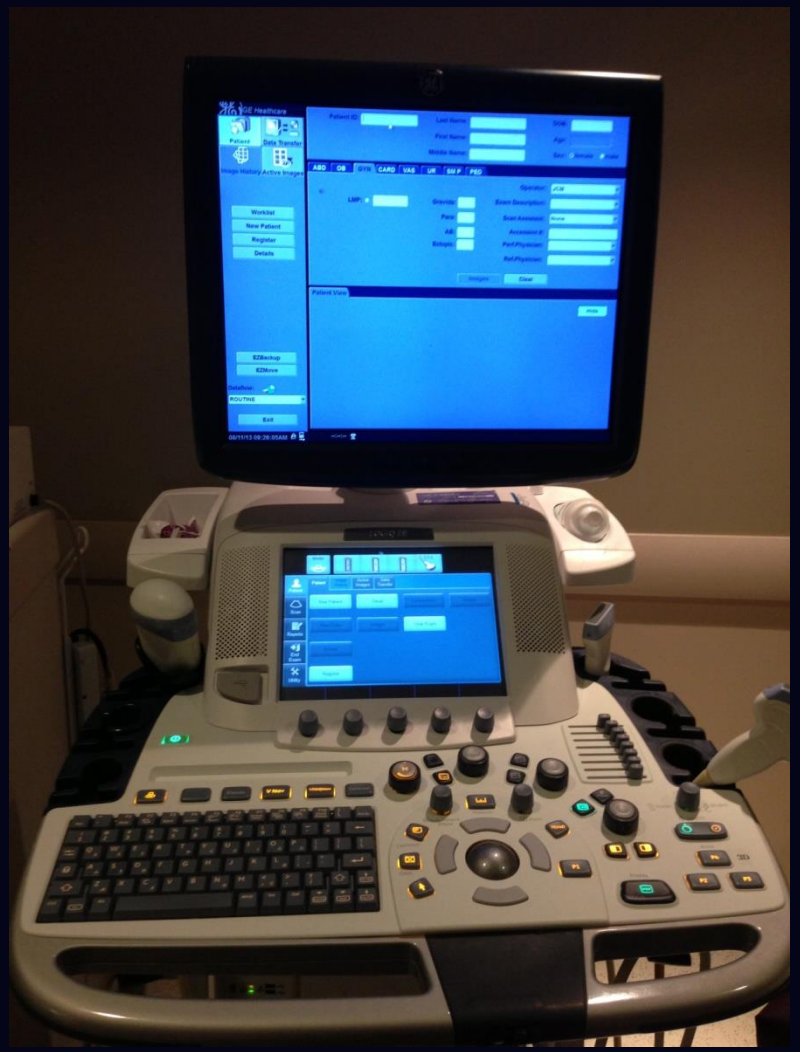


Image Optimization: The US Machine

Image Optimization: The US Machine

Image Optimization

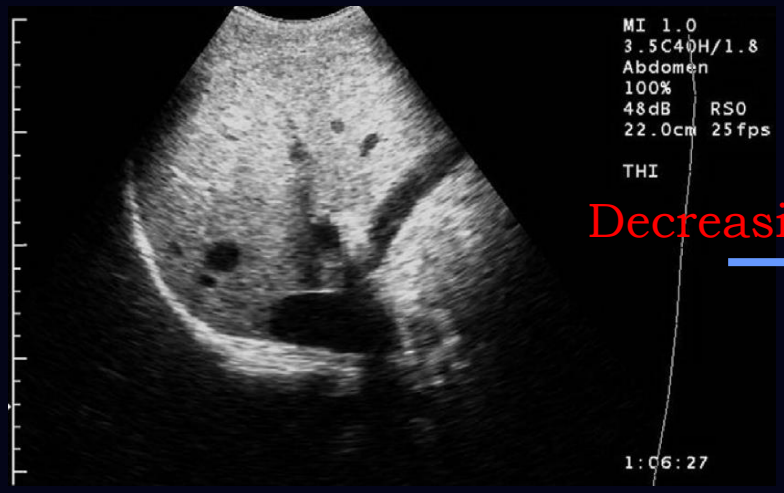
- Transmit frequency (probe selection)
  - Increases frequency increases resolution
  - Decreases frequency allows better penetration
- Focal zone
  - The depth at which beam focusing is maximal
  - Increases lateral resolution
- Field of view
  - Varies image size (depth and width)
  - Decrease depth and width to increase frame rate

Image Optimization

- Time gain compensation (TGC)
  - Compensates for attenuated signals from deeper tissues by variable amplification
- Overall gain
  - Varies amplification of returning signals
  - Changes overall image brightness

TIP: Don't make it too bright

Image Optimization



Decreasing the FOV

Adjust TGC

Adjust focal zone

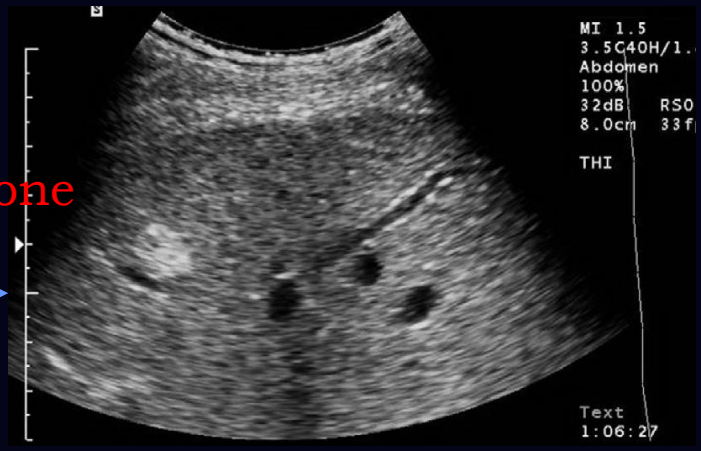


Image Optimization

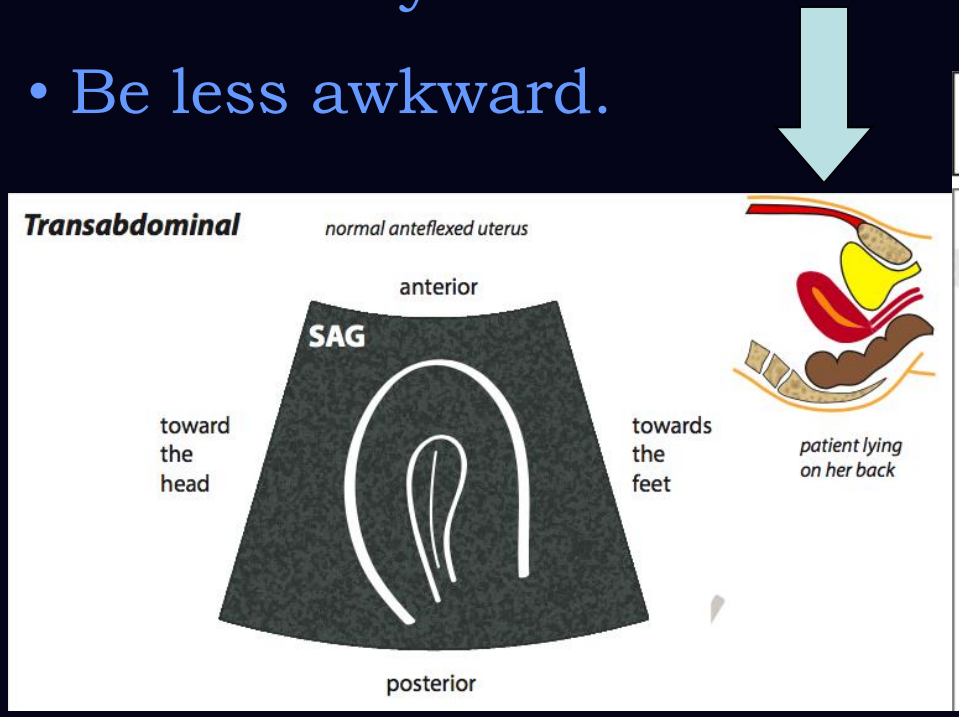
- What if you screw it up?
  - Reset by selecting the probe again, and it all goes back to the standard settings!
  - You can delete images from the US machine, or from the computers outside. You can re-label things too (from the computers).

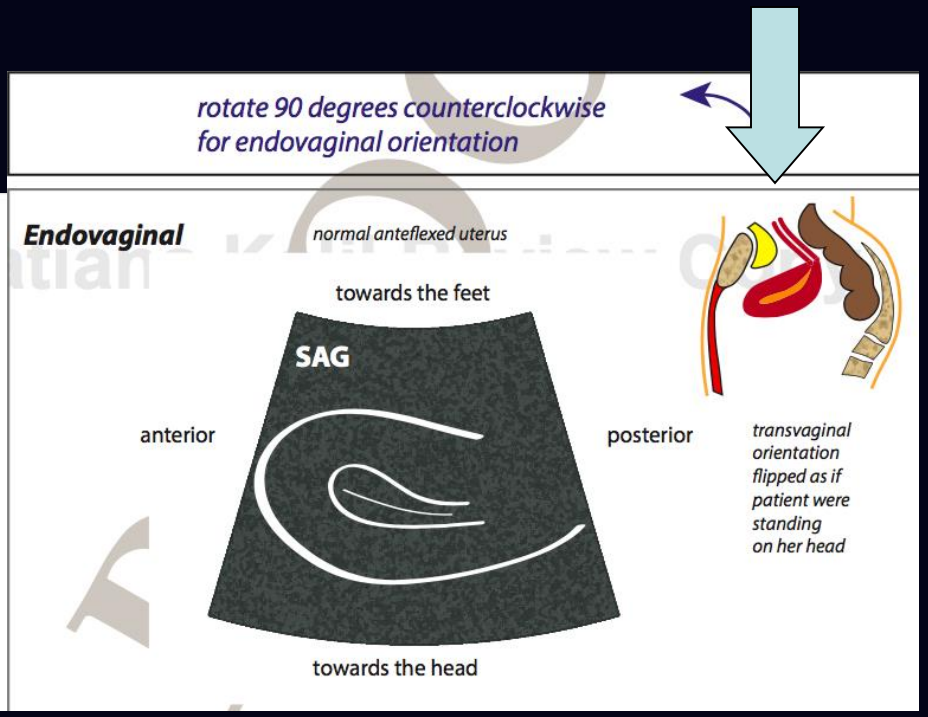
Random Tips

- Don't worry.
  - Try to balance image quality vs. time as best you can. But you will fail. It's ok.
  - You can practice after hours on a friend. Techs will help you.
- To be less awkward:
  - Tell the patient at the beginning that several other people may come in and scan, and that that doesn't mean anything is wrong.
  - If you can't find the button you're looking for and the patient is staring at you staring at the machine, you can say the machine isn't the one you're used to, or someone changed the settings, etc.

Trans Vaginal Exams

- Don't worry.
- Be less awkward.



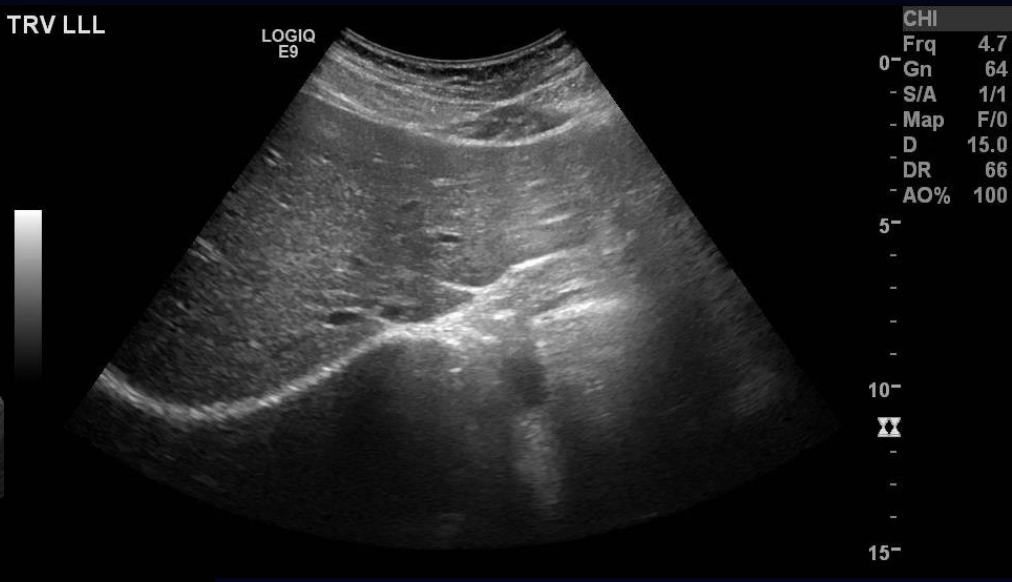


TIP: Fan from side to side

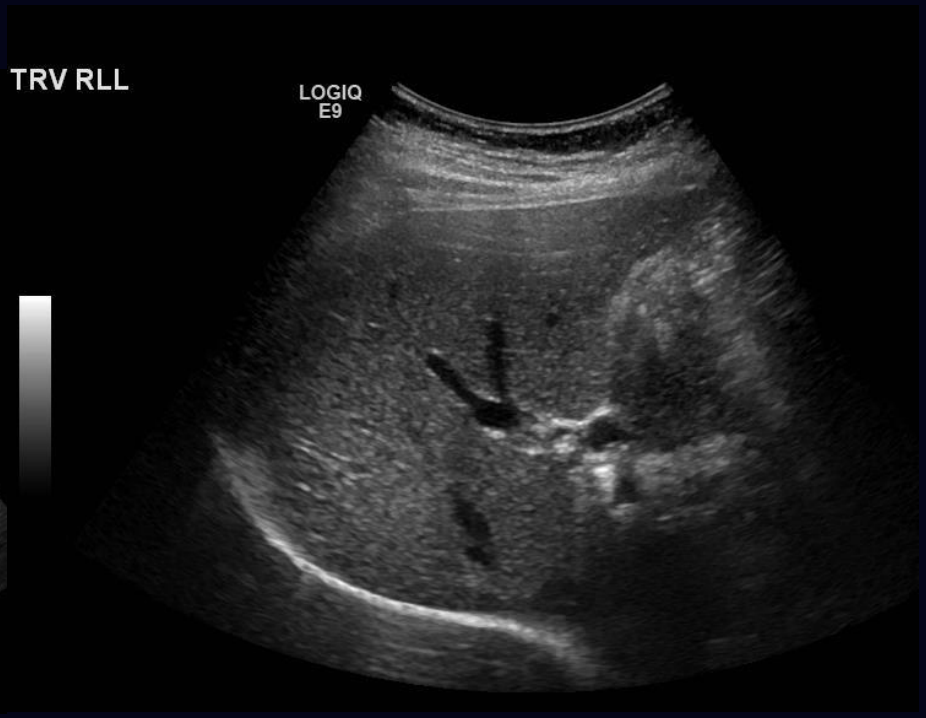
Normal Anatomy and Cases

- For cases
  - State the type of transducer used: “Transabdominal”, “Transvaginal”
  - State the organ: “Grayscale ultrasound images of the…” Look at the label on the side of the image
  - Look at the label for plane: “Sagittal” “Transverse” “Coronal”
  - If color doppler: Increased vascularity or not
  - Start describe the findings: Heterogeneous, homogeneous, hyperechoic, hypoechoic, anechoic, associated shadowing, ringdown, enhanced through transmission, thin walled, thick walled etc.

Normal Anatomy: Liver



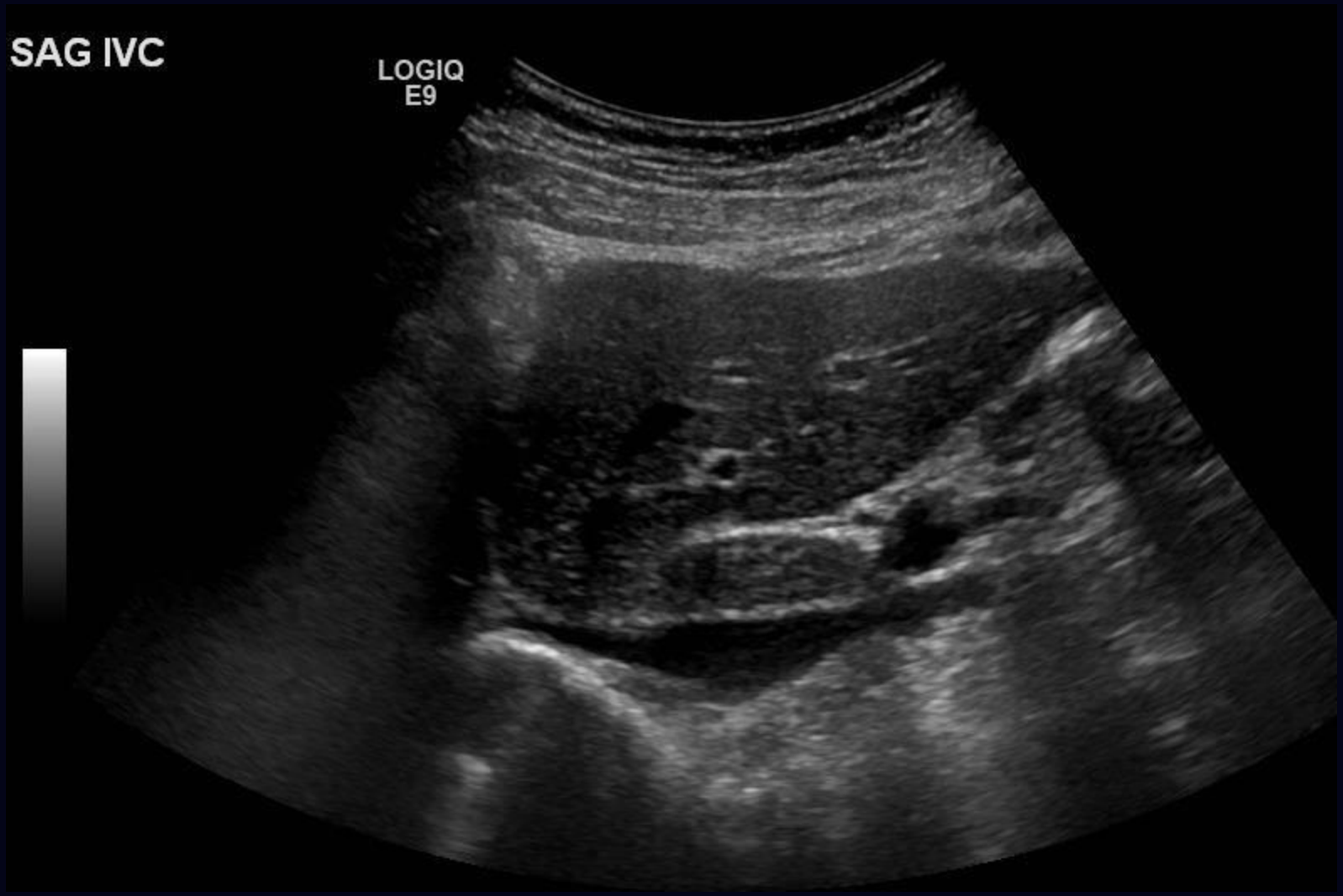
Normal Anatomy: Liver



Echogenicity should be equal or slightly greater to that of the right kidney

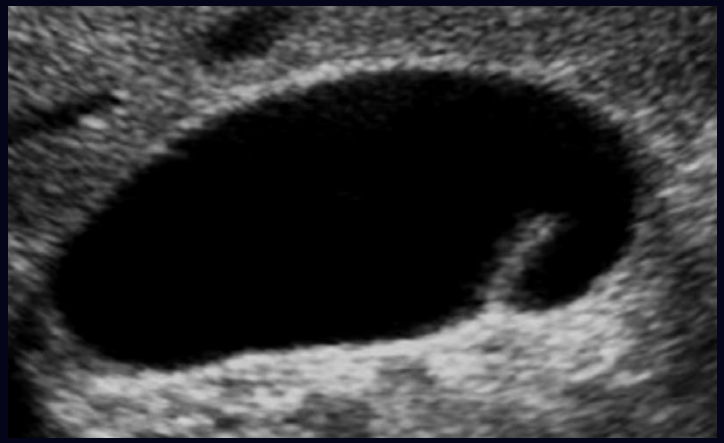
If increased echogenicity, think fatty liver. Also decreased penetration, +/- areas of sparing

Normal Anatomy: Liver

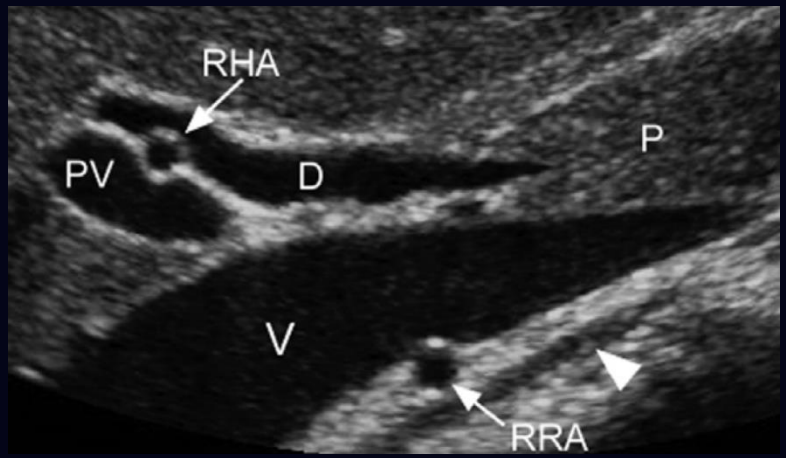


Normal Anatomy: Gallbladder

- Size less than 4 cm transverse
- Size less than 10 cm longitudinal
- Wall smooth, thickness less than 3 mm
- Lumen anechoic
- Common bile duct diameter should not exceed 6 mm (variable and increases with age)

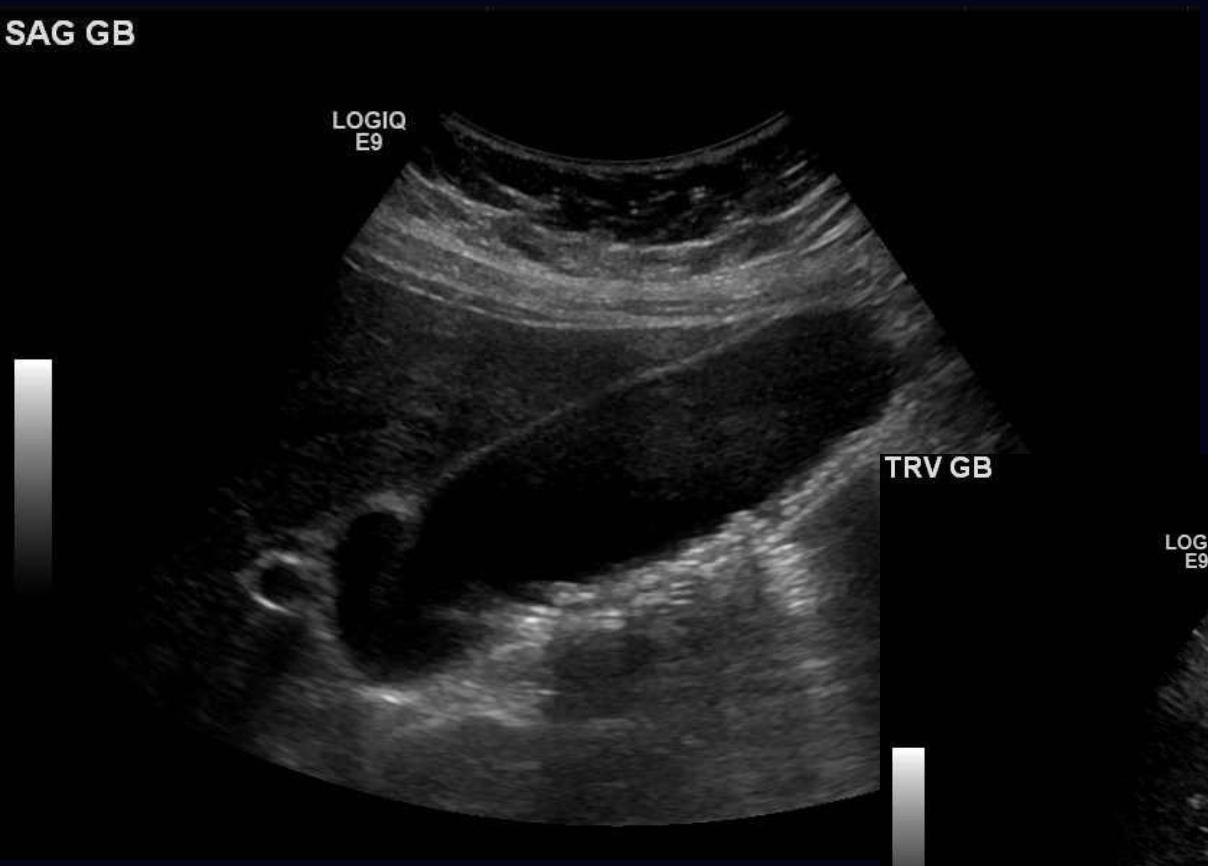


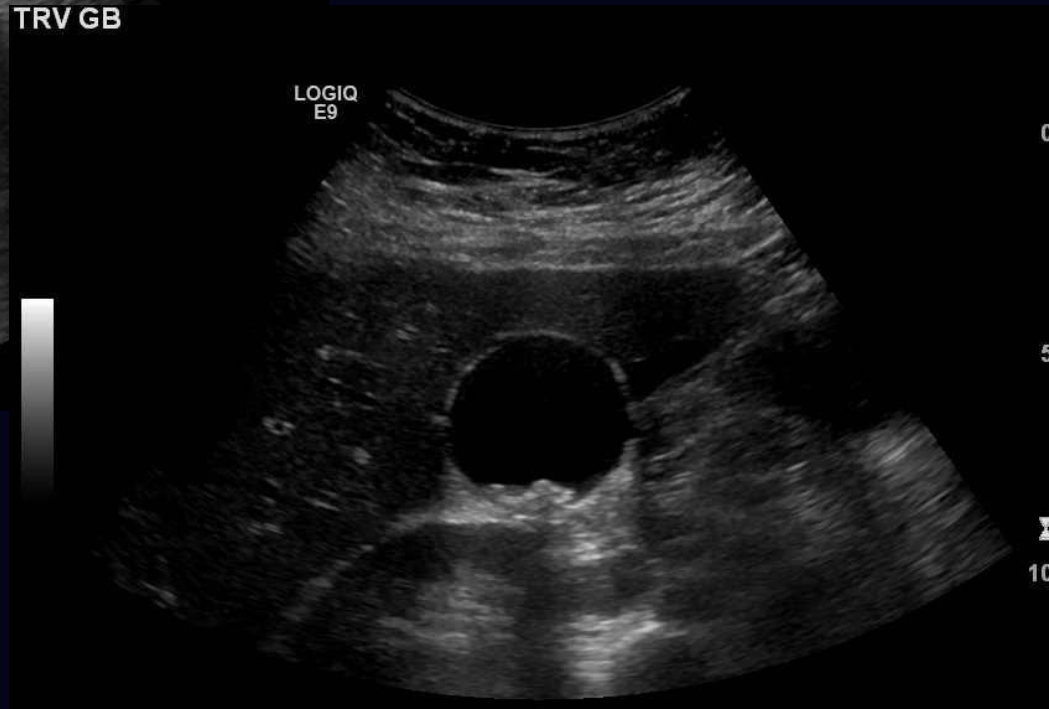
Normal gallbladder



Longitudinal view showing normal CBD appearance

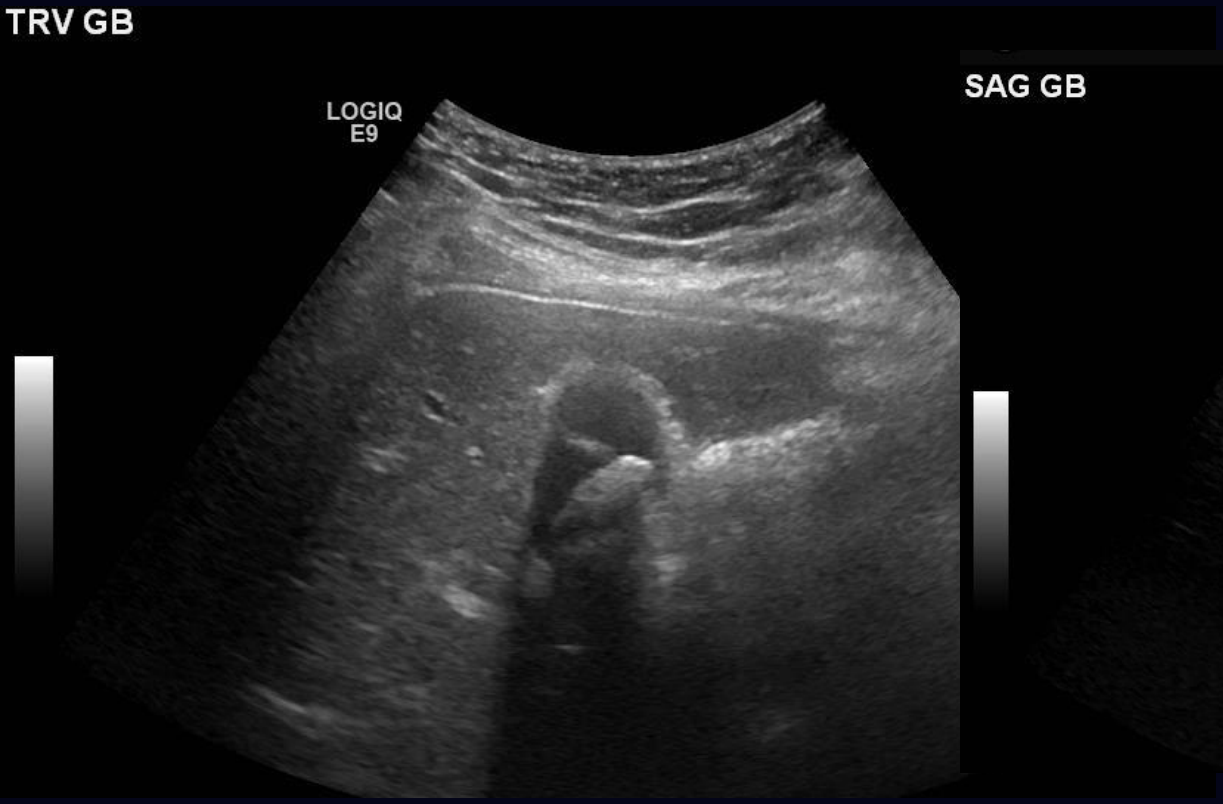
Case 1

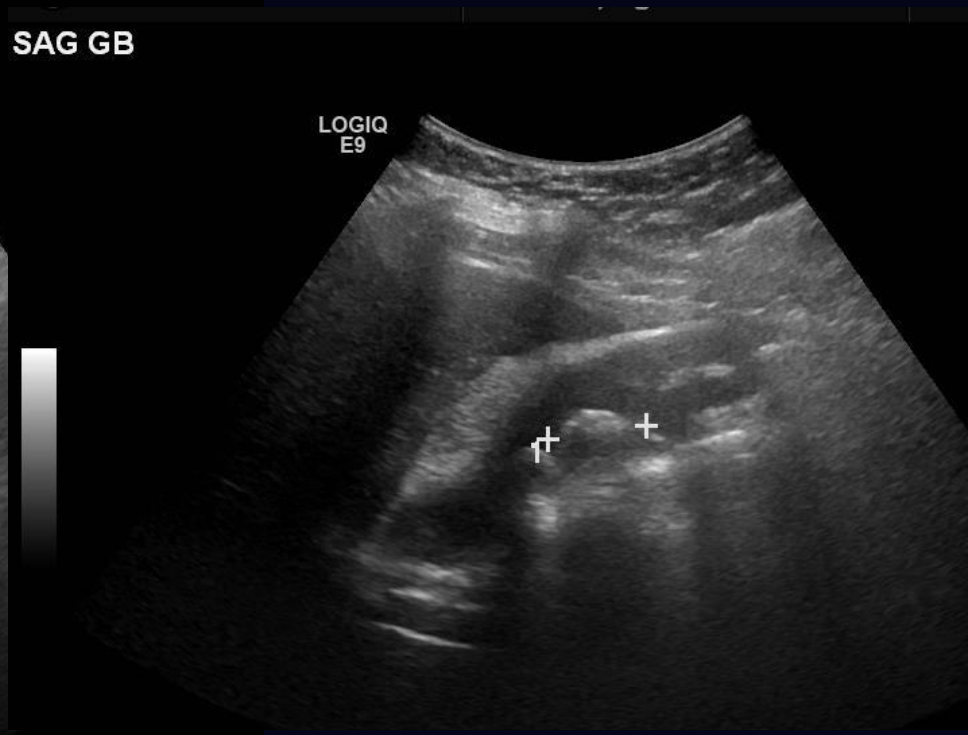




Case courtesy: Asha Sarma

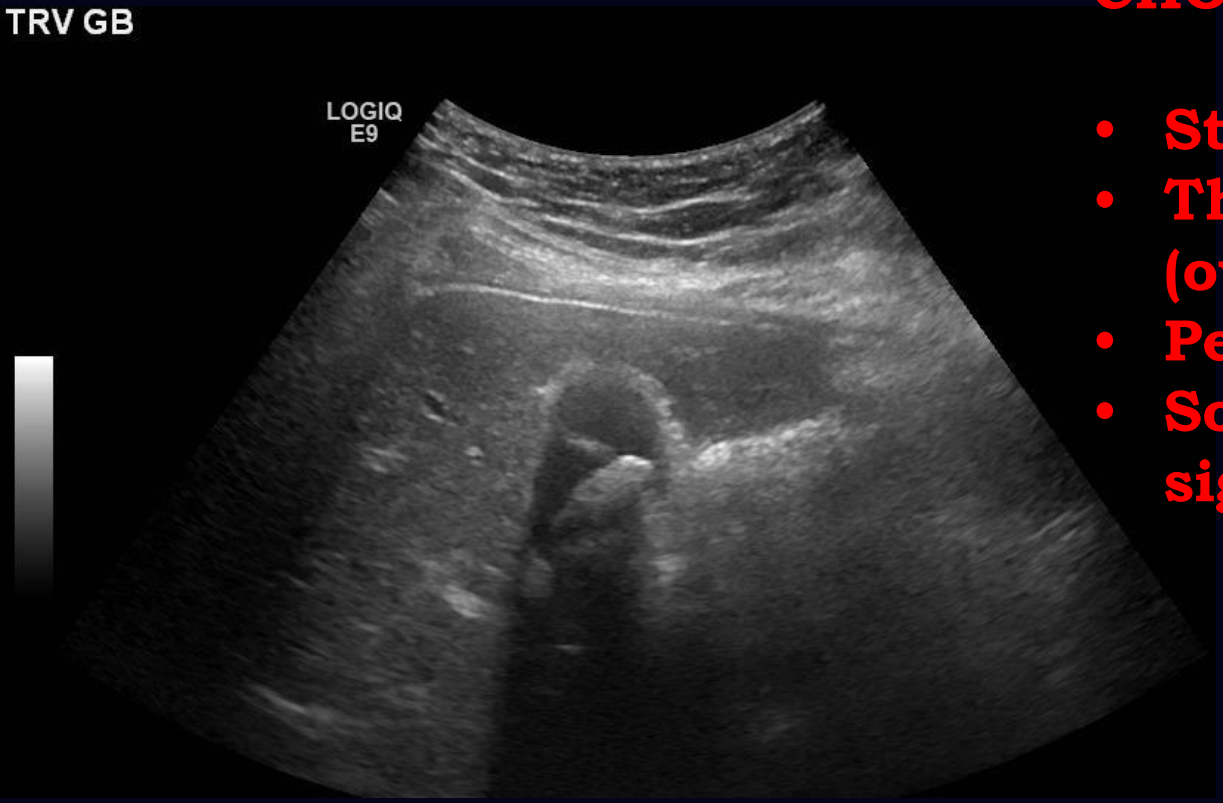
Case 2





Case courtesy: Asha Sarma

Case 2

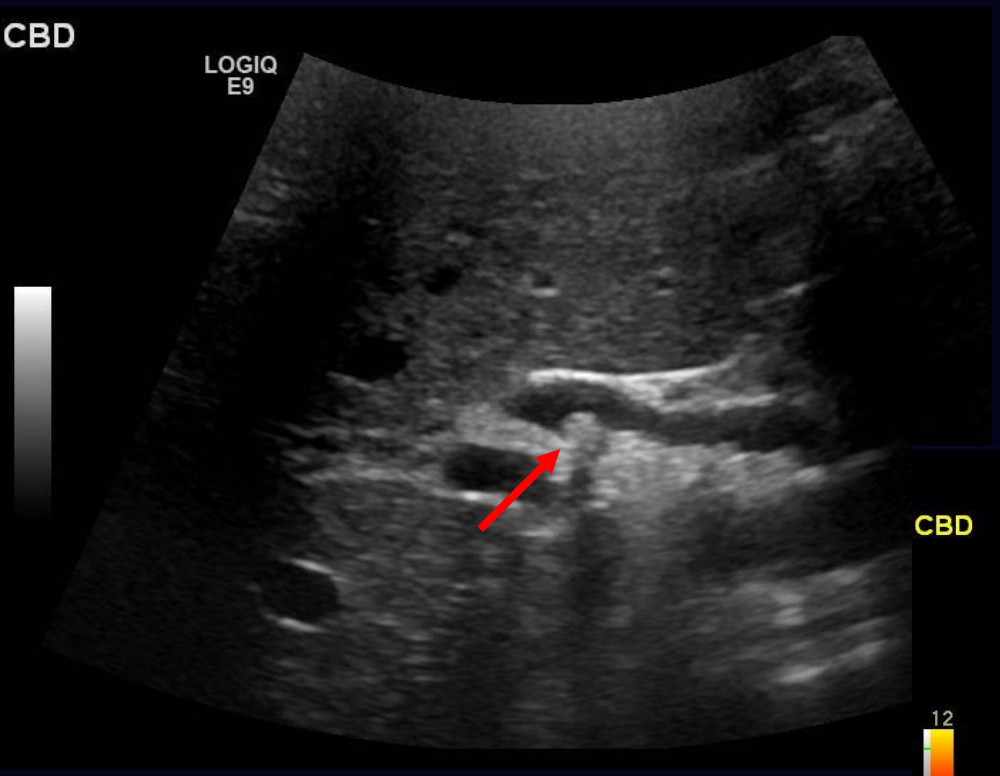


CHOLECYSTITIS

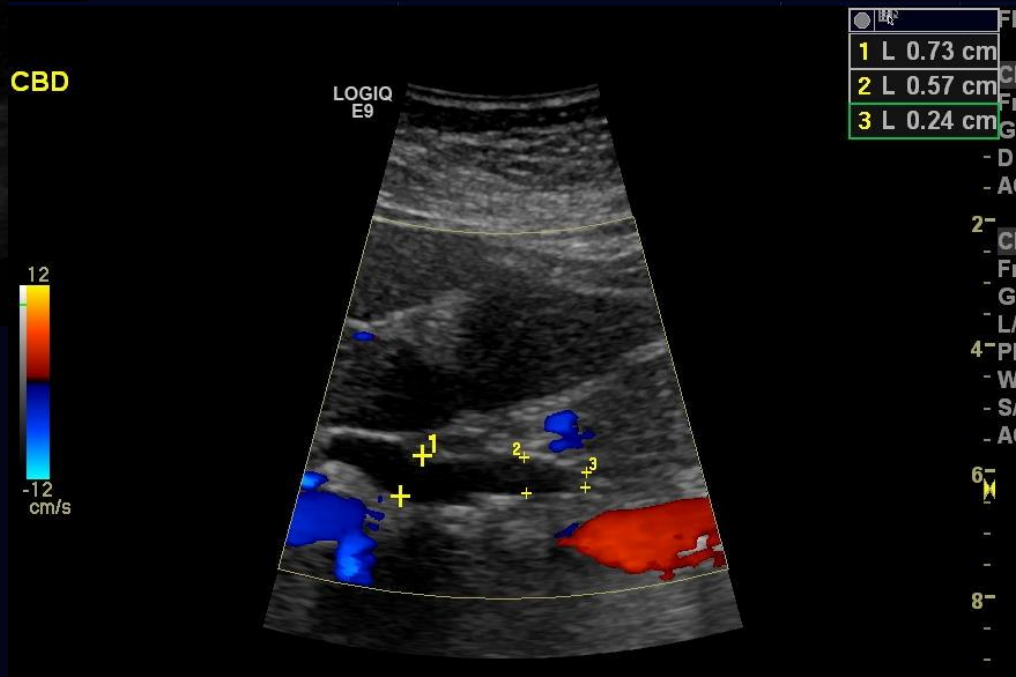
- **Stone**
- **Thickened GB wall (over 3 mm)**
- **Pericholecystic fluid**
- **Sonographic Murphy's sign**

Case courtesy: Asha Sarma

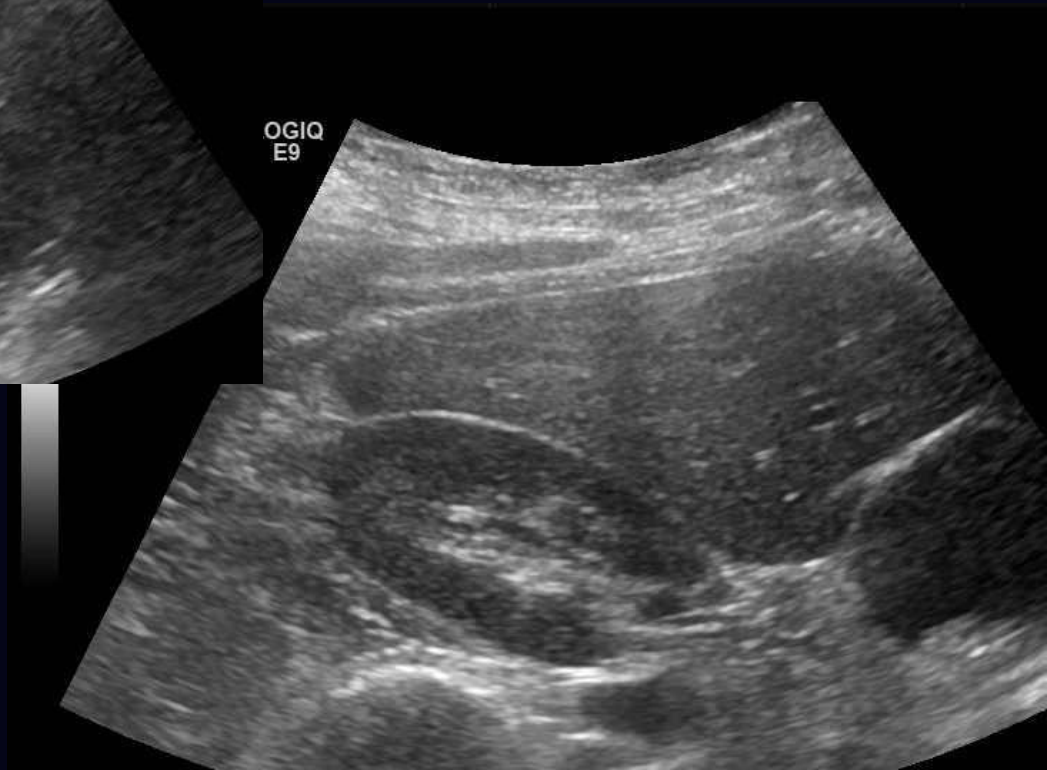
Case 3



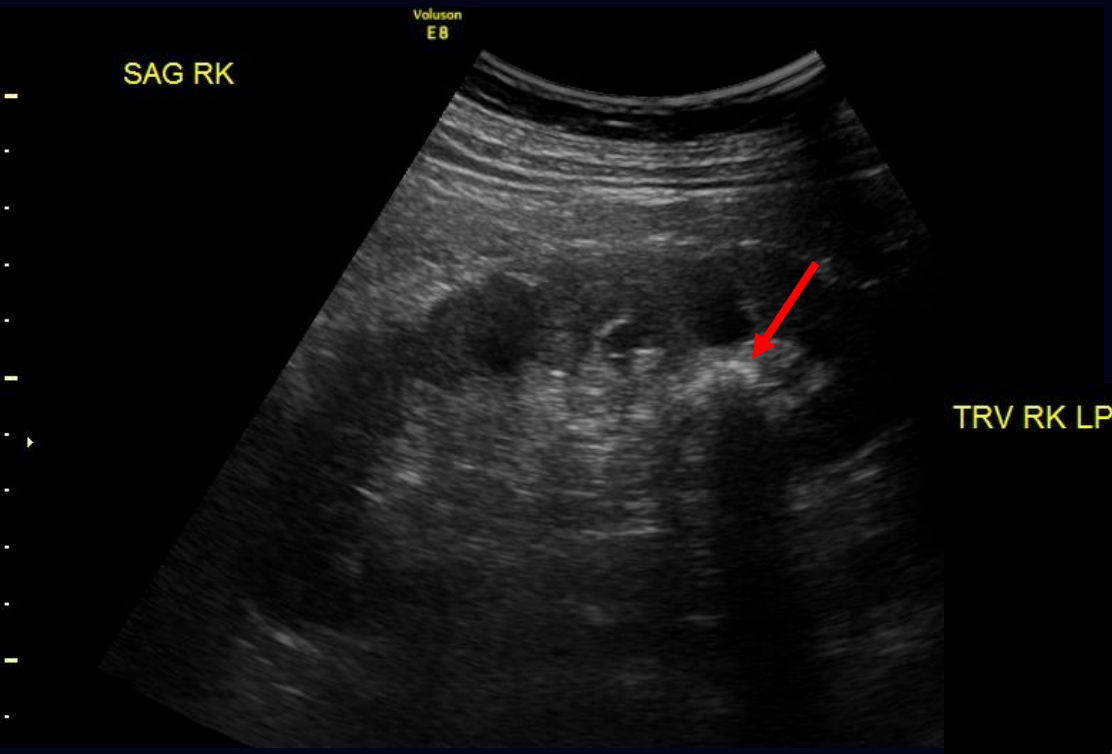
46 yo F with postprandial abdominal pain

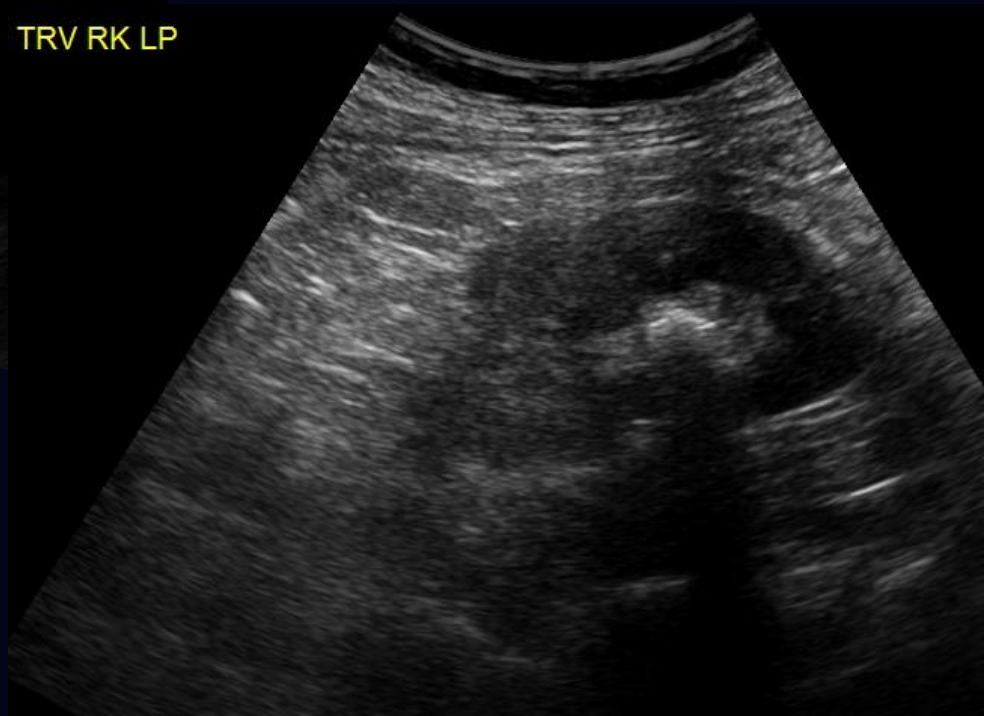


Normal Anatomy: Kidney

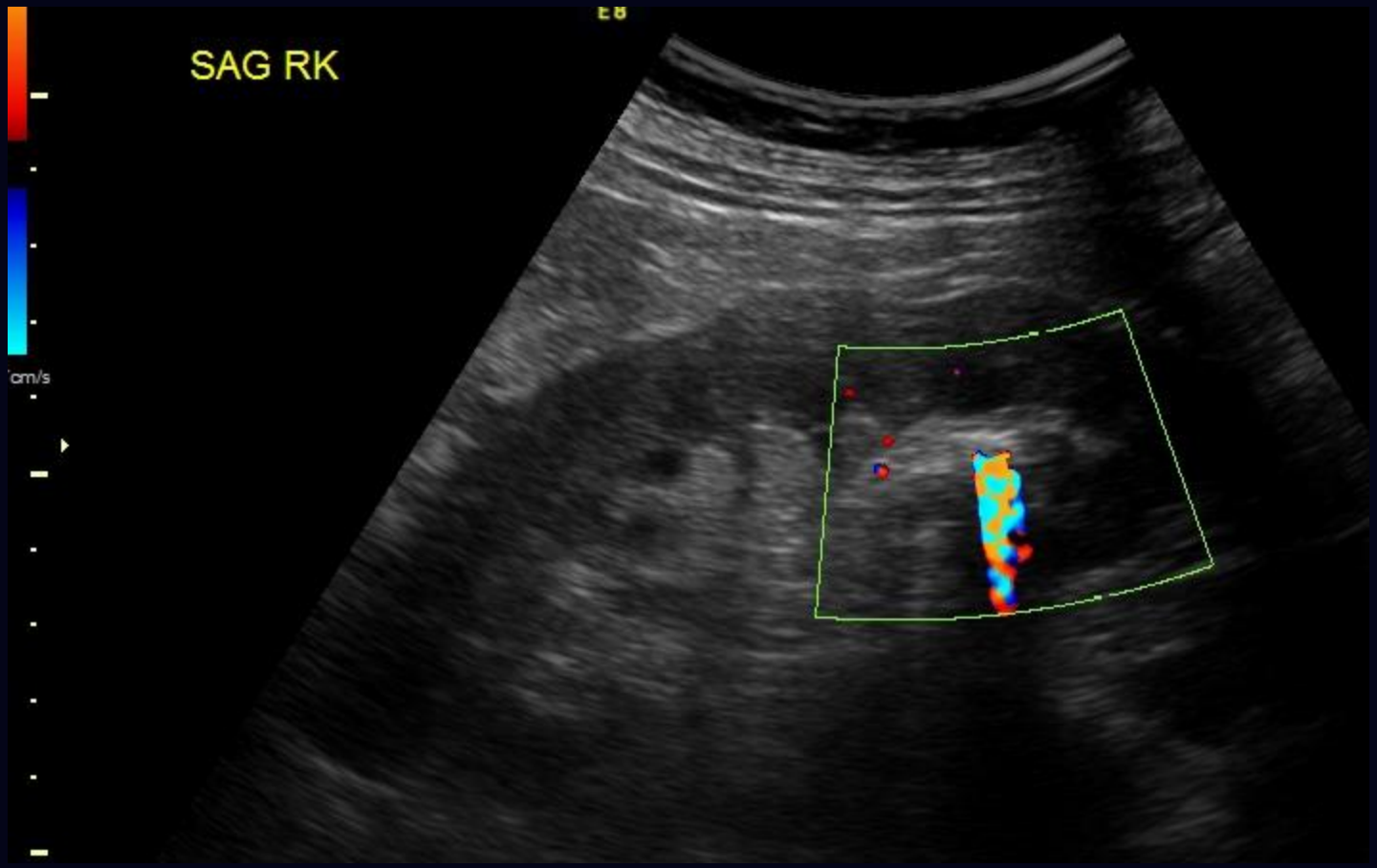


Case 4



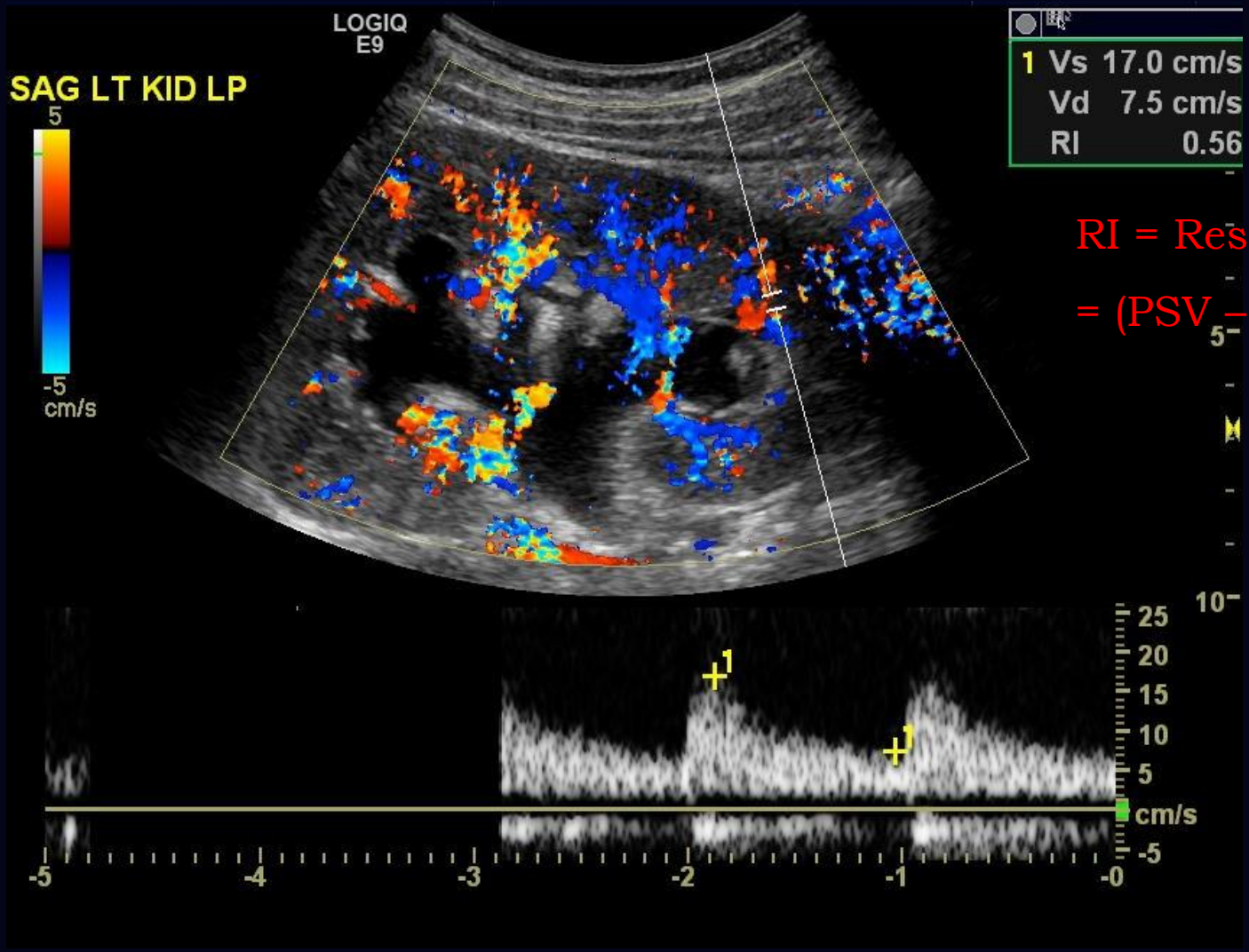


Case 4



Case 5

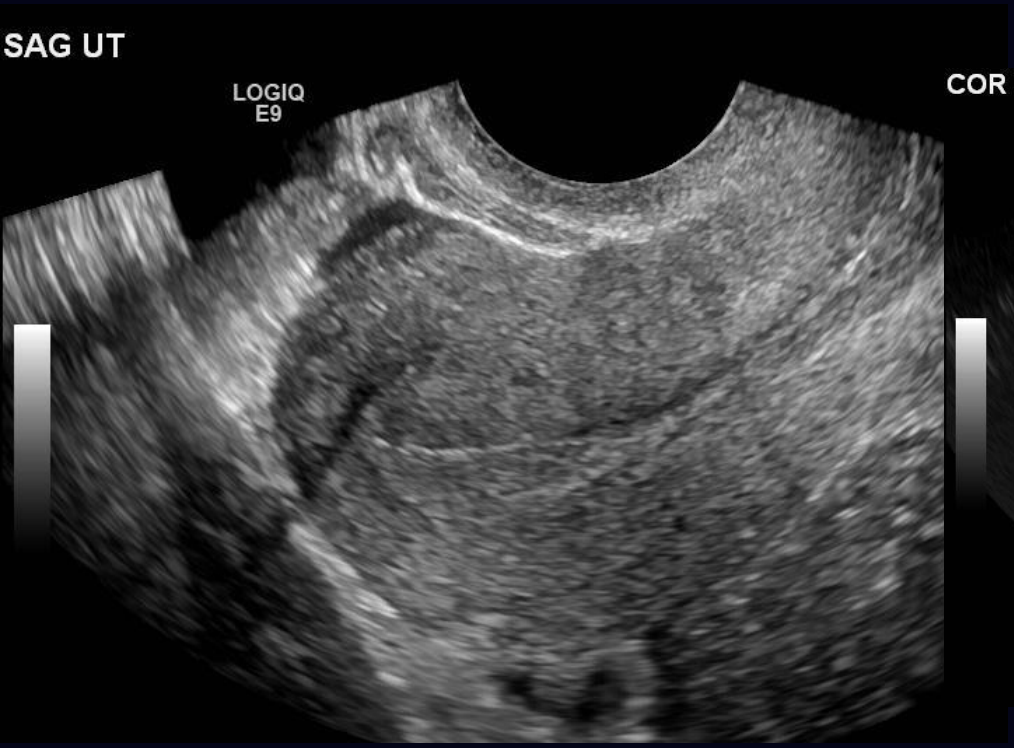
Case 5

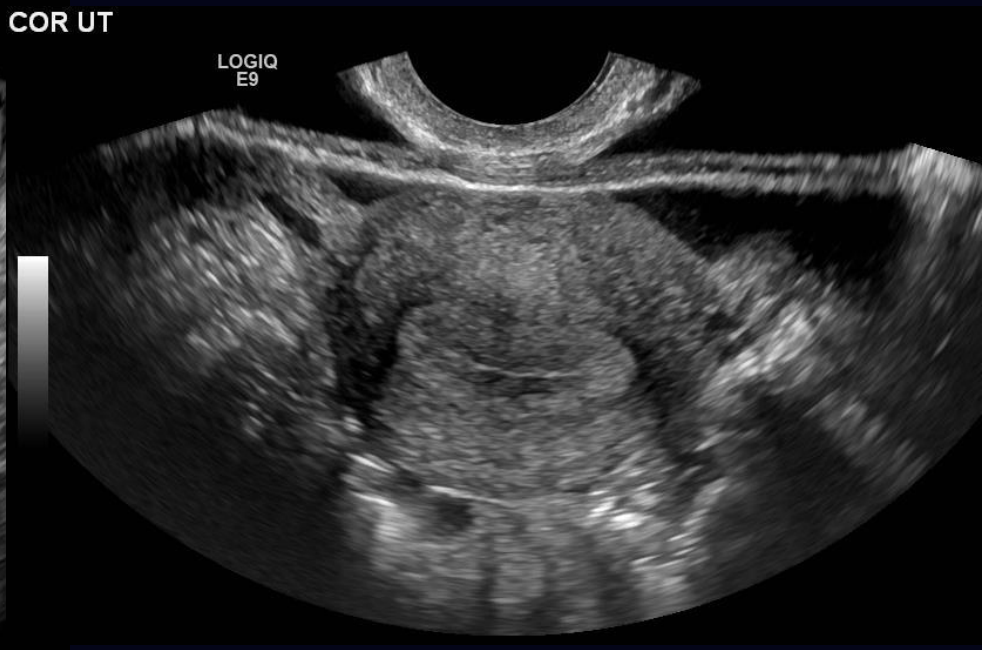


RI = Resistive index

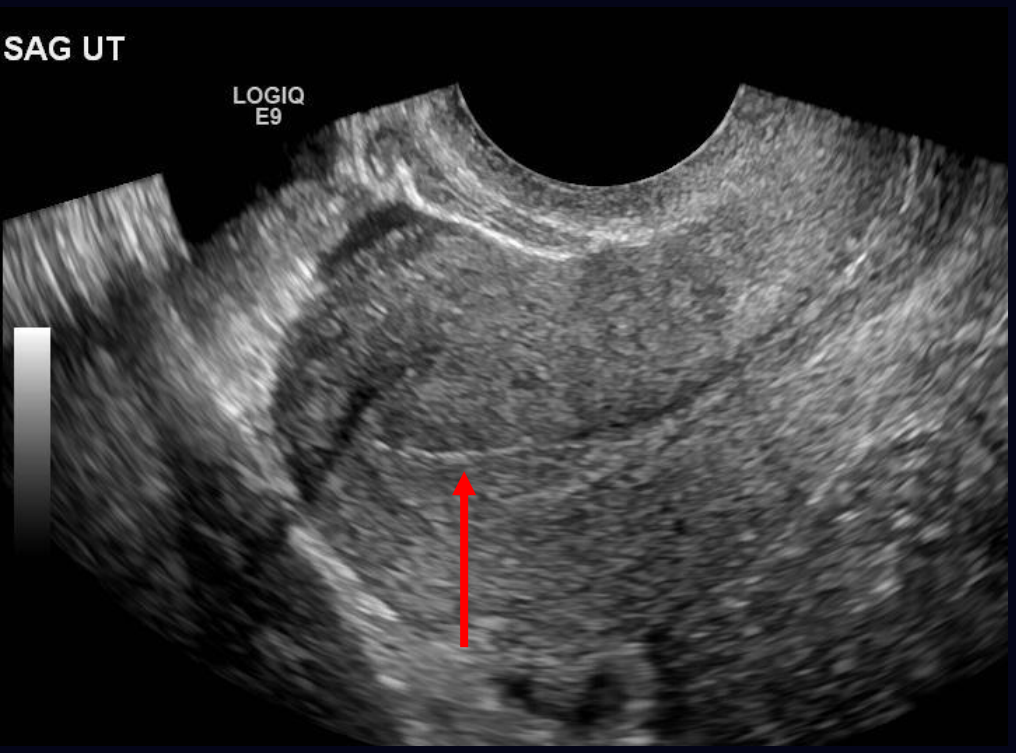
= (PSV – EDV)/PSV

Normal Anatomy: Uterus





Normal Anatomy: Uterus



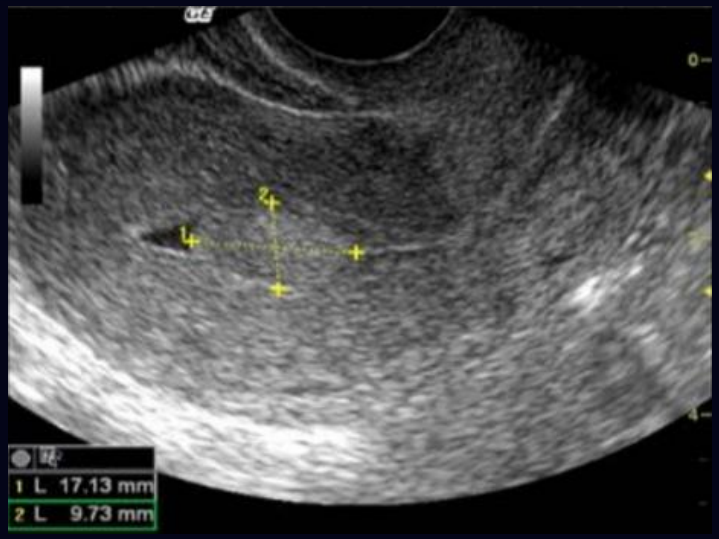
Endometrial stripe:

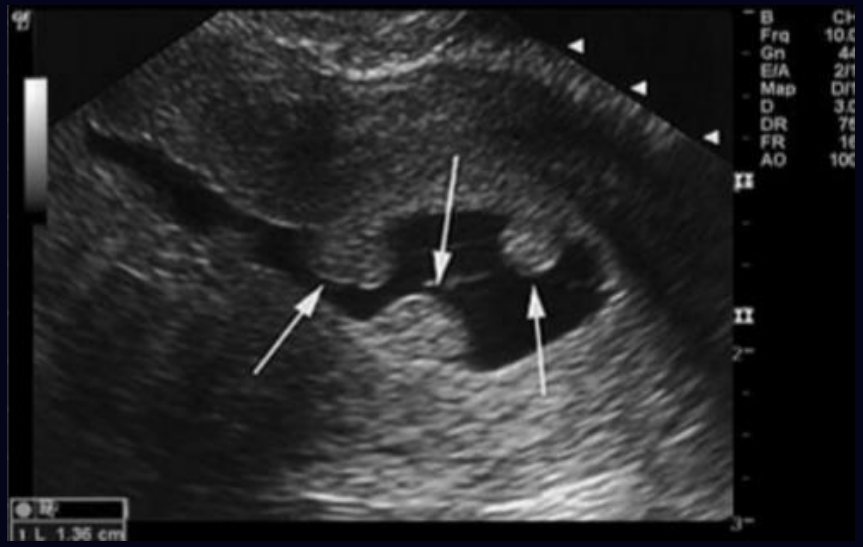
Pre-menopausal, changes throughout cycle

If post-menopausal, usually < 4mm.

If post-M and bleeding, and > 4 mm, THINK CANCER.

Normal Anatomy: Uterus



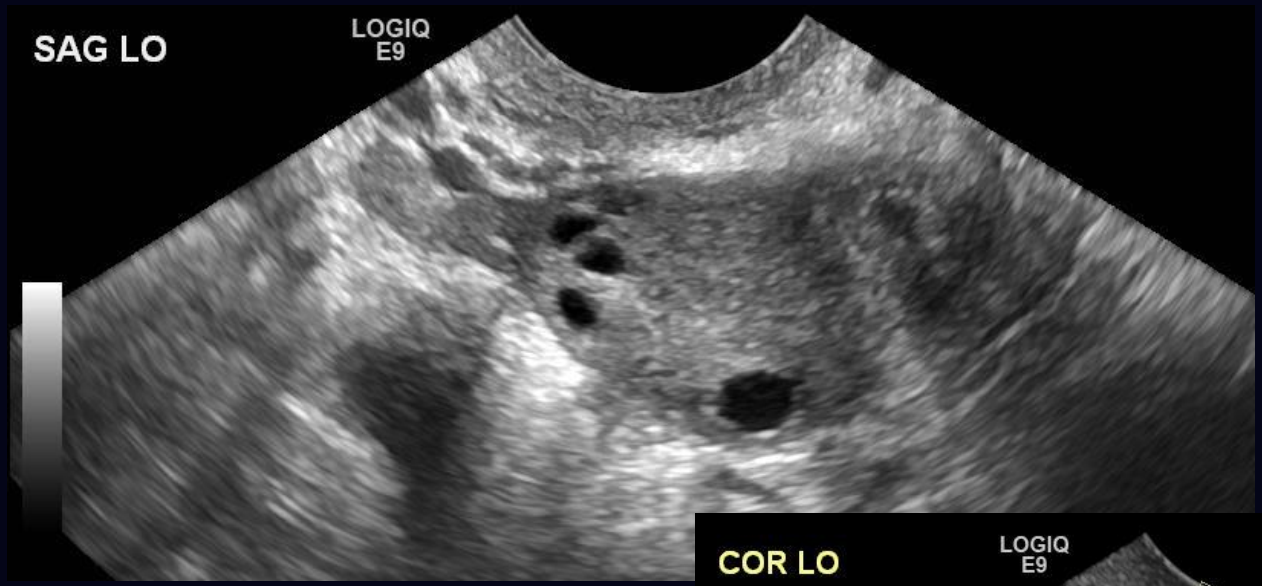


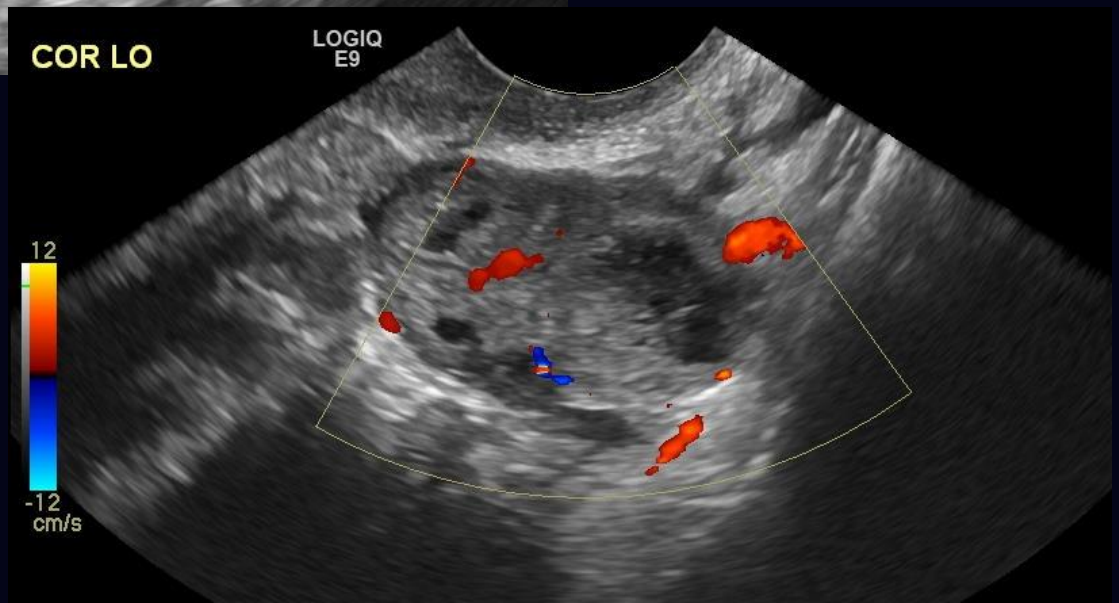
If the endometrial stripe isn't nice, think of:

- **Polyp**
- **Fibroid**
- **Cancer**

Next step is sonohysterogram or biopsy

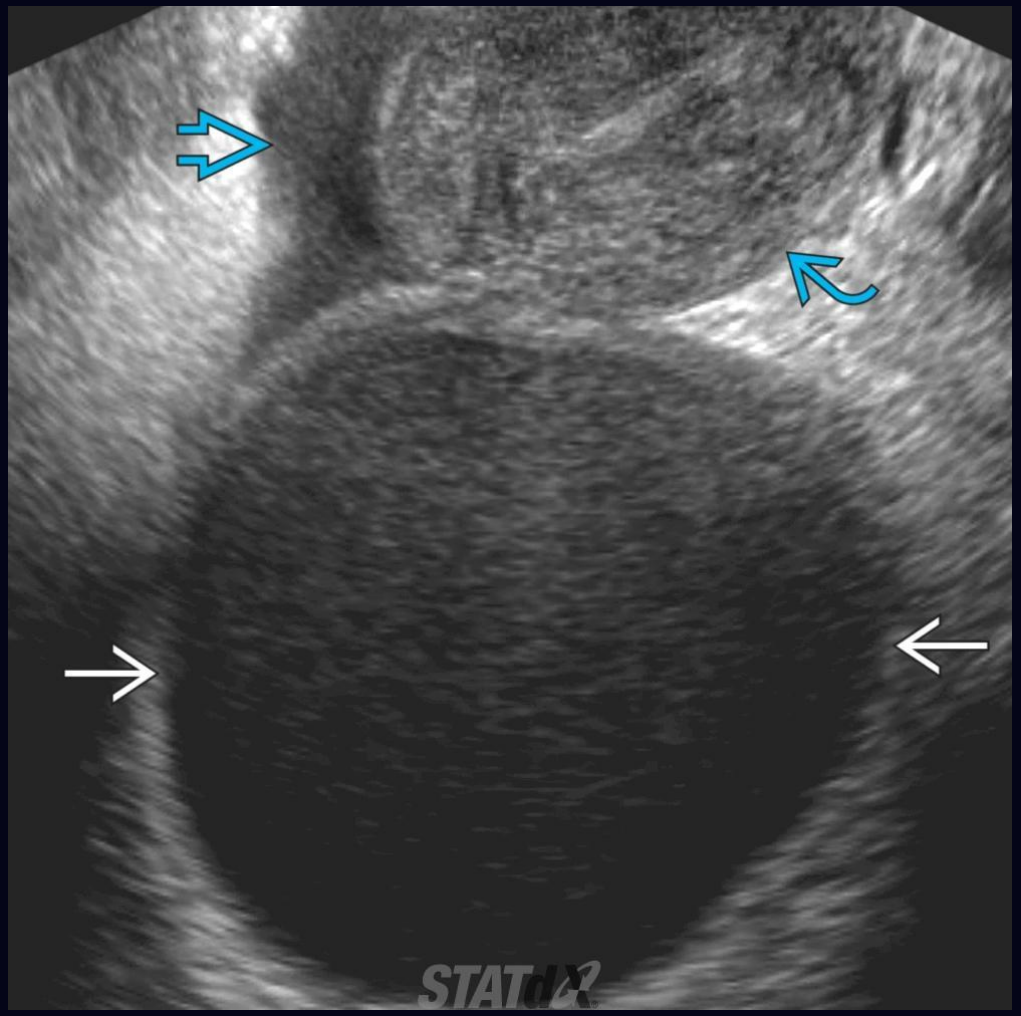
Normal Anatomy: Ovary





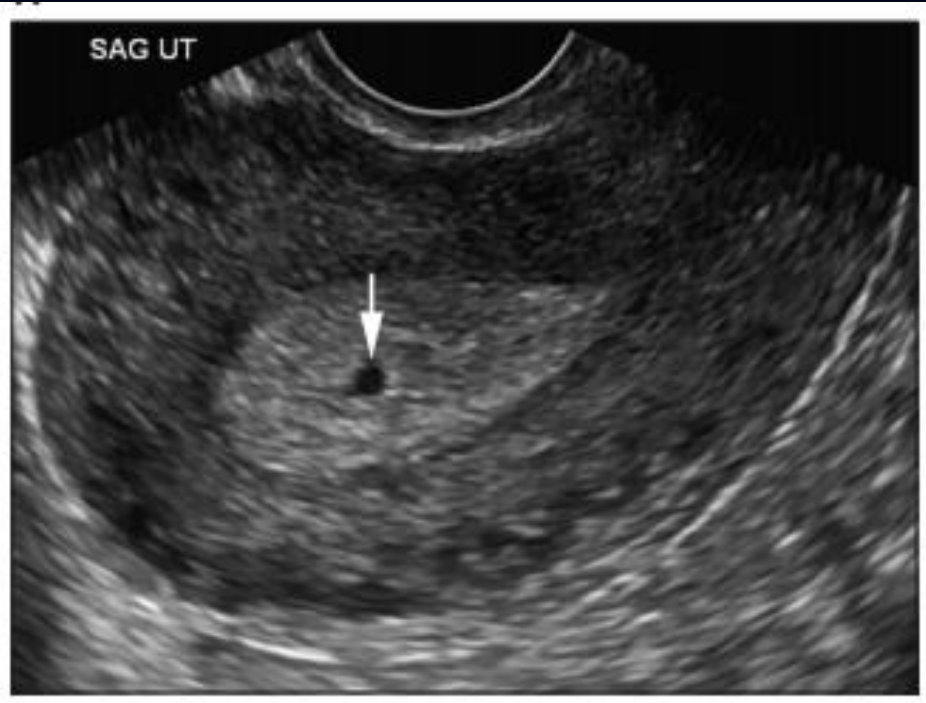
Case 6

38 yo F with chronic pelvic pain



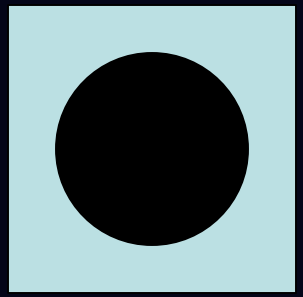
Case 7

25 yo F with positive hCG, vaginal bleeding.
Should be at 5 weeks according to LMP.

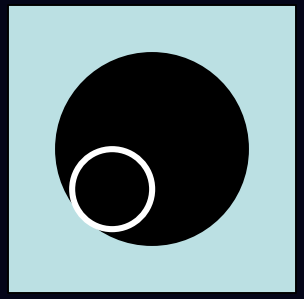


Gestational Age

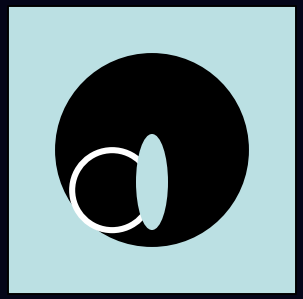
- 5.0 weeks
  - GS



- 5.5 weeks
  - GS + YS

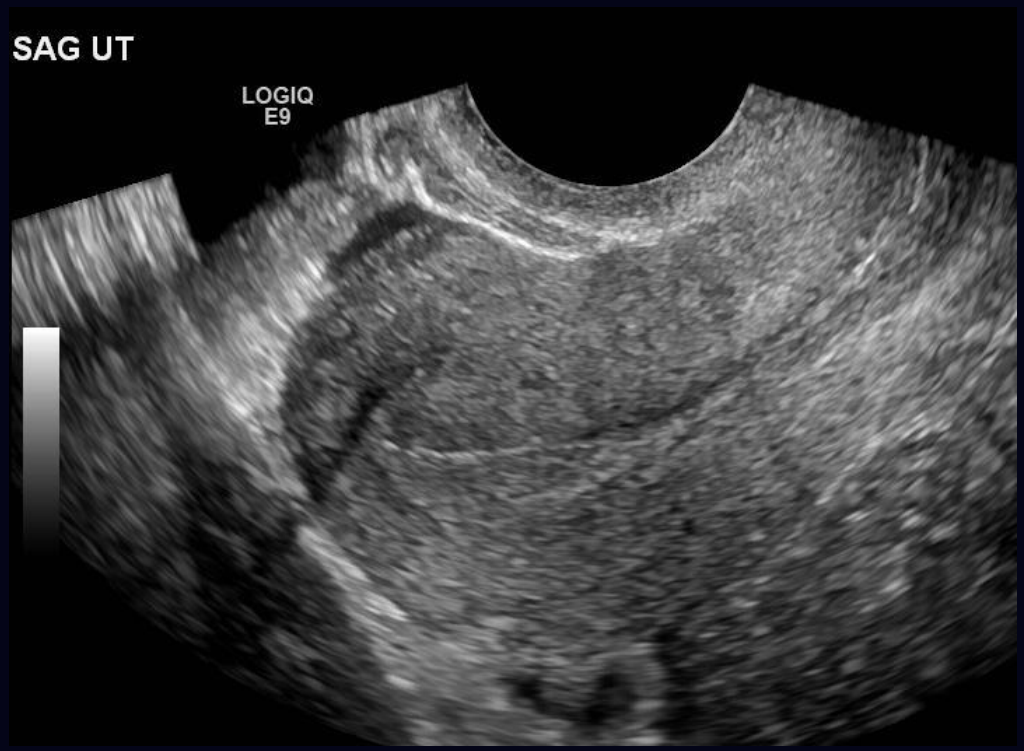


- 6.0 weeks
  - GS + YS + embryo



Case 8

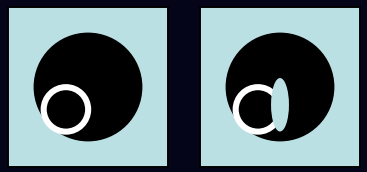
25 yo F with positive hCG, vaginal bleeding.
Should be at 5 weeks according to LMP.



Rule out ectopic

- Positive HCG, no IUP seen. +/- bleeding
- Options:
  1) IUP (normal, abnormal, or too early to see)
  2) Ectopic
  3) Spontaneous abortion

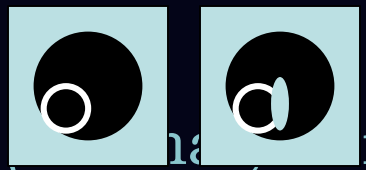
Rule out ectopic

- Positive HCG, no IUP seen. +/- bleeding
- Options:
  1) IUP (normal, or too early to see)
  2) Ectopic 
  3) Spontaneous abortion

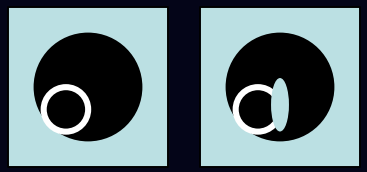
Rule out ectopic

MEMORIZE THIS

- Positive HCG, no IUP seen. +/- bleeding
- Options:
  1) IUP (normal, or too early to see)
  2) Ectopic
  3) Spontaneous abortion



YS or GS in uterus = IUP



YS or GS in adnexa = ectopic

Otherwise, if the patient is stable, do a follow up US

First, Do No Harm . . . to Early Pregnancies

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References

- Ultrasound: The Requisites
- Core radiology by Jake Mandell
- Brant and Helms