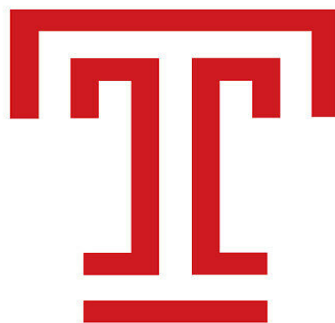
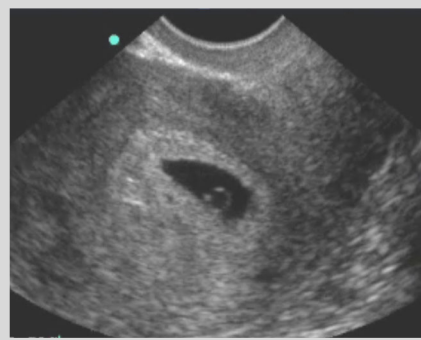
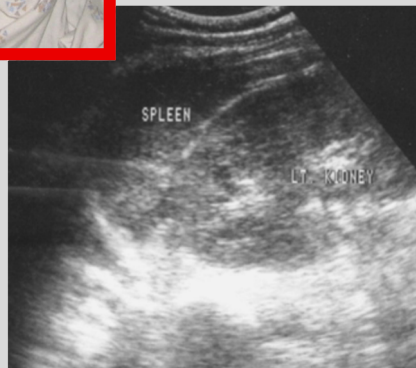
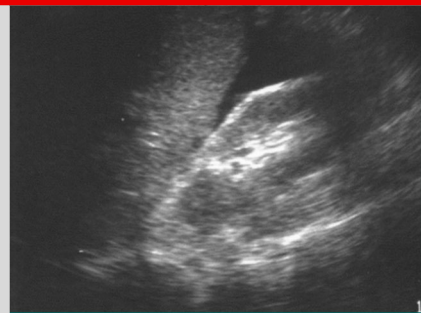
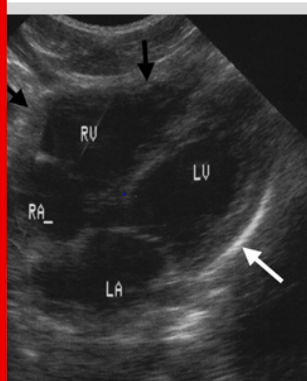


Lewis Katz School of Medicine at Temple University

POINT-OF-CARE ULTRASOUND POCKET REFERENCE





TEMPLE
UNIVERSITY

Lewis Katz School of Medicine

Ultrasound in Medical Education

Pocket Reference

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REQUIRED VIEWS (Quick Reference)

Trauma (eFAST)

- RUQ/hemithorax
- Subxiphoid
- LUQ/hemithorax
- Suprapubic
- Right Lung sliding
- Left Lung sliding

Aorta

- Trv Aorta sweep
 - may need 2 clips
- Max aorta diameter (still)
- Sag Aorta sweep

RUQ

- Sag GB
- Trv GB
- GB wall (still)
- CBD

Kidney

- Sag Kidney
- Trv Kidney
- Bladder with jets

DVT

- CFV w/ compression
- Pop Vein w/compression

Cardiac

- PSLA
- Aorta root (still image)
- PSSA
- A4Ch
- Subxiphoid (SX)

Lungs

- Right Lung B lines apex
- Right Lung B lines base
- Left Lung B lines apex
- Left Lung B lines base

Pelvic 1st trimester

- Sag Uterus
- Sag Cervix
- Trv Uterus
- Zoom Gest sac (clip) no sweep
- Yolk sac (still)
- CRL (still)
- FHT m-mode (still)
- Trv right adnexa
- Trv left adnexa

Skin/MSK

- Transverse
- Sagittal
- Measurement

GENERAL

Enter patient name, MRN, & department.

Clips are 4-6 seconds in length and prospective. Use retrospective video for ureteral jets.

Sagittal/longitudinal scans are performed from the patient's right to left and from top to bottom in the transverse plane.

Always show the images to your attending.

If you need assistance, find a senior resident or ask your attending.

If you find pathology, get extra images and show your attending.

Please take good care of the machines. They benefit you, your colleagues, and your patients.

CLEANING

- After each use, clean the probe with soap and water then dry.
- For the intra-cavitary transducer, follow the department guidelines.
- **Use a sterile barrier probe cover and sterile gel for any invasive procedure or when coming into contact with body fluids.**

Additional resources at:

www.templeemergencyultrasound.com

BASICS

- **Echogenicity** (ability to reflect sound waves back)
 - Hyper-echoic: significant echoes, appears bright white (bone)
 - Hypo-echoic: diminished echoes, appears gray (solid organs)
 - Anechoic: no internal echoes, appears black (fluid-filled structure)

- **Gain** (brightness or darkness)

- **Transducers** (or probes)
 1. Curvilinear (abdominal): low frequency, high depth penetration
 2. Linear (vascular): high frequency, low depth penetration
 3. Phased-array (cardiac)
 4. Endo-cavitary (intra-cavitary) typically for pregnancy & PTAs

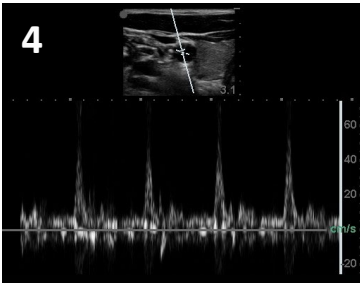
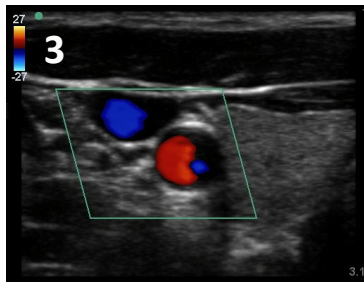
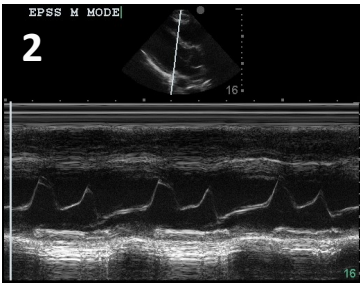
- **Orientation**
 - Transverse: probe indicator oriented to patient's right
 - Sagittal or longitudinal: probe indicator oriented to patient's head



BASICS

■ Mode

1. B-mode: two dimensional ultrasound image
2. M-mode (motion): motion *y-axis) vs time (x-axis) display of a B-mode image
3. Color flow Doppler (direction of flow)
 - Red: towards the probe; Blue: away from the probe
4. Power Doppler: depicts amplitude of flow



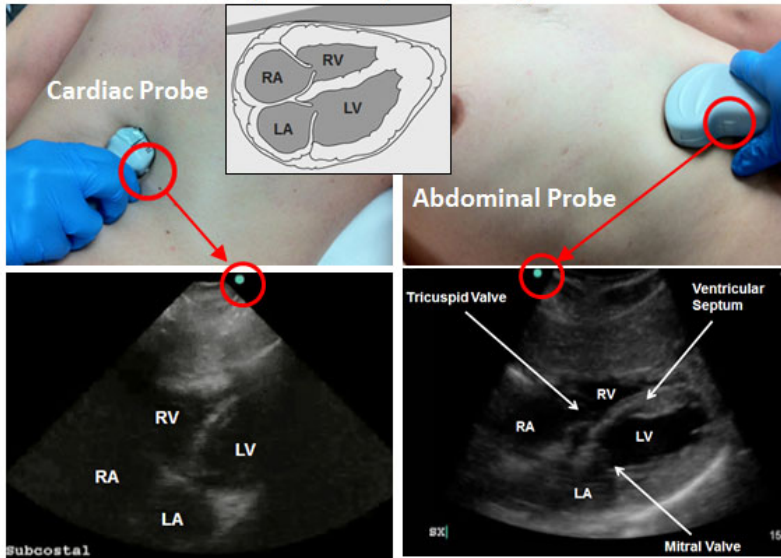
■ Probe Movements

- Rotate (clockwise or counterclockwise)
- Sweep (short axis)
- Slide (long axis)
- Rock (long axis, along a fixed point)
- Fan (short axis, along a fixed point)
- Compression/pressure

CARDIAC or FOCUS

4 Standard Views of Focused Cardiac Ultrasound (FOCUS):

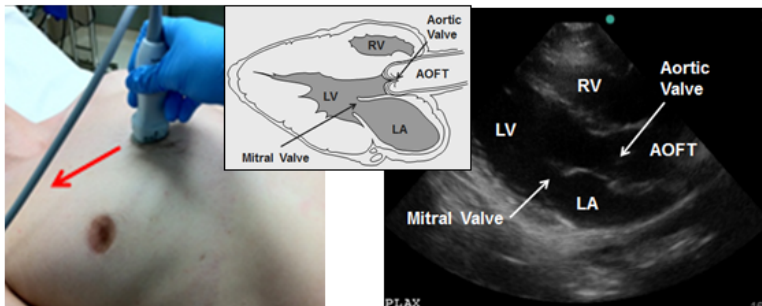
- **Subxiphoid (SX) (or subcostal) 4 Chamber View**
 - Cardiac Probe – pointer to patient’s Left
 - Abdominal Probe – pointer to patient’s Right



- Look for effusion between RV and liver
- Assess global function

- **Left Parasternal long axis (PSLA)**

- Cardiac Probe - Pointer to patient’s R shoulder
- Abdominal Probe - Pointer to “4 o’clock” - toward patient’s L Hip



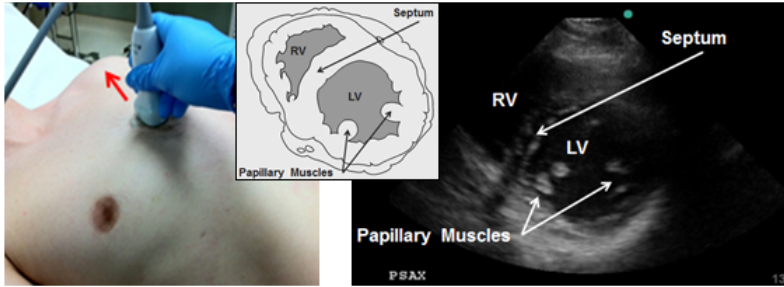
- Demonstrate LA, MV, LV, septum & LV free wall, aortic outflow, RV
- Look for effusion
- Measure aortic outflow tract (w/in 2 cm distal to annulus) (still image)
 - < 3.5 cm considered normal (inside lumen to inside lumen)

CARDIAC or FOCUS

4 Common Views (Continued)

■ Left parasternal short axis (PSSA)

- Cardiac Probe – pointer to patient's L Shoulder
- Abdominal Probe – Pointer to "8 o'clock" - toward patient's R hip

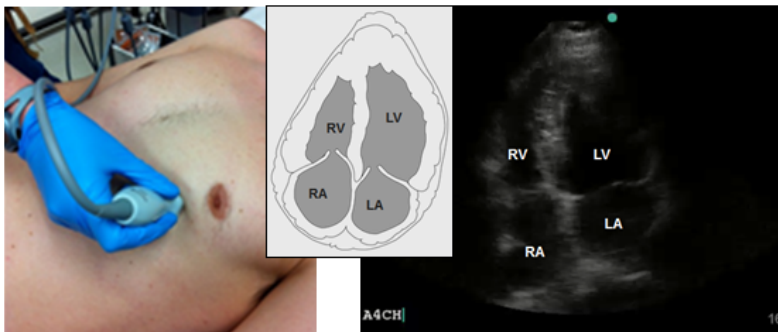


- Best for global function & wall motion abnormalities
- Should be at level of papillary muscles to estimate EF (LV walls should contract concentrically)



■ Apical four-chamber (A4Ch) at PMI, show 4 chambers

- Cardiac Probe – pointer toward patient's L (toward axilla)
- Abdominal Probe – pointer toward patient's R (toward RUQ)

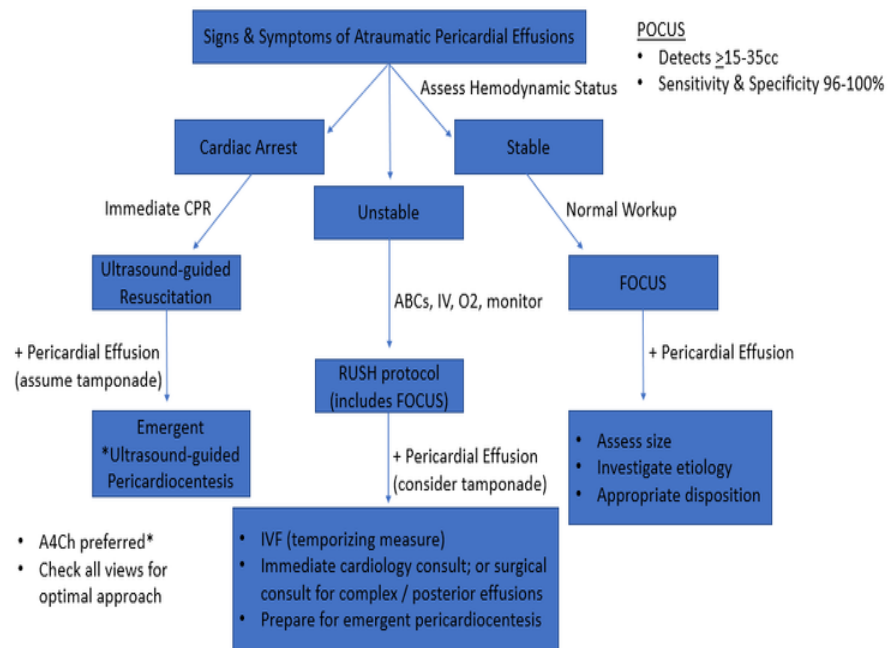


- Most challenging view. 25-30% of the time, you will not be able to visualize an A4Ch view. Place patient in left lateral decubitus position.
- Often best for guiding pericardiocentesis

CARDIAC or FOCUS

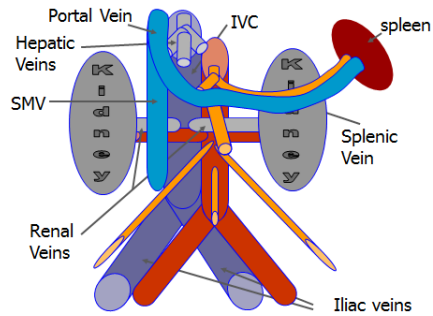
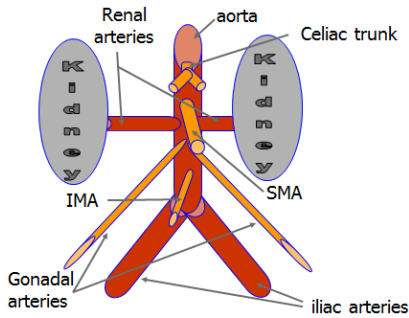
Key Findings (5 E's of echo)

- Pericardial **effusion** (+/- tamponade)
 - RV collapse in ventricular diastole
- Ejection fraction (**EF**)
 - Good EF >50%
 - Moderate 30% - 50%
 - Poor EF <30%,
- Aortic root (**Exit**)
 - <3.5 cm argues against type A dissection,
 - Undulating intimal flap — pathognomonic of dissection
- RV chamber size (should be 0.6:1.0 ratio of RV:LV) (**Equality**)
 - If acutely enlarged, consider PE (check DVT pocus)
- IVC (**Entrance**)
 - The smaller and more collapsible suggests volume depletion
 - Limited utility though in volume assessment & responsiveness



AORTA

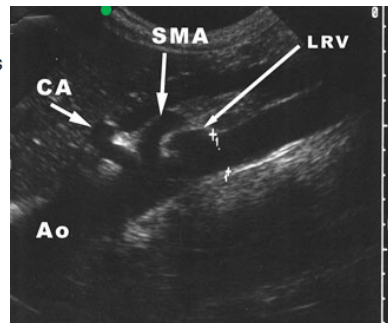
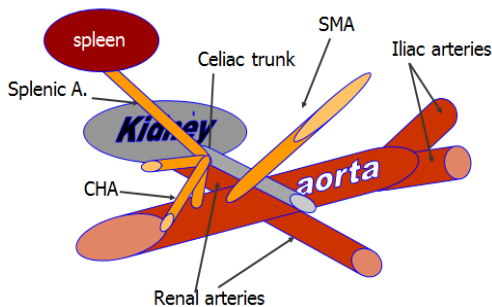
Anatomy:



Required Views — (1-2 video clips and 2 stills)

■ One sagittal / longitudinal View

- Scan from above the celiac artery to the bifurcation



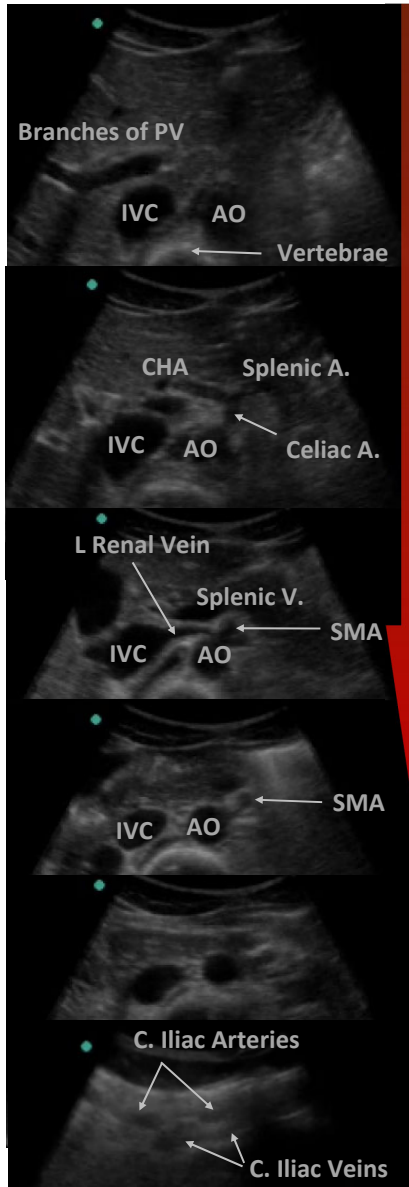
■ One AP or Transverse View



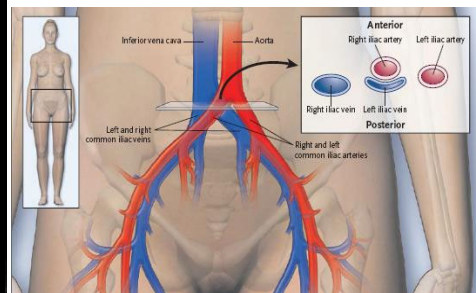
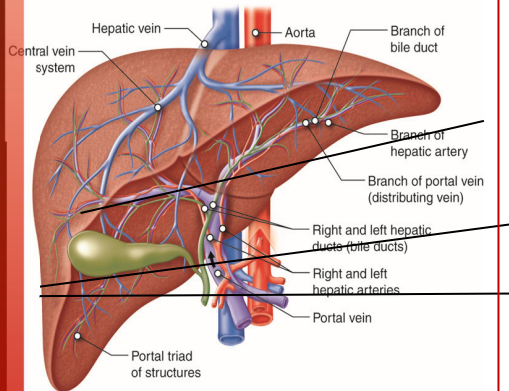
- Measure aortic diameter outer wall to outer wall at point of maximal diameter
- Be sure to include the aortic wall in your measurement
- Do not mistake false lumen of clot for aortic diameter

AORTA

- 1-2 Transverse sweep(s)**
 - In real time slowly sweep entire length to view small aneurysms
 - Start at diaphragm ~2 cm above Celiac Artery (subxiphoid area)
 - Sweep distally to bifurcation of Aorta (may need 2 clips)



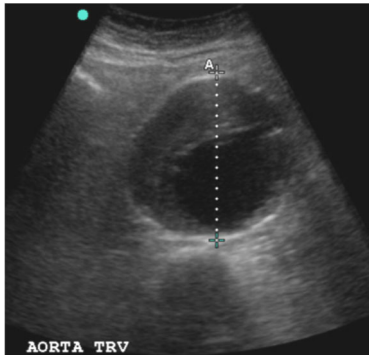
Transverse Abdominal Sweep



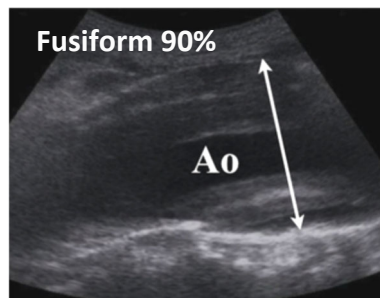
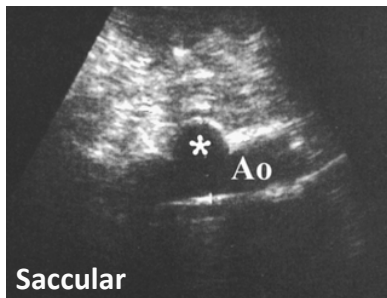
AORTA—AAA

AAA

- **Aortic diameter > 3cm**; often w/ anterolateral intraluminal thrombus
- Measured from **outer wall to outer wall** in transverse or AP diameter
- Diameter > **5cm**—risk of rupture 16 %/yr
 - Requires **urgent elective repair** (Elective repair mortality 1-5%)
- US RUQ to assess for free fluid - often absent
 - 75% retroperitoneal ruptures

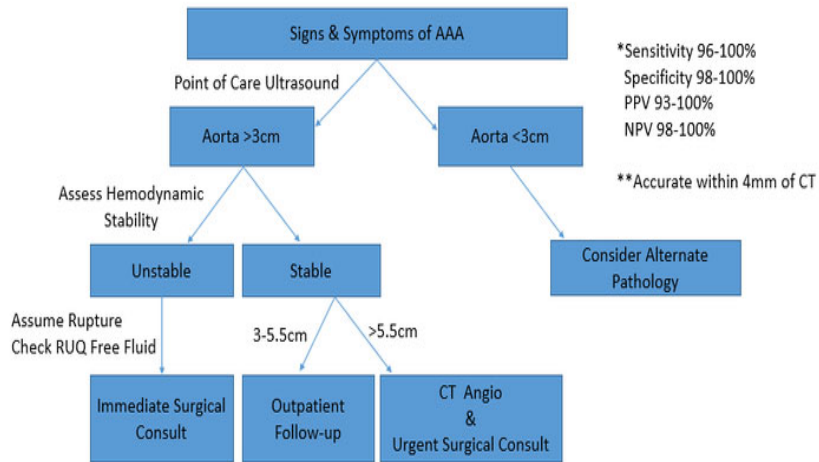


- No specific US finding for rupture
 - Combine POCUS w/clinical picture
- **Classic Triad:** Pain, hypotension, and palpable mass—only 25%
 - Pain—80%
 - Back 60%; Abd 50-80%; Groin 20%
 - Hypotension—50%
 - Syncope—25%
 - PEA—up to 50%
- Almost All in age >50



	IVC	Aorta
Pulsatile	respirophasic variation	x
Collapsibility	easily	
Wall	thin	thick
Course	hepatic veins join then enters right atrium	look for branches moving distally

AORTA— AAA / DISSECTION



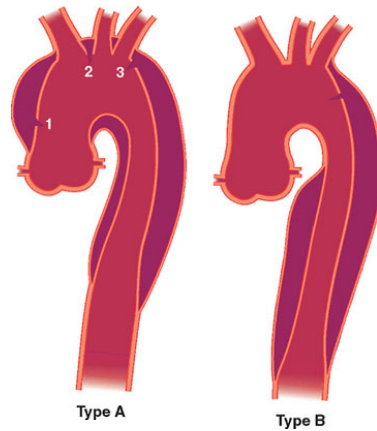
*Dent B, et al. Emergency ultrasound of the abdominal aorta by UK emergency physicians: a prospective cohort study. *Emerg Med* 2007;24(8):547-549.

*Tayal VS, et al. Prospective study of accuracy and outcome of emergency ultrasound for abdominal aortic aneurysm over two years. *Acad Emerg Med* 2003;10(8):867-871.

**Costantino TG, et al. Accuracy of emergency medicine ultrasound in the evaluation of abdominal aortic aneurysm. *J Emerg Med* 2005;29(4):455-460.

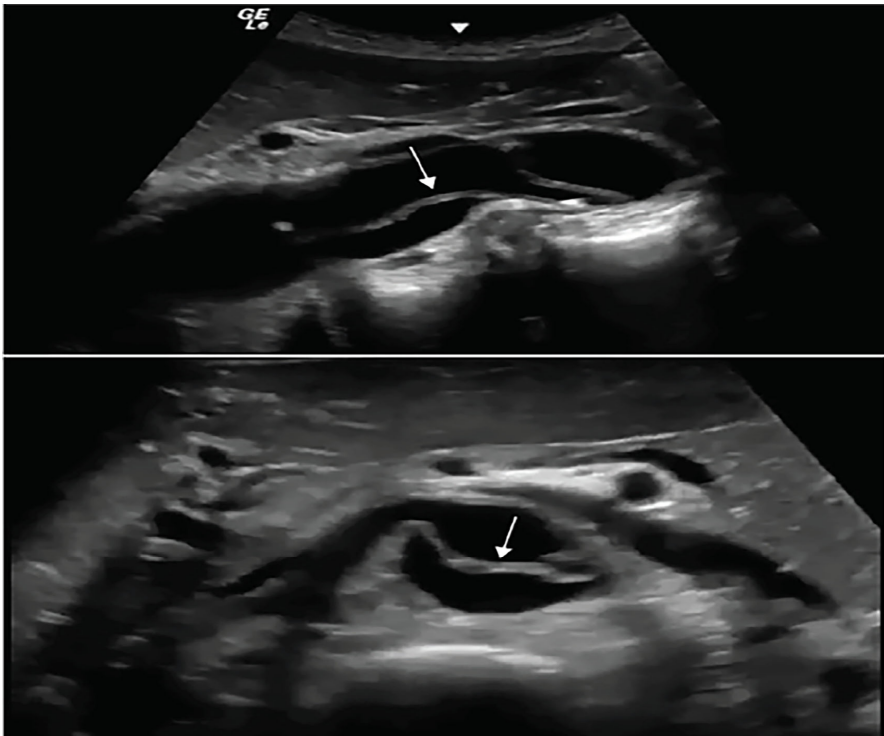
Dissection

- **Type A (2/3)** (ascending aorta)
 - HTN—only 35%
 - STAT Thoracic Surgery consult
 - Mortality—35%
- **Type B (1/3)** (descending aorta)
 - HTN—70%
 - Mortality—15%
 - Stat Vascular Surgery consult
 - Wide Mediastinum on CXR—62%
- **Treatment:**
 - B Blockade to HR 60
 - If BP stays >120, then ACE-I or other vasodilator
 - **All patients with Dissection** — Emergent Thoracic or Vascular Surgery consult
 - Type A—most need surgical repair
 - Type B—most managed medically



AORTA—DISSECTION

- **SPEED Protocol** (Sonographic Protocol for the Emergent Evaluation of aortic Dissections)
 - PSLA: assess for presence of a pericardial effusion & measure aortic outflow tract (AOFT)
 - Inner lumen to inner lumen within 2 cm of aortic valve annulus
 - Abdominal aorta scan: assess for presence of intimal flap
- US findings
 - Rule In:
 - Intimal flap that moves or undulates —nearly 100% specific (PPV); pathognomonic
 - Secondary (sensitive not specific):
 - AOFT >3.5cm in PSLA
 - <3.5 cm AOFT - 98% sensitive for excluding Type A
 - Pericardial effusion



AORTA

Indications for Aortic US:

- Abdominal/back/flank/chest pain ≥ 50
- Syncope ≥ 50
- Hypotension
- Suspected AAA &/or rupture
- Family history
- Neurovascular deficit
- All men ≥ 65 with h/o smoking (screening)

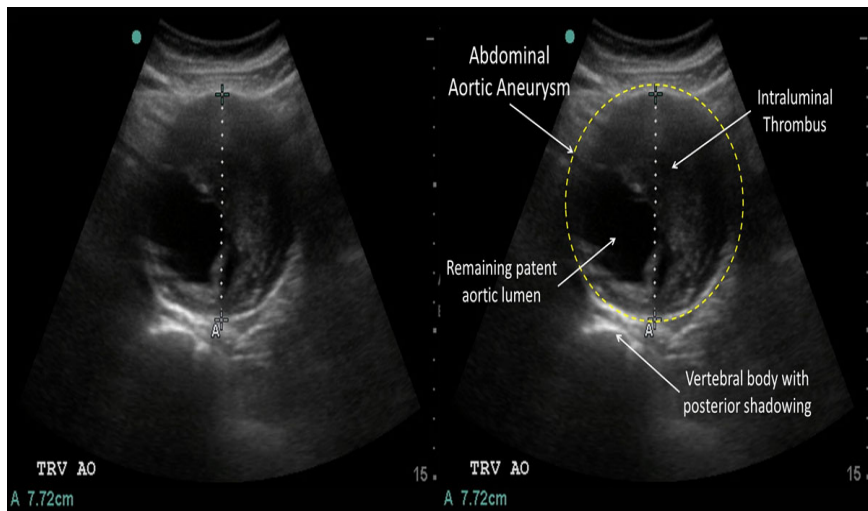
Key Findings:

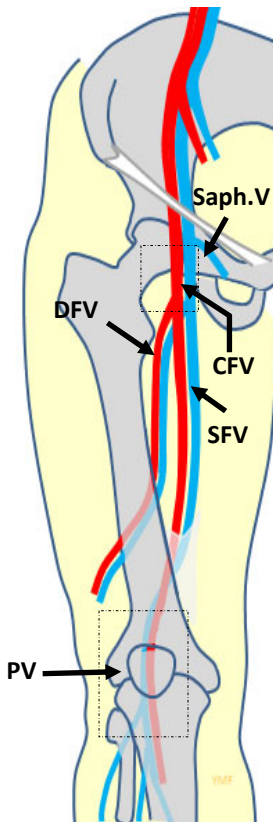
- AAA (diameter $> 3\text{cm}$)
- Aortic dissection (undulating intimal flap)

Notes

Measure outside wall to outside wall for AAA

Beware of missing clot in AAA by misidentifying false lumen as entire aorta





At least 2 video clips

1. Common Femoral Vein (CFV) with and w/o compression

- Image above saphenous vein branch until CFV splits into femoral and deep femoral veins.
- The entire region is about 7 cm long.
- Compress every 1 to 2 cm of this region.
- CFV medial to artery. **(NAVEL)**

2. Popliteal vein with and w/o compression

- Image area from above popliteal fossa (artery and vein will come from near bottom of screen) until the vein trifurcates into the anterior and posterior tibial and peroneal veins.
- Popliteal vein is typically superficial and lateral to artery. Compress every 1 to 2 cm of this region.

*Place the patient in reverse Trendelenburg and in the lateral decubitus position to augment view.

Key Findings:

- Non-compressible vein
- Visual thrombus in lumen

Remember Anatomy – these veins are always paired with an artery.

- Don't let superficial veins or lymph nodes fool you, esp. on obese pts.

All patients should be counseled to get a repeat DVT ultrasound

- **1 week later to detect propagated calf vein clots unless a d-dimer during this ED visit is negative.**

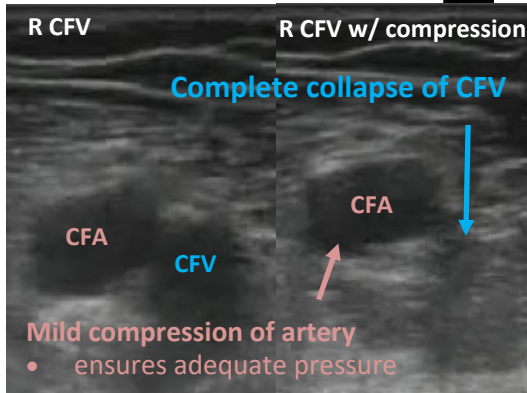
Be sure to compress until the vein walls touch.

- Failure to touch means a DVT.
- Push hard enough to make artery collapse if not sure

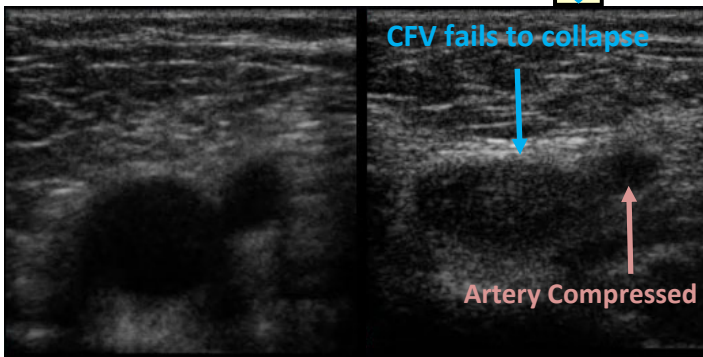
DVT

Normal CFV:

- Vein completely collapses

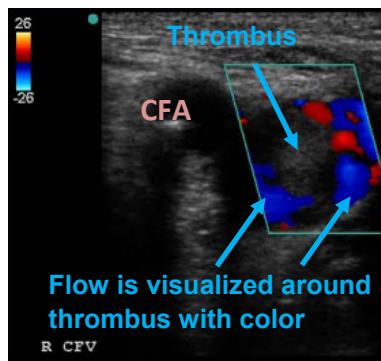


L CFV: Occlusive DVT



R CFV :

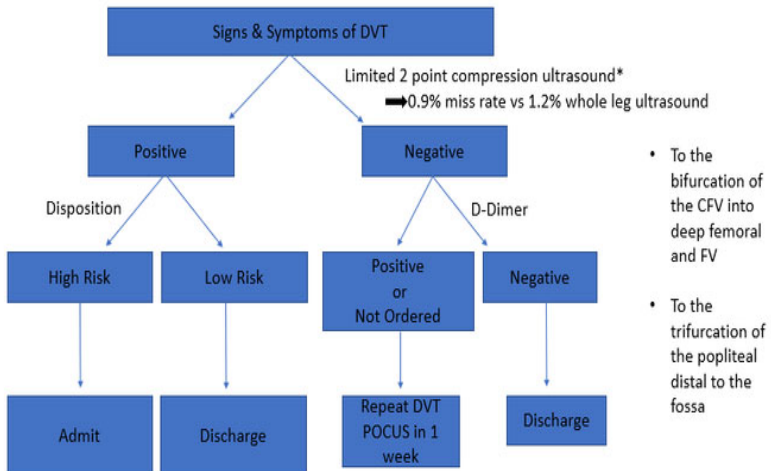
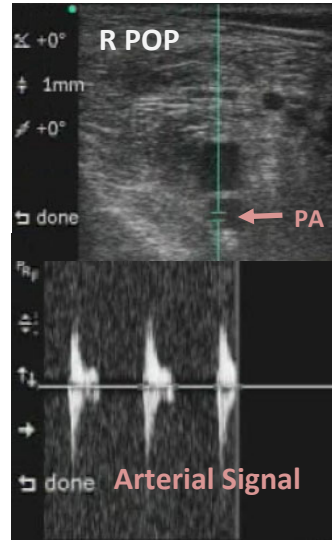
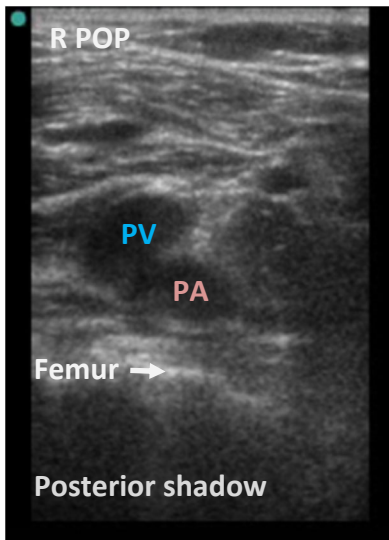
- Non—Occlusive DVT



DVT

Popliteal:

- Increase depth to visualize femur in popliteal area.
- Utilize Doppler to distinguish artery and vein if uncertain.

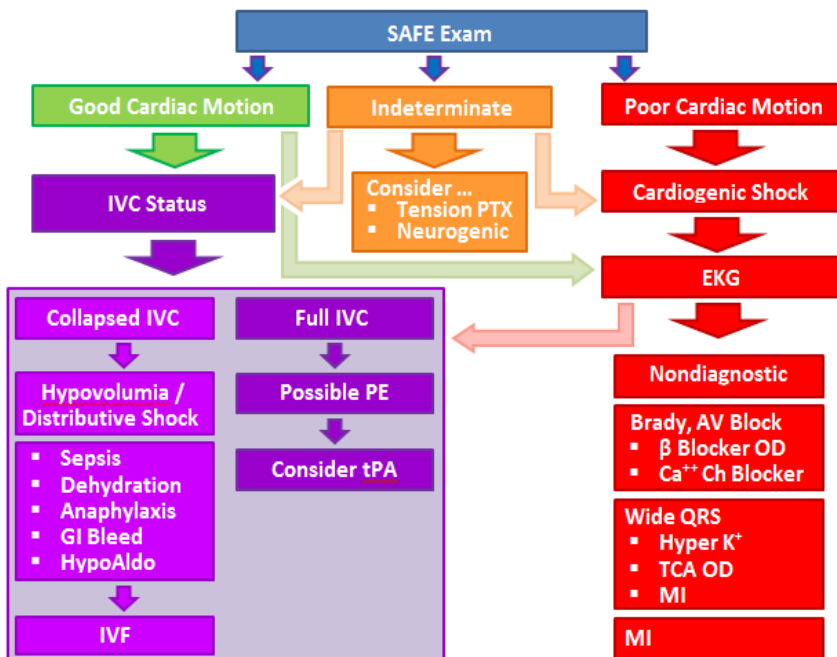


*Bernardi E, et al. Serial 2-Point Ultrasonography Plus D-Dimer vs Whole-Leg Color-Coded Doppler Ultrasonography for Diagnosing Suspected Symptomatic Deep Vein Thrombosis: A Randomized Controlled Trial. *JAMA*. 2008;300(14):1653–1659. doi:10.1001/jama.300.14.1653

UNDIFFERENTIATED HYPOTENSION—SAFE EXAM

SAFE (Sonographic Assessment For the Emergently ill)

- a.k.a. RUSH Exam (Rapid Ultrasound for Shock and Hypotension)
- **Combined Ultrasound Scans:**
 - **eFAST**
 - Free Fluid (Trauma/ ectopic/ rupture AAA, etc.)
 - Assess for bilateral lung sliding (PTX)
 - **Cardiac** (single subxiphoid view)
 - Tamponade (effusion + RV collapse in RV diastole)
 - Global Cardiac Function—good/moderate/poor
 - RV strain (PE) +/- DVT study
 - **AORTA**
 - AAA or Dissection
 - **IVC** (measure at End Expiration 1-2cm distal to right atrium)
 - <1cm or 100% collapse = likely hypovolemic or distributive shock
 - >2cm or no collapse = obstructive or cardiogenic shock
 - No strong data to support IVC with respect to volume status; or fluid tolerance or responsiveness

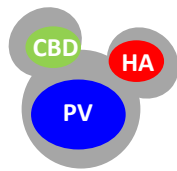


RUQ / BILIARY

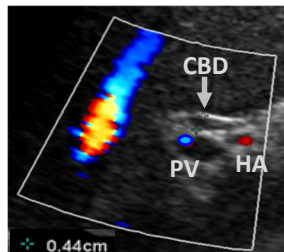
- Start in the epigastrium in the longitudinal plane.
- Move laterally along liver edge to identify the first cystic structure
- Note: “longitudinal” and “TRV” views are w/ respect to gallbladder axis

Usually 2 video clips and 2 still images

- **Gallbladder:** 2 videos and 1 still image
 - 1 sagittal/longitudinal view: sweep right to left with a video clip
 - 1 TRV view: sweep top to bottom with a video clip
 - 1 TRV view still image with GB wall measured (anterior wall best)
- **Portal Triad:**
 - Portal vein, hepatic artery, and common bile duct (CBD)
 - One still image of the porta hepatis (“Mickey Mouse sign”) with calipers measuring the size of CBD, which is typically the right or cephalic “ear”. 20-30% of the time it will be left or caudad.
 - Measure inner lumen of CBD (do not include the walls)



“Mickey Mouse Sign”



- Use color flow to distinguish hepatic artery from CBD.
- CBD often found following the GB neck (longitudinally) along the middle lobe fissure towards the portal vein.
- Complete sweep of the liver from right to left to look for intrahepatic ductal dilation.
- If unable to visualize try: ask patient to take a deep inspiration, left lateral decubitus position, use phased array probe between ribs

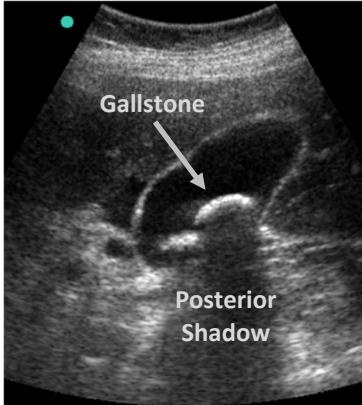
Indications:

- RUQ/epigastric pain or tenderness, Nausea/vomiting
- Suspected cholecystitis/biliary colic
- Risk factors: Obese, female, fertile, 40s

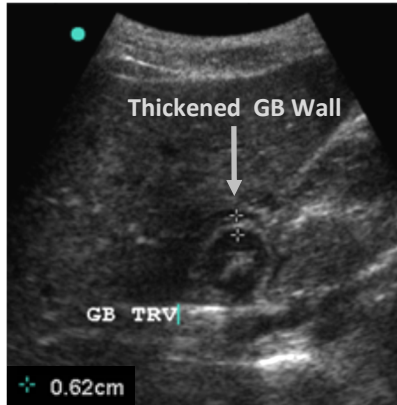
RUQ / BILIARY

Key Findings:

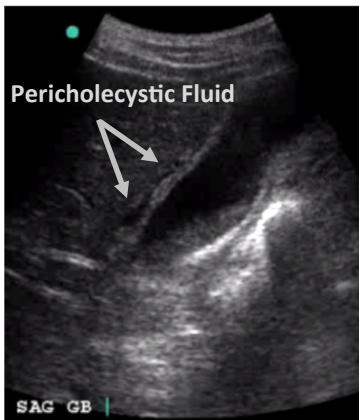
- Sonographic Murphy sign: maximal ttp overlying the GB



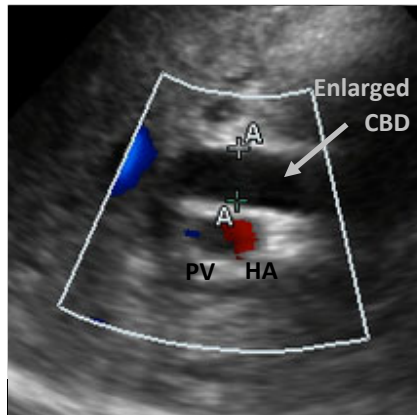
- Gallstones



- Wall Thickness (<3mm normal)



- Pericholecystic fluid



- Enlarged CBD

CBD measurements (inner wall to inner wall)

- <5mm = typically normal
- 5-7mm = clinically correlate
- >7mm = typically abnormal
- Enlarged s/p cholecystectomy and 1mm each decade >50yo (i.e. 70yo with 7mm CBD is normal)

*Ultrasound 99% sensitive for gallstones

**Gallstones + 1 of the 4 findings above = 90% PPV for cholecystitis

***Unable to visualize GB: surgically absent, WES sign, porcelain GB

KIDNEYS

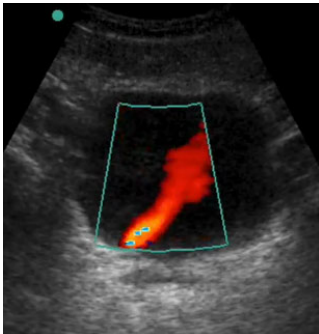
Always scan both kidneys and bladder

2 videos of each kidney and 2 videos of bladder

- Longitudinal video sweep
- Transverse video sweep
- The kidneys are retroperitoneal so start in the sagittal orientation with your hand against the bed then move anteriorly. Ribs 11-12 for right kidney and slightly higher for the left.

In real time slowly sweep the entire width and length to avoid missing small abnormalities!

- **Bladder** - at least 1 TRV bladder sweep from above level of prostate/ vagina (i.e. above level of UVJ)
 - In transverse, **set “clips” to retro and use color flow.**



- Wait for ureteral jets from UVJ bilateral and capture with video. Usually requires 2 separate videos. May take a few minutes to see jets.

Indications:

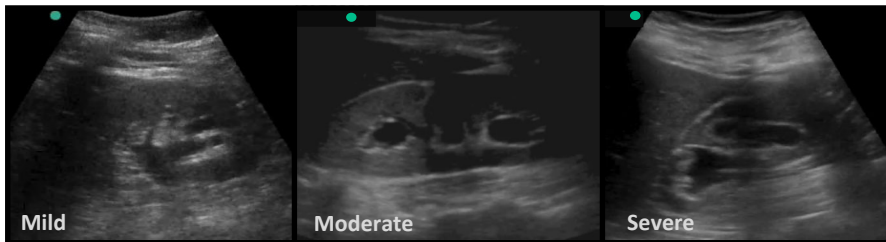
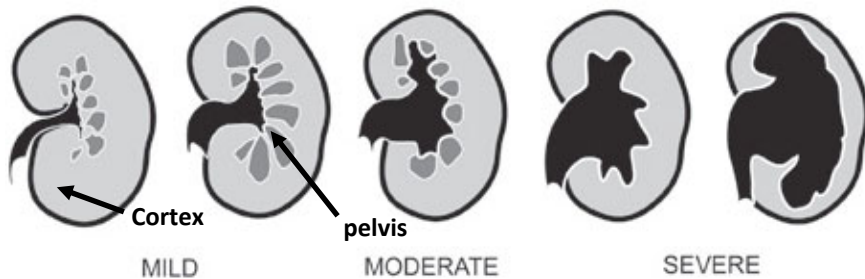
- Flank pain, hematuria
- Febrile UTI/pyelonephritis
- Suspected nephrolithiasis
- New onset Acute Renal Failure (obstructive uropathy)
- ***Check for AAA in all patients ≥ 50 with hydronephrosis**

KIDNEYS

Key Findings:

- **Hydronephrosis**

- **Mild** - renal pelvis dilatation
- **Moderate** - partial cortex involvement
- **Severe** - entire medulla replaced with black and cortex thinned

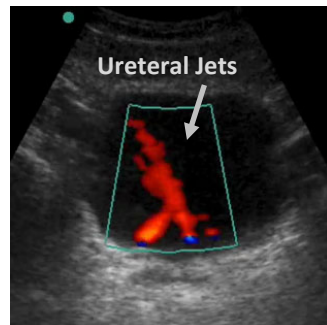


- **Unilateral absent jet**

- Bilateral jets & absence of hydronephrosis — “rules-out” obstructing stones

- **Kidney stone in ureter or bladder** (rarely seen on POCUS)

hy-



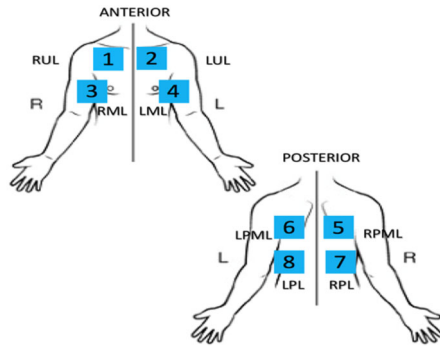
Limit CT scanning for routine kidney stones. Only scan obstructed, infected stones or in high risk patients*

*Smith-Bindman R, et al. US vs CT for Suspected Nephrolithiasis. NEJM 2014;371(12):1100-10.

LUNG

Required Views:

- Anterior
- Lateral
- Posterior

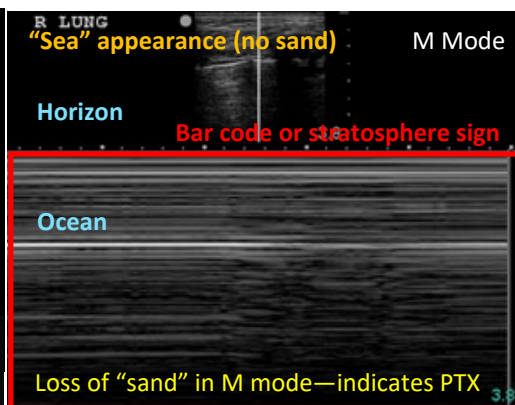
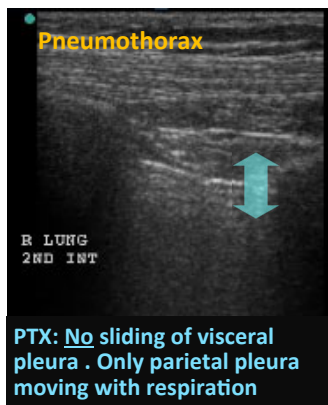
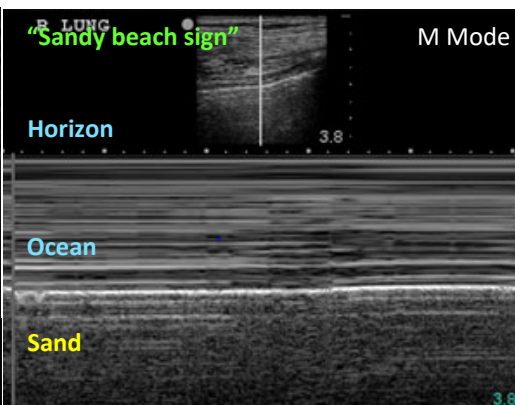
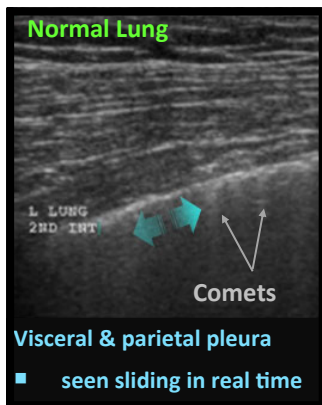


5 L's of LUS

- 3 Lines: A-, B-, & pleural line
- Liver
- Liquid

Pneumothorax:

- Absence of lung sliding along pleural line; no B-lines; normal A-lines
- M-Mode: "Bar Code Sign" for lack of sliding
- Supine: 2-4 ICS; Upright: 1-3 ICS



LUNG

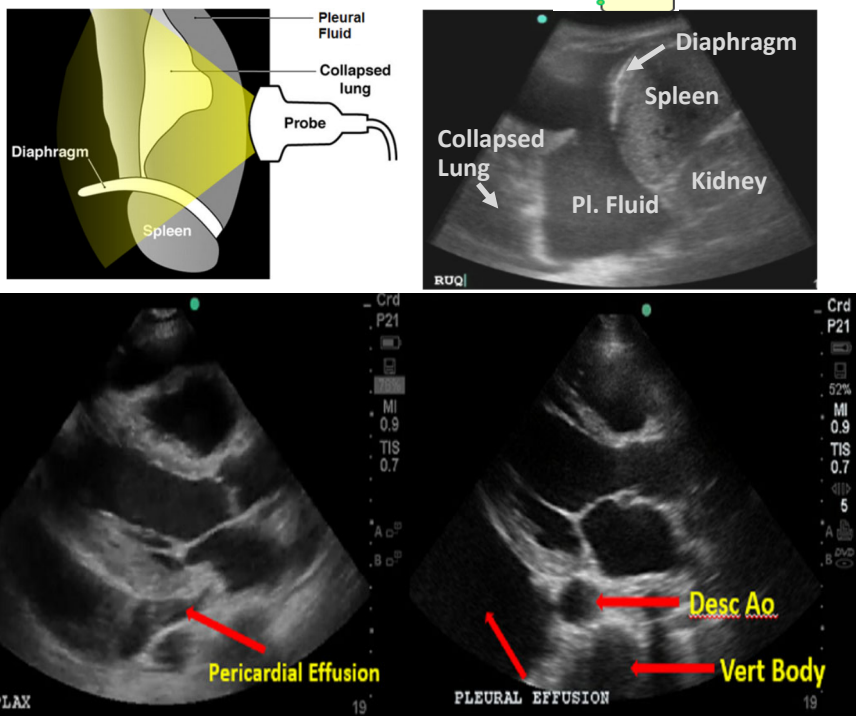
Pulmonary Edema (or)

■ B Lines:

- Represents an interstitial process
 - Focal: pneumonia, contusion, PE
 - Diffuse: edema (smooth pleural line); fibrosis (irregular pleural line)
- Extend from pleura to the bottom of screen
 - Do not confuse w/ comet tails which do not extend to bottom of screen, and are not pathological
- A-lines (reverberation artifact from pleural line) typically absent

Pleural effusion (Liquid)

- Start at liver/spleen then move cephalad above the diaphragm



- Pleural effusions are confined to each hemithorax.
- Pericardial effusions cross the midline separating the descending aorta

LUNG

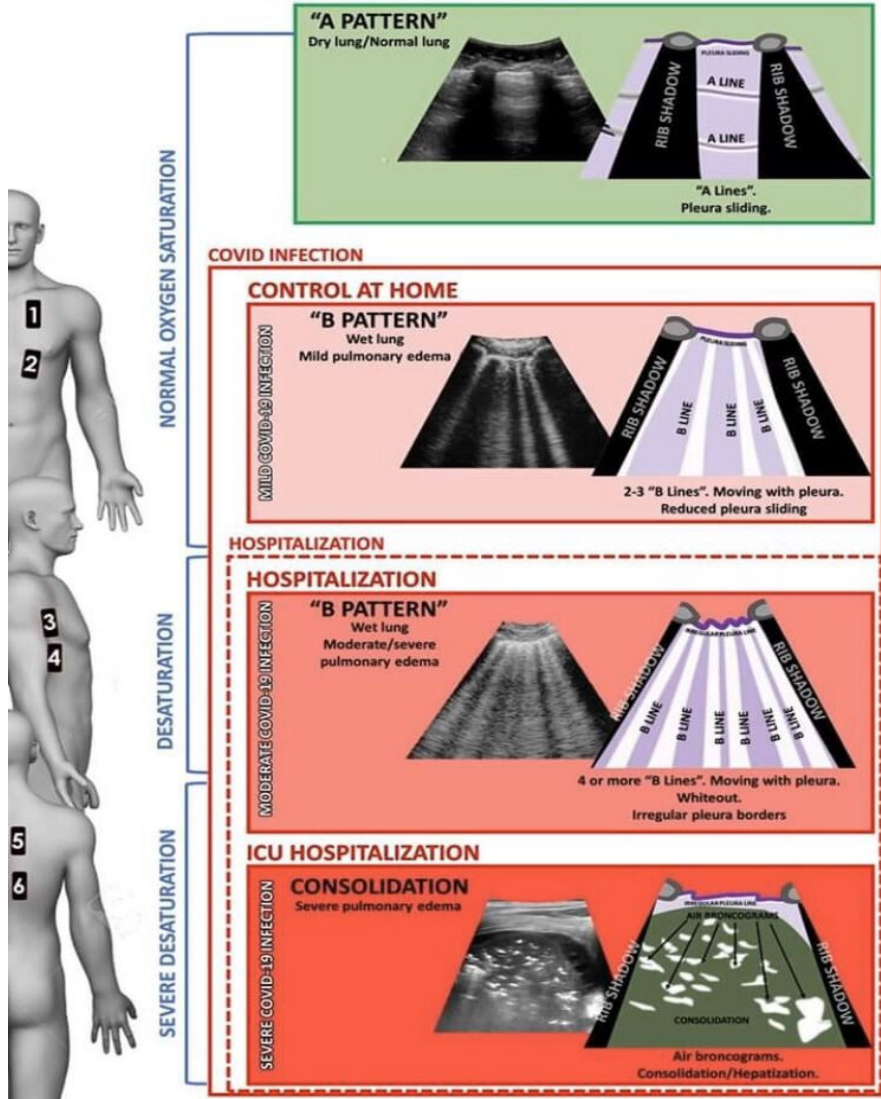
Pneumonia

LUNG ULTRASOUND COVID-19 TRIAGE PROTOCOL

Arrixaca
M. U. YRGEN DE LA ARRIXACA

Dr. M. Carmen Martínez López
Dr. Carlos Rodríguez Escobar
Dr. Alejandro Ortega

Protocol not validated. Interpretable according to the context



Gibbons RC, Magee M, Goett H, Murrett J, Genninger J, Mendez K, Tripod M, Tyner N, Costantino TG. Lung Ultrasound vs. Chest X-Ray Study for the Radiographic Diagnosis of COVID-19 Pneumonia in a High-Prevalence Population. J Emerg Med 2021;60(5):615-25.



WHY learn lung ultrasound for COVID-19?

Because experience from the medical community in China and Italy has demonstrated that it helps in 3 key areas:

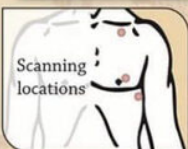
1. COVID-19 disease demonstrates a particular pattern of findings on lung ultrasound that can help differentiate it from other causes of acute dyspnoea.
2. Proning of patients is a mainstay of managing ventilated patients with refractory hypoxaemia. The changes responsive to proning can be seen easily on ultrasound.
3. Lung ultrasound can be done at the bedside easily and may well be as sensitive as CT for these things, without the significant logistical issues of obtaining a CT within the context of a pandemic.

So what does normal lung look like on ultrasound?

It is simple and homogeneous and grey. It sits between ribs when the probe is aligned cephalad-caudad. The ribs cast black shadows. A thin, bright white pleural line with small speckles on it sits atop the lung between the ribs and moves back and forth with each breath.

In much of the lung there is a normal, parallel, white line, an A-line, below the pleura (it will return with disease resolution).

At the base you won't see diaphragm, just lung, then straight to organs.



Scanning locations

Where do I scan the lungs?

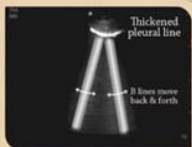
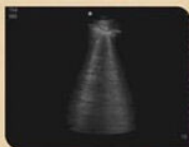
An ultrasound probe is placed to scan at the apex of the lung, baso-anteriorly and postero-laterally (posterior axillary line). This will pick up most pathology, even though some may not make it to the pleura due to aeration.

What probe do I use?

A low-frequency, curvilinear probe will allow you to see between multiple ribs. Better for obese or oedematous patients. A high-frequency linear probe will show between just one pair of ribs, but with better, shallower, resolution.

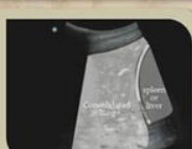
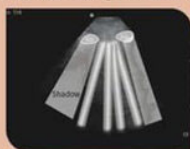
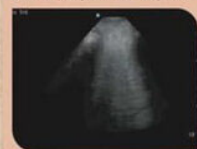
Early / Mild COVID-19 disease

COVID-19 has a particular pattern in early and mild disease. This involves development of lung ultrasound B lines. These are white lines that arise from the pleura and descend into the lung. They move with breathing. They spread out a little and don't fade as they descend. You may normally have one or two at the lung base. The thin pleural line thickens and develops a lumpy texture to it. Areas with lots of B lines are next to areas with none, causing 'skip lesions'. The pleural line will also thicken causing discrete 'subpleural consolidations'. These features initially appear anteriorly in COVID-19.



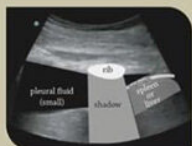
Progressing / Moderate COVID-19 disease

As the disease develops, the B line numbers increase in areas affected, from mainly basal to other areas of the lungs. The B lines also increase in number to become coalescent. In COVID-19 disease this is referred to as **Pattern 1**. With increasing B lines and progressive hypoxaemia fluid balance becomes very important. B lines increase in number as the extravascular lung fluid increases, such as in hypervolaemic states. Fluid removal may be required or increasing the PEEP may improve this. Response would be seen with reducing B line numbers.



Severe COVID-19 disease

This patient group will likely be already ventilated. The lung will be progressively de-aerated. Alveoli will be full of fluid, secretions or there may be a secondary infection. This lung consolidation can now be easily seen on ultrasound. Changes are mainly postero-basal. It can cause the lung to look like the liver, "hepatification". (Scan over the liver to see what this might look like). Pleural effusions may also develop. They form black areas of varying size between the ribs and the lung. In COVID-19 these changes are referred to as **Pattern 2**. These findings suggest proning may be of value. Response would reduce these ultrasound changes toward normality with return of A lines.



Where to from here?

Governance is importance. Do not over-call interpretations. If in doubt seek expert advice if available or use other imaging modalities. All imaging must be taken in its clinical context.

Ultrasound can be used to diagnose pneumothorax, surgical emphysema, etc., but has been omitted here as it is less relevant to COVID-19.

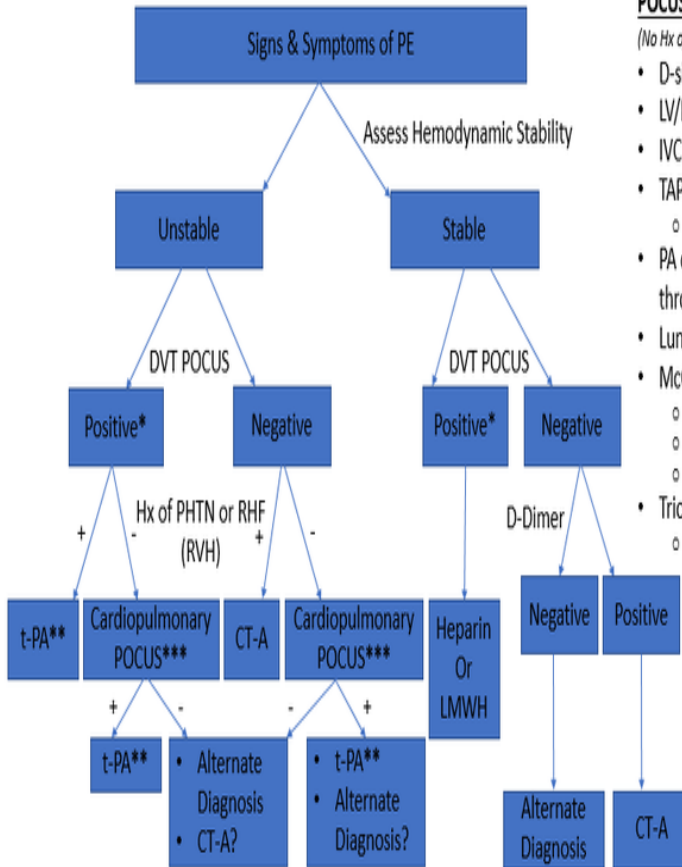
There is a lot more lung ultrasound you can learn. See www.ics.ac.uk for details of the FUSIC lung ultrasound training programme and other modalities.



LUNG

Pulmonary Embolism

- Subpleural consolidations
- Focal B-lines
- Combine with cardiac and DVT POCUS



POCUS PE Findings***

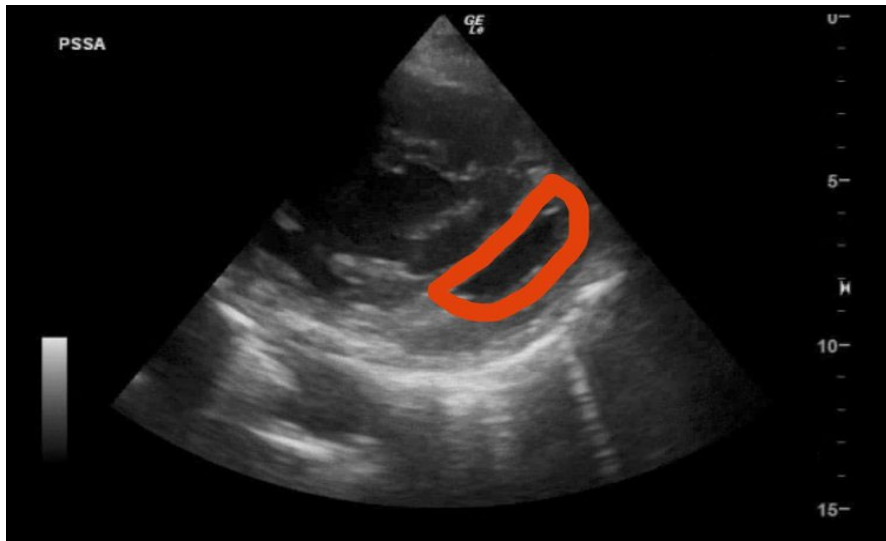
(No Hx of Pulm HTN or RHF)

- D-sign (septal bowing)
- LV/RV < 0.6
- IVC plethora
- TAPSE < 1.6cm
 - Severe < 1.0cm
- PA or Right Heart thrombus
- Lung consolidation
- McConnell's Sign
 - Rare but specific
 - Medial wall akinesis
 - Apical sparing
- Tricuspid Regurgitation
 - More likely in chronic conditions

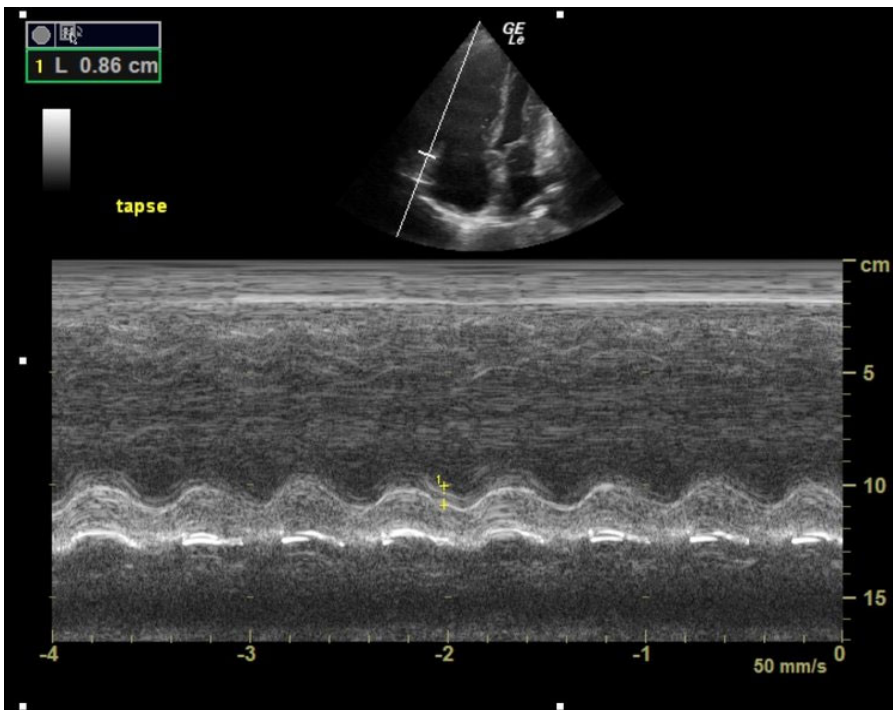
*30-40% of PEs will have a +DVT study

**Consider discussion with ICU &/or PERT team

LUNG

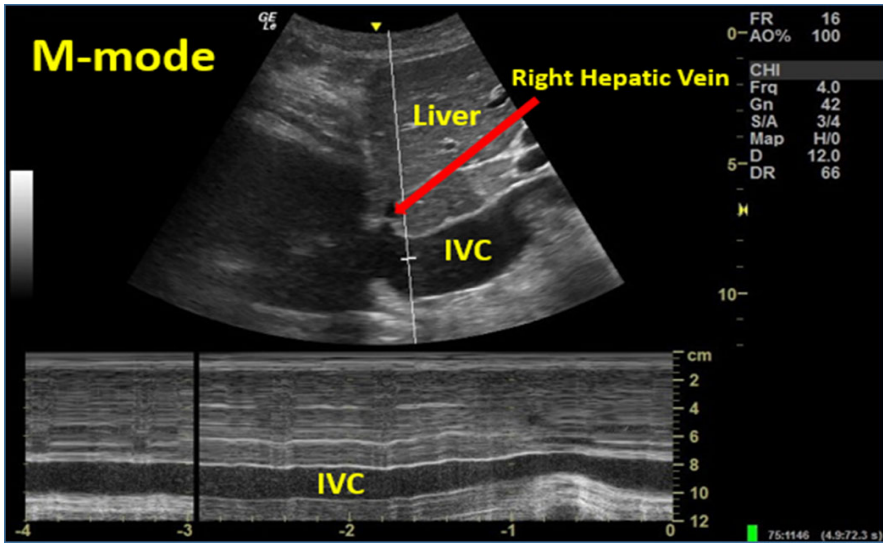


D-sign of RV strain

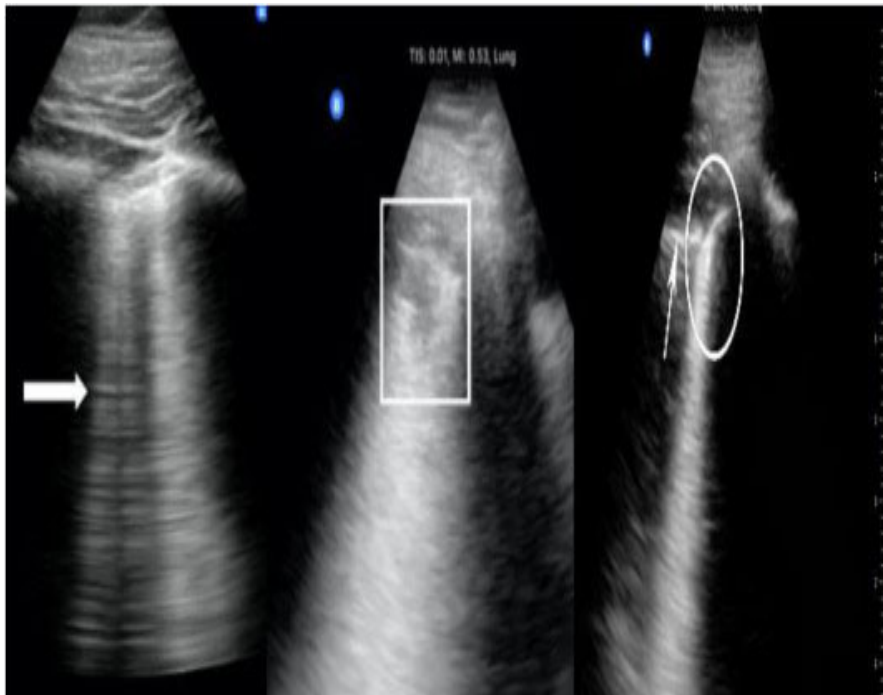


Diminished TAPSE < 1.5cm

LUNG



IVC plethora



B-lines and subpleural consolidations

PELVIS

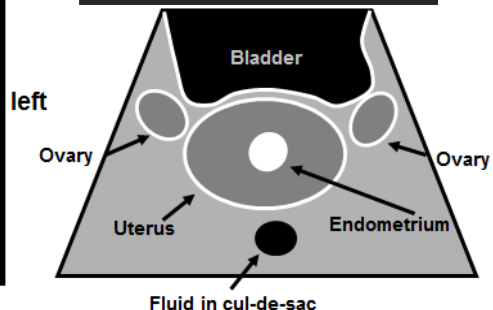
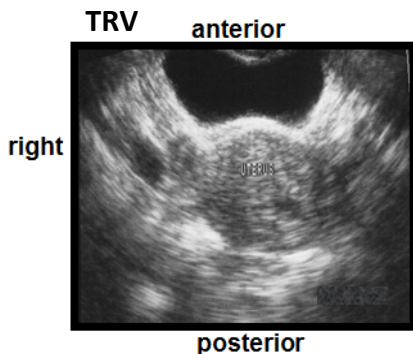
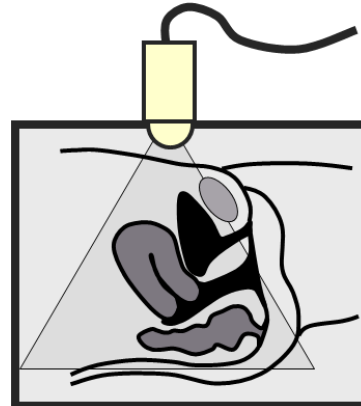
Transabdominal

- Best with full bladder

Required Views

Uterus:

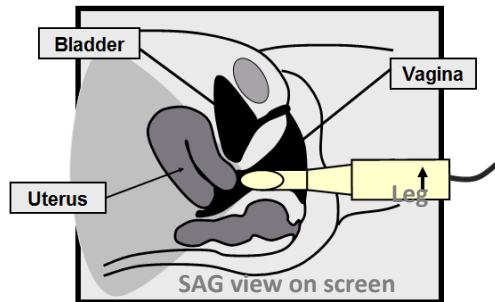
- **Sagittal view(s)**
 - Visualize vaginal stripe, cervix, and endometrial stripe.
- **Transverse view(s):**
 - Video clip—Sweep top of fundus to cervix
- **If gestational sac found,**
 - Zoom in to clip the fetal pole with FHT, do not sweep.
 - Still image of CRL (BPD or Femur Length if >10 weeks)
 - Still of m-mode with FHR
- **Adnexa (best with intracavitary probe)**
 - Video—sweep each adnexal in transverse plane
 - Ovaries/ tubes should be between uterus and iliac vessels
- **If IUP >10 weeks**—no need for endo-cavitary ultrasound



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Endovaginal (all pregnancies <10 WGA)

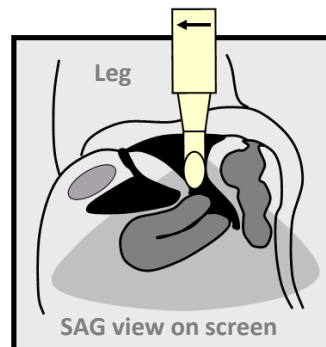
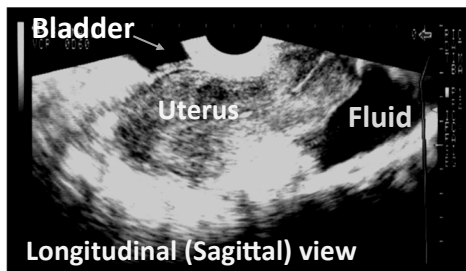
- Best with empty bladder
- Transabdominal view **FIRST** to identify uterine position (anteflexed, etc)



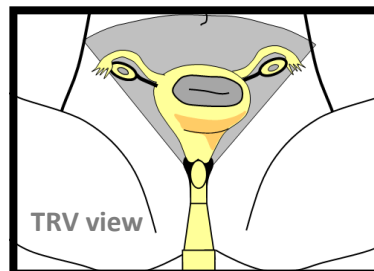
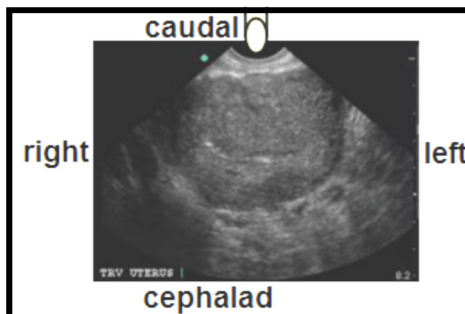
Required Views:

(Same as transabdominal)

- **Longitudinal**



- **Coronal** (analogous to TRV)



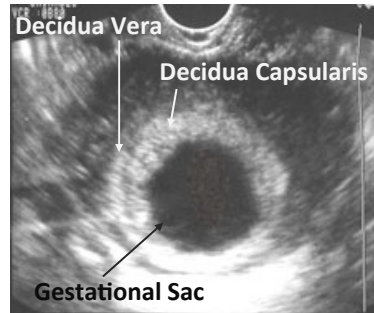
- **If IUP not identified or ectopic, do RUQ view to look for FF.**

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Intrauterine Pregnancy (IUP)

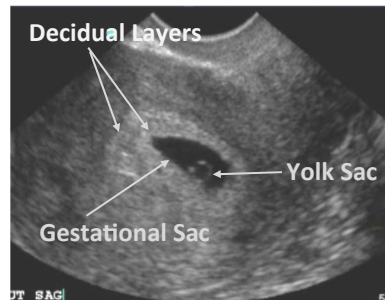
Gestational Sac

- Eccentric to endometrial stripe
- **Double Decidual Sign**—2 echogenic rings that surround a true sac
 - Decidua Capsularis (inner ring layer)
 - Decidua Vera (outer ring layer)
 - Highly suggestive but **NOT** definitive sign of IUP
- Confirmation of IUP requires a yolk sac or fetal pole with FHT



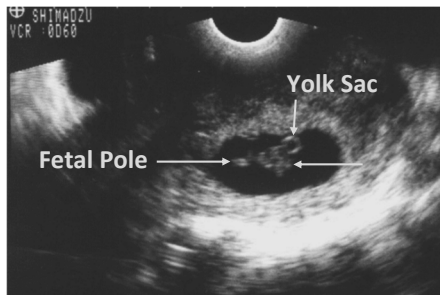
Yolk Sac—"Ring"

- 100% predictive of IUP
- 3-7mm sphere w/in gestational sac
- 1st embryonic structure visible, @% weeks
- Disappears after 10 -12 weeks
- Gestational sac >25mm w/o yolk sac
 - Blighted ovum



Fetal Pole

- Appears 2 days after yolk sac
- As small as 2mm
- >7mm w/o FHT= IUFD
- **CRL (crown rump length)** - Do not include yolk sac
 - Most accurate measure for dates
 - Always obtain to date pregnancy



PELVIS

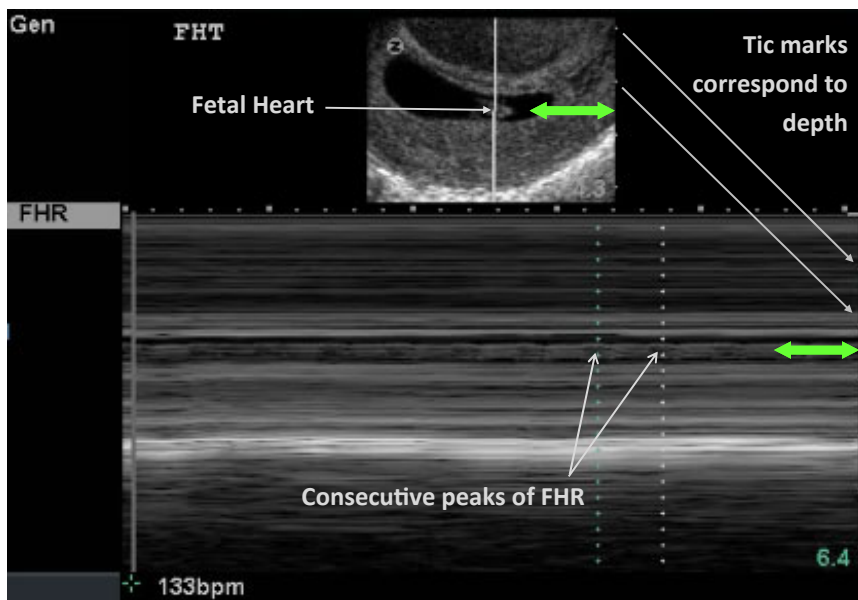
Fetal Heart Motion or Tones (FHM or FHT)

- Appears @5.5 weeks EGA
- Should always be present if fetal pole >7mm
- Symptomatic patients w/
 - FHM noted at 6 weeks — 20% SAB rate
 - FHM noted at 8 weeks — < 5% SAB rate

Average Fetal Heart Rate (FHR)

- 6 weeks = 110
- 7 weeks = 125
- 8 weeks = 160
- Record FHR in M-mode (M-mode shows depth and tissue motion)
 - Find a repetitive pattern in tracing that is at same depth as fetal heart. Fetal heart depth can be seen on small image at top of screen. (Use tic marks to judge depth. Tic marks on small image are same depth as tic marks on tracing.)
 - Measure peak to peak, or trough to trough

***Do not use Doppler for FHR**

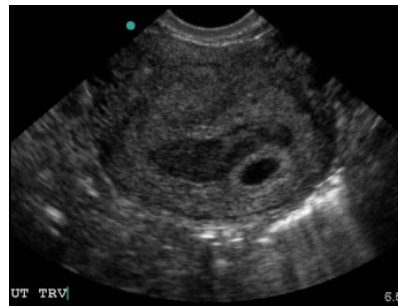
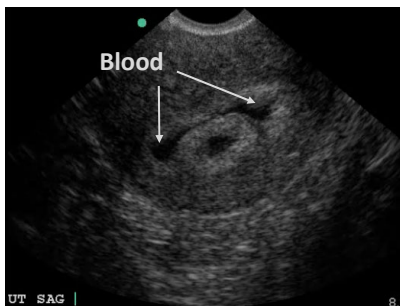
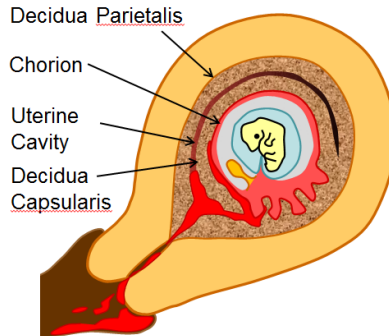


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Other US Findings:

Subchorionic Hemorrhage

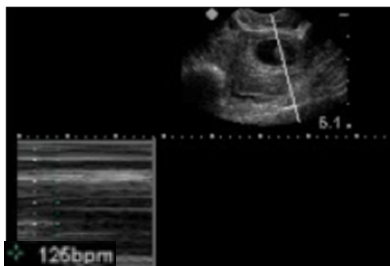
- 20% of 1st Tri. bleeding
- >50% gestational sac → increased risk of miscarriage
- May vary from echogenic to anechoic



Ectopic Pregnancy

■ **Definite Ectopic**

- Yolk Sac or fetal pole w/ fetal heart tones outside uterus

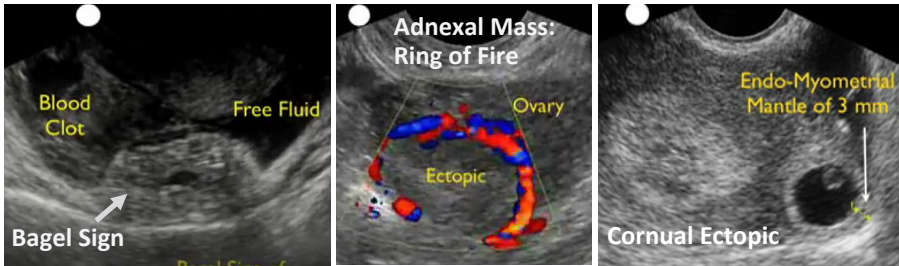


■ **Ectopic Signs**

- Bagel Sign—thickened fallopian tube
- Ring of Fire—increased vascularity around gestational sac
- Adnexal Mass
- Large Free Fluid
- Myometrial Mantle <8mm (interstitial or cornual ectopic)

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■ Ectopic Signs (continued)



Sonosite.com (<https://www.youtube.com/watch?v=iui0HF95XAw>)

■ Probable Ectopic - Empty uterus w/ ...

- **Large Free Fluid:**
 - ✓ cul de sac
 - ✓ Morrison's pouch
 - 30-60% sensitive, 86% PPV
- **Echogenic Free Fluid:**
 - increases PPV
- **Adnexal Mass:**
 - 60-80% sensitive, 90% PPV



Disposition

- IUP proven -
 - Use threatened miscarriage instructions, f-u w/ OB/Gyn prn
- Indeterminate - Obtain Radiology US
 - Quant > 3000 - Consult OB
 - Quant <3000 - Beta Book
 - If unstable and +FF on POCUS, call OB stat.
 - These have a 95% chance of being ruptured ectopic
 - Should go straight to OR
- Definite Ectopic
 - Unstable → straight to OR
 - Stable → OB consult5

Under Documents in EPIC

- Choose Indeterminate Ultrasound in Pregnancy Discharge instruction sheet which properly informs patient of risk of early IUP vs. miscarriage vs. ectopic.

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Indications:

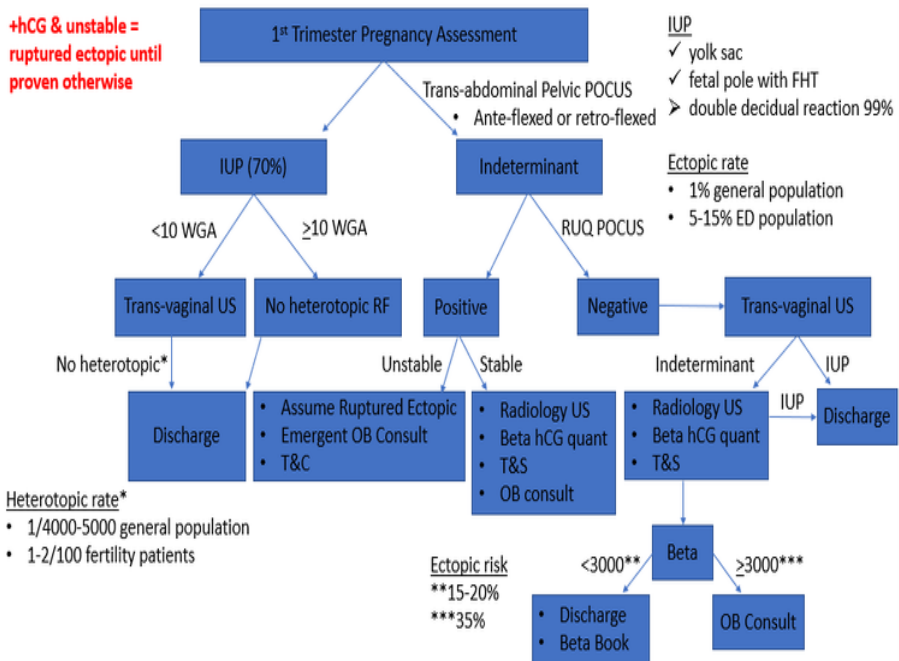
1st trimester pregnancy with pain or vaginal bleeding

Key Findings:

- IUP defined by either yolk sac (if <6weeks) or fetal pole with FHT
- Definite ectopic or free fluid
- Indeterminate – either an empty uterus or lack of yolk sac or fetal pole with FHT
 - These must have a Beta-HCG and a radiology ultrasound
 - Possibly and OB/GYN consult or added to beta book

Systematic, real-time scanning through all planes more important than still images for QA

- ***Avoid doppler on fetal hearts (Use M-mode)**
- **If <10 weeks, perform endovaginal US with sweep of each adnexa to assess for heterotopic (1/4000-5000): fertility meds**



PELVIS

Per New England Journal of Medicine Guidelines (PM Doubilet et al, 2013), findings diagnostic of a pregnancy failure are:

1. Crown-rump length $> 7\text{mm}$ and no heartbeat
2. Mean sac diameter of $>25\text{mm}$ and no embryo
3. Absence of embryo with heartbeat >2 weeks after a scan that showed a gestational sac without a yolk sac
4. Absence of embryo with heartbeat >11 days after a scan that showed a gestational sac with a yolk sac

E-FAST

Technique (use abdominal probe)

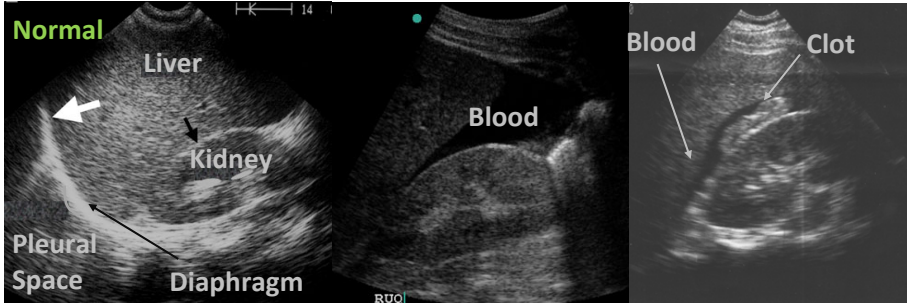
- Patient supine
- Start in RUQ, go clockwise
- RUQ > Subxiphoid (SX) > LUQ > Suprapubic > Lungs
- Some debate re: beginning w/ RUQ or Subxiphoid
 - If blunt trauma patient arrives dead or near dead, look at heart 1st
 - Hypotensive blunt trauma patients:
 - ~ 2/3 have hemoperitoneum dx on RUQ US
 - <1% have tamponade
- Adjust gain & depth for SX

Statistics

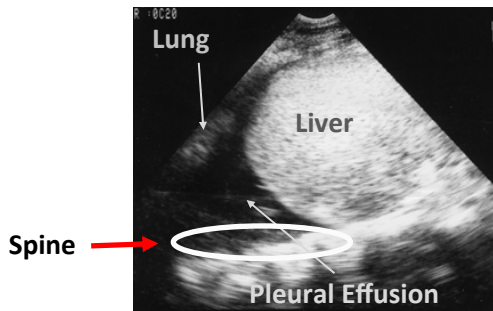
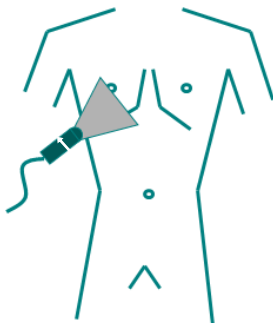
- Hemodynamically stable 85% sensitive
- Hemodynamically unstable @100% sensitive
- Most common views to visualize free fluid
 - 75% RUQ
 - 35% suprapubic
 - 30% LUQ
 - 1% SX
 - Only 1% of patients will have +LUQ only

E-FAST

RUQ—longitudinal orientation

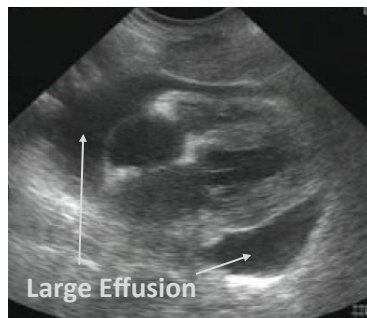
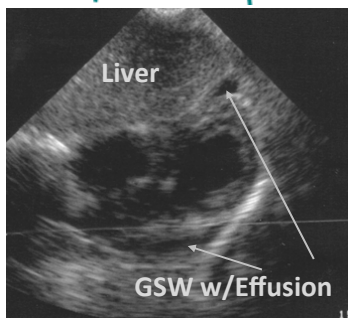
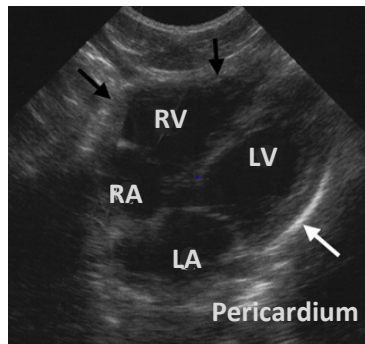


- **Morrison's pouch** (a.k.a. Hepatorenal Fossa)
 - Trendelenburg improves sensitivity
- Be sure to view:
 - Posterior pleural space (hemithorax)
 - Diaphragm
 - Left liver edge
 - Lower pole of R kidney/ cephalad colic gutter
- **Blood** is anechoic (center image above)
- **Clots** are hypo or hyperechoic
- **Perinephric adipose** - often in obese pts.—appears gray—adjust gain

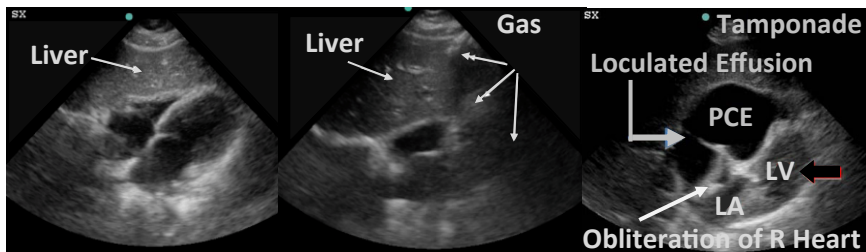


E-FAST

Subxiphoid (other views may be used as needed, esp PSLA)



- Use liver as the acoustic window
 - w/o liver bowel gas can scatter the image
- Adjust depth so heart appears distal to the liver
- Adjust gain so blood in ventricles is black
- Be sure to see both superior and inferior pericardial borders
 - Look for pericardial effusion/ hemopericardium



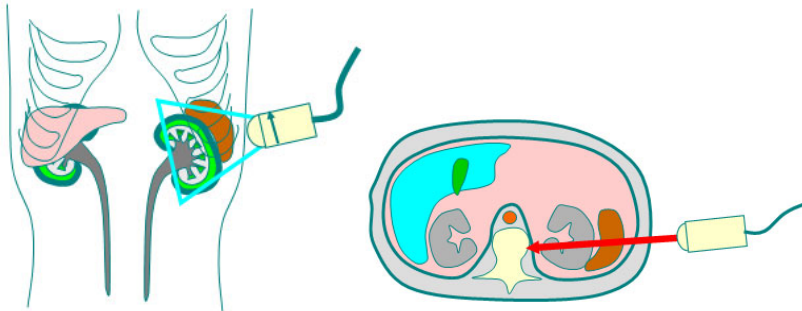
<https://sonospot.wordpress.com/2013/07/12/sonotips-tricks-the-fast-scan-the-cardiac-views-foamed/>

<http://westjem.com/articles/cardiac-tamponade-after-minimally-invasive-coronary-artery-bypass-graft.html>

E-FAST

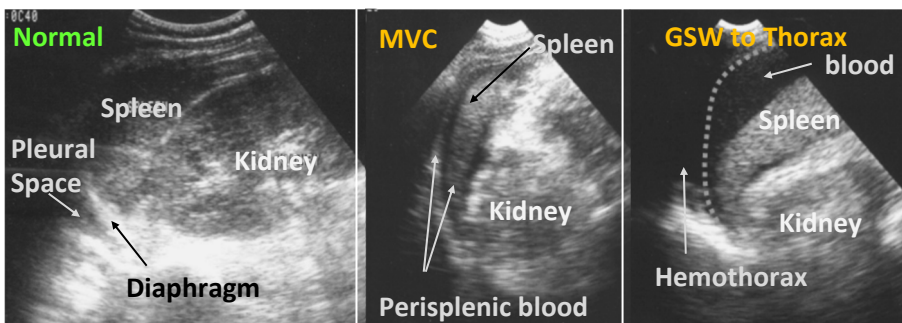
LUQ:

- Technically more difficult:
 - Spleen is a small acoustic window
 - more interference with bowel gas
 - Position probe at posterior axillary line @ 10 rib space
 - Angle or rotate probe to avoid rib shadowing
 - Modest inspiration improves view



▪ Other Difficulties:

- Splenic intraparenchymal blood is echogenic & difficult to identify
 - Severe splenic injuries can look normal
- If scan too soon—not enough blood accumulation to identify
- Free fluid does not always settle in splenorenal fossa
- Try to view:
 - Posterior pleural space, diaphragm, spleen, splenorenal space, kidney, lower pole of L kidney/cephalad colic gutter

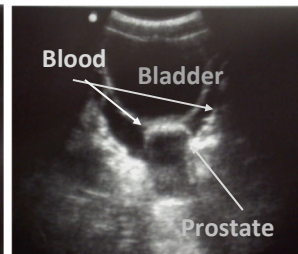
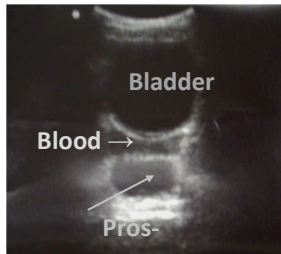
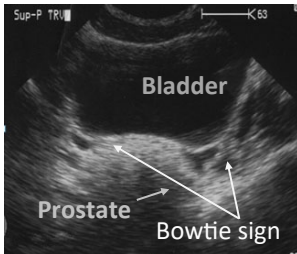
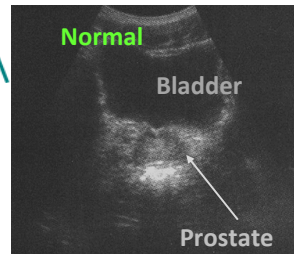
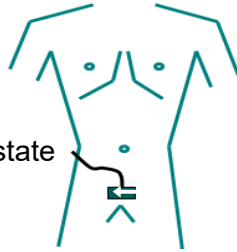


E-FAST

Suprapubic:

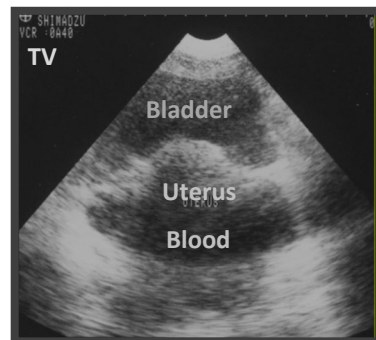
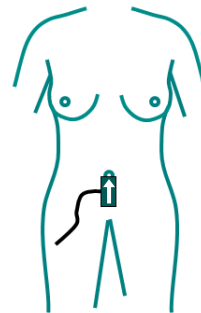
Men:

- Transverse view
- Bladder above prostate



Women:

- Longitudinal view
- Visualize uterus & bladder
- Pouch of Douglas (rectouterine)



FAST

Indications:

- All blunt thoracoabdominal trauma
- All penetrating thoracoabdominal trauma

Key Findings:

- Intraperitoneal Hemorrhage
- Pericardial effusion (+/- tamponade)
- Hemothorax
- Pneumothorax (requires view of the 1st-4th intercostal spaces along the midclavicular line); absence of lung sliding
 - Upright patient 1st-3rd IC space
 - Supine patient 2nd-4th IC space
 - Decrease gain to better visualize pleural line sliding

OCULAR

Indications

- Visual complaints
- Ocular trauma

Views

- Transverse sweep
- Longitudinal sweep
- Still image & measurement of optic nerve sheath diameter (ONS)
- Still transducer with recording of extraocular movements (EOM) & consensual light reflex

Pathology

- Vitreous detachment (VD) & hemorrhage (VH)
- Retinal detachment (RD)
- Central retinal artery occlusion (CRAO) (*case reports*)
- Lens dislocation (*case reports*)
- Globe rupture
- Retinal bulbar hematoma (RBH)
- Papilledema and enlarged ONSD (?increased ICP)
- Foreign body
- Cataracts
- Test EOM & consensual light reflex - *place probe along inferior aspect of globe and tilt upward; shine light onto unaffected eye*

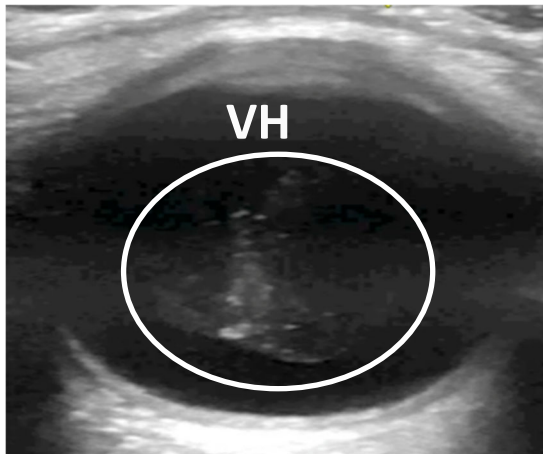
OCULAR

Technique

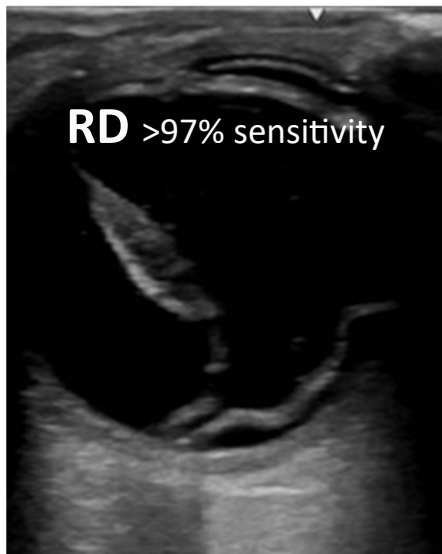
- Linear (vascular) transducer
- Limit pressure
- Use liberal amount of sterile gel
- Apply tegaderm over eye (limited underlying air)
- Adjust gain and depth



OCULAR



Vitreous hemorrhage.
 “Washing machine” or
 “snow globe” effect when
 holding probe still and hav-
 ing the patient move the eye
 left and right.



	RD	VD
Mobility	Tethered; limited	Moves freely
Echogenicity	hyper	Hypo (increase gain)
Thickness	thicker	thin
Optic nerve	does not cross	crosses
Vision loss	yes	rare
Emergency	yes	no

OCULAR

CRAO

(CVA equivalent)

Globe

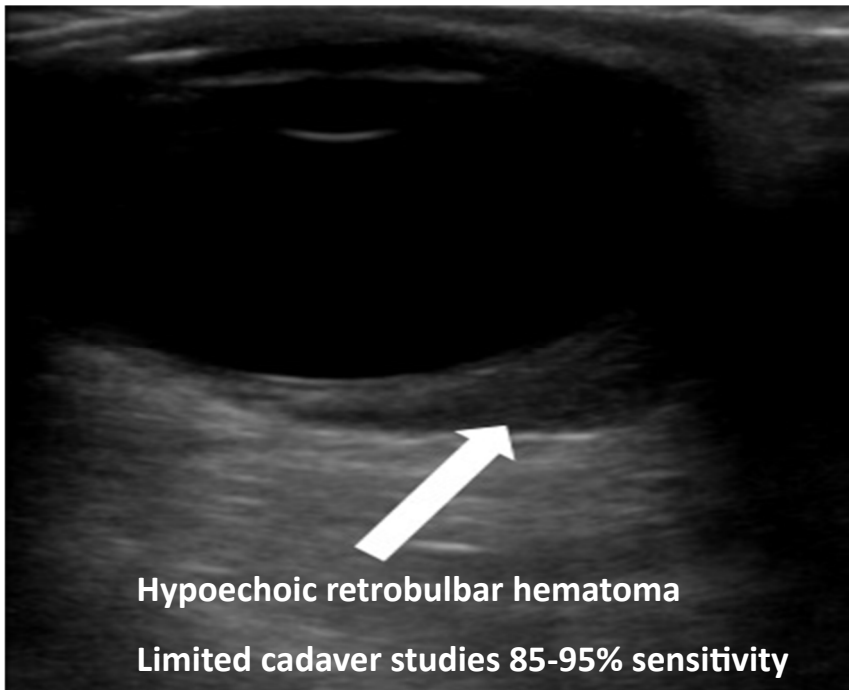
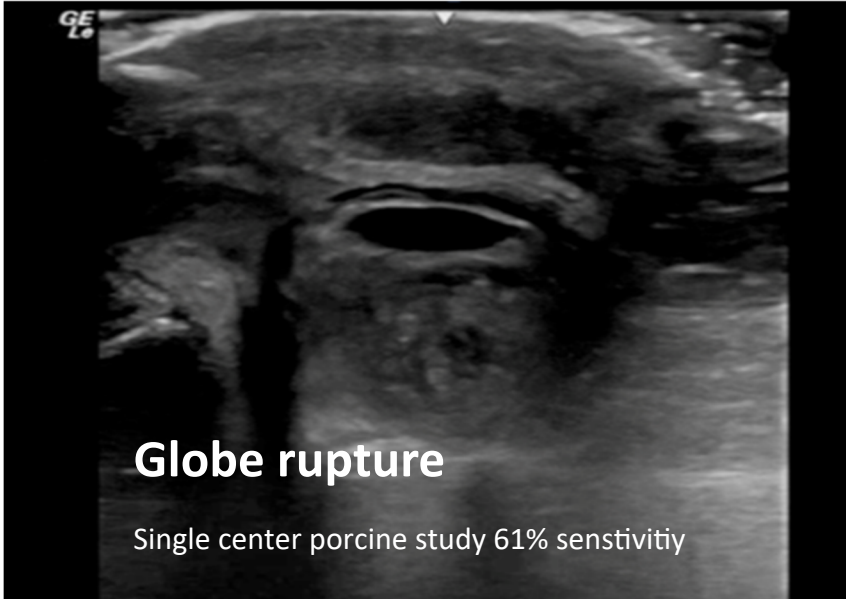
Clot

Use color flow to depict
absent blood flow

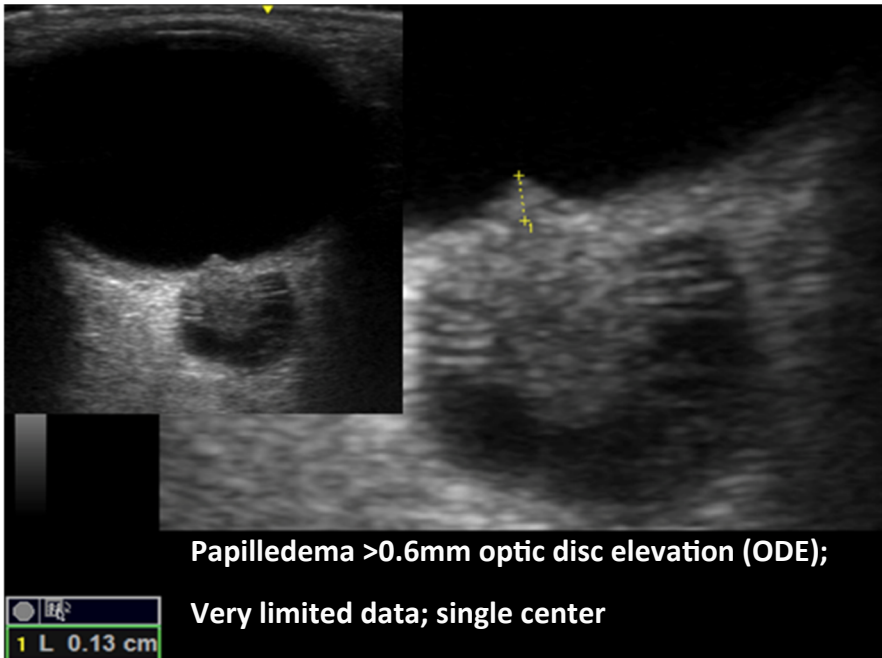
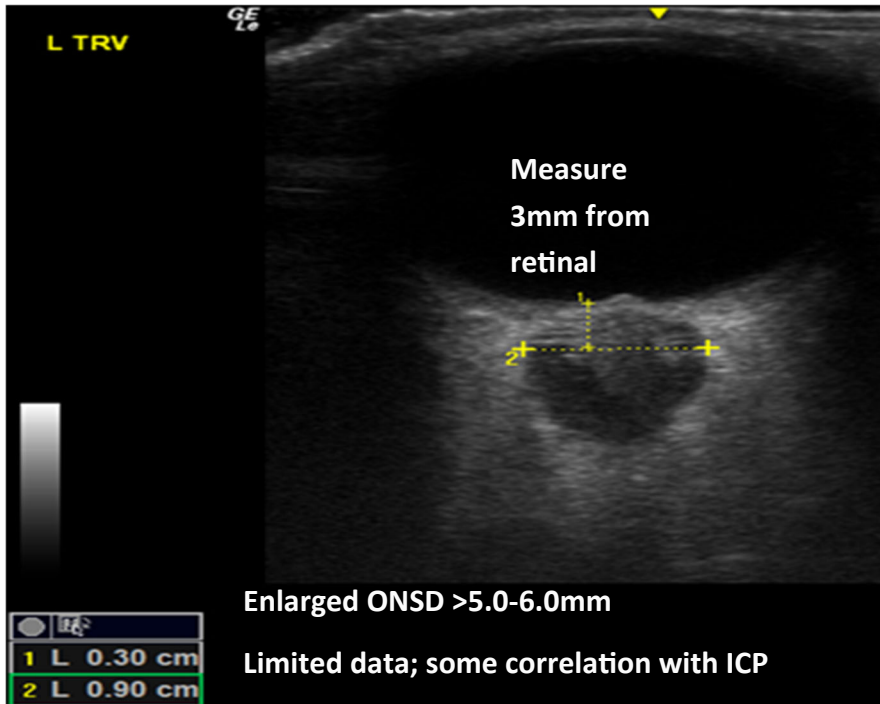
Normal blood
flow

Lens Dislocation

OCULAR



OCULAR



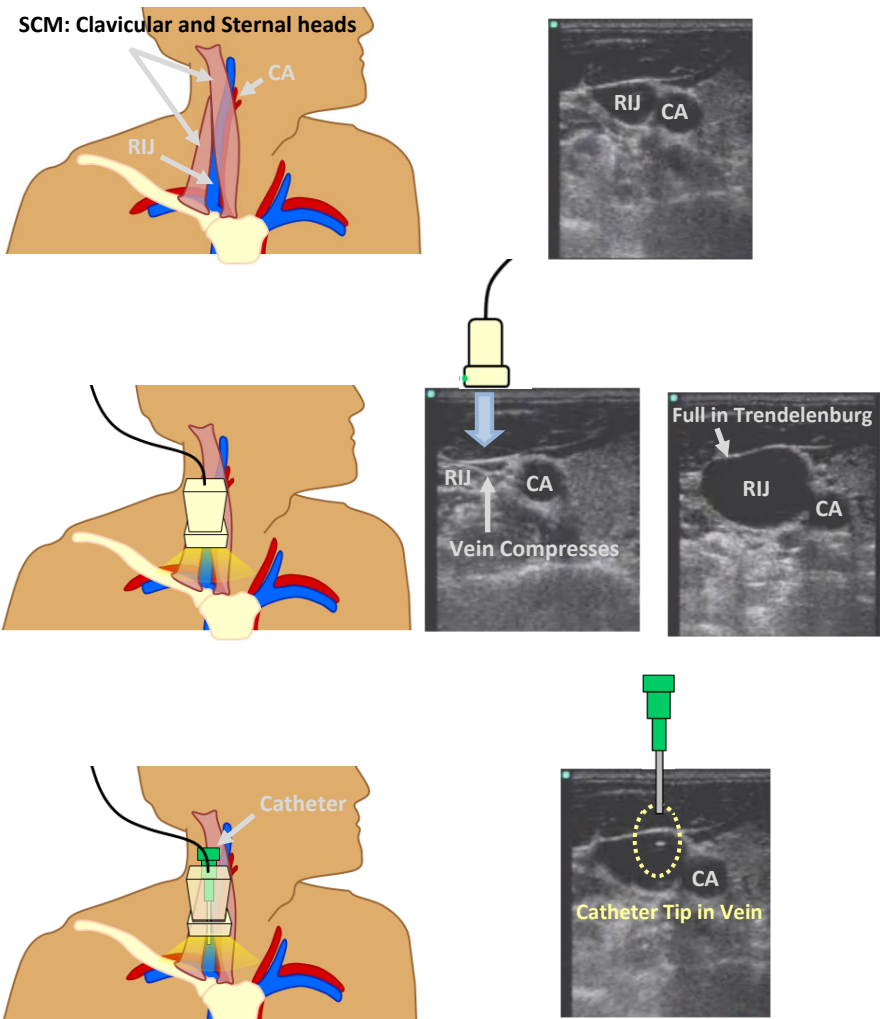
PROCEDURAL

Procedural US

Examples:

- **Central Venous Access**
 - Internal Jugular (trendelenburg position)
 - Use Doppler & compression to distinguish venous & arterial flow
 - Visualize needle and wire before proceeding

SCM: Clavicular and Sternal heads

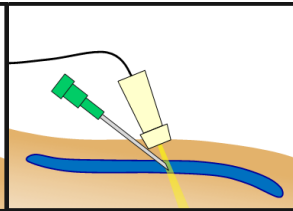
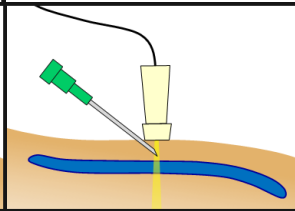
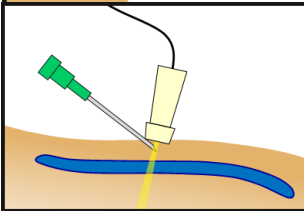
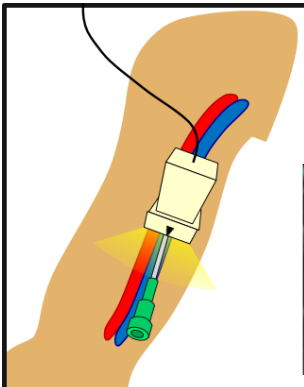
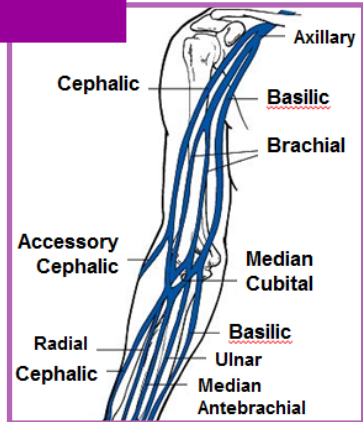


PROCEDURAL

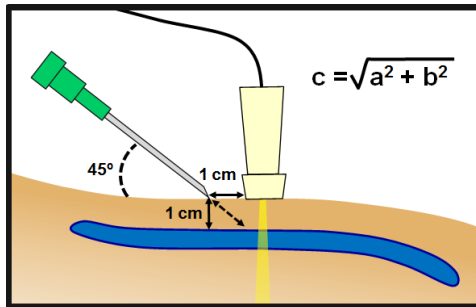
Examples (continued):

■ USG Peripheral IV

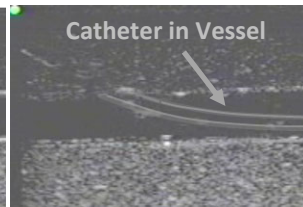
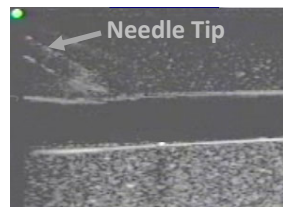
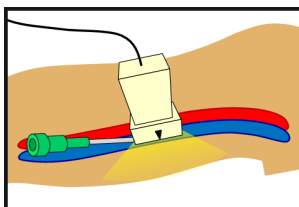
- Transverse Approach
 - Needle tip followed w/ beam



- Geometric Approach:



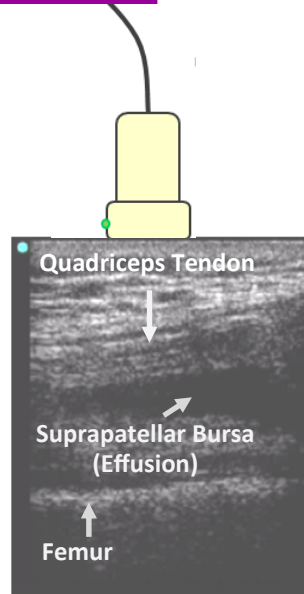
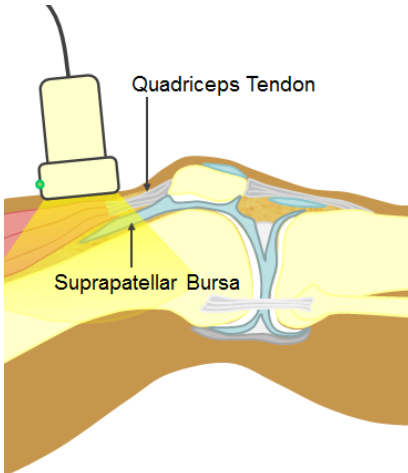
- Longitudinal Approach



PROCEDURAL

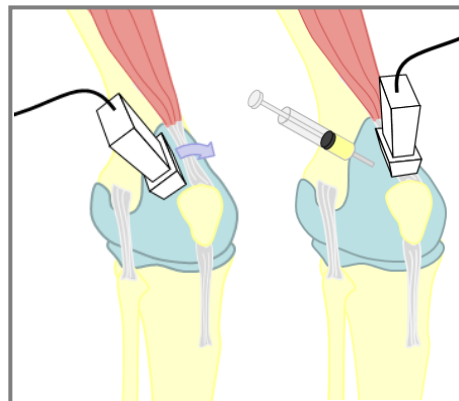
Examples (continued):

■ Arthrocentesis



• Knee US

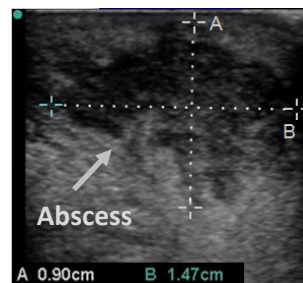
- Start suprapatellar
- Identify landmarks:
 - ◆ Patellar ligament
 - ◆ Suprapatellar bursa
 - Just deep to quadriceps tendon
 - Communicates w/ joint
 - ◆ Femur



- Move medially & laterally to find ideal location for aspiration

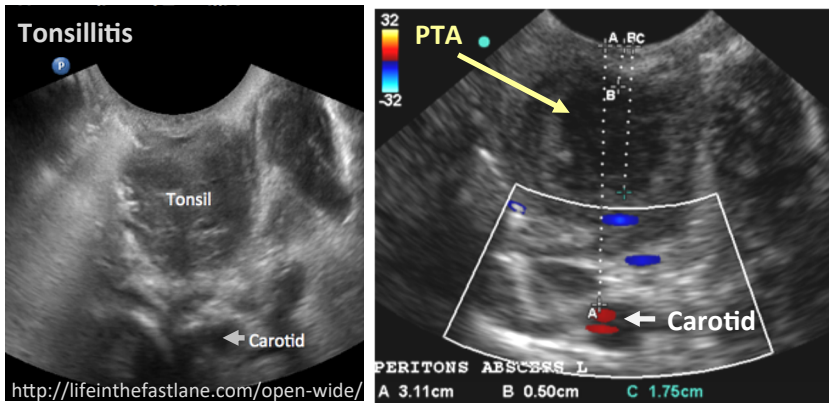
■ Abscess drainage

- measure size in greatest diameter
- Use color flow to identify vascular structures
- Look for subcutaneous air (NSTI) & tracking along tendons (tenosynovitis)



PROCEDURAL

■ Peritonsillar Abscess (PTA)



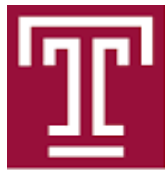
- Look for anechoic areas in or around tonsil
- Locate carotid (use color flow) - Carotid is ~3cm deep to surface
- Measure distance from ...
 - Surface to top of abscess
 - Surface to bottom of abscess
 - Surface to carotid
- Same person doing US must do the aspiration
- Anesthetize with 0.5cc lido after Hurricane spray
- Use 18 gauge needle with guard
 - Use trauma sheers - cut guard so needle extends past guard to depth of center of abscess (ensures carotid not punctured)
- 10% recurrence rate—patient should f/u in 2 days

■ Foreign Body Removal (>97% sensitivity; real time guidance)



Other Procedures: Lumbar puncture; thora-, para-, & pericardiocentesis; regional anesthesia (similar to USGPV)

TEMPLE MADE



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