POCUS: Physics and Instrumentation

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AAFP

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The following individual(s) in a position to control content for this session have disclosed the following relevant financial relationships.

- Dr. Mark Deutchman disclosed: Advisor: EchoNous (ultrasound); Royalties or patent beneficiary: Cooper Surgical (US patent on fetal vacuum extractor)

All relevant financial relationships have been mitigated. All other individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Describe how ultrasound transducers emit and receive sound energy and how images are generated.
2. Describe how images are processed.
3. Understand the physical limitations of ultrasound imaging and resolution imposed by physics.
4. Describe sonographic artifacts.
5. Describe conventions for image orientation

Point of Care Ultrasound – Physics and Instrumentation

This module provides essential **pre-study** that is to be completed **prior** to the organ based modules and subsequent hands-on scanning session.

Studying and understanding the concepts in this module provides a basis for understanding how ultrasound equipment works, artifacts that must be recognized and how images are oriented.

Transducers

Low frequency curvilinear

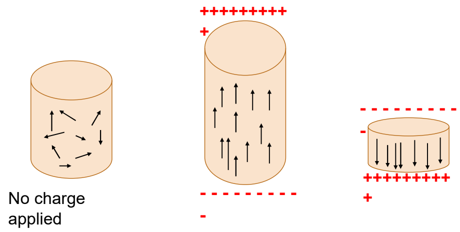
High frequency linear

High frequency intra-cavitary

Transducers are composed of piezoelectric crystals

- Synthetic ceramic material
- Change shape when an electric charge is applied, therefore can be made to vibrate.
- Emit a tiny electric charge when struck by a mechanical force such as a sound wave.

Applying charge to piezoelectric crystals causes them to vibrate



Vibrating crystals emit a wave front

Crystal characteristics and energy applied determine frequency

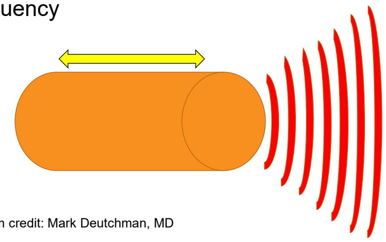
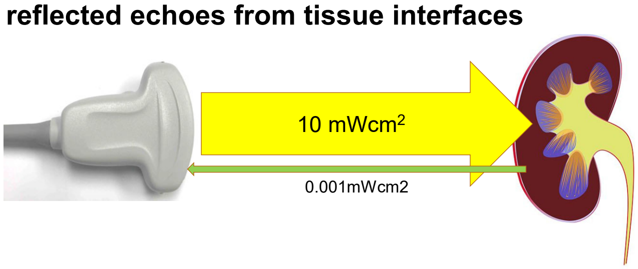


Diagram credit: Mark Deutchman, MD

US imaging depends on VERY WEAK reflected echoes from tissue interfaces



The greater the difference in acoustic impedance (density) between the tissues at the interface, the more complete the reflection of sound energy and the brighter the reflection will be displayed.

Brightness terminology

- “Echogenic”
- “Sonolucent”

Echo brightness example

Stone/bile interface produces a brighter echo than liver-vessel interfaces so the stone appears brighter than liver tissue.

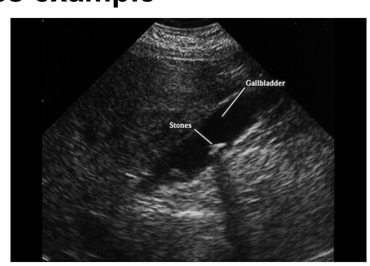


Image: Mark Deutchman, MD

Echo depth calculation

- Time taken by returning echoes to reach transducer is used by the machine to calculate the depth of the interface that generated the echo and where to display the echo on the screen.

Crystal arrangement

- A single crystal would produce only one dimension, unless it is mechanically moved
- Multiple crystals form a sweeping beam producing a second dimension.
  - linear array
  - curvilinear array
  - phased array

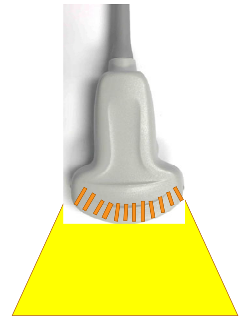


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Image display

- B-mode = brightness
  - ✓ realtime, 2-D B-mode
- M-mode = motion in one line over time

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B-Mode:
"brightness" mode
2-dimensions

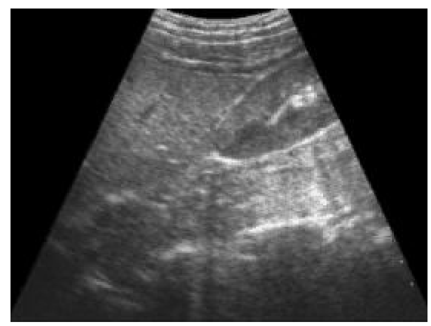

Image credit:
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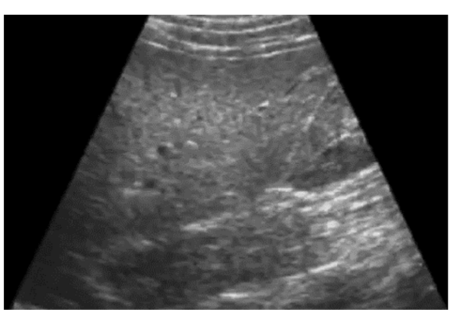
Real time B-Mode:
Updates image about 30 frames per second



Video credit:
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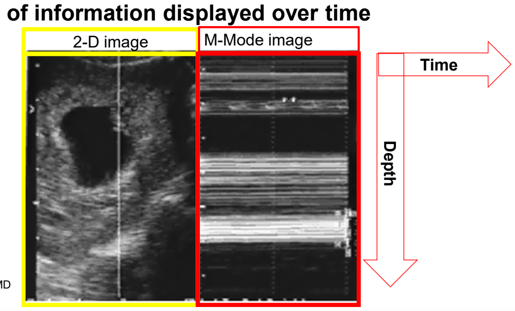
M-Mode (or TM-Mode):
one line of information displayed over time



Images credit:
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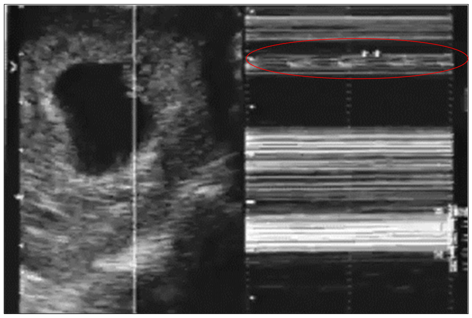
M-Mode Video



Video credit:
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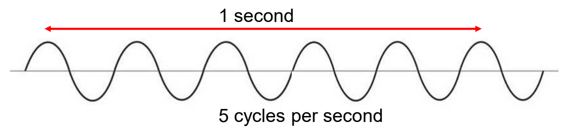
Frequency

- Measured in cycles per second= Hertz (Hz)
- Diagnostic ultrasound energy is in the megahertz range
  (million cycles per second)



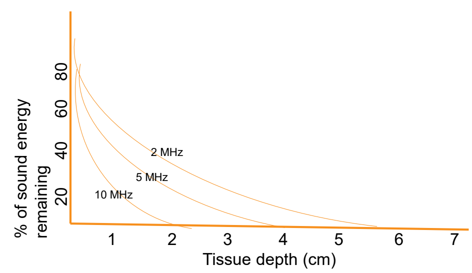
Frequencies for Clinical Applications

Deep

- Cardiac 2.0 to 3.0 MHz
- Abdominal and OB 3.0 to 5 MHz
- Pelvic transvaginal 5.0 to 7.5 MHz
- Vascular/small parts 7.5 to 10 MHz

Superficial

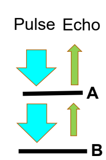
Higher frequencies are attenuated more rapidly



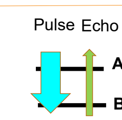
Resolution

- The ability to display objects lying close to each other separately
  - Axial: depth
  - Lateral: side-by-side

Axial resolution



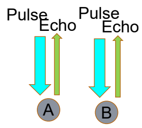
A sound pulse shorter than the distance between A and B will produce separate echoes “seeing” that A and B are separate targets.



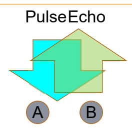
A sound pulse longer than the distance between A and B will produce only one echo and will “see” A and B as a single target.

Diagrams: Mark Deutchman, MD

Lateral resolution



A sound beam narrower than the distance between A and B will produce separate echoes “seeing” that A and B are separate targets.



A sound beam wider than the distance between A and B will produce only one echo and will “see” A and B as a single target.

Diagrams: Mark Deutchman, MD

Frequency v. resolution

- Higher frequency transducers produce more detailed axial and lateral resolution but have a shallower depth of view.

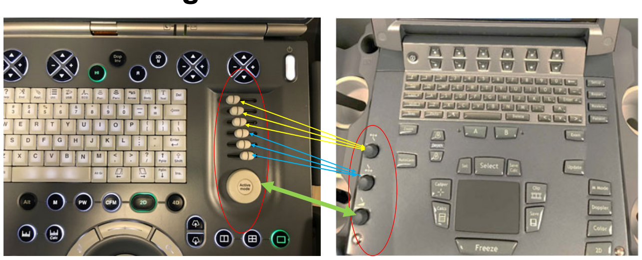
Image Processing

- Power
- Overall gain
- Time gain compensation
- Focal zones

Overall Gain and Time Gain Compensation

- Gain: Amplification of returning echoes
- Necessary because returning echoes are extremely weak
- TGC: Differential amplification of echoes from deeper structures

Variation in gain controls



Photos credit: Mark Deutchman, MD

TGC controls: overall and slide ramp

Video credit:
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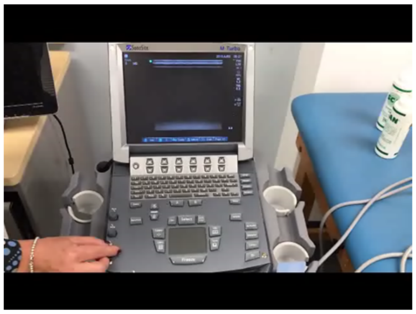
TGC controls: overall, near, far



Video credit:
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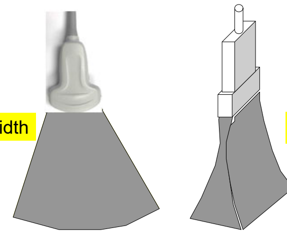
Beam characteristics

Beam length and width



Beam thickness

Diagram credit:
Mark Deutchman, MD

Focal Zone

- The focal zone is where the beam is the narrowest
- Best resolution occurs in focal zone
- Created by electronic beam focusing
- Operator controls location

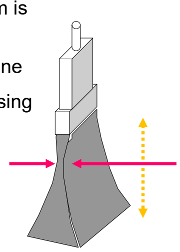


Diagram credit:
Mark Deutchman, MD

Keyboard controls

- Gain
- TGC
- Focal zone
- Depth
- Freeze
- Calipers
- Measurements
- Save

Photo: Mark Deutchman, MD

Sound attenuation

- Absorption
- Reflection
- Scattering
- Refraction

Searching for the best reflections: acoustic windows and enhancement

- Fluids such as urine, cysts and amniotic fluid allow sound energy to pass freely, enhancing the view of structures beneath or within them.

Acoustic enhancement

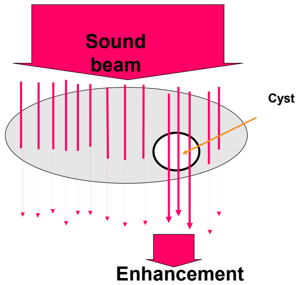


Diagram credit: Mark Deutchman, MD

Acoustic shadows

- When adjacent tissues differ widely in density, strong echoes are produced and no sound is transmitted.
- Structures lying beneath such an area are shadowed.
- Transducer position must be changed to see the shadowed area.

Acoustic shadows

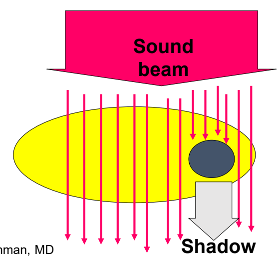
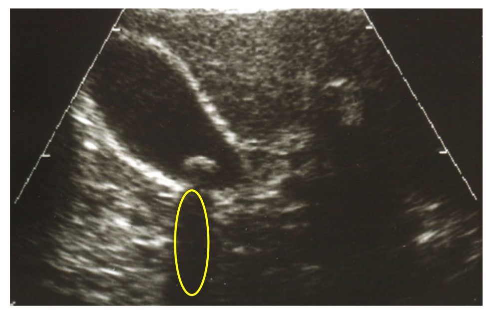


Diagram credit: Mark Deutchman, MD

Acoustic shadowing



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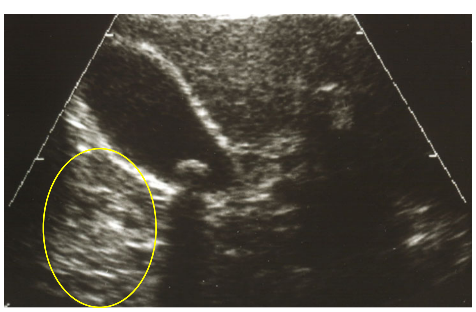
Acoustic enhancement



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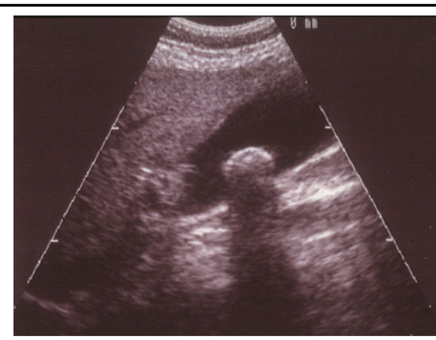
Acoustic enhancement and shadowing



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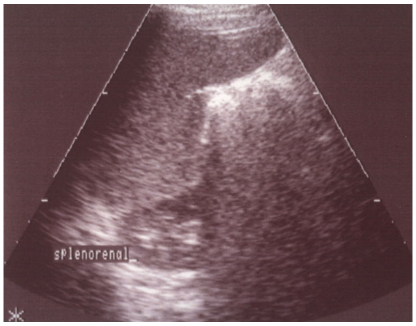
Scatter associated with bowel gas



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Reverberation artifact

- Displays interfaces that aren't really there as parallel echoes
- Common in fluid-filled structures
- Can be diminished by turning the gain down

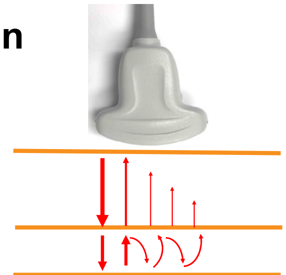


Diagram: Mark Deutchman, MD

Urinary bladder reverberation artifact

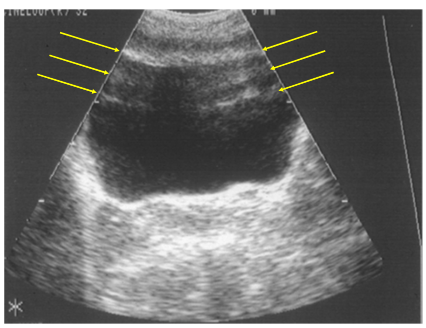


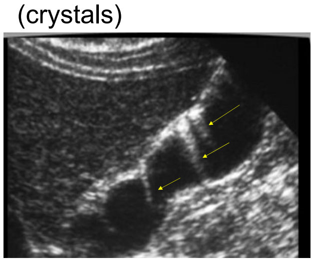
Photo credit: Mark Deutchman, MD

Ring-down and Comet Tail artifacts

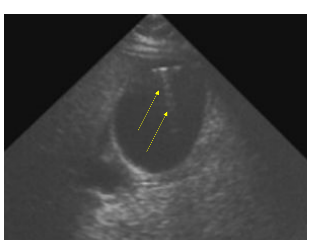
Appear similar but are created differently:

- Ring-down: reverberation between the transducer and echogenic surfaces like small stones or like foreign bodies embedded in tissue.
- Comet Tail: originates from liquid between gas bubbles

Ring-down (crystals)



Comet Tail (gas)



Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Doppler ultrasound

Based on the Doppler effect:

- When a sound beam encounters a moving object, its frequency is shifted to a shorter wavelength moving toward a stationary observer and longer when moving away.
- Commonly encountered as a drop in pitch of an ambulance siren as it passes by.

Doppler ultrasound modes

<u>Spectral Doppler</u>
Displays velocity, direction and slope of movement as a waveform with or without sound

<u>Color Doppler</u>
Displays velocity and direction of movement as color

Spectral Doppler of the aorta

Video: Mark Deutchman, MD

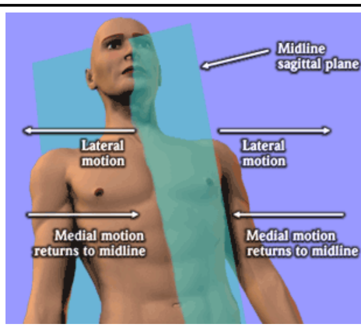
Color Doppler of the aorta

Video: Mark Deutchman, MD

Image orientation and display

- Sagittal planes
- Transverse or axial planes
- Coronal planes
- Orientation of images on the video screen

Sagittal plane



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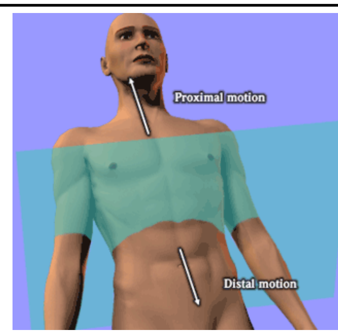
Transverse or Axial plane



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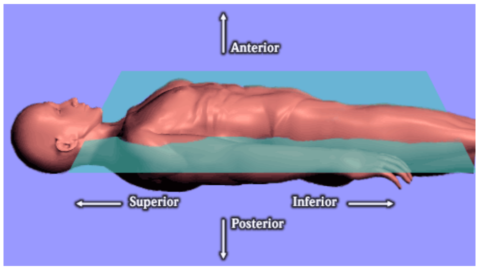
Coronal plane



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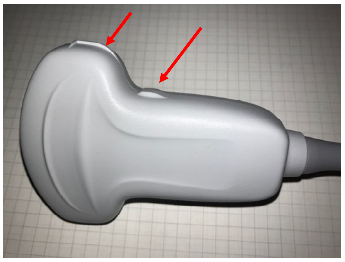
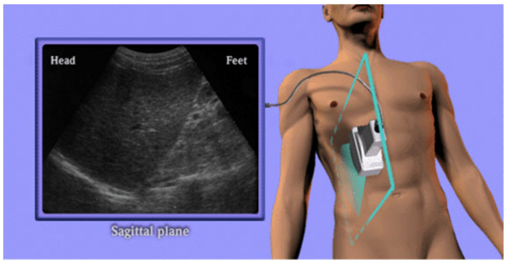
Determining which side of the transducer is "up"?



Sagittal image display



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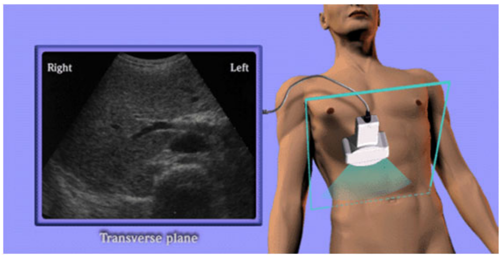
Transverse (axial) image display



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The End

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AAFP CME

Skin and Soft Tissue

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Learning Objectives

1. Evaluate the evidence for common applications point of care ultrasound of the skin and soft tissue used to improve patient care (cellulitis, abscess, identification of foreign body, and differentiating cysts from masses).
2. Recognize ultrasound physics and the general principles of ultrasound equipment use and image acquisition relevant to imaging of the skin and soft tissue.
3. Identify ultrasound characteristics of normal and abnormal skin and soft tissue anatomy and identify different tissue planes.
4. Recognize characteristics that differentiate fluid filled cysts from masses.
5. Develop appropriate coding and documentation practices for skin and soft tissue ultrasound examinations.

Clinical Case Scenario

- 45-year-old Ms. Judson, presents with localized swelling and pain on her upper arm. Her cat scratched her a few days ago and she is wondering if she has an infection?
- PMH: high BMI, pre-DM
- Medications: contraceptive implant (not palpable).
- FH: breast cancer and deep vein thrombosis
- Soc: smokes 2 packs per day
- VS: stable
- Is this an abscess?
- Or is it a lymph node?
- Where is the implant?
- You decide to perform a point of care ultrasound exam.

Clinical Indications and Application

First

- Cellulitis vs Abscess
- Vascular vs nonvascular
- Solid vs Cystic Lesion
- Foreign Body
- Tissue Layers (superficial vs deep)

Next

- Lumps and Bumps
- Epidermoid Cyst
- Lipomas
- Abnormal Lymph nodes
- Needle Guidance

Evidence and Clinical Guidelines (SORT)

Abscess diagnosis (SORT A)

- A meta-analysis of 14 studies that included 2,656 participants found that point-of-care ultrasonography has good diagnostic accuracy. Its use leads to changes in management in approximately 10% of cases overall and more so among those in which there is uncertainly based on clinical evaluation alone. Significantly more changes are appropriate than inappropriate. POCUS was 94.6% sensitive and 85.4% specific with a positive LLR of 6.5 and negative LLR of 0.06 for diagnosing abscesses. (Gottlieb, 2020)

Needle Guidance and Peripheral IV access (SORT B)

- Cochrane Review - 16 studies with 2267 participants comparing peripheral intravenous cannulation using ultrasound guidance to the landmark method. The effect of ultrasound guidance was dependent on the difficulty levels of cannulating people using the landmark method. The largest effect was seen in people classed as 'difficult' to cannulate, and the effect became smaller as the difficulty decreased. (Tada, 2022)

Diagnosis of Cysts (SORT B)

- Ganglion Cysts- Read et al used ultrasonography to evaluate 26 patients with clinically suspected ganglion cysts. Using ultrasonography, the authors reported a sensitivity and specificity of 96% and 100%, respectively. Osterwalder et al evaluated the sensitivity and specificity of ultrasonography when used to diagnose occult ganglions about the wrist. The authors noted a sensitivity, specificity, and accuracy of 88%, 85%, and 87%, respectively. (Zoller, 2023)
- Simple Cysts from Solid Breast Lesions **-**Breast ultrasound (performed by experts) is used to differentiate simple cysts from solid lesions with 98–100% accuracy (Bassett and Kimme-Smith 1991; Hilton et al. 1986; Jackson 1995; Sickles et al. 1984). (Booi, 2007)

Evidence and Clinical Guidelines (SORT)

Diagnosis of Common Superficial soft tissue mass (SORT C)

- If a soft-tissue mass is superficial, there is a group of common diseases that have pathognomonic or characteristic features that enable a confident diagnosis. (Jacobson 2022)

Foreign Body identification (SORT B)

- A study of 131 wounds in 105 pediatric patients and 12 (9.2%) found to contain foreign body. The identification of FB by US was comparable to the performance of radiography interpreted by an attending pediatric radiologist, sensitivity of 66.7%, specificity of 96.6.%. It can be observed that ultrasound performs better for the radiolucent foreign bodies i.e., thorn, plastic and wood. (Friedman, 2005)
- After a short tutorial, 6 EM physicians 14 EM trainees were able to correctly identify foreign bodies on hand models with sensitivity 96.7%, specificity 70% amongst physicians and 85.7%, 82.9% amongst trainees. (Nienaber, 2010)

Introduction to Scanning

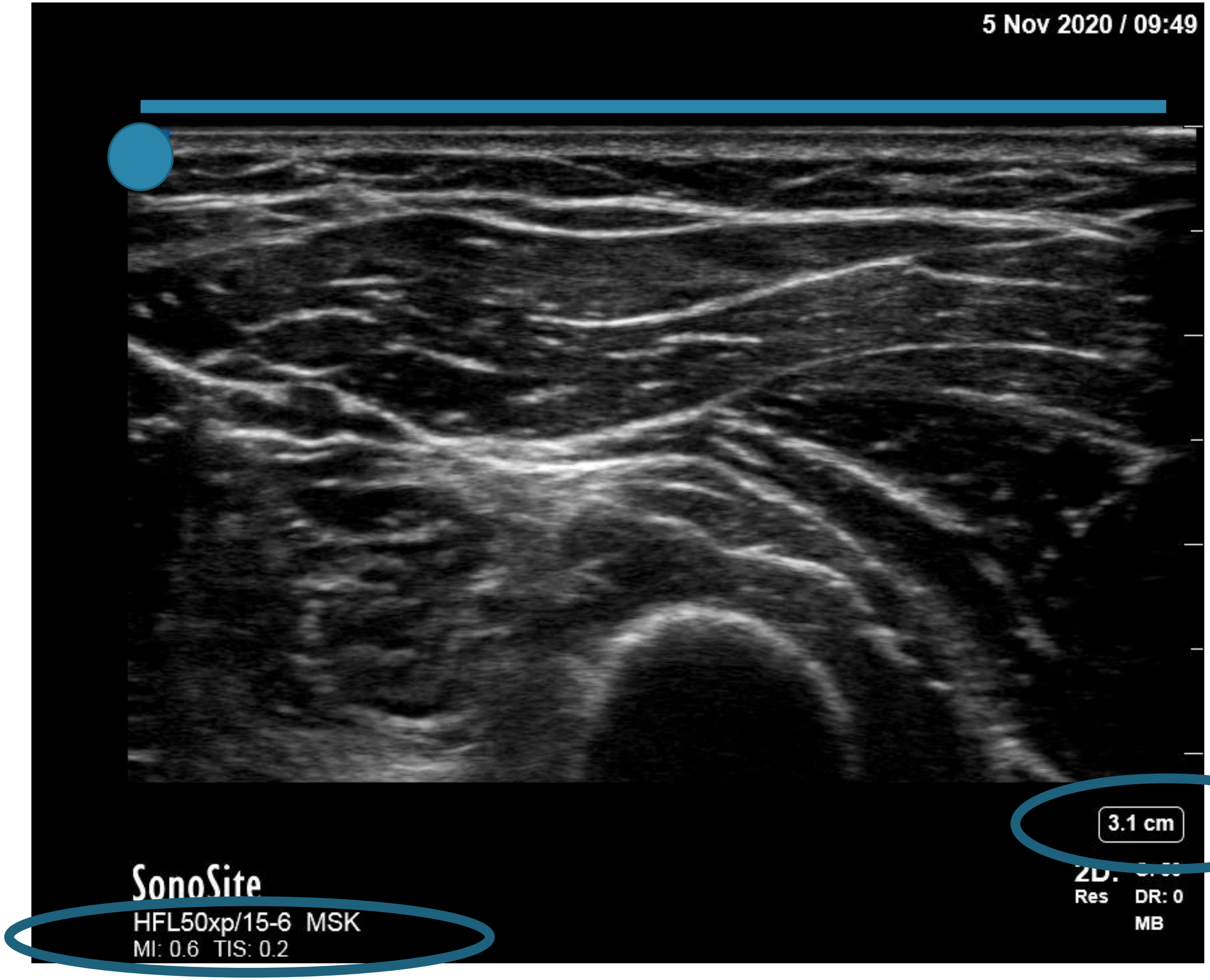
1. Patient Setup – Variable for patient comfort
2. Probe selection – Linear, high frequency
3. Preset- Small Parts or MSK
4. Probe position- Area of concern
5. Probe movement- Review
6. Planes of cut (orientation)- Transverse and sagittal

Patient Setup and Probe Selection

- Patient is Supine or Seated
- Use towels for neutral position and draping
- Setup the machine relative to the patient so that the screen matches your line of site
- Dim the lights, with an ambient lighting
- Linear- High Frequency 12-18 MHZ
- Probe shapes and footprint can vary
    - Wide, narrow, hockey stick

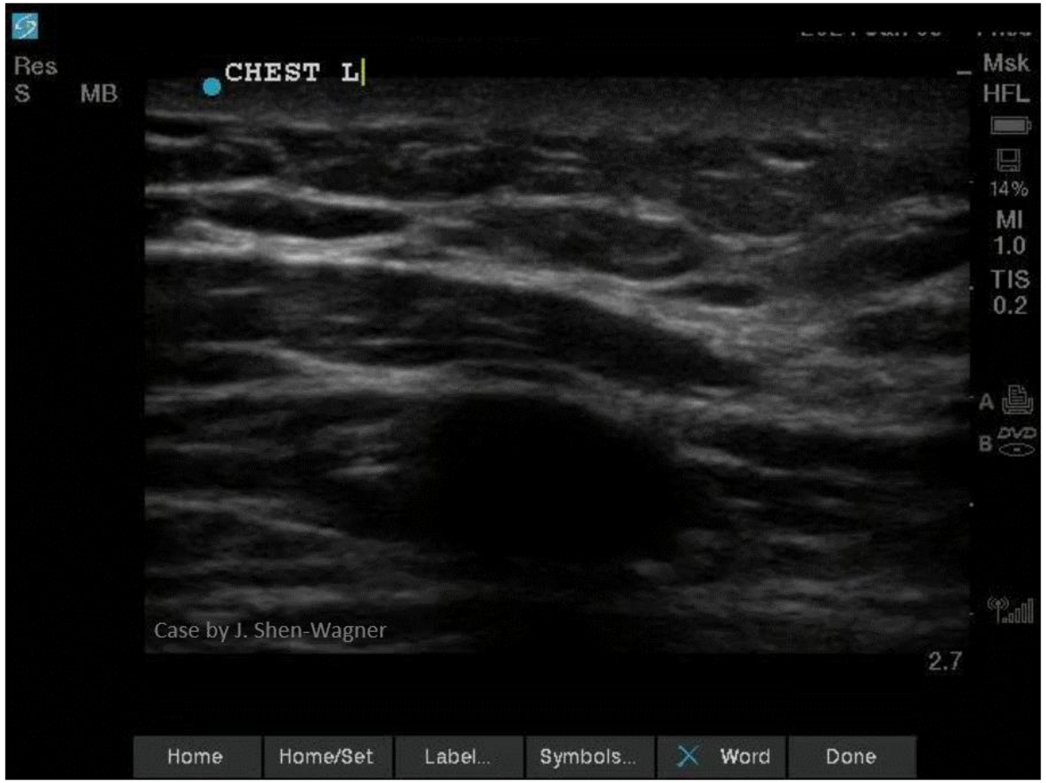
Preset Selection

- MSK, Vascular, Nerves, Small Parts
- Probe Marker is on the left side of the screen and note the square configuration of the image.



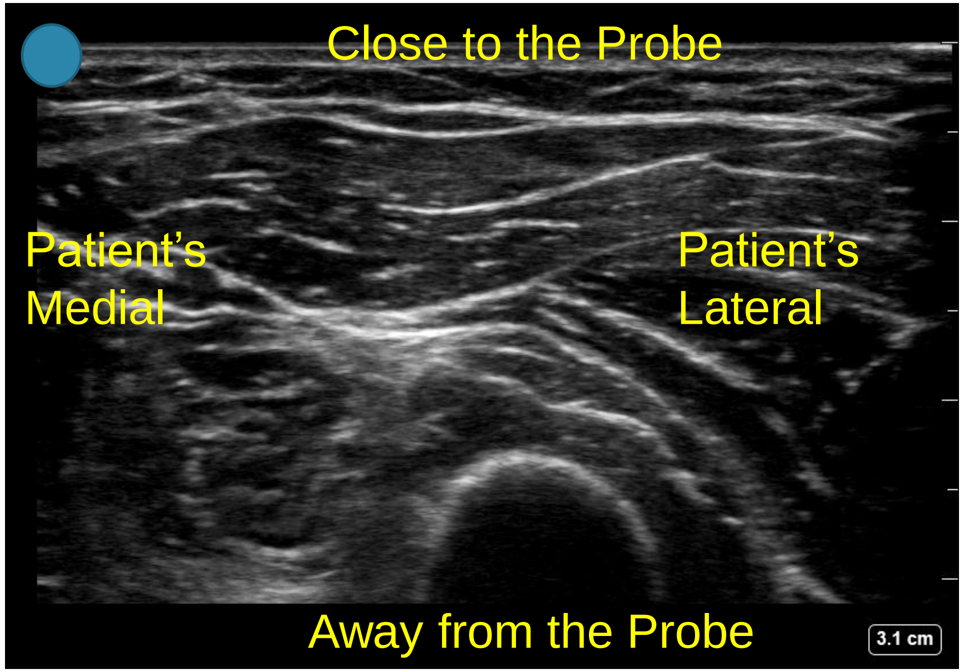
Probe Position

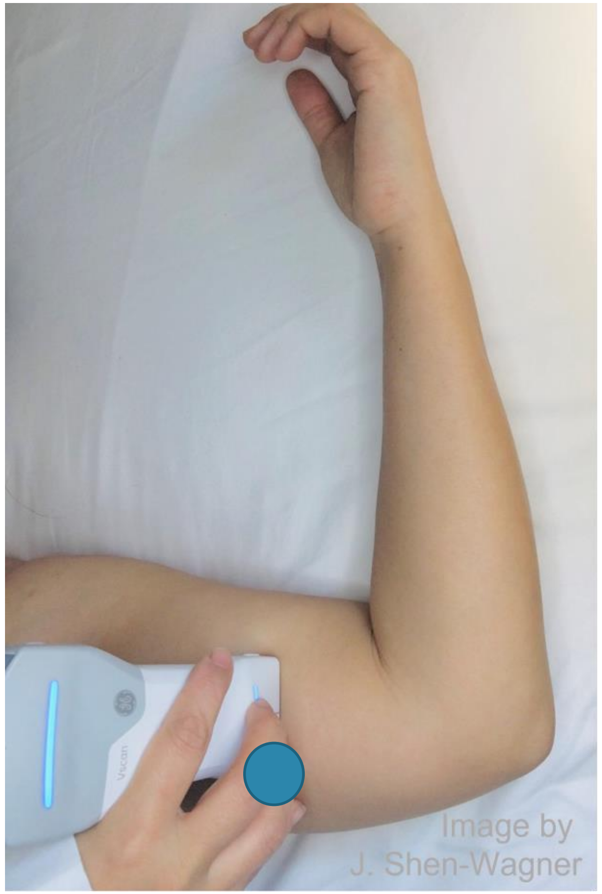
- Easy! Over the area of concern
- Tip- Check normal areas first and move towards the area of concern
- Use light pressure, structures are small and easily distorted.
- Use a gel pad or try a water bath for superficial scans, fingers and toes



Planes of Cut - Transverse

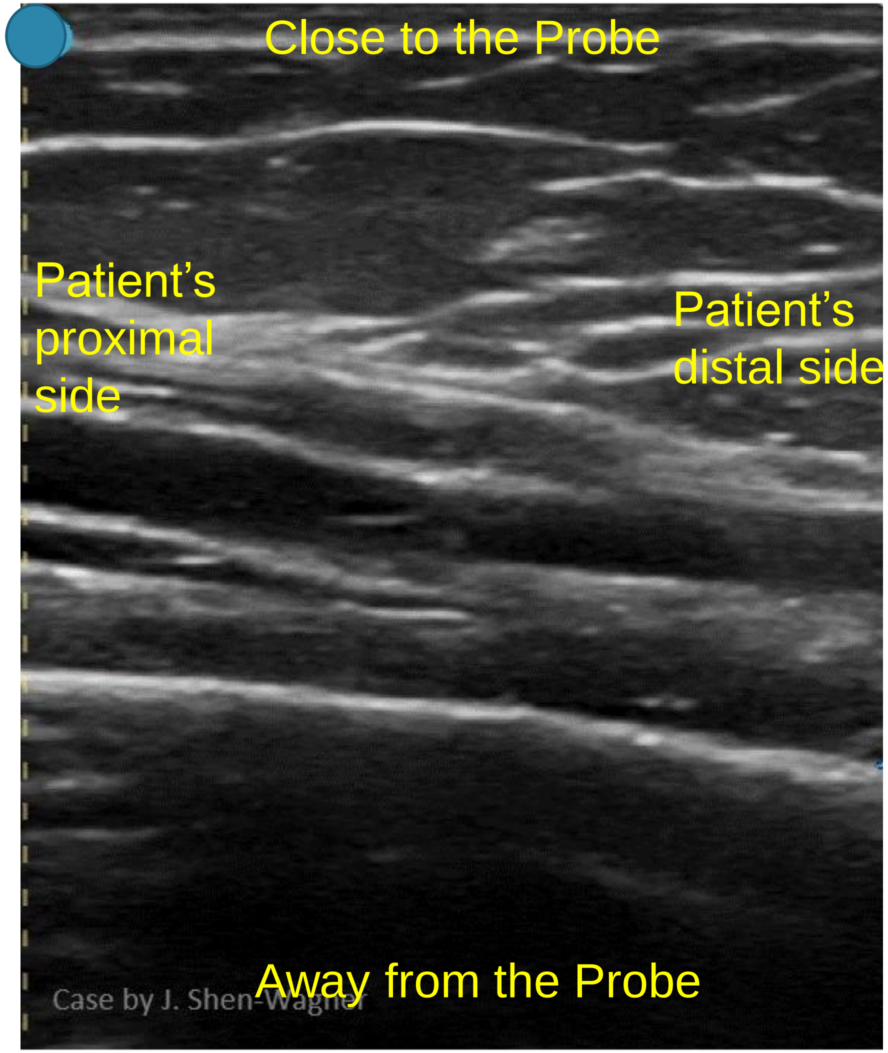
Align the probe marker transverse to the structure (generally towards the patient's right side).

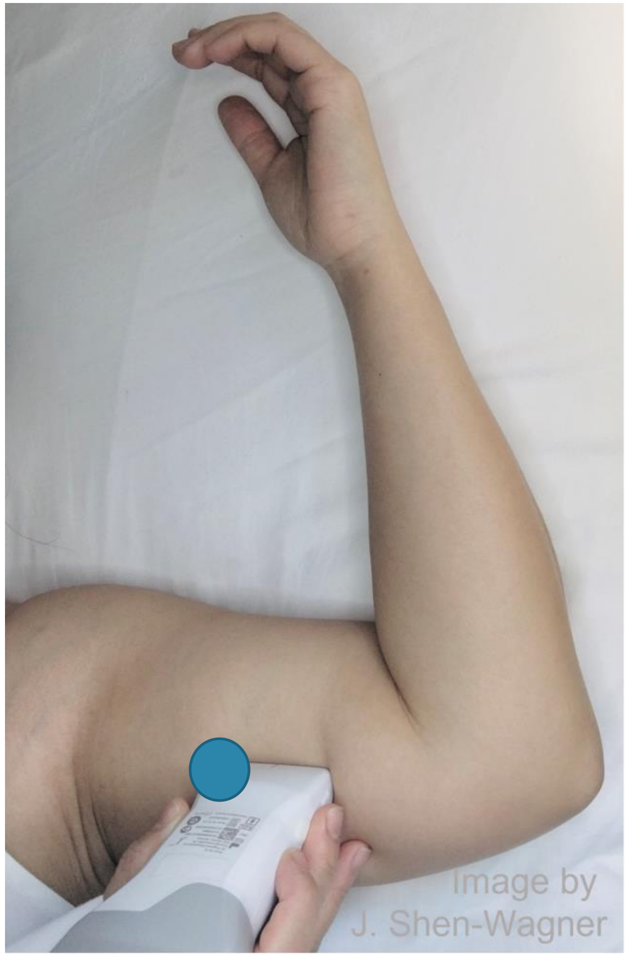




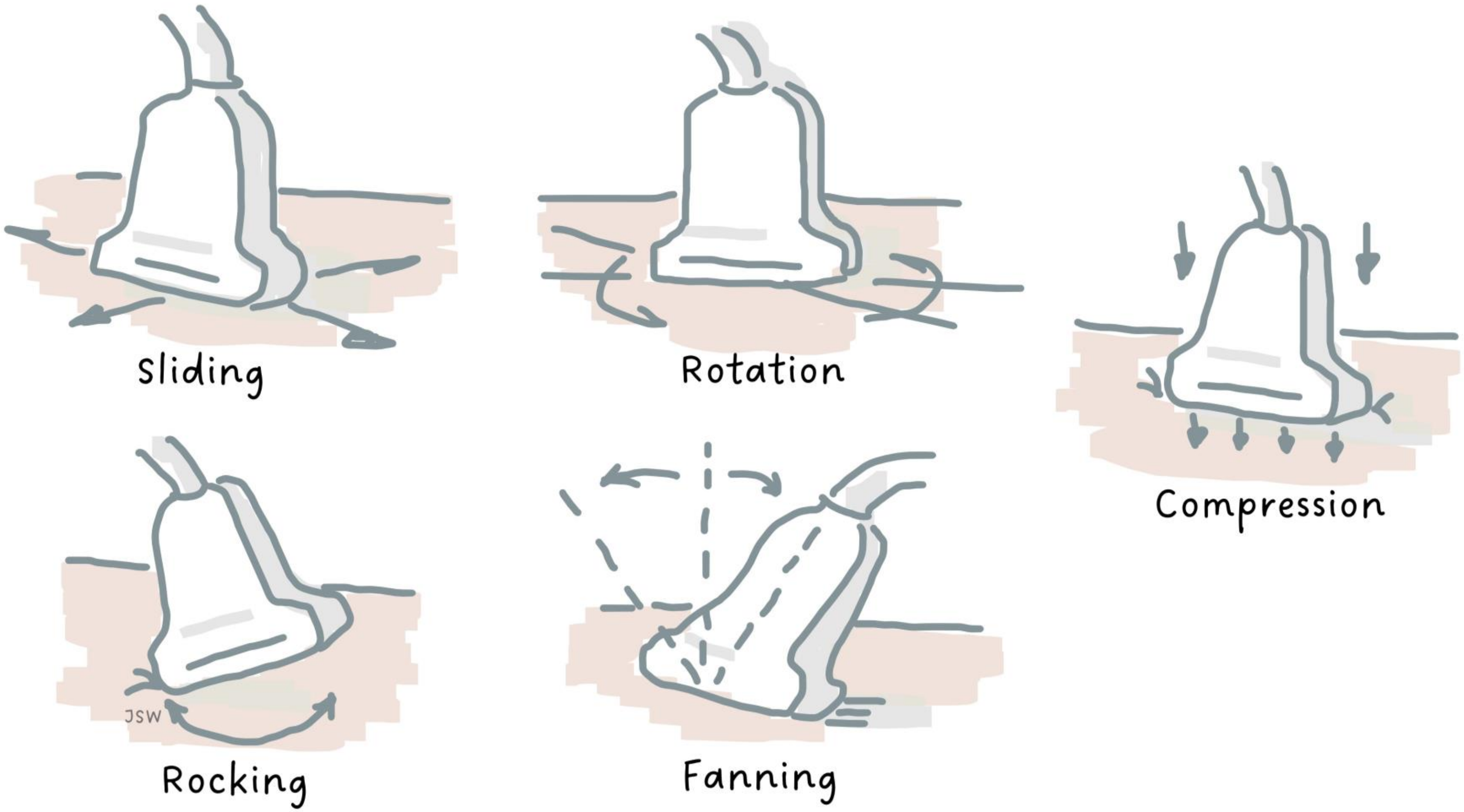
Planes of Cut - Sagittal

Align the probe marker cranially in sagittal





5 Cardinal Movements of Ultrasound



Anatomy of Skin and Soft Tissue

Anatomy

Epidermis/Dermis

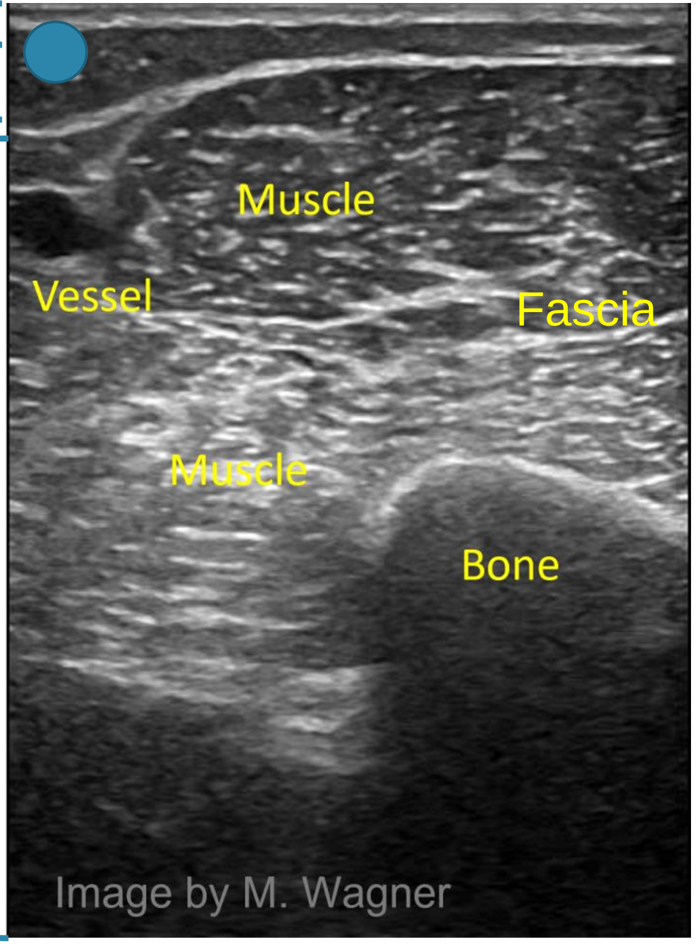
Subcutaneous Tissue (Hypodermis)

Fascia

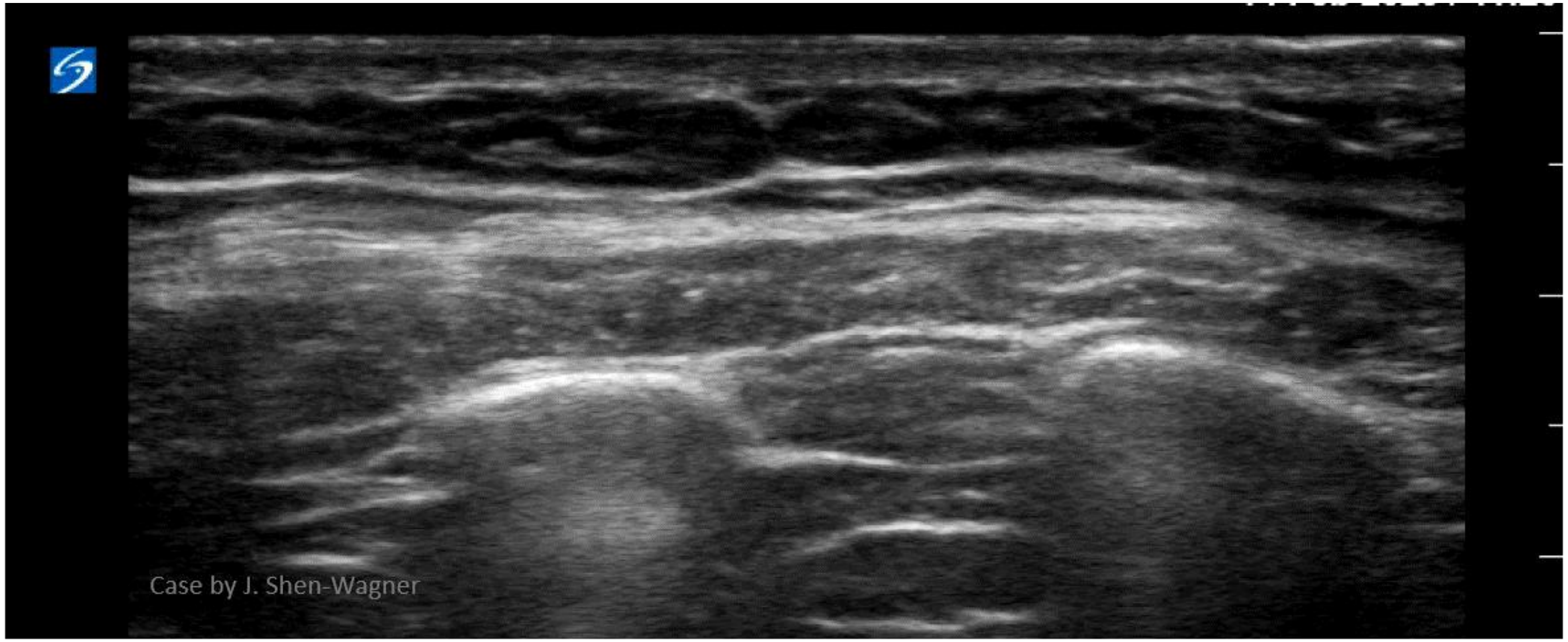
Muscle

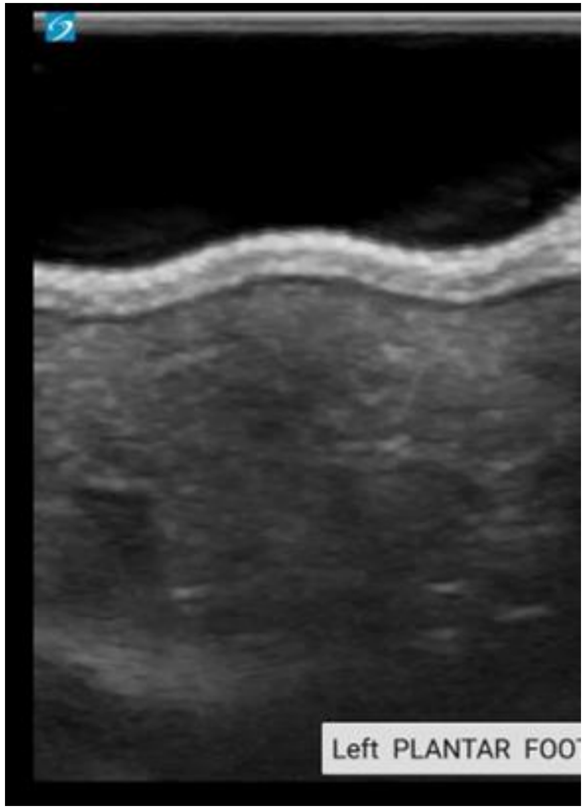
Vessels

Bone

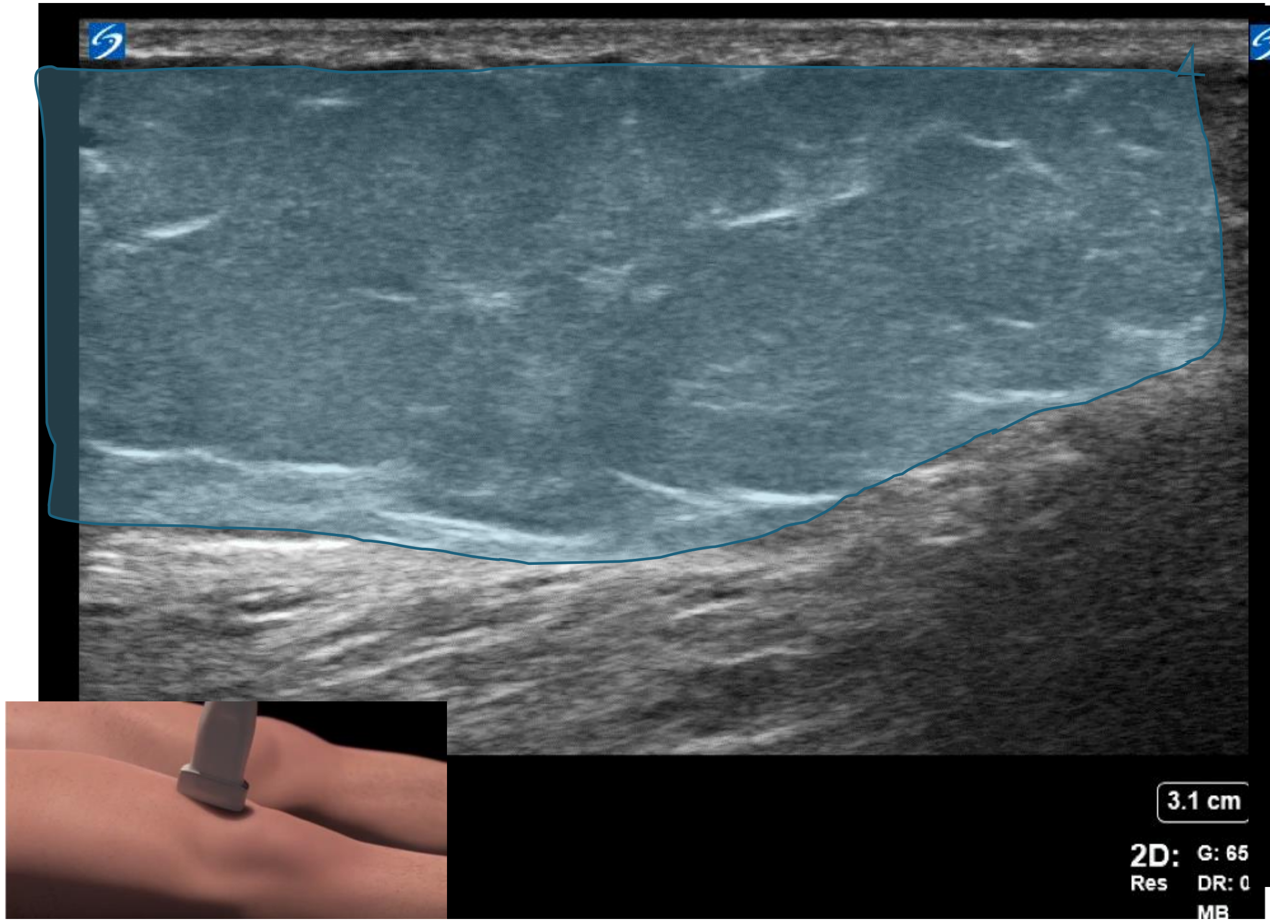


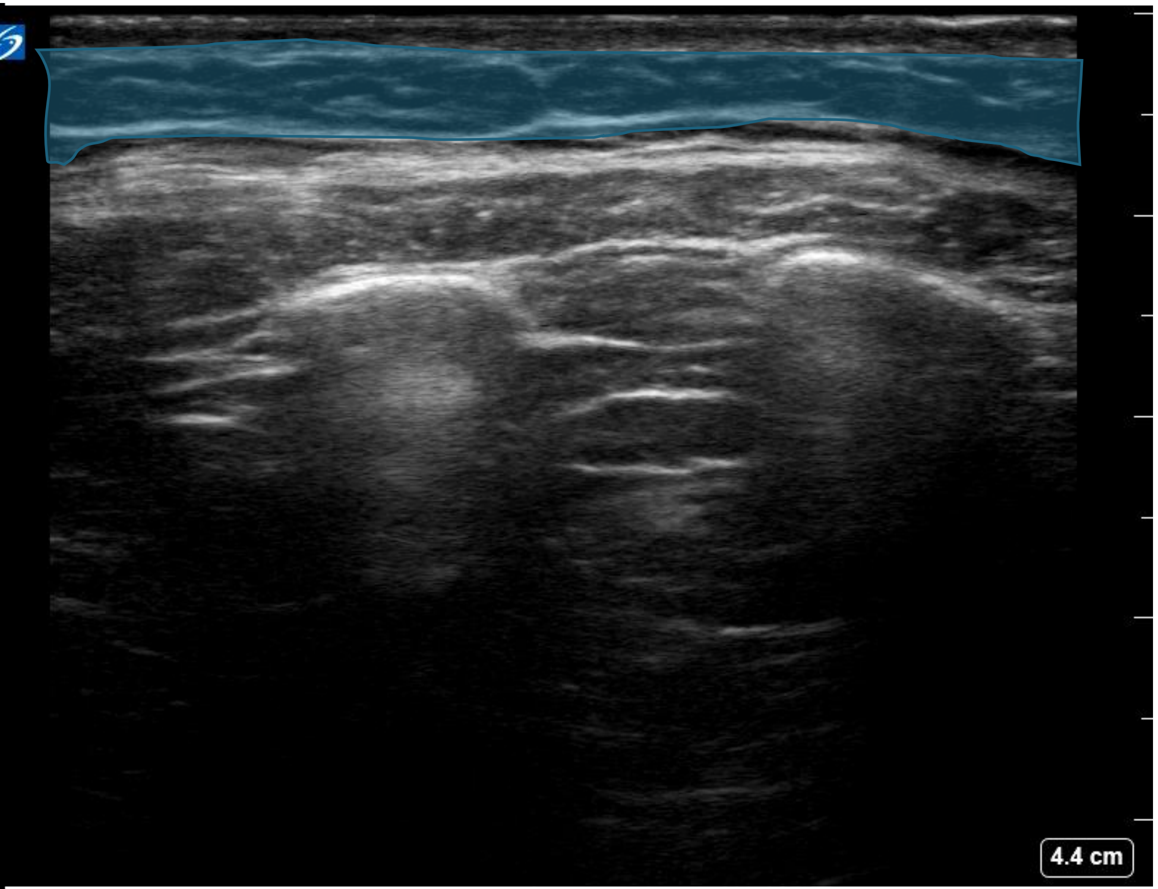
Skin Anatomy - Epidermis/Dermis





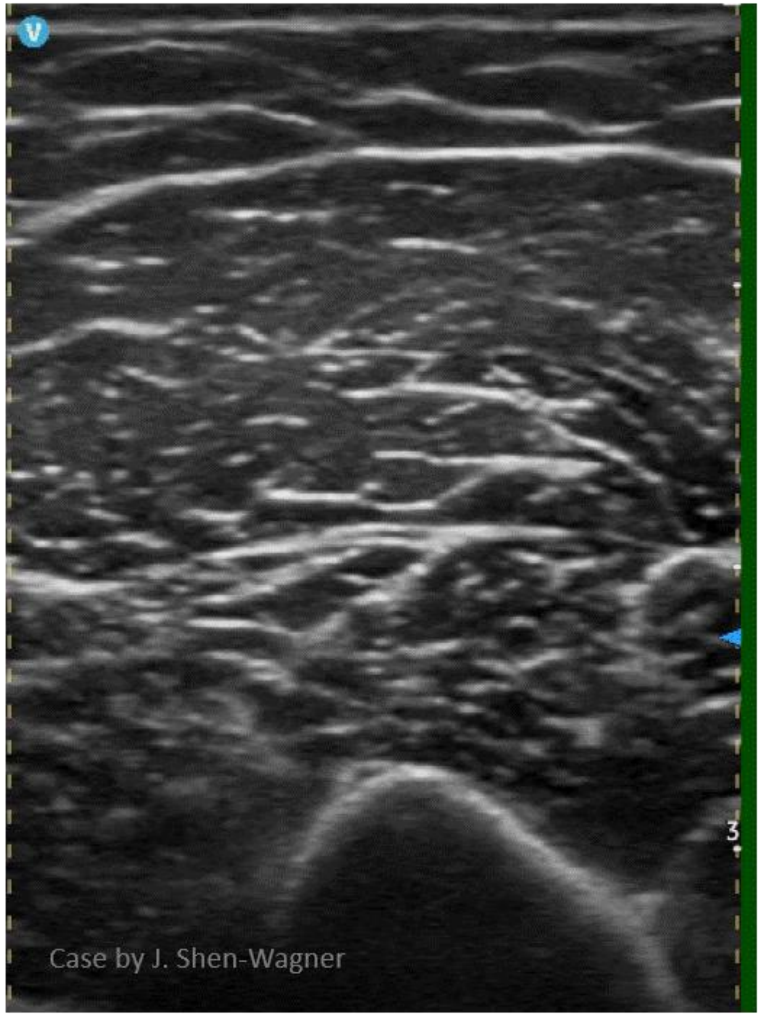
Subcutaneous Tissue





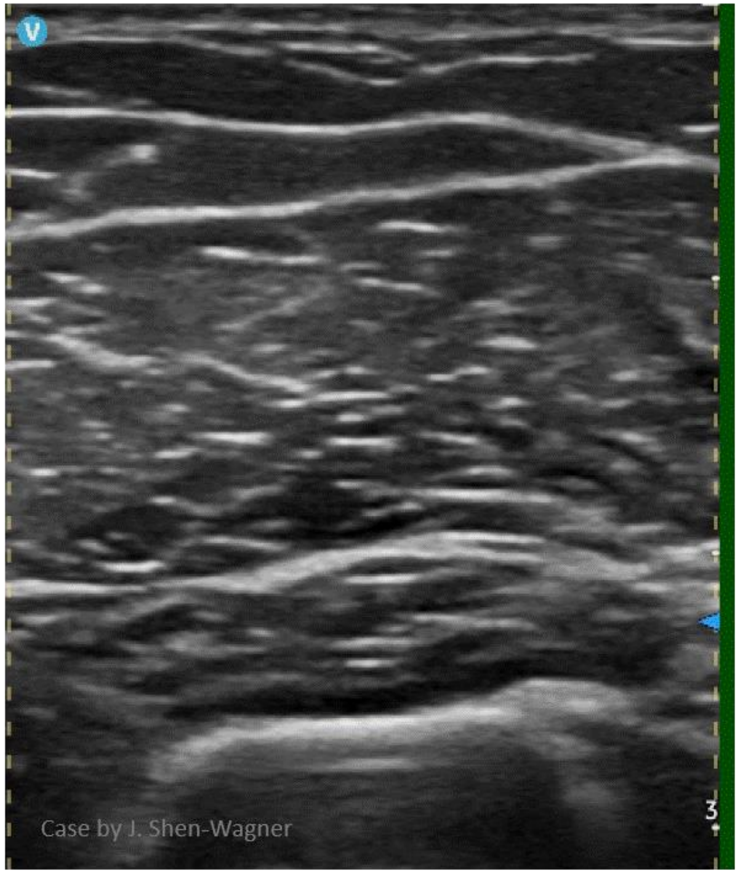
Muscle

Starry Sky pattern in transverse view



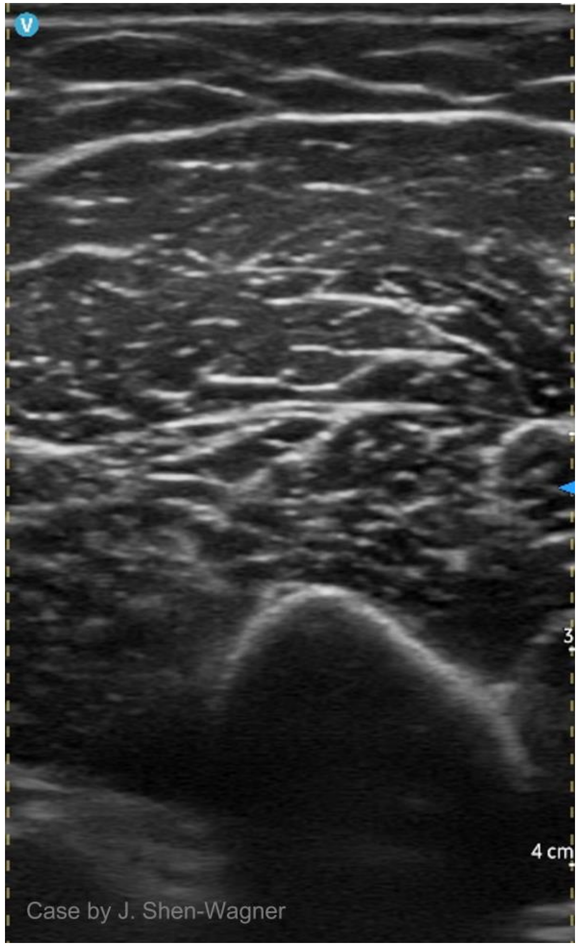
Muscle

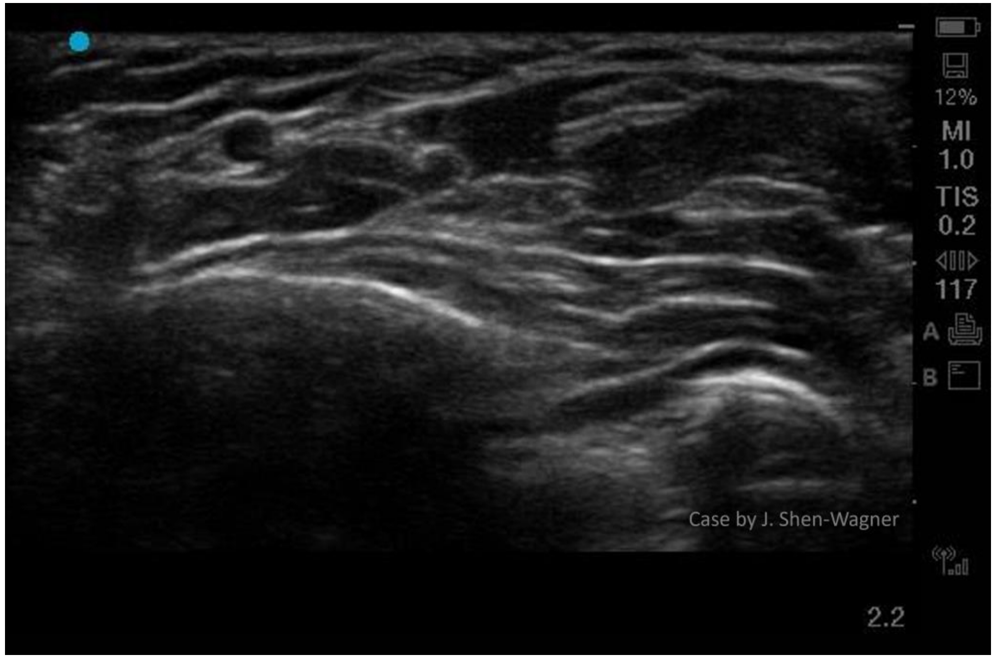
Pennate pattern in longitudinal view



Bone

- Floor of your image
- Reflective surface with posterior shadowing
- Shape of the bone is a landmark for location



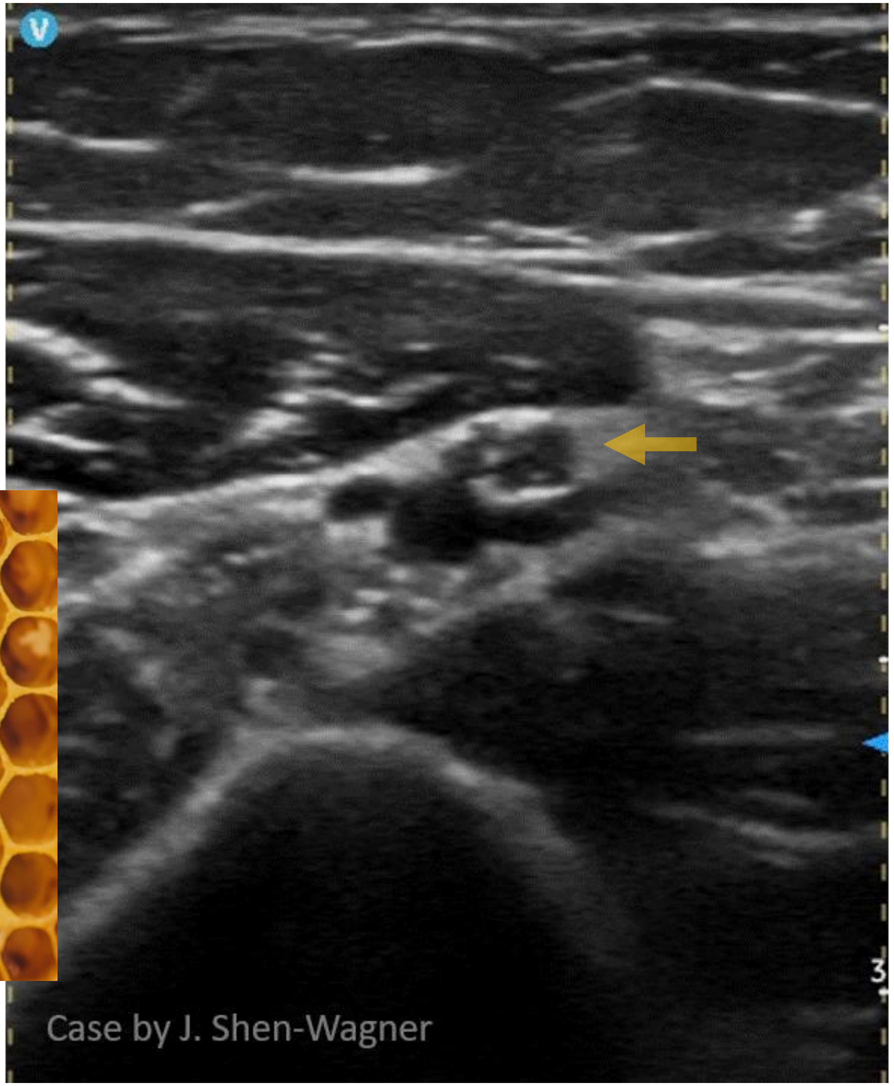


Vessels

Artery and veins appear anechoic. Veins are easily compressible, and arteries are pulsatile. Color flow is useful if you are uncertain. They are found both deep and superficial layers.

Nerves

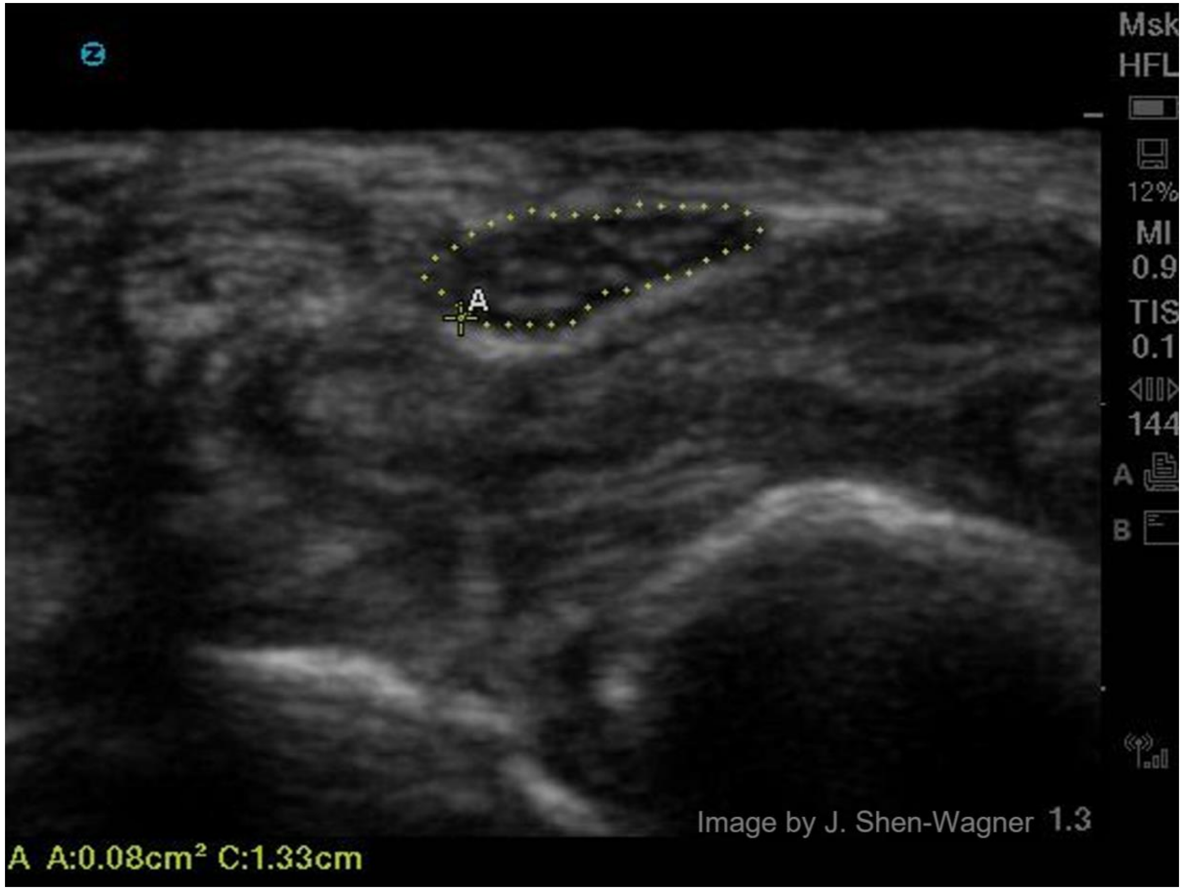
Nerves have a honeycomb appearance with a bright outer epineurium with internal hypoechoic fascicles.



AAFP CME

Nerves

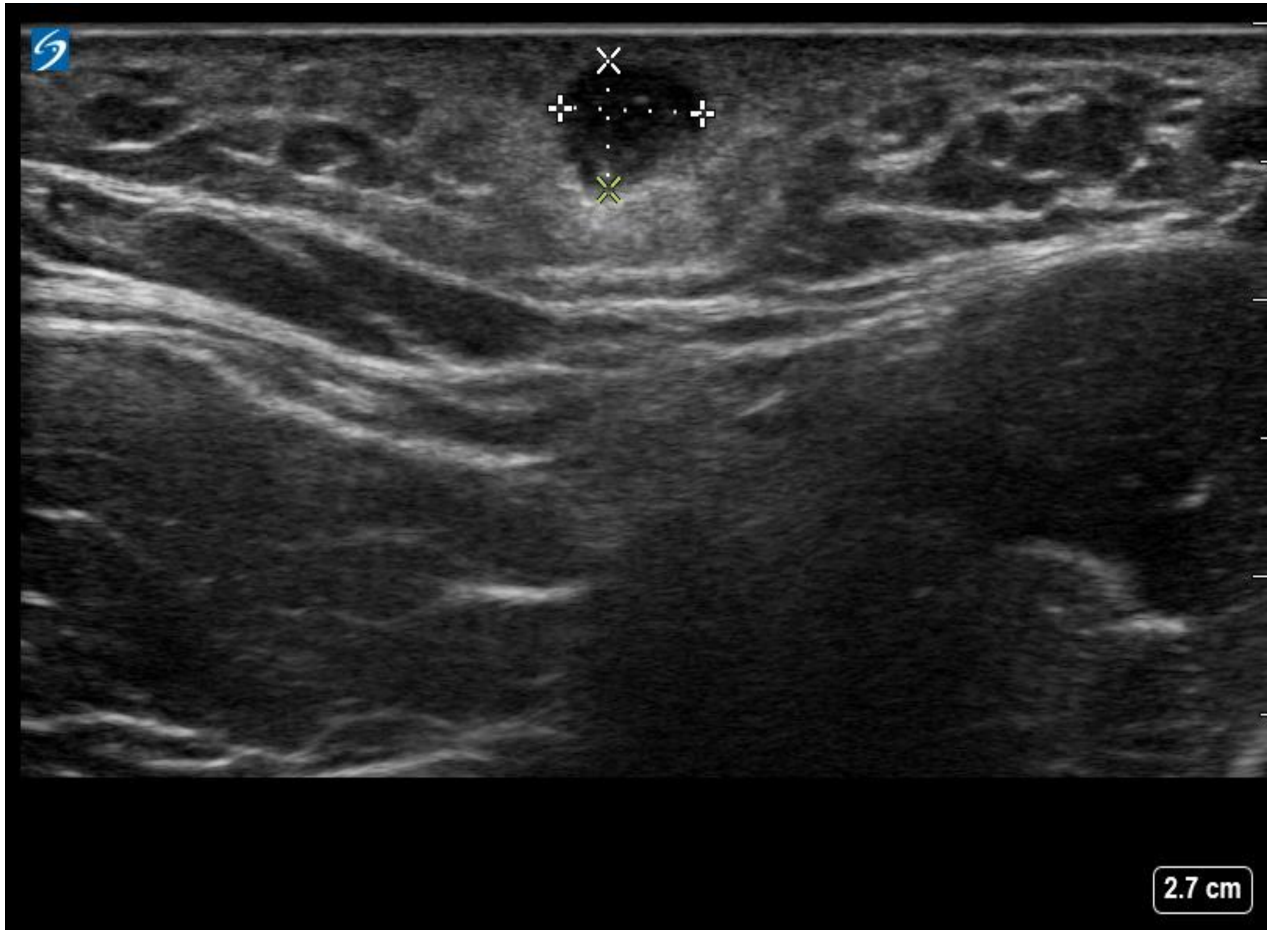
Nerves have a honeycomb appearance with a bright outer epineurium with internal hypoechoic fascicles.



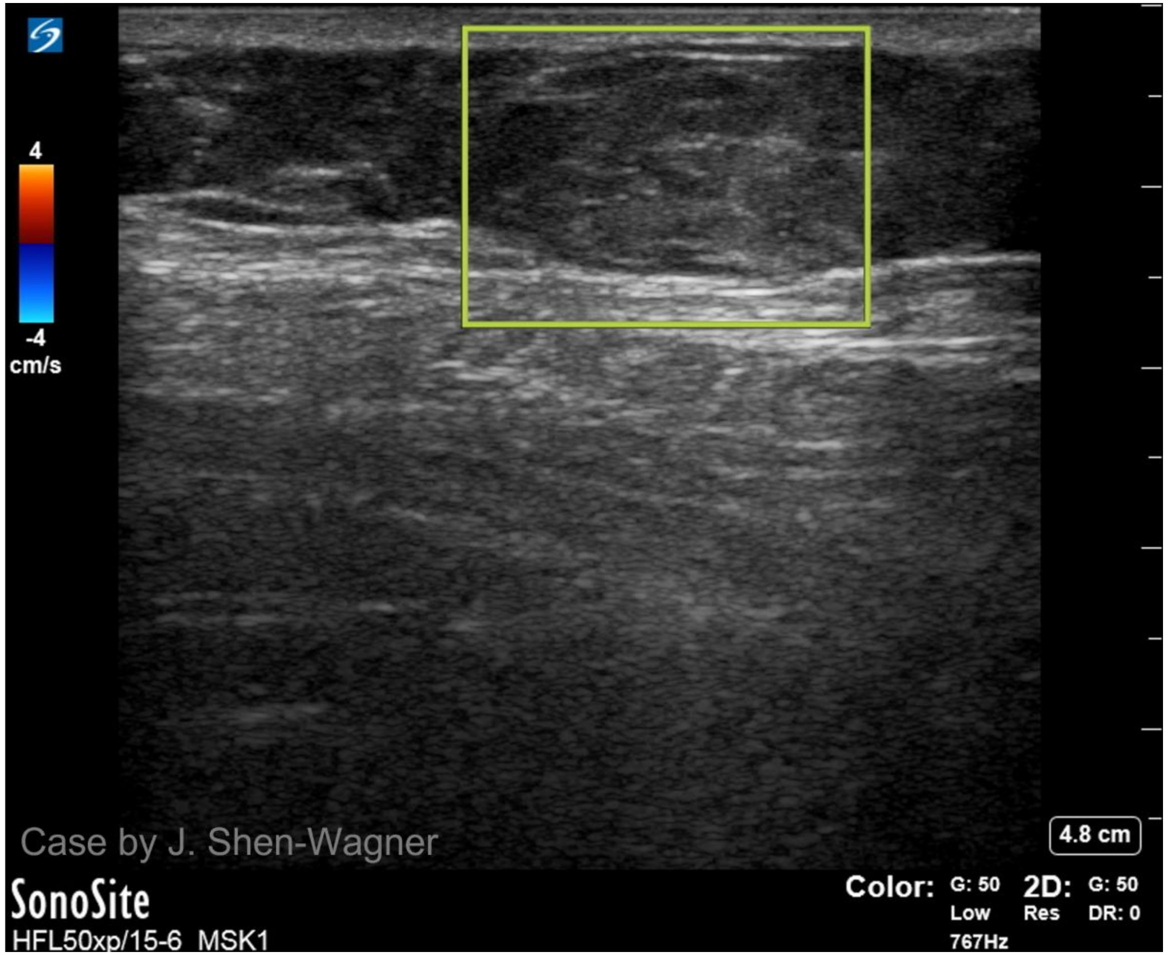
Tissue Layers (superficial vs deep)

Indications for Skin and Soft Tissue POCUS

Superficial vs Deep



Superficial vs Deep



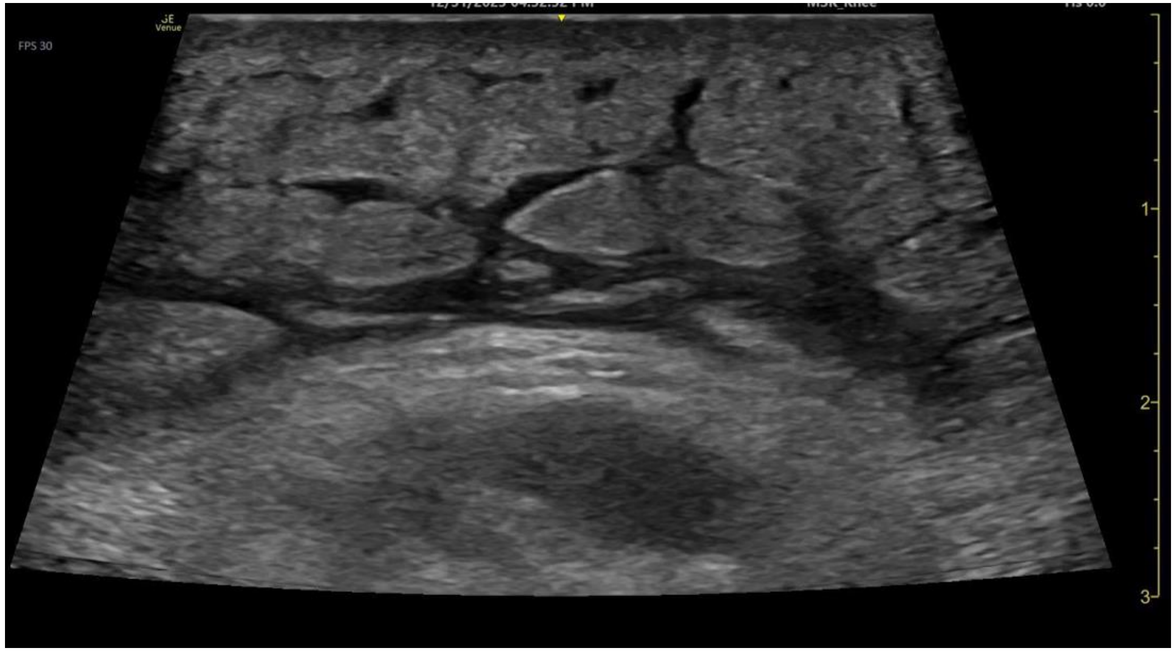
Superficial vs Deep

Cellulitis vs Abscess

Indications for Skin and Soft Tissue POCUS

Normal vs Cellulitis

Cellulitis vs Abscess

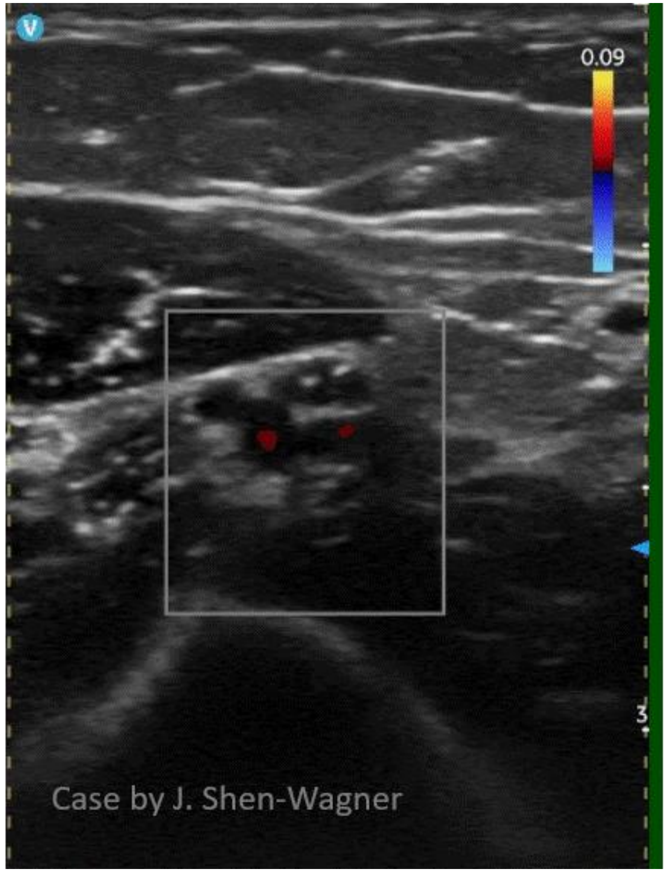


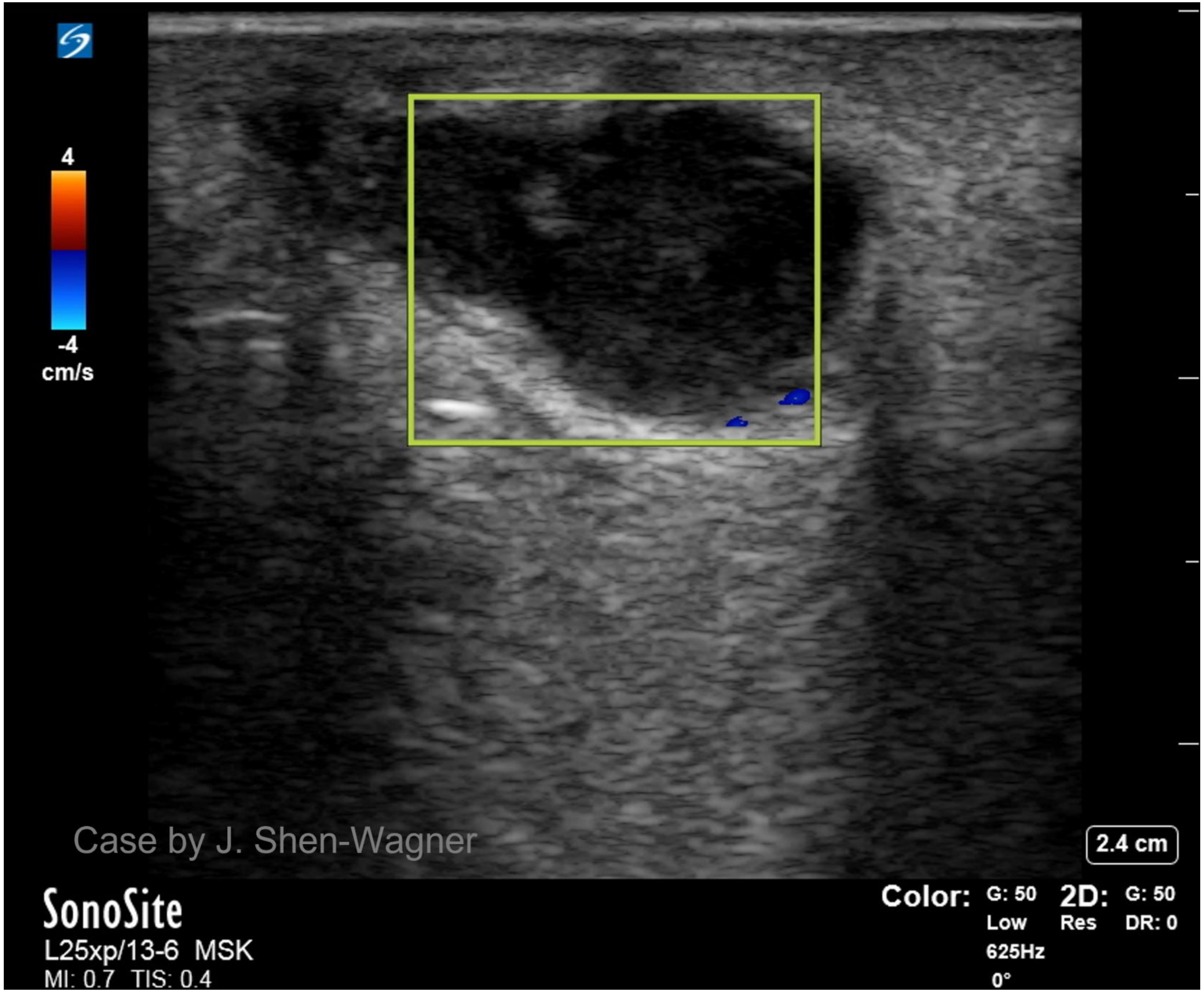
Vascular vs Nonvascular

Indications for Skin and Soft Tissue POCUS

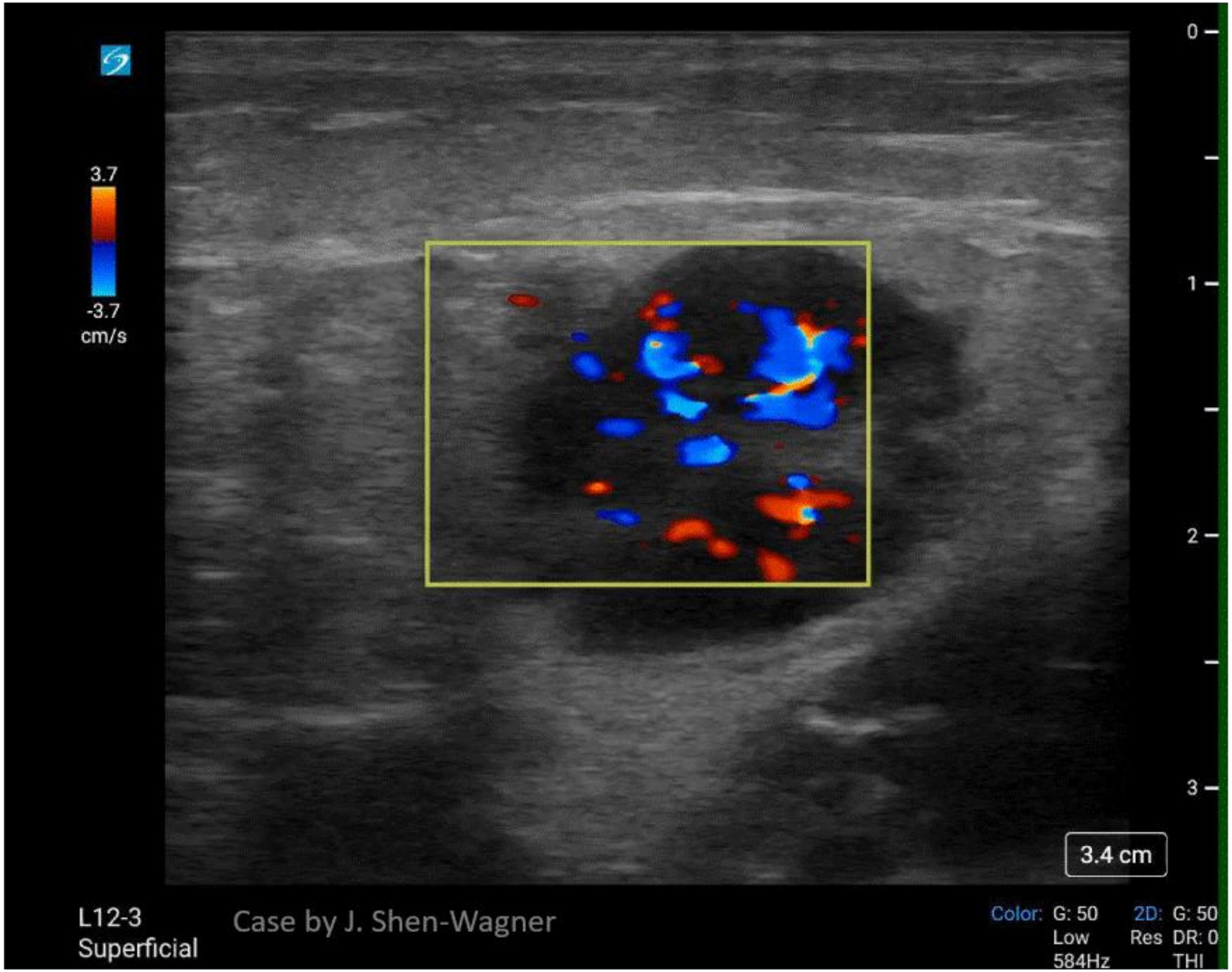
Vessels

Color flow is useful if you are uncertain.




4
-4
cm/s
Case by J. Shen-Wagner
2.4 cm
SonoSite
L25xp/13-6 MSK
MI: 0.7 TIS: 0.4
Color: G: 50
Low
625Hz
0°
2D: G: 50
Res DR: 0

Physic!


3.7
-3.7
cm/s
0
1
2
3
3.4 cm
L12-3
Superficial
Case by J. Shen-Wagner
Color: G: 50
Low
584Hz
2D: G: 50
Res DR: 0
THI

Foreign Body

Indications for Skin and Soft Tissue POCUS

Foreign Body Identification

Physic!

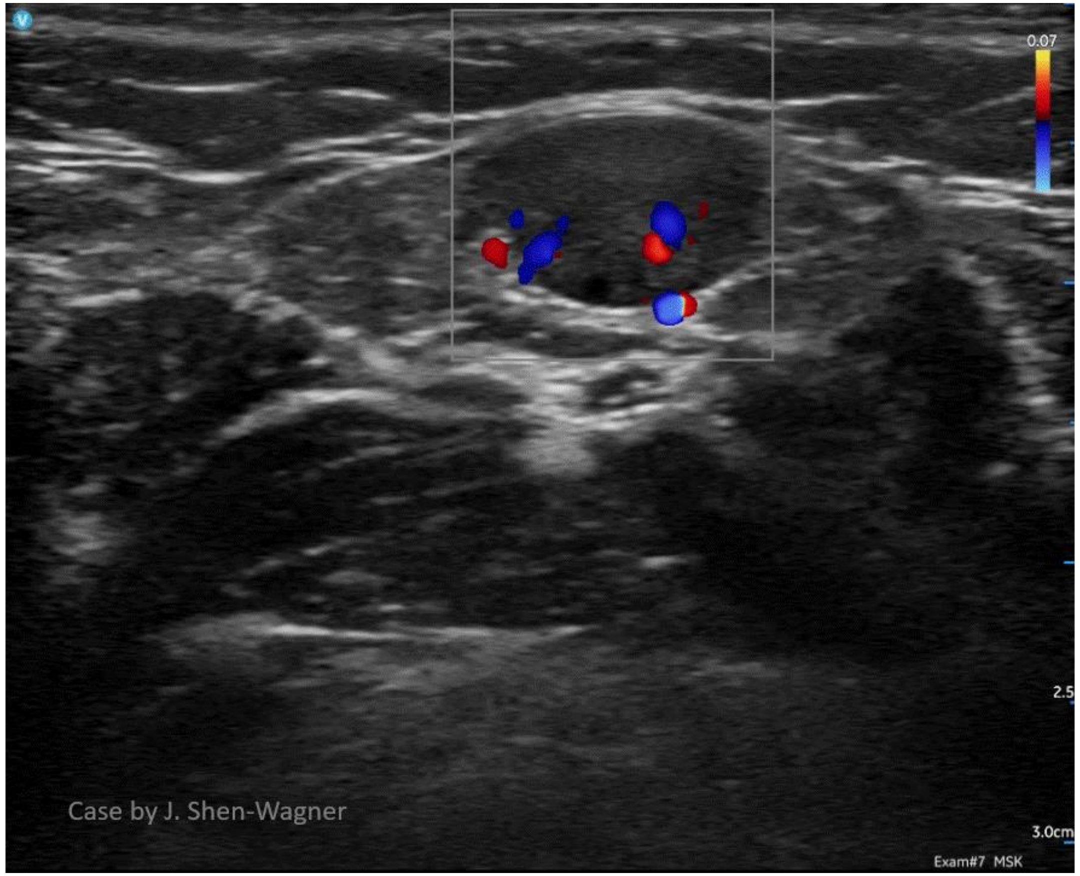
Non-palpable Implant

Non-palpable Implant- Shadow Artifacts

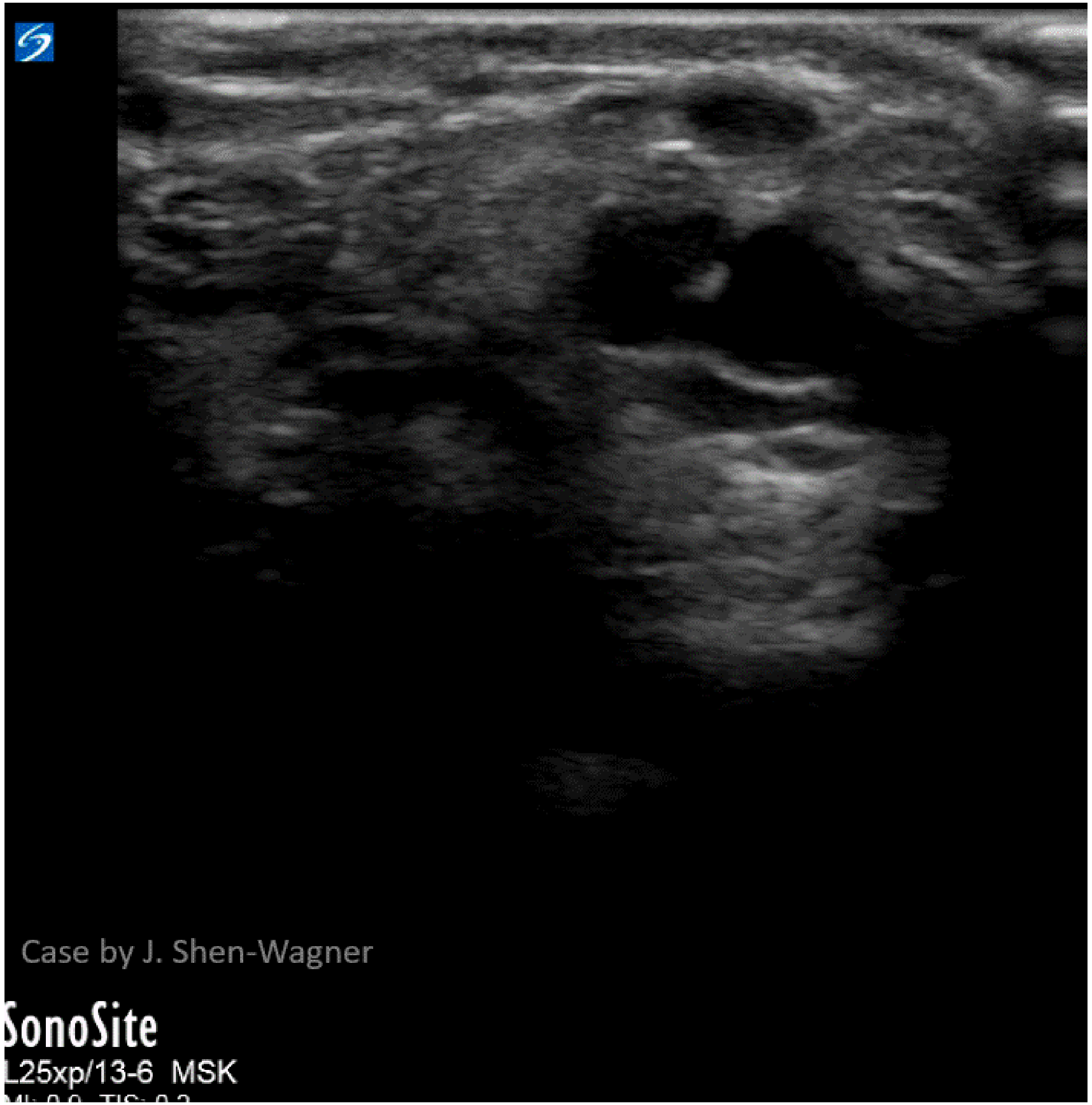
Solid vs Cystic Lesion

Indications for Skin and Soft Tissue POCUS

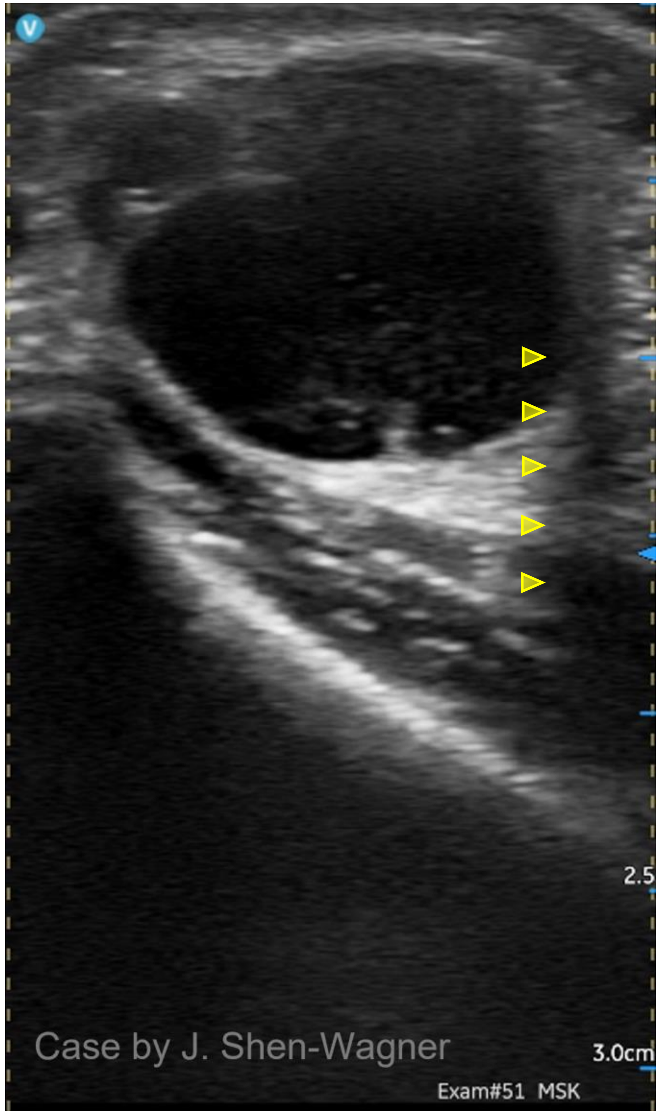
Solid vs Cystic



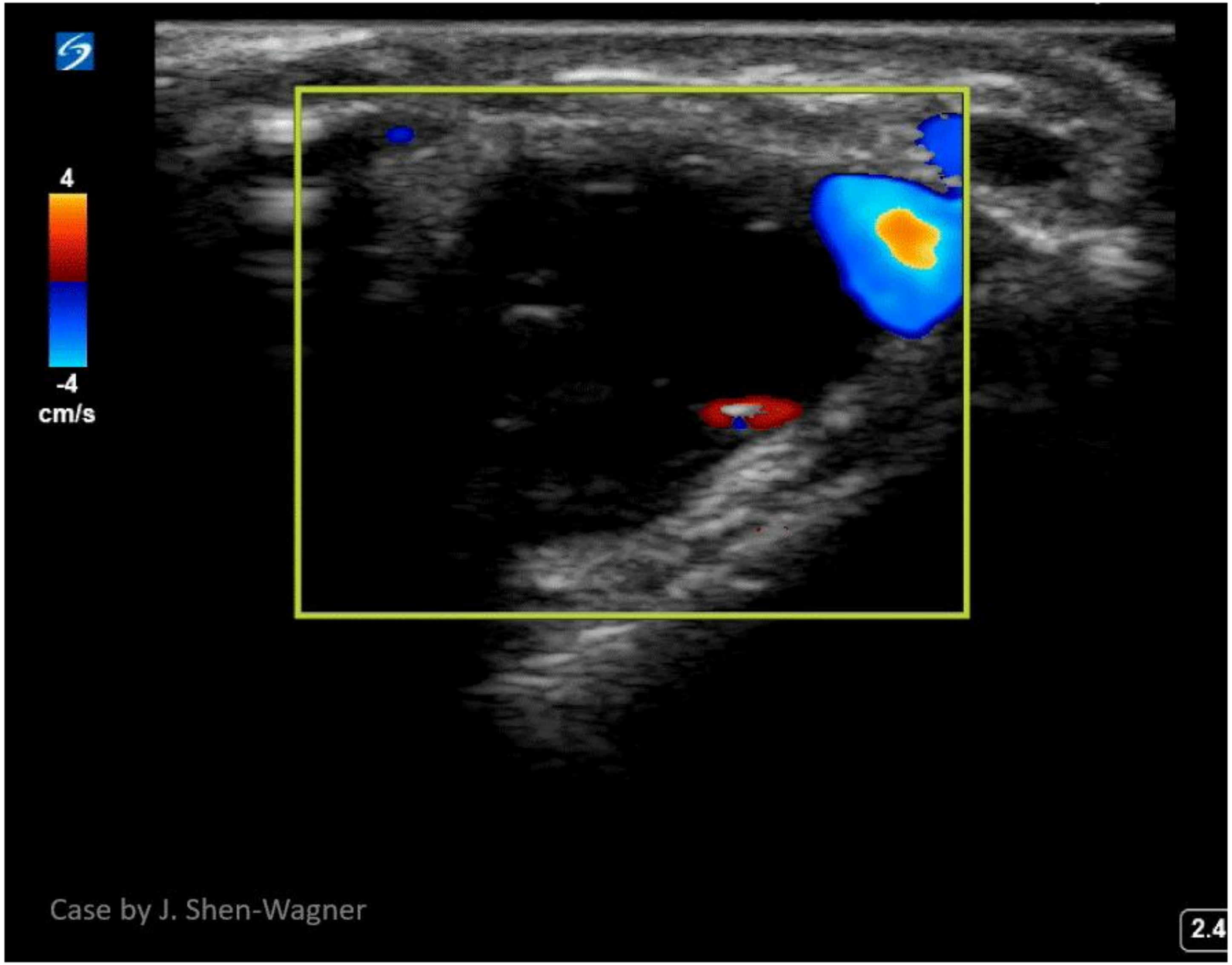
http://en.wikipedia.org/wiki/Image:Ganglion-cyst.jpg



Solid vs Cystic



Physic!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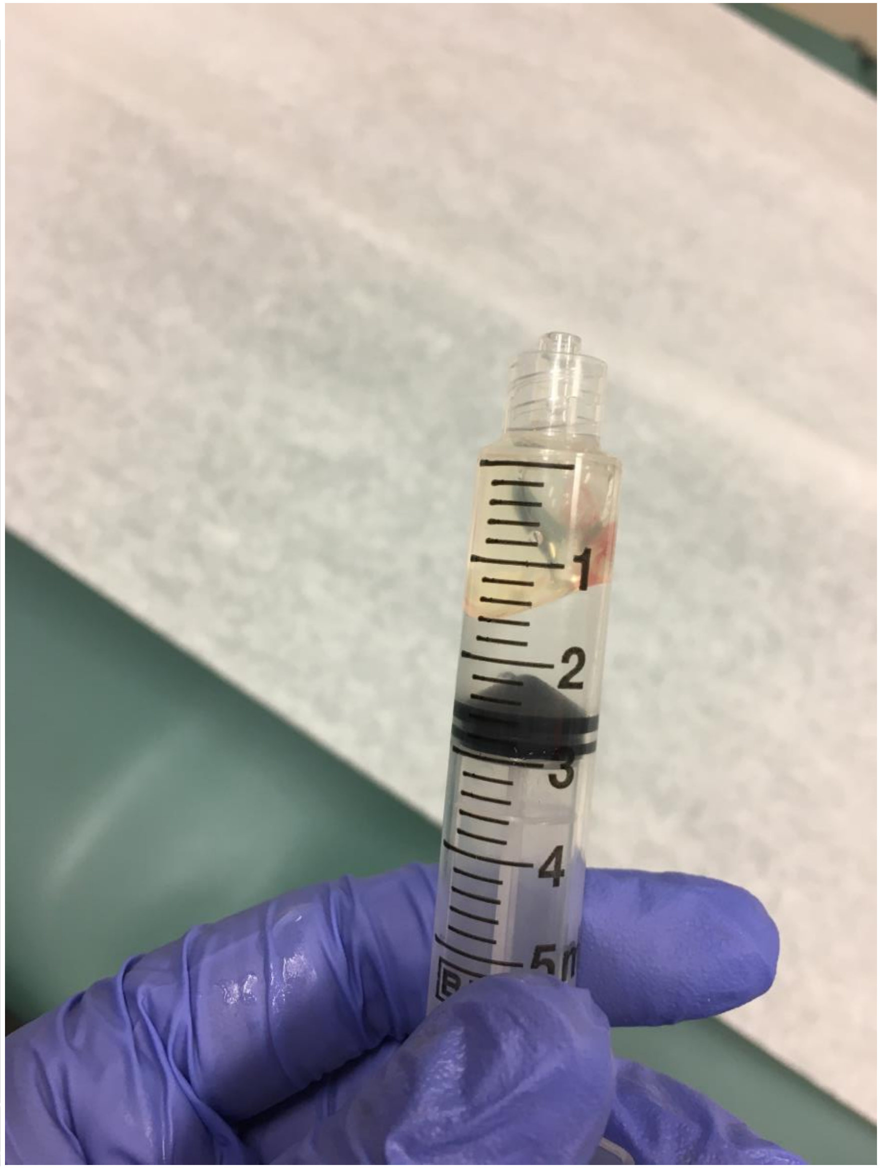
cm/s
Case by J. Shen-Wagner
2.4


1
2
3
4

Practice Recommendations

1. For small or superficial structures use light touch, gel pad or water bath.
2. Use both high and low frequency probe, and low frequency for lower extremity deeper structures.
3. Tissue layers have different proportions in different body parts, practice identifying tissue layers and fascial planes in different areas.
4. Before you stick it, check it for internal blood flow with Color Doppler!
5. Look for posterior enhancement and shadows to help characterize structures like cysts, bones or foreign body.

Billing and Coding

CPT code

76882 Ultrasound, limited, joint or focal evaluation of other nonvascular extremity structure (EG, joint space, periarticular tendon(s), muscle(s), nerve(s), other soft tissue structures (s), or soft tissue masses, real time with image documentation.

https://www.cms.gov/medicare-coverage-database/view/article.aspx

Code	Soft tissue area
76882	Upper extremity
76882	Lower extremity
76882	Axilla
76882	Nerves, peripheral
76604-52	Chest wall
76604-52	Upper back
76705	Lower back
76705	Abdominal wall
76857	Pelvic wall
76587	Buttock

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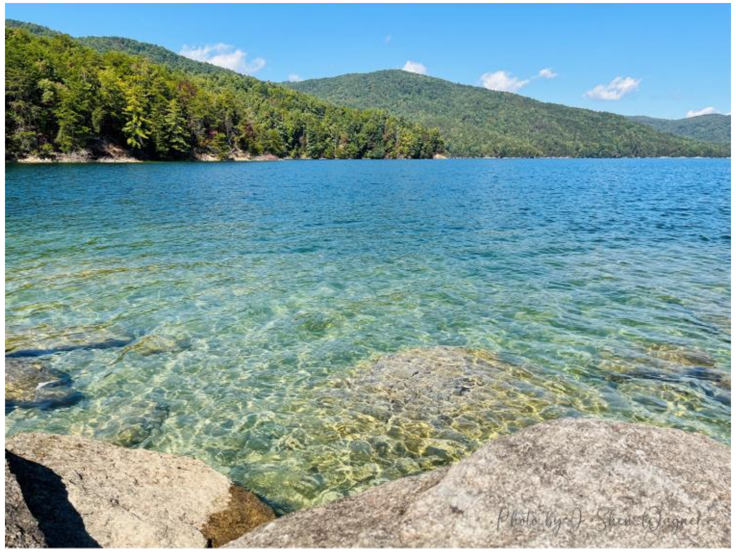
Thank you!



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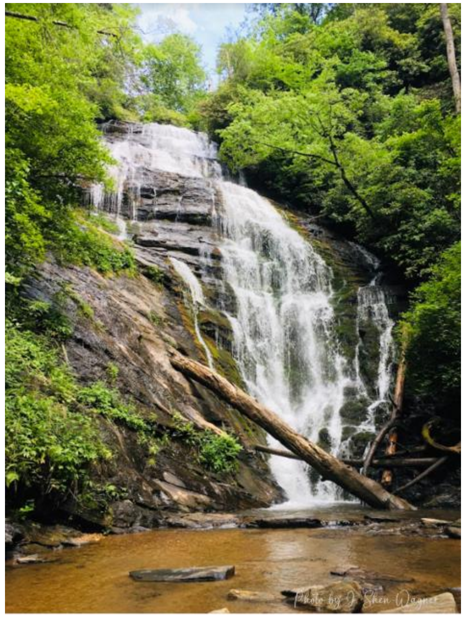

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AMERICAN ACADEMY OF FAMILY PHYSICIANS

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Musculoskeletal Upper Extremity Ultrasound

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Point-of-Care Ultrasound Director, OHSU FM Residency

Disclosure Statement

It is the policy of the AAFP that all individuals in a position to control CME content disclose any relationships with ineligible companies upon nomination/invitation of participation. Disclosure documents are reviewed for potential relevant financial relationships. If relevant financial relationships are identified, mitigation strategies are agreed to prior to confirmation of participation. Only those participants who had no relevant financial relationships or who agreed to an identified mitigation process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Review the evidence behind the most common conditions for which point of care ultrasound can be used to help improve care of patients with upper extremity musculoskeletal injuries.
2. Develop beginner-level proficiency in using point-of-care ultrasound for evaluation of the shoulder and wrist with guided ultrasound protocols.
3. Assess for shoulder and wrist pathologies such as supraspinatus injury, subacromial bursitis, and carpal tunnel syndrome.
4. Learn to find and assess the median nerve for carpal tunnel syndrome

Benefits of MSK POCUS

- Lower cost
- Ability to perform a dynamic examination
- Ability to do examination under manipulation with immediate patient–clinician feedback
- Immediate side to side comparison (with hypothetical contralateral extremity)
- No contraindications to patients with metallic or electronic implanted devices such as a pacemaker or military shrapnel

Clinical Applications

Beginner	Advanced
Shoulder: - Assessing biceps tendon Wrist: - Assessing median nerve for carpal tunnel	Shoulder: - Identifying rotator cuff injuries - Assessing for calcific tendinitis or SASD bursitis - US guided injections Wrist: - US guided median nerve injections

Shoulder Point-of-Care Ultrasound

Clinical Applications

POCUS can be helpful for diagnosing:

- Major rotator cuff tears
- Bursitis or effusion
- Calcific tendinopathy
- Impingement
- Dislocation (more urgent care or ED)

Clinical Applications

POCUS is less accurate for:

- Labral tears
- Fractures
- Partial or small rotator cuff tears

Evidence for MSK US for Shoulder Pathology

TABLE 3

Musculoskeletal Ultrasonography of the Shoulder Compared with MRI

	Musculoskeletal ultrasonography		MRI	
Condition	**Sensitivity**	**Specificity**	**Sensitivity**	**Specificity**
Calcifying tendinitis	100%	85% to 98%	98%	96%
Full thickness rotator cuff tear	92%*	93%	94%*	93%
Partial thickness rotator cuff tear	52%	93%	74%	93%
Subacromial bursitis	79% to 81%	94% to 98%	Not reported, higher than ultrasonography	

MRI = magnetic resonance imaging.

*—A Cochrane review found these sensitivities were equivalent.

Information from references 30-33.

Lenza M, et al. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane Database Syst Rev*. 2013;(9)

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	Evidence rating	Comments
Use plain radiography as the recommended initial imaging modality for traumatic shoulder injuries to rule out fracture.[10]	C	Consistent evidence from cohort studies
Consider surgery in active patients younger than 25 years with anterior shoulder dislocation.[23-26]	B	Consistent evidence from cohort studies showing a lower rate of recurrence after surgery
Encourage nonoperative treatment of proximal humerus fractures in older patients.[36]	B	Consistent evidence from cohort studies showing fewer complications and better or equivalent outcomes compared with surgical management
Use ultrasonography or magnetic resonance imaging to detect complete rotator cuff tears. They have similar sensitivity and specificity.[37,42,45-47]	C	Limited evidence from randomized controlled trials showing skilled ultrasonography is equivalent to magnetic resonance imaging in detecting full-thickness rotator cuff tears but less accurate at identifying damage to deep structures; magnetic resonance imaging and ultrasonography are less sensitive for partial tears

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to https://www.aafp.org/afpsort.

Table 2

Selected Tests of the Shoulder

EXAMINATION MANEUVER	ASSOCIATED CONDITION	SENSITIVITY (%)	SPECIFICITY (%)	LR+	LR−
Inspection					
Supraspinatus or infraspinatus atrophy[10]	Chronic rotator cuff tear	56	73	2.07	0.60
Provocative tests					
Hawkins' impingement[15]	Impingement/rotator cuff disorder	72	66	2.1	0.42
Drop-arm[15]	Large rotator cuff tear	27	88	2.25	0.83
Empty-can supraspinatus[15]	Rotator cuff disorder involving supraspinatus	44	90	4.4	0.62
Lift-off subscapularis[17]	Rotator cuff disorder involving subscapularis	62	100	> 25	0.38
External rotation/infraspinatus strength[15]	Rotator cuff disorder involving infraspinatus	42	90	4.2	0.64
Cross-body adduction[18]	Acromioclavicular joint OA or chronic sprain	77	79	3.50	0.29

Burbank et al. Am Fam Physician. 2008 Feb 15.

Case: Classic “FOOSH” (Fall On OutStretched Hand)

- 40 year old person, with Right shoulder pain for 10 days
- A week ago, was running with dog and fell and landed out on his right arm, no immediate pain at the time
- 3 days later, was starting a lawnmower, pulling the string, and felt sharp pain
- Now cannot lift the right arm

Case: Classic “FOOSH” (Fall On OutStretched Hand)

Right Shoulder exam:

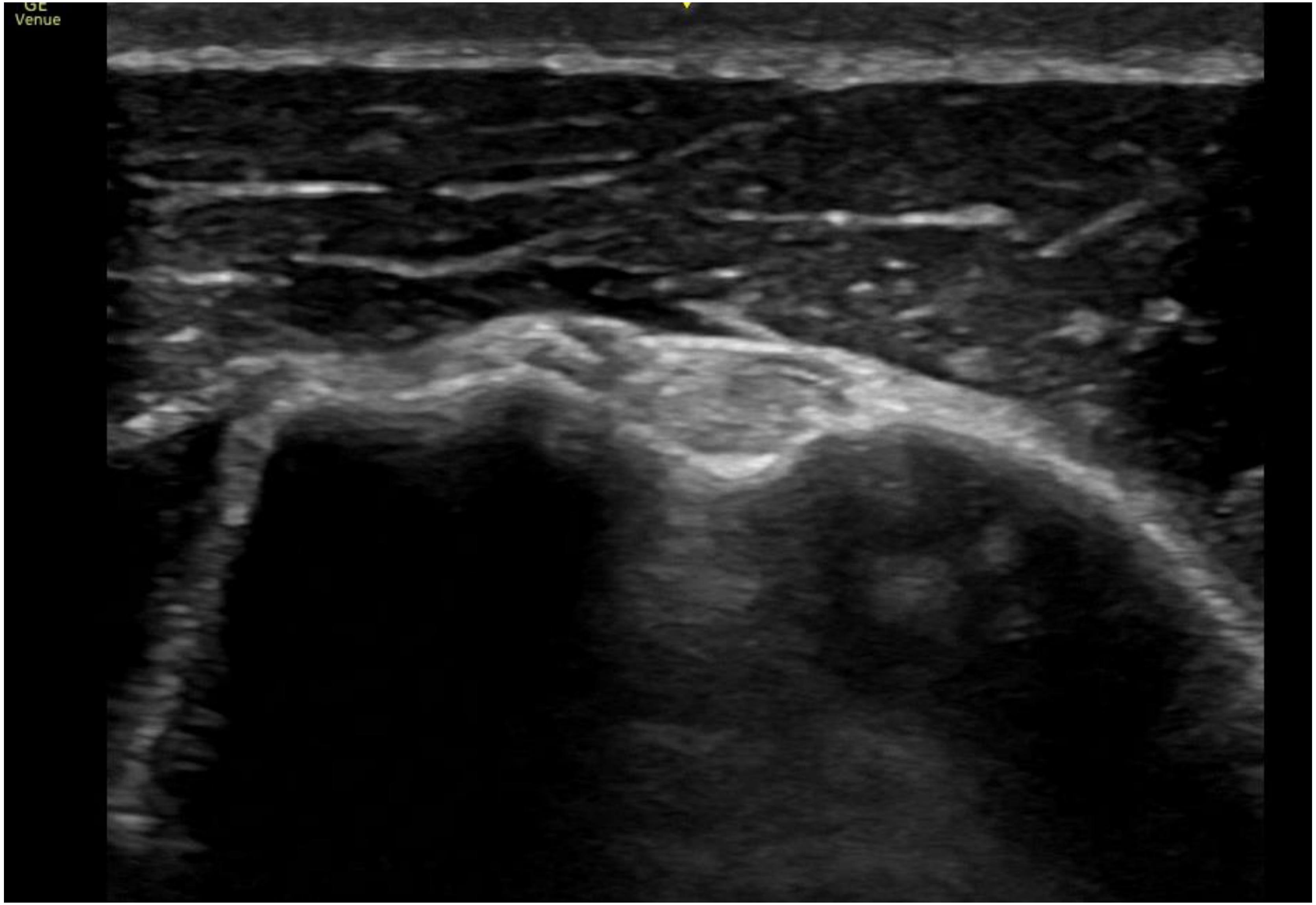
No swelling, deformities, or dislocations

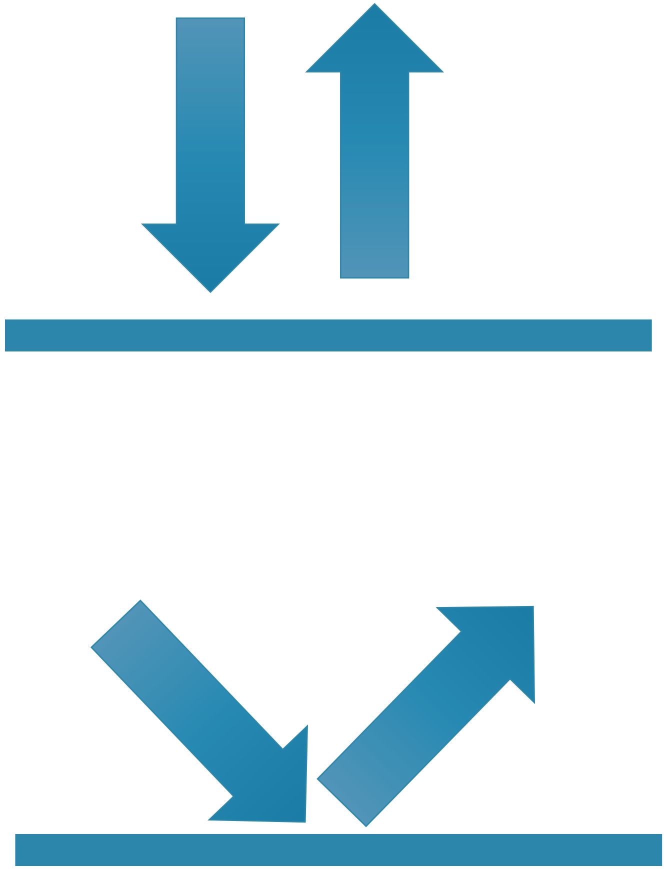
Flexion to 30 degrees, Abduction to 70 deg, full extension, intact internal and external rotation

3/5 strength Abduction

+Empty can test (Jobe’s test)

ANISOTROPY





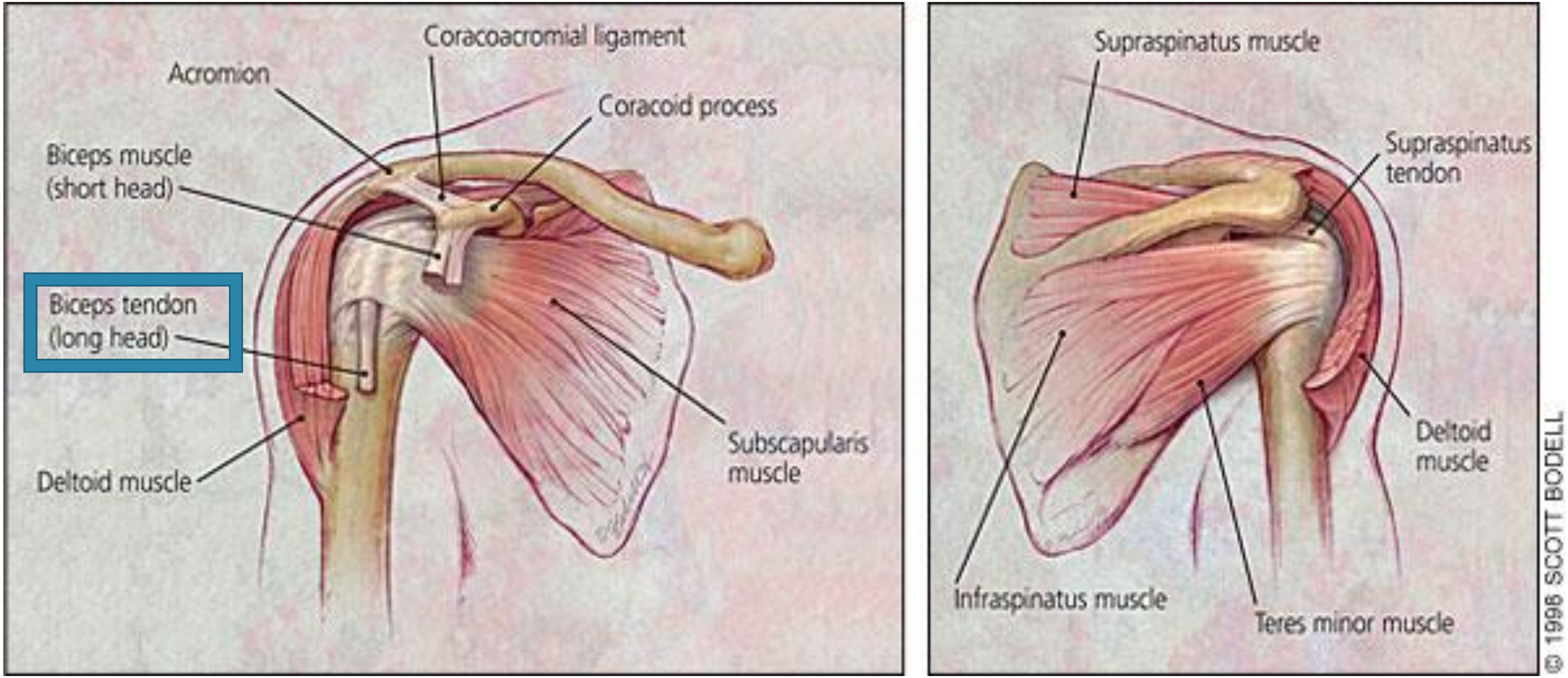
Scanning Protocol

Step	Protocol
1	Biceps brachii tendon, long head
2	Subscapularis
3	Supraspinatus and rotator cuff interval
4	Acromioclavicular joint, subacromial-subdeltoid bursa, dynamic range of motion for impingement
5	Infraspinatus, teres minor, posterior labrum

Set up

1. Have patient sit upright in chair
2. Using linear transducer
3. Exam mode: MSK (or Shoulder if have more specific setting)

Biceps Tendon



Fongemie AE et al. Management of shoulder impingement syndrome and rotator cuff tears. Am Fam Physician. 1998 Feb.

Biceps Tendon Short Axis (Home Base)

"Home Base"
- Patient seated
- Can scan facing same direction as patient (vs towards the patient)
- Palm is facing up on lap (supinated)
- Start in short axis, transverse cut of biceps tendon

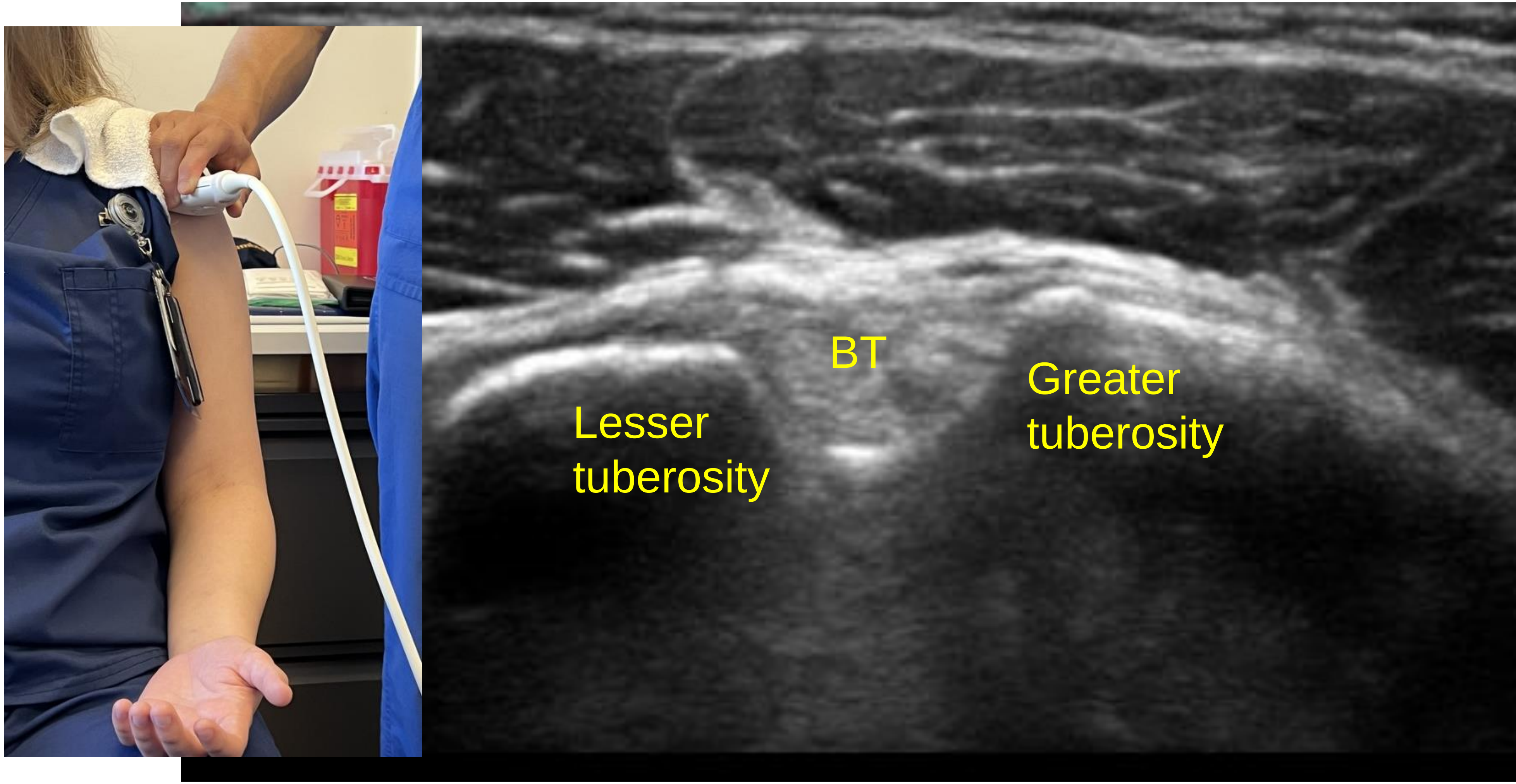


Image Credit: Matt Chan, MD

Biceps Tendon Short Axis (Home Base)

Aim Transducer beam slightly cephalad (towards head) to avoid anisotropy

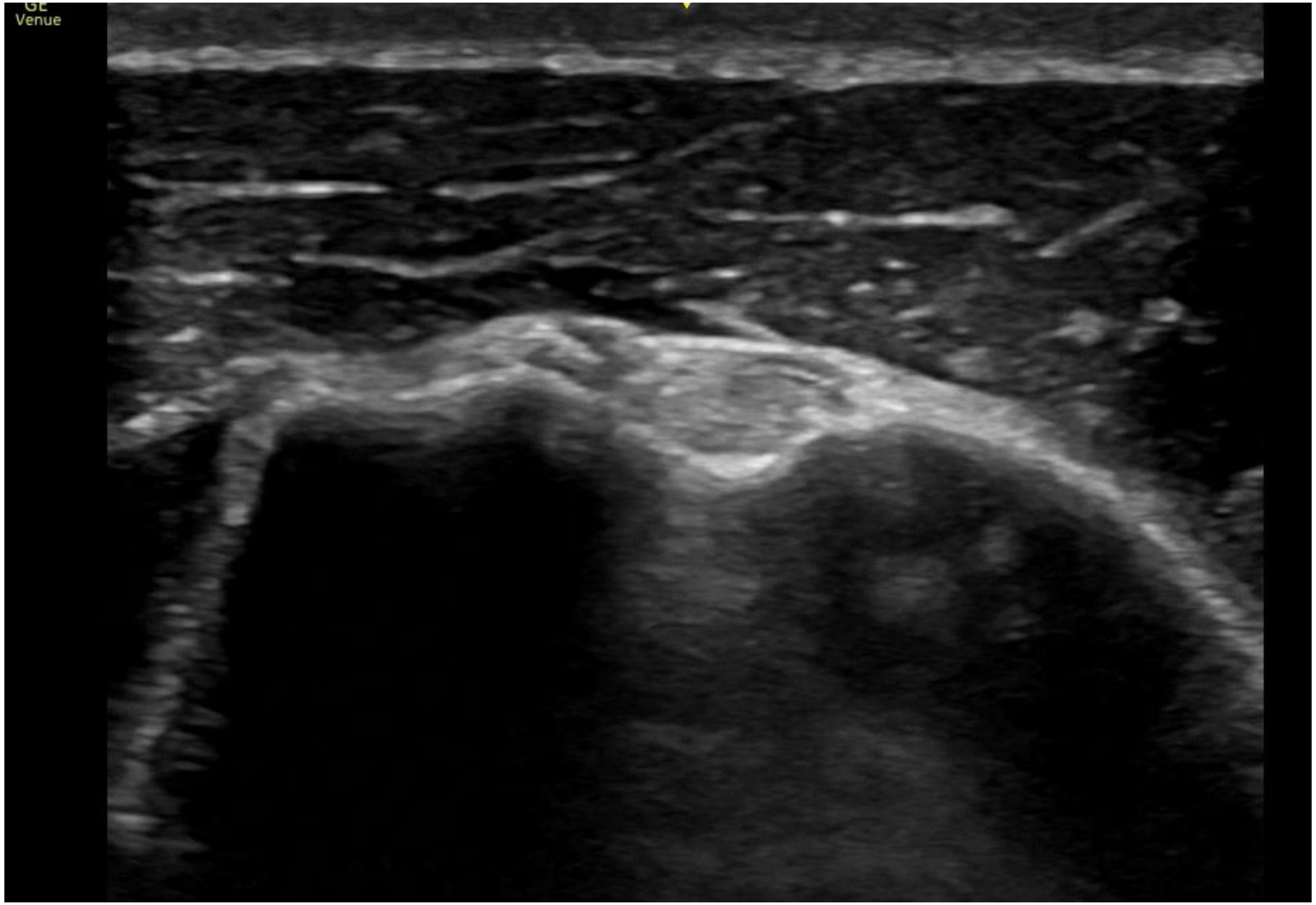
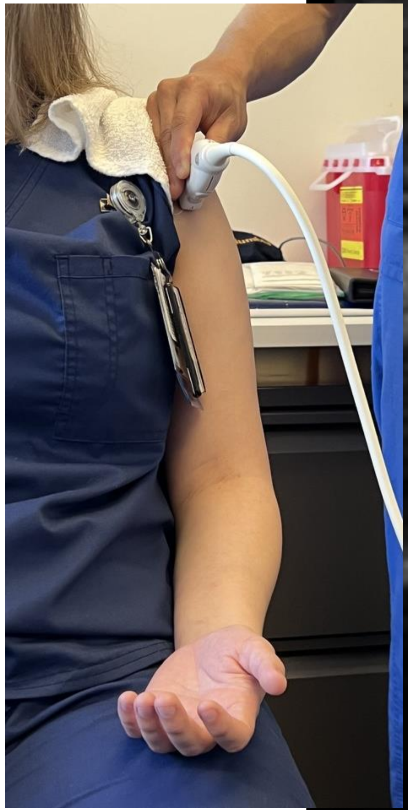


Image Credit: Matt Chan, MD

Biceps Tendon Long Axis

- Turn transducer with probe marker towards ceiling for long axis view
- **“Ski slope” of biceps**



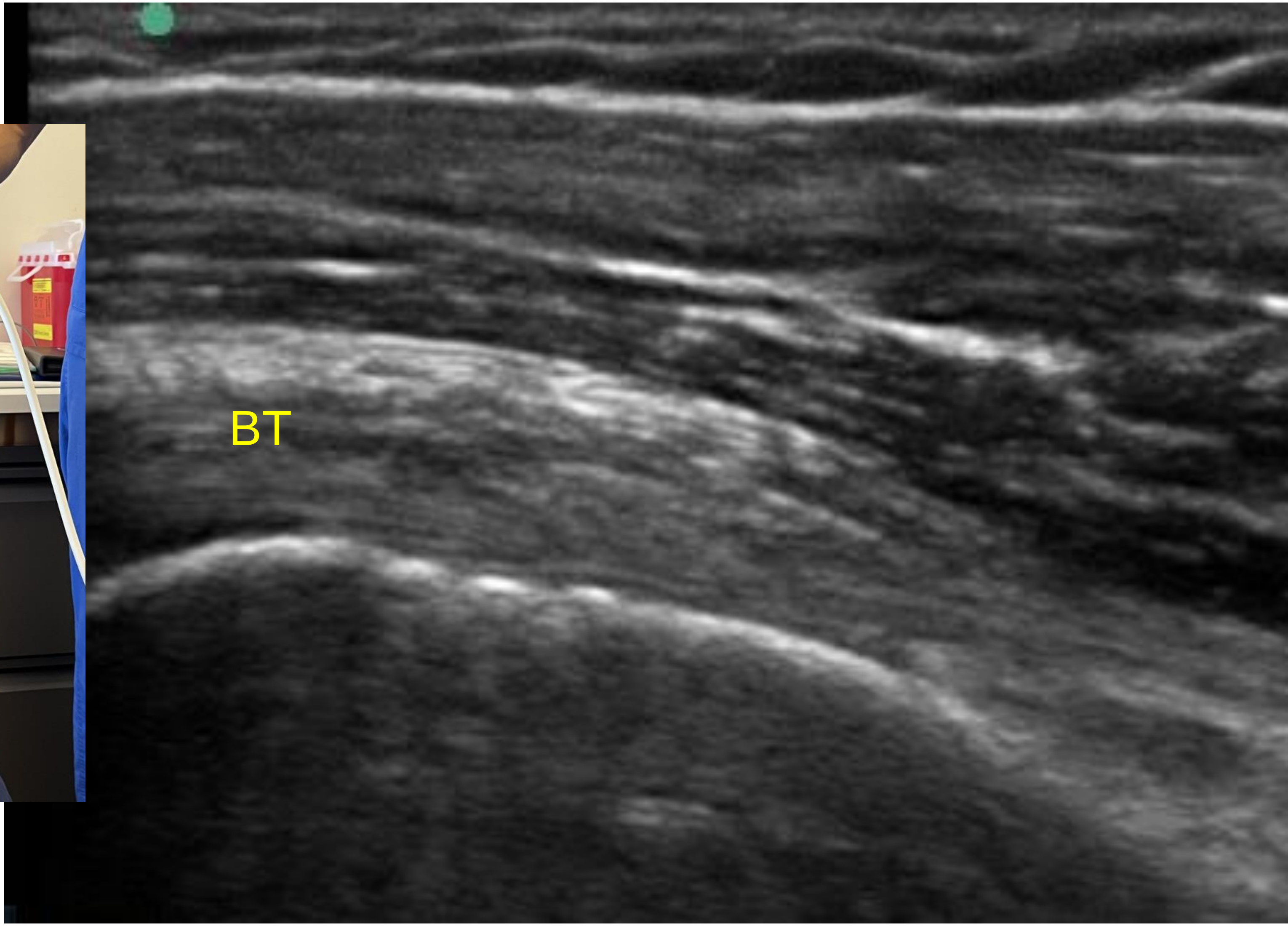
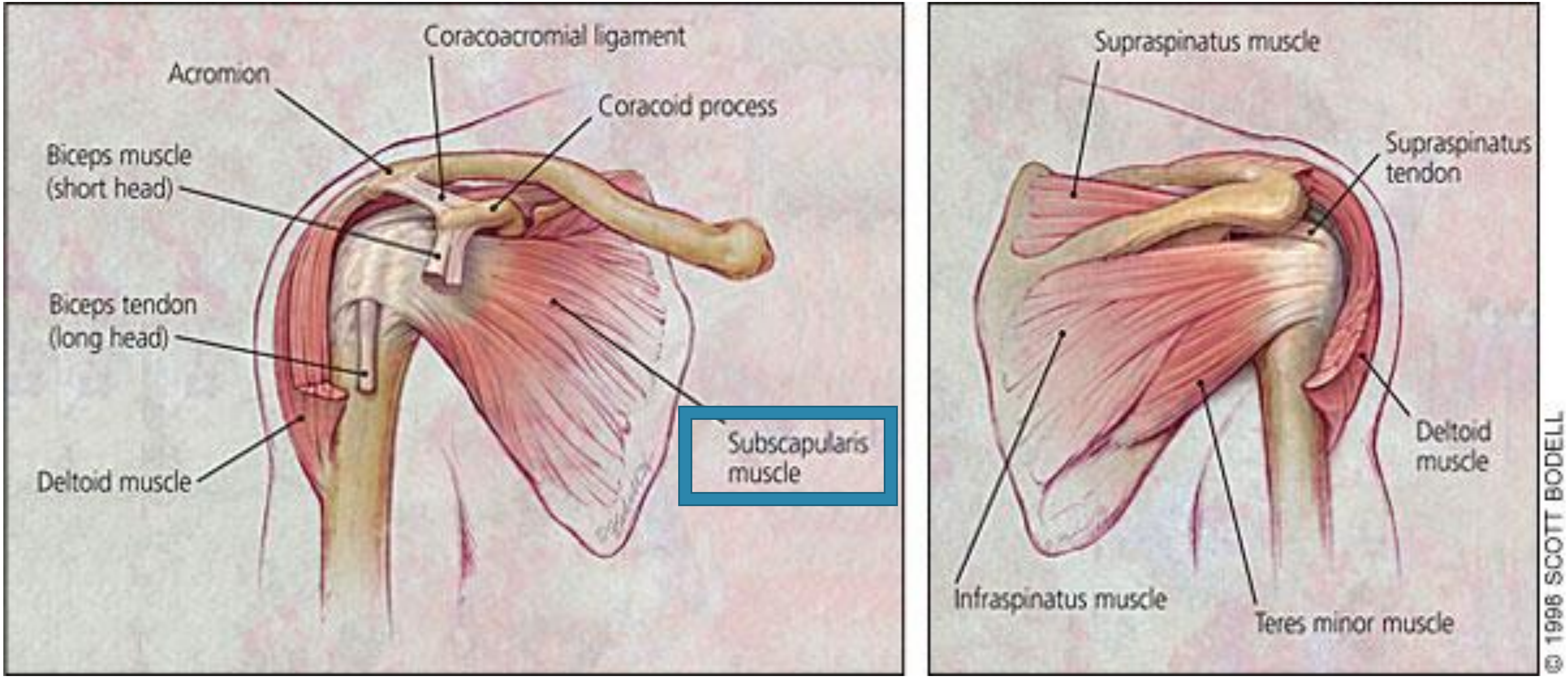


Image Credit: Matt Chan, MD

Subscapularis



Fongemie AE et al. Management of shoulder impingement syndrome and rotator cuff tears. Am Fam Physician. 1998 Feb.

Subscapularis Long Axis

- Return to "Home Base"

- Have patient externally rotate the arm (passive ROM, then active)

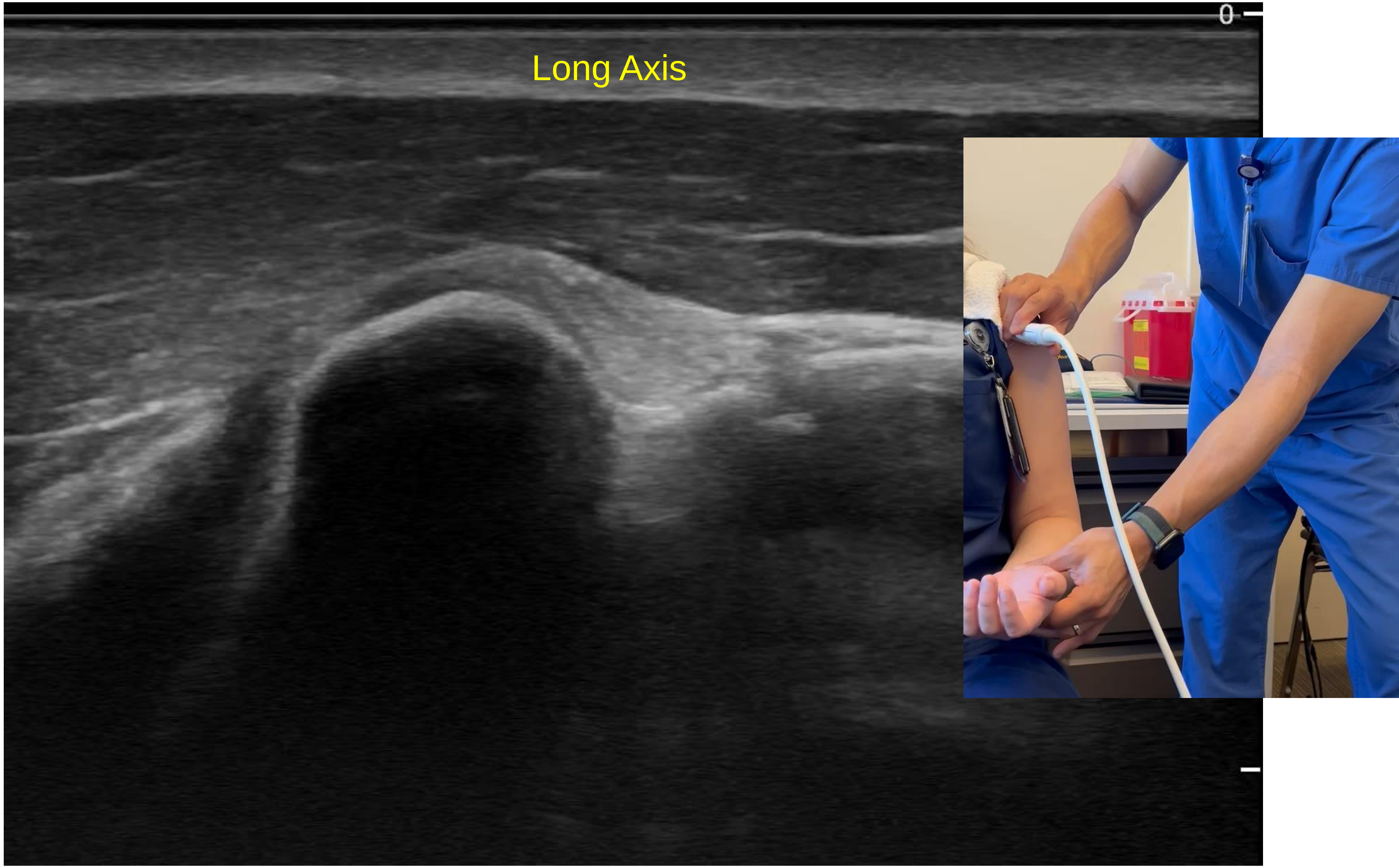
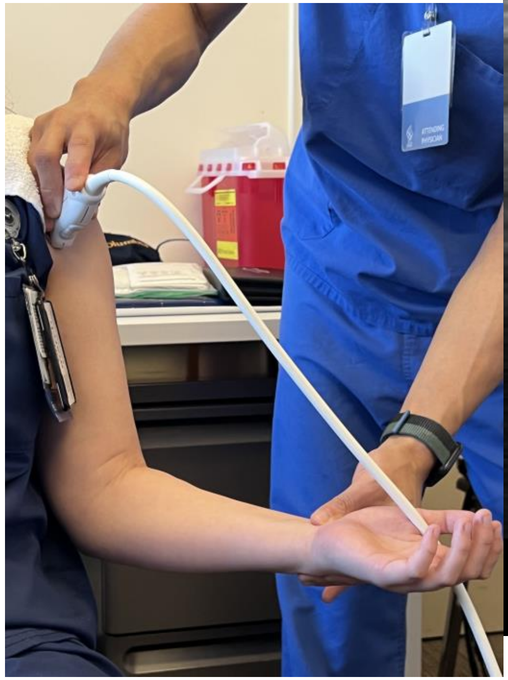
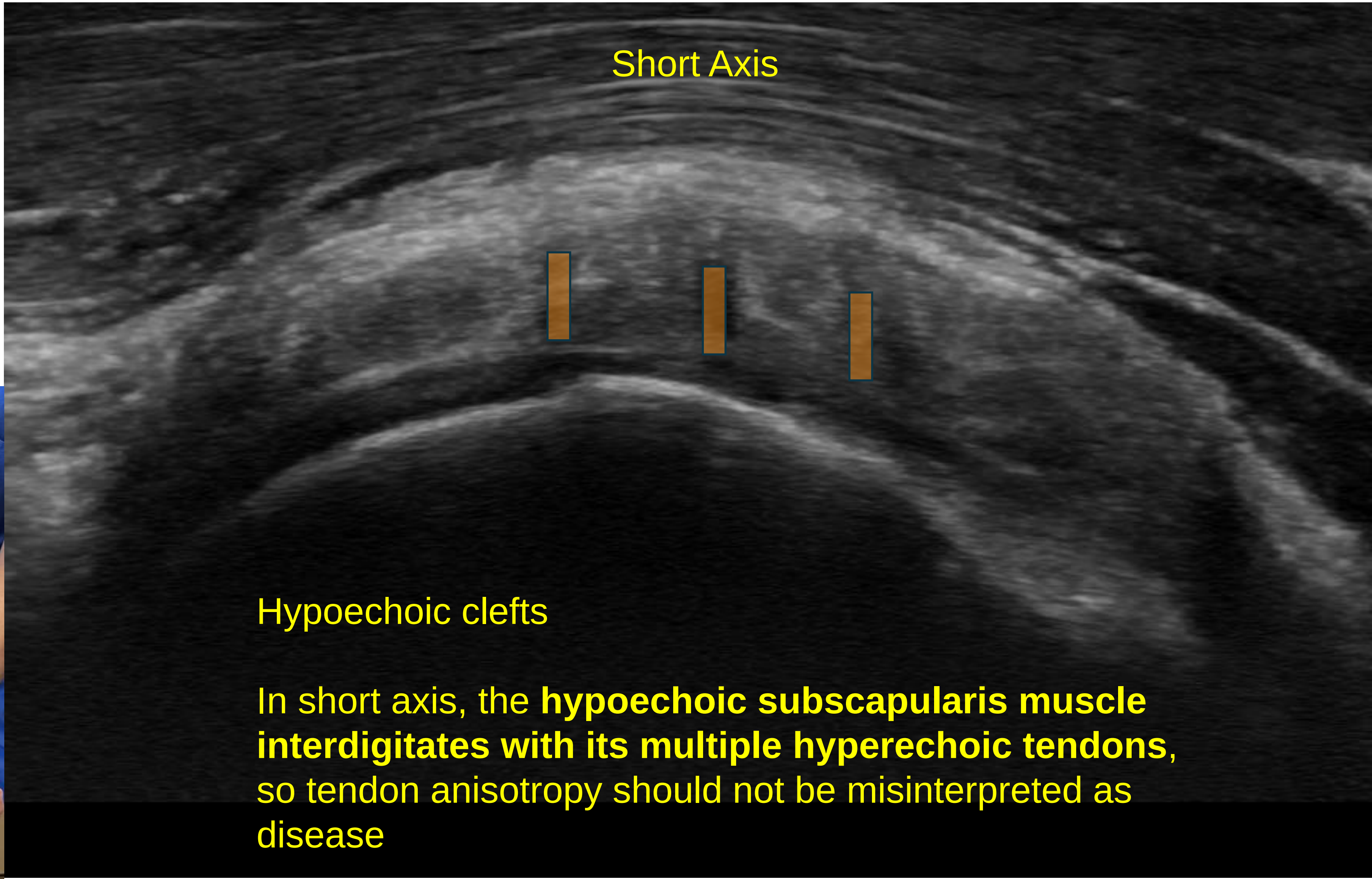


Image Credit: Matt Chan, MD

Subscapularis Short Axis

Rotate probe 90 degrees with probe marker up to look at subscapularis in short axis

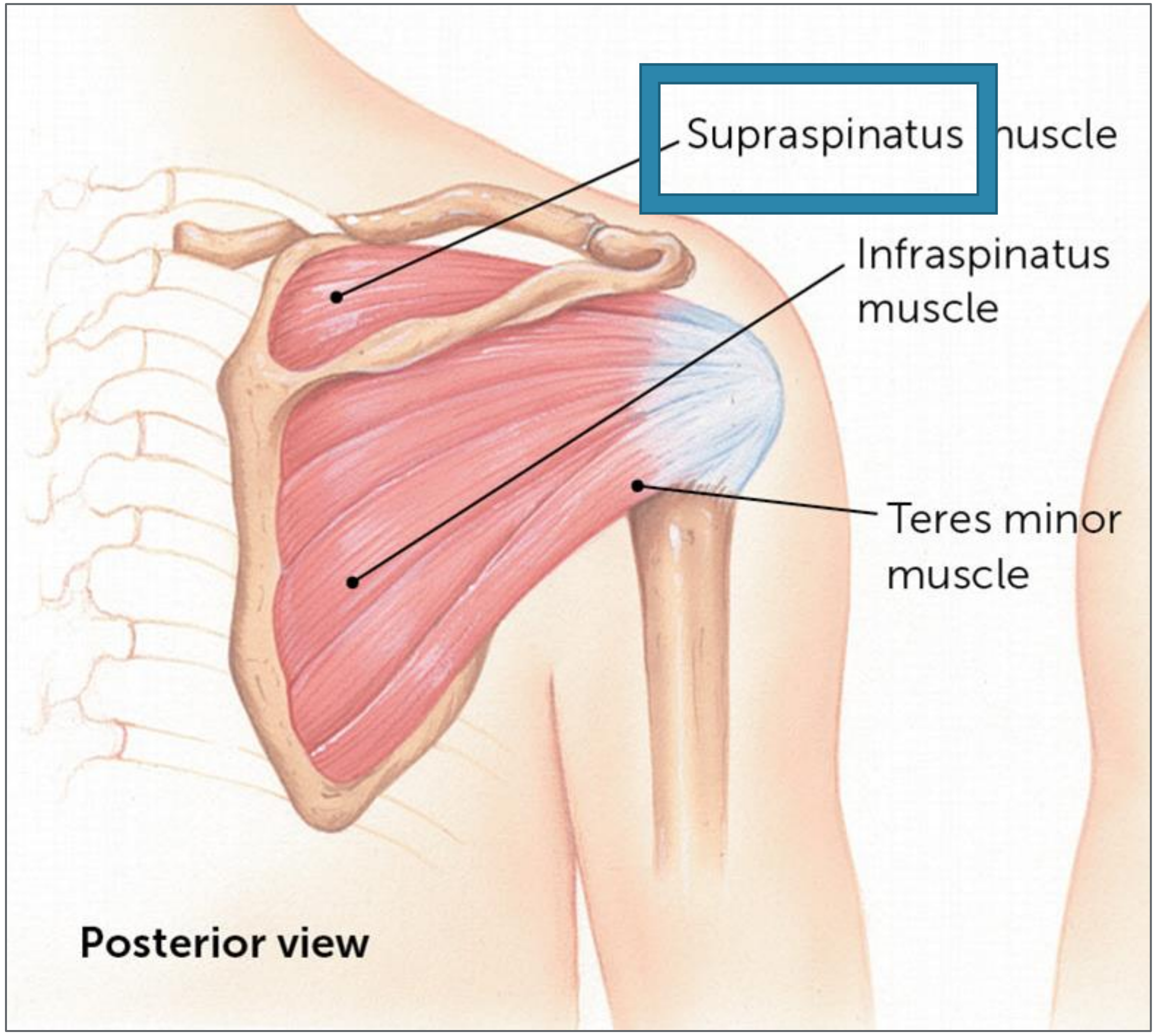




In short axis, the **hypoechoic subscapularis muscle interdigitates with its multiple hyperechoic tendons**, so tendon anisotropy should not be misinterpreted as disease

Image Credit: Matt Chan, MD

Supraspinatus



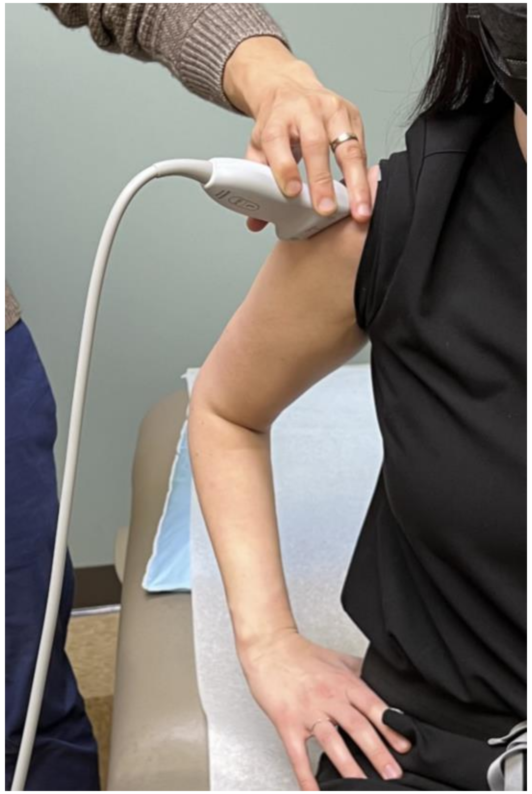
Crass Position
- Hard for patients if painful

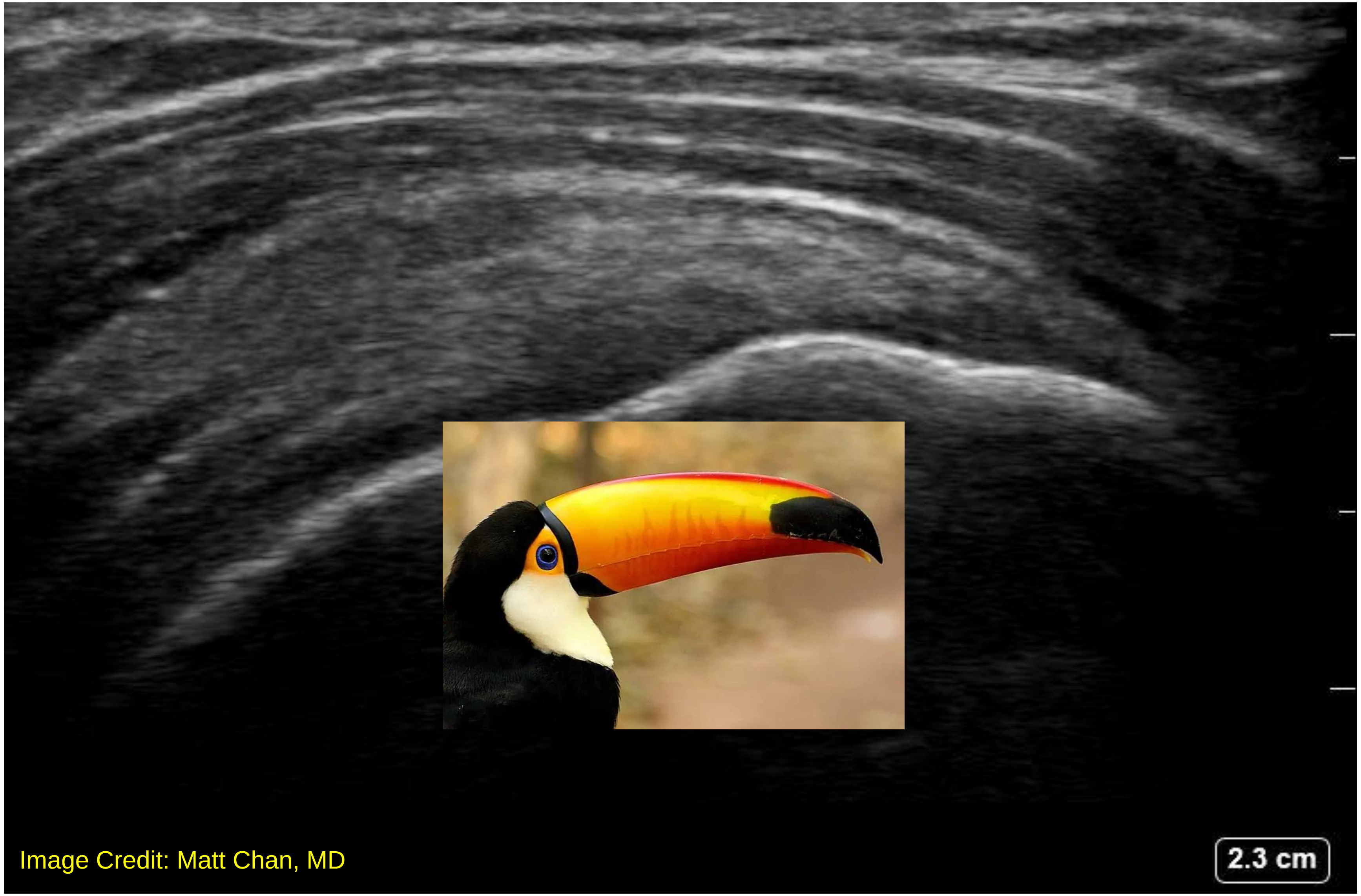
Modified Crass Position
- Usually easier for most patients

Simon LM, et al. Acute Shoulder Injuries in Adults. Am Fam Physician. 2023 May

Supraspinatus Long Axis

- Start from “Home base” as if scanning the biceps
- Rotate probe to angle towards the ear





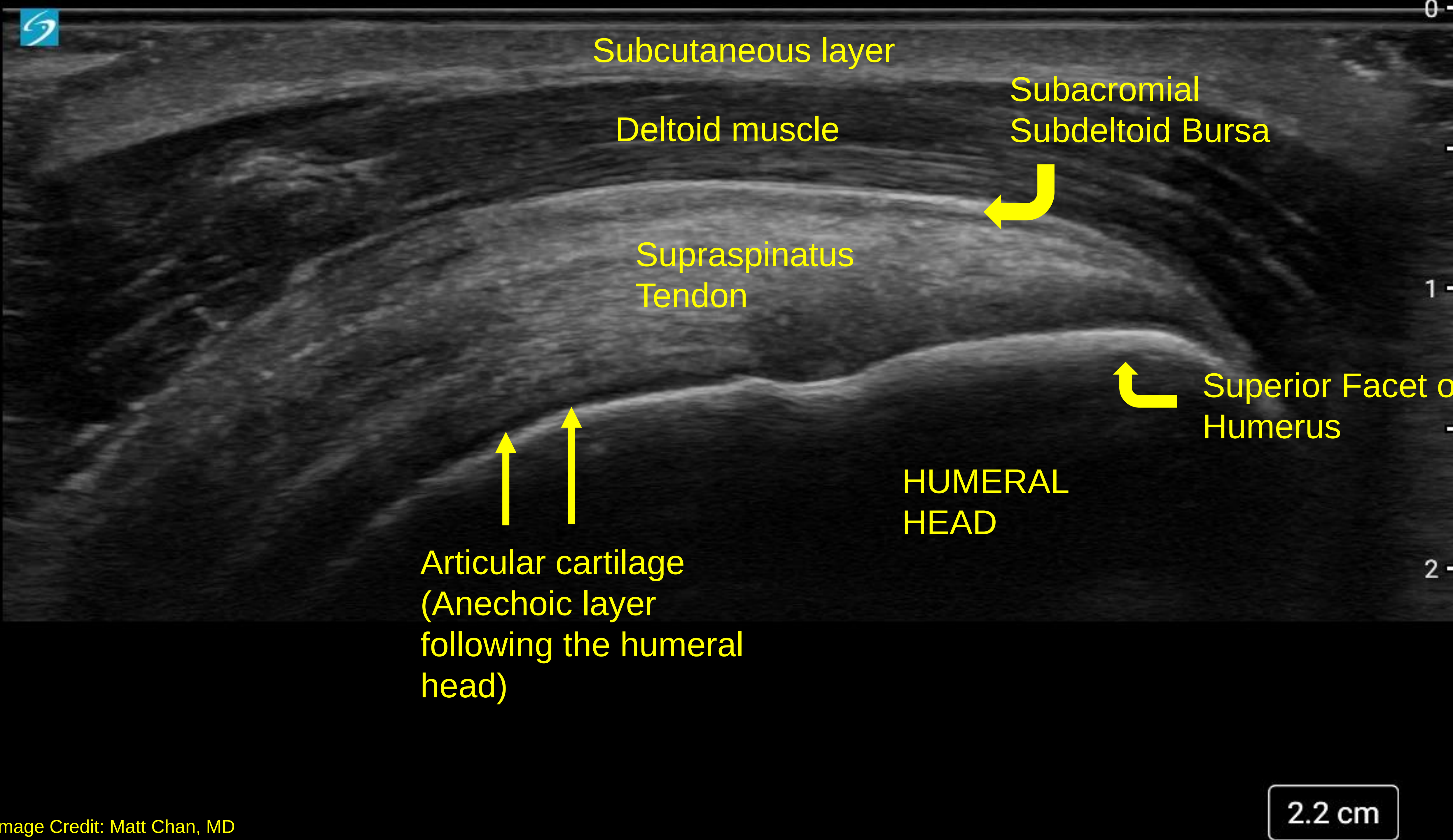


Image Credit: Matt Chan, MD

Supraspinatus Short Axis

Rotate probe 90 degrees

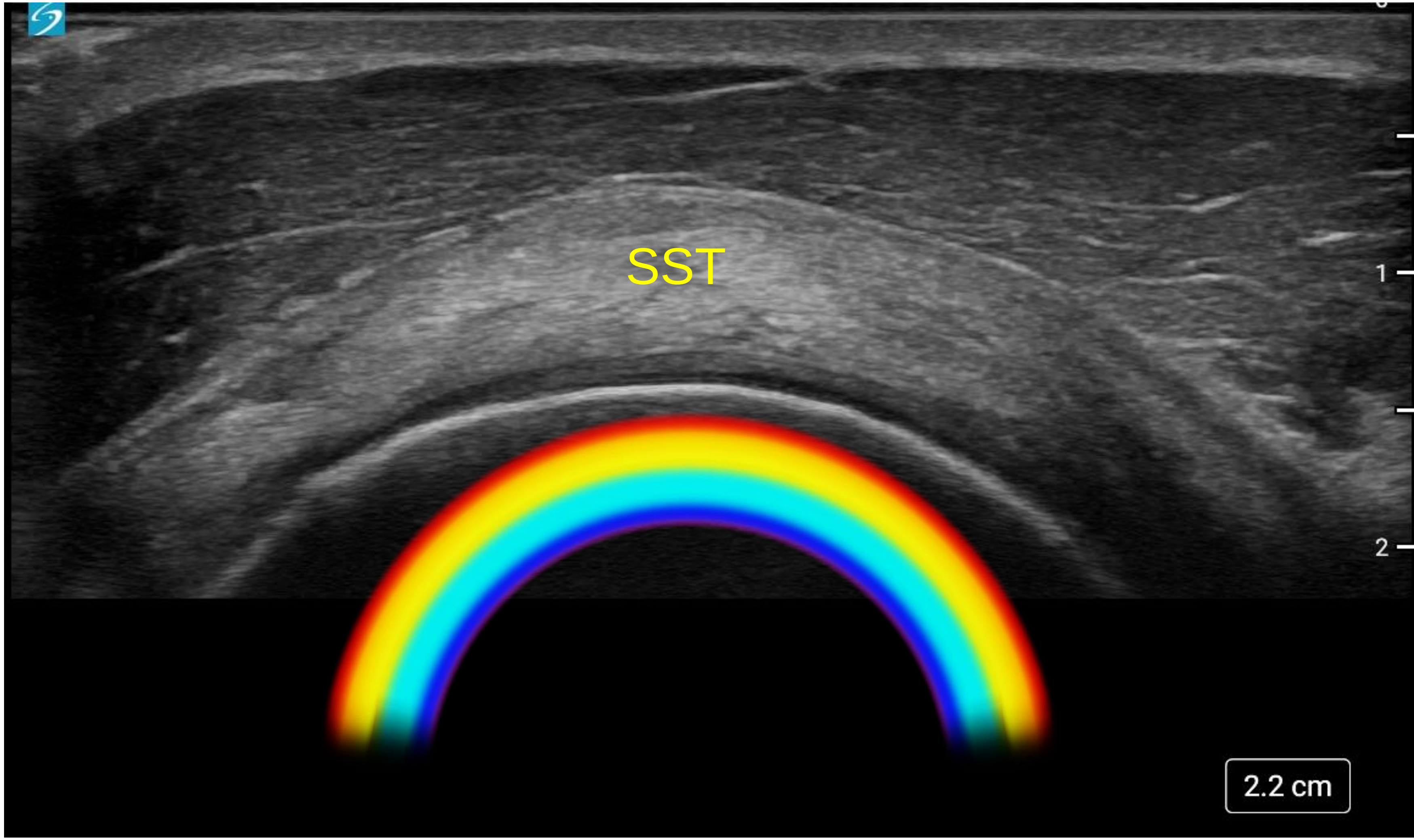
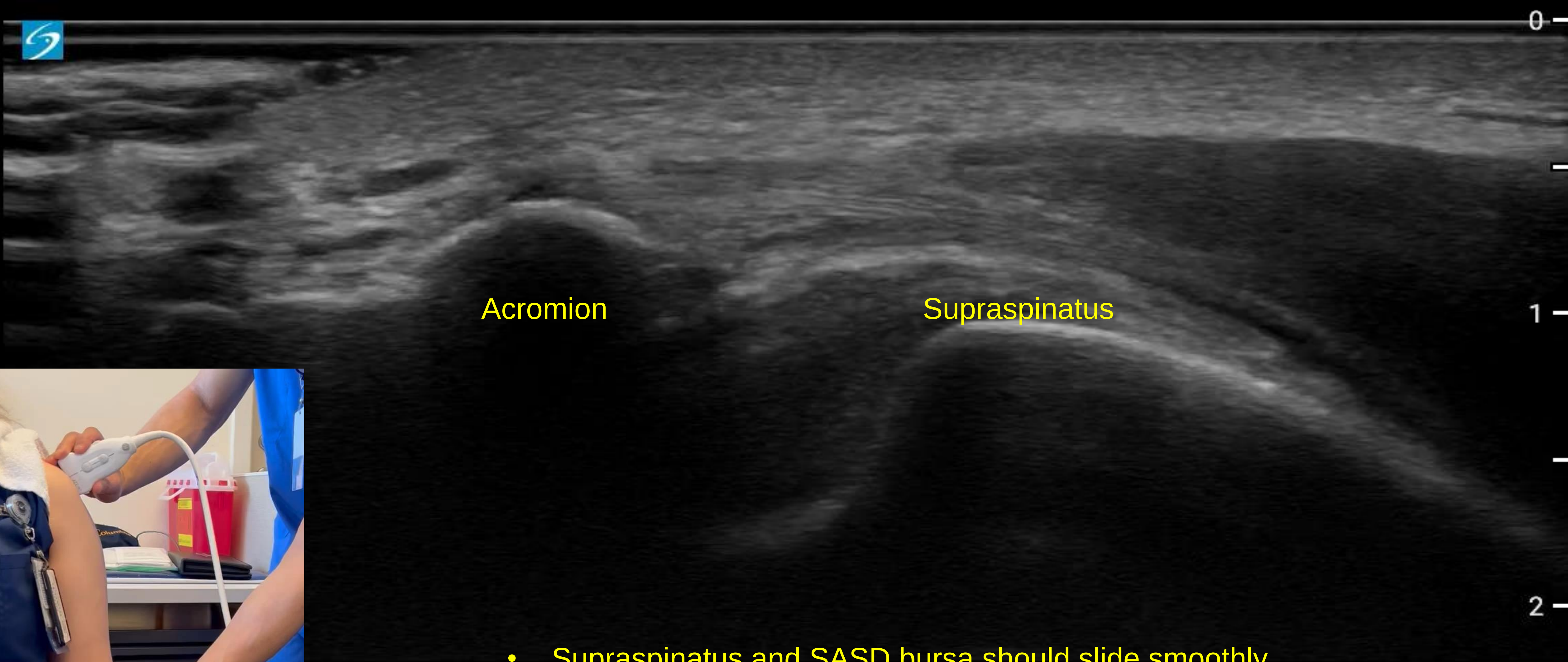


Image Credit: Matt Chan, MD

Dynamic Impingement examination

- Transducer placed on lateral shoulder

- Patient ABducts, and can watch supraspinatus/SASD bursa slide underneath the acromion



- Supraspinatus and SASD bursa should slide smoothly underneath the acromion

- If there is pooling of fluid in lateral aspect of subacromial-subdeltoid bursa, concern for impingement

Image Credit: Matt Chan, MD

2.2 cm

AC Joint

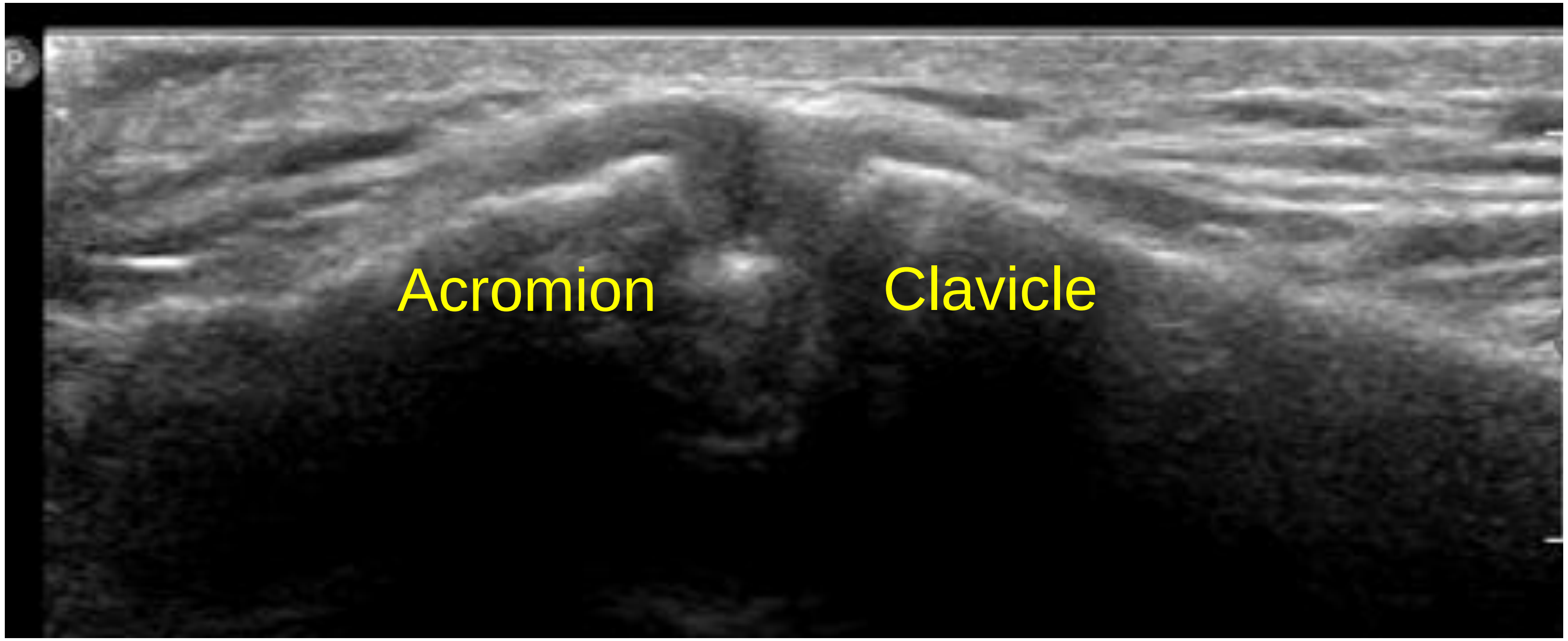


Image Credit: Matt Chan, MD

Infraspinatus and Teres Minor Long Axis

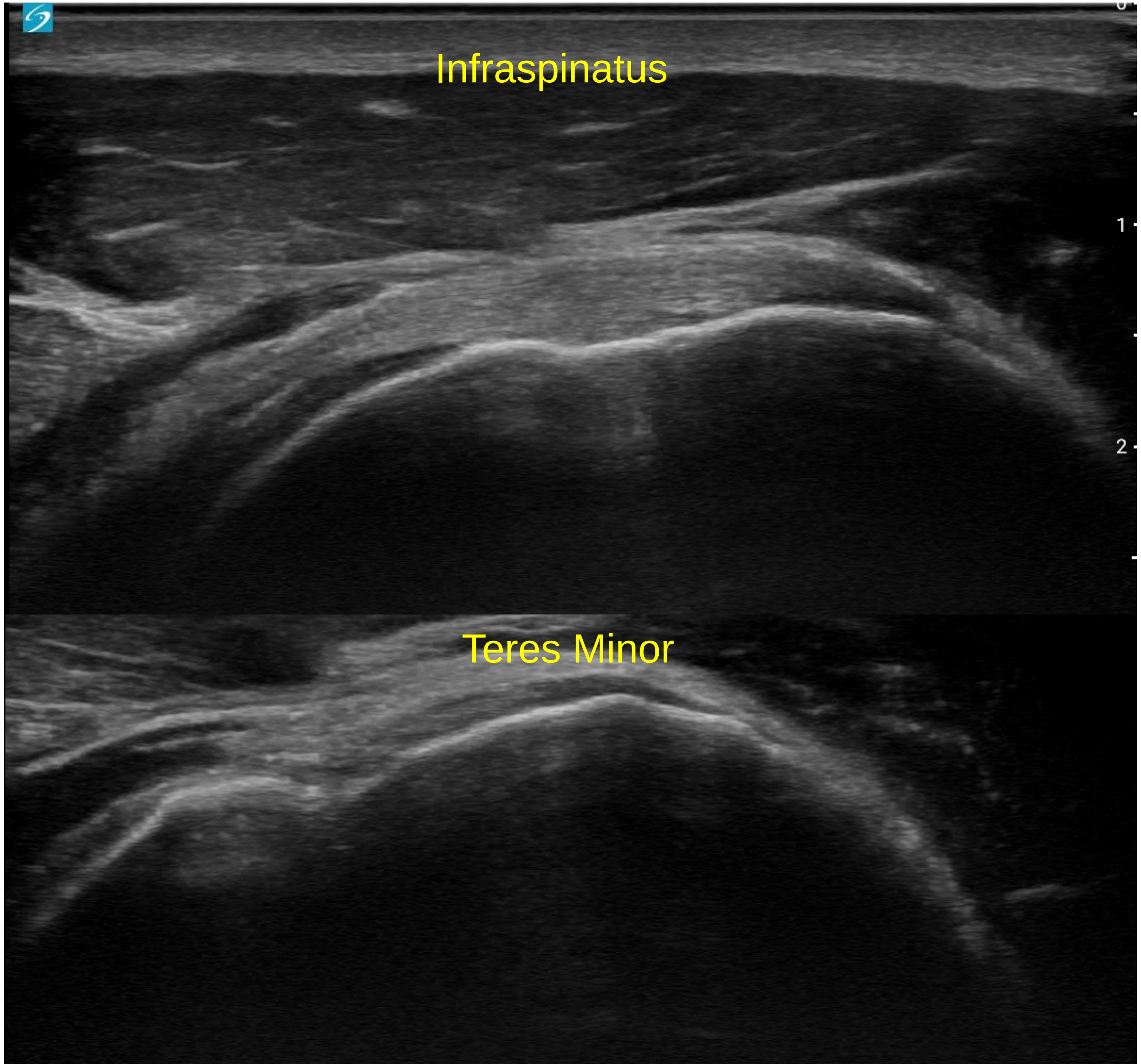
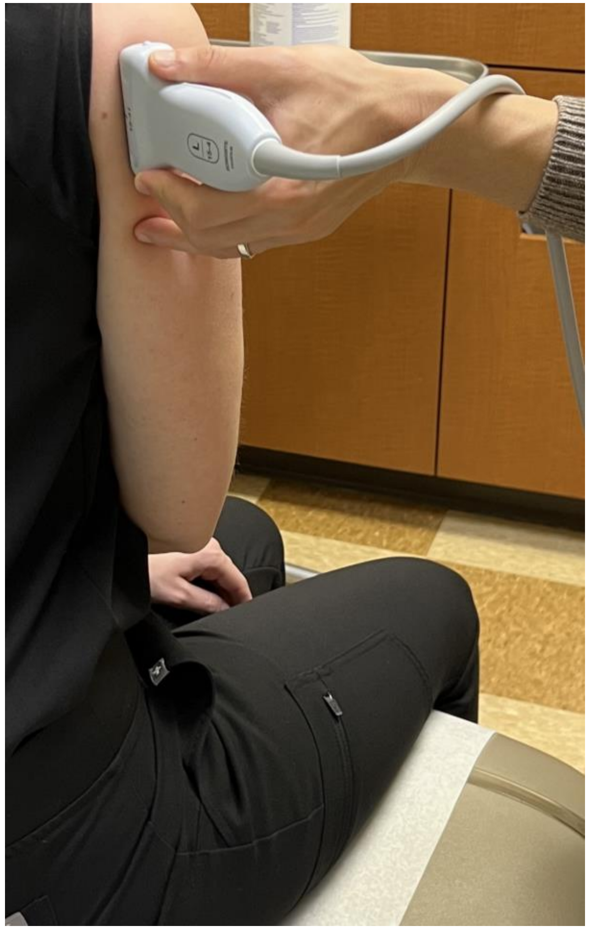


Image Credit: Matt Chan, MD

Infraspinatus and Teres Minor Short Axis



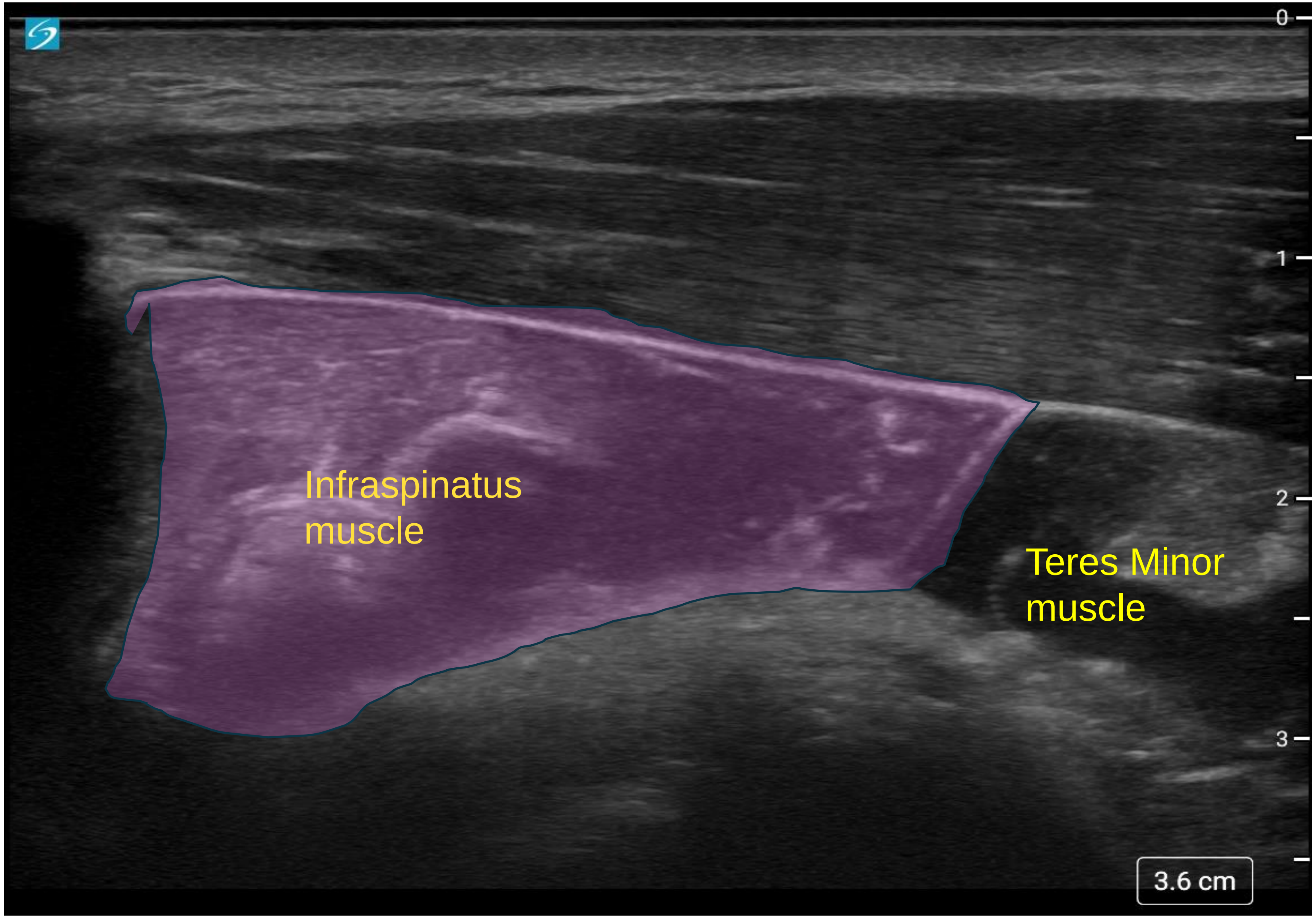


Image Credit: Matt Chan, MD

Posterior Glenohumeral Joint

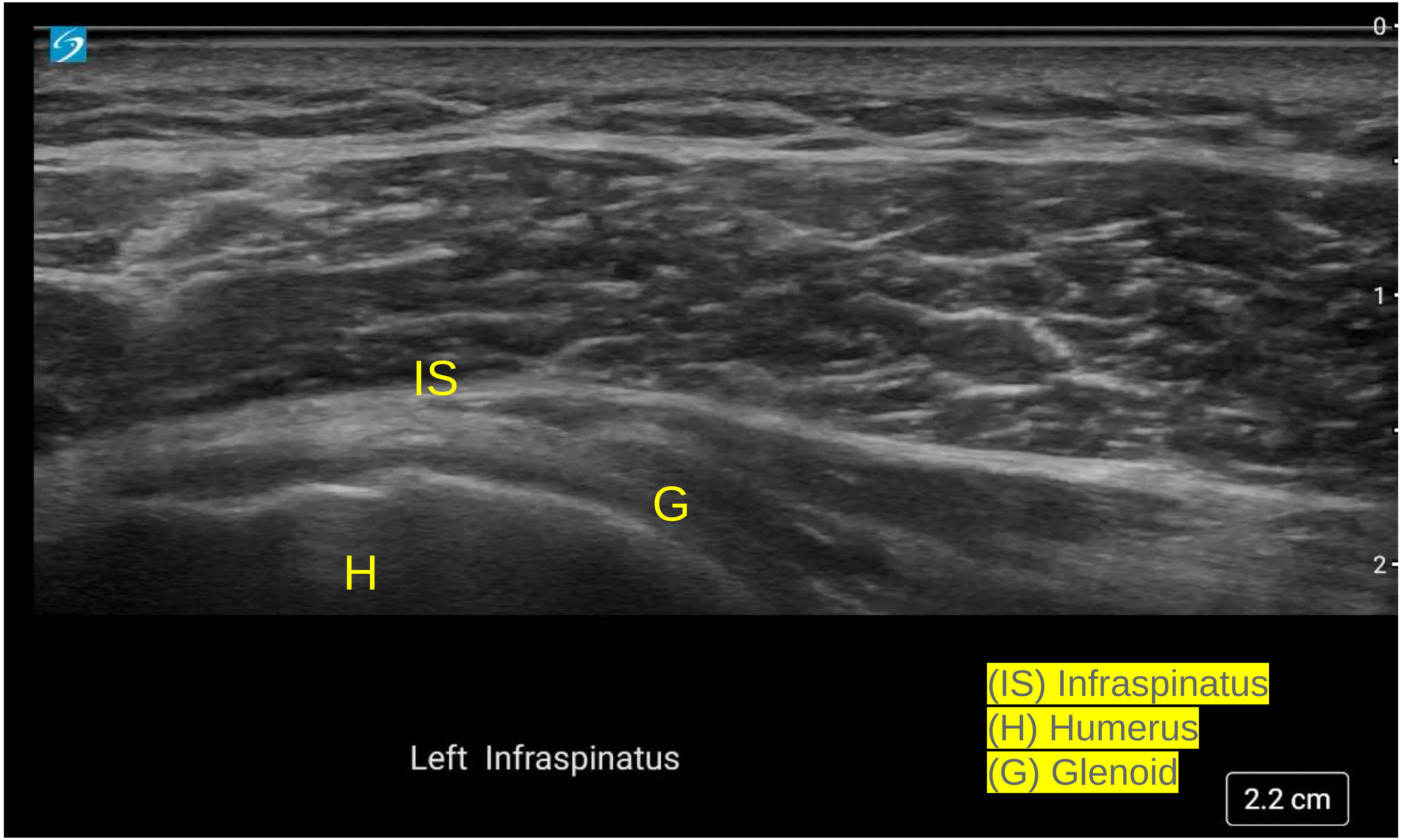
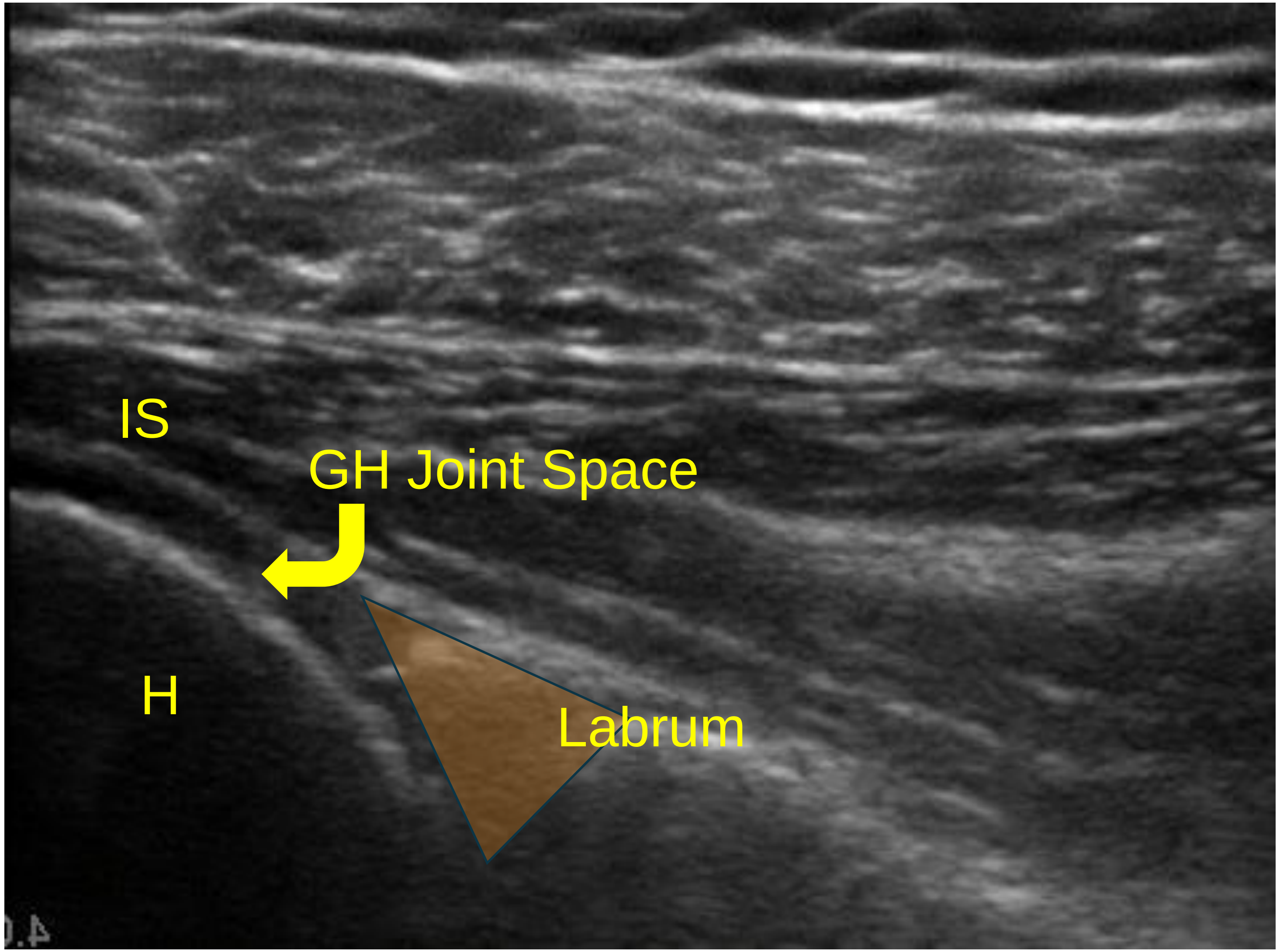


Image Credit: Matt Chan, MD

Posterior Glenohumeral Joint

Image Credit: Matt Chan, MD



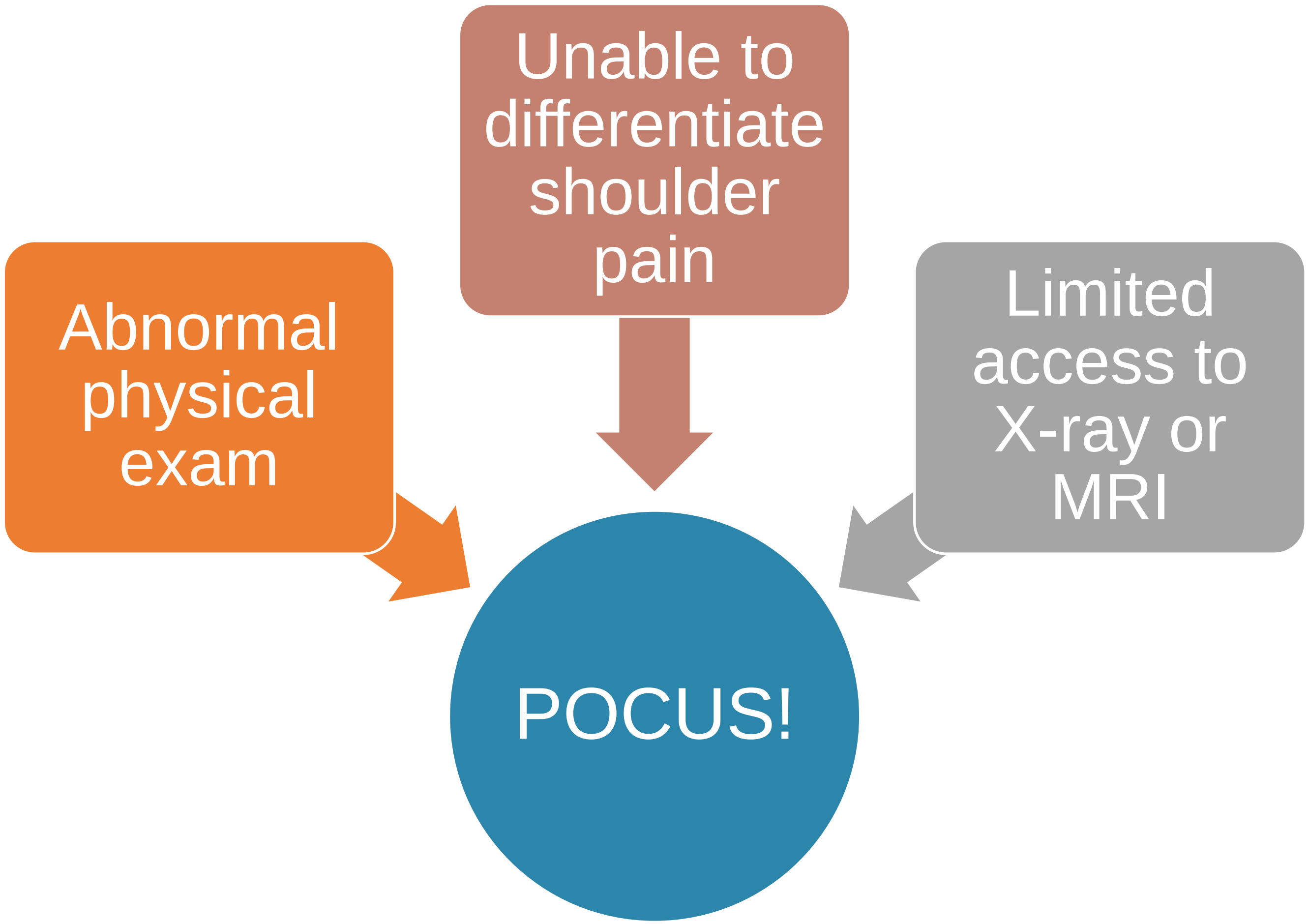
Back to our case…

Case: Classic "FOOSH" (Fall On OutStretched Hand)

- 35 year old person, with Right shoulder pain for 10 days
- A week ago, was running with dog and fell and landed out on his right arm, no immediate pain at the time
- 3 days later, was starting a lawnmower, pulling the string, and felt sharp pain
- Now cannot lift the right arm

Does my patient have a rotator cuff tear?

If you suspect a rotator cuff injury…

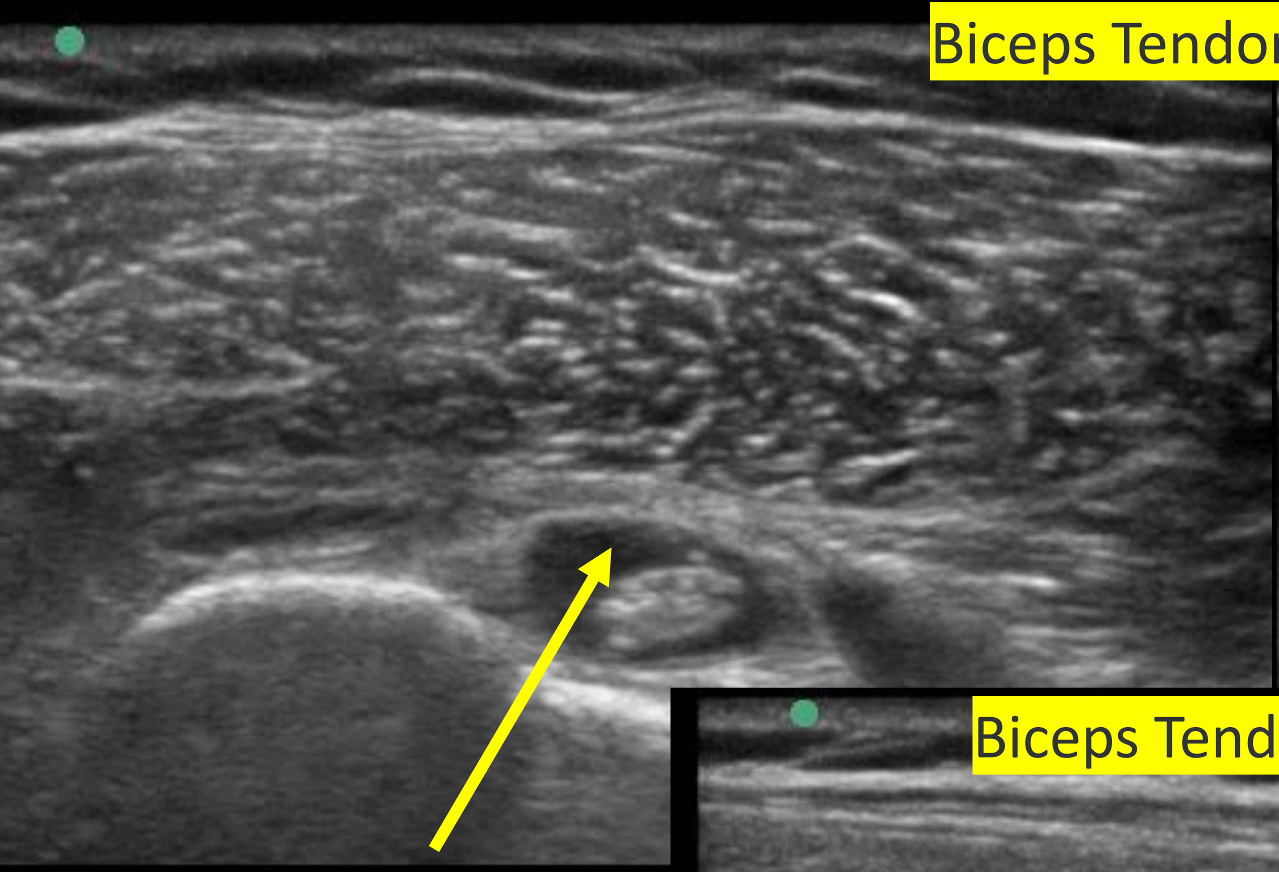
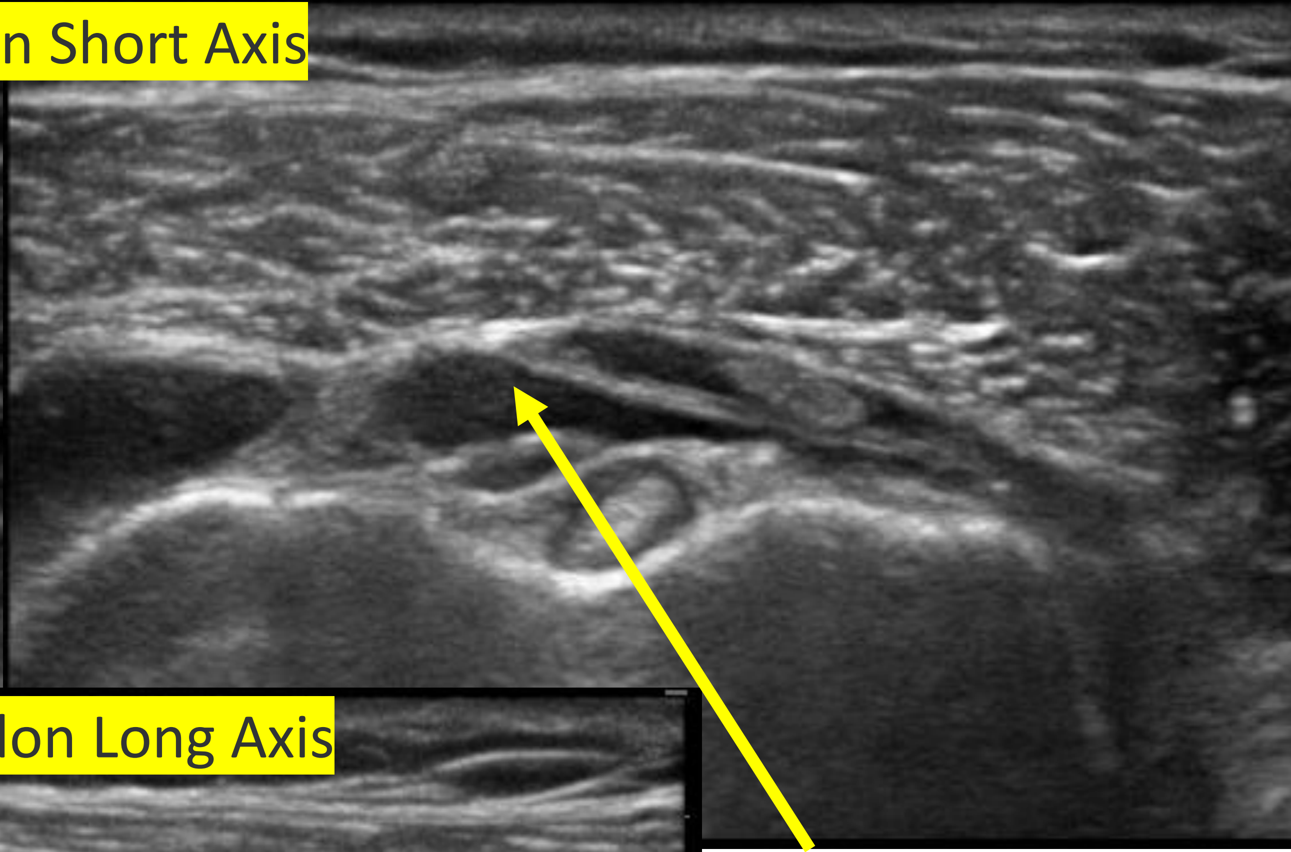


Differential Diagnosis

Concern for rotator cuff tear based on +Empty can and limited Abduction

DDx

- Bursitis
- Impingement
- Overuse tendinitis/tendinopathy
- Calcific tendinitis

Anechoic fluid around the biceps tendon

Anechoic fluid anterior to biceps, from subacromial bursa

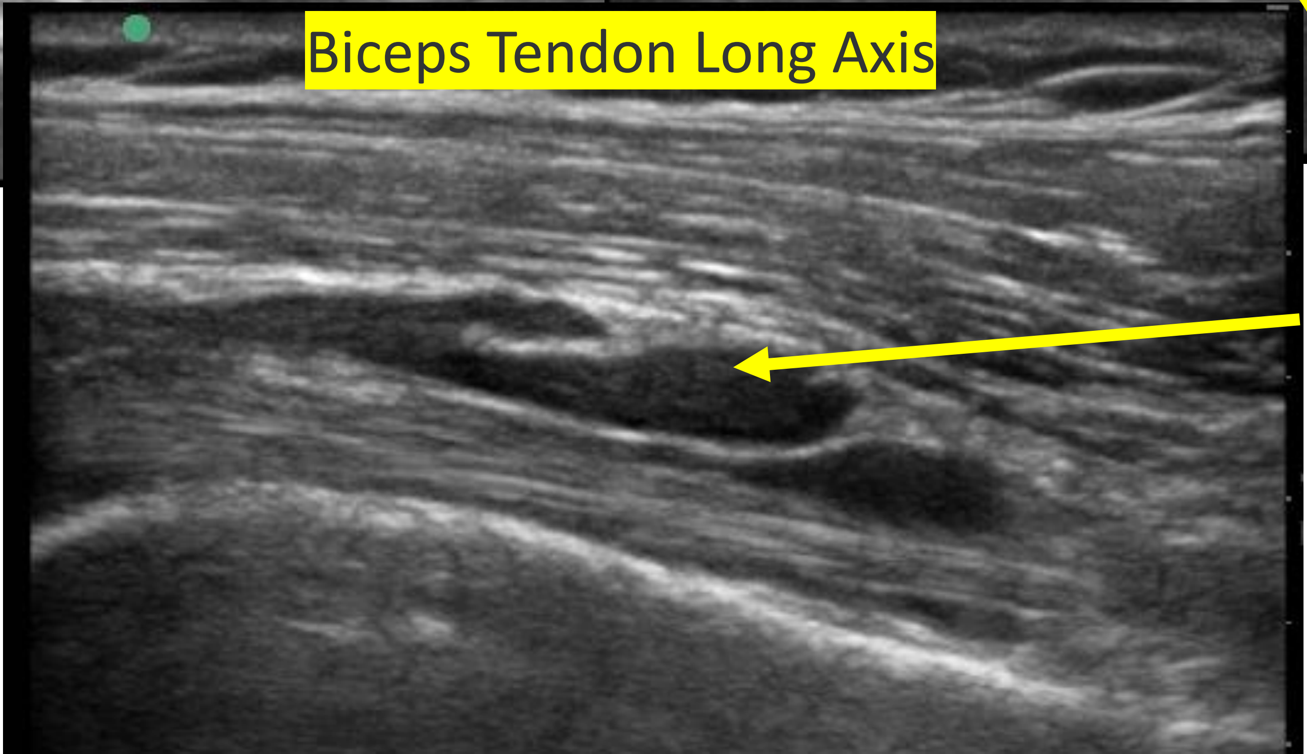


Image Credit: Matt Chan, MD

AAFP **CME**

Right Supraspinatus

- Long axis
- Complete tear extending from the bursal side of the supraspinatus all the way through to the articular side

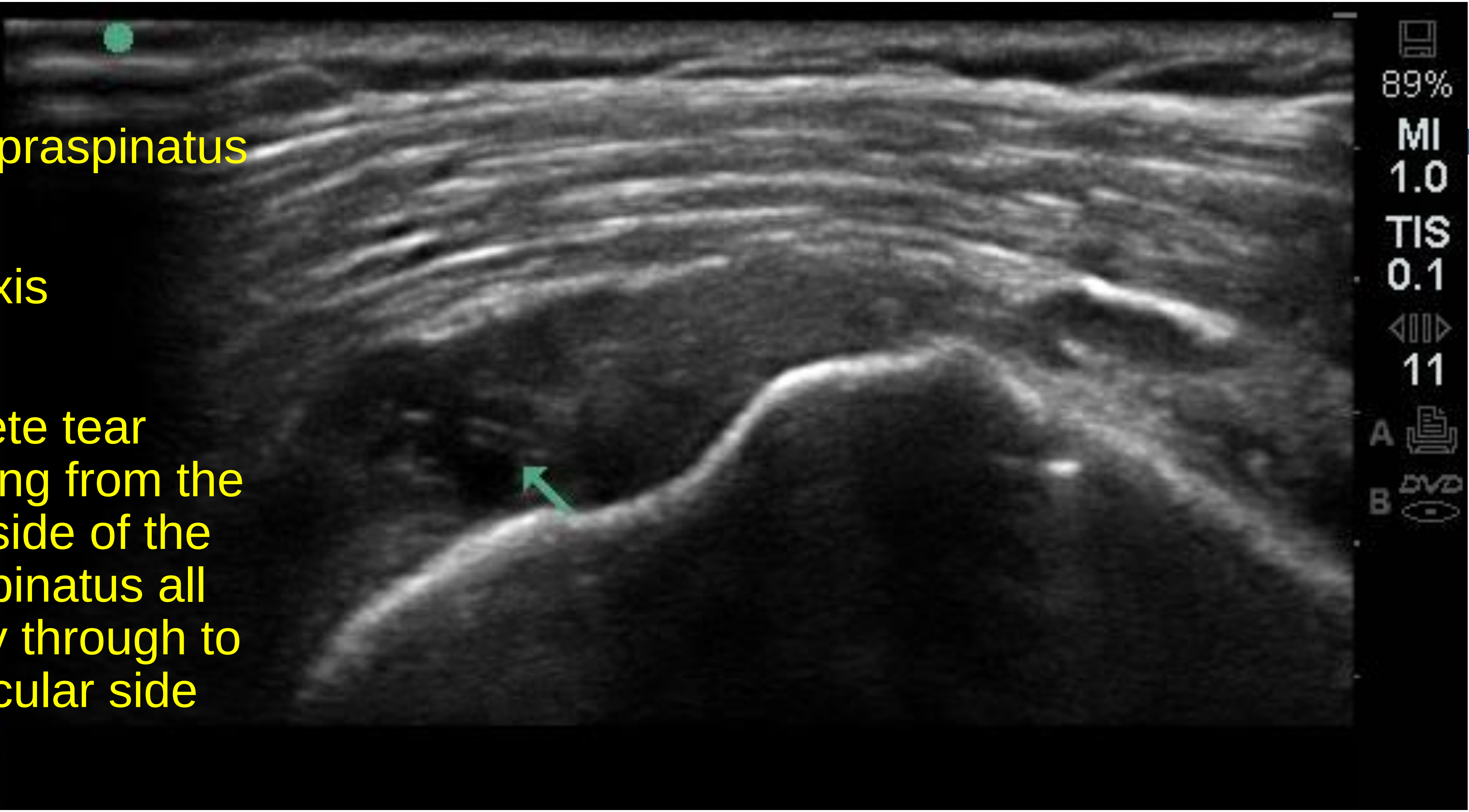
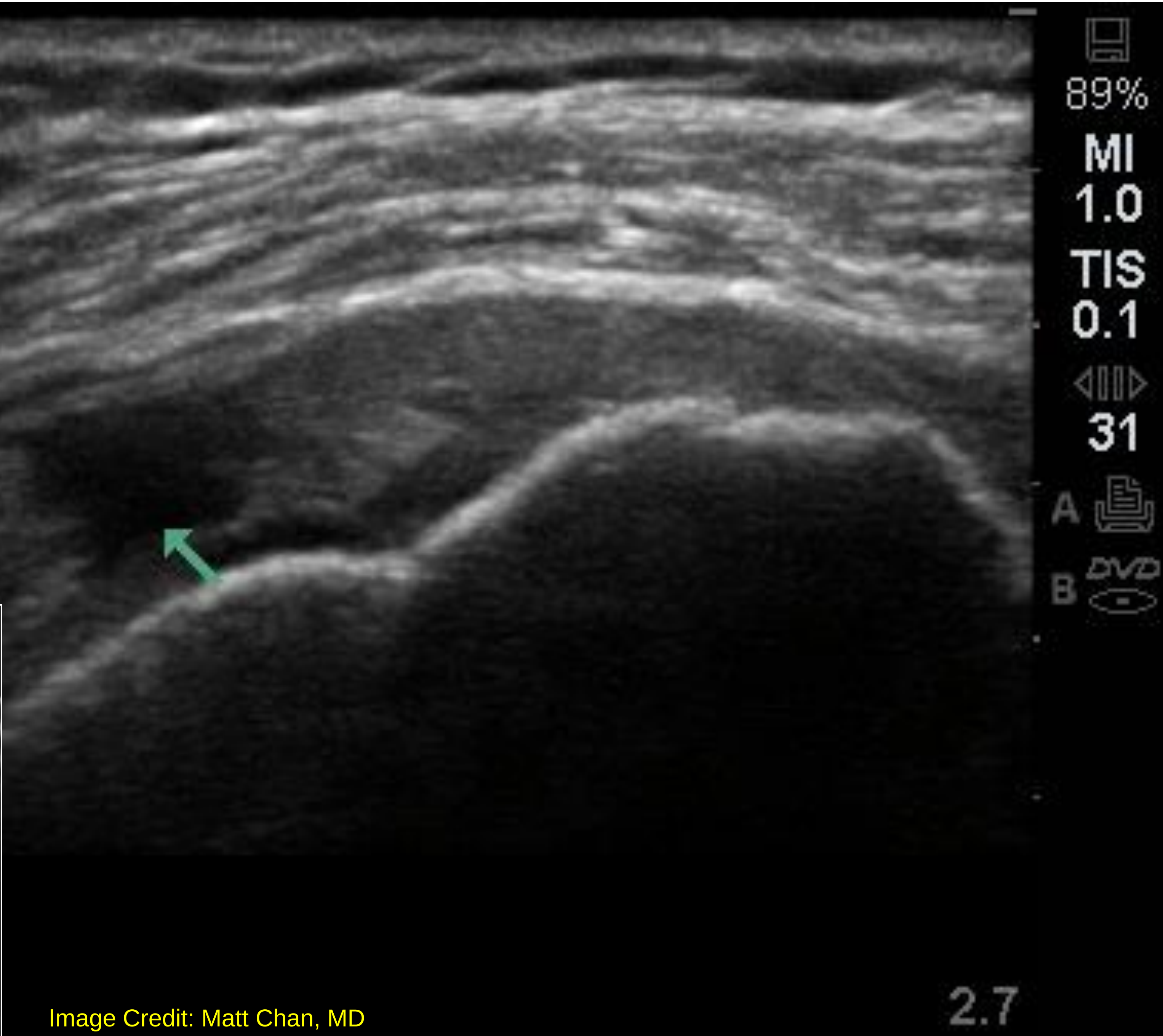


Image Credit: Matt Chan, MD

Right Supraspinatus

- Compared to Left SST, which appears normal



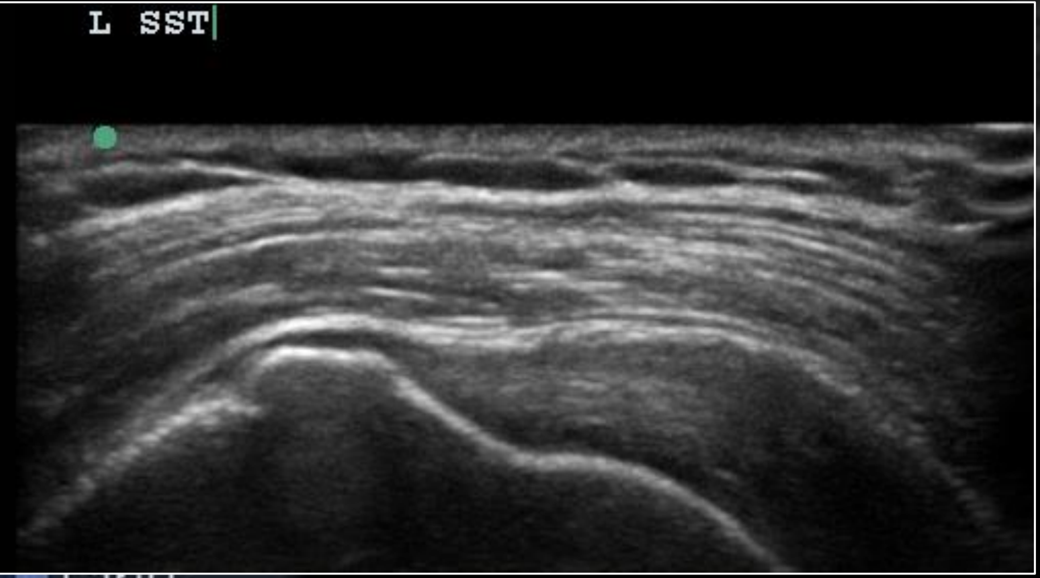


Image Credit: Matt Chan, MD

Right Supraspinatus

- Short axis
- Tear extending majority of the width of the supraspinatus

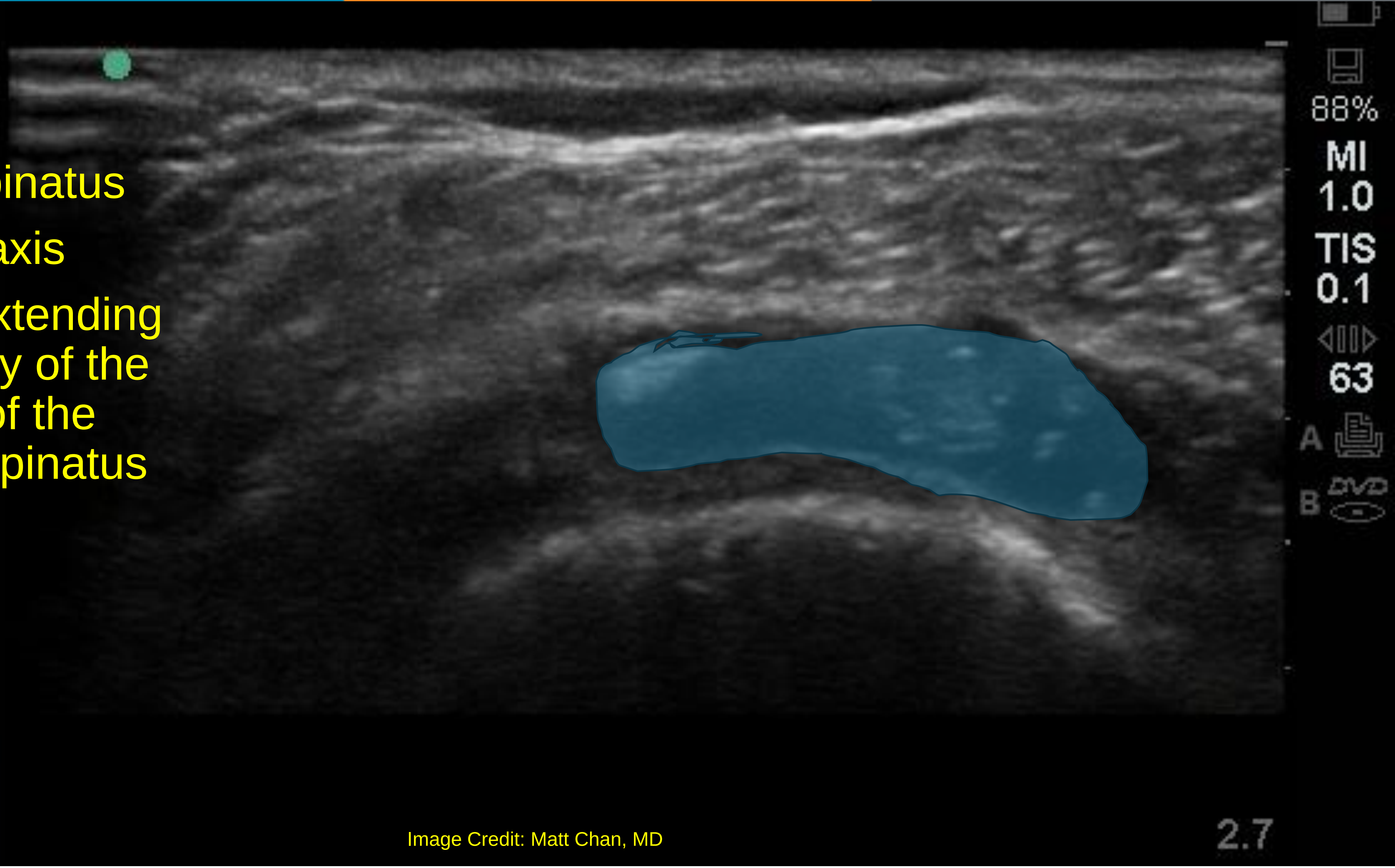


Image Credit: Matt Chan, MD

Case 1 conclusion

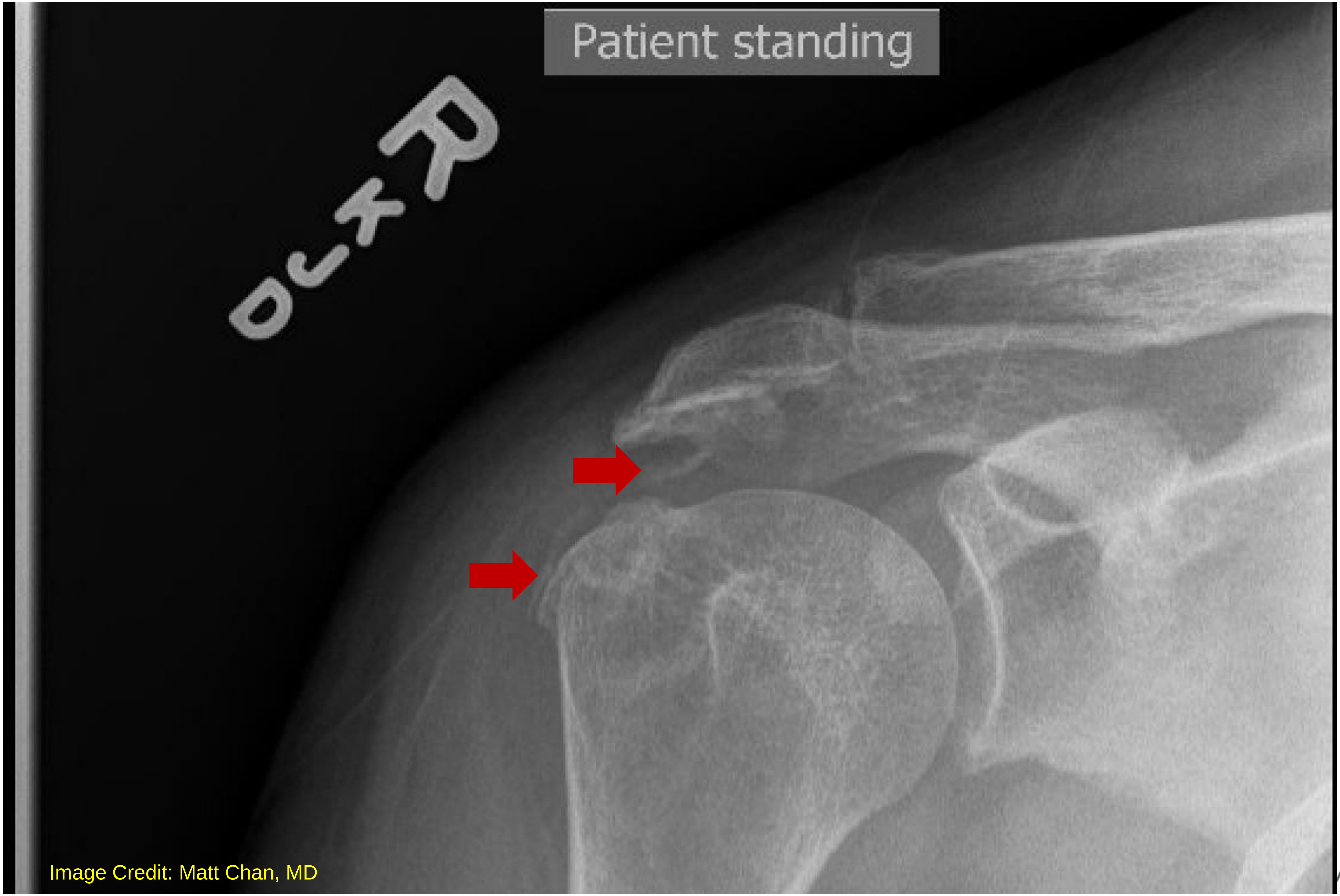
- With concern for full thickness supraspinatus tear and younger aged patient, expedited referral into Orthopedic Surgery instead of managing conservatively, and was seen soon after.

- Patient opted in for surgical repair, and is currently in PT post-operatively with return of range of motion

Case #2

- 65 year old woman with acute onset of right shoulder pain for 1 month
- Pain in 2018, received steroid injection with good relief
- Now her shoulder pain is daily, unable to do her hair or reach overhead, not responding to exercises or NSAIDs

AAFP CME


Patient standing
R
Image Credit: Matt Chan, MD

Calcific Tendinopathy

- Pre-calcific -> Calcific -> Resorptive -> Repair

- Amorphous in beginning phases or late phases more painful
- More established calcifications can be less painful sometimes

Case #2 (alternative)

Similar presentation could also be…

Acute SASD Bursitis

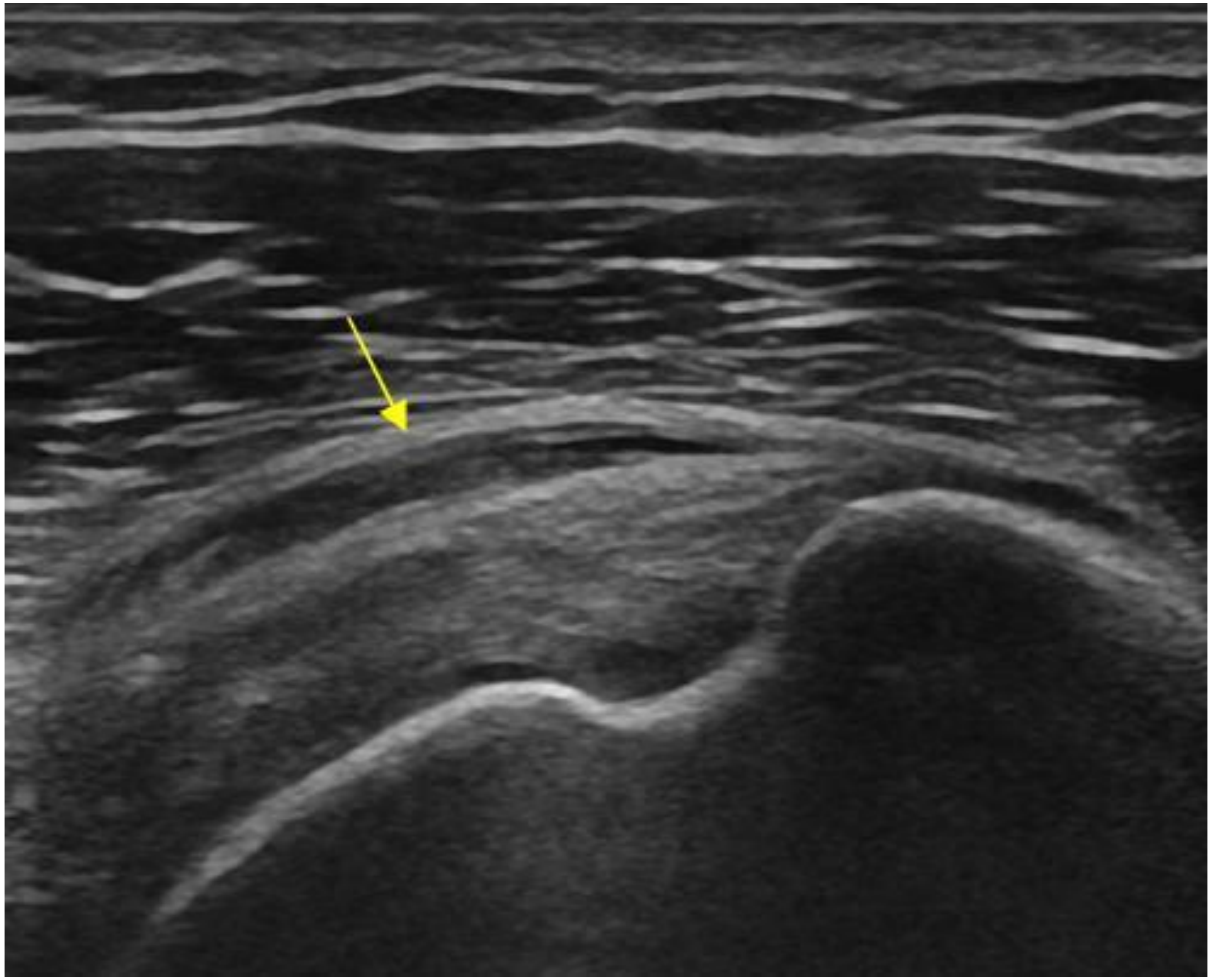


Image Credit: Matt Chan, MD

Case #2 Conclusion

- Repeat corticosteroid injection since had significant relief a few years ago
- Referral to PT
- Consider needling to break up calcifications, and/or MRI imaging if no improvement

Case #3

- 43 yo individual, new job at as delivery person for last 3 months
- Pain in anterior Left shoulder
- +TTP to the anterior shoulder, +Speed’s and Yergason’s (for biceps tendinitis)

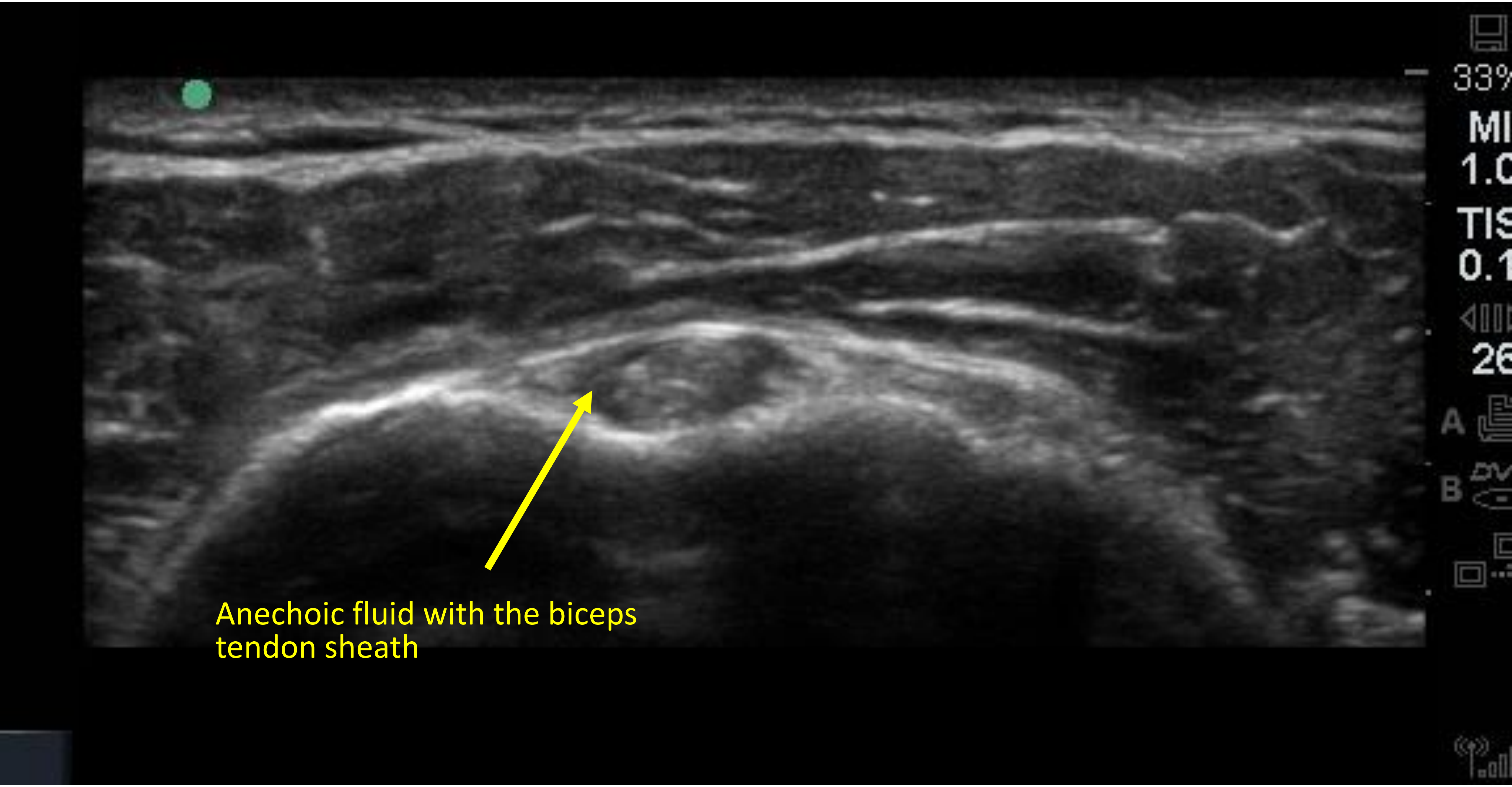


Image Credit: Matt Chan, MD

Biceps Tenosynovitis

- Fluid surrounding the biceps tendon
- Look for hyperemia with color doppler, pain with transducer pressure
- Can consider further conservative management with PT, NSAIDs, etc
- Or can consider US guided steroid injection depending on severity of pain

Biceps Tenosynovitis Ddx

Glenohumeral joint effusions

- Communicates with glenohumeral joint space
- Effusions tend to be more compressible, non-tender to pressure, no hyperemia, and tendon appears normal

SASD bursitis

- Anterior to tendon sheath
- Fluid in sheath + bursa, 95% sensitive for rotator cuff tear

Anechoic fluid anterior to biceps, from subacromial bursa

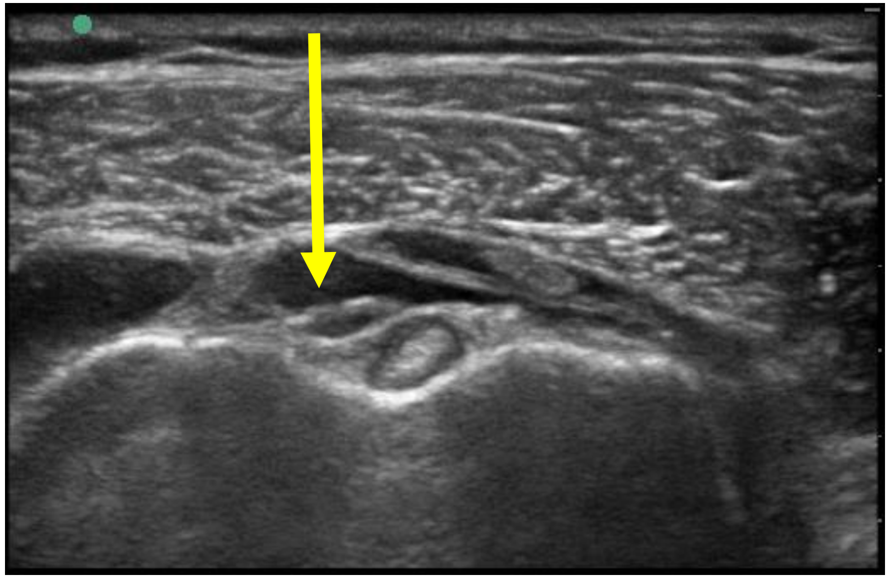


Image Credit: Matt Chan, MD

Pearls and Pitfalls

Scan the contralateral side for comparison!

If concern for a tear (anechoic disruption in tendon)

- Scan in two orthogonal planes
- Fan, rock, or slide the transducer to check for anisotropy
- Humeral head is rounded structure, and can accentuate anisotropy

- POCUS has high sensitivity and specificity for full thickness tears, but less so for partial thickness tears

- The shoulder protocol has several steps, but most high yield will be examining the biceps and supraspinatus tendons if limited on time

Shoulder POCUS Summary

- Shoulder POCUS can be used as first line tool to help differentiate acute shoulder pain

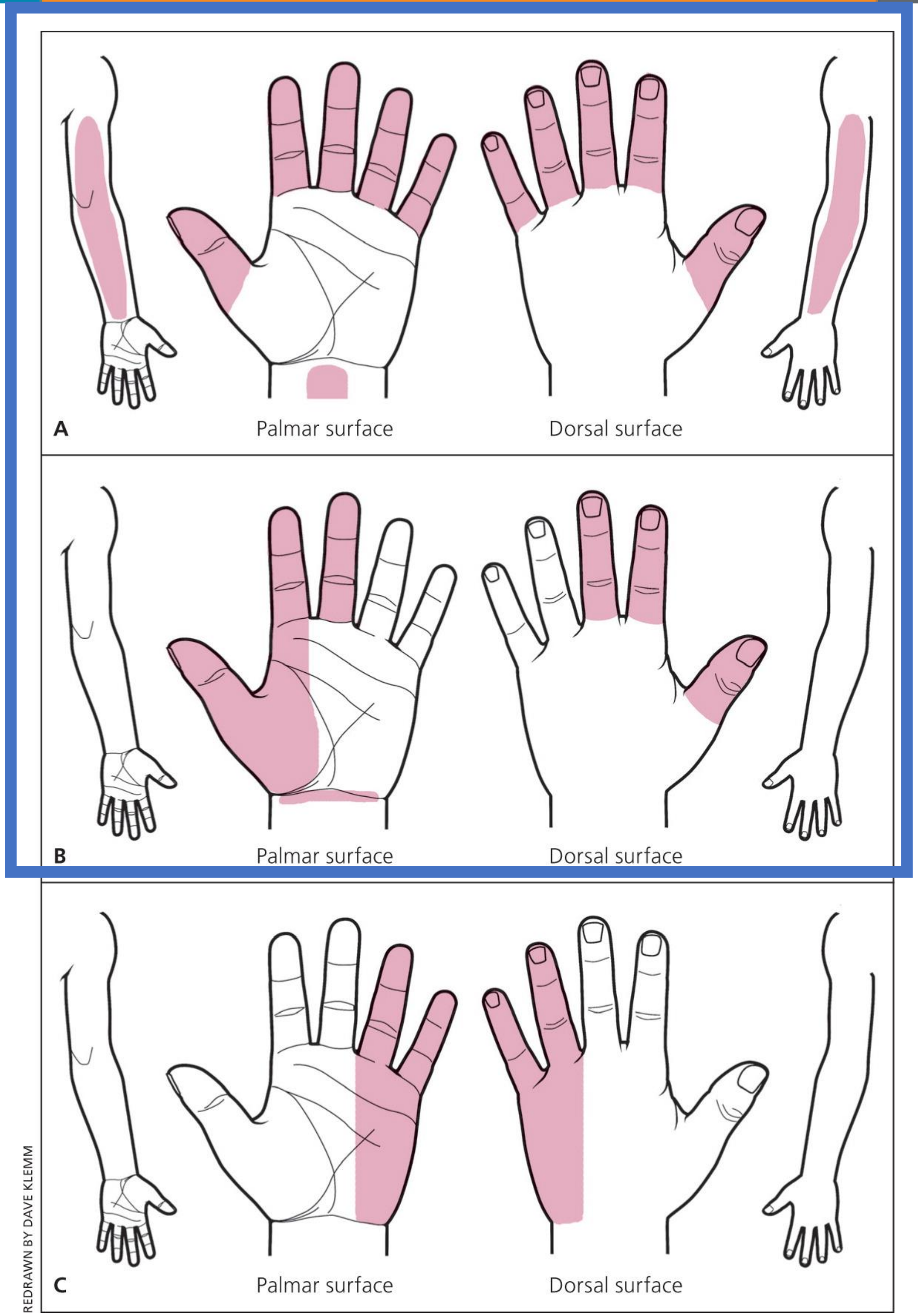
- Shoulder POCUS can be used to detect rotator cuff tears, calcific tendinopathy, and biceps tendinopathy with high sensitivity and specificity

Assessing the Median Nerve for Carpal Tunnel Syndrome

Case

- 33 year-old person comes to see you for 6 months of worsening pain and paresthesias in their left hand and wrist.

- Based on your exam, you suspect maybe the patient has carpal tun



Wipperman J, Goerl K. Carpal Tunnel Syndrome: Diagnosis and Management. Am Fam Physician. 2016 Dec 15

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	*Evidence rating*	*References*
Ultrasound measurement of a cross-sectional area of the median nerve by an experienced clinician may be used as a diagnostic test for carpal tunnel syndrome.	C	14, 15
Local corticosteroid injection is effective for more than one month in patients with mild to moderate carpal tunnel syndrome and delays the need for surgery at one year.	A	20-24
Splinting, therapeutic ultrasound, carpal bone mobilization, and nerve glide exercises are effective short-term treatments for carpal tunnel syndrome.	B	25-27
Endoscopic and open carpal tunnel release are equally effective, long-lasting treatments for carpal tunnel syndrome.	A	30

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to http://www.aafp.org/afpsort.

Wipperman J, Goerl K. Carpal Tunnel Syndrome: Diagnosis and Management. Am Fam Physician. 2016 Dec 15

Set up

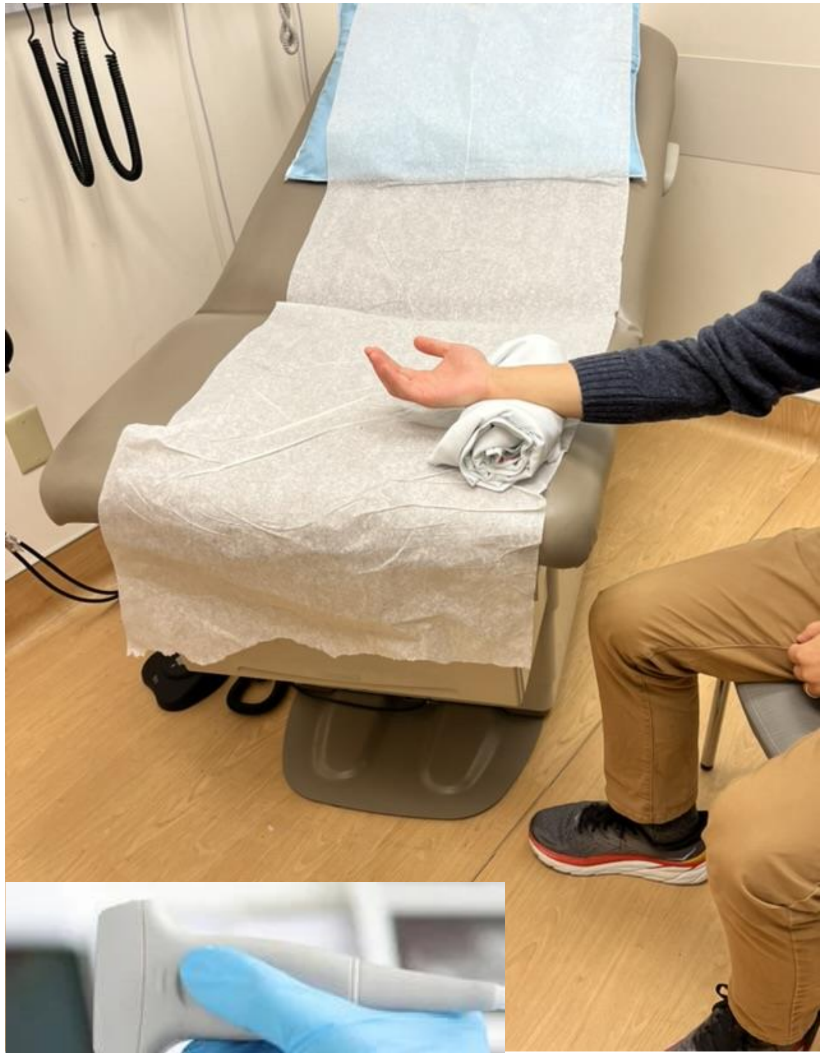
Have patient seated in chair, resting their arm on the exam table

Towel roll underneath the wrist

You can sit next to them or across from them

Transducer: Linear (or high frequency linear)

Setting: MSK or Nerve



Find the Median Nerve

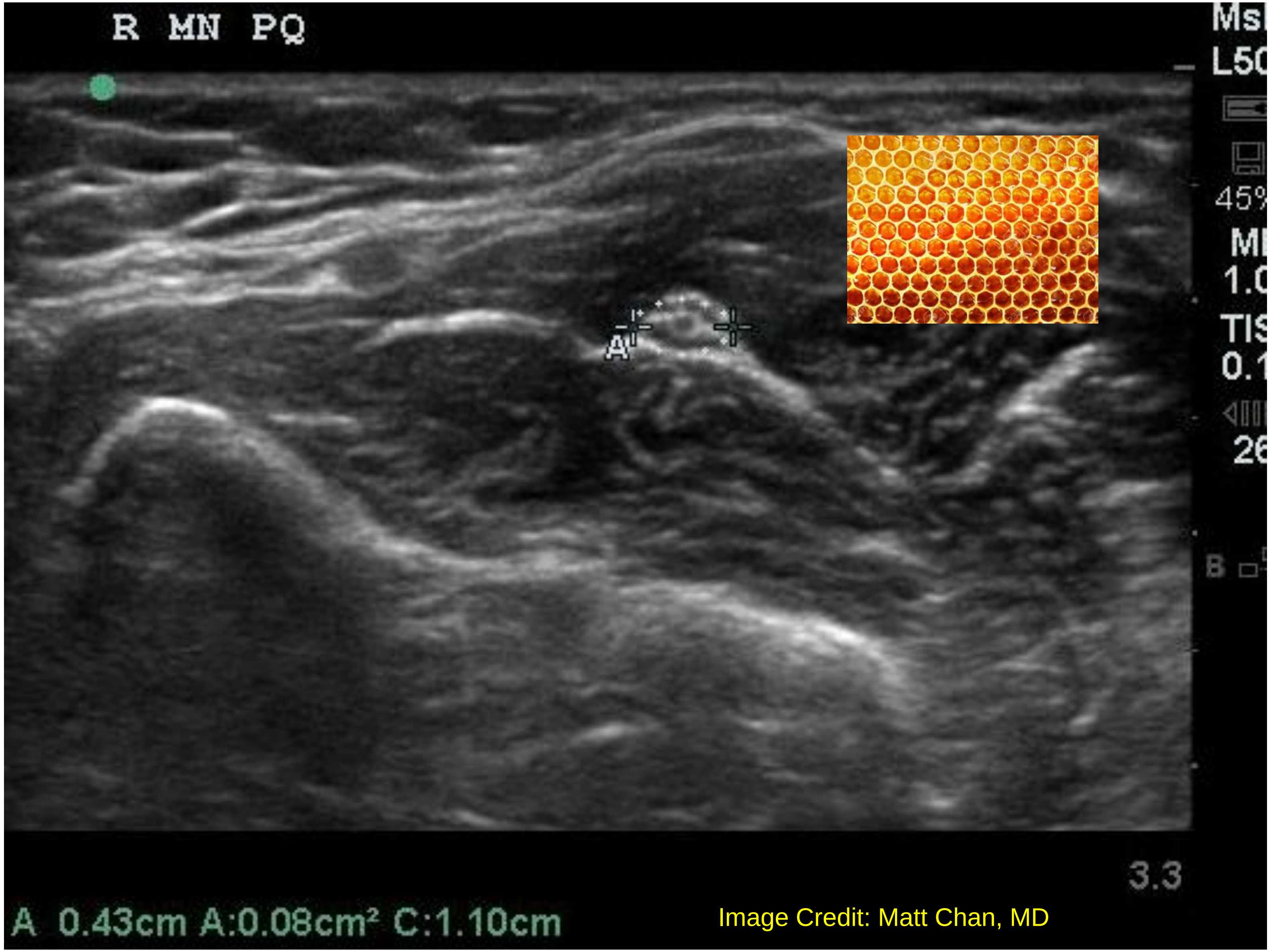
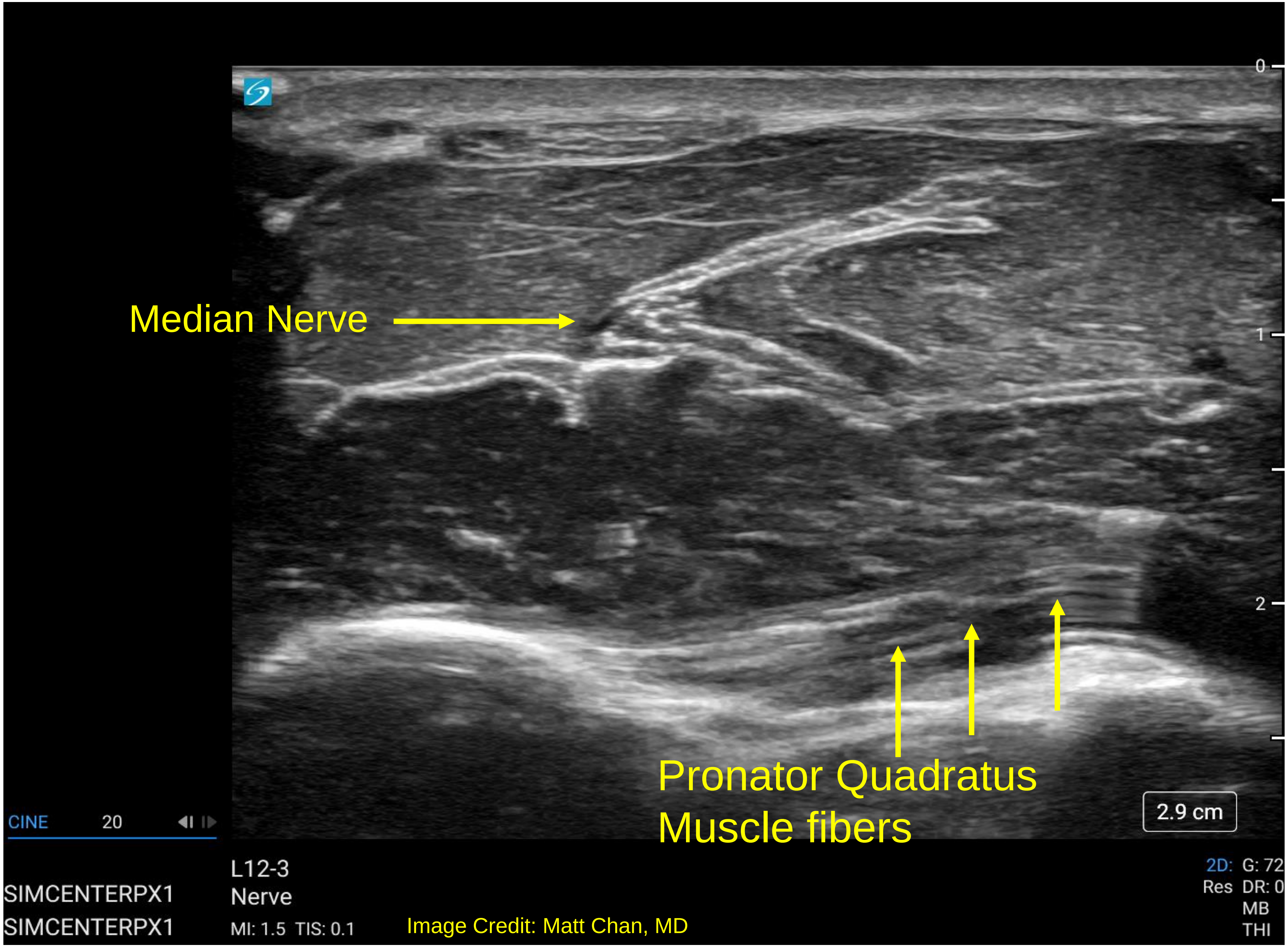
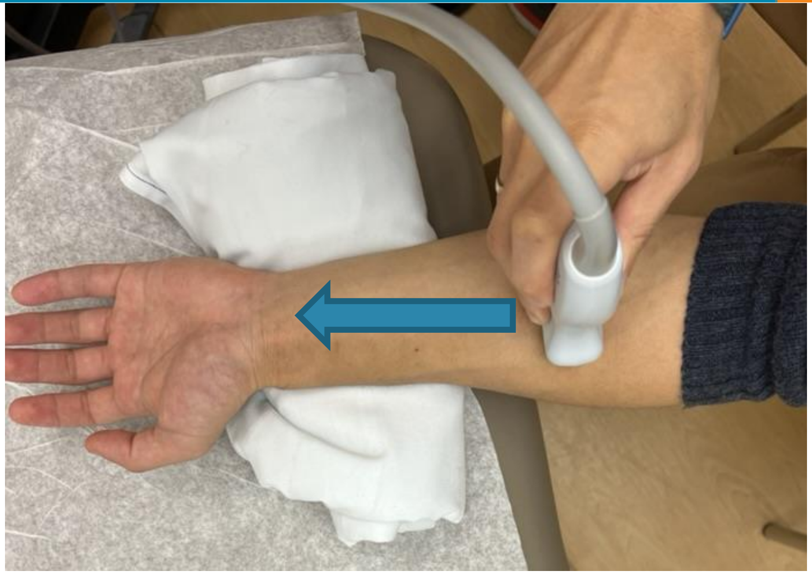


Image Credit: Matt Chan, MD

- Start in short axis across the proximal forearm
- Look for “honeycomb” appearing circular nerve, usually in middle of the muscle belly



Median Nerve
Pronator Quadratus
Muscle fibers
CINE 20
2.9 cm
L12-3
Nerve
MI: 1.5 TIS: 0.1
SIMCENTERPX1
SIMCENTERPX1
2D: G: 72
Res DR: 0
MB
THI
Image Credit: Matt Chan, MD



Slide down the forearm until you reach the bony carpal tunnel

Median nerve will curve more radially, and then swoop back towards the midline as you slide the transducer

Image Credit: Matt Chan, MD

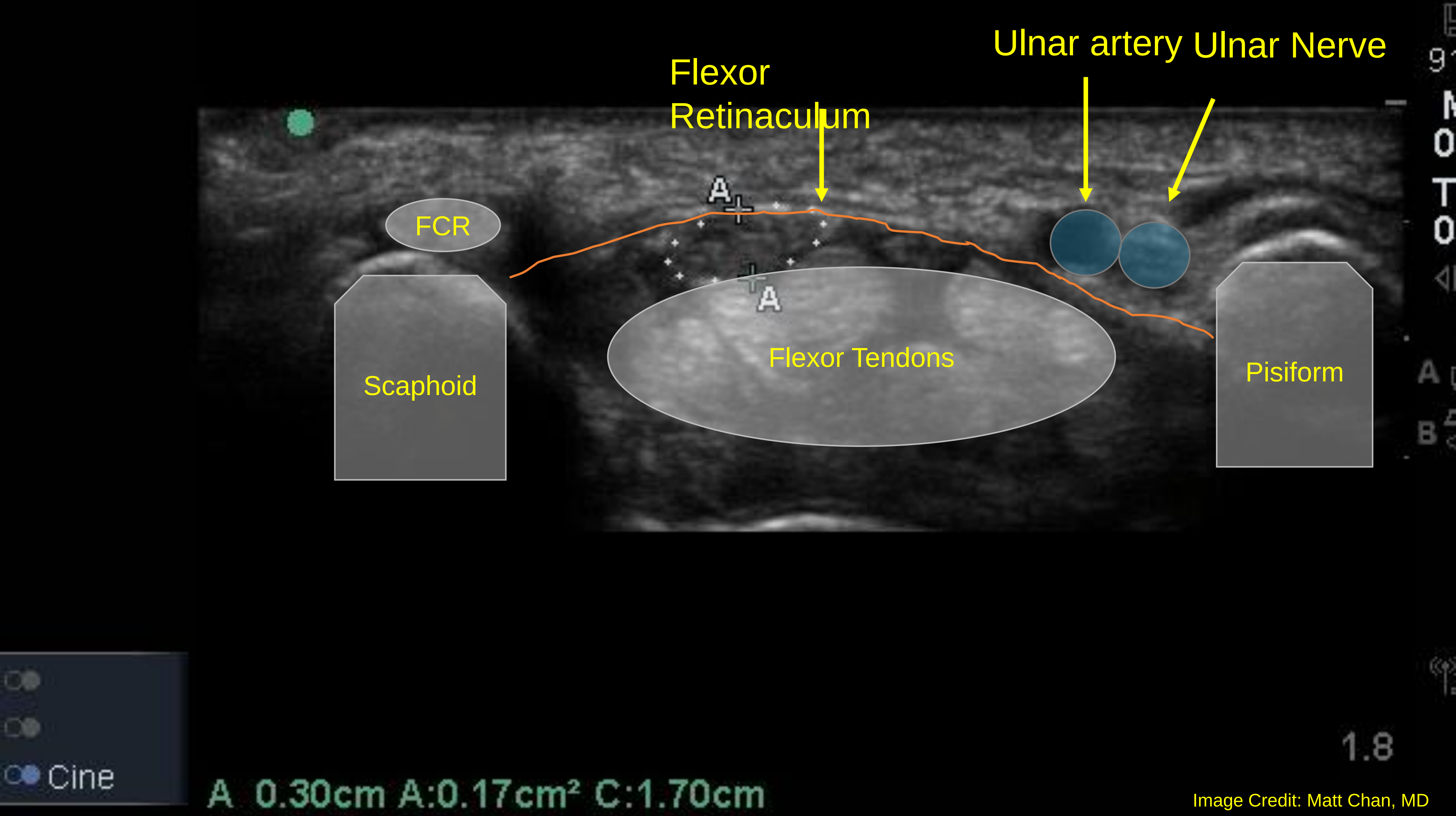
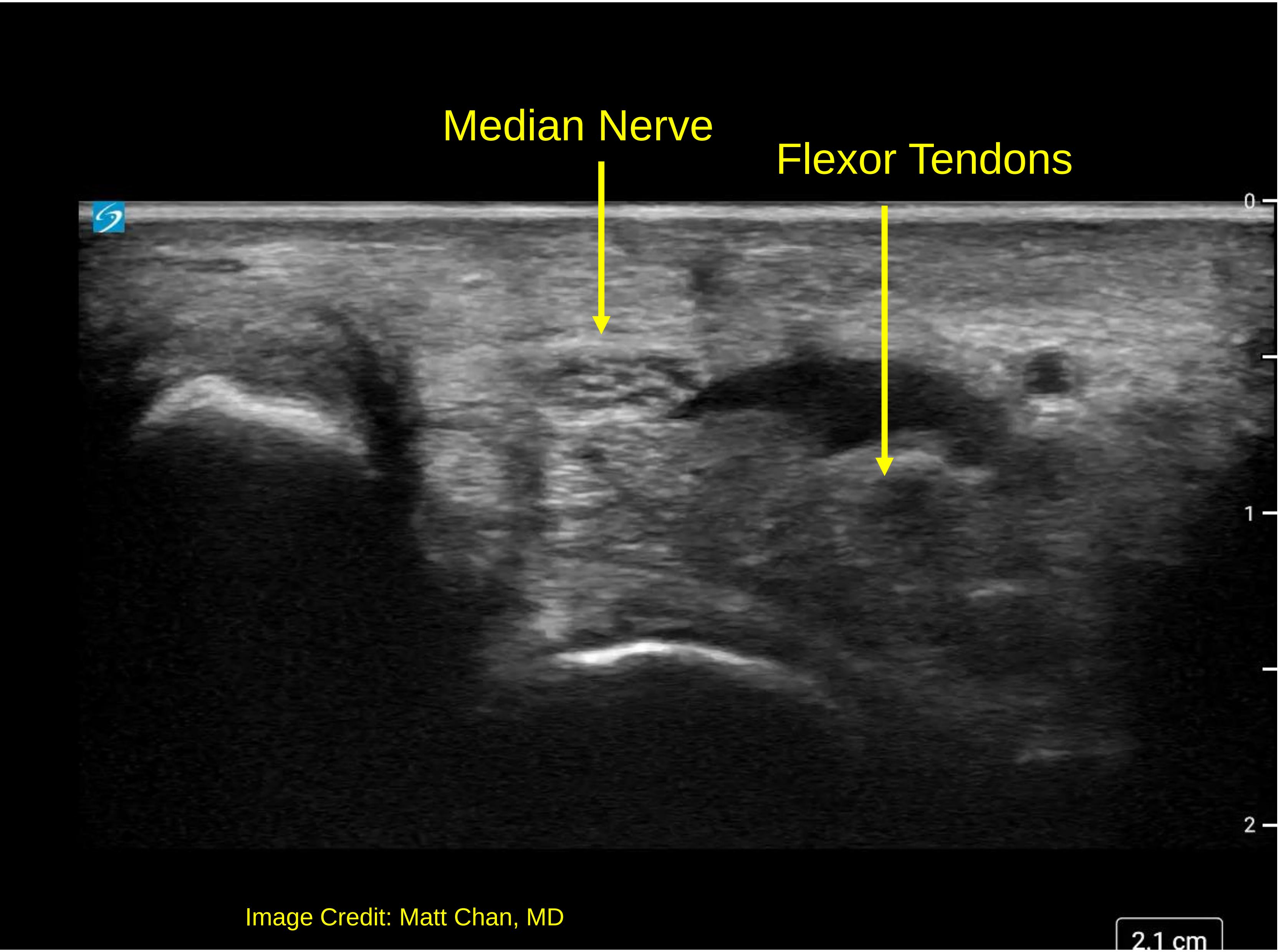
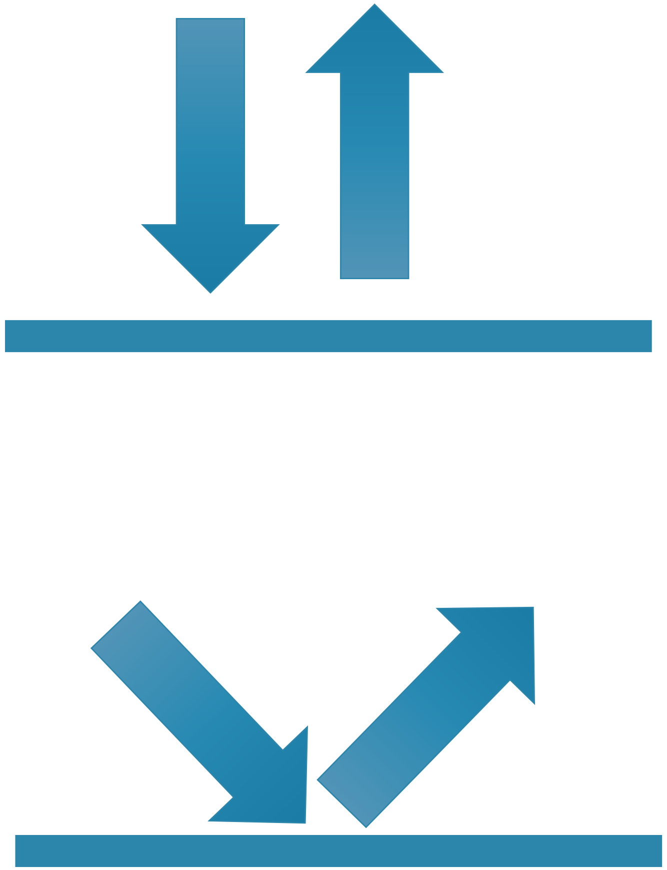
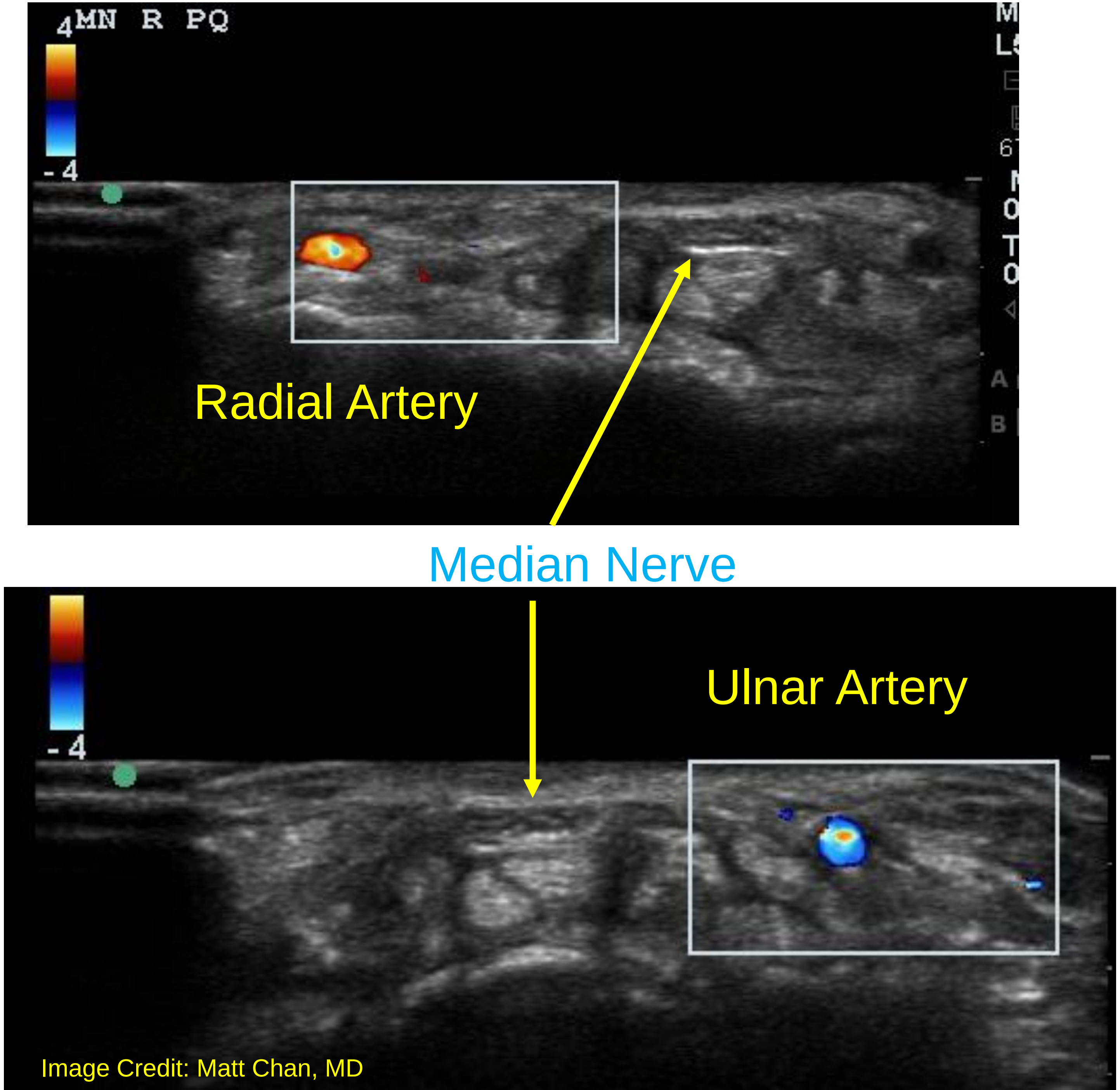


Image Credit: Matt Chan, MD

ANISOTROPY


Median Nerve
Flexor Tendons
0
1
2
Image Credit: Matt Chan, MD
2.1 cm




4MN R PQ
-4
Radial Artery
Median Nerve
-4
Ulnar Artery
Image Credit: Matt Chan, MD

Lots of methods to grading Carpal Tunnel severity…

- Cross-sectional area of Median Nerve at bony carpal tunnel
- CSA measurement difference of median nerve at pronator quadratus vs bony carpal tunnel
- Bowing of flexor retinaculum measurement
- Flattening ratio of Median Nerve

Lots of methods to grading Carpal Tunnel severity…

- Cross-sectional area of Median Nerve at bony carpal tunnel
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- Bowing of flexor retinaculum measurement
- Flattening ratio of medican nerve

Measure Cross Sectional Area

Measuring Cross Sectional Area (CSA) @ Bony Carpal Tunnel to stratify Carpal Tunnel Syndrome severity

Carpal Tunnel Severity	CSA Measurement
No CTS	$<11mm^2$
Mild	$11\text{-}13mm^2$
Moderate	$13 - 17mm^2$ *$>13\ mm^2$ has specificity of 97%
Severe	$>17mm^2$

Adapted from Petering, R. Wrist Ultrasound. Global Ultrasound Institute.
Roomizadeh P, et al. Ultrasonographic Assessment of Carpal Tunnel Syndrome Severity: A Systematic Review and Meta-Analysis. Am J Phys Med Rehabil. 2019 May;98(5):373-381. doi: 10.1097/PHM.0000000000001104. PMID: 30702462.

Familiarize yourself with the "Ellipse" tool on your machine!

Image Credit: Matt Chan, MD

Image Credit: Matt Chan, MD

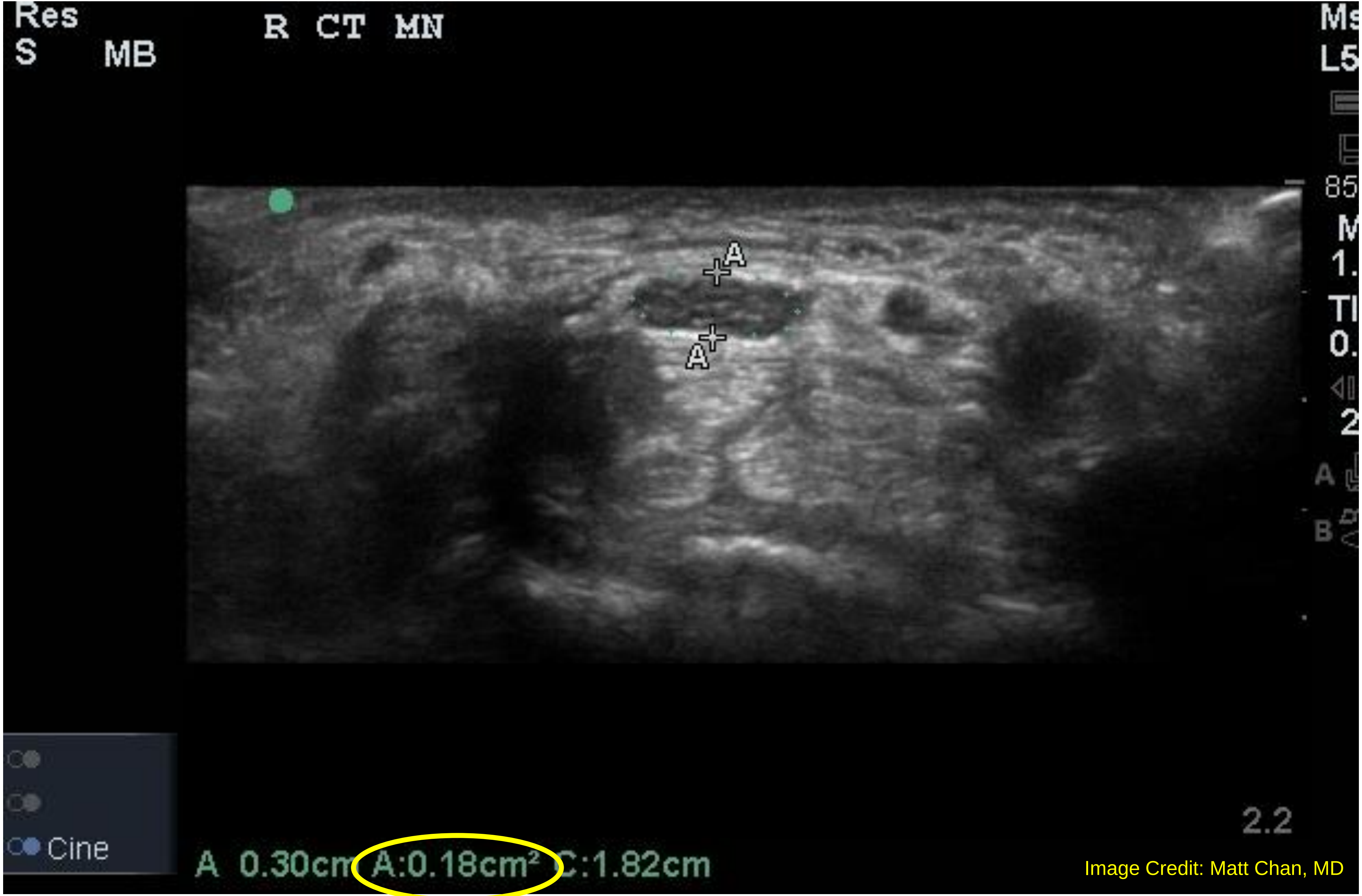

Image Credit: Matt Chan, MD

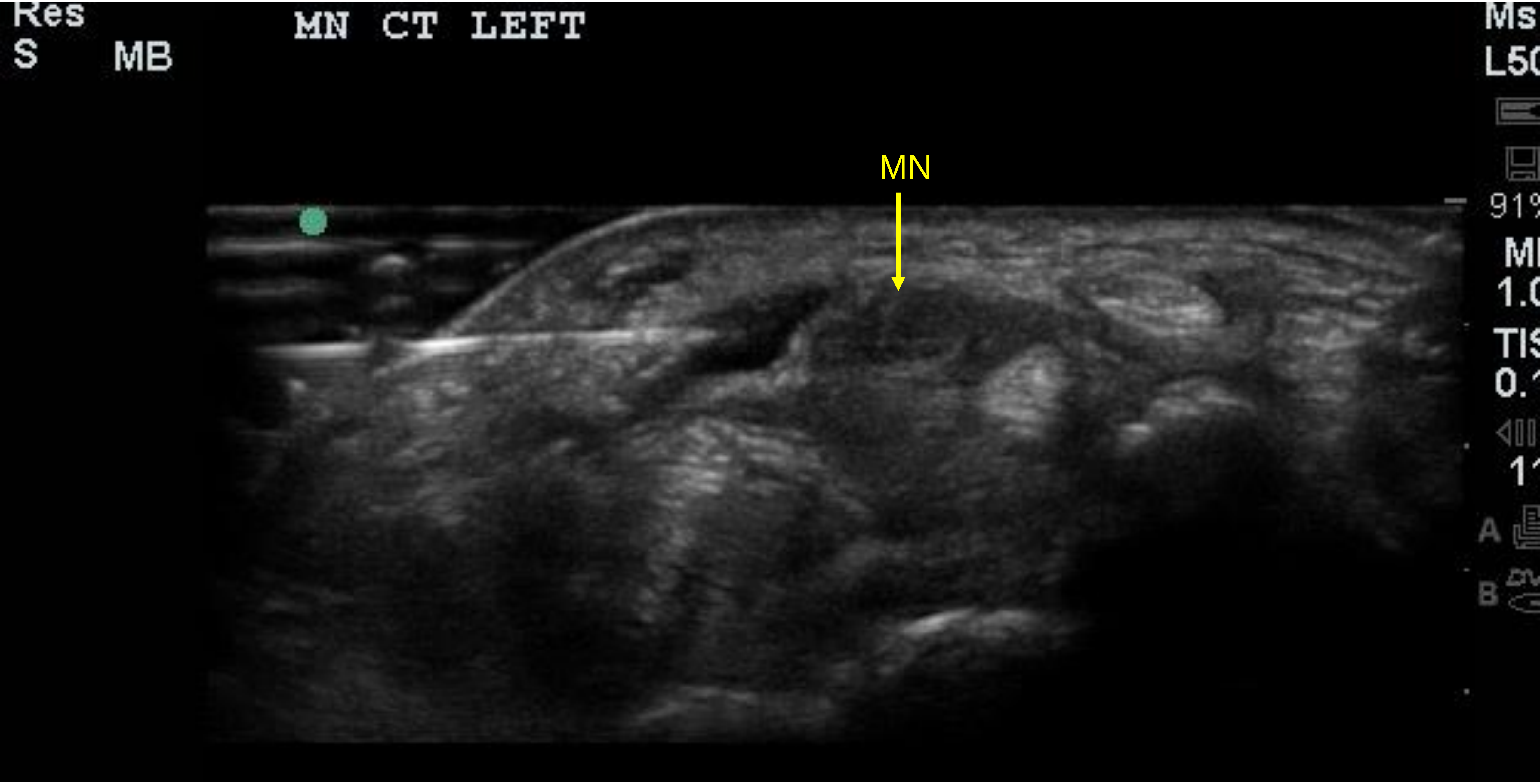

Image Credit: Matt Chan, MD

Billing and Coding

CPT Code	Description
76881	Ultrasound, extremity, nonvascular, real time with image documentation; complete
76882	**Ultrasound, extremity, nonvascular, real time with image documentation; limited, anatomic specific**

https://www.cms.gov/medicare-coverage-database/view/article.aspx

Carpal Tunnel POCUS Summary

- The cross sectional area of the median nerve at the bony carpal tunnel, when correlated with the history and exam, can corroborate the severity of carpal tunnel syndrome.

- Use anisotropy to your advantage to differentiate tendons from the median nerve.

- The pronator quadratus is a good landmark to measure the median nerve in the proximal forearm as comparison to the measurement at the bony carpal tunnel.

THANK YOU!

Questions?

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AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

Limited Cardiac Ultrasound

Michael Wagner, MD, FACP

Associate Professor of Medicine
University of South Carolina School of Medicine-Greenville

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All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Evaluate the evidence for using point of care ultrasound to evaluate heart failure and pericardial effusion.
2. Recognize the sonographic features of pericardial effusion and systolic dysfunction.
3. Visually assess and measure the inferior vena cava and clinical integration.

Clinical Case Scenario

55-year-old female in clinic for dyspnea, fatigue

Recent low speed MVA

+sick contacts, feels she has “bronchitis”

PMH: anxiety, HTN, ?sarcoid vs RA

VS: HR 98 SBP 160s SPO2 92 RA

Can POCUS be useful here?

Clinical Indications for Cardiac POCUS

Undifferentiated Dyspnea

Undifferentiated Chest Pain

Hypotension

Lower Extremity Edema

Syncope/Pre-syncope Syndromes

Fatigue

Cardiac POCUS: Pathology

Early Users

- Pericardial Effusion
  - Moderate-Large Effusions
- LV Systolic Dysfunction
  - Severe
- IVC size and collapsibility
  - “Plethoric” vs “sliver”

More Experienced Users

- Pericardial Effusion
  - Small Effusions, Features of Tamponade
- Grading LV Function
  - Hyperdynamic, Normal, Moderately Reduced, Severely Reduced
- IVC size and collapsibility
  - Measurements
- Chamber Symmetry/ Enlargement
  - LV, LA, Aortic Root, RV, RA
- Other
  - LVH, Valvular Heart Disease

How To/Key Concepts

1. See demonstration video
2. Avoid ribs, sternum, lungs, stomach to find cardiac "window"
3. View heart in at least 2 planes of cut when feasible
4. Assess IVC like evaluating neck veins - not to be used in isolation

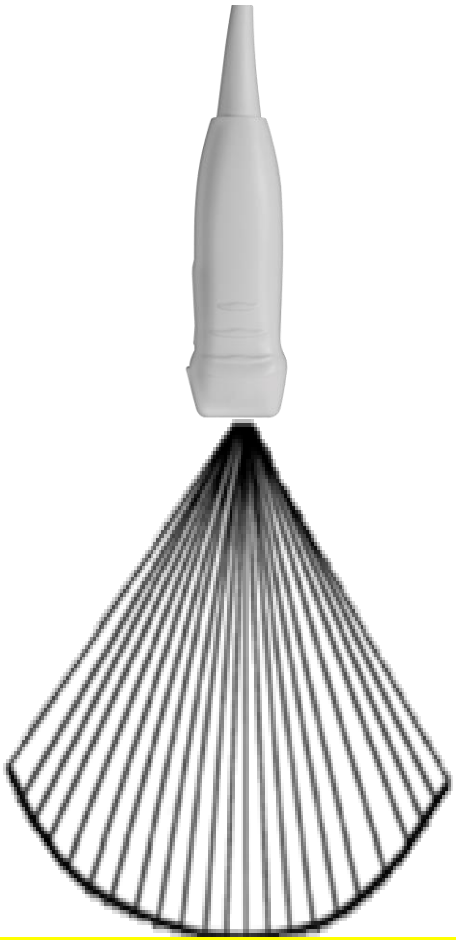
Introduction to Scanning

1. Probe selection
2. Preset
3. Patient Setup
4. Probe position
5. Planes of cut (probe marker and orientation)
6. Pathology?

Probe Selection: Sector

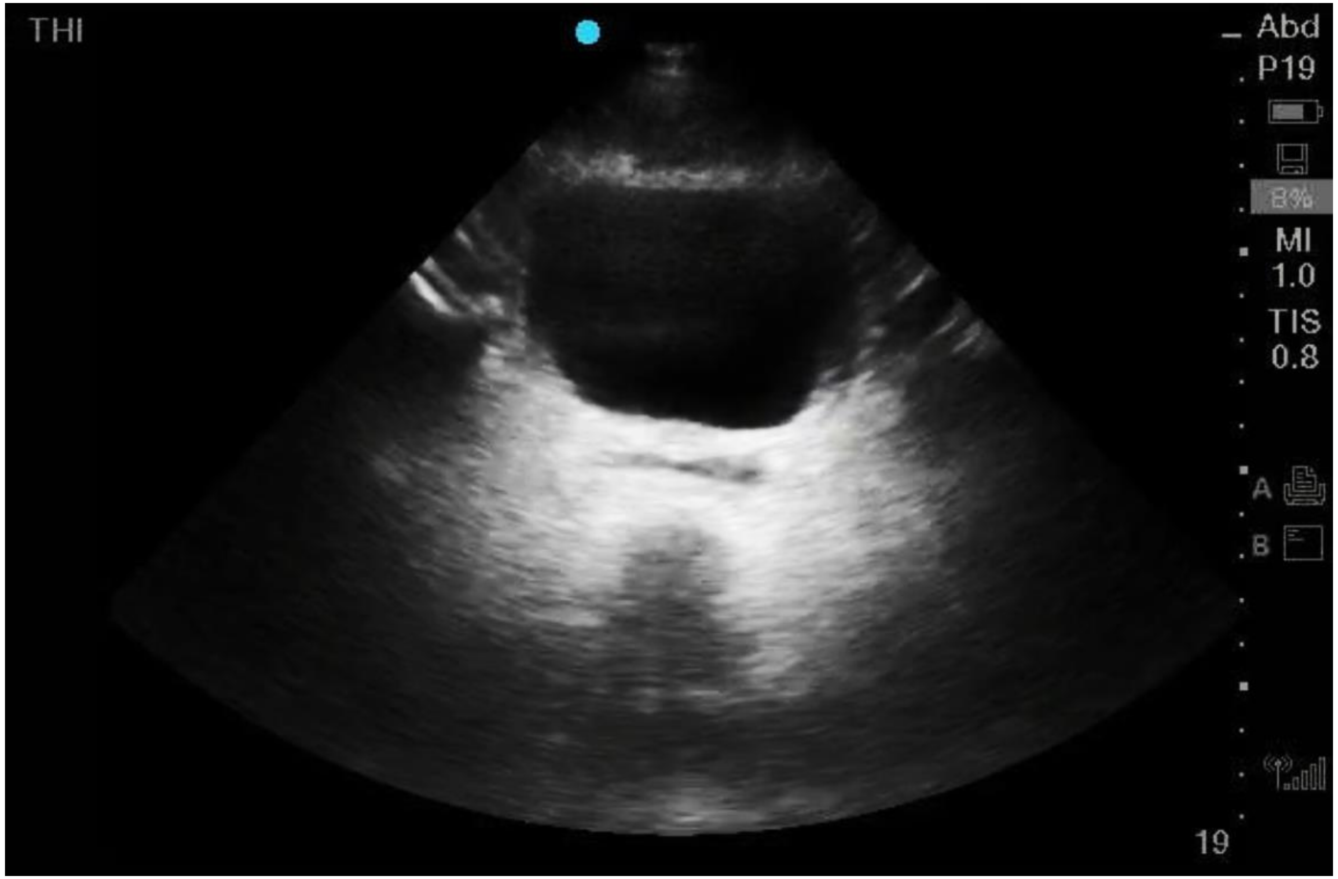
LINEAR

SECTOR
(PHASED ARRAY)

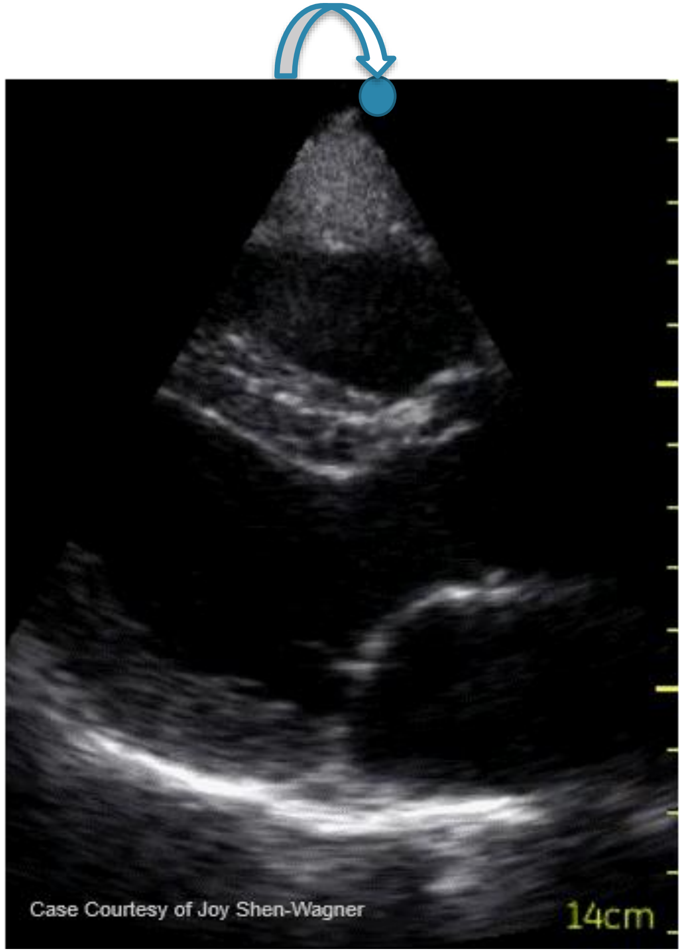


CONVEX
(CURVED/CURVILINEAR)

Preset: Cardiac*



Abdominal Preset



Cardiac Preset

Patient Position

- Supine (or *Left Lateral Decubitus*)
- Patient-centered POCUS
  - Draping, gel and pressure
  - Screen Position
  - Participation Breath holding

Permission for Image by Andrea Lewis, DO

Key Windows/Probe Positions

Parasternal

-**Parasternal Long Axis (PLAX)**

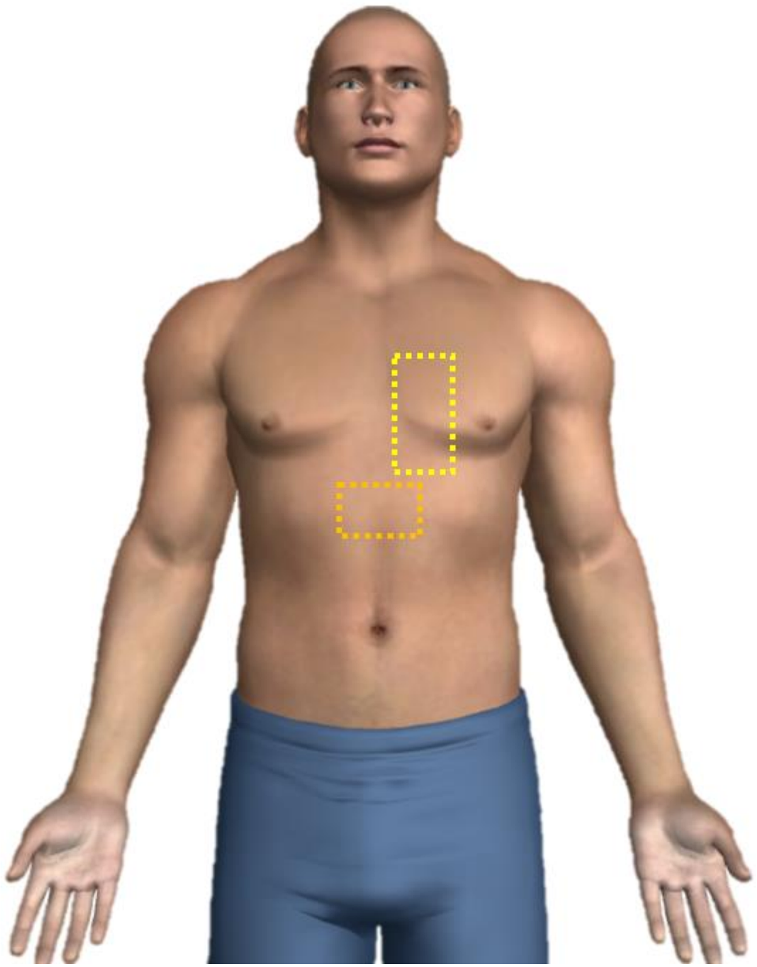
-Parasternal Short Axis (PSAX)

Subxiphoid/Epigastric

-Subxiphoid 4 Chamber (Sx4C)

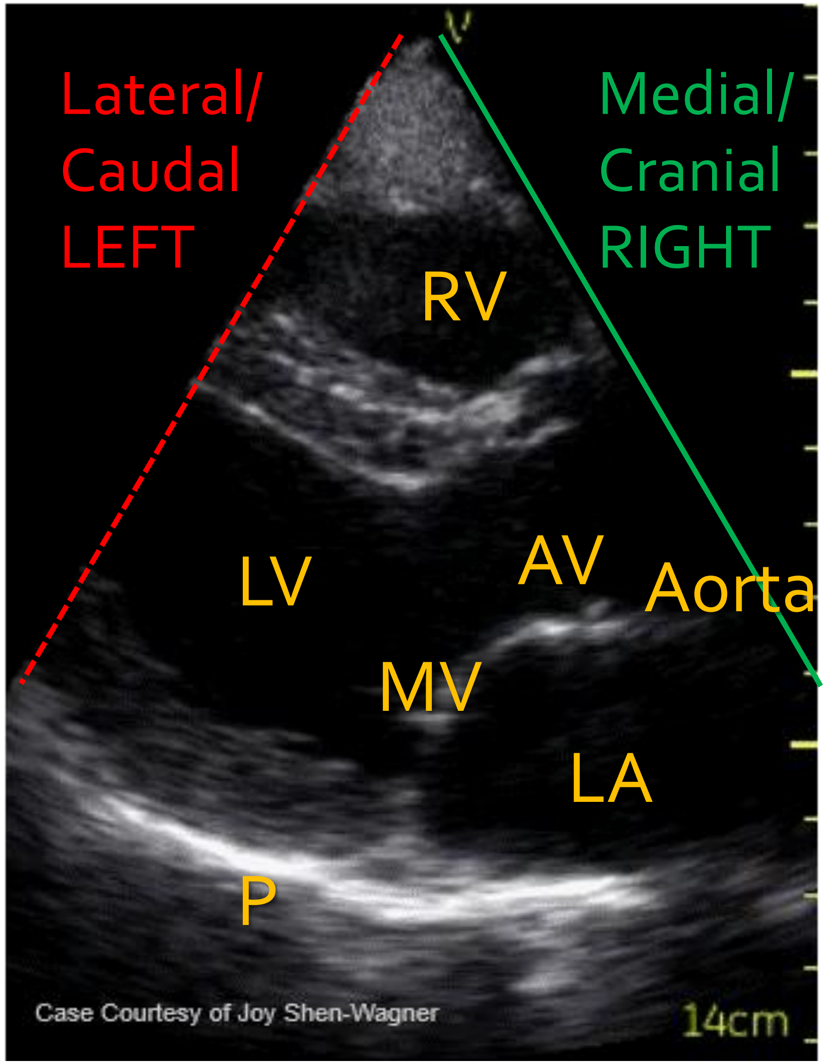
-Inferior Vena Cava- transverse

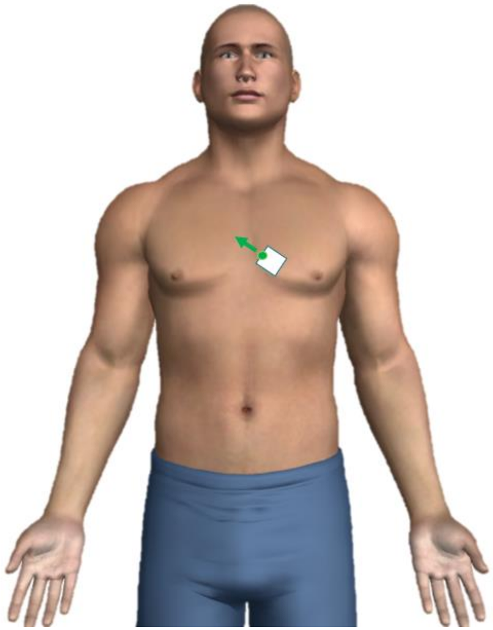
-**Inferior Vena Cava- sagittal**

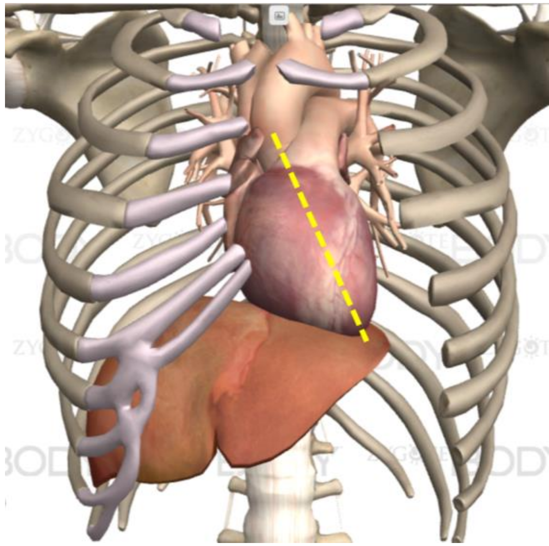


Parasternal Long Axis (PLAX)

- Probe Marker:
  - Pt's RIGHT shoulder
- Plane: Long Axis of LV
- Key Landmarks
  - Right Ventricle
  - Left Ventricle
  - Left Atrium
  - Mitral and Aortic Valves
  - Ascending Aorta
  - Pericardium

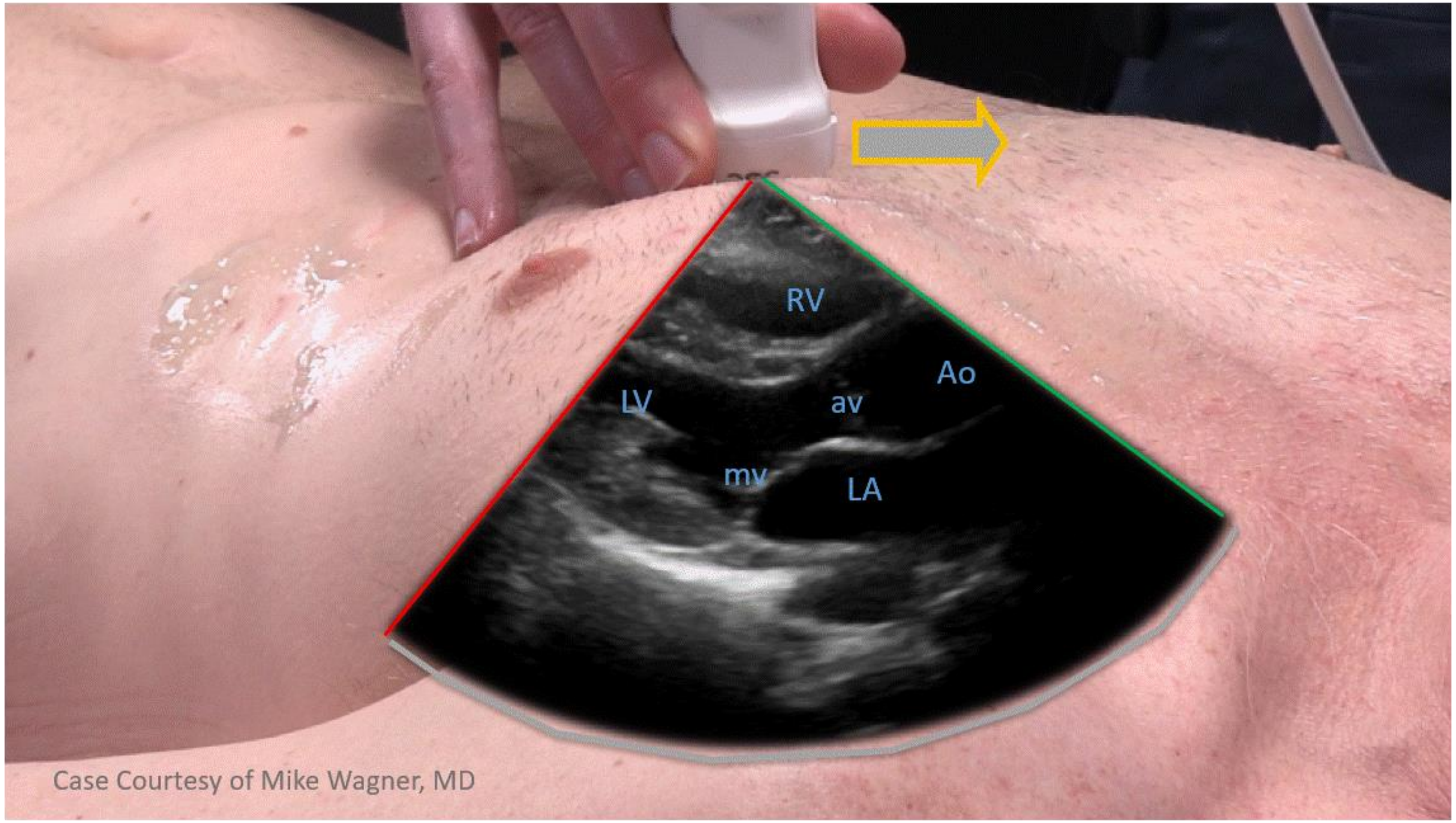




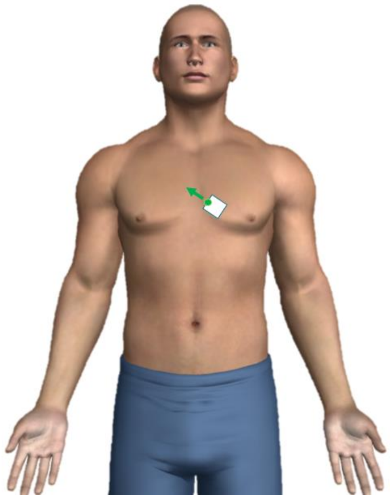


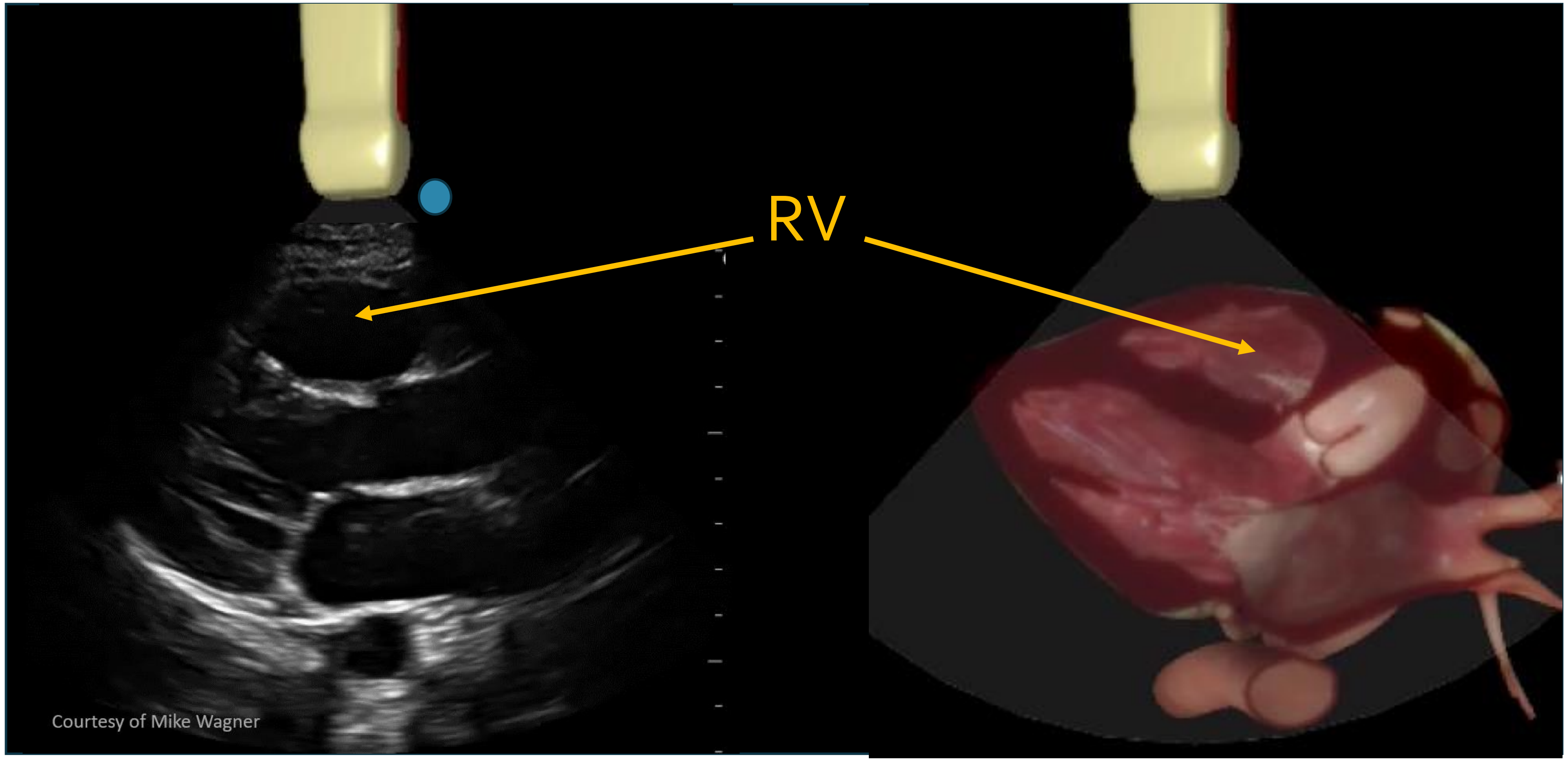
Orientation and Perspective

- Parasternal Long Axis (PLAX)
- Perspective is looking from LEFT shoulder towards RIGHT hip

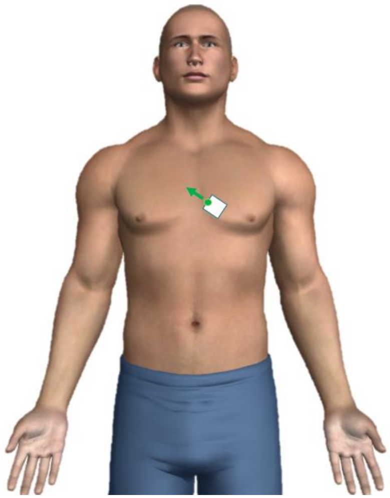


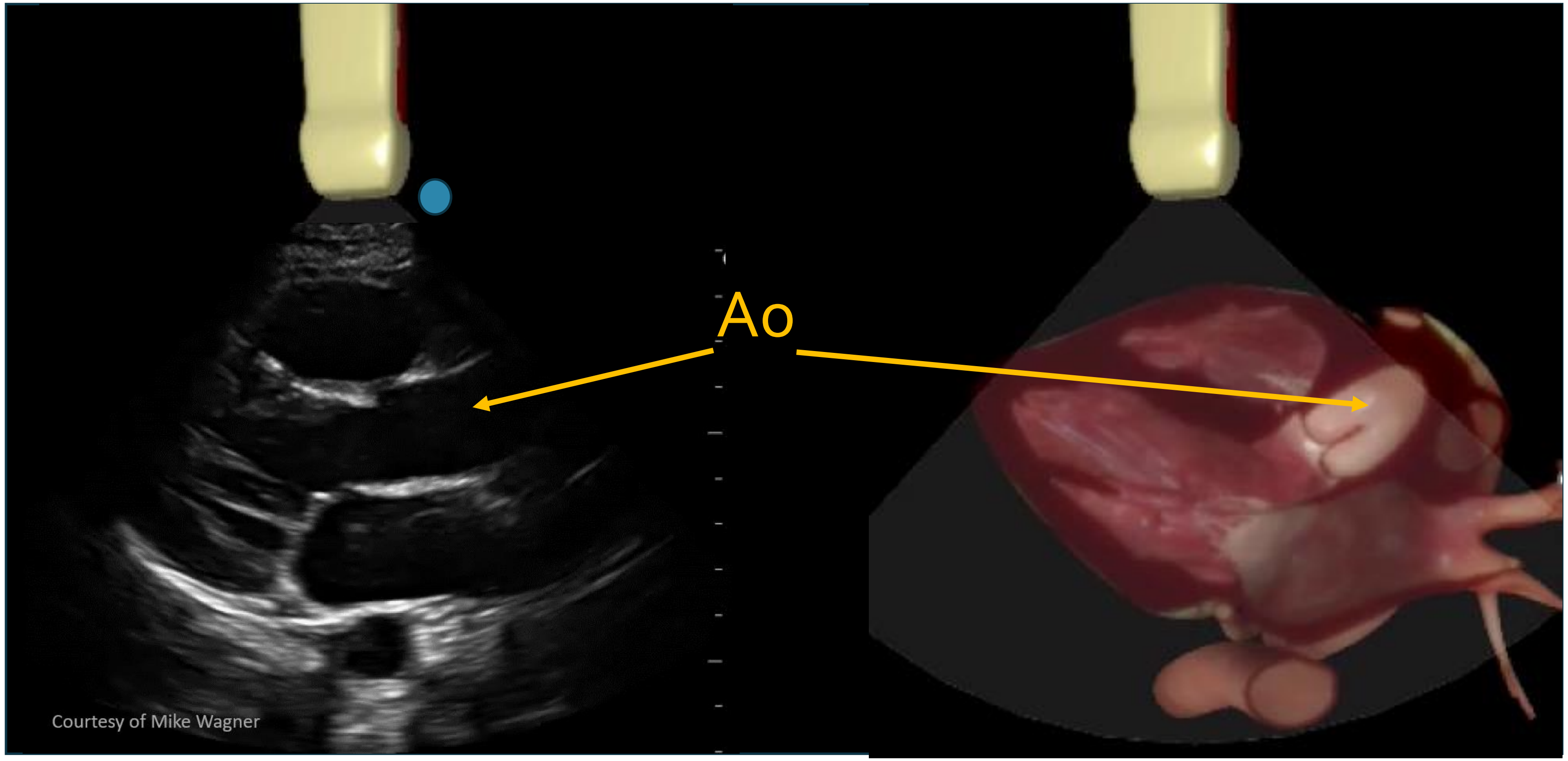
Parasternal Long Axis (PLAX)



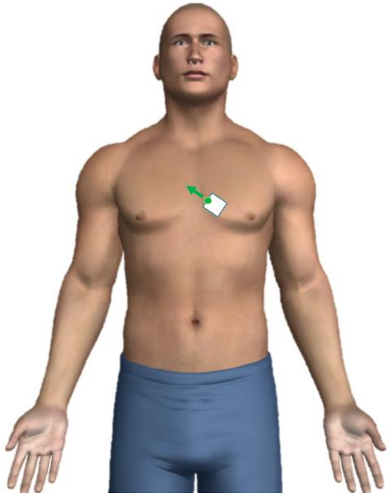


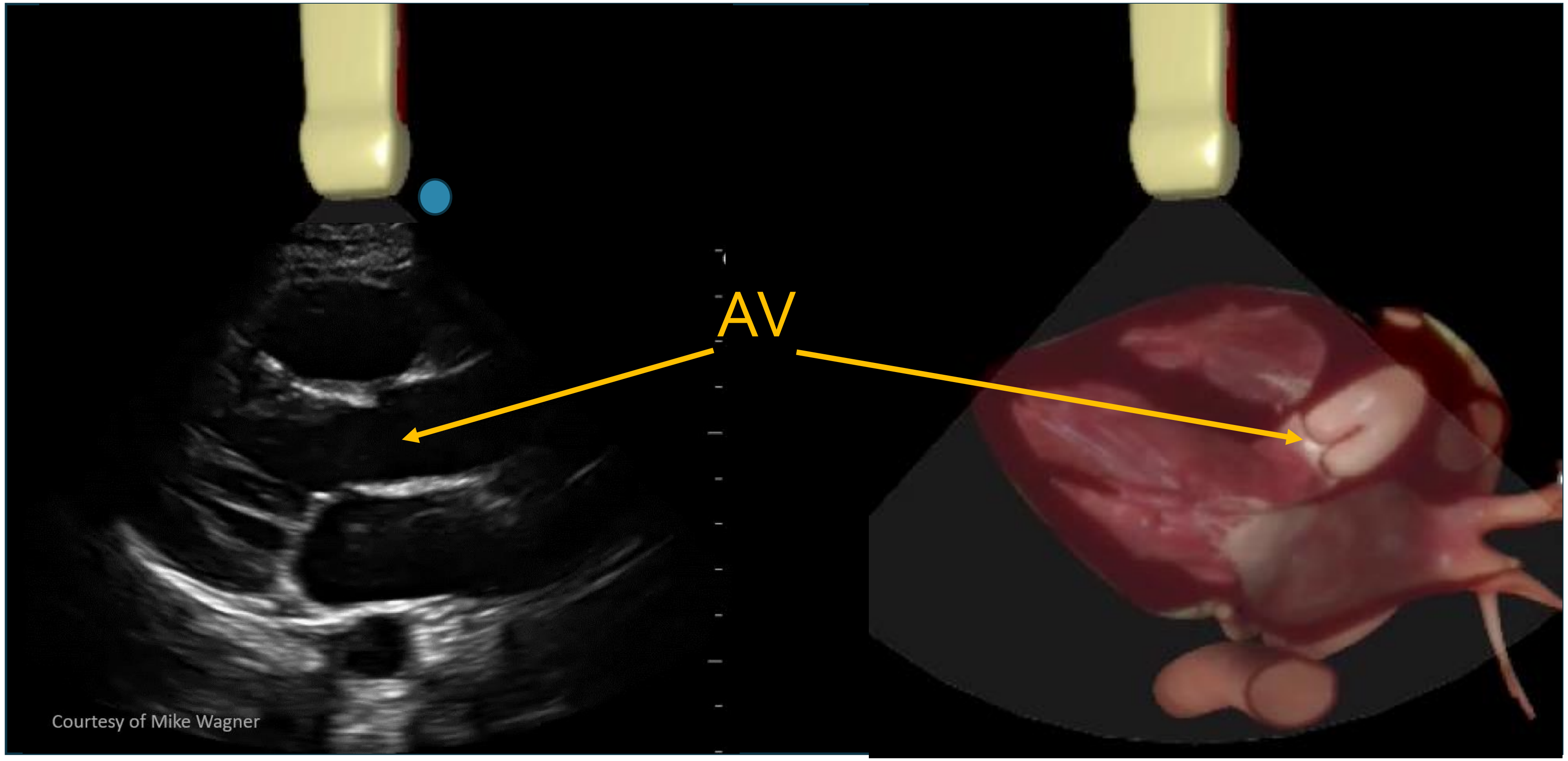
Parasternal Long Axis (PLAX)



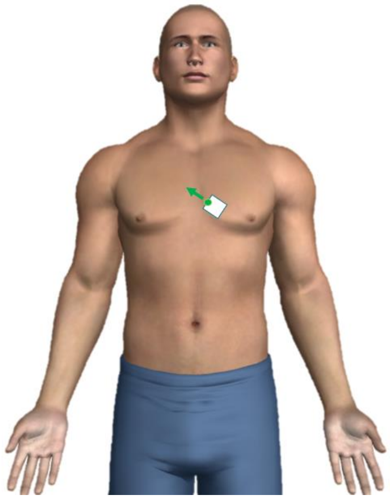


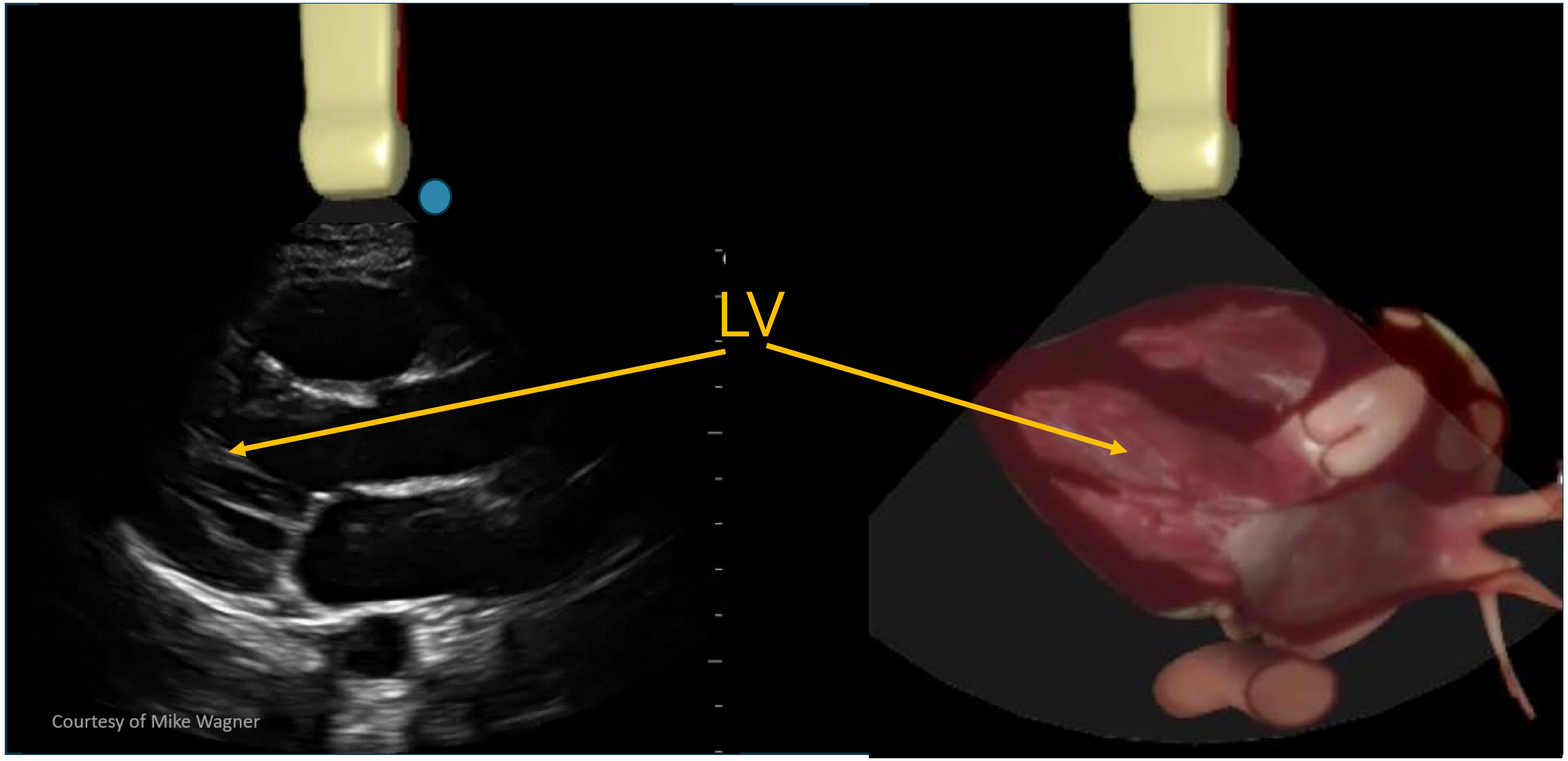
Parasternal Long Axis (PLAX)



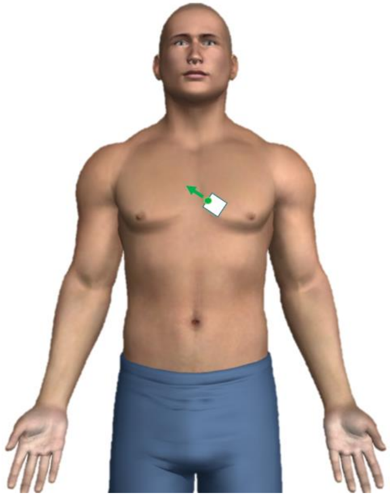


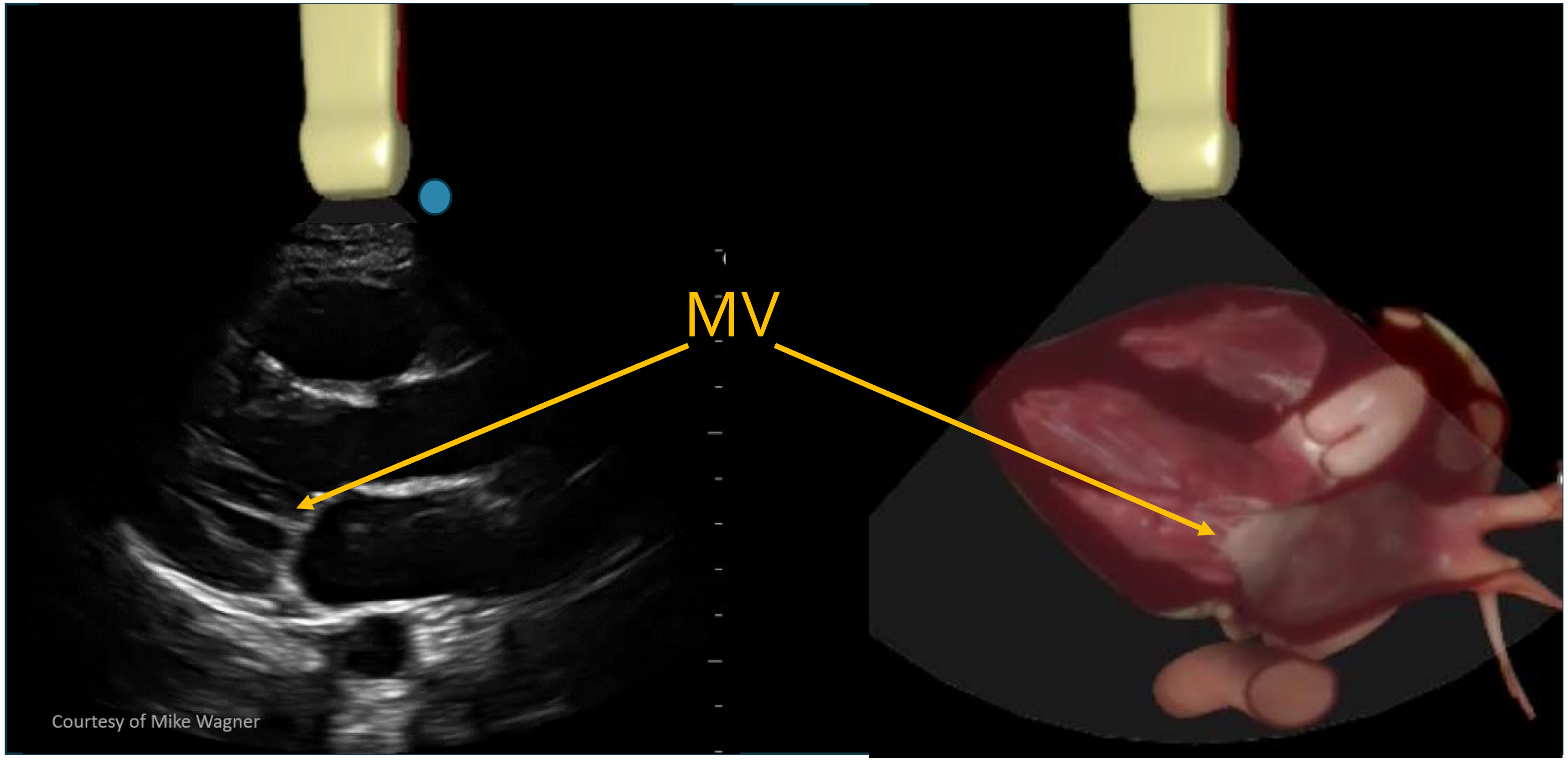
Parasternal Long Axis (PLAX)



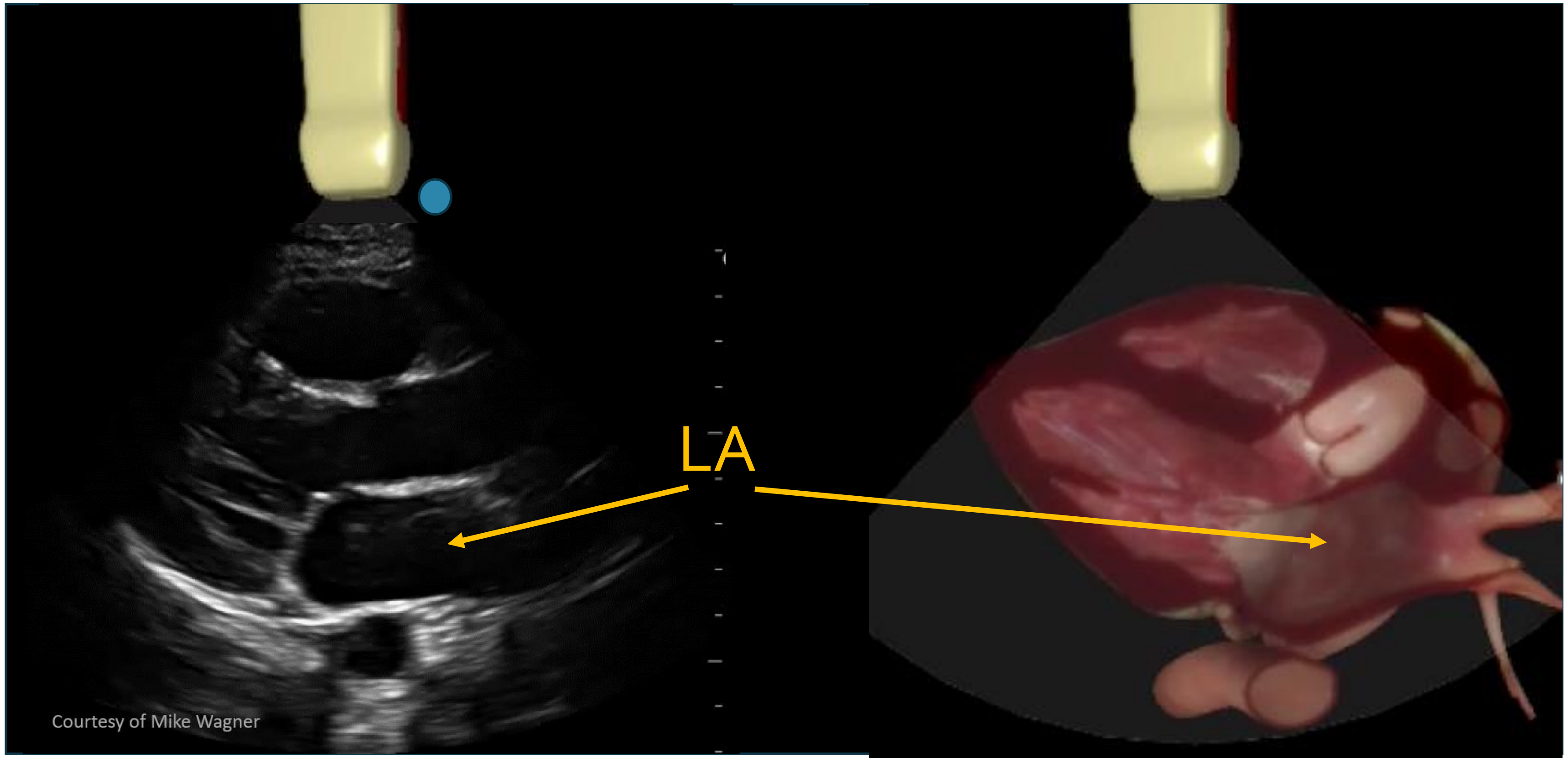


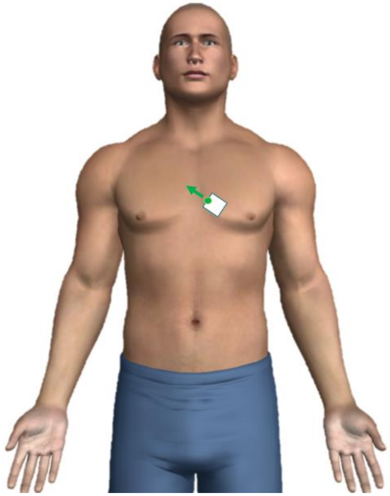
Parasternal Long Axis (PLAX)





Parasternal Long Axis (PLAX)

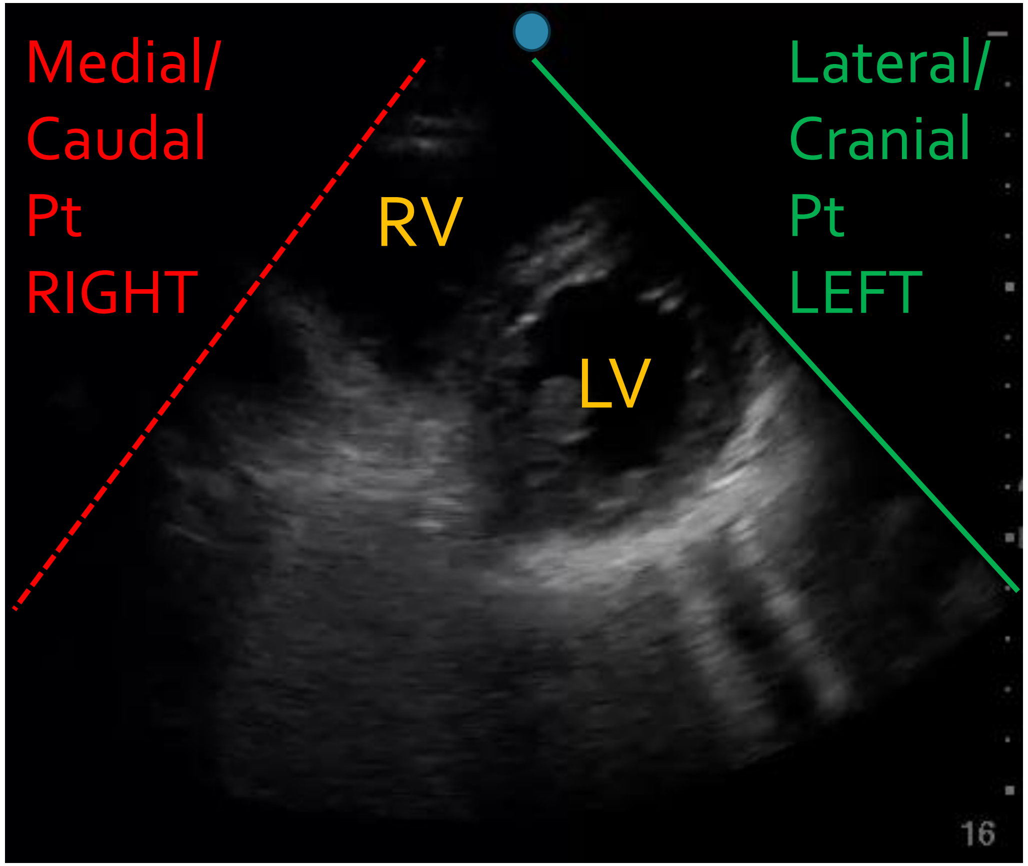


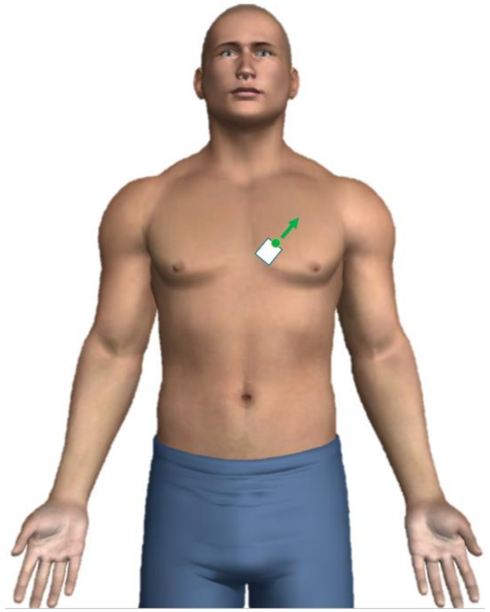


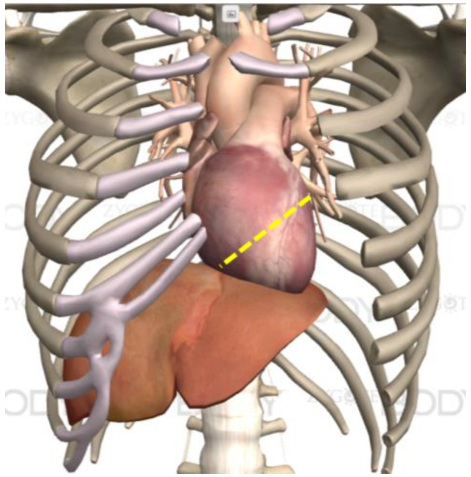
Additional Cardiac Views:

Parasternal Short Axis (PSAX)

- Probe Marker:
  - Pt's LEFT shoulder
- Plane: Short Axis
- Key Landmarks
  - Left Ventricle
  - Right Ventricle
  - Interventricular Septum
  - Papillary Muscles



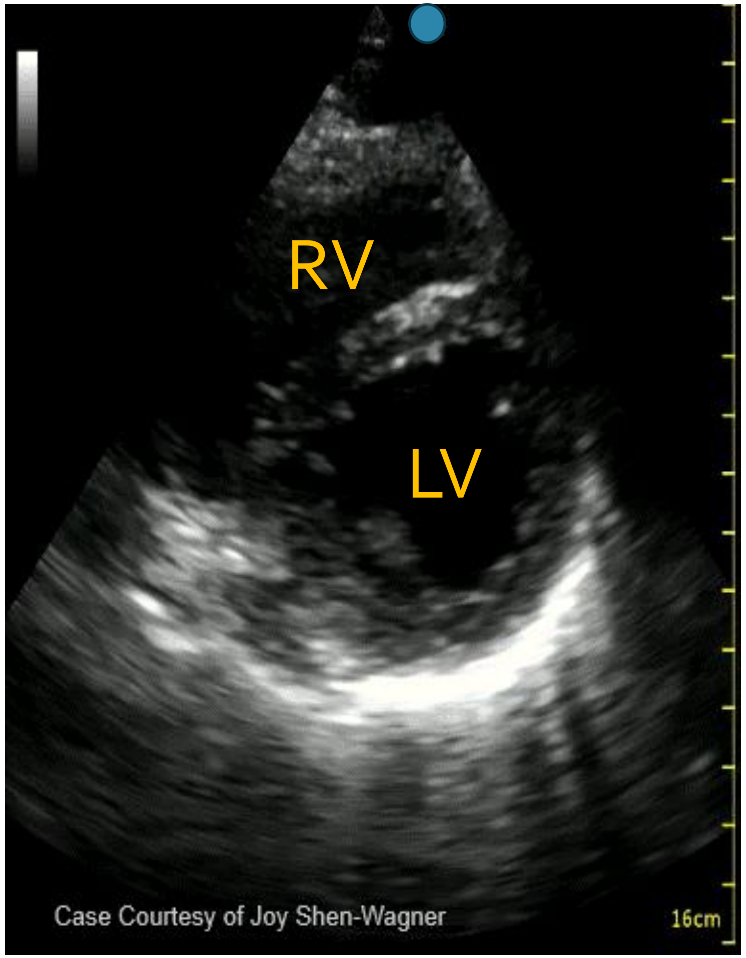


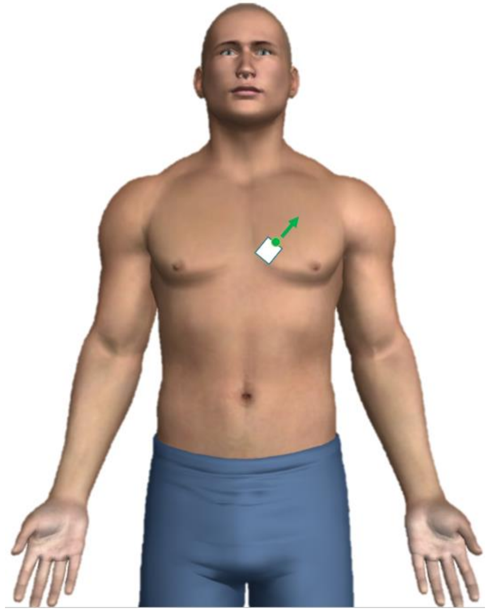


Additional Cardiac Views:

Parasternal Short Axis (PSAX)

- Pros:
  - Easier to Conceptualize
  - Second Look at “Squeeze”
  - Wall Motion Abnormality
- Cons:
  - Hardier to Acquire
  - Like PLAX, often difficult in COPD



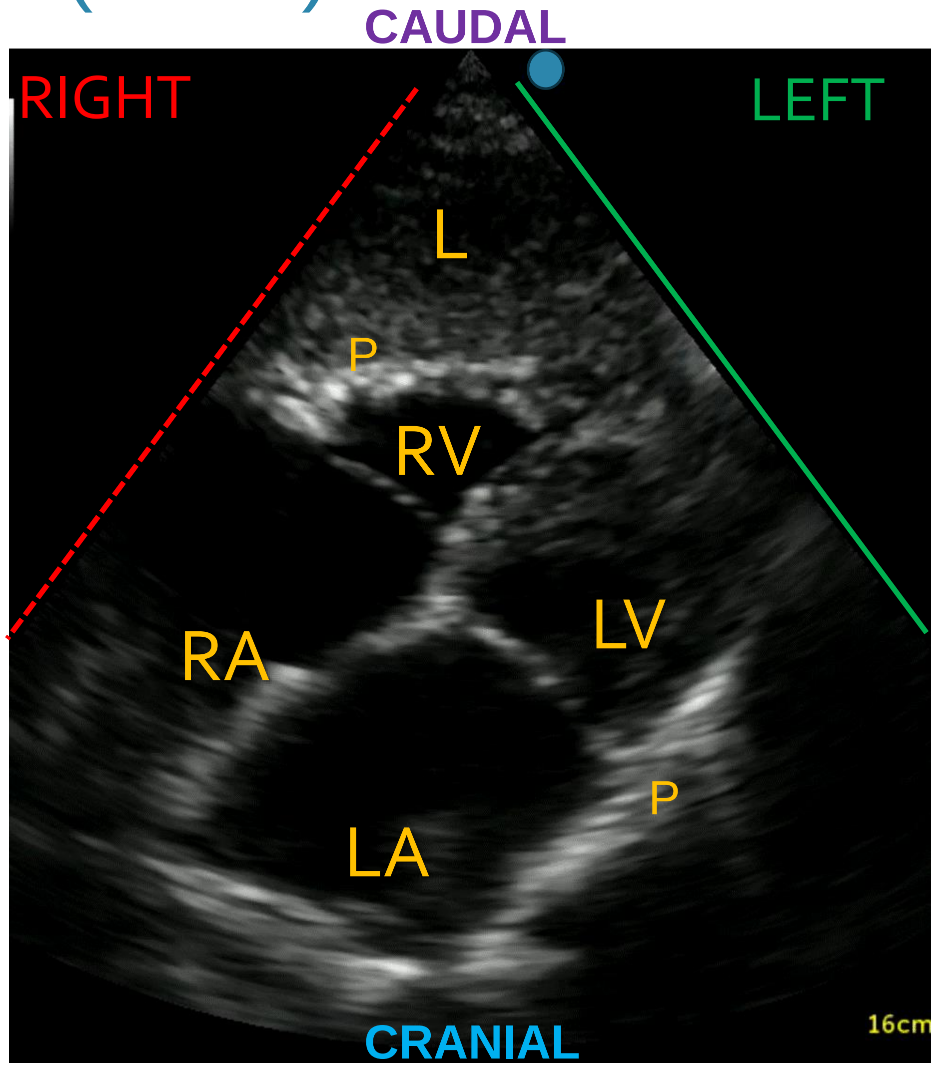


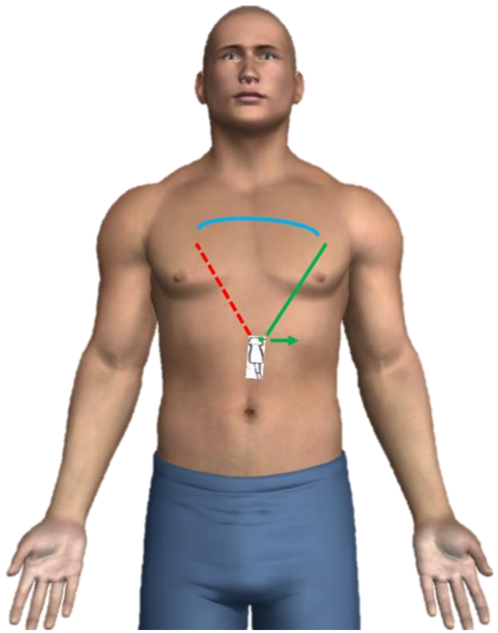
“Breakfast view”-
Ryan Barnes DO

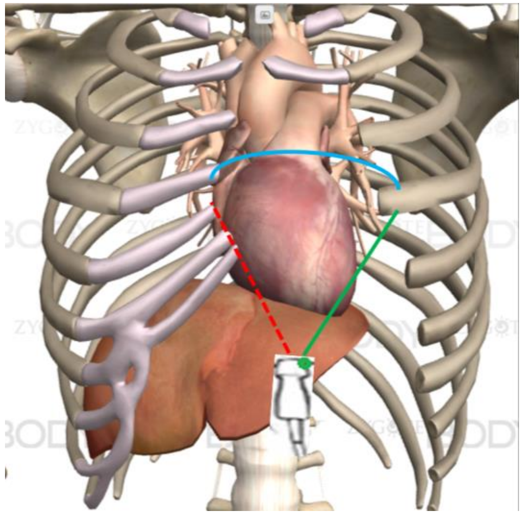
Additional Cardiac Views:

Subxiphoid 4 Chamber (Sx4C)

- Probe Marker:
  - Pt's LEFT
- Plane: Coronal
- Key Landmarks
  - Liver
  - Pericardium
  - Right Ventricle
  - Right Atrium
  - Left Ventricle
  - Left Atrium



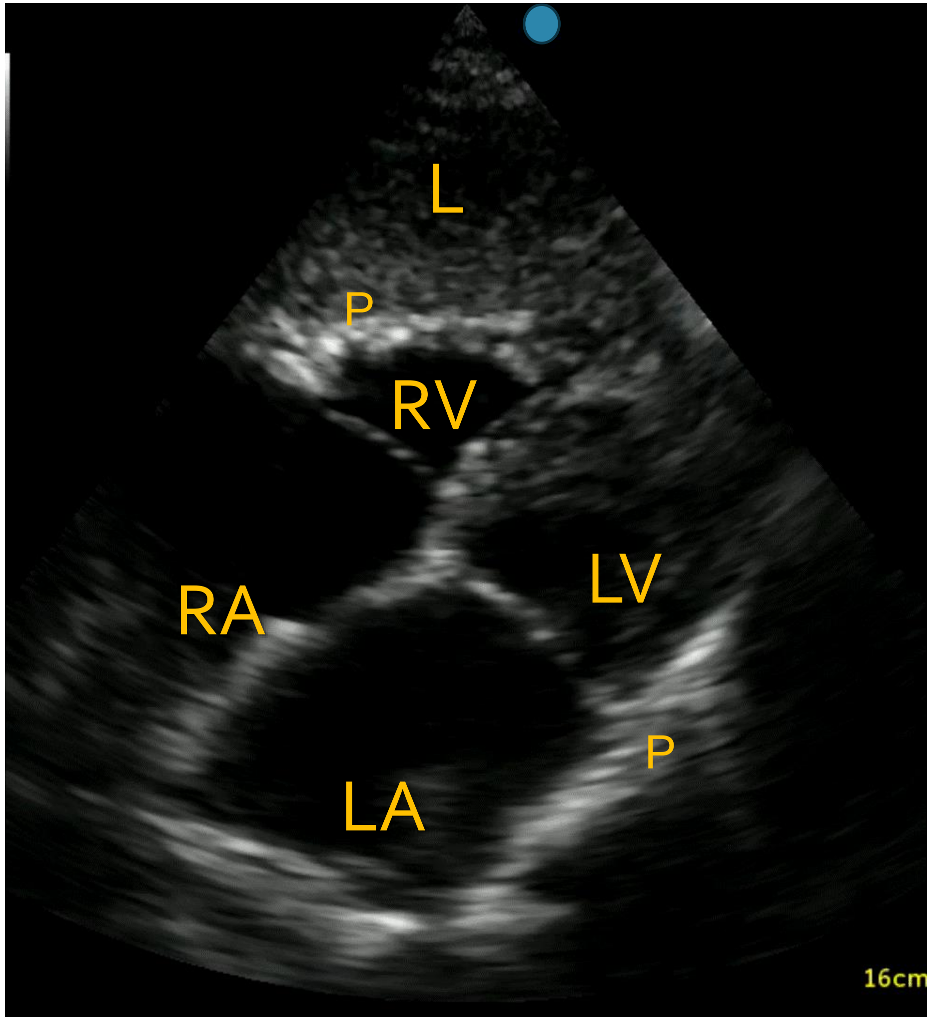


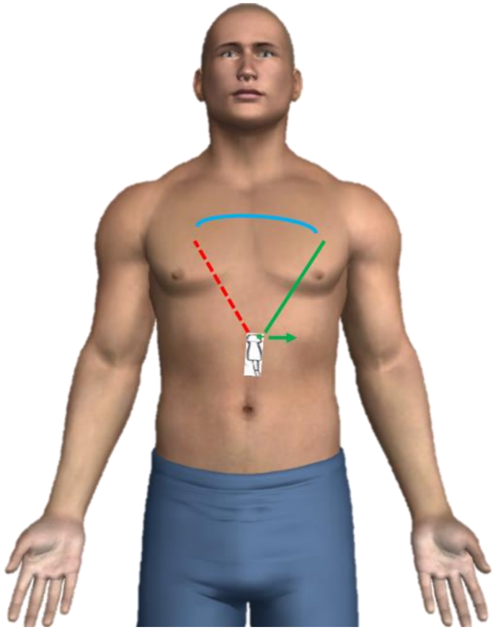


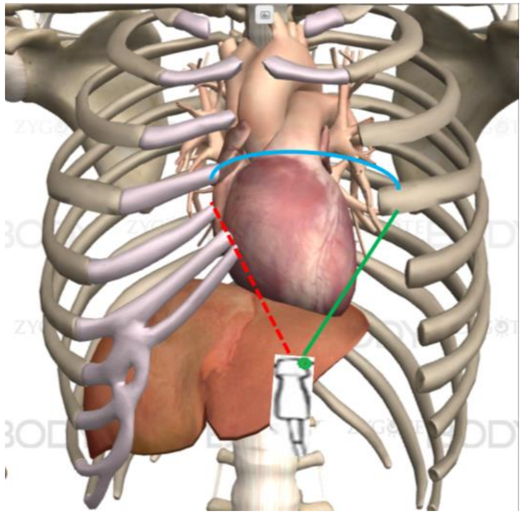
Additional Cardiac Views:

Subxiphoid 4 Chamber (Sx4C)

- Pros:
  - Easiest window in COPD
  - Best view for pericardial effusions
- Cons:
  - Orientation challenging
  - Can be difficult with
    - Obese habitus
    - Large stomachs
    - Small liver window







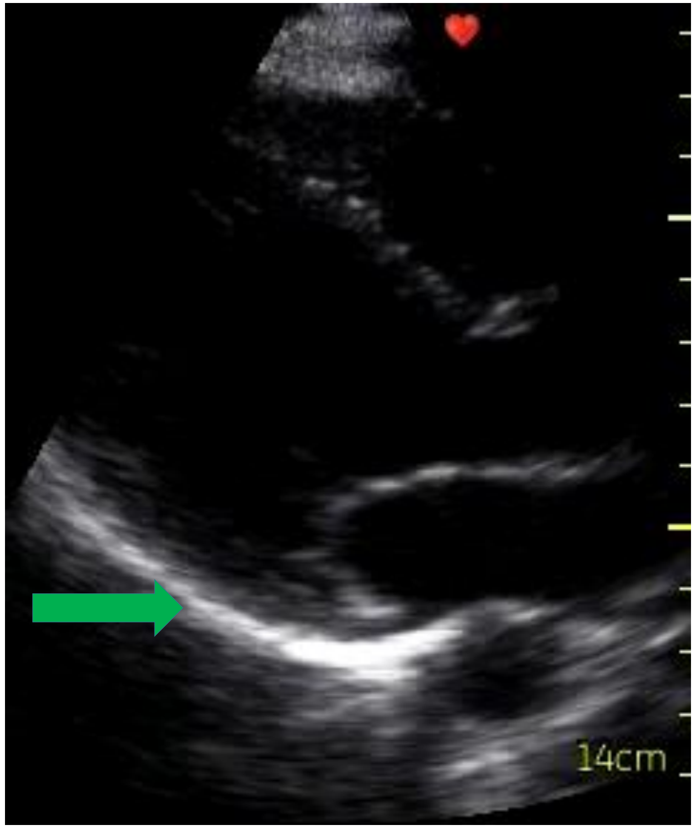
Early Applications/Pathology

Moderate-Large Pericardial Effusion

Severe Left Ventricular Systolic Dysfunction

PLAX – Pericardial Effusion

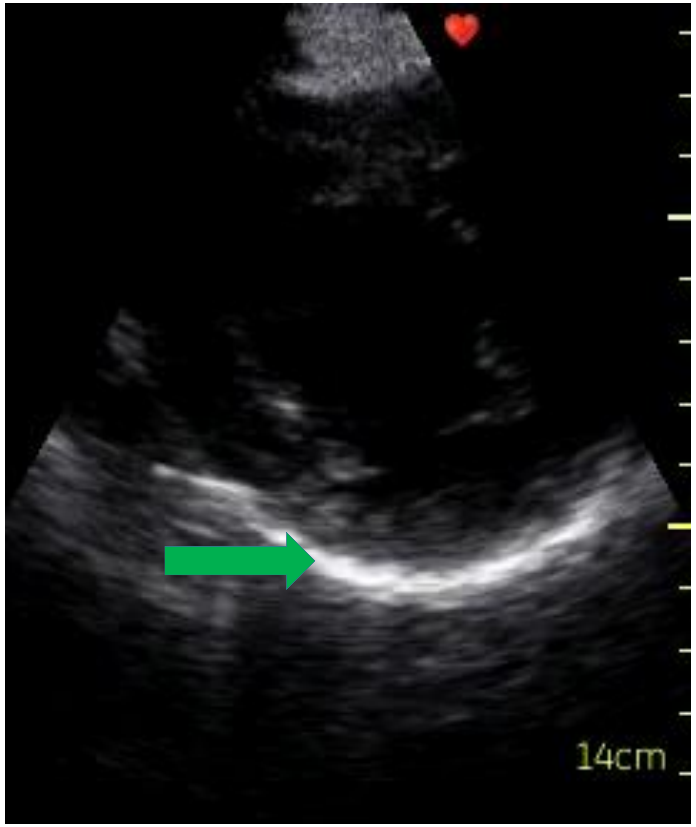
Normal



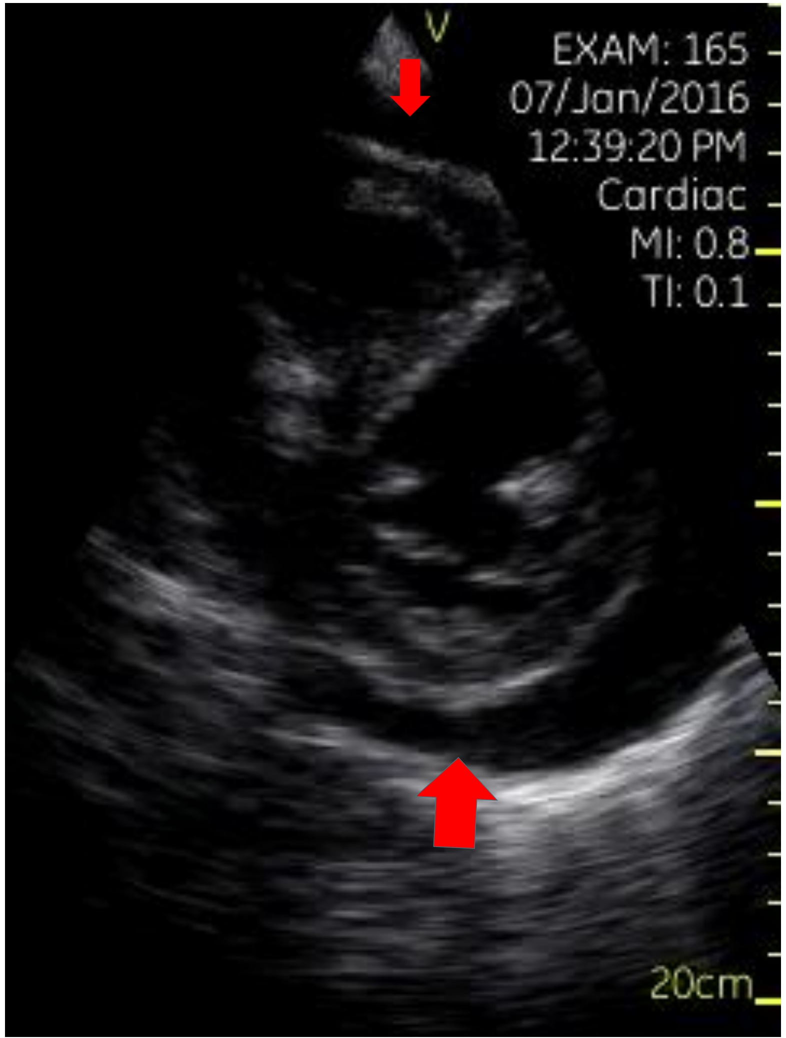
Pericardial Effusion

PSAX – Pericardial Effusion

Normal

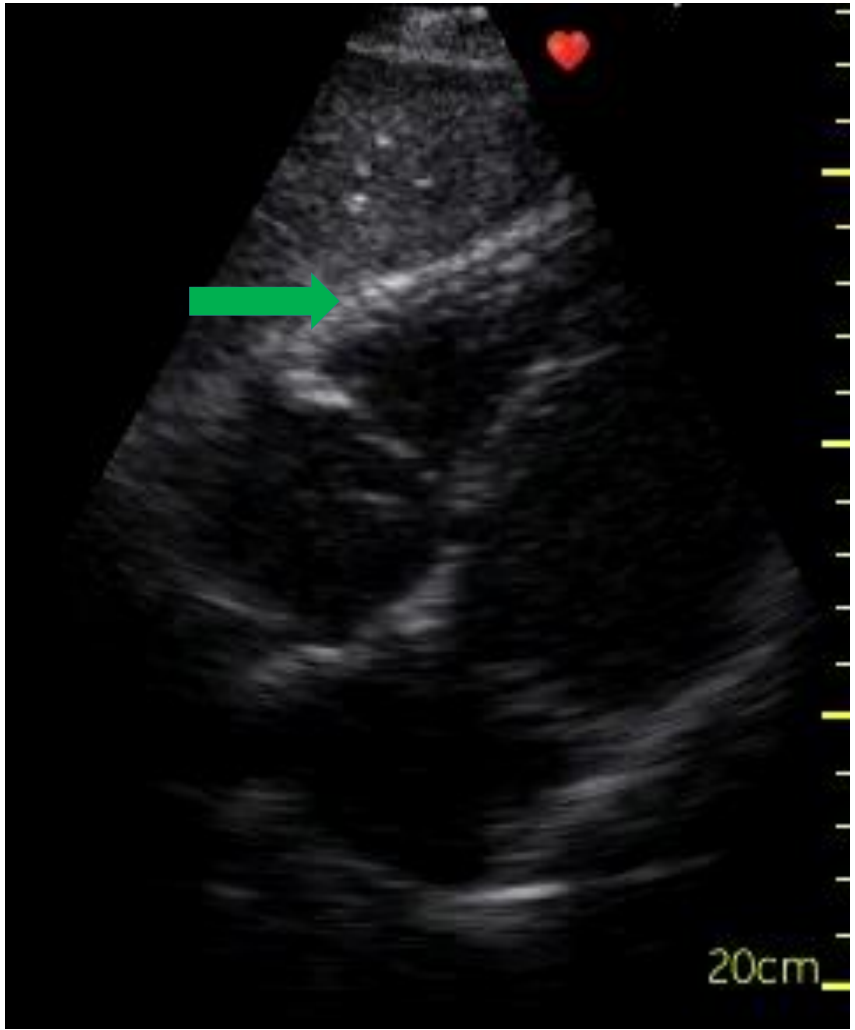


Pericardial Effusion

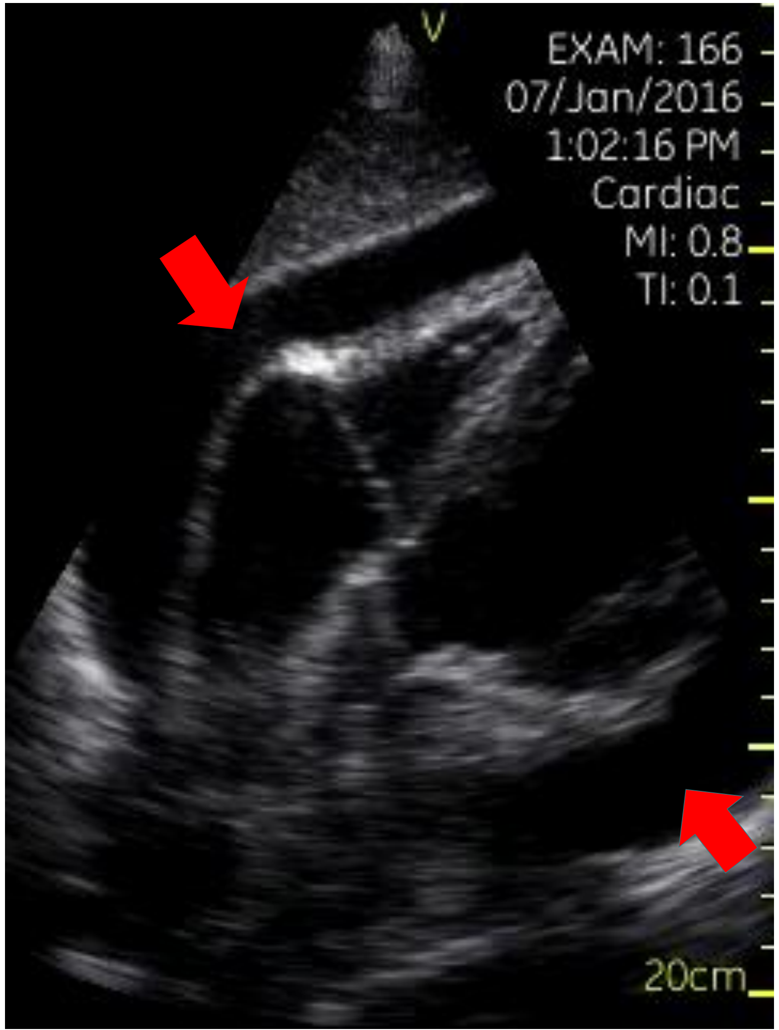


Sx4C – Pericardial Effusion

Normal

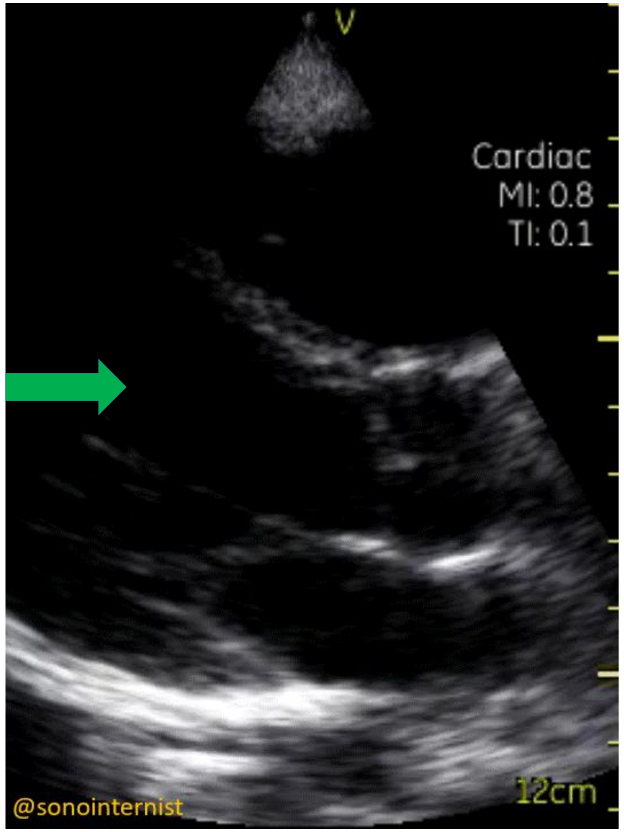


Pericardial Effusion

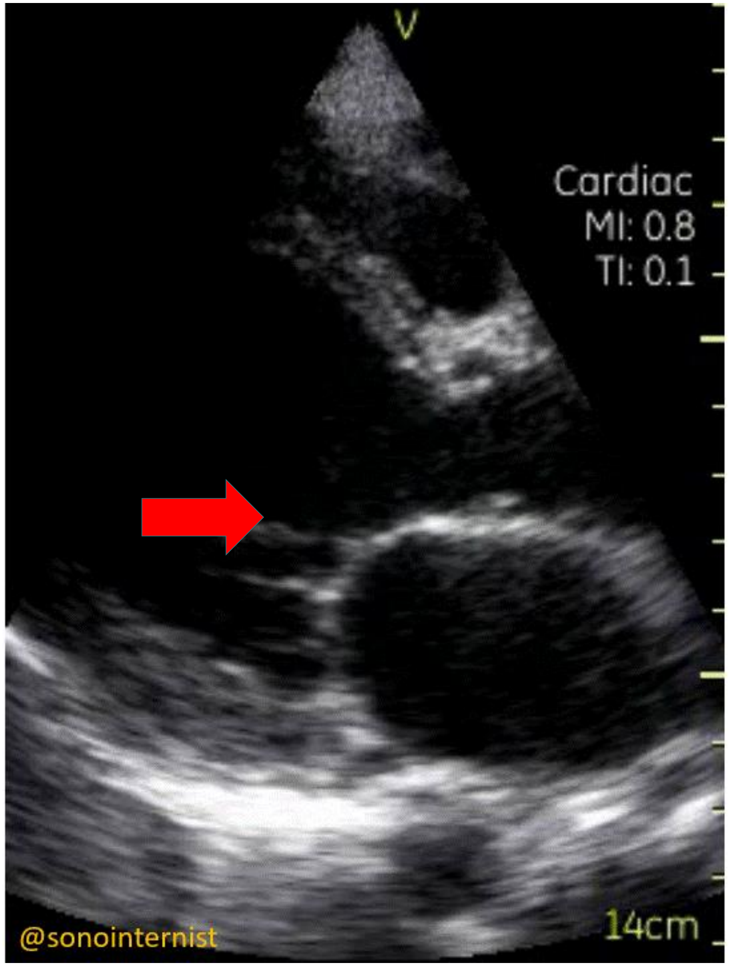


PLAX – Severe Left Ventricular Systolic Dysfunction

Normal



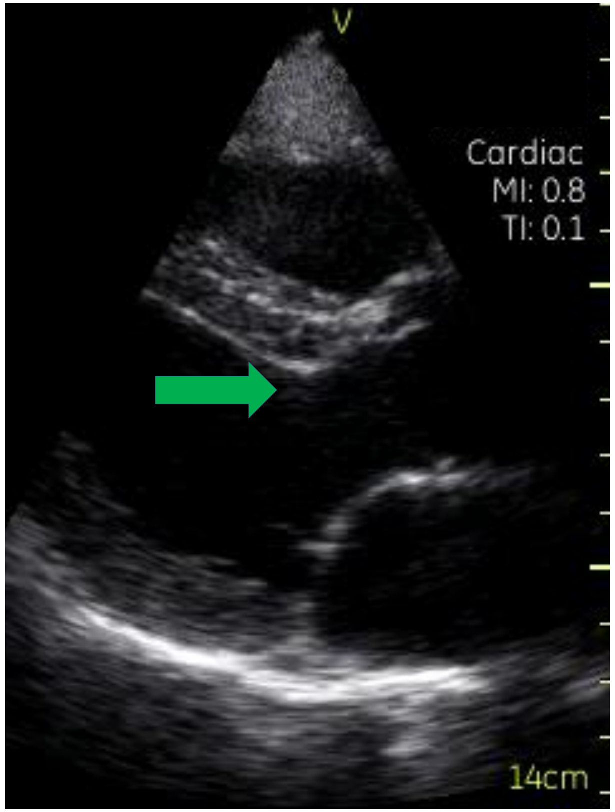
Severe LVSD

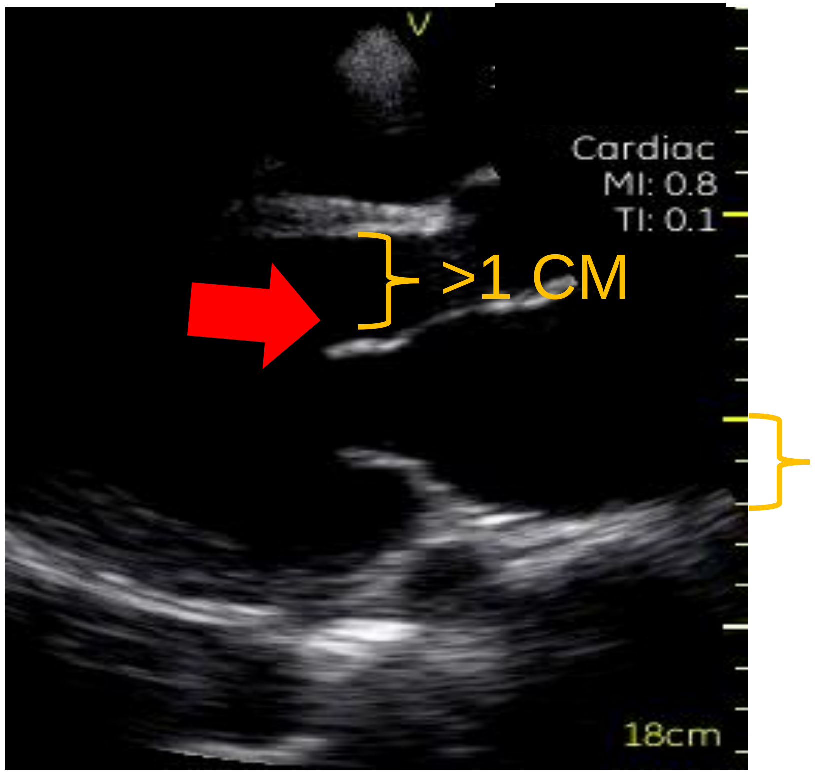


MV movement as surrogate for LV systolic function

Normal

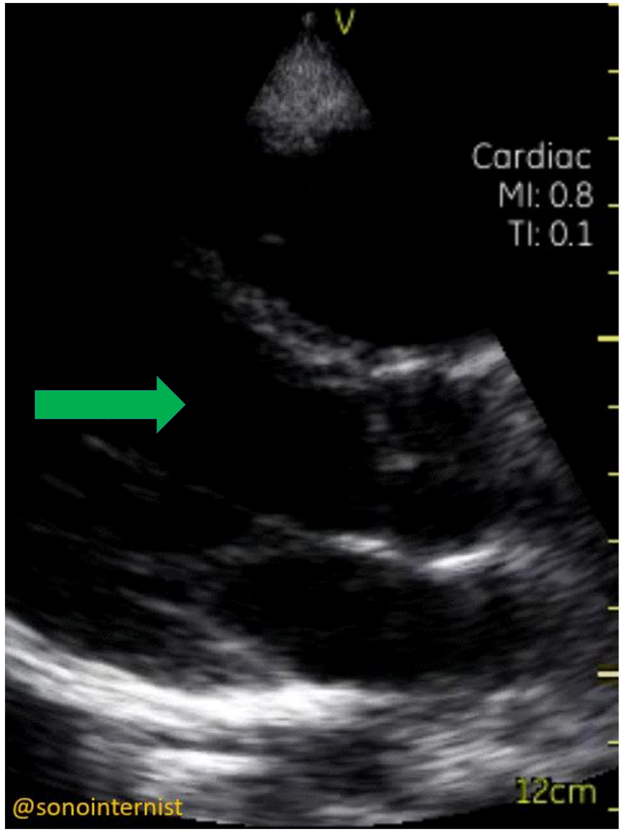
Abnormal



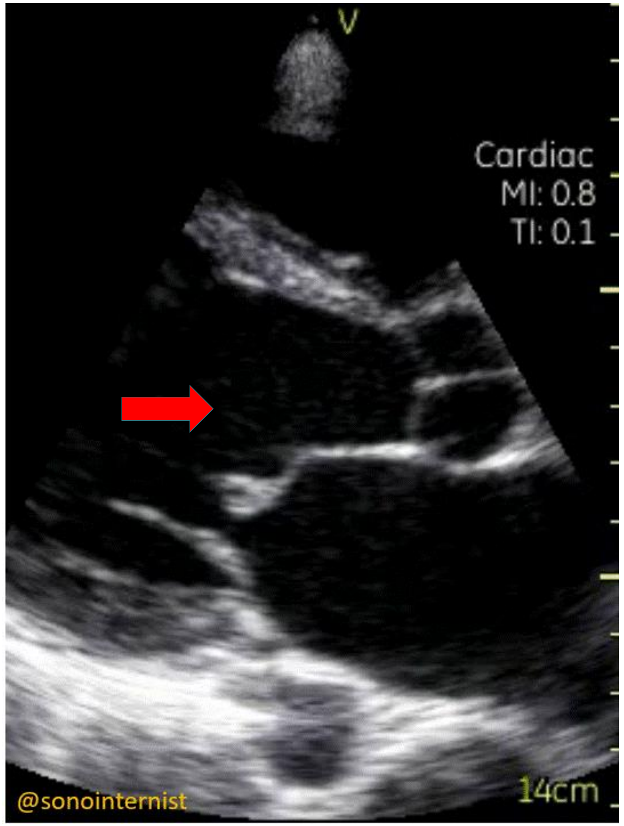


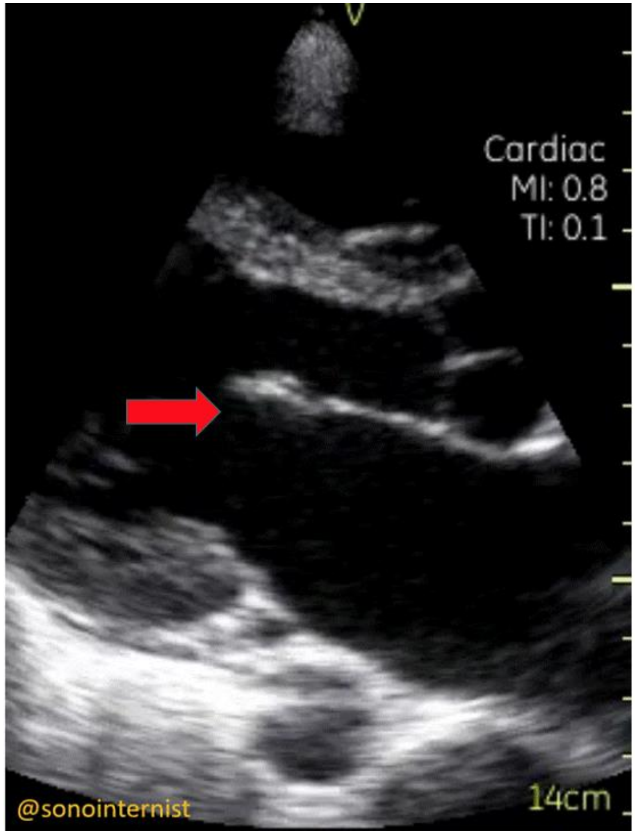
PLAX – Severe Left Ventricular Systolic Dysfunction

Normal



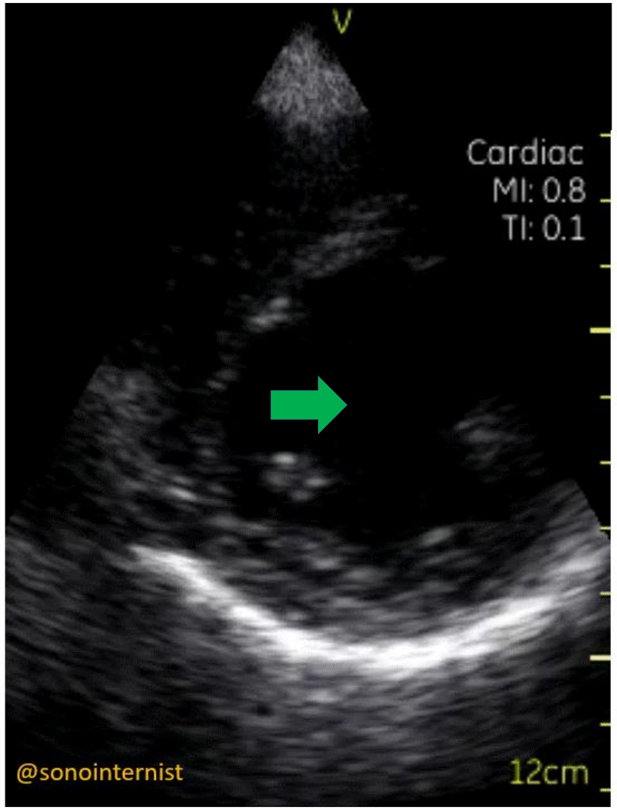
Also Severe LVSD



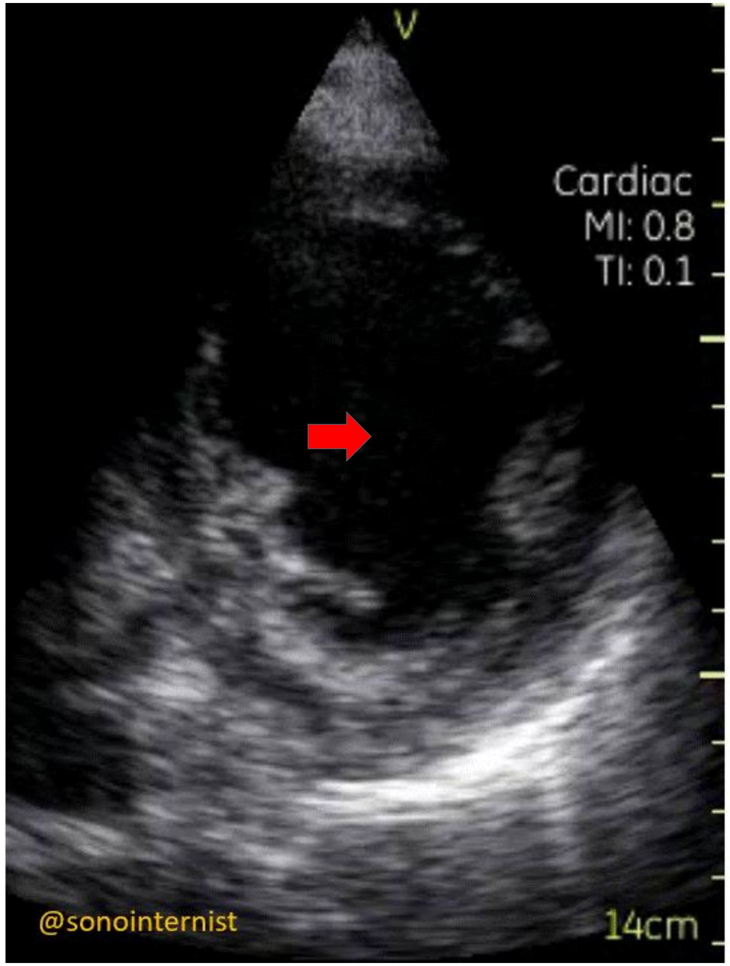


PSAX – Severe Left Ventricular Systolic Dysfunction

Normal

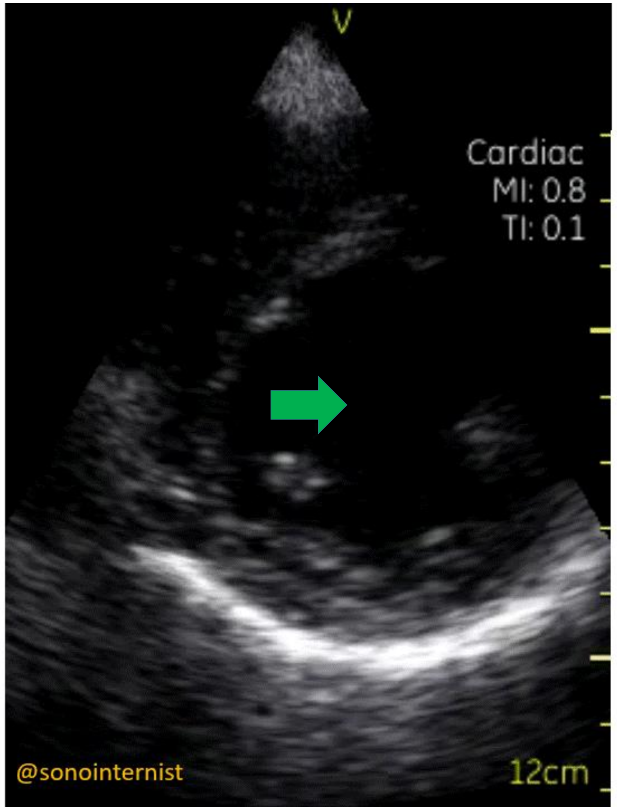


Severe LVSD

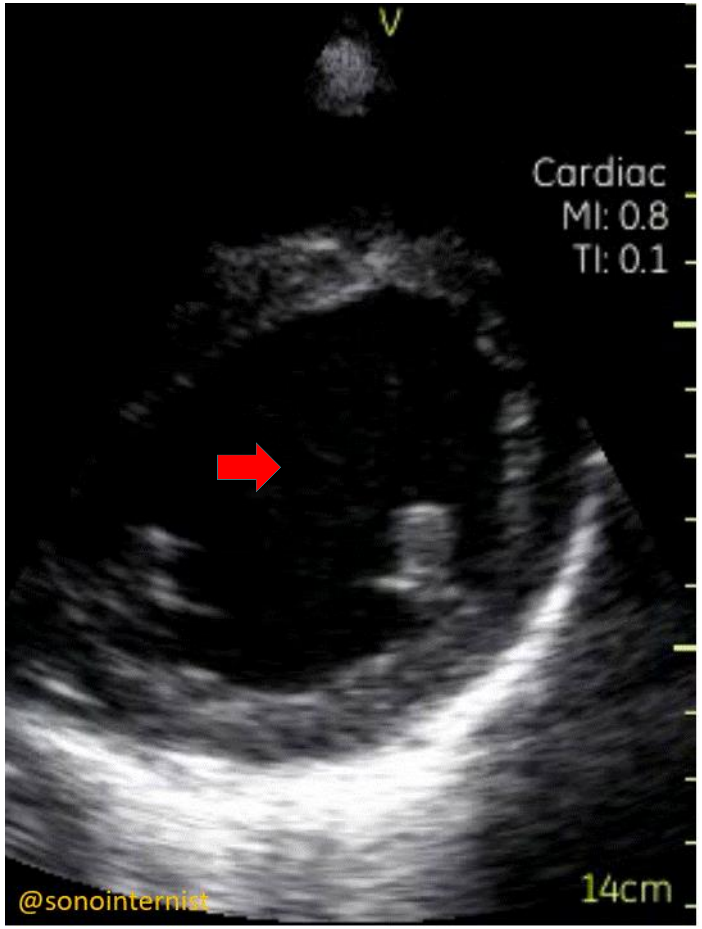


PSAX – Severe Left Ventricular Systolic Dysfunction

Normal

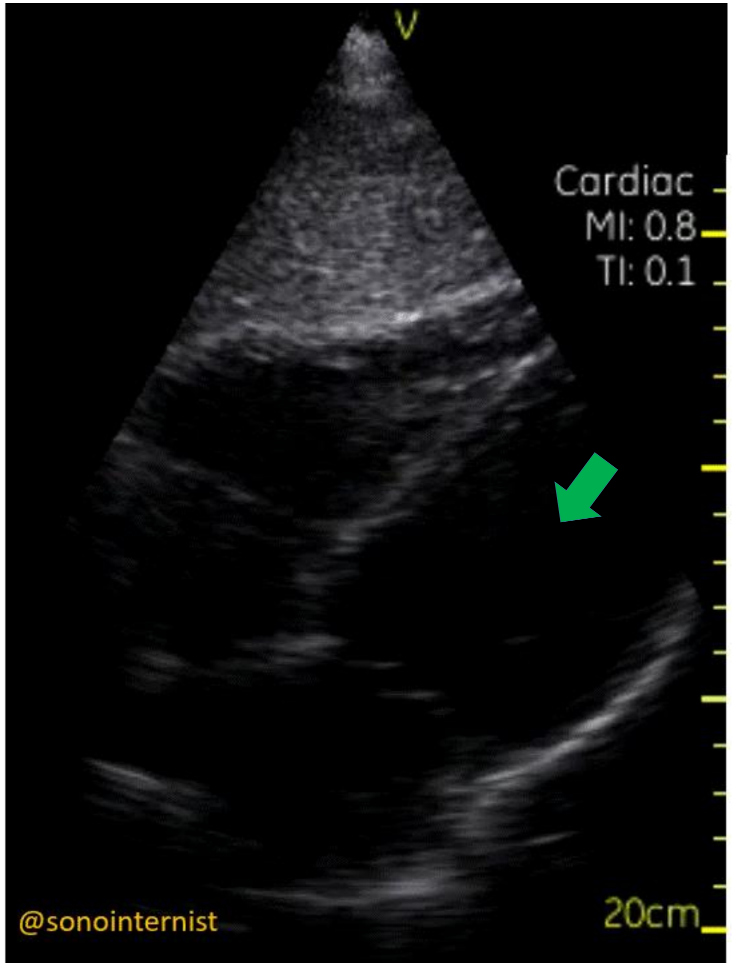


Also Severe LVSD

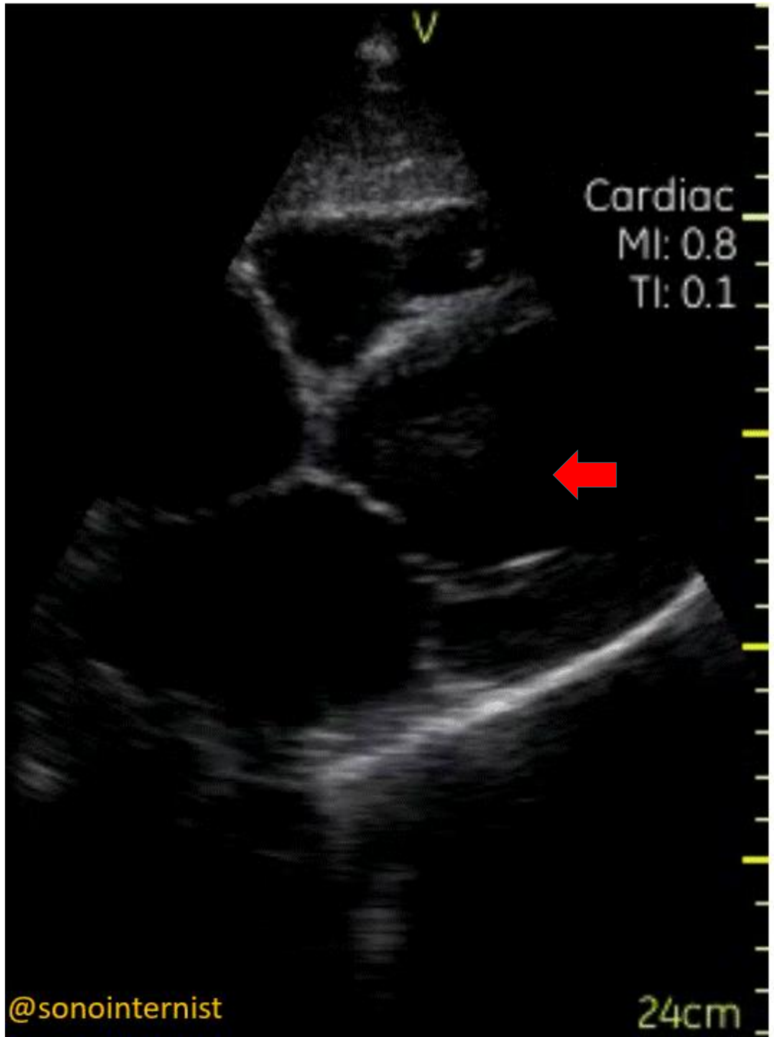


Sx4C – Severe Left Ventricular Systolic Dysfunction

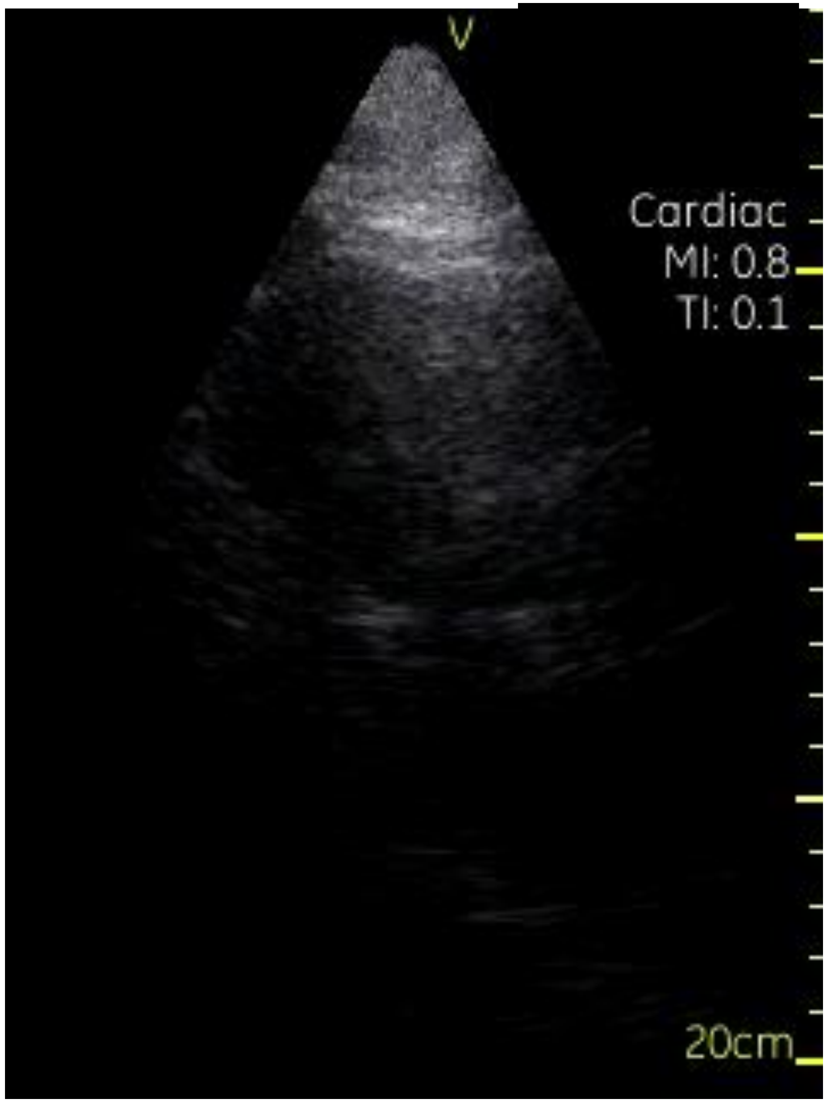
Normal



Severe LVSD



Non-diagnostic Images



Avoiding Pitfalls

- Don’t make a call based on a non-diagnostic scan
  - Sometimes patients have difficult windows
- Ensure all landmarks are in view prior to assessing for Left Ventricular function
  - Beginners often confuse Right Ventricle with Left Ventricle and Tricuspid Valve with Mitral Valve when off-axis
- Pericardial effusions for the VAST majority of patients are Anechoic
  - Same echogenicity as blood in chambers
- Don’t confuse Aorta with IVC!
- Always looks at the HEART with the IVC
  - A big IVC does not equal furosemide deficiency!

Evidence: Cardiac POCUS

Academic Emergency Medicine
Official Journal of the Society for Academic Emergency Medicine

BRIEF REPORT

Can Junior Emergency Physicians Use E-Point Septal Separation to Accurately Estimate Left Ventricular Function in Acutely Dyspneic Patients?

Michael A. Secko, MD, RDMS, Jason M. Lazar, MD, Louis A. Salciccioli, MD, and Michael B. Stone, MD, RDMS

Internal Medicine Point-of-Care Ultrasound Assessment of Left Ventricular Function Correlates with Formal Echocardiography

Benjamin K. Johnson, MD,[1] David M. Tierney, MD, FACP,[1] Terry K. Rosborough, MD, FACP,[1] Kevin M. Harris, MD, FASE,[2] Marc C. Newell, MD[2]

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Received 19 December 2014; accepted 1 April 2015

CLINICAL INVESTIGATIONS
ECHOCARDIOGRAPHY AT THE "POINT OF CARE"

Bedside Hand-Carried Ultrasound by Internal Medicine Residents Versus Traditional Clinical Assessment for the Identification of Systolic Dysfunction in Patients Admitted with Decompensated Heart Failure

Rabia Razi, MD, Jeremy R. Estrada, MD, Jacob Doll, MD, and Kirk T. Spencer, MD, FASE, *Chicago, Illinois*

Background: The rapid detection of left ventricular systolic dysfunction (LVSD) is an important step in the clinical management of patients admitted with acute decompensated heart failure, because it allows the initiation of treatment specific to LVSD and avoidance of contraindicated therapies. The aim of this study was to determine whether internal medicine residents with limited ultrasound training could use hand-carried ultrasound (HCU) to identify LVSD.

Methods: Fifty patients admitted with acute decompensated heart failure were imaged from the parasternal window at the bedside with an HCU device by residents blinded to all clinical data, who had undergone limited cardiac ultrasound training (20 practice studies). Ejection fraction (EF) on HCU was graded as >40% or <40%. HCU EF and a number of physical exam findings and electrocardiographic and laboratory variables were compared for their ability to predict to formal echocardiographic left ventricular EF.

Results: The average formal EF was 32 ± 16% (range, 7%–70%), with 66% of patients having EFs < 40%. The residents' ability to detect an EF < 40% with HCU was excellent (sensitivity, 94%; specificity, 94%; negative predictive value, 88%; positive predictive value, 97%). Binary logistic regression demonstrated that HCU EF was the most powerful predictor of EF < 40%, with minimal additional value from clinical, exam, lab, and electrocardiographic variables. The time interval between clinical assessment and availability of formal echocardiographic results was 22 ± 17 hours.

Conclusions: Residents with limited training in cardiac ultrasound were able to identify LVSD in patients with acute decompensated heart failure with superior accuracy compared with clinical, physical exam, lab, and electrocardiographic findings and an average of 22 hours before the results of formal echocardiography were available. (J Am Soc Echocardiogr 2011;24:1319-24.)

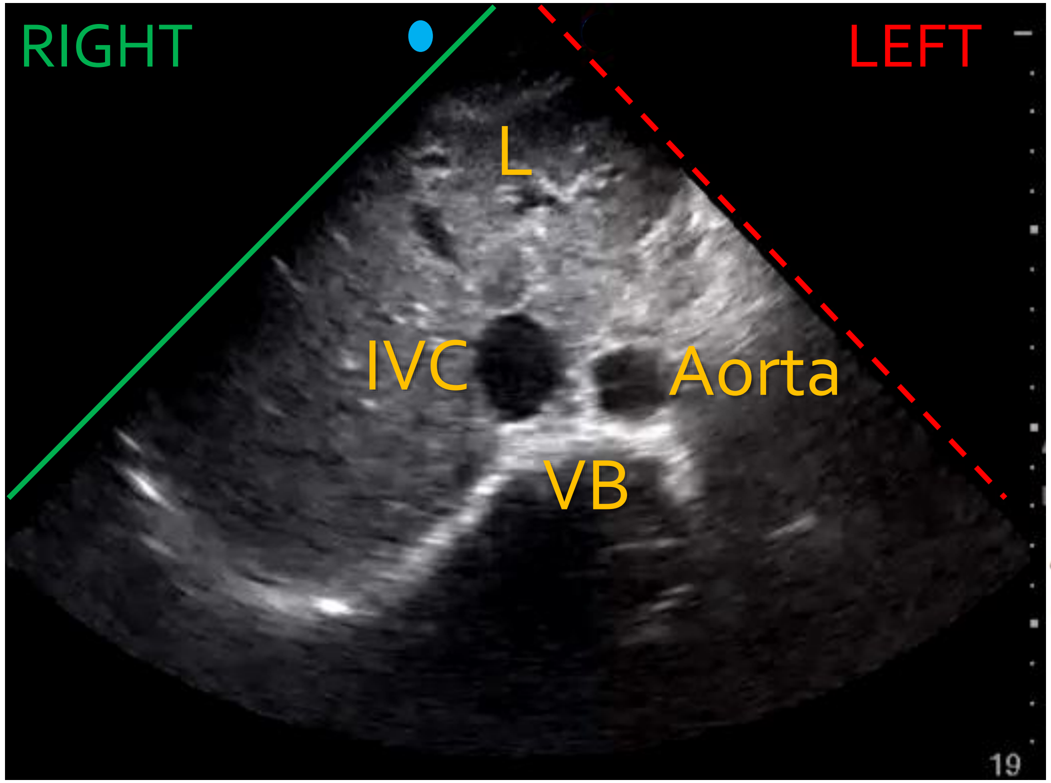
Inferior Vena Cava

How To/Key Concepts

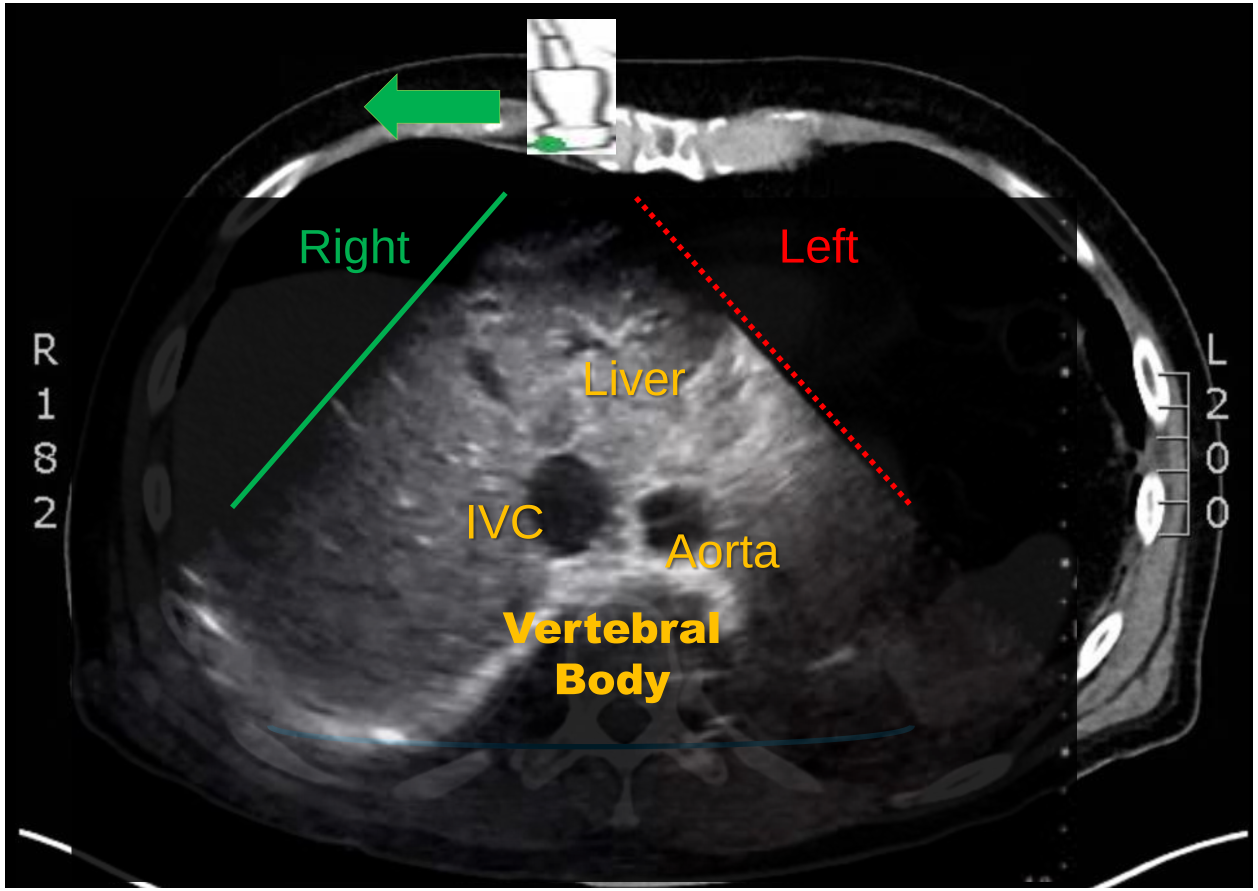
1. Find the LIVER first, then IVC
2. Alternative strategy to start from subxiphoid view and fan caudally from RA
3. View IVC in short and long axis
4. Assess size and collapsibility 2 cm from RA junction
5. Stick with 1 convention to train your eye- non-cardiology or cardiology

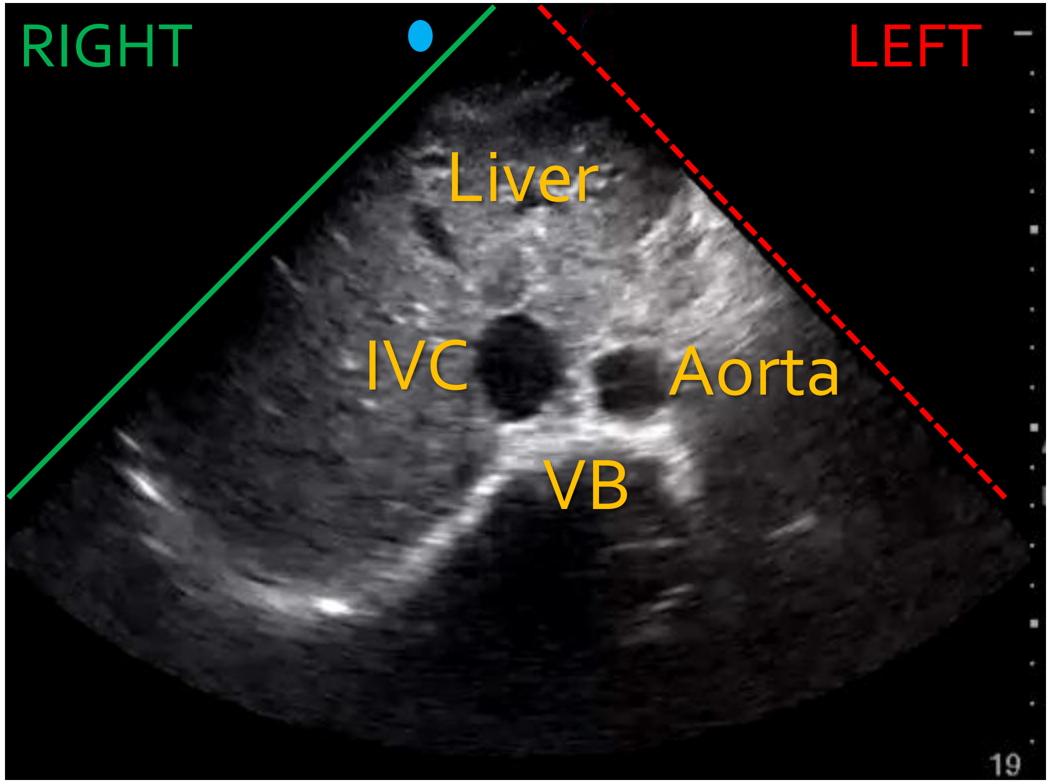
Inferior Vena Cava- Transverse

- Probe Marker:
  - Pt Right (abdominal preset)
  - Pt Left (cardiac preset)
- Plane: Transverse
- Key Landmarks
  - Liver
  - Vertebral Bodies
  - IVC
  - Aorta

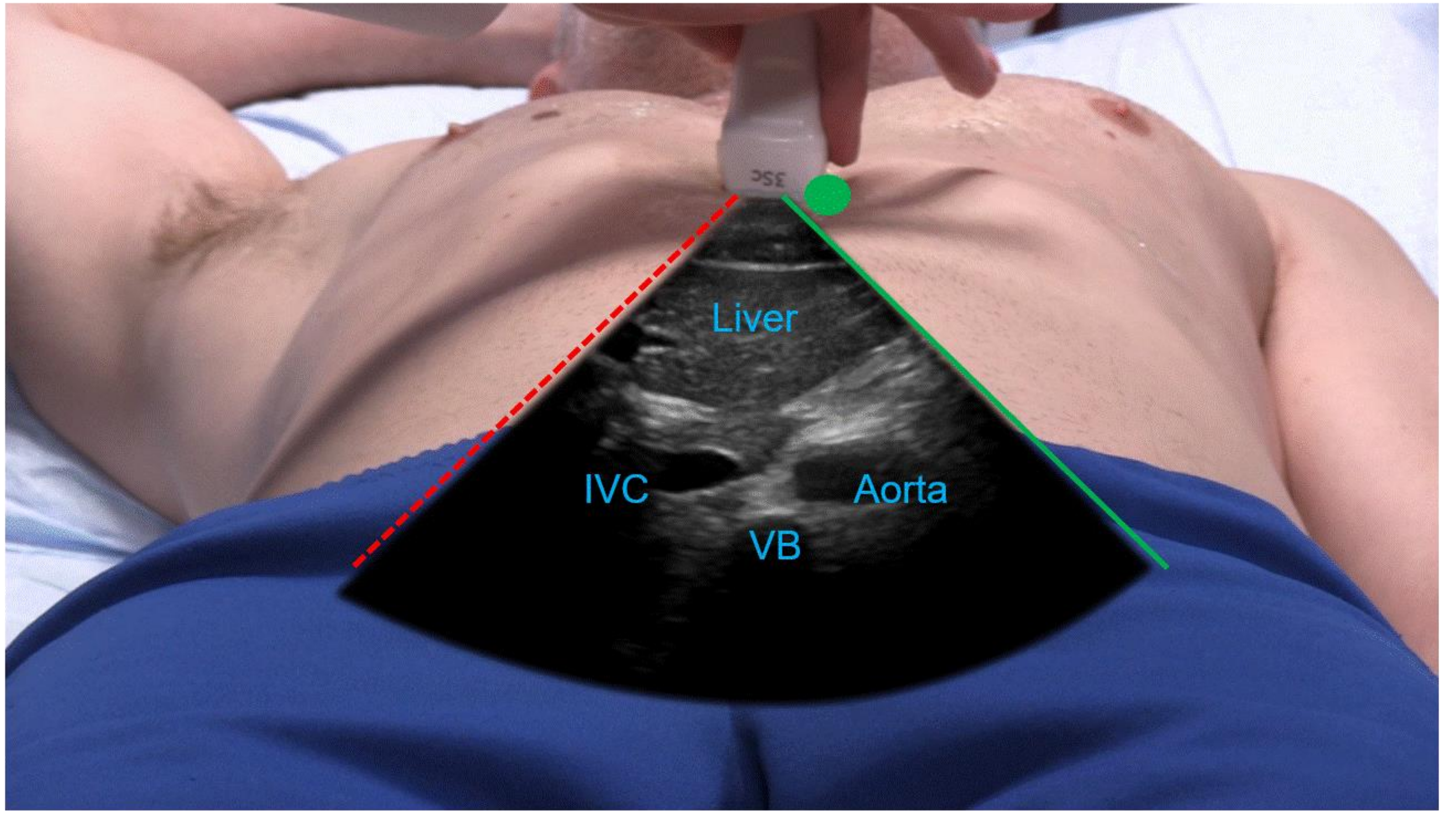


IVC- Transverse Plane



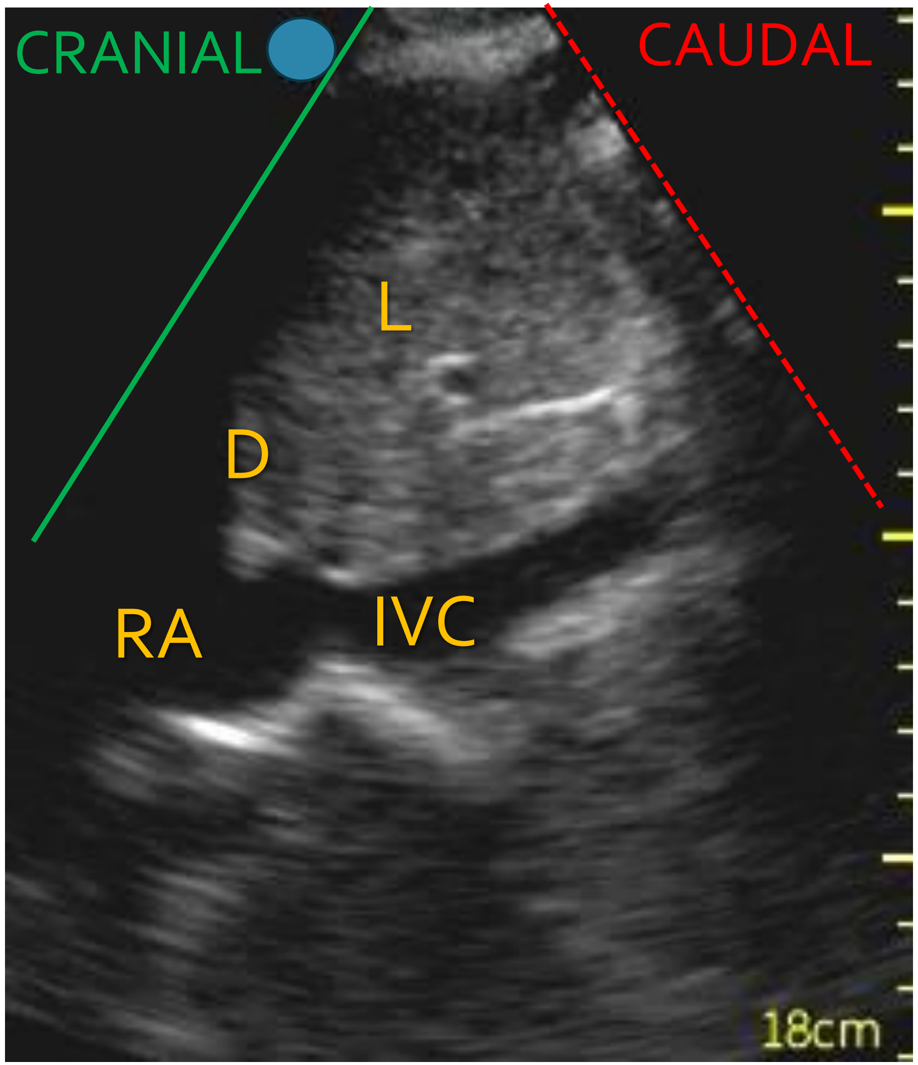


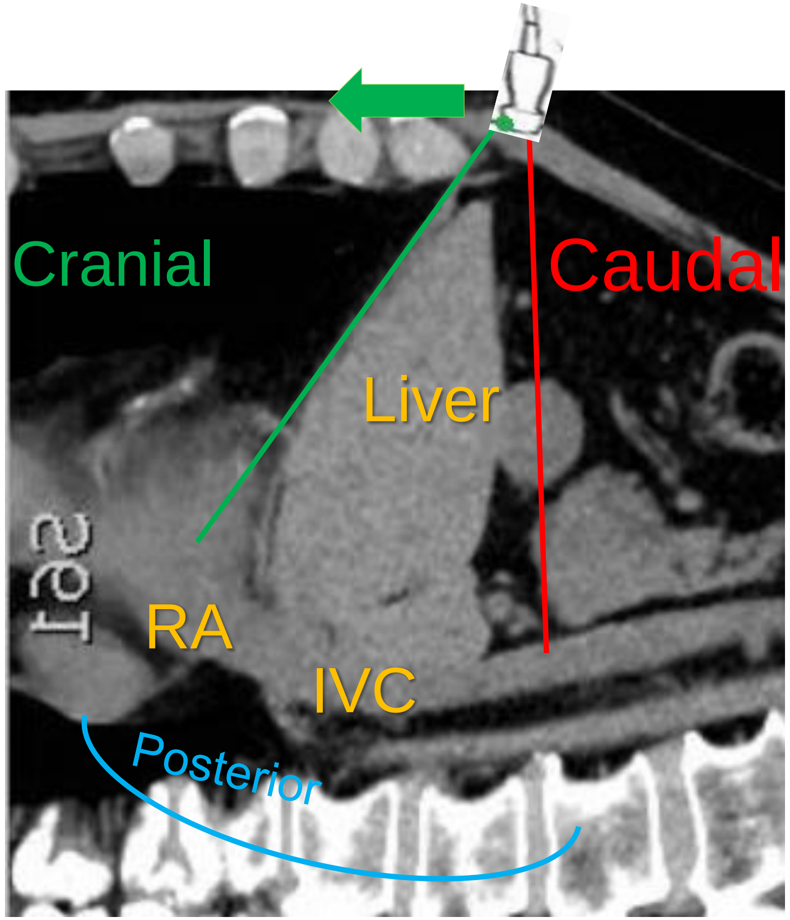
IVC – Probe Position and Orientation (cardiac preset)

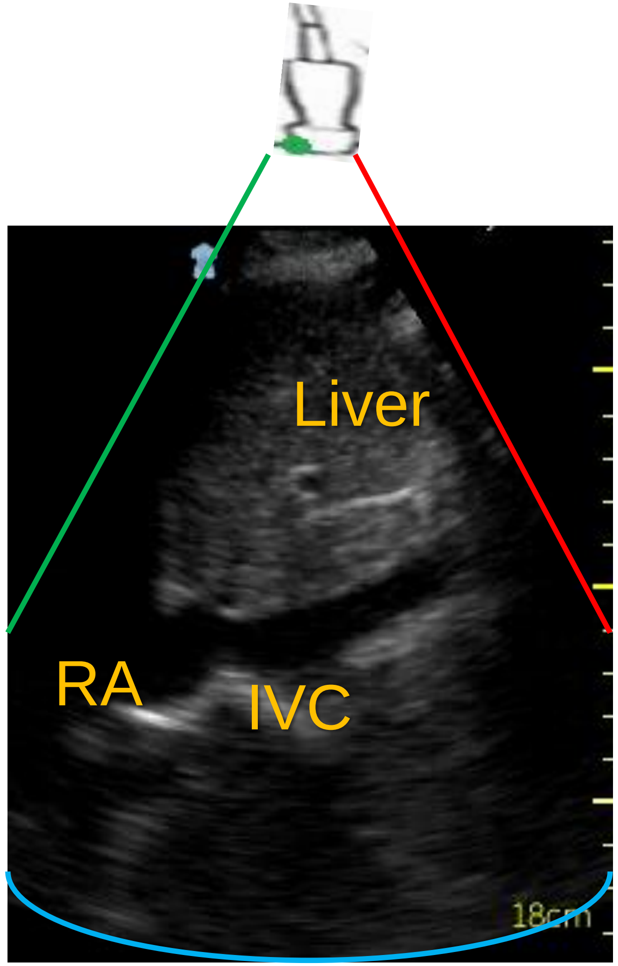


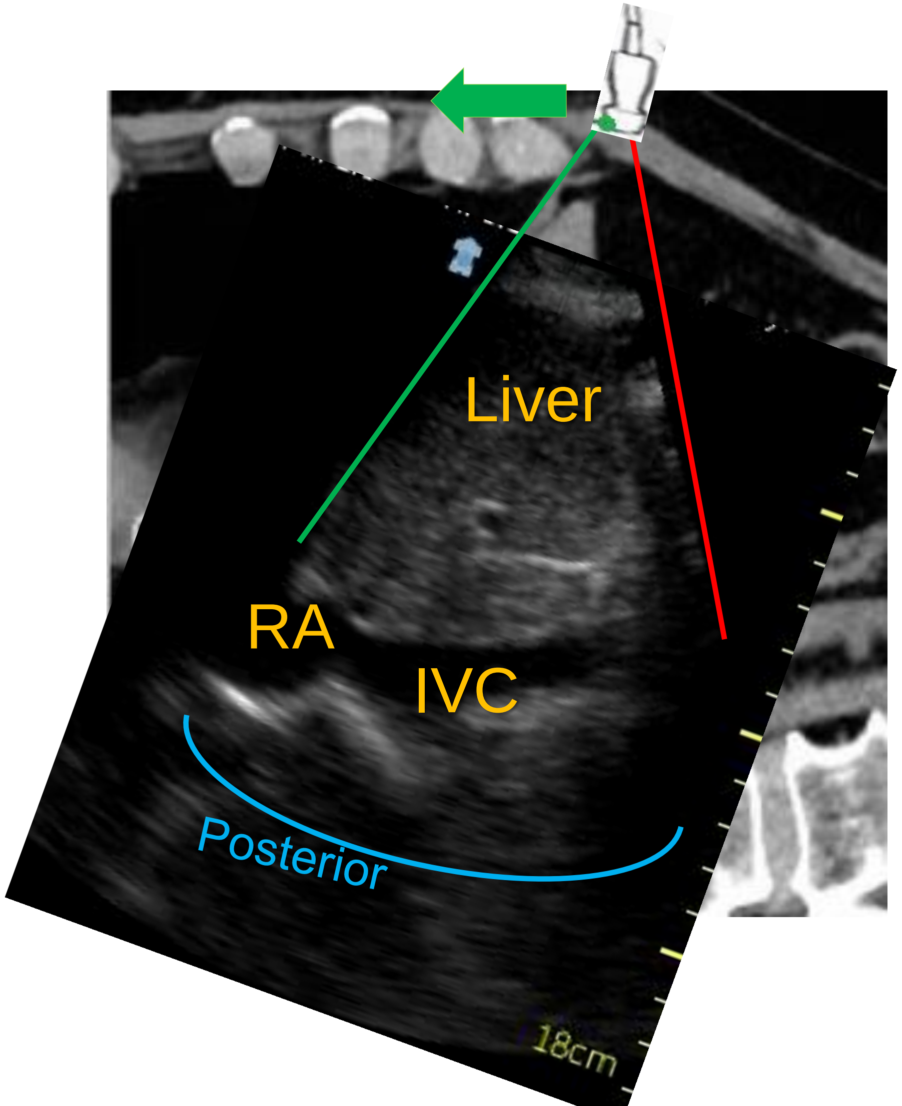
Inferior Vena Cava- Sagittal (abdominal preset)

- Probe Marker:
  - Pt’s HEAD
- Plane: Sagittal
- Key Landmarks
  - Liver
  - IVC
  - Diaphragm
  - Right Atrium

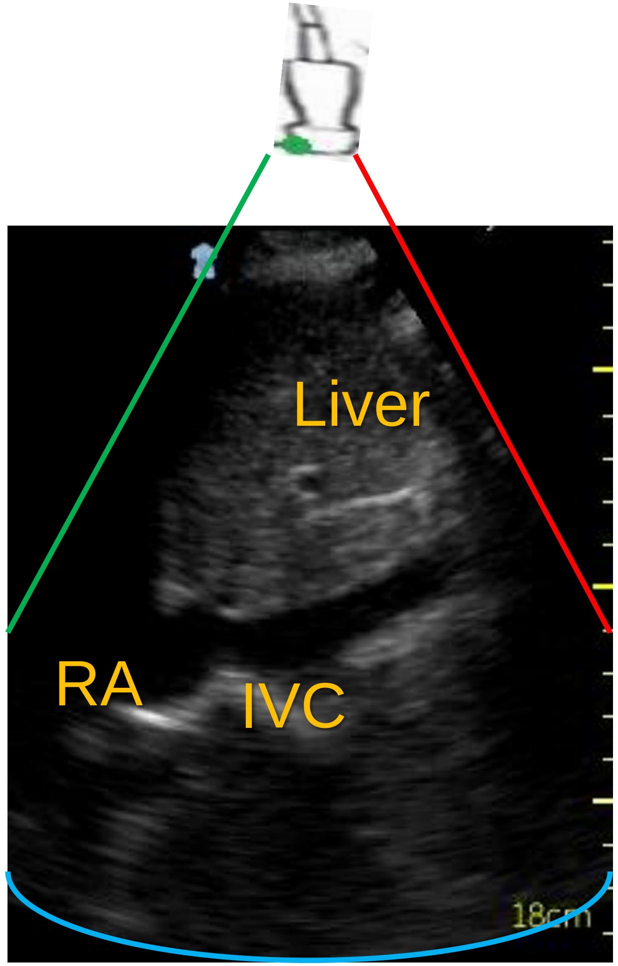



Cranial
Caudal
Liver
RA
IVC
Posterior


Liver
RA
IVC
18cm

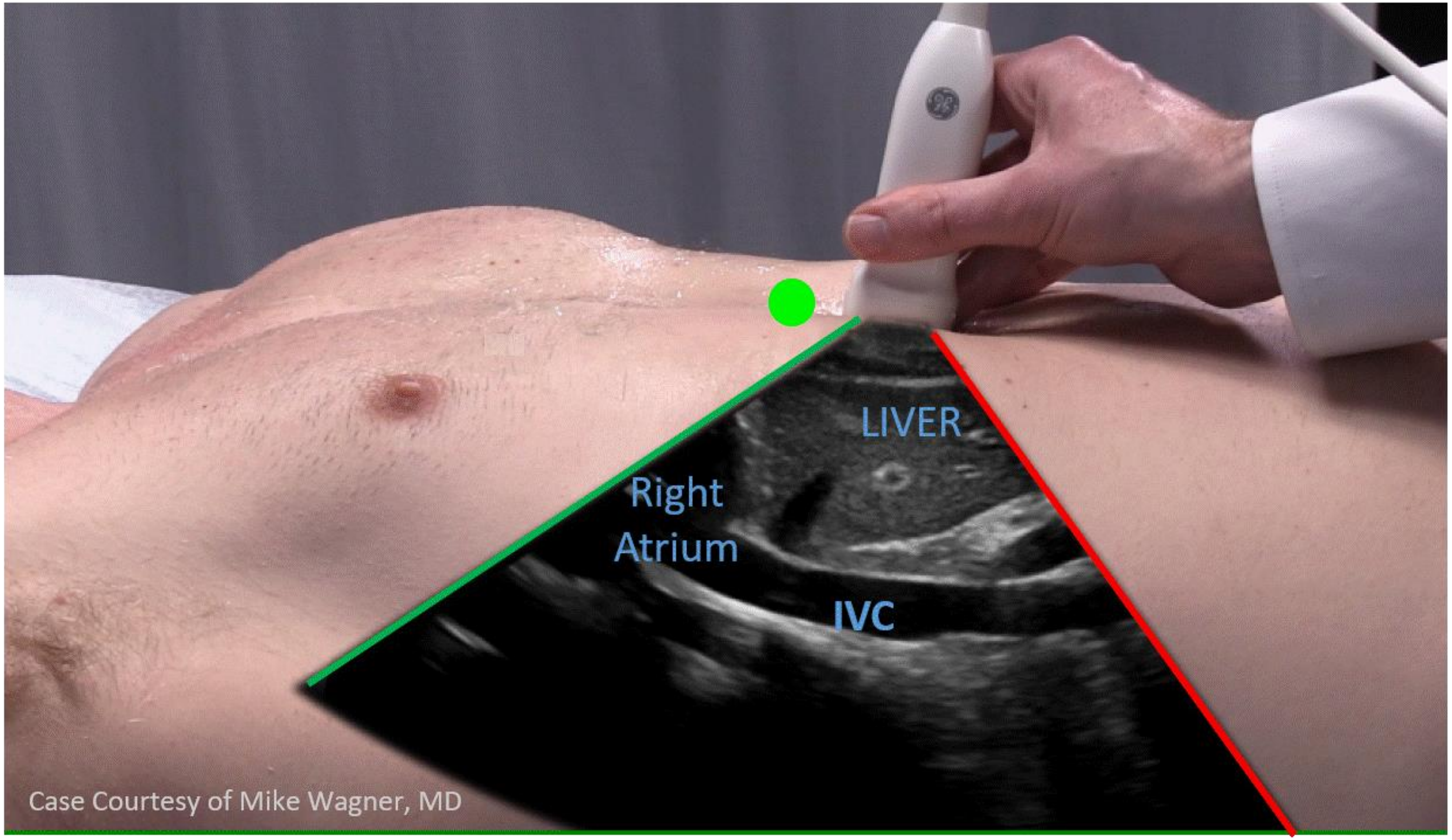


Liver
RA
IVC
Posterior
18cm



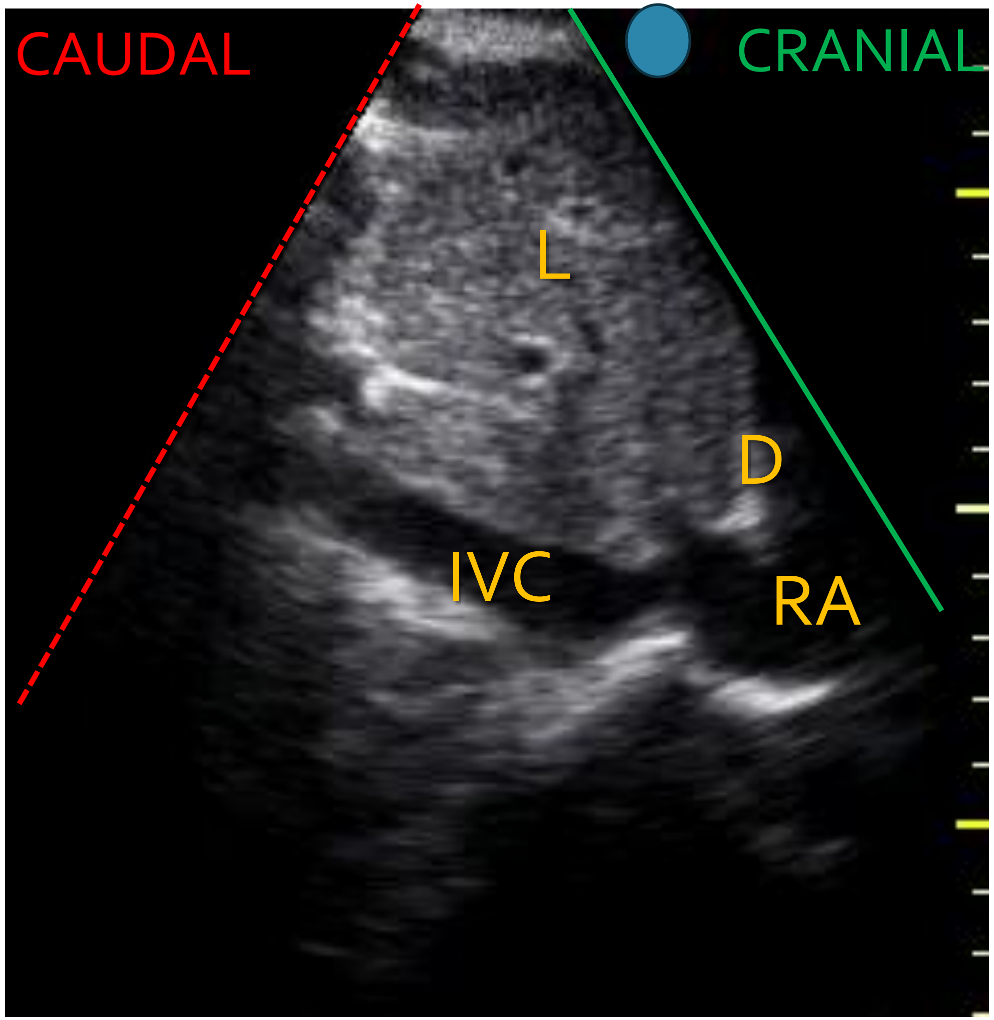
Liver
RA
IVC
18cm

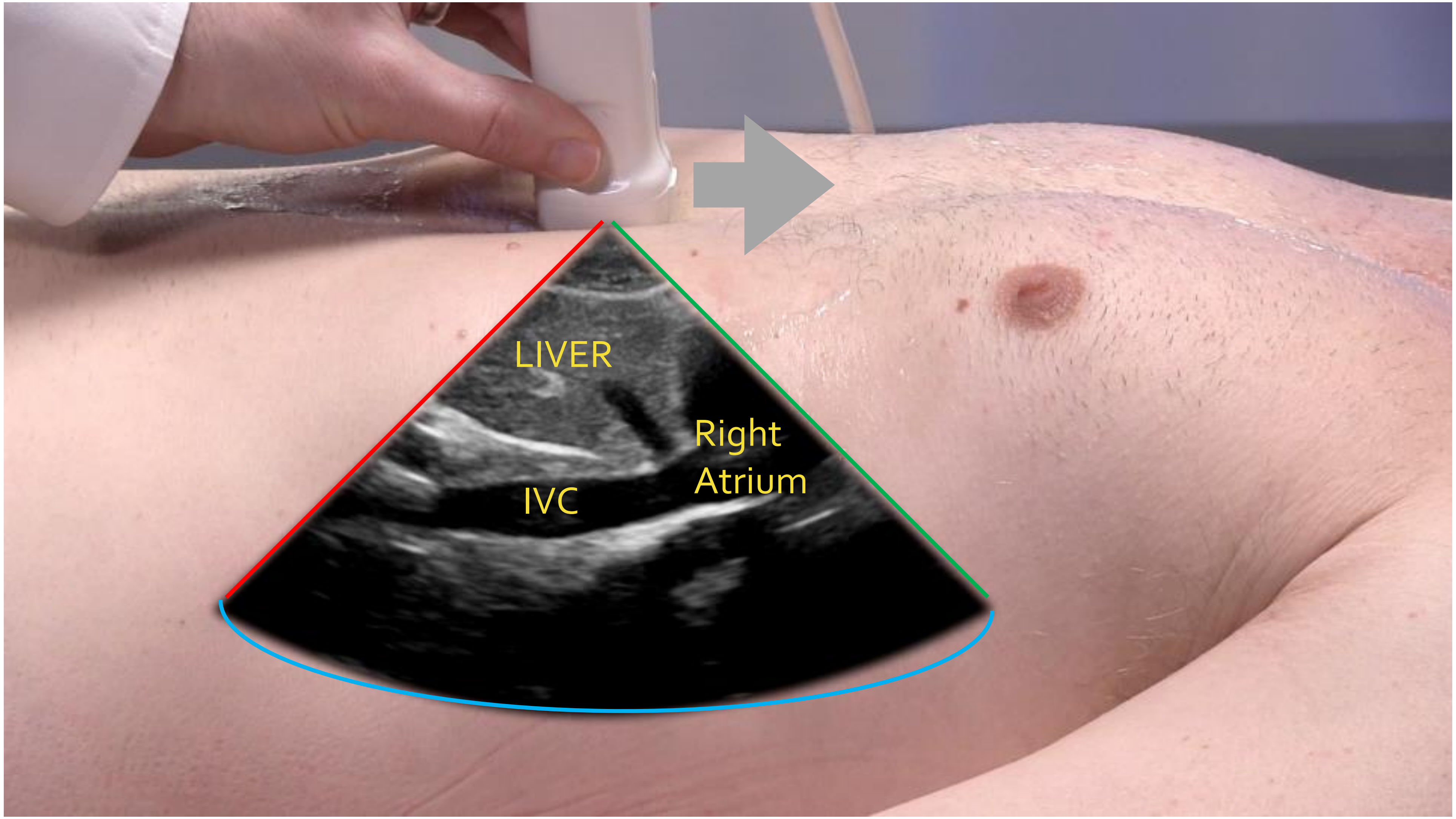
IVC – Probe Position and Orientation



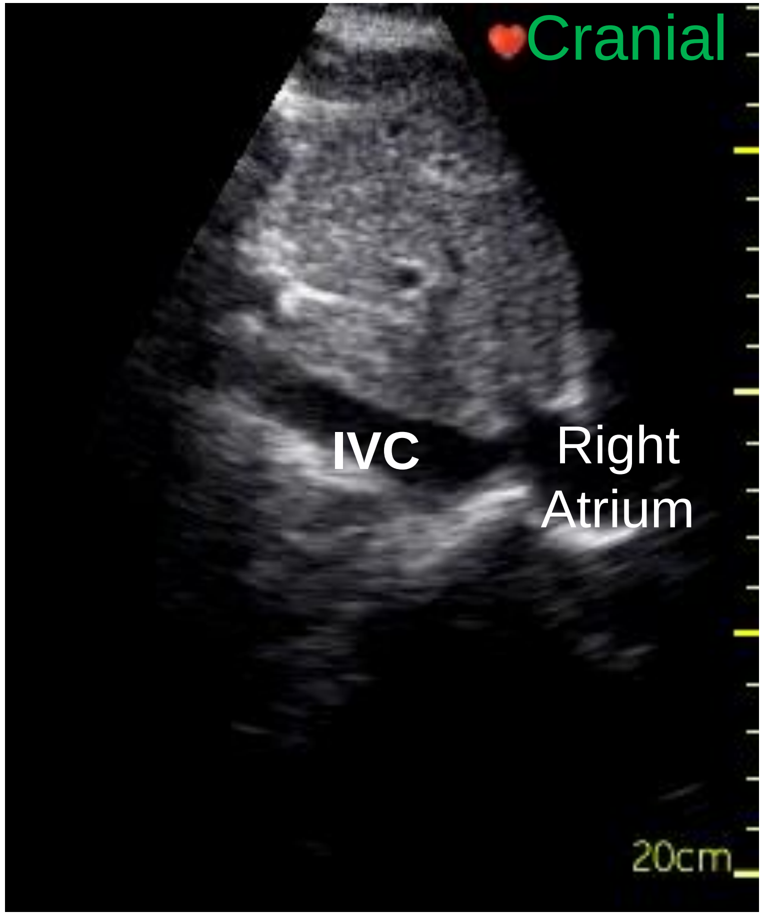
Inferior Vena Cava- Sagittal (cardiac)

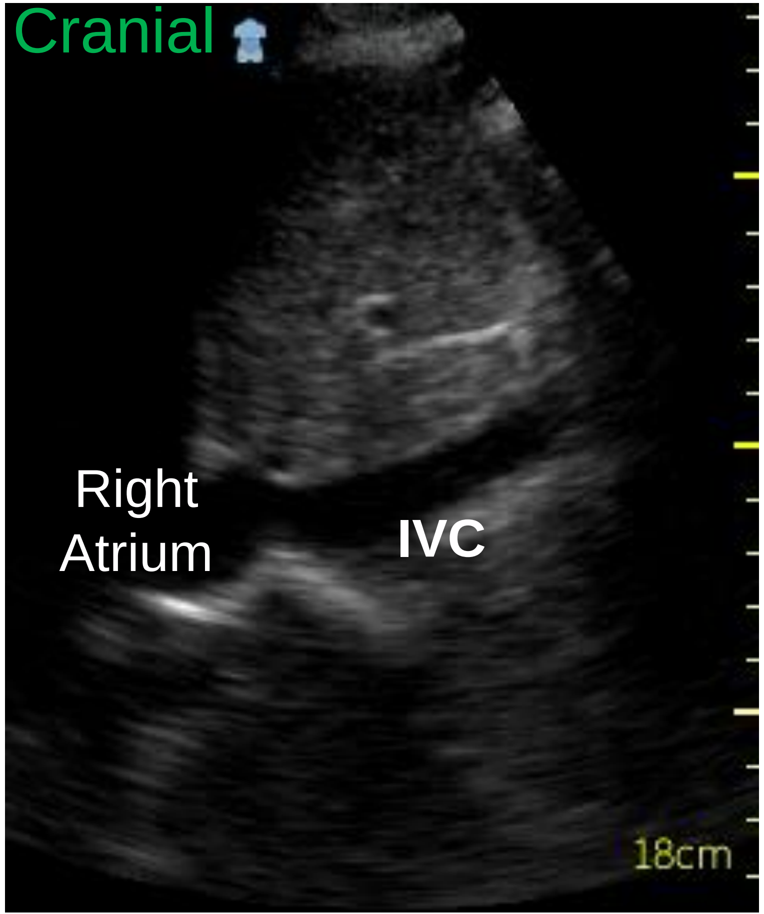
- Probe Marker:
  - Pt's HEAD (cardiac and abdominal preset)
- Plane: Sagittal
- Key Landmarks
  - Liver
  - IVC
  - Diaphragm
  - RA




LIVER
Right Atrium
IVC

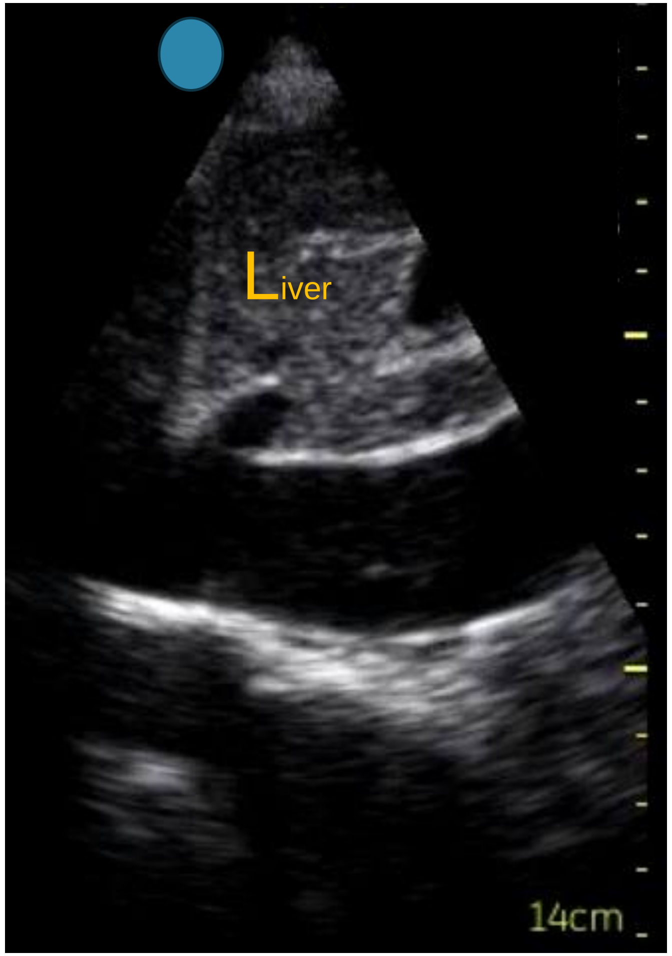
IVC- Longitudinal (cards vs rads)



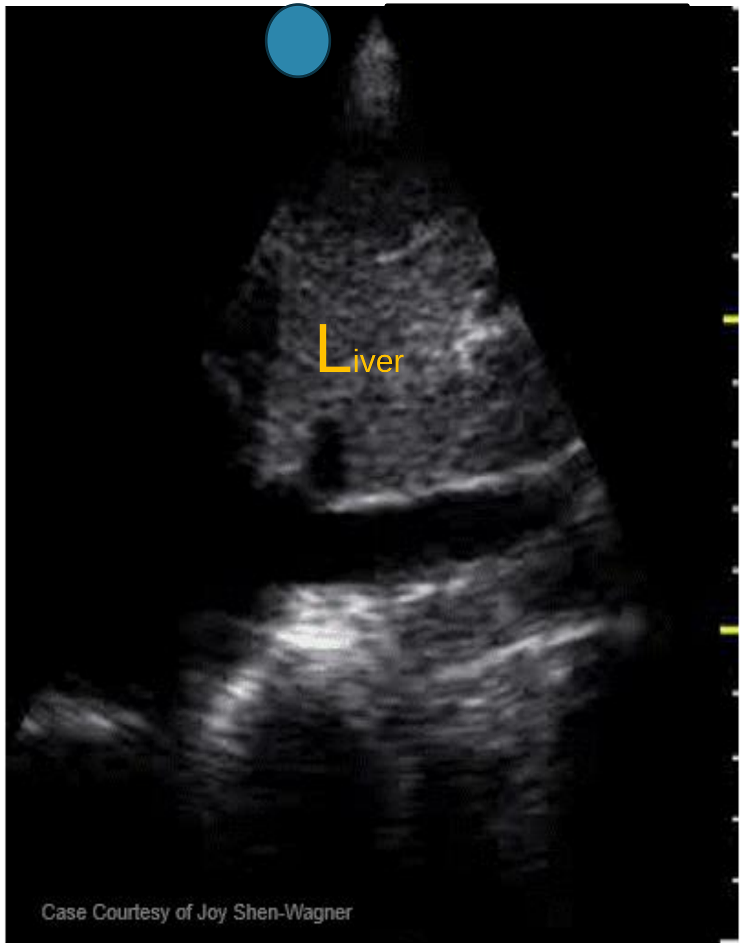


IVC- Sagittal (Abdominal Preset)

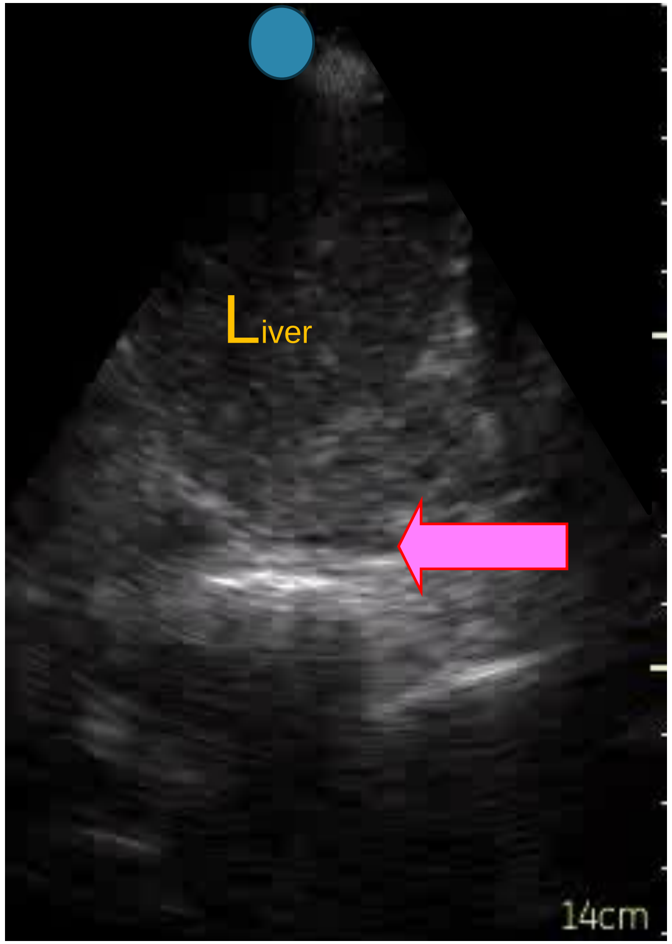
Plethoric



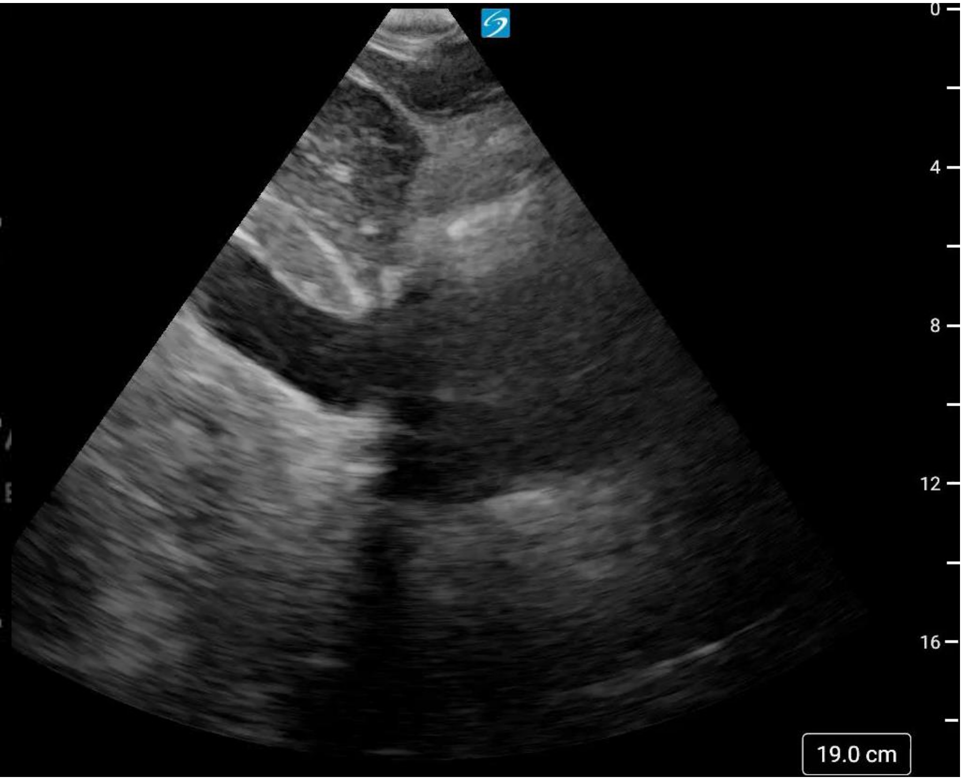
Normal



Small



IVC Sagittal- Pathology (Cardiac Preset)



IVC and RA pressure (site)

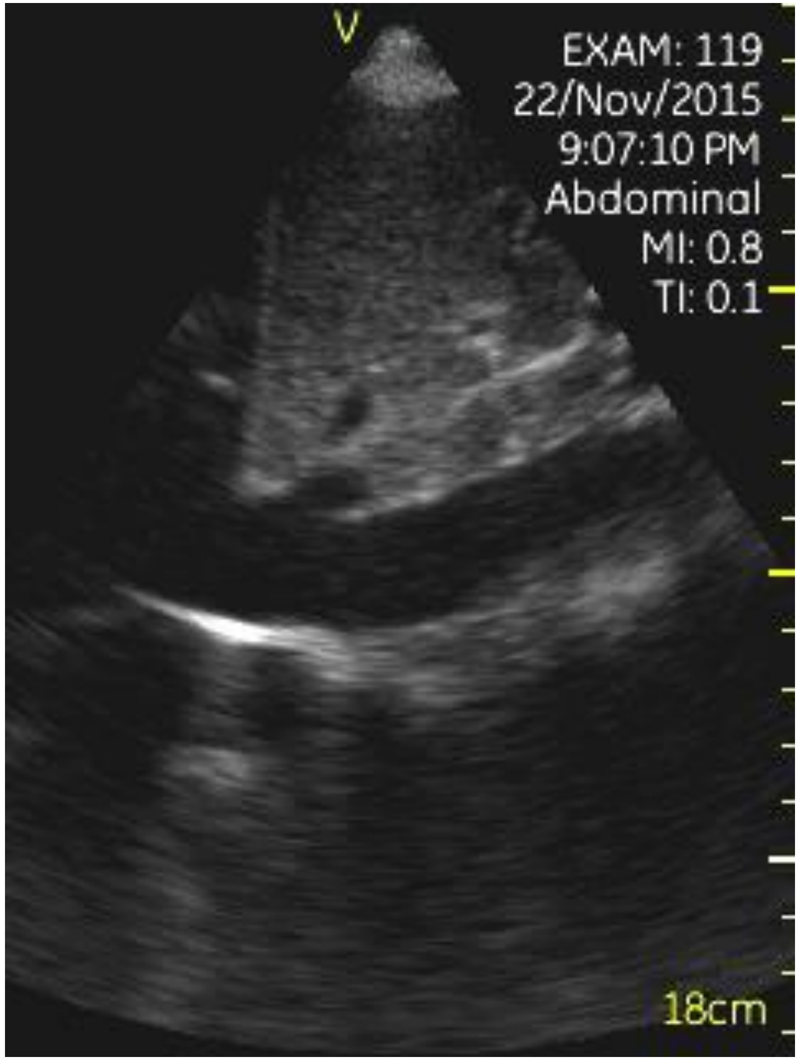
Table 3 Estimation of RA pressure on the basis of IVC diameter and collapse

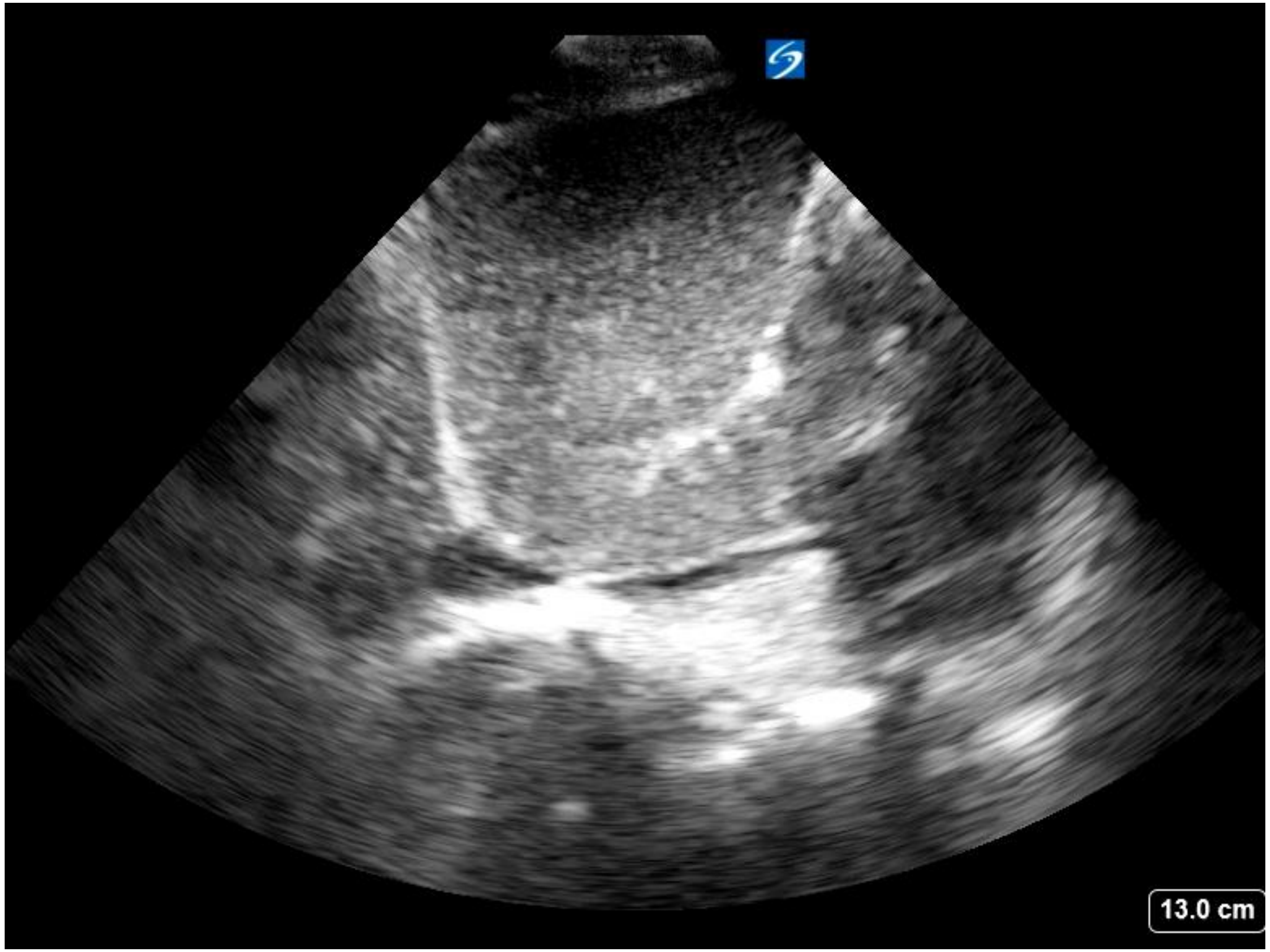
Variable	Normal (0-5 [3] mm Hg)	Intermediate (5-10 [8] mm Hg)		High (15 mm Hg)
IVC diameter	≤2.1 cm	≤2.1 cm	>2.1 cm	>2.1 cm
Collapse with sniff	>50%	<50%	>50%	<50%
Secondary indices of elevated RA pressure				• Restrictive filling • Tricuspid E/E′ > 6 • Diastolic flow predominance in hepatic veins (systolic filling fraction < 55%)

Ranges are provided for low and intermediate categories, but for simplicity, midrange values of 3 mm Hg for normal and 8 mm Hg for intermediate are suggested. Intermediate (8 mm Hg) RA pressures may be downgraded to normal (3 mm Hg) if no secondary indices of elevated RA pressure are present, upgraded to high if minimal collapse with sniff (<35%) and secondary indices of elevated RA pressure are present, or left at 8 mm Hg if uncertain.
IVC, Inferior vena cava; *RA*, right atrial.

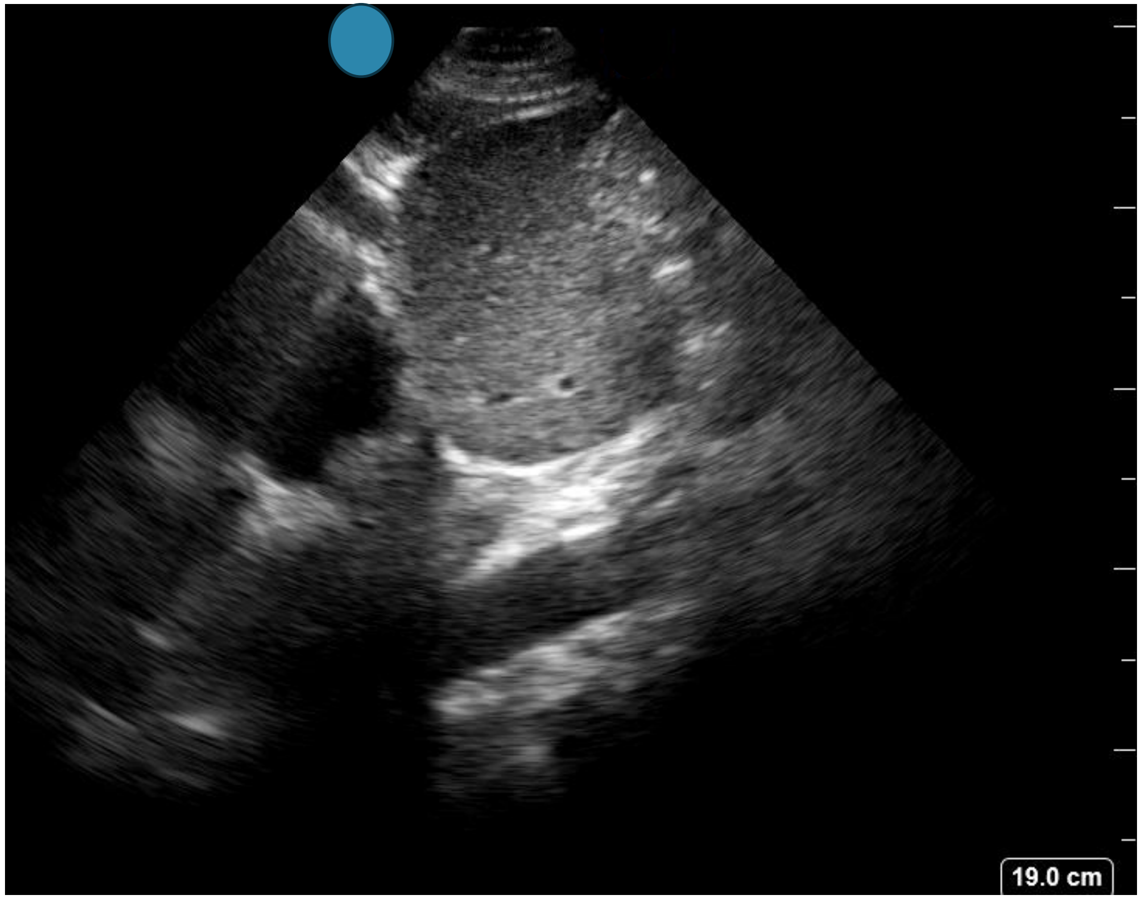
De Vecchis, Renato et al. “Estimating Right Atrial Pressure Using Ultrasounds: An Old Issue Revisited With New Methods.” *Journal of clinical medicine research* vol. 8,8 (2016): 569-74. doi:10.14740/jocmr2617w

Before and after diuresis/CHF treatment



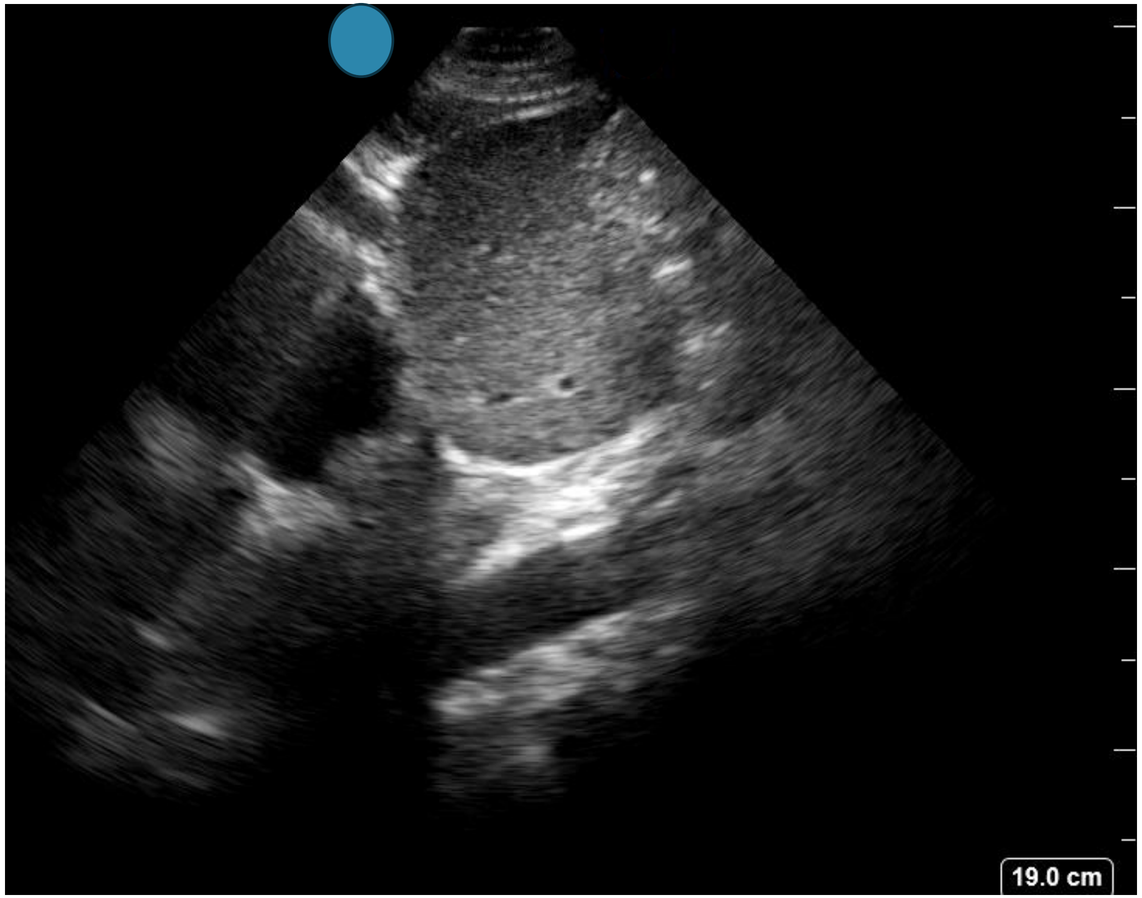

13.0 cm

“Does this patient have a plethoric IVC?”

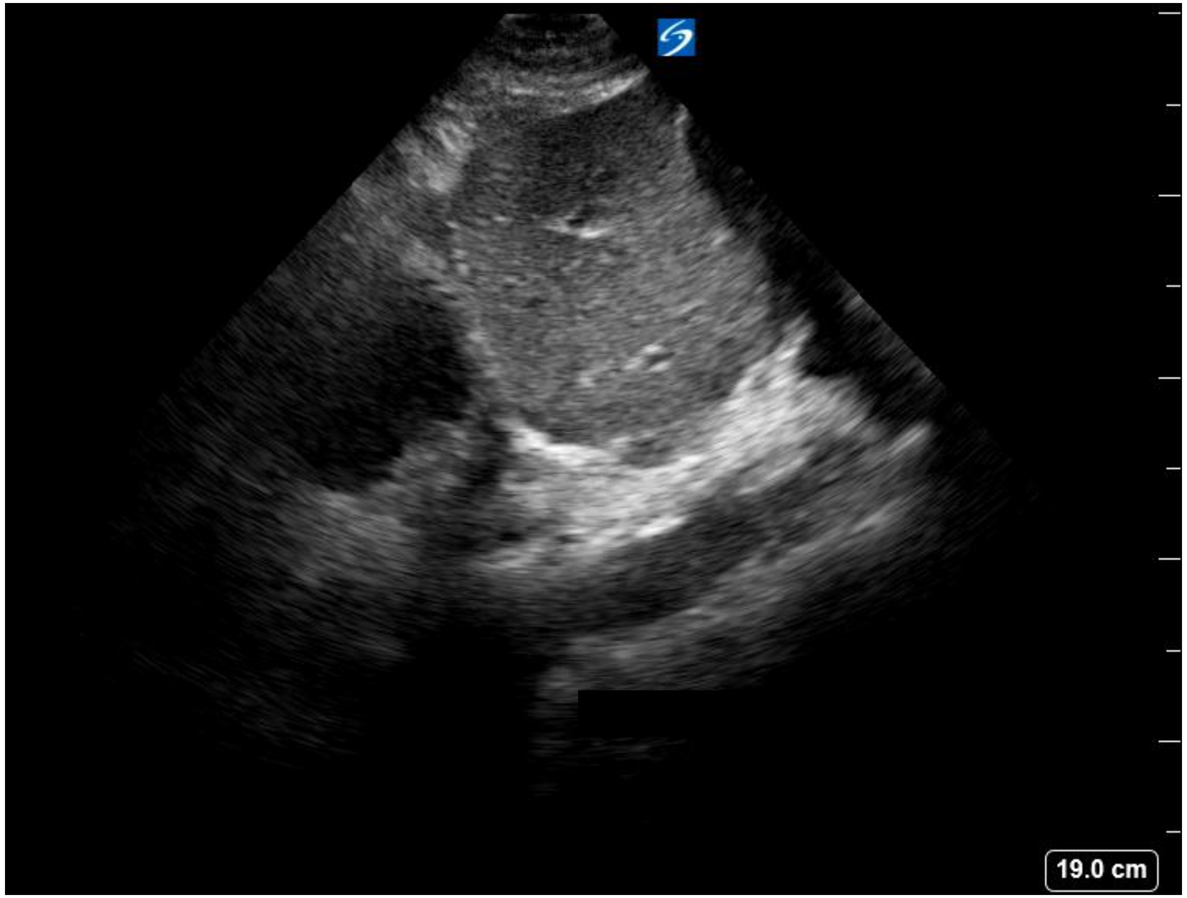


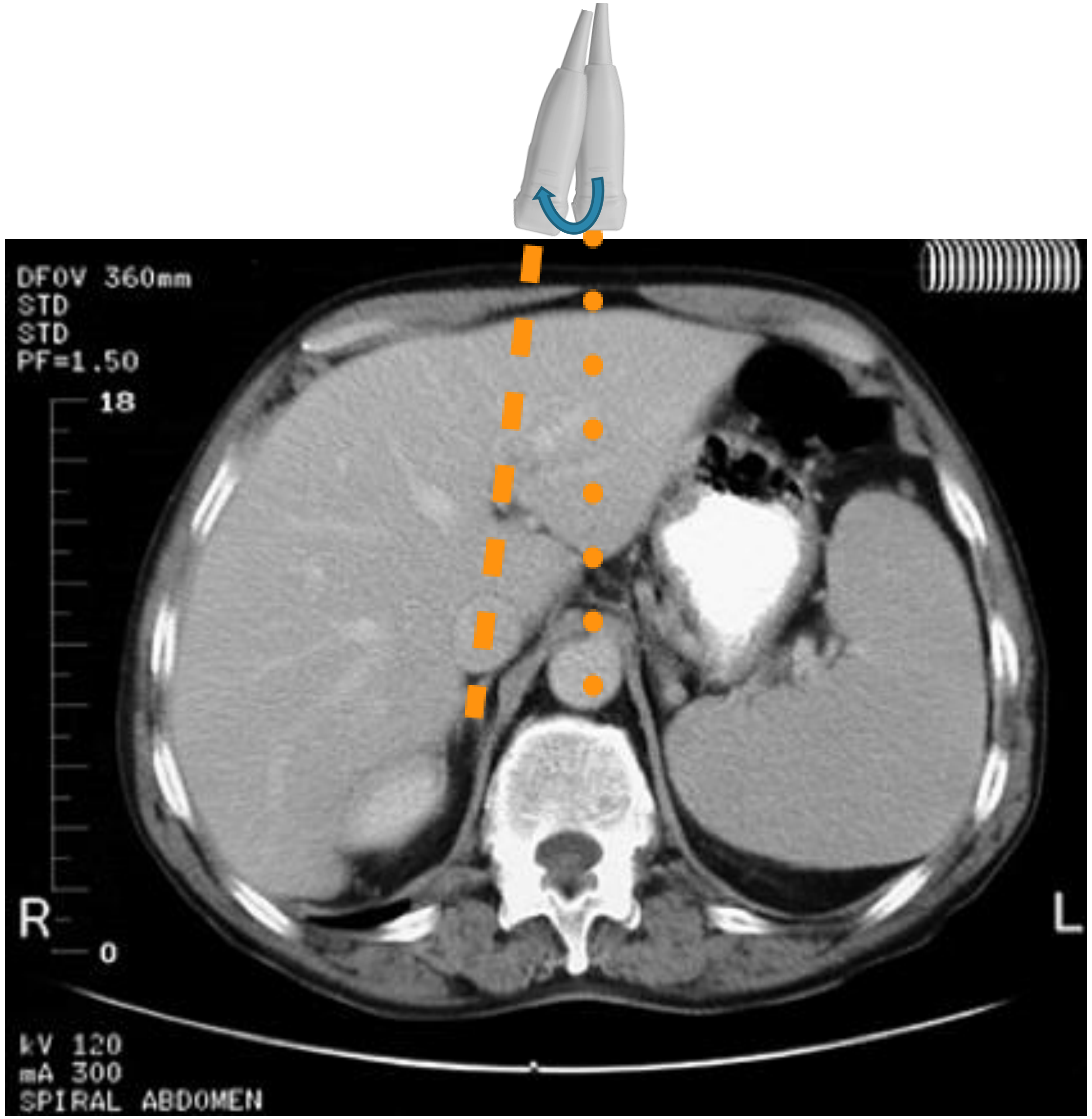
A. You can’t tell based on this image.
B. I can’t tell that based on *any* image!
C. Yes, IVC size looks big and I don’t see good respiratory variation.
D. No, size looks ok and I see good respiratory variation.

“Does this patient have a plethoric IVC?”

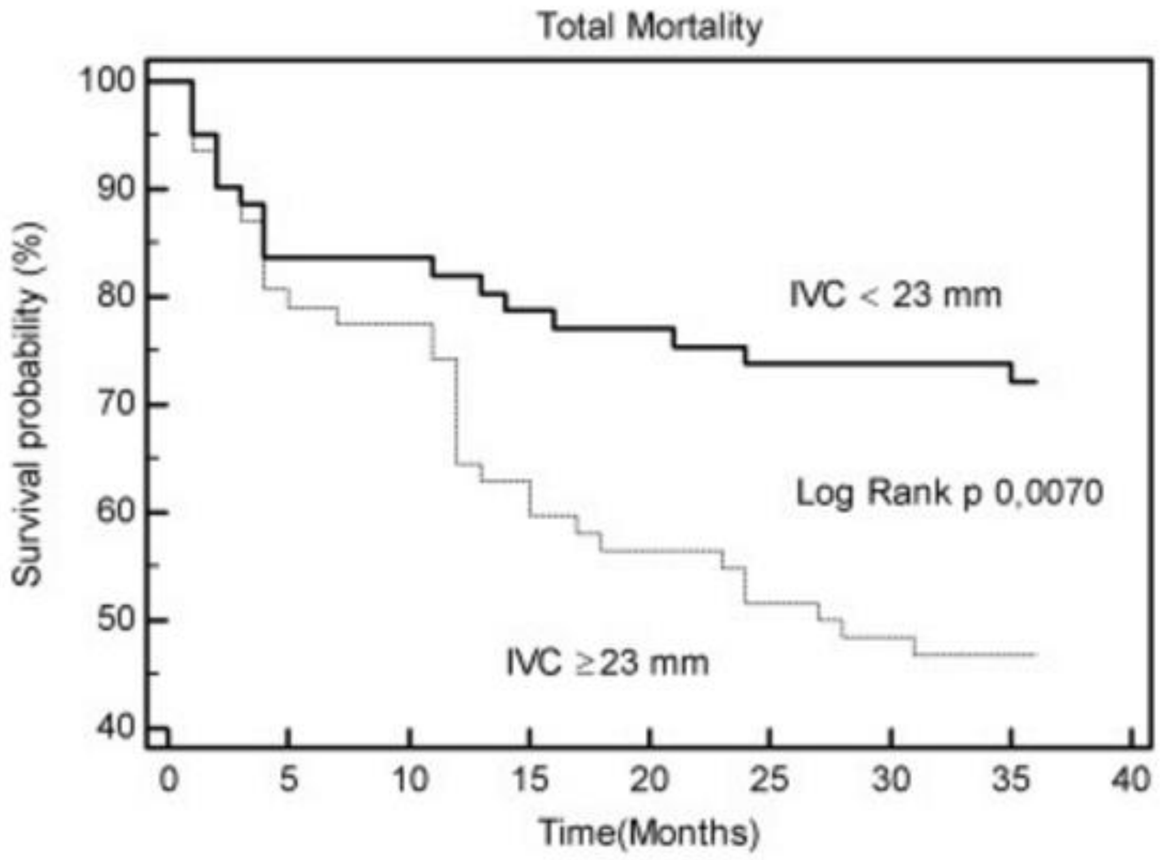


A. **You can’t tell based on this image.**
B. I can’t tell that based on any image!
C. Yes, IVC size looks big and I don’t see good respiratory variation.
D. No, size looks ok and I see good respiratory variation.


19.0 cm


DFOV 360mm
STD
STD
PF=1.50
18
R
0
L
kV 120
mA 300
SPIRAL ABDOMEN

Evidence for IVC POCUS



Bed-side inferior vena cava diameter and mean arterial pressure predict long-term mortality in hospitalized patients with heart failure: 36 months of follow-up

Daniele Torres, Francesco Cuttitta *, Salvatore Paterna, Alessandro Garofano, Giosafat Conti, Antonio Pinto, Gaspare Parrinello

Eur J Intern Med. 2016 Mar;28:80-4.

IVC Interpretation Cautions

- IVC and Central Venous Pressure
- Anchoring bias towards Hypervolemia
- Consider a differential for dilated IVC with elevated CVP/RA pressures, look at the heart!
- IVC can be dilated in healthy patients with normal RA pressures

Pitfalls

- Confusing Aorta for IVC
- Off axis imaging (over or under estimating size)
- Using IVC in isolation for “volume status”
    - Not looking at heart, lungs, etc
    - Too much blind faith in IVC measurements

Evidence and Clinical Guidelines (SORT)

- Cardiac POCUS is useful to narrow the differential diagnosis in patients with undifferentiated shock- A
- Cardiac POCUS helps accurately detect and risk stratify patients with pericardial effusion- B
- Cardiac POCUS helps direct the management of patients with LV systolic dysfunction- B
- Cardiac POCUS is generally more accurate than the traditional physical exam for assessing LV systolic function- A
- Normal IVC size and respiratory variability is highly sensitive in excluding cardiac tamponade- B
- IVC size is associated with higher readmission risk and worse prognosis- B

Billing and Coding- Cardiac

https://www.cms.gov/medicare-coverage-database/view/article.aspx

accessed Jan/2024

CPT code: 93308 (Limited transthoracic echo)

Supportive ICD 10 codes:

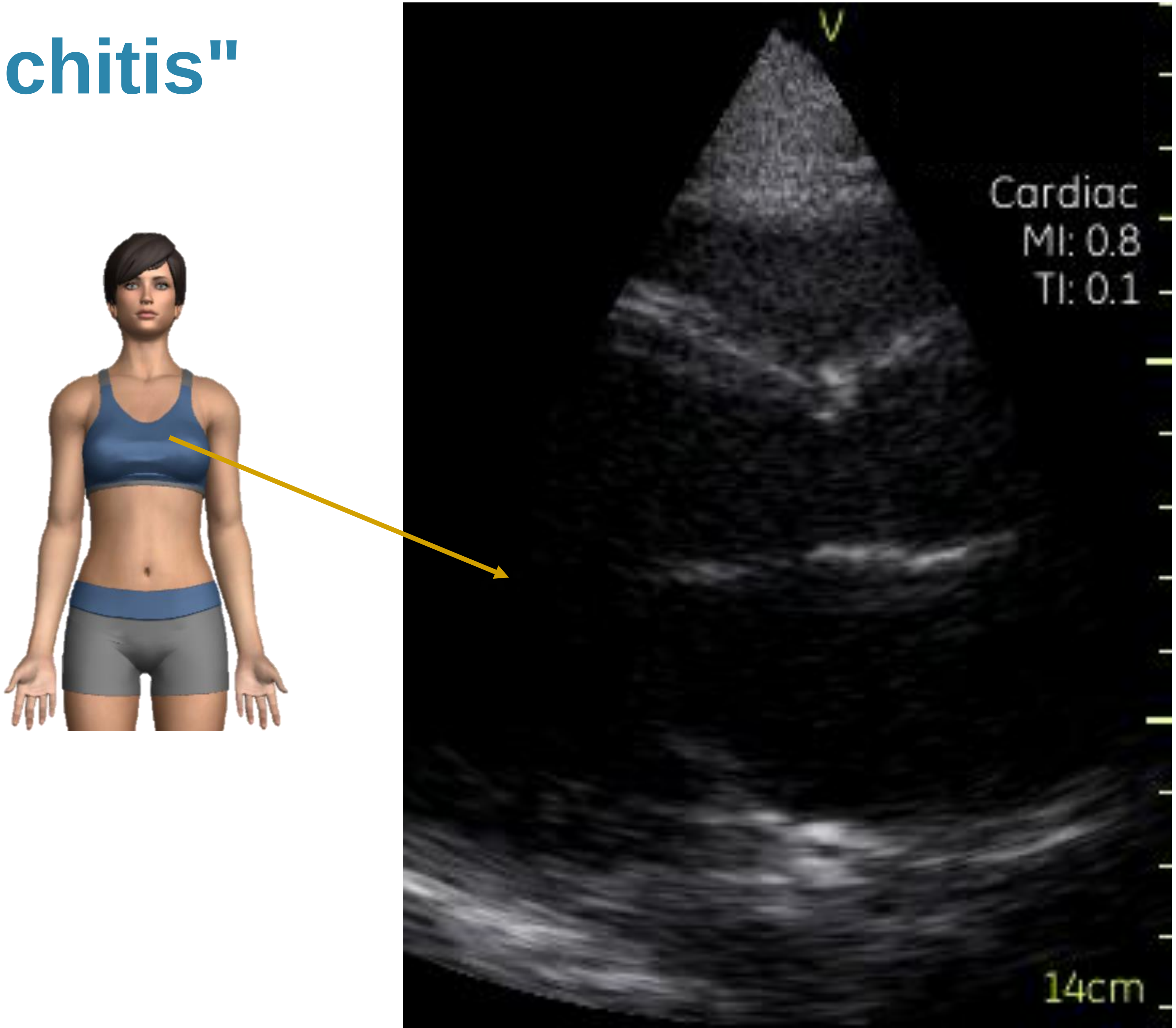
R06.00- Unspecified dyspnea

R07.9- Unspecified chest pain

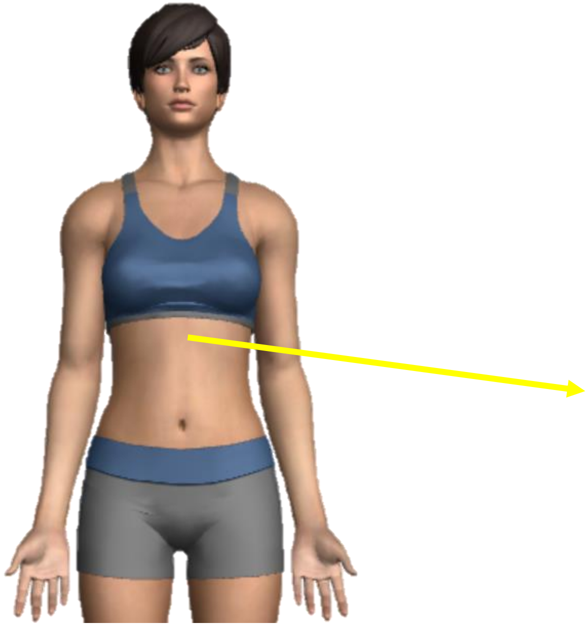
I95.9- Unspecified hypotension

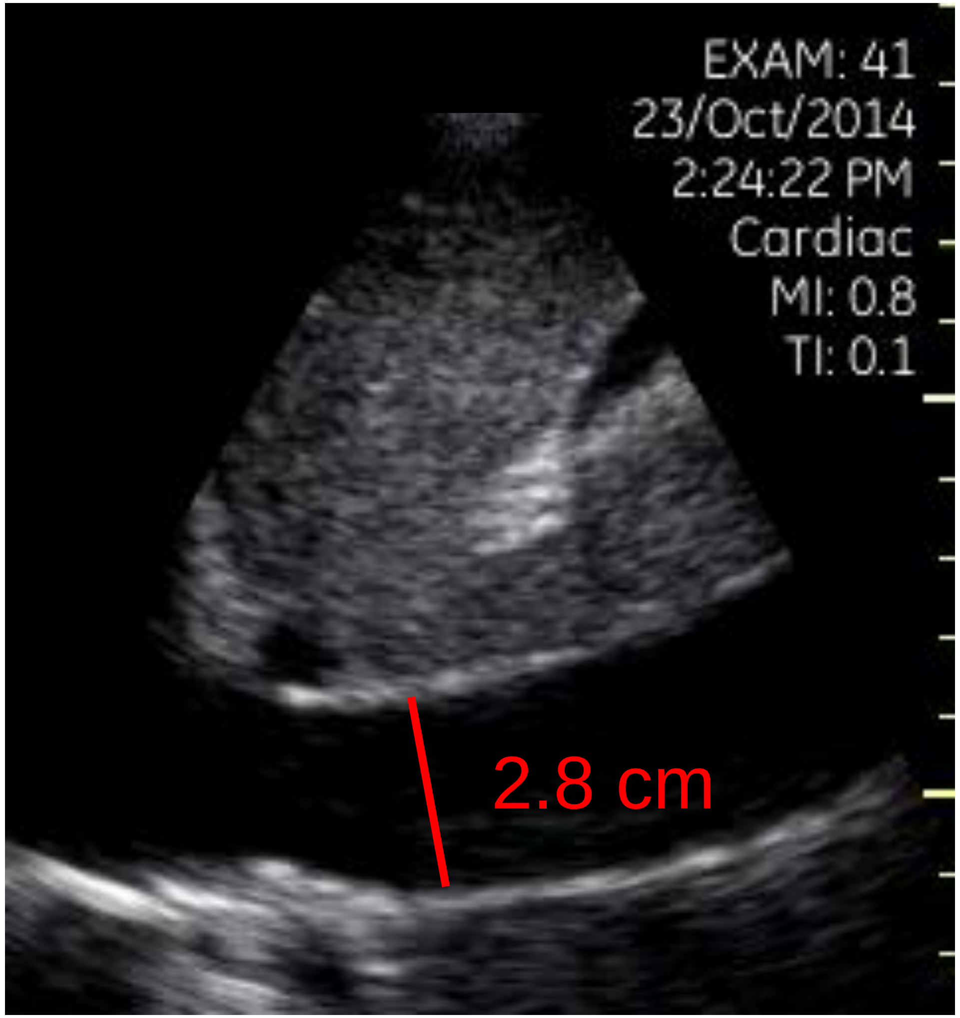
R55- Syncope and collapse

In the Clinic: "Bronchitis"



In the Clinic: "Bronchitis"





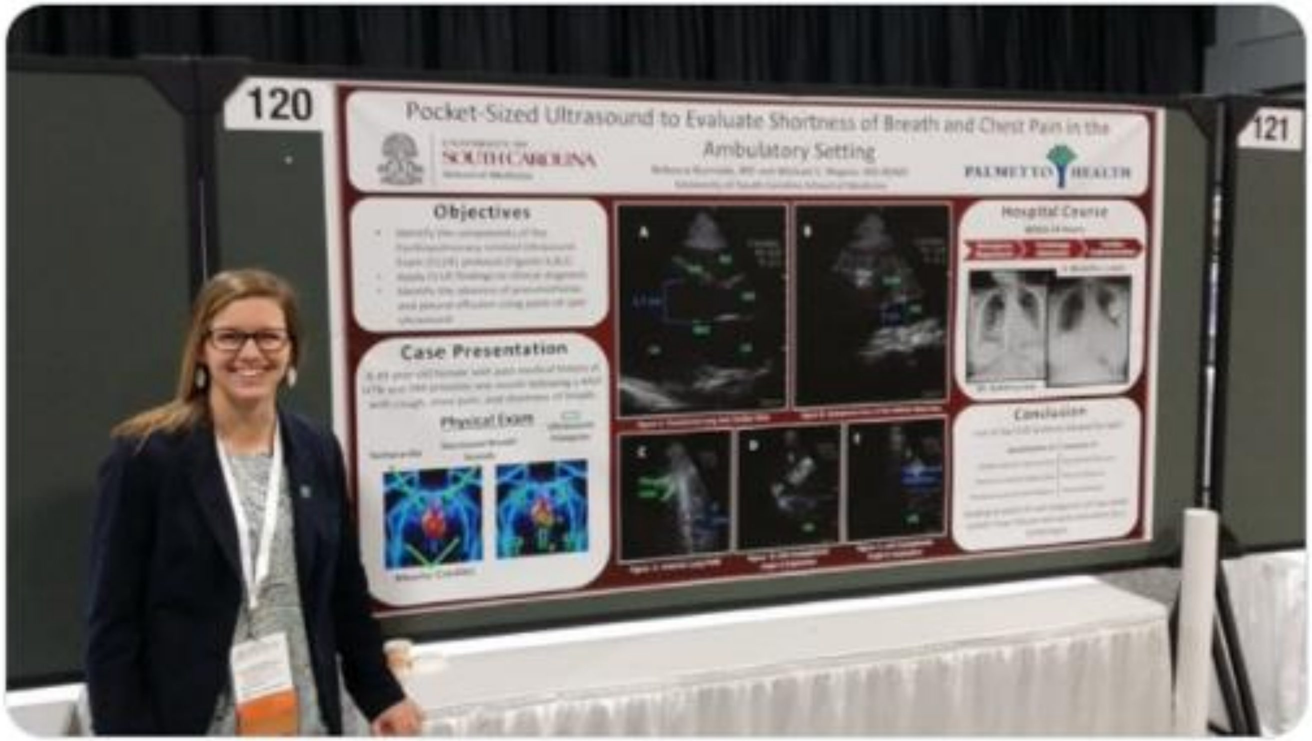
Case Resolution

- Hospital eval: bp 163/107, hr 110, 96%RA
- BNP 63, cTroponin and DDimer negative

- Cardiology- left heart catheterization
- Dx: Nonischemic Cardiomyopathy, severe Left Ventricular Systolic Dysfunction
  - ICD/pacemaker
  - Guideline Directed Medical Therapy
  - 4 months later, her ejection fraction had improved, symptoms were improved

Mike Wagner @SonoInternist · May 6, 2016

IM residents using pocket-sized #ultrasound 4 outpt dyspnea eval. Learn more at poster 120 today! #IMpocus #IM2016



10 14

Take Home Points

- Cardiac POCUS is a BIG topic with big impact- start small and easy
  - Pericardial effusions will be anechoic space between gray myocardium and white pericardium, with moderate effusions 1 cm posteriorly and large effusions seen circumferentially.
  - Severe LV systolic dysfunction – look for >1 cm of anterior mitral valve leaflet from interventricular septum
- IVC POCUS is a useful ADJUNCT impacted by CVP and intravascular volume, but other factors as well
- Look at multiple views before interpreting the IVC.
  - Generally measured in long axis for reproducibility

References

1. Via G et al. International evidence-based recommendations for focused cardiac ultrasound. J Am Soc Echocardiogr 2014; 27:683.e1–683.e33
2. Yoshida T et al. Diagnostic accuracy of point-of-care ultrasound for shock: A systematic review and meta-analysis. Crit Care 2023; 27:200.
3. Razi R et al. Bedside hand-carried ultrasound by internal medicine residents versus traditional clinical assessment for the identification of systolic dysfunction in patents admitted with decompensated heart failure. J. Am. Soc. Echocardior. 2011;24:1319–1324.
4. Johnson BK et al. Internal medicine point-of-care ultrasound assessment of left ventricular function correlates with formal echocardiography. J Clin Ultrasound 2016; 44:92–99
5. Torres D. Bed-Side Inferior Vena Cava Diameter and Mean Arterial Pressure Predict Long-Term Mortality in Hospitalized Patients with Heart Failure: 36 Months of Follow-Up. Eur. J. Intern. Med. 2016;28:80–84.

Thank you!

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Sonointernist@gmail.com

AAFP

AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

AAFP CME

Introduction to Lung Ultrasound

Joy Shen-Wagner, MD, FAAFP

Associate Professor, Department of Family Medicine

University of South Carolina School of Medicine – Greenville, SC

Disclosure Statement

It is the policy of the AAFP that all individuals in a position to control CME content disclose any relationships with ineligible companies upon nomination/invitation of participation. Disclosure documents are reviewed for potential relevant financial relationships. If relevant financial relationships are identified, mitigation strategies are agreed to prior to confirmation of participation. Only those participants who had no relevant financial relationships or who agreed to an identified mitigation process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Evaluate the evidence for using lung ultrasound in common pulmonary conditions (dyspnea, pleural effusion, pulmonary edema, pneumothorax and guidance for thoracentesis).
2. Describe the general principles of ultrasound equipment use, and artifact interpretation in lung ultrasound.
3. Develop beginner-level proficiency including basic probe positioning, image acquisition, image interpretation, and awareness of common pitfalls, to help guide therapeutic decisions.
4. Develop appropriate coding and documentation practices for lung ultrasound examinations.

What is Lung Ultrasound?

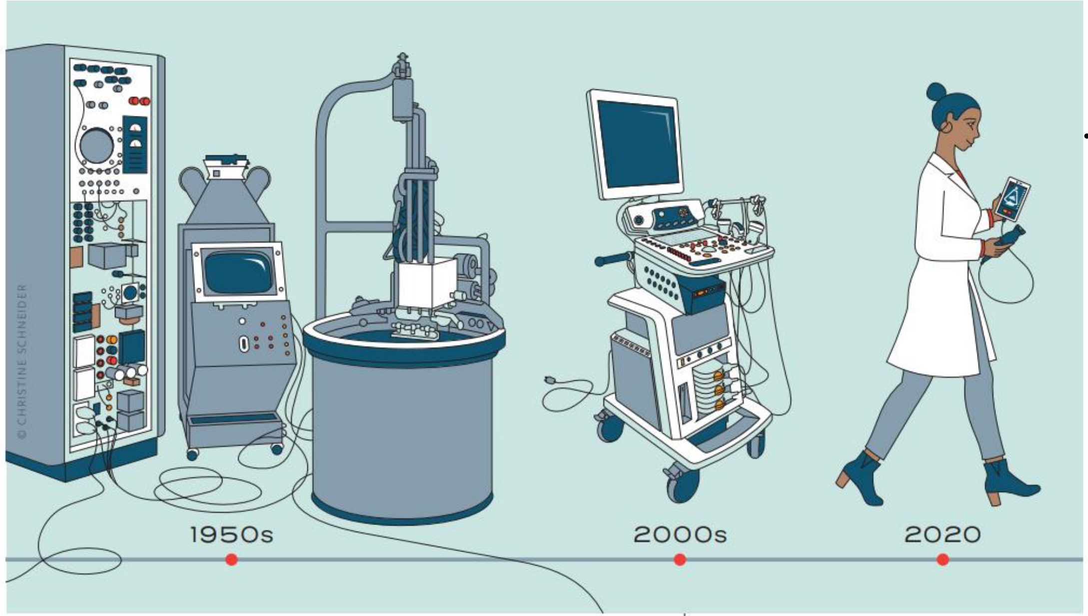
POINT-OF-CARE ULTRASOUND USES

POCUS uses	Scope of use	Example questions
Physical exam extension	Focused	"Is this palpable mass a cystic or solid structure?" "Is the baby in the cephalic or breech presentation?"
Procedural	Focused	"Where is the best location to insert a needle?" "Where is the foreign body?"
Diagnostic	Focused	"Are there stones in the gallbladder?" "Is there a pregnancy in the uterus?"
Multi-organ scans	Extended	"Is the patient's hypotension due to sepsis, heart failure, or acute blood loss?" "What is causing the patient's dyspnea?"

CME

JOY SHEN-WAGNER, MD, FAAFP, AND MARK DEUTCHMAN, MD, FAAFP

Point-of-Care Ultrasound: A Practical Guide for Primary Care



Shen-Wagner J, Deutchman M. Point-of-Care Ultrasound: A Practical Guide for Primary Care. Fam Pract Manag. 2020 Nov/Dec;27(6):33-40.

What is Lung Ultrasound?

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Multi-organ scans	Extended	"Is the patient's hypotension due to sepsis, heart failure, or acute blood loss?" "What is causing the patient's dyspnea?"

Shen-Wagner J, Deutchman M. Point-of-Care Ultrasound: A Practical Guide for Primary Care. Fam Pract Manag. 2020 Nov/Dec;27(6):33-40.

Are the crackles on auscultation due to pulmonary edema or fibrosis?

Does the patient need a thoracentesis? Where is the best location for needle insertion?

Is there a pleural effusion? Is the pleural effusion complex in characteristic? Is there a pneumothorax?

After looking at the heart, lung and IVC, what is causing the patient's dyspnea?

Indication

- Dyspnea Evaluation in Chest POCUS

Beginner/First

- Pleural effusion
- Pulmonary Edema
- Heart Failure vs COPD

Advanced/Next

- Needle Guidance in Thoracentesis
- Pneumothorax
- Lung consolidation/Pneumonia

Evidence for Lung Ultrasound

Intensive Care Med (1998) 24: 1331–1334
© Springer-Verlag 1998

BRIEF REPORT

D. Lichtenstein
G. Mezière

A lung ultrasound sign allowing bedside distinction between pulmonary edema and COPD: the comet-tail artifact

Intensive Care Med (2012) 38:577–591
DOI 10.1007/s00134-012-2513-4

CONFERENCE REPORTS AND EXPERT PANEL

Giovanni Volpicelli
Mahmoud Elbarbary
Michael Blaivas
Daniel A. Lichtenstein
Gebhard Mathis

International evidence-based recommendations for point-of-care lung ultrasound

JACC Cardiovasc Imaging. 2010 Jun;3(6):586-94. doi: 10.1016/j.jcmg.2010.02.005.

Detection of pulmonary congestion by chest ultrasound in dialysis patients.

Mallamaci F[1], Benedetto FA, Tripepi R, Rastelli S, Castellino P, Tripepi G, Picano E, Zoccali C.

CHEST Original Research
IMAGING

Can Chest Ultrasonography Replace Standard Chest Radiography for Evaluation of Acute Dyspnea in the ED?

Maurizio Zanobetti, MD; Claudio Poggioni, MD; and Riccardo Pini, MD

JACC Cardiovasc Imaging. 2013 Nov;6(11):1141-51. doi: 10.1016/j.jcmg.2013.08.004. Epub 2013 Oct 2.

Lung ultrasound for the evaluation of pulmonary congestion in outpatients: a comparison with clinical assessment, natriuretic peptides, and echocardiography.

Miglioranza MH[1], Gargani L, Sant'Anna RT, Rover MM, Martins VM, Mantovani A, Weber C, Moraes MA, Feldman CJ, Kalil RA, Sicari R, Picano E, Leiria TL.

Kajimoto *et al. Cardiovascular Ultrasound* 2012, **10**:49
http://www.cardiovascularultrasound.com/content/10/1/49

CARDIOVASCULAR ULTRASOUND

RESEARCH Open Access

Rapid evaluation by lung-cardiac-inferior vena cava (LCI) integrated ultrasound for differentiating heart failure from pulmonary disease as the cause of acute dyspnea in the emergency setting

Katsuya Kajimoto[1*], Keiko Madeen[1], Tomoko Nakayama[2], Hiroki Tsudo[3], Tadahide Kuroda[1] and Takashi Abe[3]

Chest. 2015 Feb 5. doi: 10.1378/chest.14-2608. [Epub ahead of print]

Lung ultrasound-implemented diagnosis of acute decompensated heart failure in the Emergency Department - A SIMEU multicenter study.

Pivetta E, Goffi A, Lupia E, Tizzani M, Porrino G, Ferreri E, Volpicelli G, Balzaretti P, Banderali A, Iacobucci A, Locatelli S, Casoli G, Stone MB, Maule MM, Baldi I, Merletti F, Cibinel G; for the SIMEU Group for Lung Ultrasound in the Emergency Department in Piedmont.

SORT: Key Recommendations for Practice

	Evidence Rating
Lung ultrasound is useful in detecting pulmonary congestion in differentiating decompensated heart failure from pulmonary disease in the acute setting (Russell, 2015) (Kajimoto 2012) (Lichtenstein, 2008).	B
In the evaluation of undifferentiated dyspnea, Lung ultrasound reduces the time to diagnosis of pleural effusion, pericardial effusion, pneumothorax and heart failure, outperforming the traditional exam with chest x-ray in the emergency department setting (Zanobetti, 2017).	C
Diagnostic thoracentesis is indicated for pleural effusions that are new onset, unilateral, in the absence of clinically evident heart failure, cirrhosis, or renal failure that is appropriately responding to therapy. (Feller-Kopman, 2018)	C
Ultrasound-guided thoracentesis should be used to decrease complications from pneumothorax and solid organ puncture. (Roberts, 2023)	B
A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to https://www.aafp.org/afpsort.	

Case

55-year-old male has been surfing off the coast of South Carolina. He was hit by a big wave, and afterwards developed a painful cough. He is calling your triage line requesting a same day visit. "Doc, I've got bronchitis, I just need antibiotics!" +Fatigue, +chest tightness

PMH: HTN, HLD

FM: paternal heart disease   Soc: Chaplain in the Hospital, sick contact?

VS: BP 110/85, HR 86, RR 18, 93% on RA, Temp 98

On exam: Diminished breath sounds

DDx- Bronchitis, Pleural Effusion, New CHF, Pneumothorax?

Lung POCUS Exam

Lung POCUS Setup

- Probe Selection
- Presets
- Patient Position
- Probe Position
- Planes of Cut (Orientation)

Probe Selection

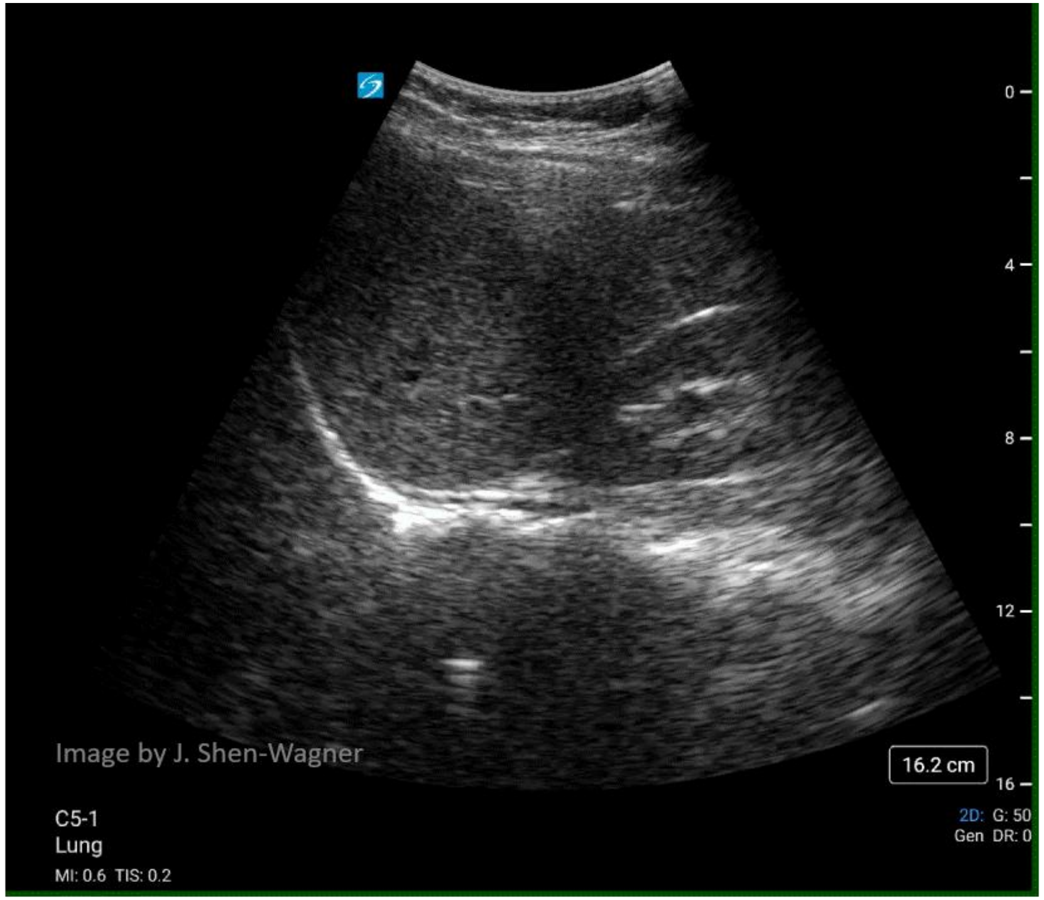
Curvilinear Probe
3-5 MHz

Phased Array Probe
3-5 MHz

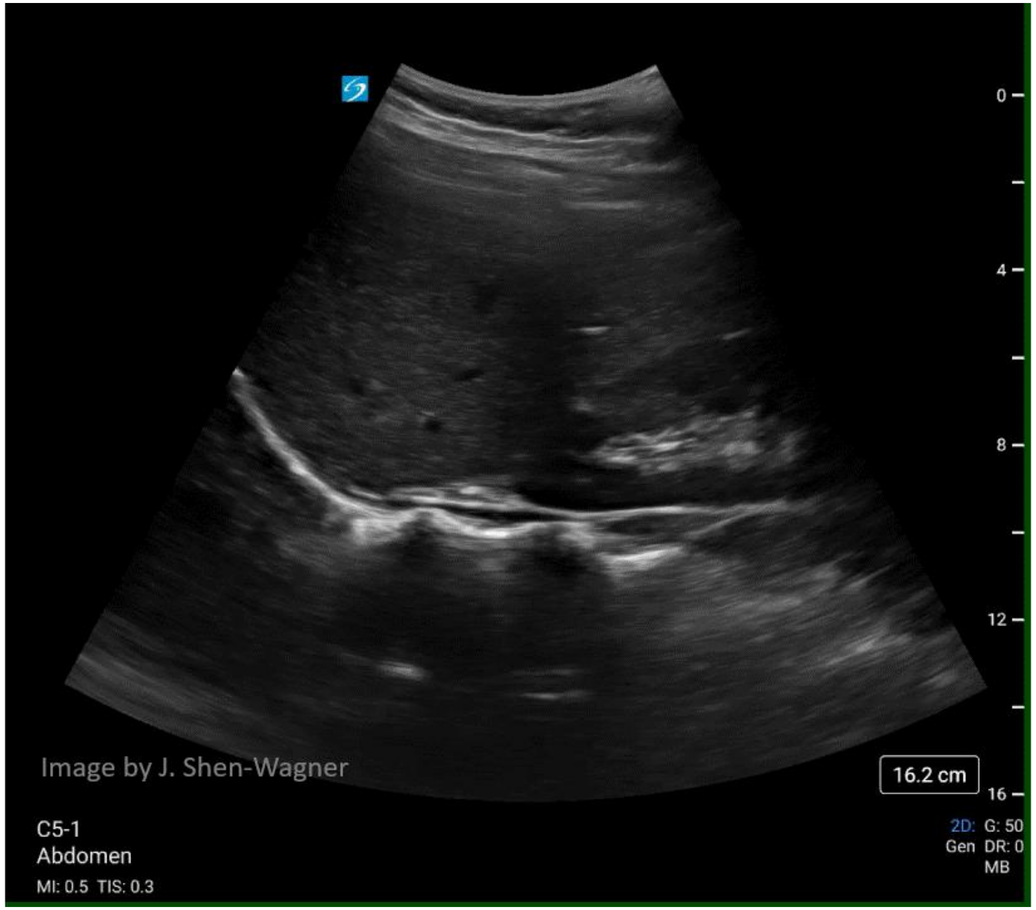
Linear Probe
5-12 MHz

Presets

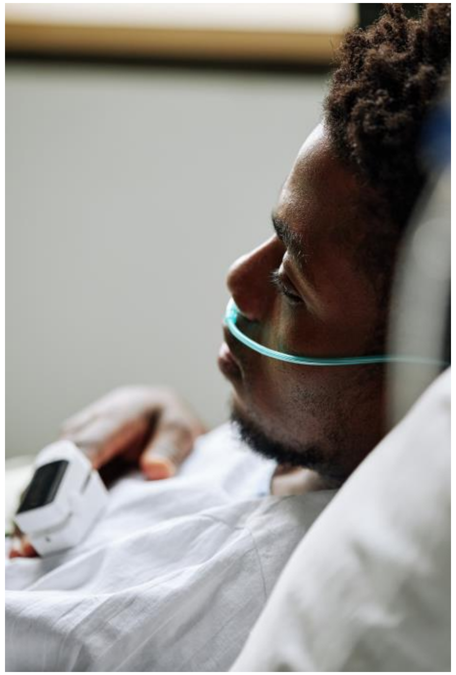
LUNG PRESET



ABDOMEN PRESET



Patient Position



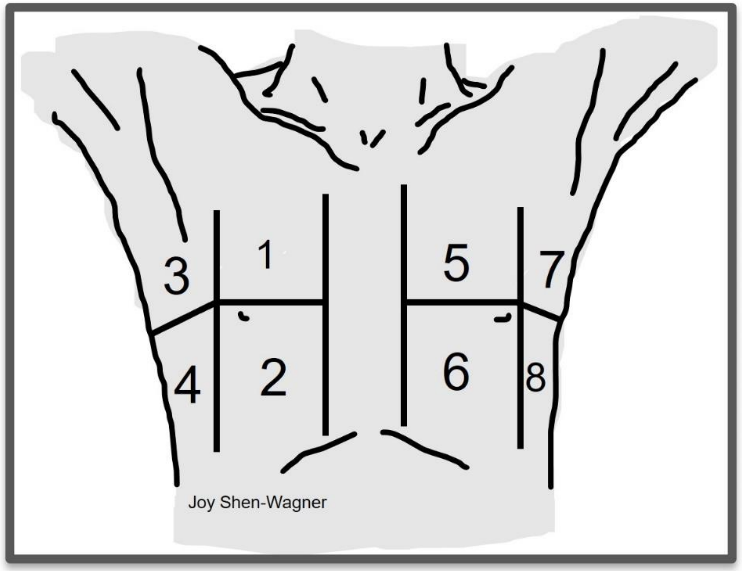
Supine***

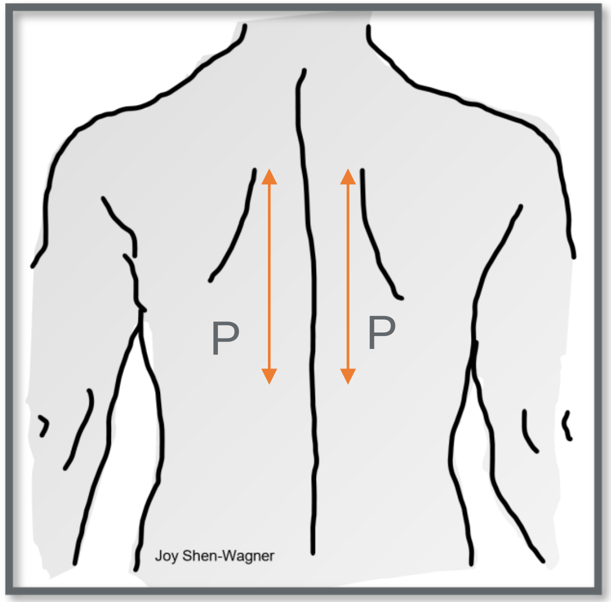
Lateral Decubitus

Sitting upright

Probe Positions- Lung Zones

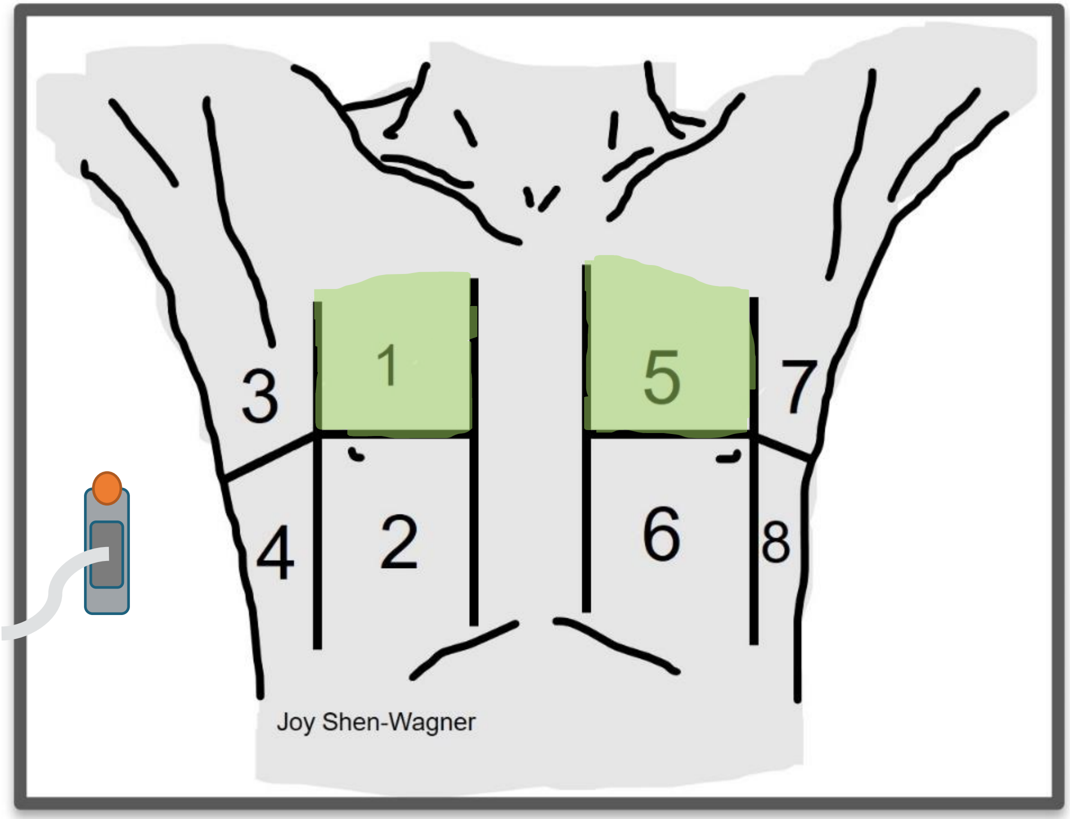
- Anterior Lung- Begin by scanning the anterior chest near the sternum and progressing laterally
- Zones 1-8 (Zones 4 and 8 are RUQ/LUQ)
- 2 additional posterior zones



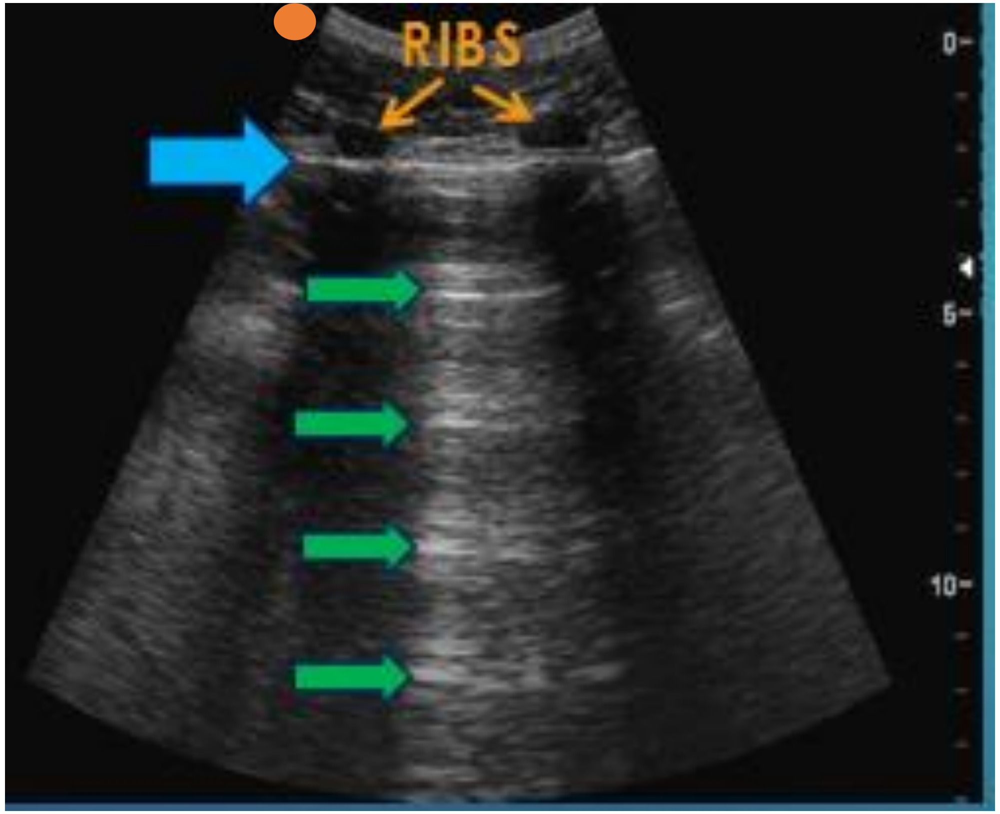


Orientation- Sagittal in Anterior Zones

- If available use the Lung Preset in Anterior Zones

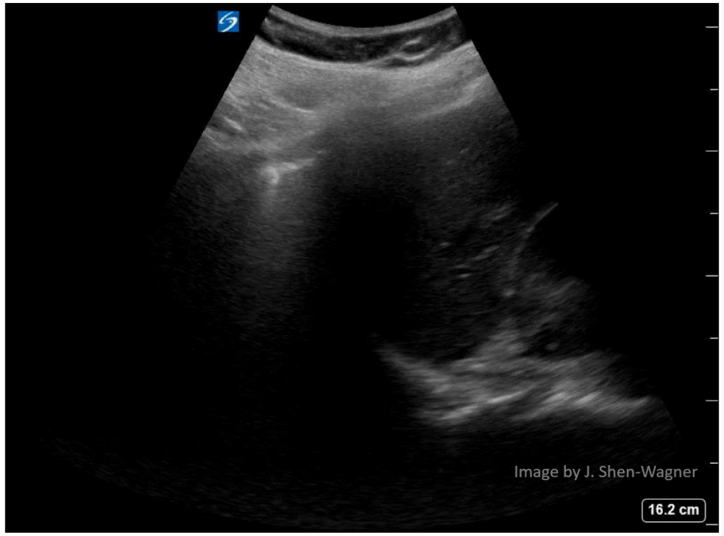


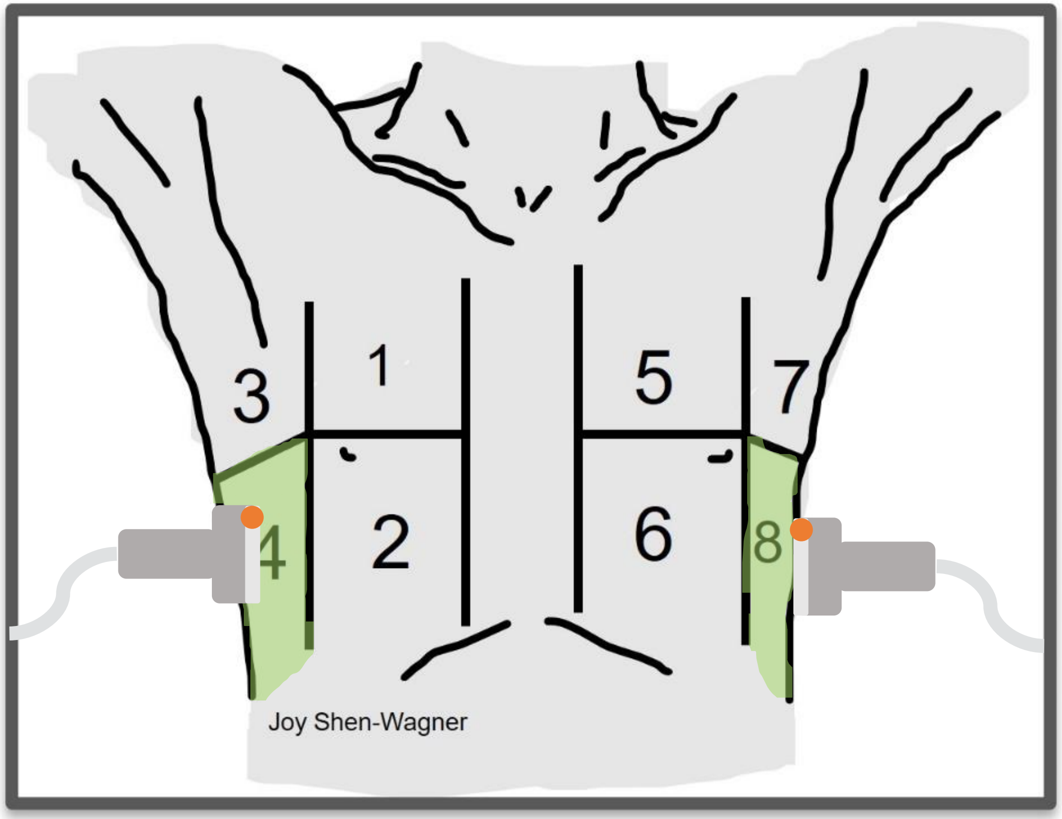
Superior rib Inferior rib



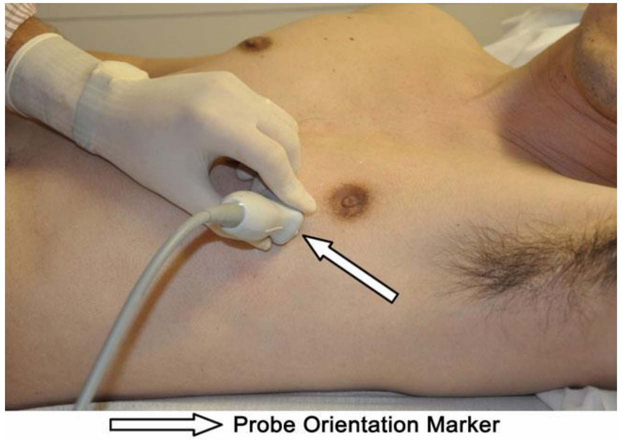
Orientation- Coronal in Z4 and Z8 midaxillary

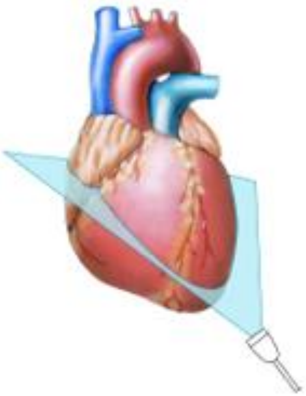
- If available use the Abdomen Preset in Coronal Views

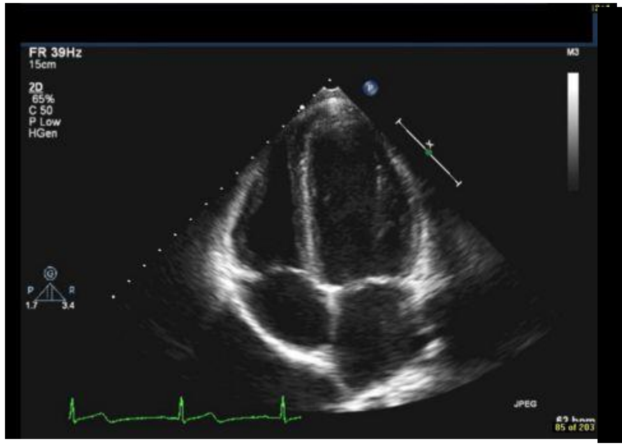


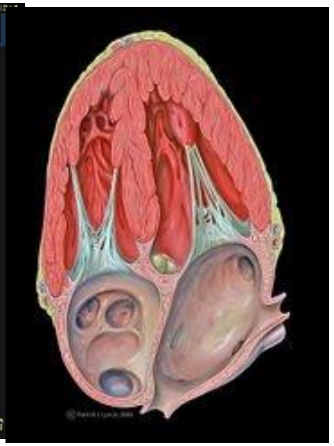


Normal Lungs

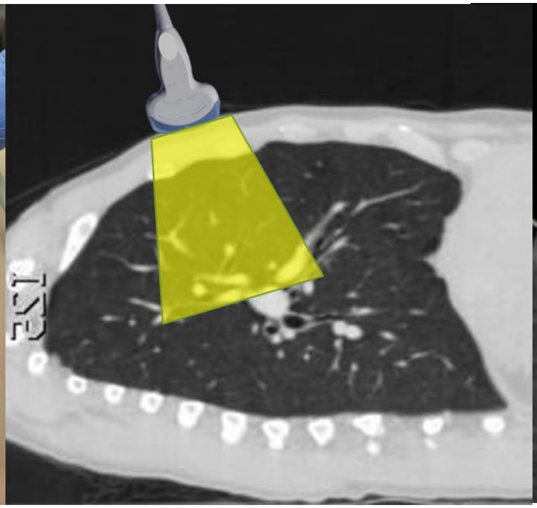


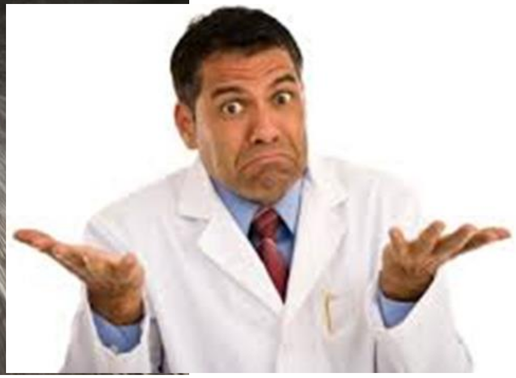






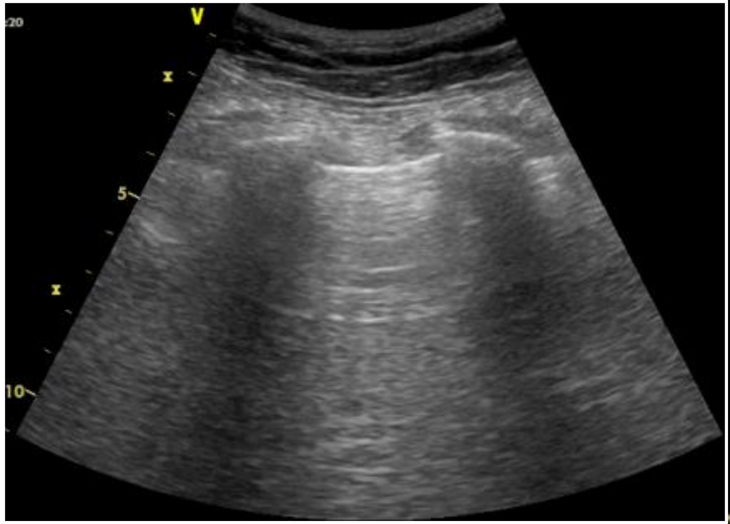
Lung Ultrasound Just Looks *Different*…

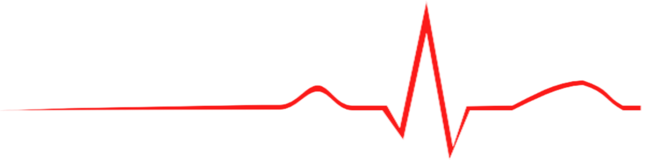


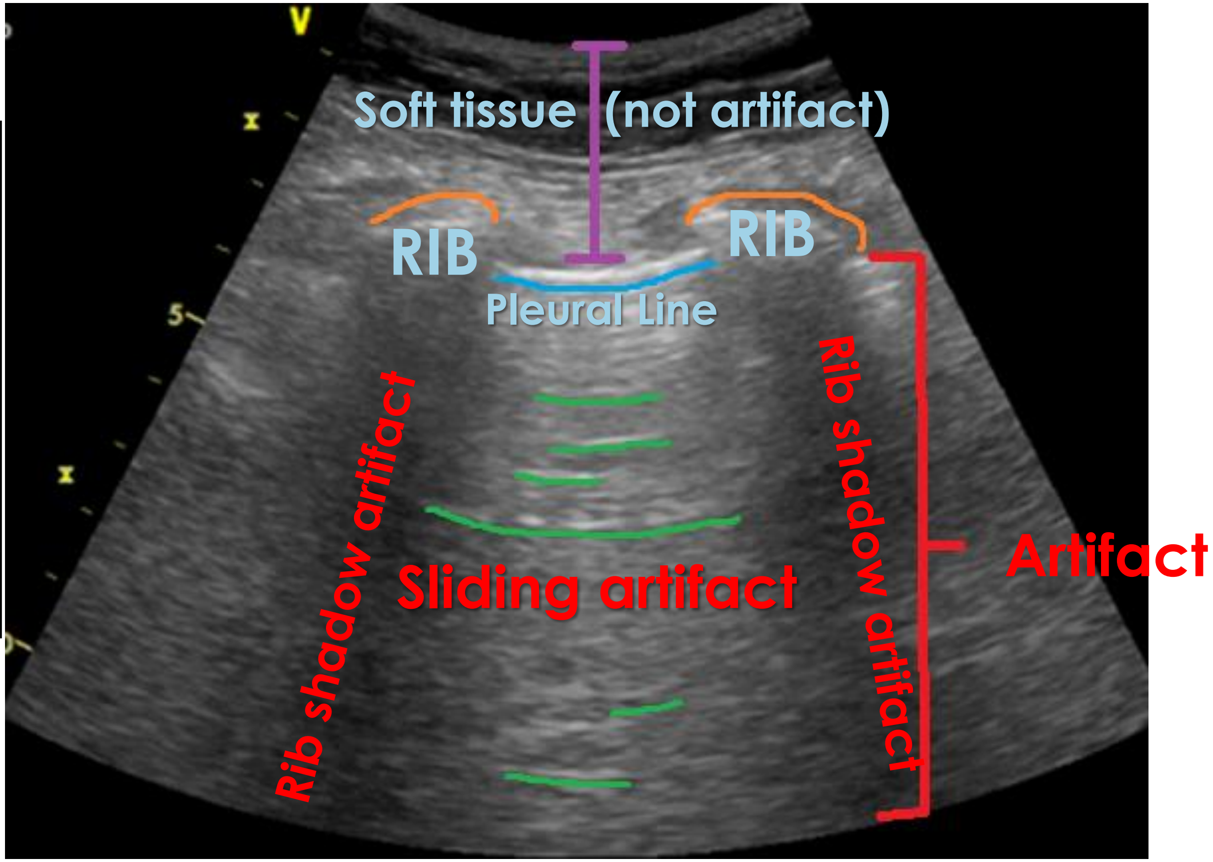


Courtesy of Mike Wagner, MD

Making Sense of Artifacts



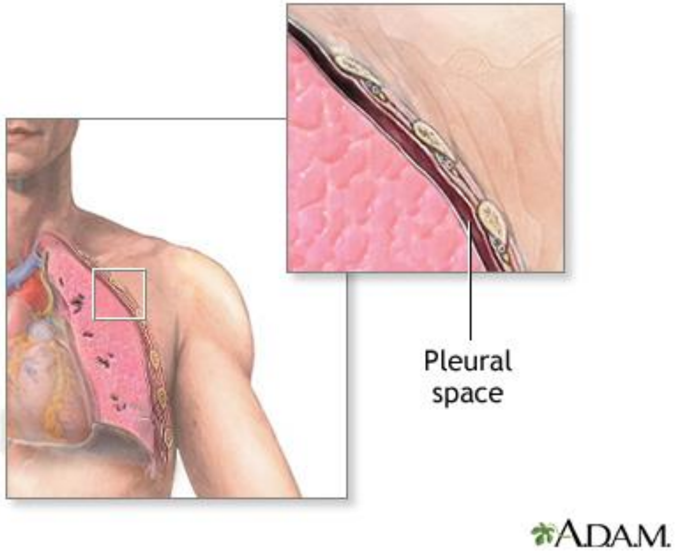


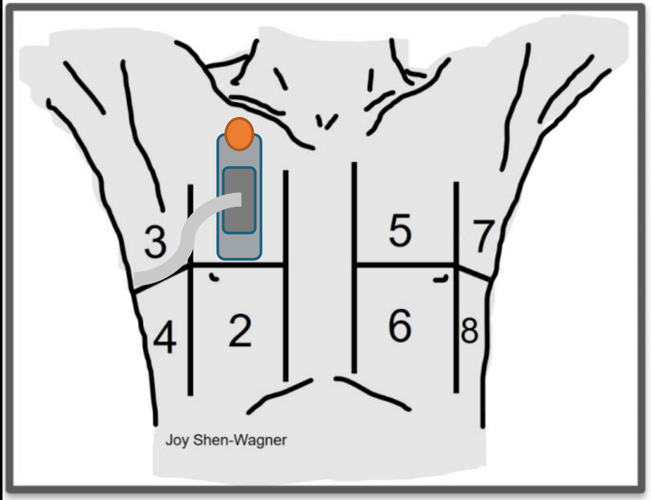


Goal is to distinguish *Abnormal* artifacts from the normal ones…

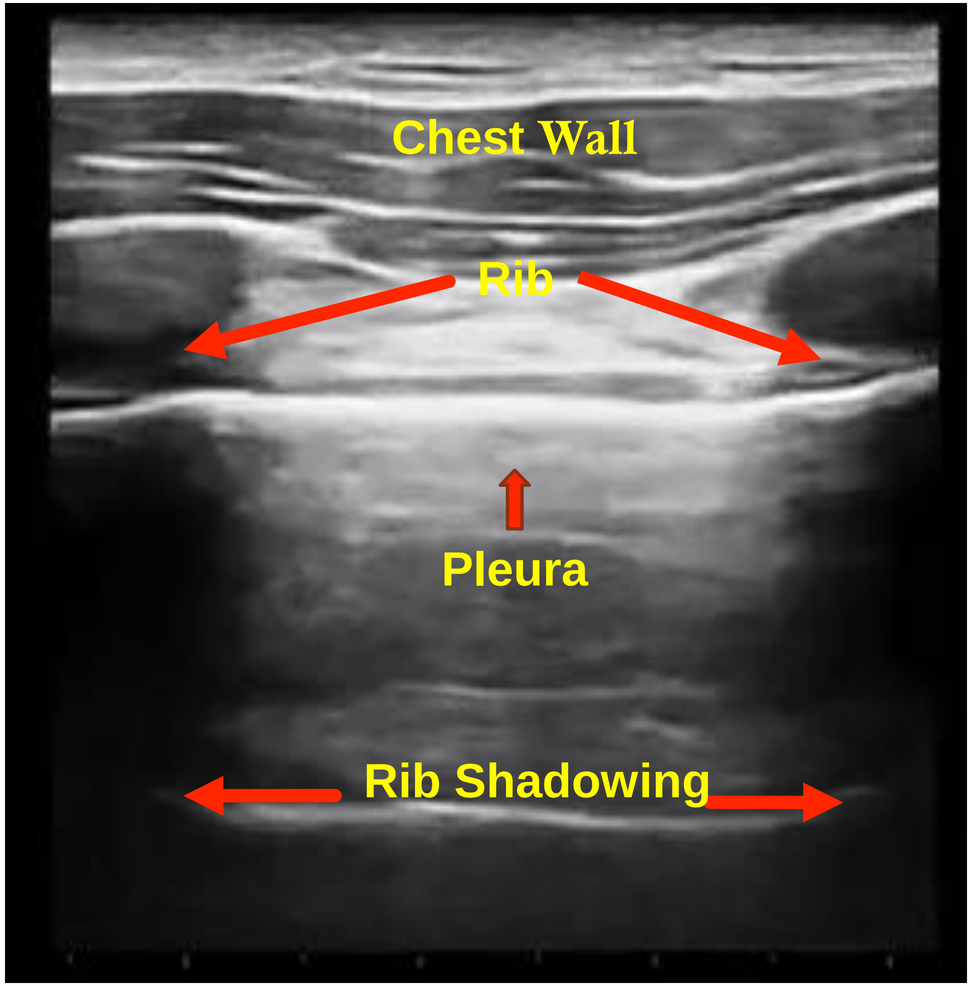
Lung Sliding

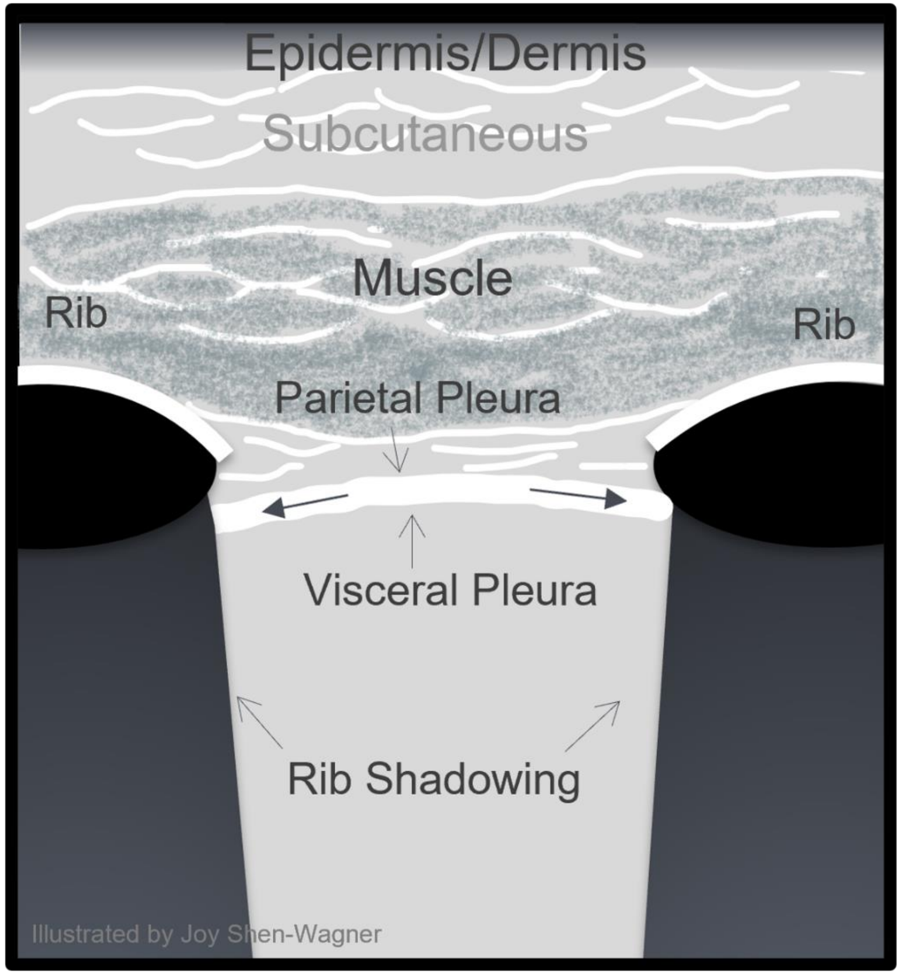
- Created by parietal and visceral pleura moving over each other
- Regular movement synchronized with respirations
- Layers **MUST** be in contact with each other to see movement





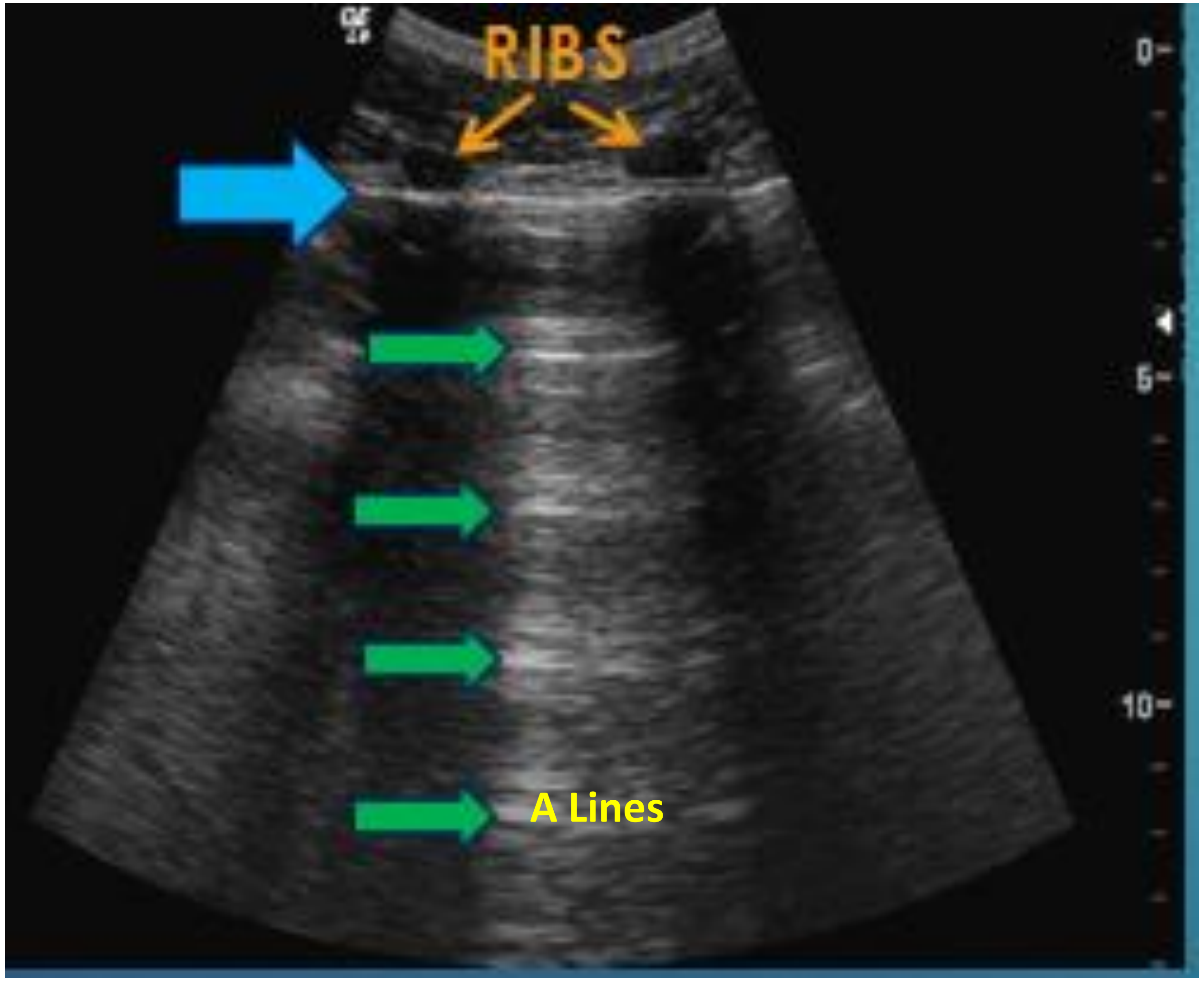
Lung Sliding

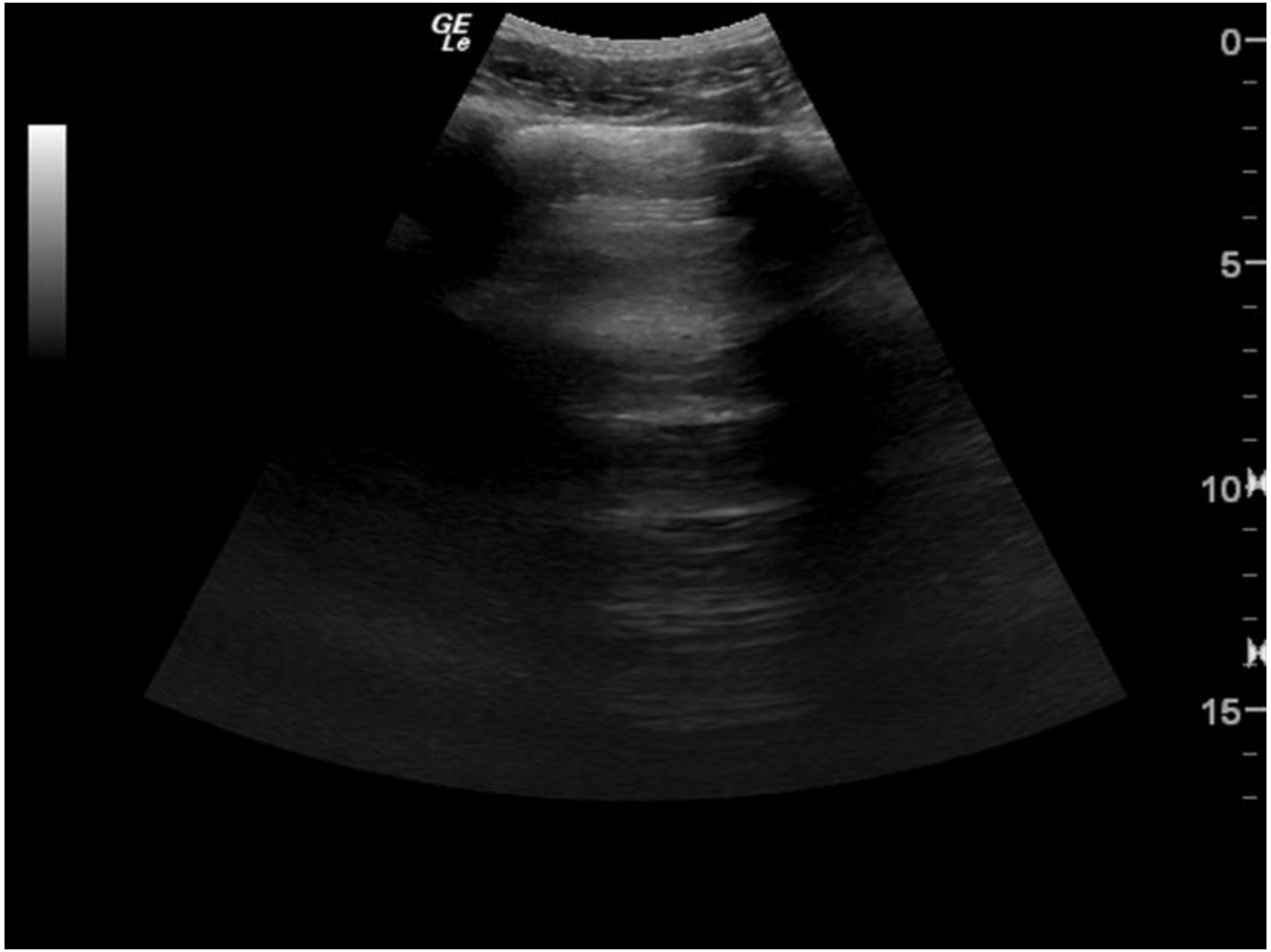




A-Lines

- Repeating horizontal lines at regular intervals
- Reverberation artifact from the visceral and parietal pleura interface
- Seen in aerated lung (also seen in fibrosis and COPD)

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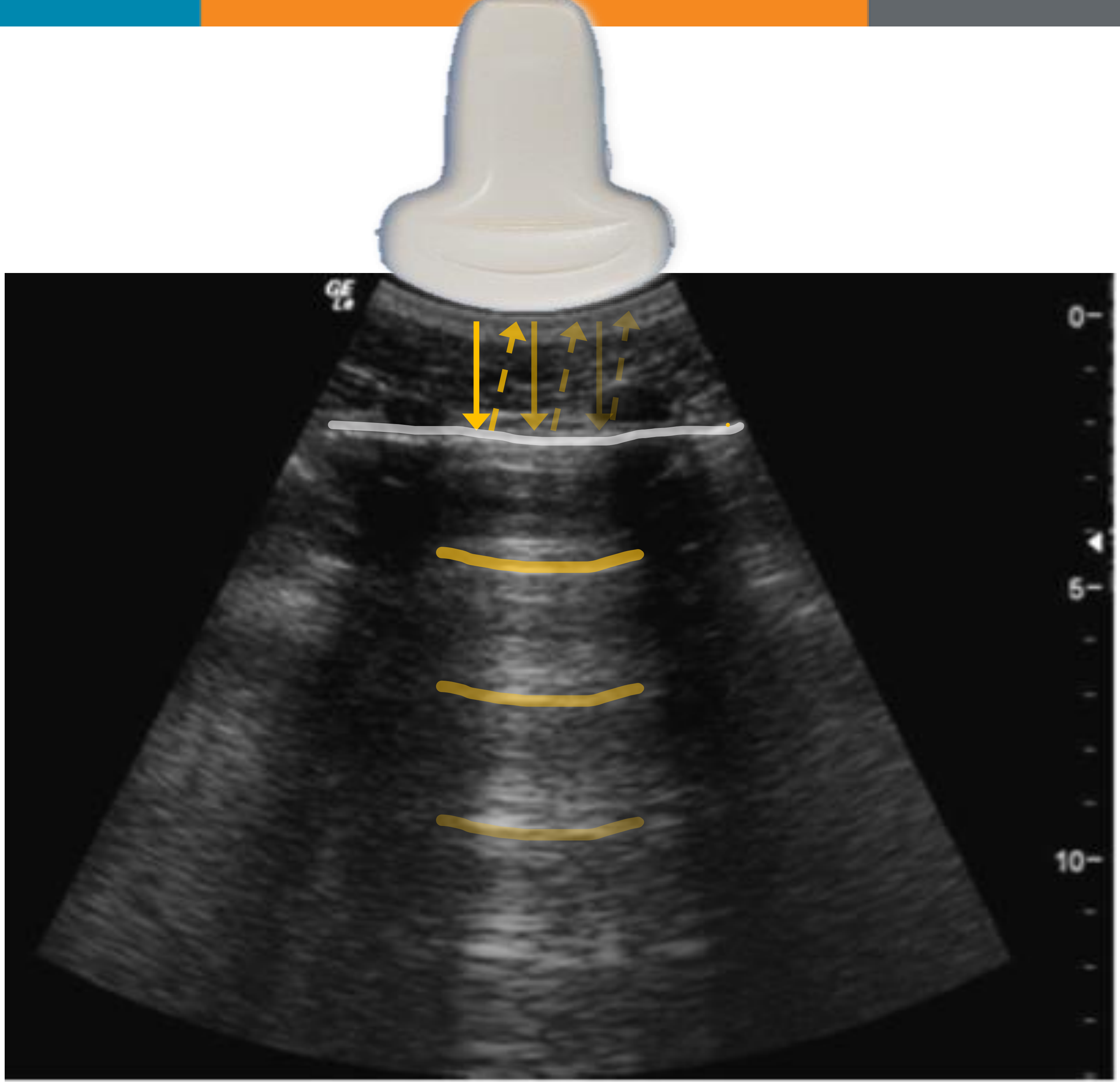

0
5
10

Pulmonary Edema

What is a “B-Line”?

- Hyperechoic Vertical line arising from the pleural line
- Moves with lung sliding
- Long (does not fade)
  - “comet tail artifacts” =short
- Erases A lines

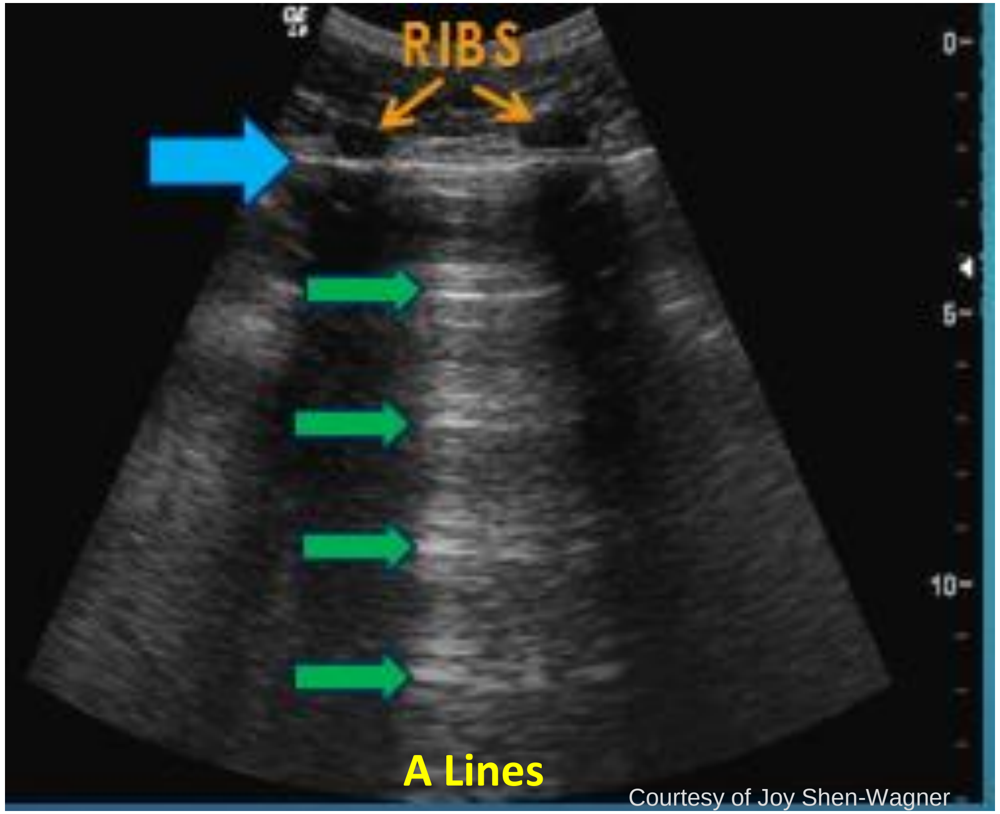
Courtesy of Joy Shen-Wagner, MD

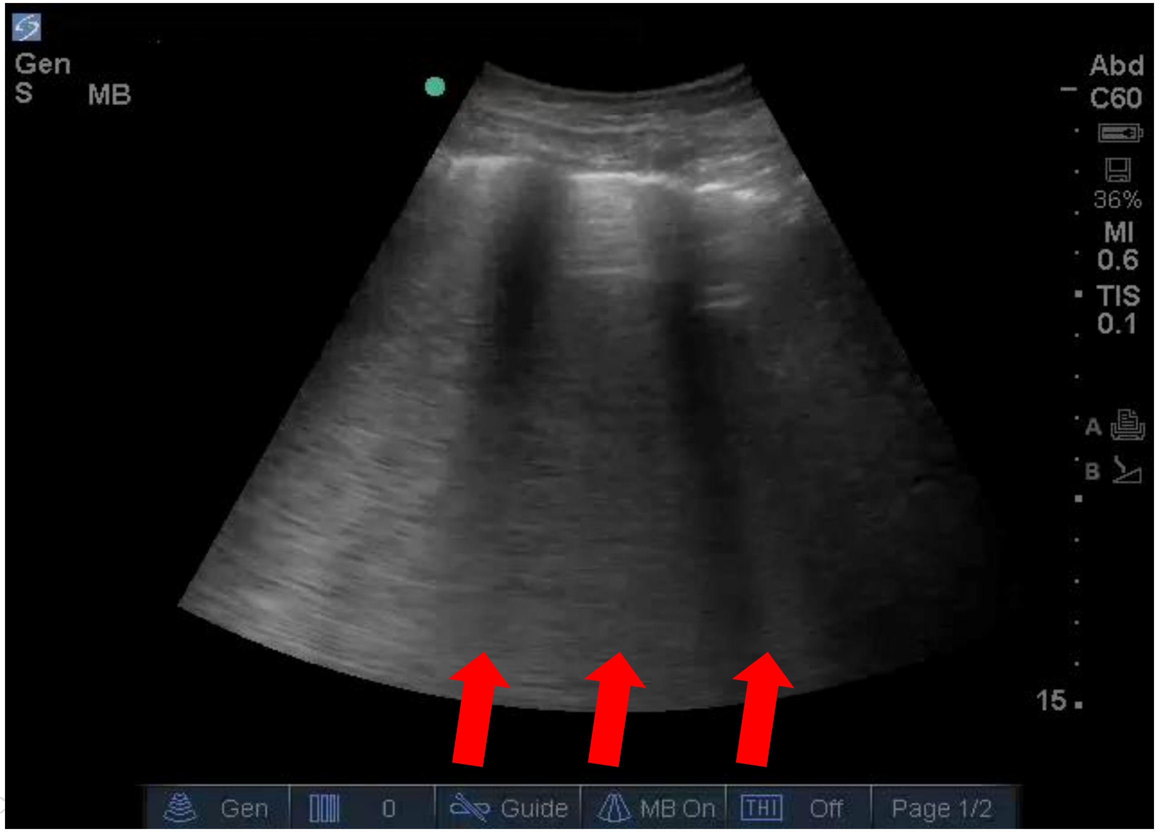
B Lines


Courtesy of Joy Shen-Wagner, MD
15.0 cm


14cm
Case Courtesy of Joy Shen-Wagner

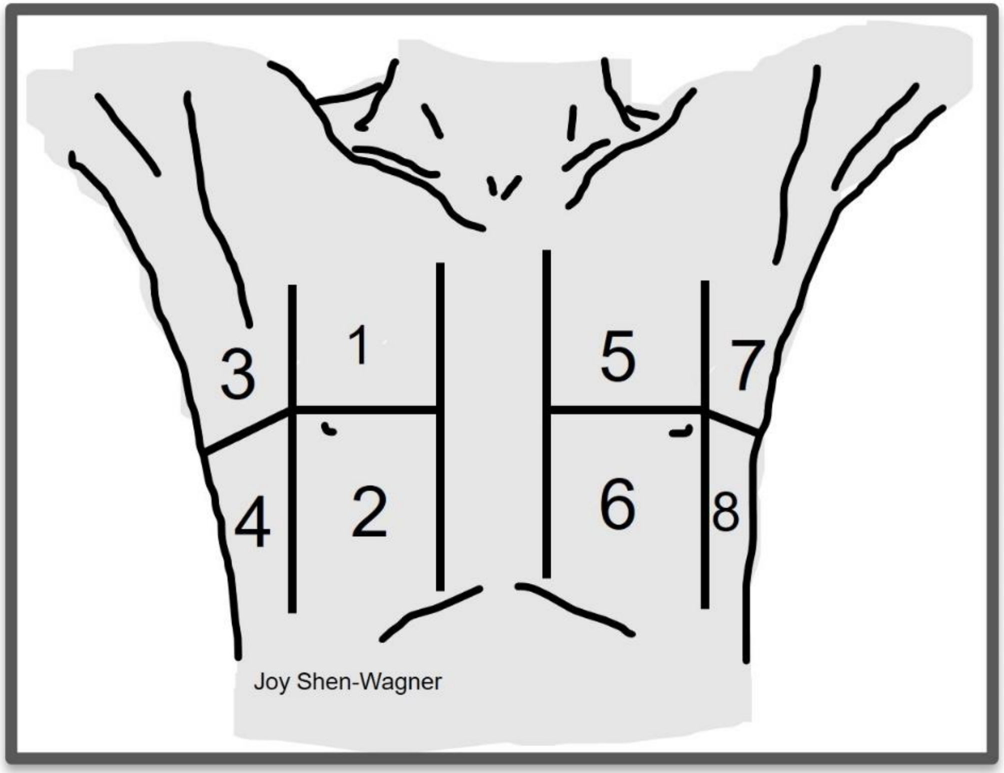
A Lines vs B Lines



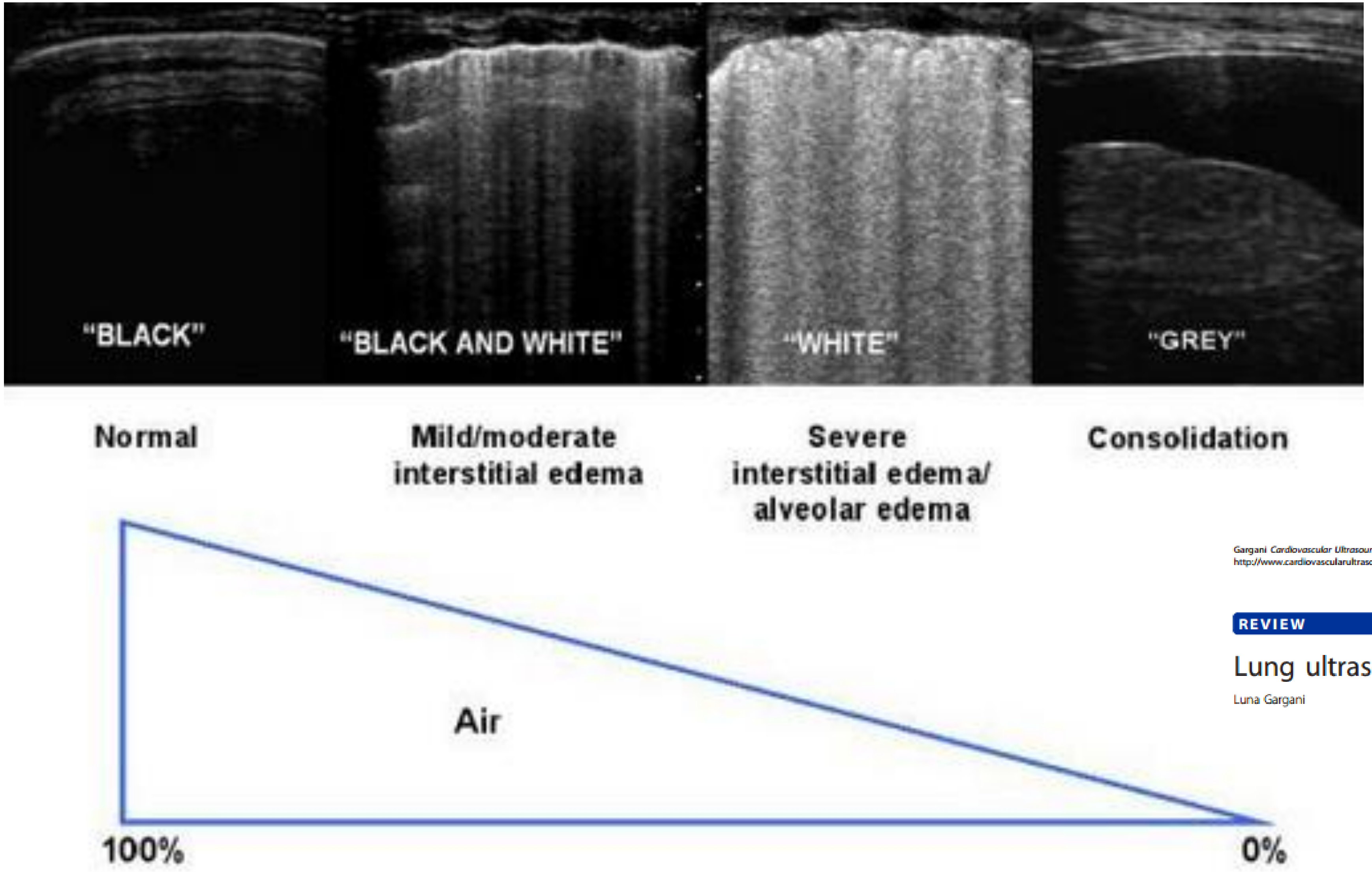


B Lines in Heart Failure

- “Positive zone” ≥ 3 B lines per intercostal space.
- Pulmonary edema = 2 positive zones, bilaterally, so 4 zones total.



Ultrasound as a *Densitometer* of the Lung



Gargani *Cardiovascular Ultrasound* 2011, 9:6
http://www.cardiovascularultrasound.com/content/9/1/6

CARDIOVASCULAR ULTRASOUND

REVIEW Open Access

Lung ultrasound: a new tool for the cardiologist

Luna Gargani

Gargani. 2011. *Cardiovascular Ultrasound*.

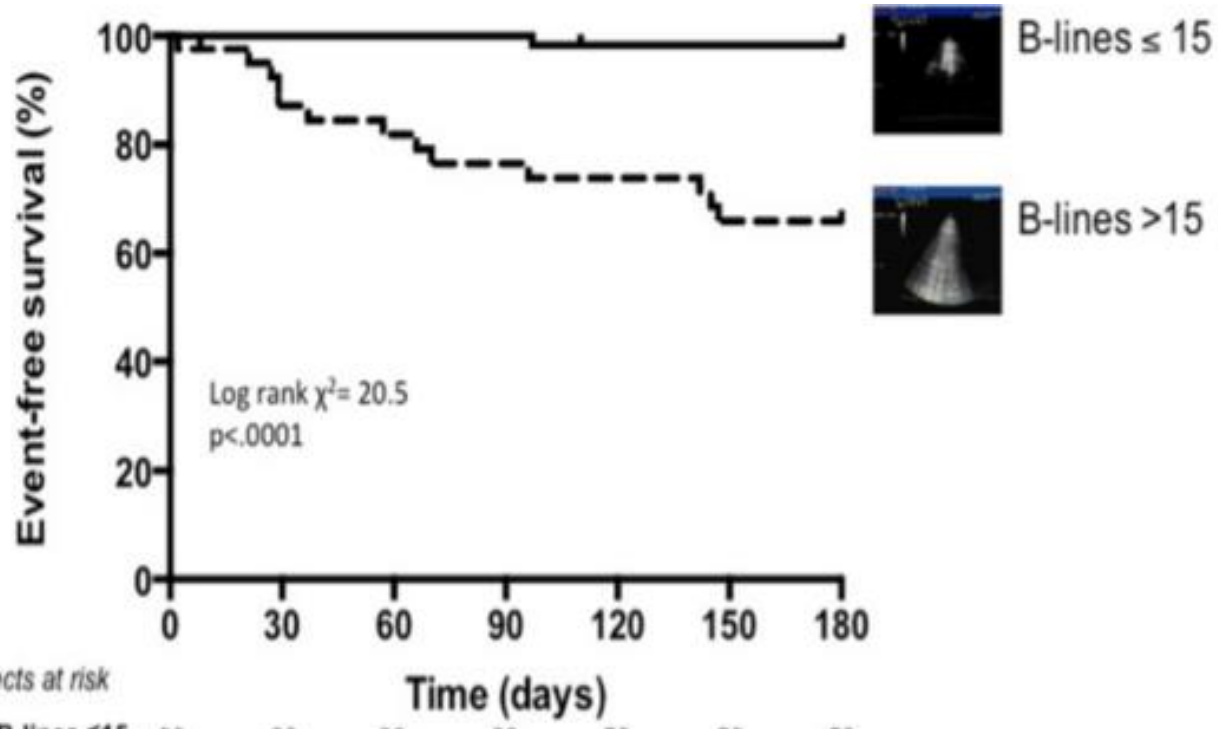
Gargani et al. Cardiovascular Ultrasound (2015) 13:40
DOI 10.1186/s12947-015-0033-4

CARDIOVASCULAR ULTRASOUND

RESEARCH Open Access

Persistent pulmonary congestion before discharge predicts rehospitalization in heart failure: a lung ultrasound study

Luna Gargani[1*], P. S. Pang[2], F. Frassi[3], M.H. Miglioranza[4], F. L. Dini[3], P. Landi[1] and E. Picano[1]



Subjects at risk							
B-lines ≤15	60	60	60	60	59	59	59
B-lines >15	40	35	33	31	30	27	27

Fig 2 Kaplan-Meier survival curves in HF patients stratified according to the number of B-lines before discharge, at 6-months follow-up

Pitfalls

-Assuming that B line presence is pulmonary congestion (also present in pulmonary fibrosis)

-Not scanning multiple zones, both hemisphere.

Focal vs bilateral b line pattern.

-No depth adjustment, assuming that small short reverberations off the pleural surface are B lines.

Pleural Effusion

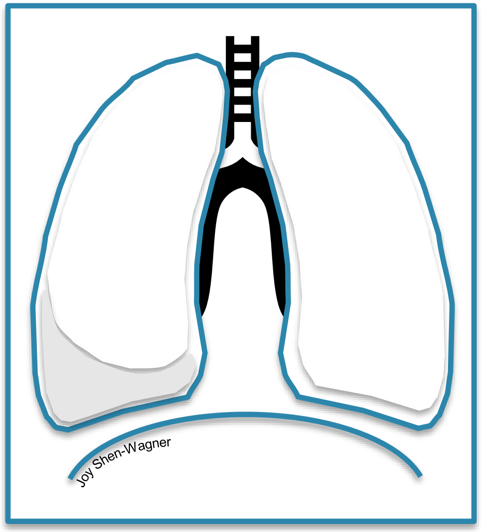
Guidelines: POCUS for Pleural Effusion

Intensive Care Med (2012) 38:577–591
DOI 10.1007/s00134-012-2513-4

CONFERENCE REPORTS AND EXPERT PANEL

Giovanni Volpicelli
Mahmoud Elbarbary
Michael Blaivas
Daniel A. Lichtenstein
Gebhard Mathis
Andrew W. Kirkpatrick

International evidence-based recommendations for point-of-care lung ultrasound



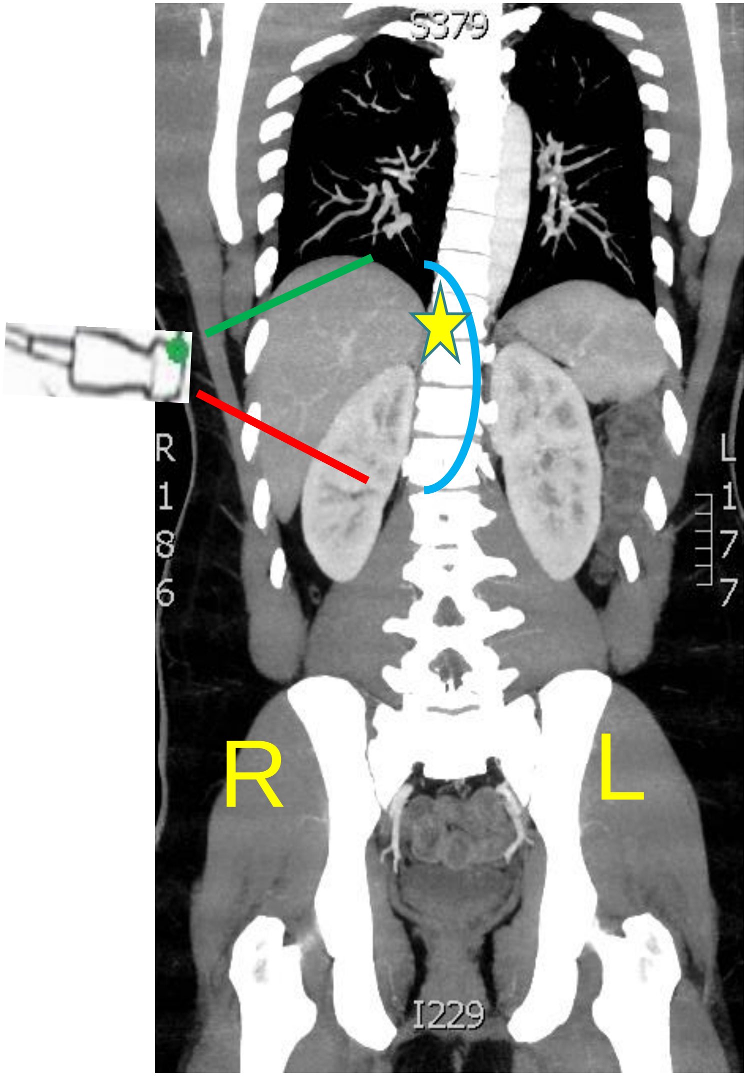
RL-D4-S4 (strong: level A)

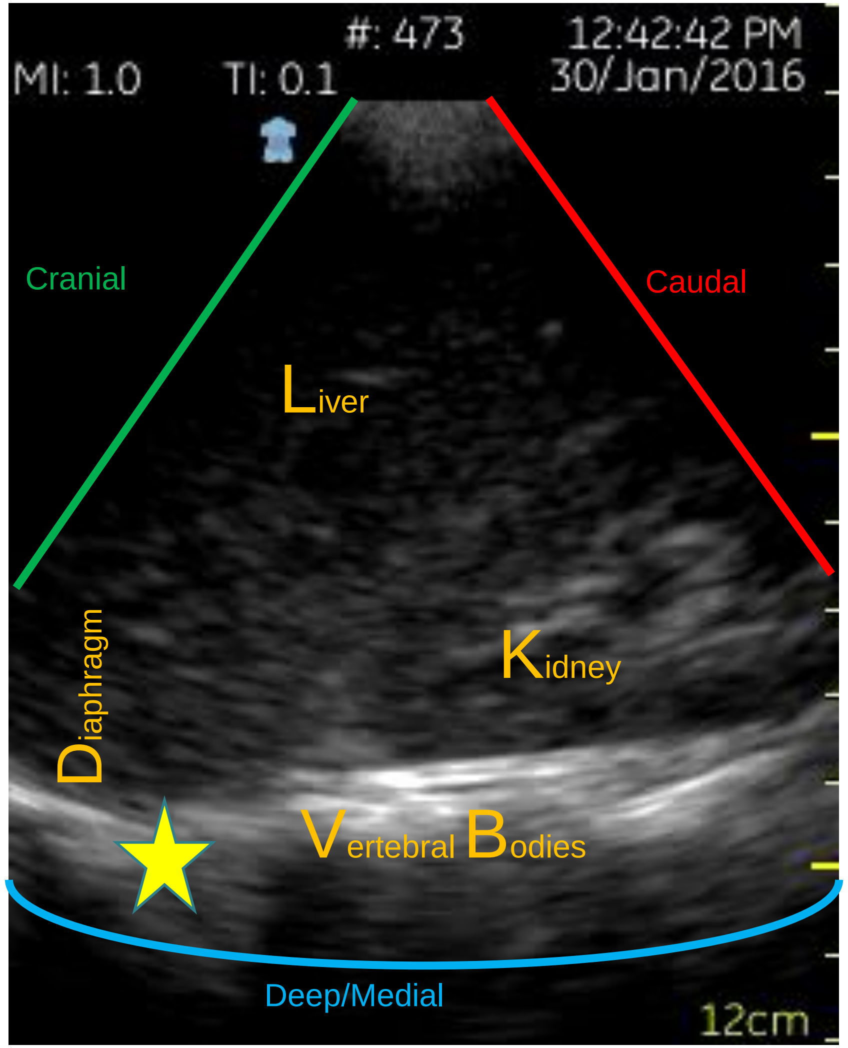
- For the detection of effusion, lung ultrasound is more accurate than supine radiography and is as accurate as CT.

B-D4-S7 (strong: level A)

- In opacities identified by chest radiography, lung ultrasound should be used because it is more accurate than chest radiography in distinguishing between effusion and consolidation.

RUQ View (z 4) - above the diaphragm



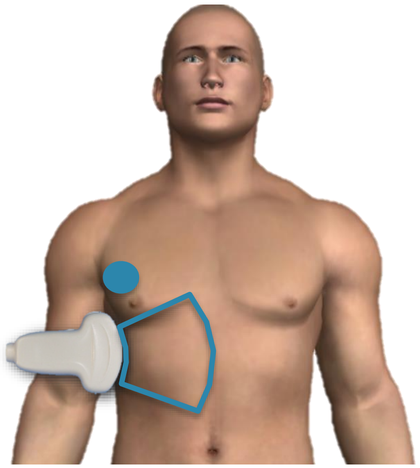


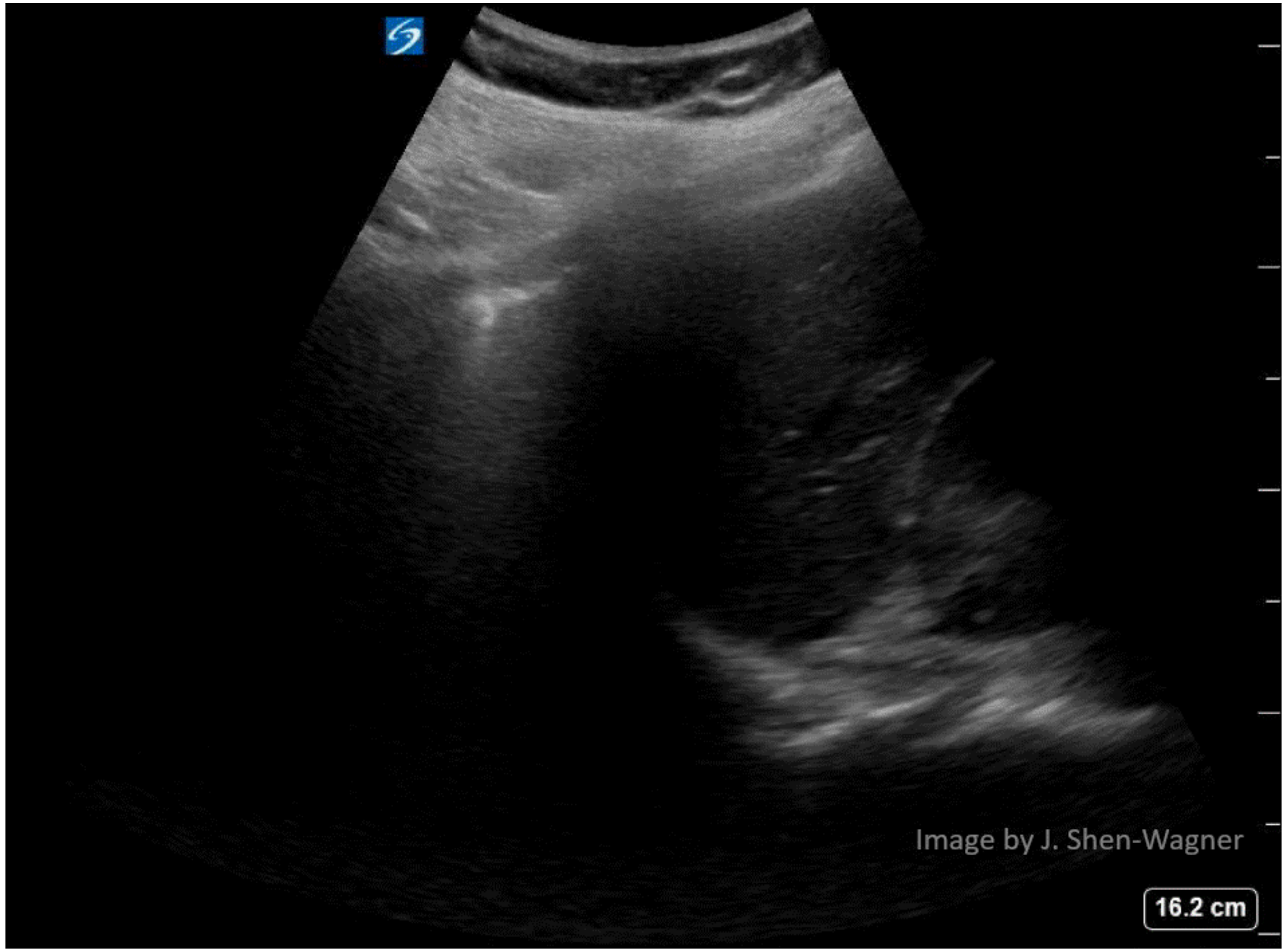
Normal Lung Artifacts: Curtain Sign

NORMAL

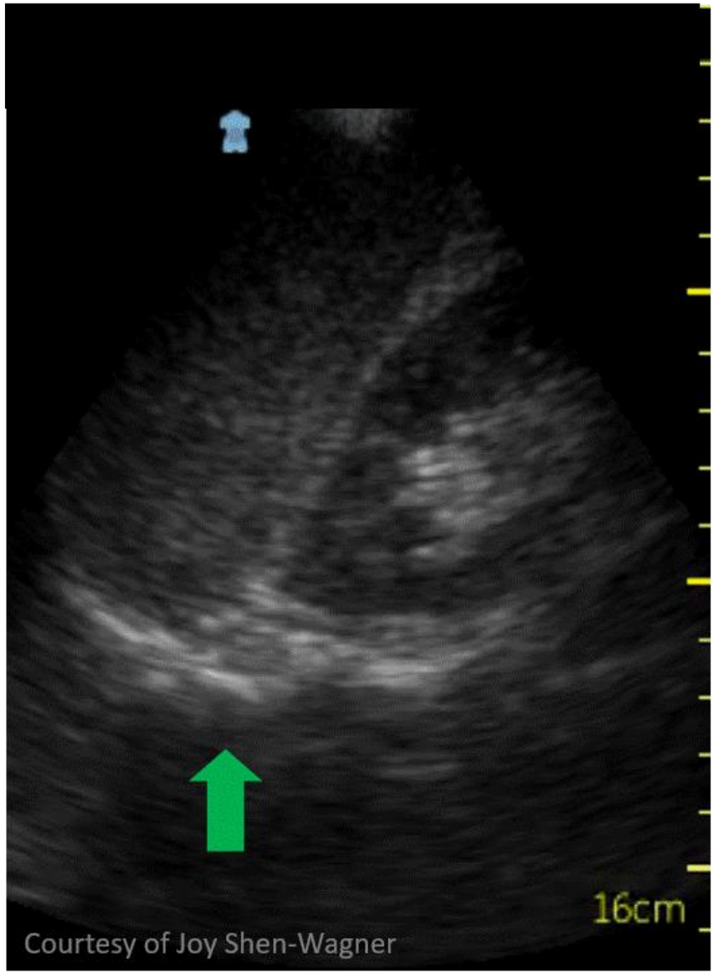
(No Pleural Effusion)

Curtain Sign

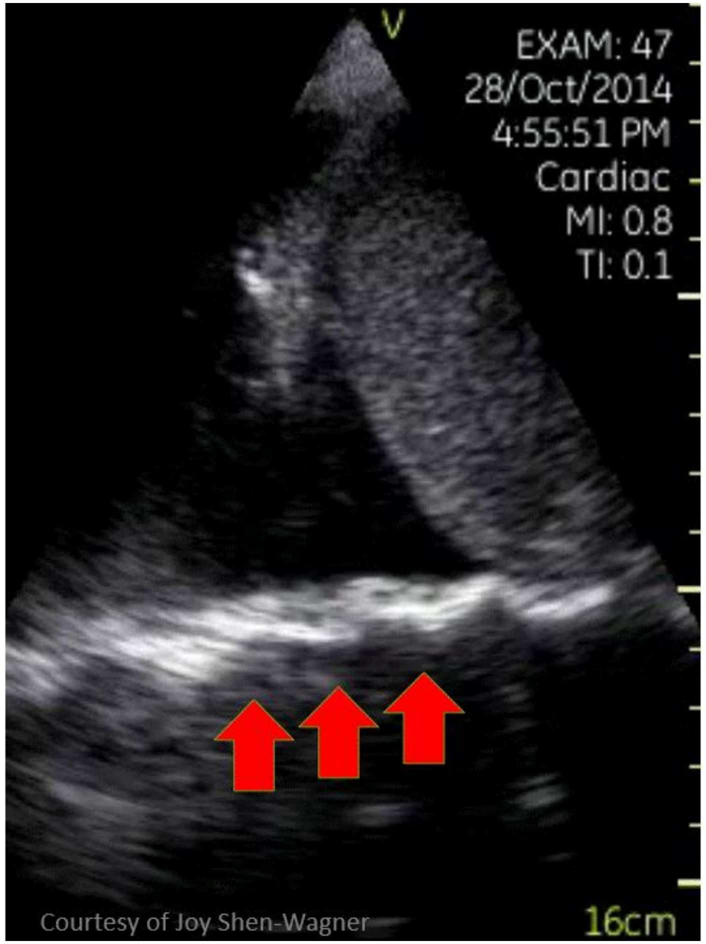




Pleural Effusion Artifacts: Spine Sign

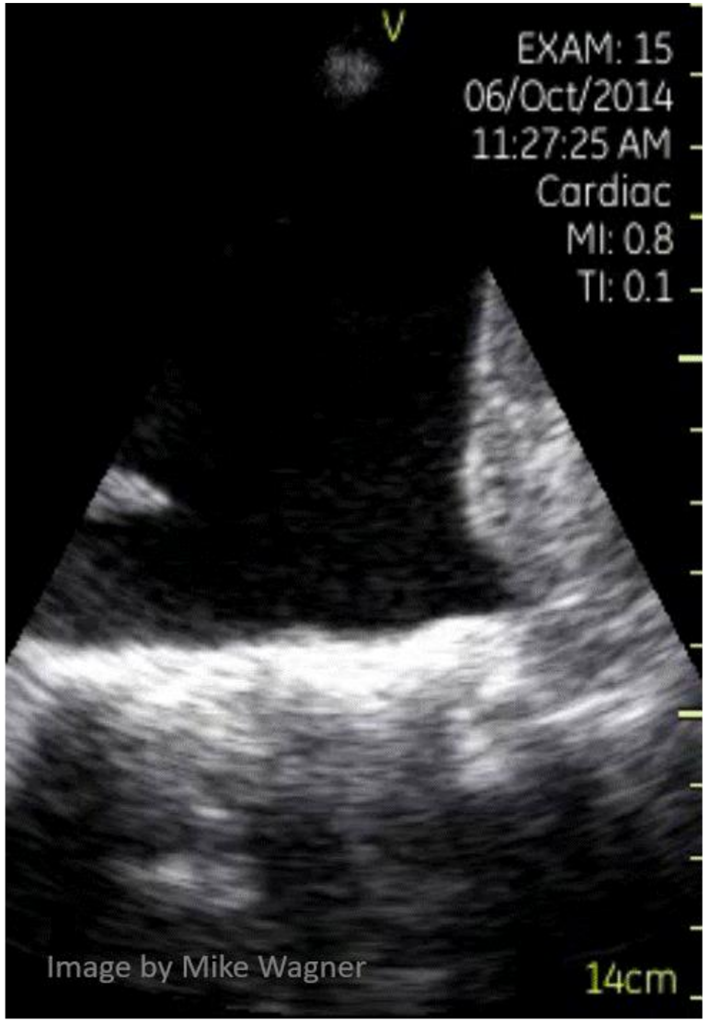


NORMAL Negative Spine Sign



Spine sign (+ effusion)

Large Pleural Effusion



Needle Guidance Thoracentesis

(Image Credit: Michael Wagner, used with permission AFP Shen-Wagner, 2023)

Pitfalls

- In coronal views, not fanning through Z4 and Z8 to detect an effusion
- Normal mirroring across the diaphragm mistaken for pneumonia.
- Mistaking a pleural effusion for a pericardial effusion.

Pneumothorax

Pneumothorax

- Begin by scanning the least dependent region of the anterior chest and scan laterally

Tips

The patient should lay as supine as possible as air collects in the least dependent portion.

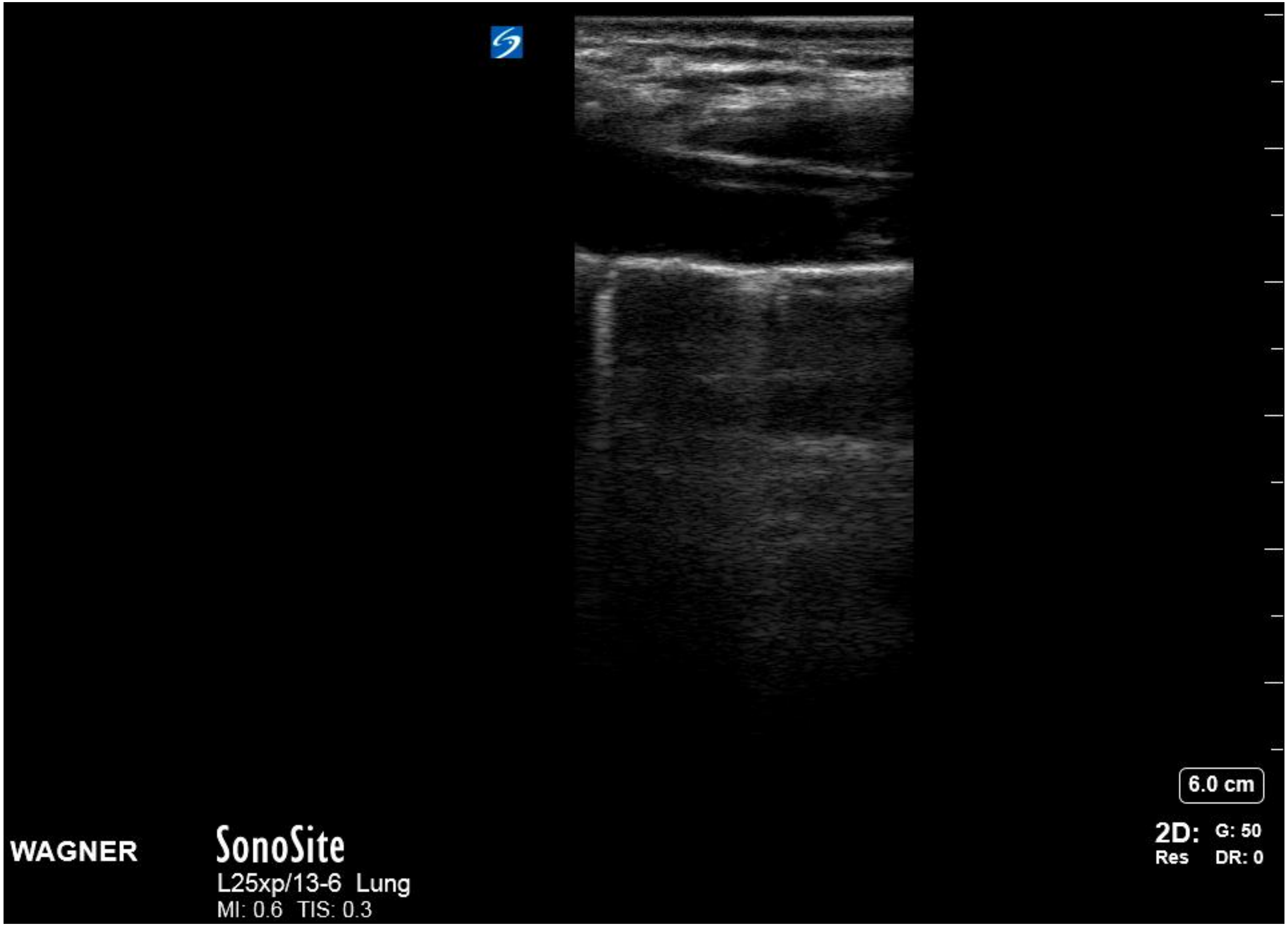
Supine -> Anterior chest

Sitting up -> Apices of the chest

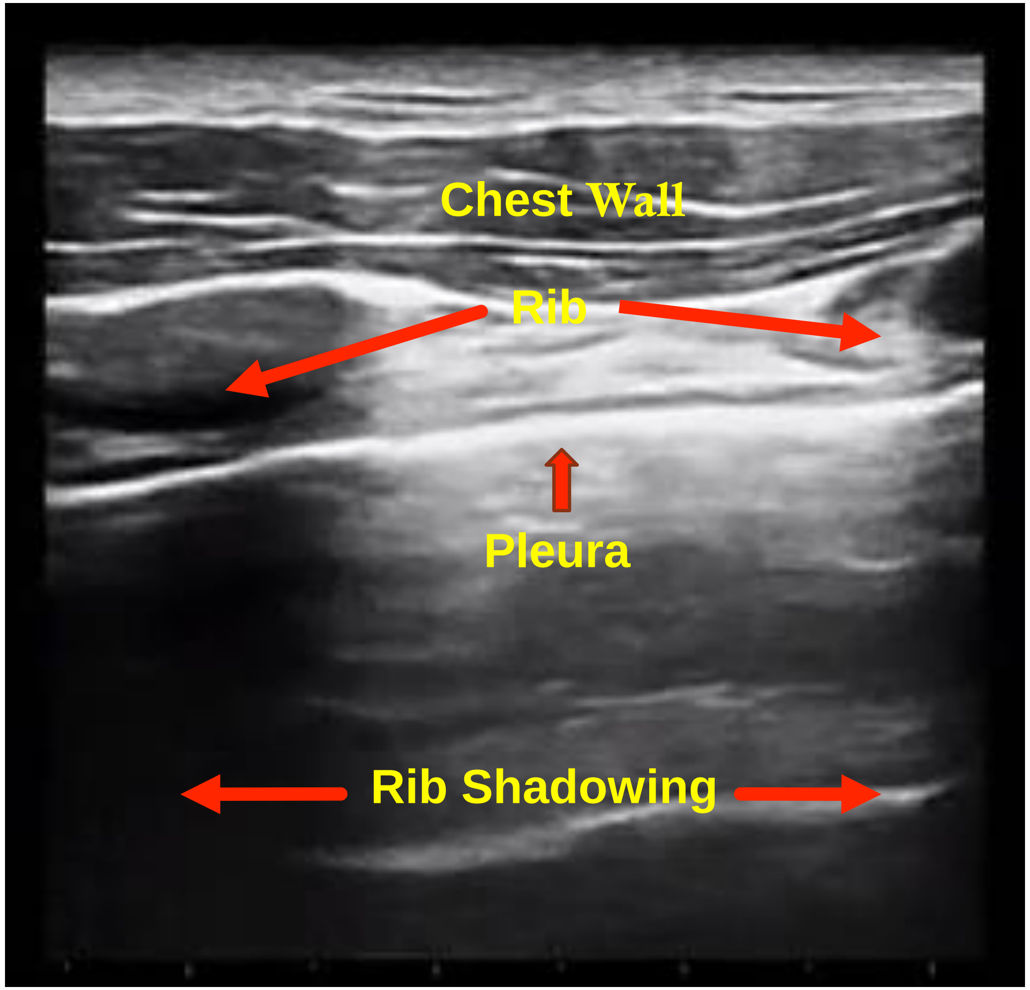
The presence of a B line means there is no pneumothorax, as B lines are formed by visceral parietal pleura interface.

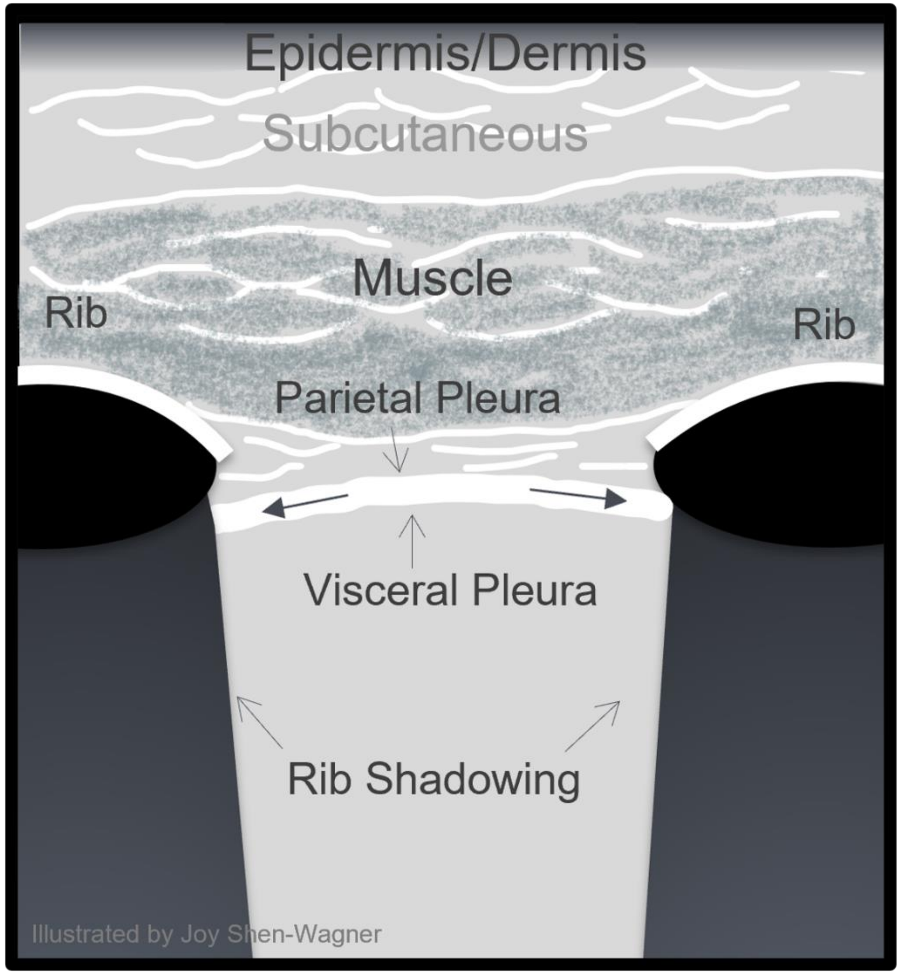
Pitfalls

- The lung diagram border and lung cardiac point can appear as a false positive lung point.
- A line pattern ≠ normal lung i.e. trapped air still has an A line pattern.
- Movement of the chest wall may be mistaken as lung sliding

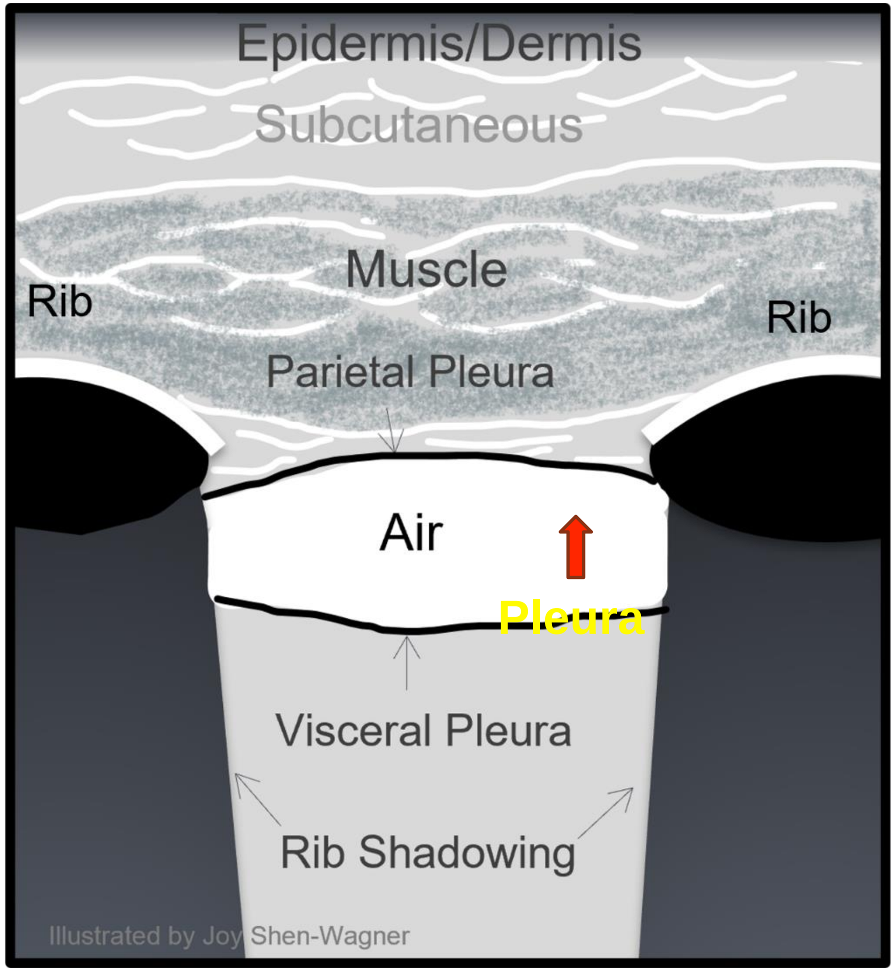

6.0 cm
2D: G: 50
Res DR: 0
WAGNER
SonoSite
L25xp/13-6 Lung
MI: 0.6 TIS: 0.3

Normal: Lung Sliding



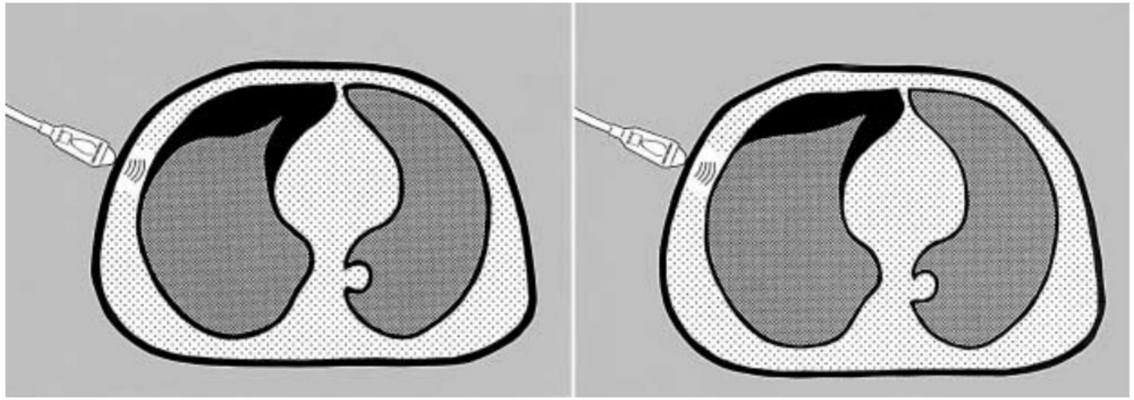


Pneumothorax: No lung sliding



Pneumothorax: Lung Point

Expiration Inspiration



Intensive Care Med (2000) 26: 1434–1440
DOI 10.1007/s001340000627

ORIGINAL

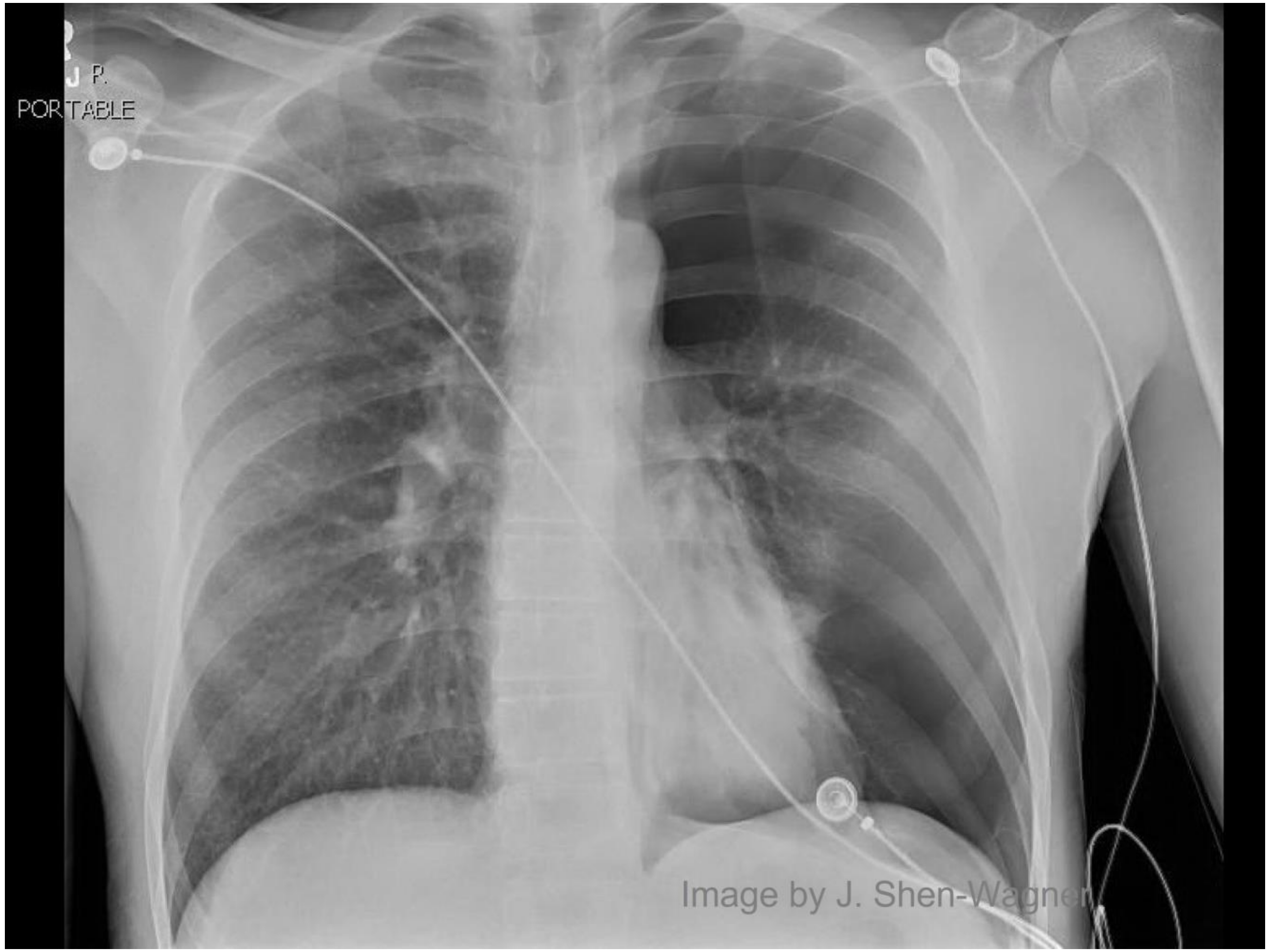
Daniel Lichtenstein
Gilbert Mezière
Philippe Biderman
Agnès Gepner

The "lung point": an ultrasound sign specific to pneumothorax

Back to our Patient with “bronchitis”

CME

Case Resolution



Escorted the patient to the hospital
Dx Large Pneumothorax
Chest tube placed within 3 hrs

SMJ // Article

Perspectives

A Patient's Perspective: Pairing the Stethoscope with POCUS to Evaluate Acute Dyspnea in the Clinic

Authors: Joy Shen-Wagner, MD, Michael Wagner, MD, Anthony Hughes, MDiv

CLUE Protocol:
Normal

American Journal of Emergency Medicine (2012) 30, 32–36

ELSEVIER

The American Journal of Emergency Medicine

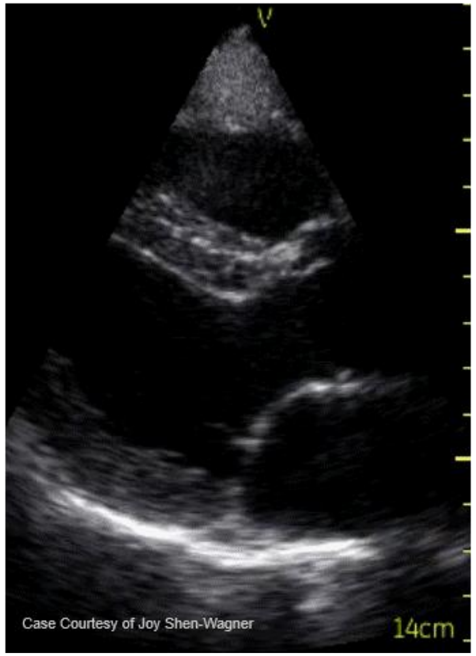
www.elsevier.com/locate/ajem

Original Contribution

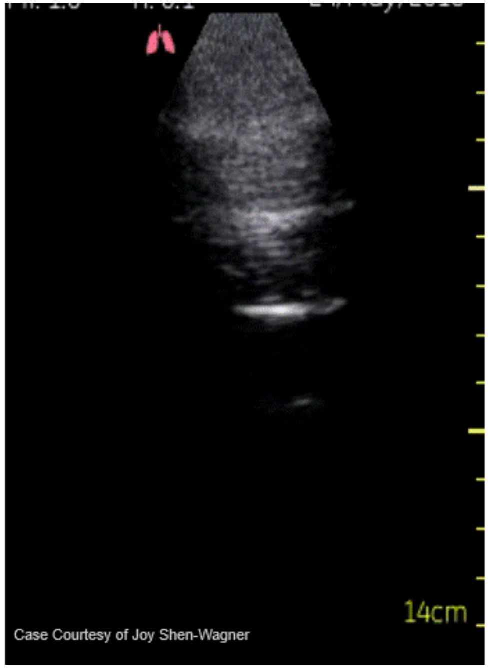
Diagnostic performance of a pocket-sized ultrasound device for quick-look cardiac imaging☆,☆☆,★

Bruce J. Kimura MD[a,*], Glynn W. Gilcrease III MD[a], Brian K. Showalter RDCS[a], James N. Phan RDCS[a], Tanya Wolfson[b]

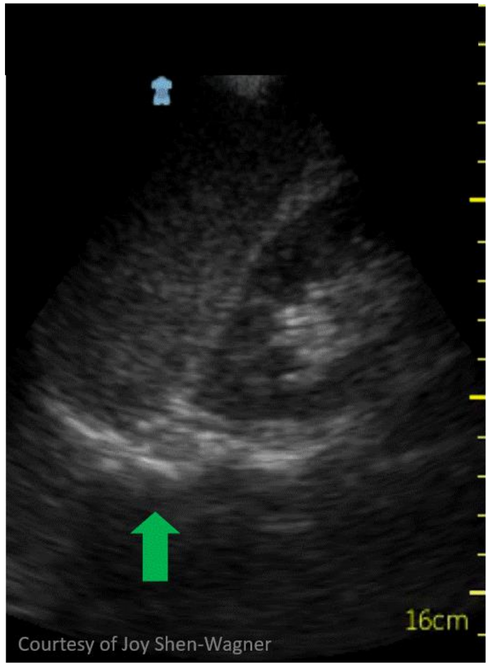
PLAX



Anterior Lungs



RUQ/LUQ

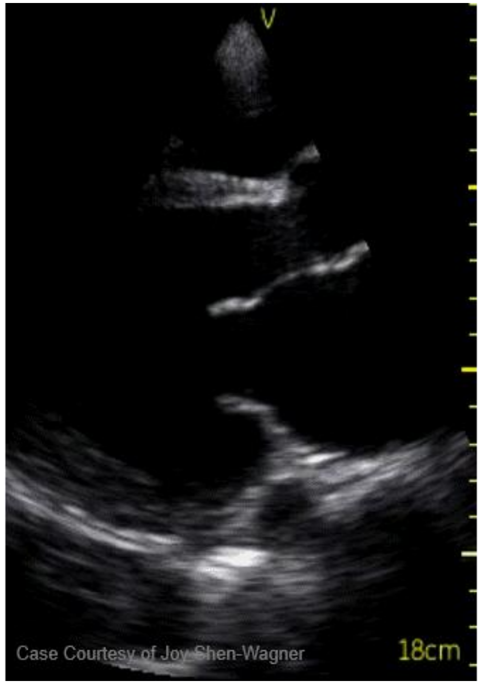


IVC

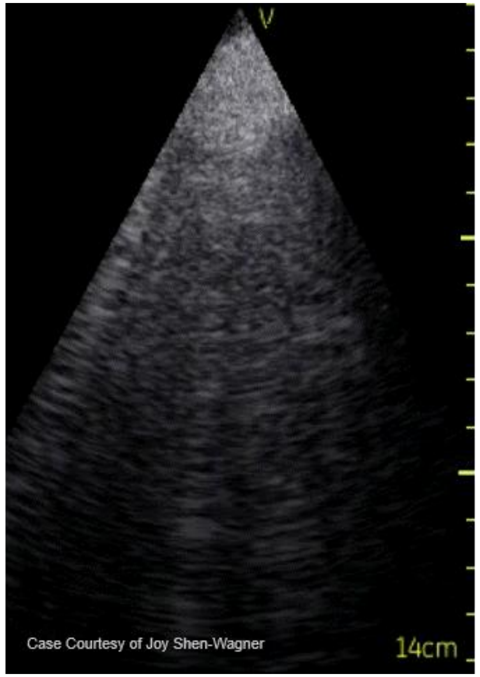
CLUE Protocol

Dyspneic patient with a history of HTN, DM2 and HLD with new onset cough and hypoxia.

- PLAX

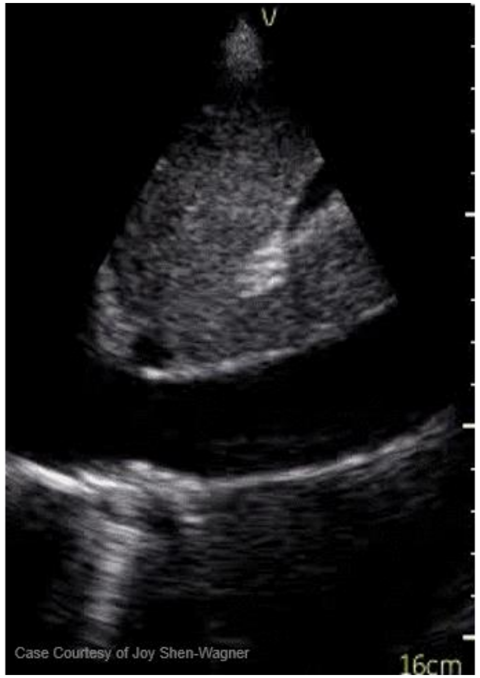


Anterior Lungs



RUQ/LUQ

IVC



Practice Recommendations

- Document an Indication for the study
- Create an independent report
- Permanent storage of retrievable images
- Follow rules per your institution for credentialing

Shen-Wagner J, Deutchman M, “POCUS: A Practical Guide for Primary Care,” Family Practice Management. 2020 Nov/Dec;27(6):33-40.

CPT

Limited chest ultrasound: 76604

Take Home Points

- B lines are the more sensitive version of crackles, a visual for pulmonary edema.
- Lung ultrasound is sensitive for pleural effusion.
- Lack of lung sliding does not equal PTX, find a lung point.
- Incorporate lung views into a multi-organ ultrasound physical to workup undifferentiated dyspnea.

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Thank you!

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AAFP

AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

AAFP CME

Abdominal Aortic Aneurysm Screen

Andrea Lewis, DO, RDMS, FAAFP

Assistant Professor, Southern Colorado Family Medicine

Disclosure Statement

It is the policy of the AAFP that all individuals in a position to control CME content disclose any relationships with ineligible companies upon nomination/invitation of participation. Disclosure documents are reviewed for potential relevant financial relationships. If relevant financial relationships are identified, mitigation strategies are agreed to prior to confirmation of participation. Only those participants who had no relevant financial relationships or who agreed to an identified mitigation process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Describe the rationale and current recommendations for performing AAA screening.
2. Describe anatomical landmarks visualized during AAA screening and know which representative images to measure and save.
3. Identify normal from abnormal abdominal aorta appearance and know when the aorta has NOT been adequately imaged.
4. Recognize appropriate billing practices.

What other clinical and screening reasons for AAA?

- Most AAA are asymptomatic!!!!

  Prevalence is as high as 4-7% in elderly men

- Listen to your elderly patients with back/flank/abdominal pain (AAA commonly misdiagnosed as other diseases such as diverticulitis, UTI, renal stones….)

- Trauma evaluation

Christina L. Marcaccio, Marc L. Schermerhorn, Epidemiology of abdominal aortic aneurysms, Seminars in Vascular Surgery, Volume 34, Issue 1, 2021, Pages 29-37, ISSN 0895-7967. https://doi.org/10.1053/j.semvascsurg.2021.02.004.

Services Task Force (USPSTF) AAA Clinical Guideline

Grade B: Men 65-75yo who have ever smoked (100 cigs)

-One time screening with ultrasound

Grade C: Men 65-75yo Never Tobacco

-Selective screening

Grade D: Screening women never tobacco

-Recommends against screening

Grad I: Screening women 56-75yo who smoked

-Insufficient evidence

Last updated 12/2019: https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/abdominal-aortic-aneurysm-screening

American Heart Association & American College of Cardiology

Joint Committee on Clinical Practice Guidelines Recommendation for AAA screening 2022

COR	Recommendations
1	MEN ≥ 65yo who ever smoked → US AAA screening recommended
1	Everyone ≥ 65yo with 1st degree relative having a AAA → US AAA screening recommended
2a	WOMEN ≥ 65yo who ever smoked → US AAA screening reasonable
2b	Everyone < 65yo with multiple risk factors or 1st degree relative having a AAA → US AAA may be considered
3 (no benefit)	Everyone > 75yo with negative initial US AAA screen → Repeat US AAA screen NOT recommended

Isselbacher, et al. 2022

AAA Screening Rationale

- Incidence increased with age especially > 50
- Smoking increases risk
- AAA rupture = high mortality even if it happens while in the hospital

LeFevre, 2014

Define Abdominal Aortic Aneurysm

> 3 cm

Risk of Rupture increases with size

Aortic Diameter	Annual Risk of Rupture
<4 cm	<1%
4 - 4.9 cm	1-5%
5 - 5.9 cm	3-15%
6 - 6.9 cm	10-20%
>7 cm	20-50%

Reported % varies, table summary of information from Society for Vascular Surgery, Merck manual, American College of Physicians, American Family Physicians and local consensus.

Which Transducer should we use and why?

Curvilinear or

Linear

Which Transducer should we use and why?

Curvilinear or Linear

Lower frequency with better penetration for the abdomen.

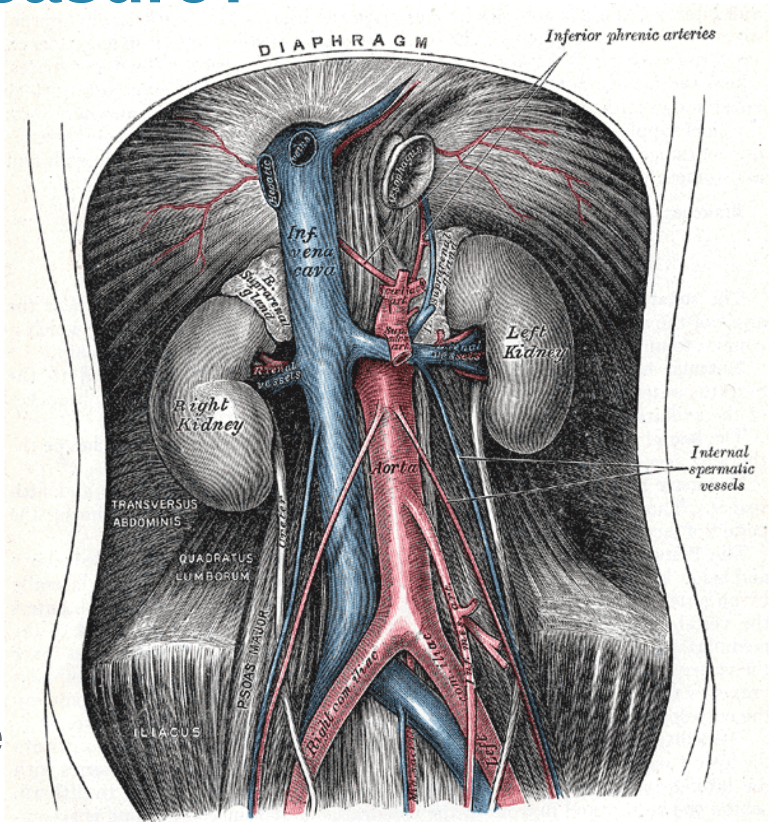
What views to image and measure?

Representative Images

- Proximal Aorta
- Mid Aorta
- Distal Aorta
  - -Long and Short of each
- Iliac bifurcation

Measure

- Anterior → Posterior (AP) and transverse at each level of Aorta
- AP and transverse of Iliacs



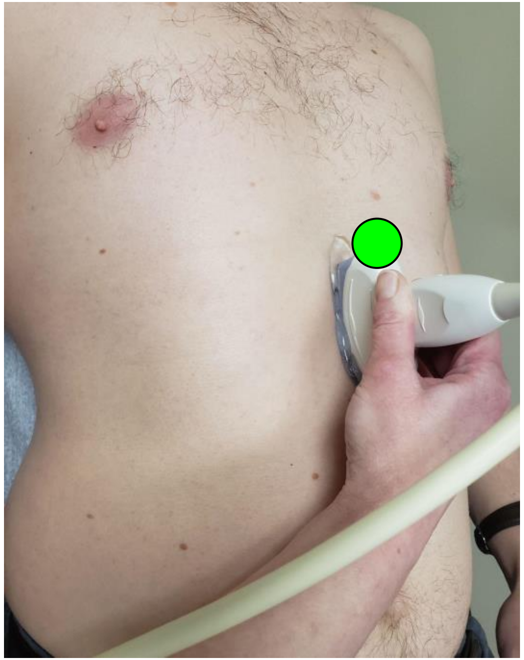
Henry Gray (1825–1861). Anatomy of the Human Body. 1918. FIG. 531

Aorta: Scanning Technique

- TOUCH THE XIPHOID with your left hand
- Put the probe on the sub-xiphoid region using left lobe of liver as an acoustic window
- Distinguish arterial AAA from venous IVC pulsations
- Remember your anatomy (the Aorta should be to the patient’s Left)
- Follow distally to iliac bifurcation in transverse and sagittal planes
- Use varying transducer pressure to work around bowel gas

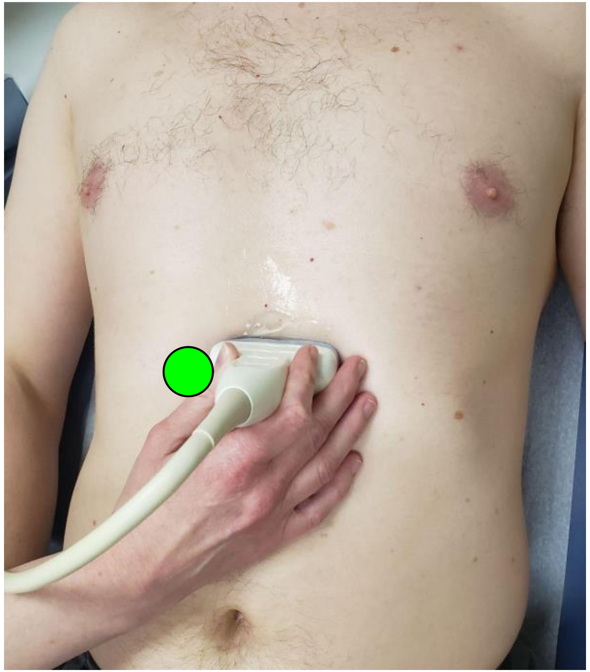
Transducer positions: Aorta and IVC

Sagittal midline subxiphoid



Probe marker: To head or right of patient

Transverse midline subxiphoid



Photos credit: Andrea Lewis, DO

Abdominal aorta branches visible w/ US

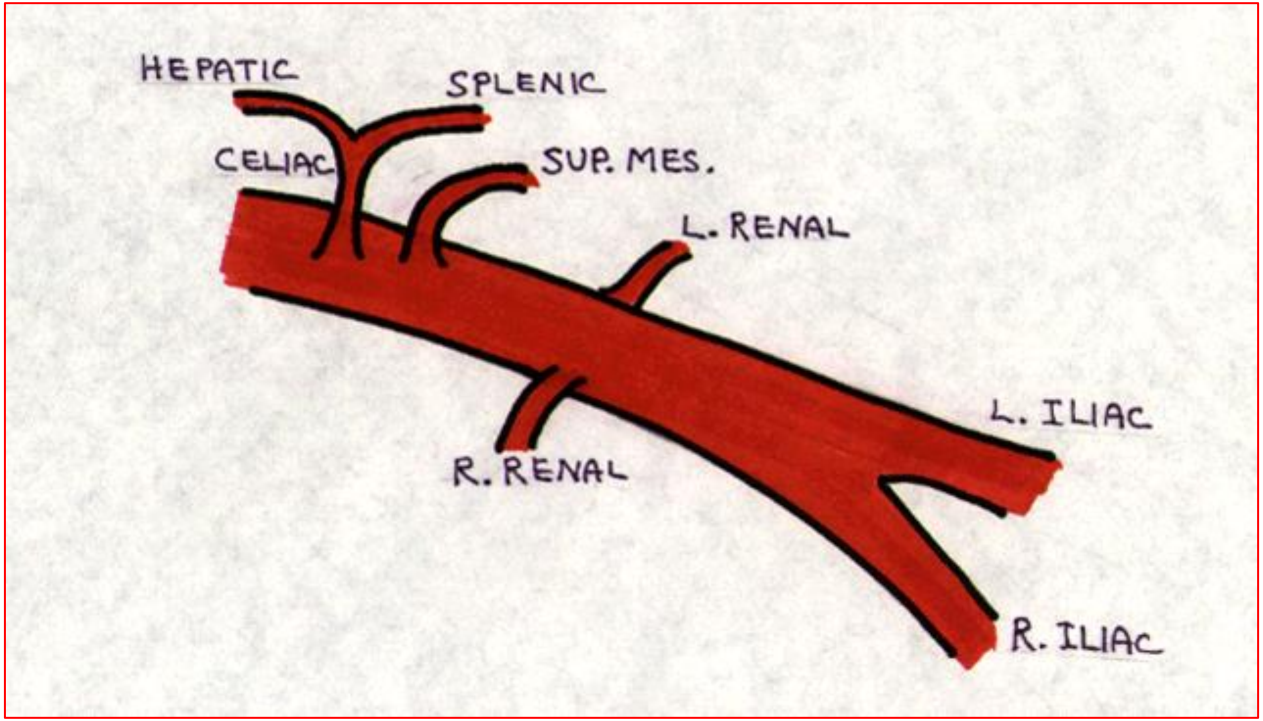
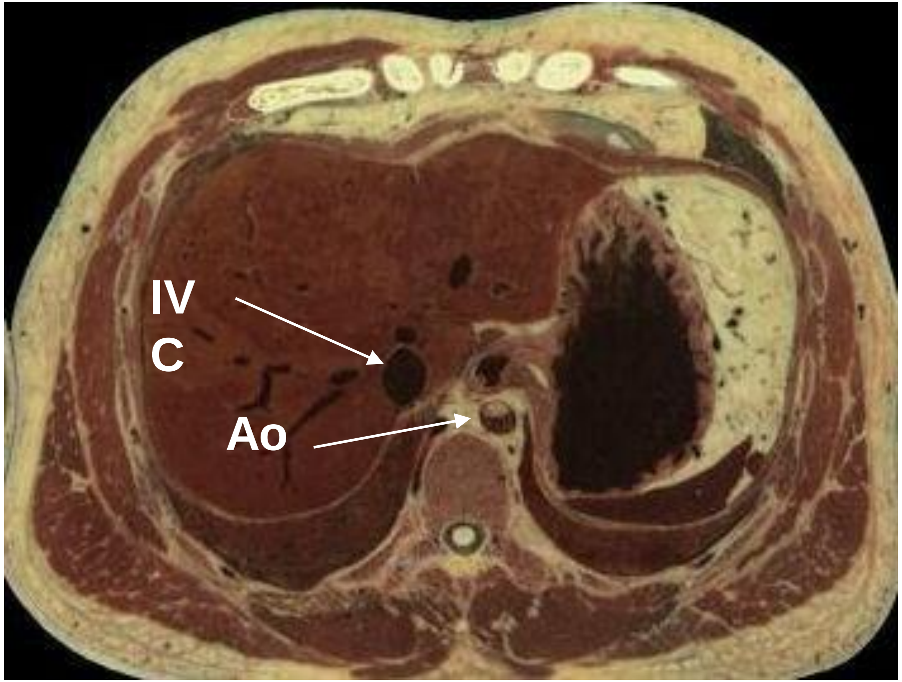


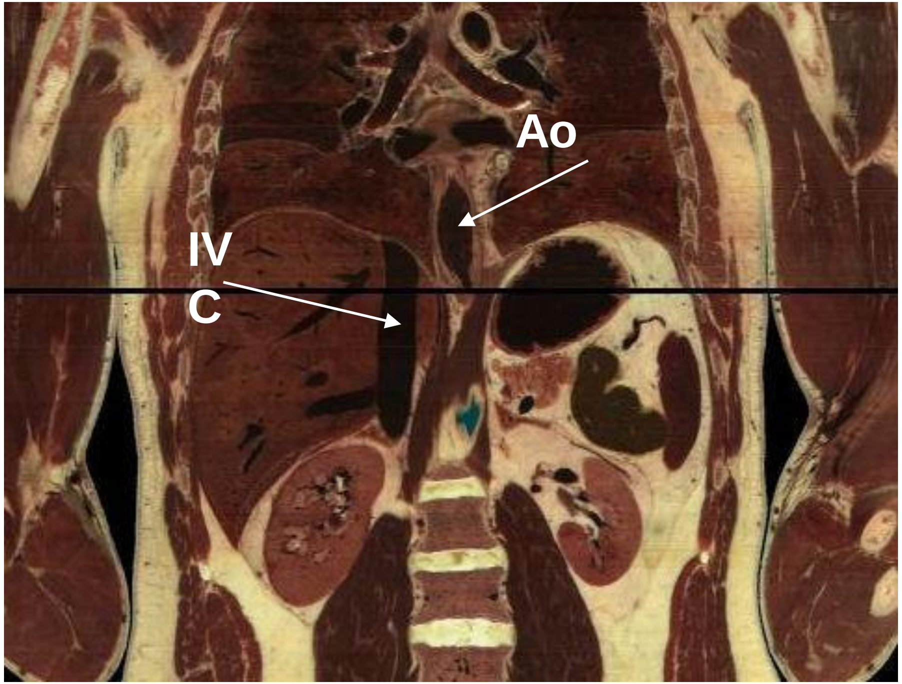
Diagram credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission

Relationship of liver to aorta and IVC

Axial



Coronal



Images: U.S. National Library of Medicine, Visible Human Project

Proximal abdominal aorta normal sagittal

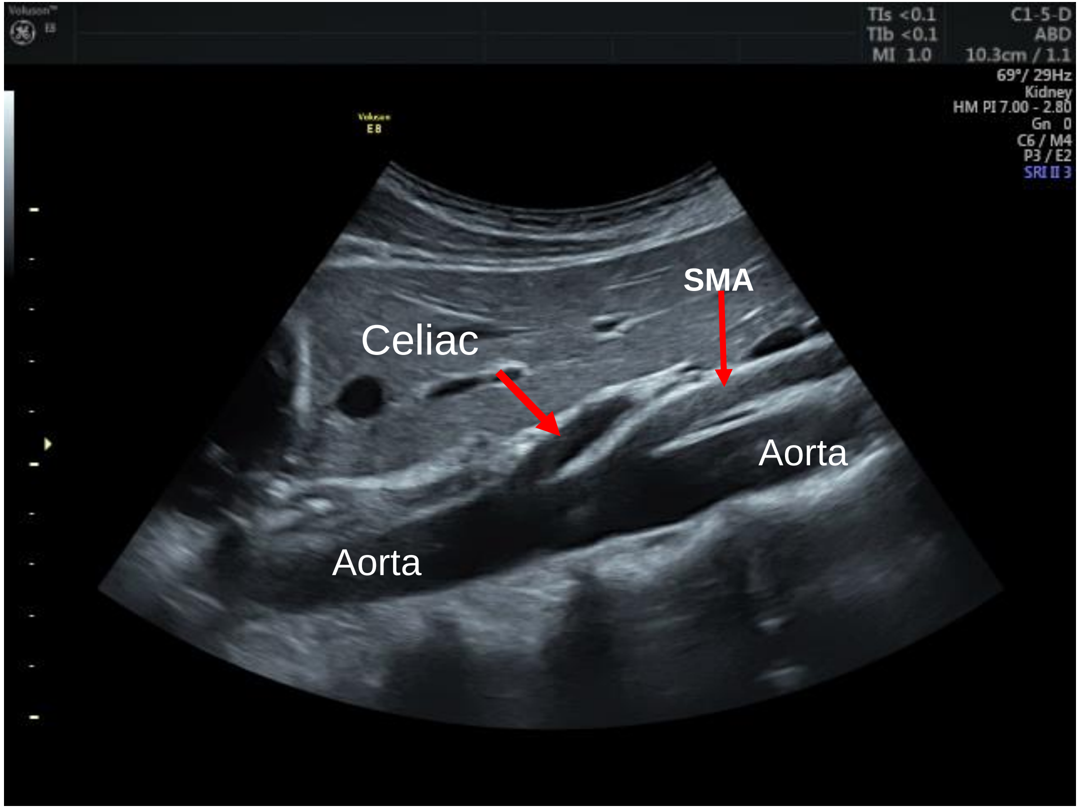


Image: Andrea Lewis, DO

Proximal abdominal aorta normal sagittal

Video: Mark Deutchman MD

Proximal abdominal aorta: normal transverse

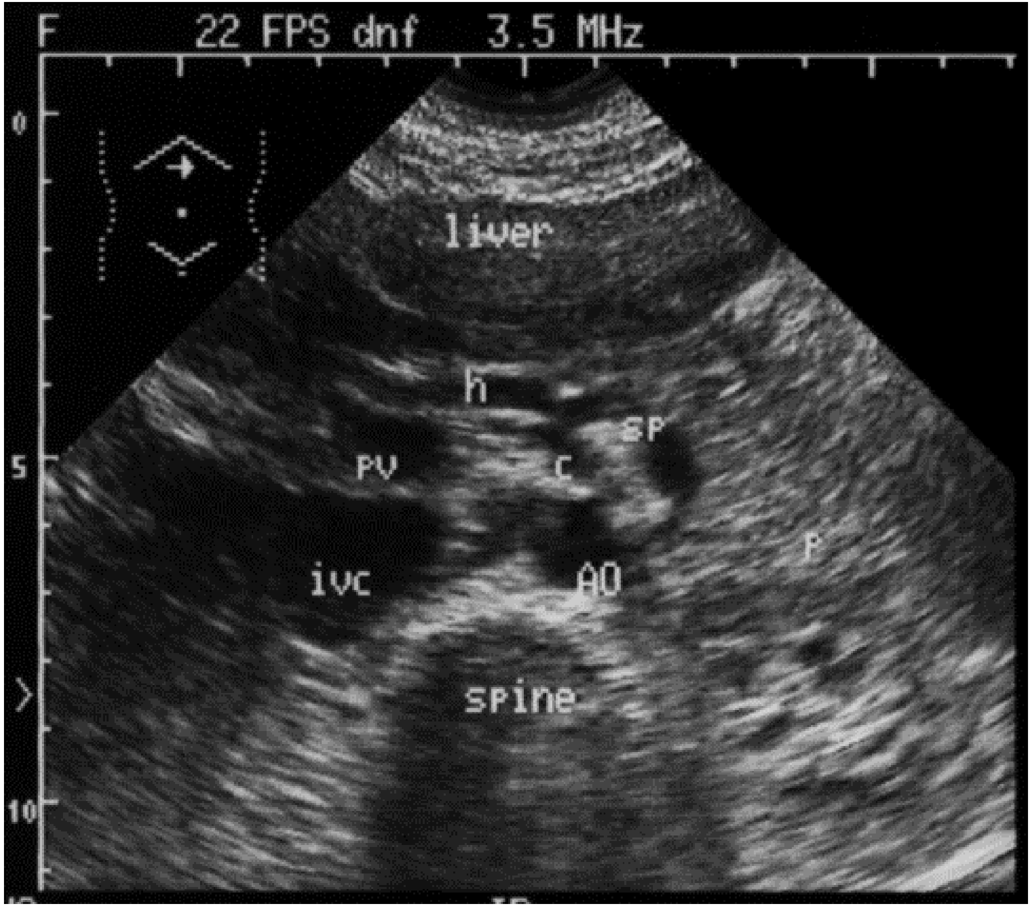
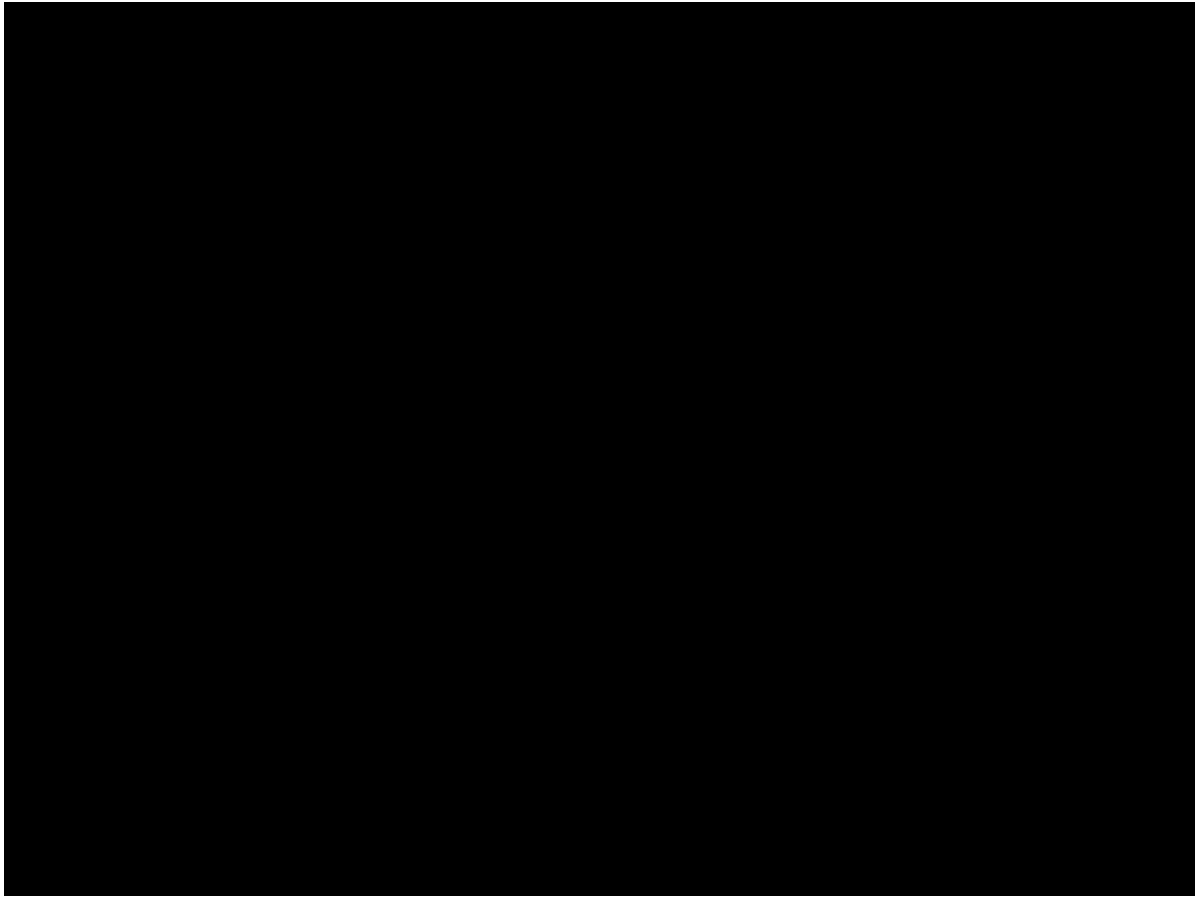


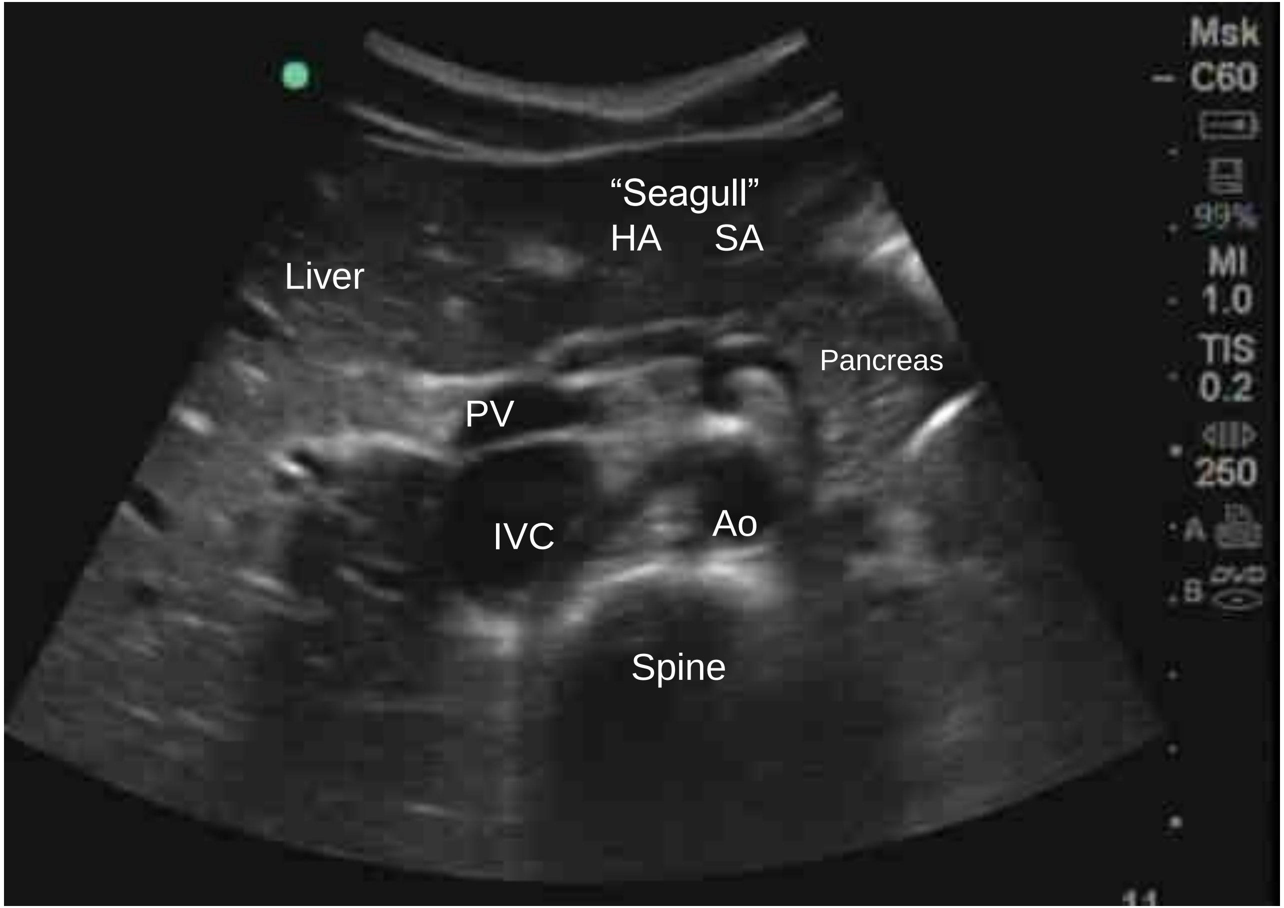
Image credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission

Proximal abdominal aorta normal: transverse video



Video with permission from:
Mark Deutchman MD

Proximal abdominal aorta normal transverse: detail



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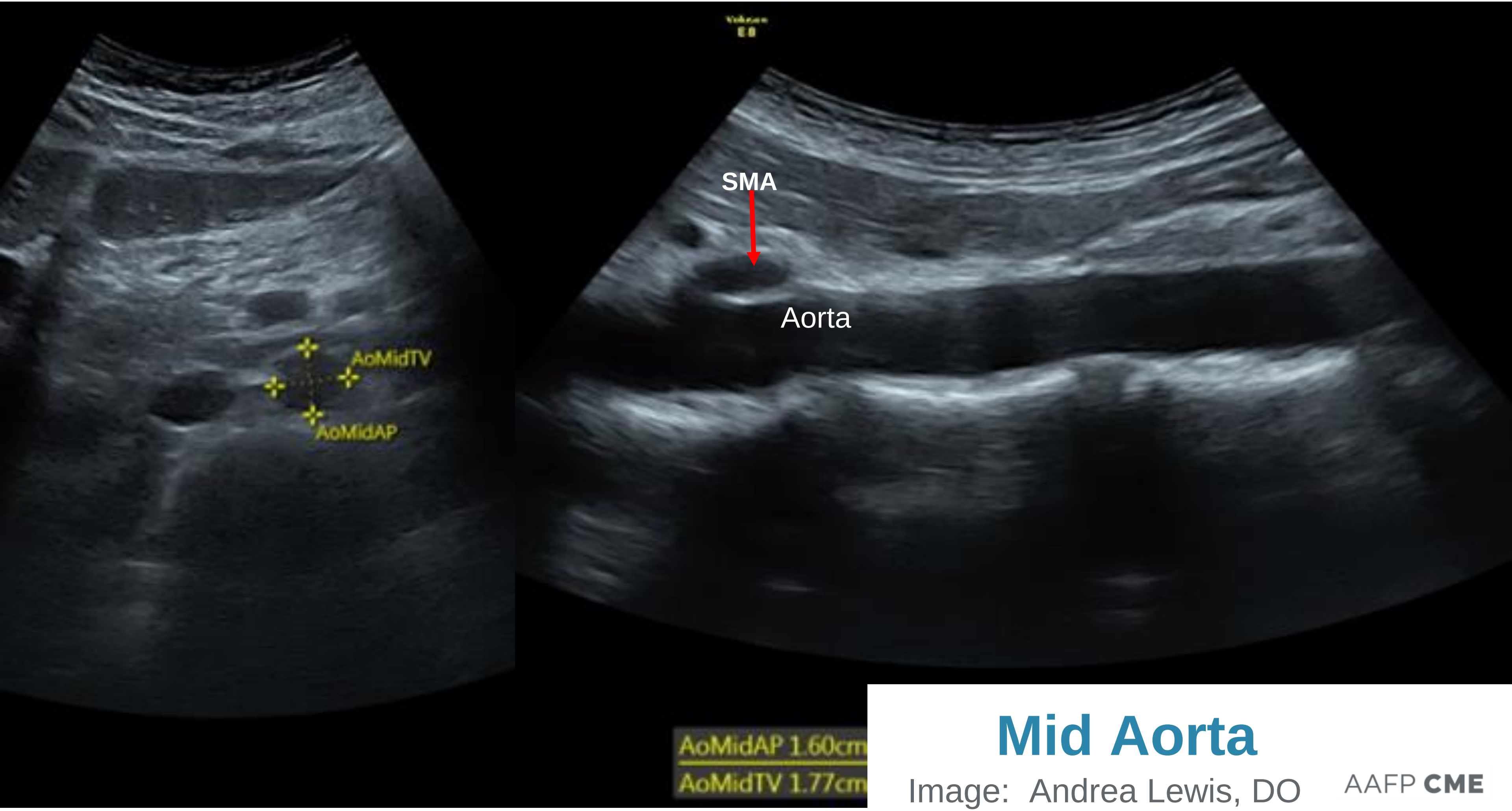


Mid Aorta

Image: Andrea Lewis, DO

AAFP CME

AAA Transverse

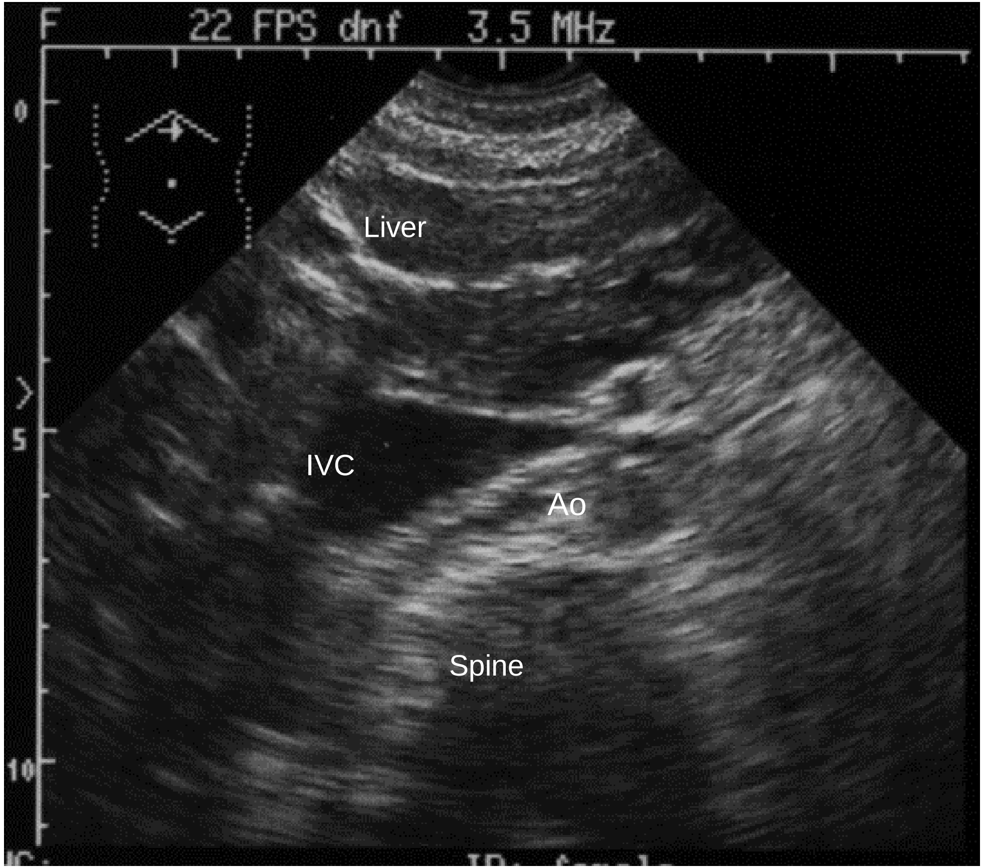
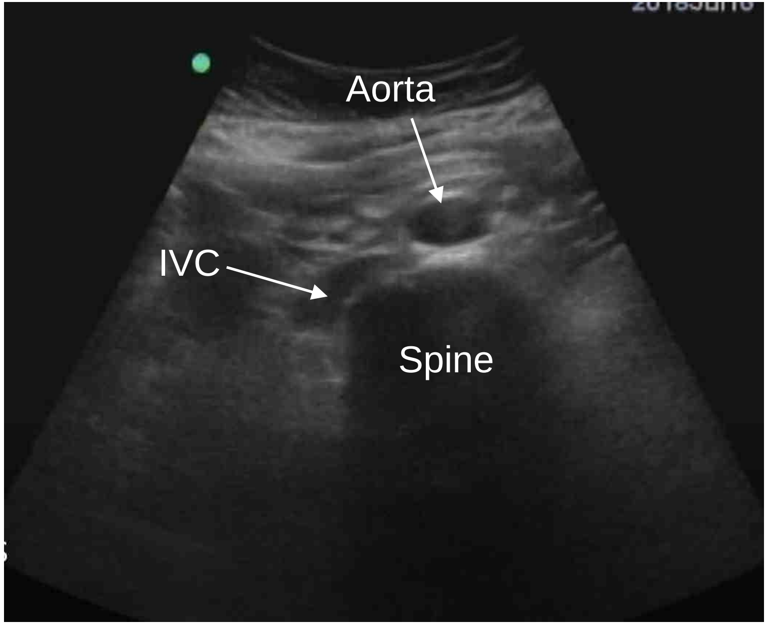


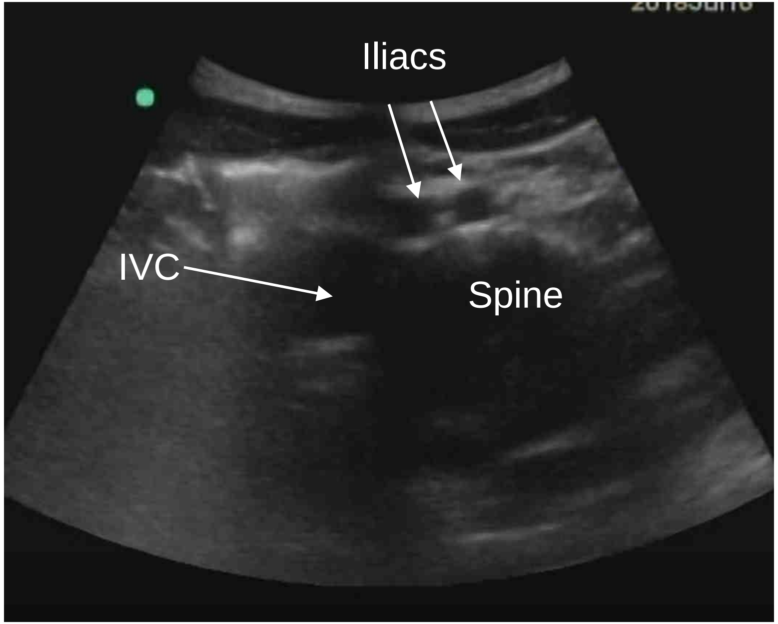
Image credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Abdominal aorta normal transverse at epigastric area and iliac bifurcation: detail

Epigastric level



Iliac bifurcation level



Images: Mark Deutchman MD

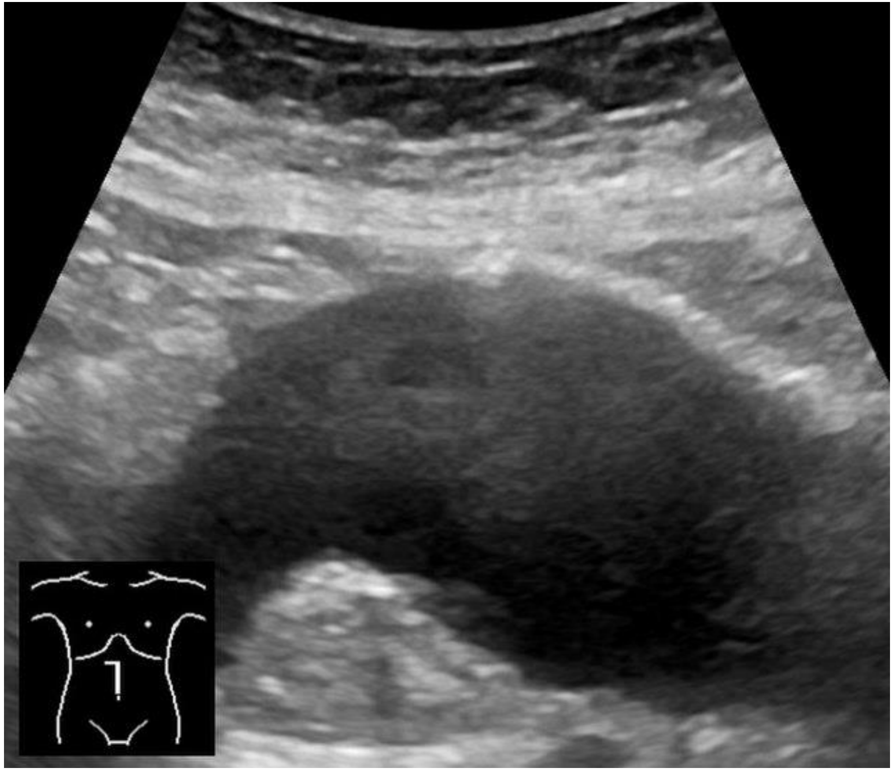
Abdominal aorta: transverse of iliac bifurcation

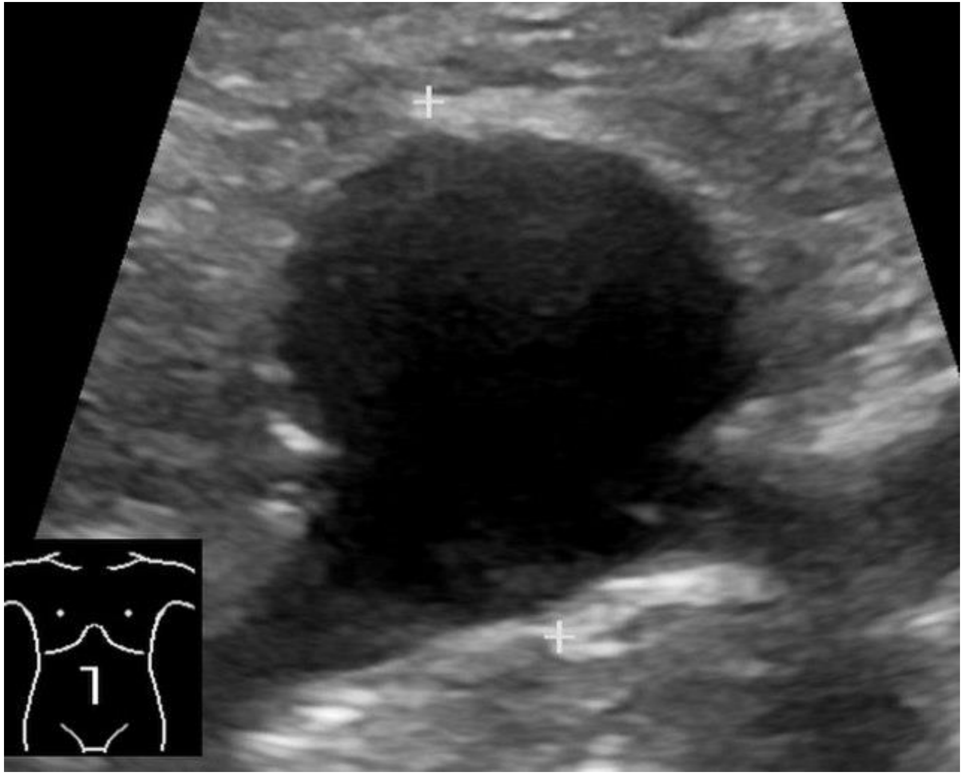
Video credit: Andrea Lewis, DO

AAA sonographic findings

- Most common shape: fusiform v. saccular
- Common location: infra-renal
- False lumen
- Thrombus and plaque
- Flaps
- Rupture

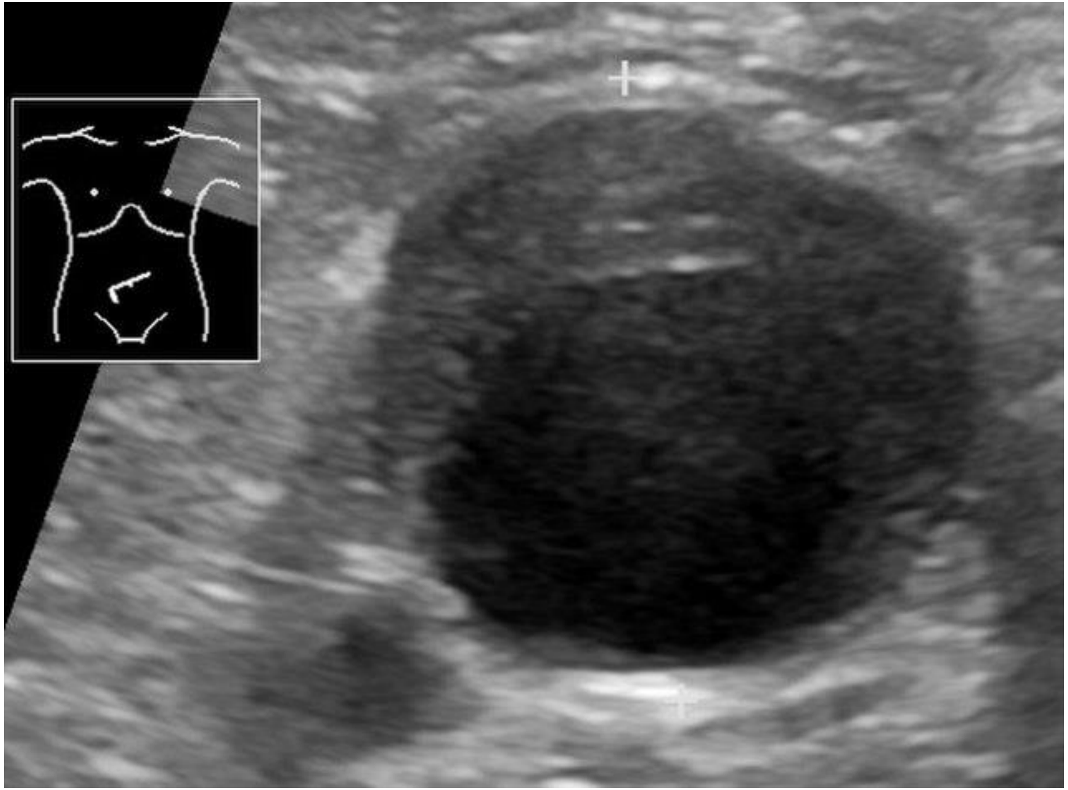
Fusiform vs.





https://commons.wikimedia.org/wiki/File:Ultrasonography_of_abdominal_aortic_aneurysm_with_mural_thrombus.jpg From the (medical) gallery of Mikael Häggström, M.D..

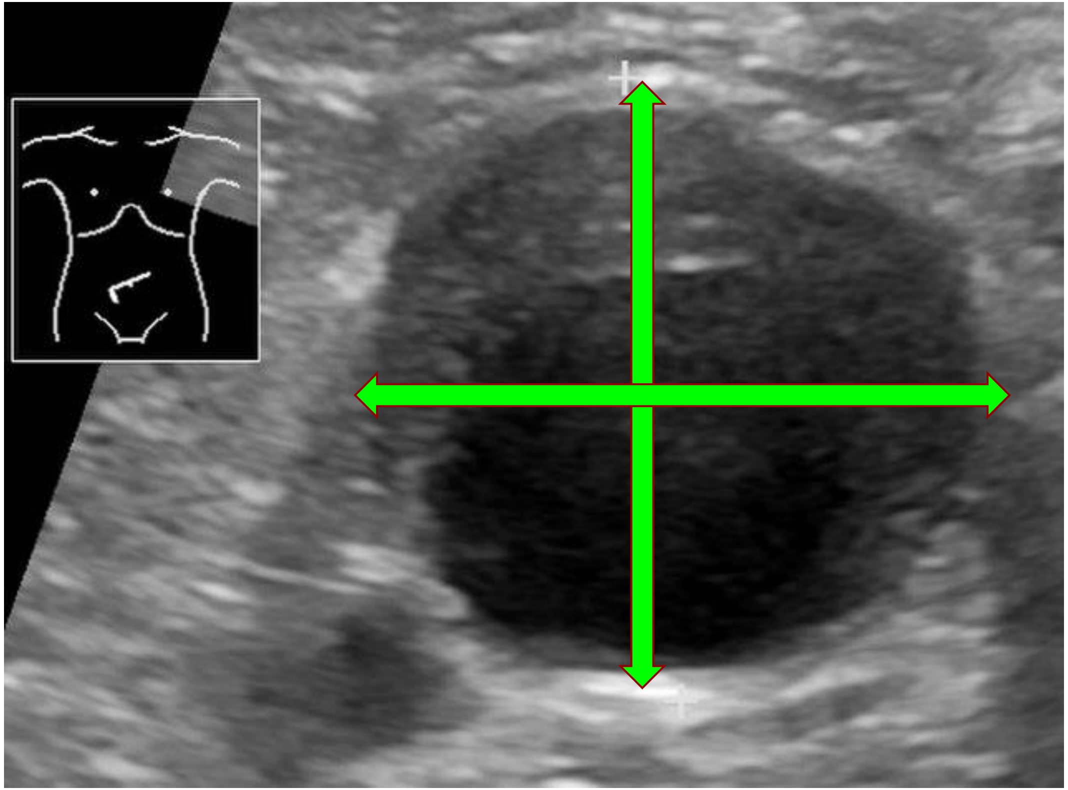
AAA transverse



https://commons.wikimedia.org/wiki/File:Ultrasonography_of_abdominal_aortic_aneurysm_with_mural_thrombus.jpg From the (medical) gallery of Mikael Häggström, M.D.. Creative Commons CC0 1.0 Universal Public Domain Dedication, used with permission.

AAFP CME

Measure AAA outer edge to outer edge



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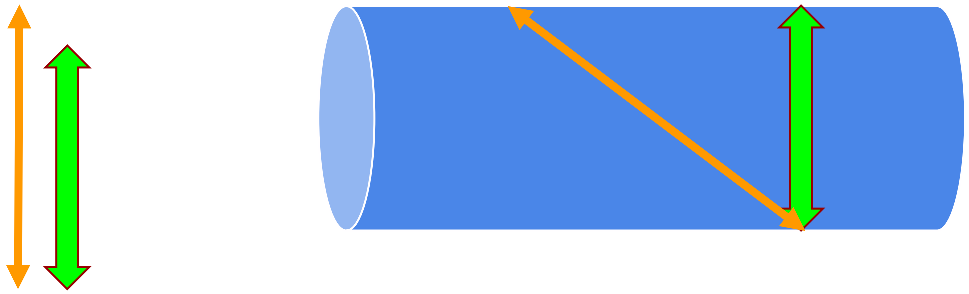
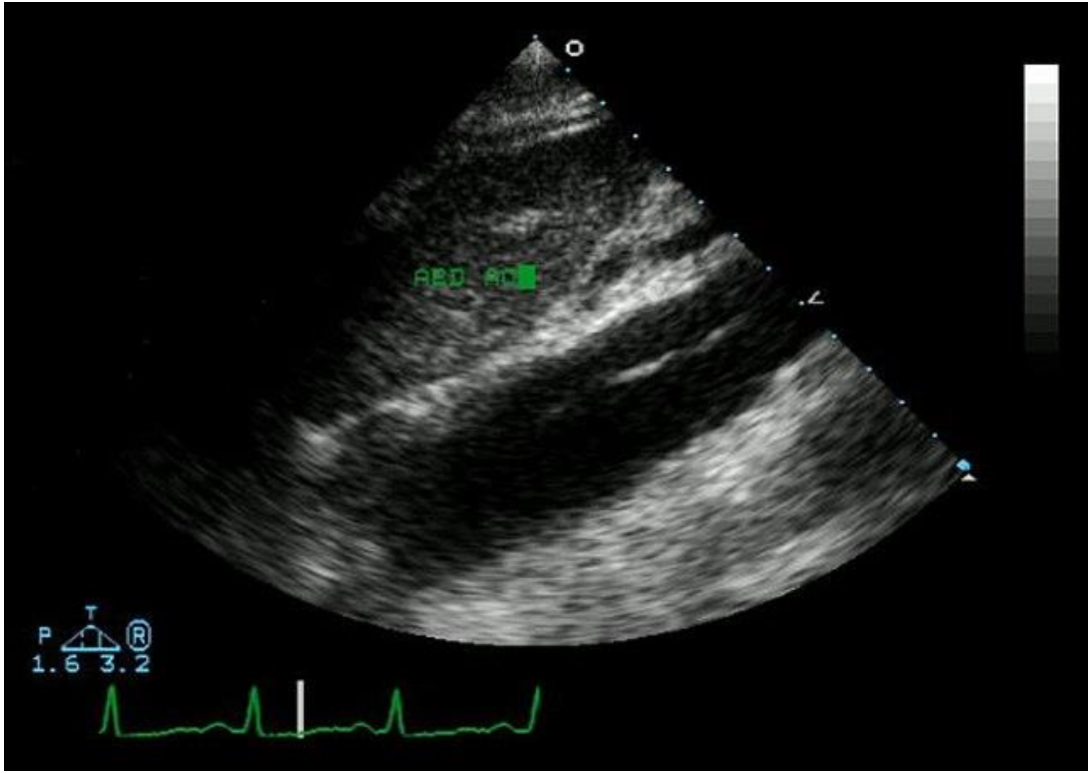
Measurements: always measure 90 degrees



Oblique causes an artificially high measurement

AAA sagittal



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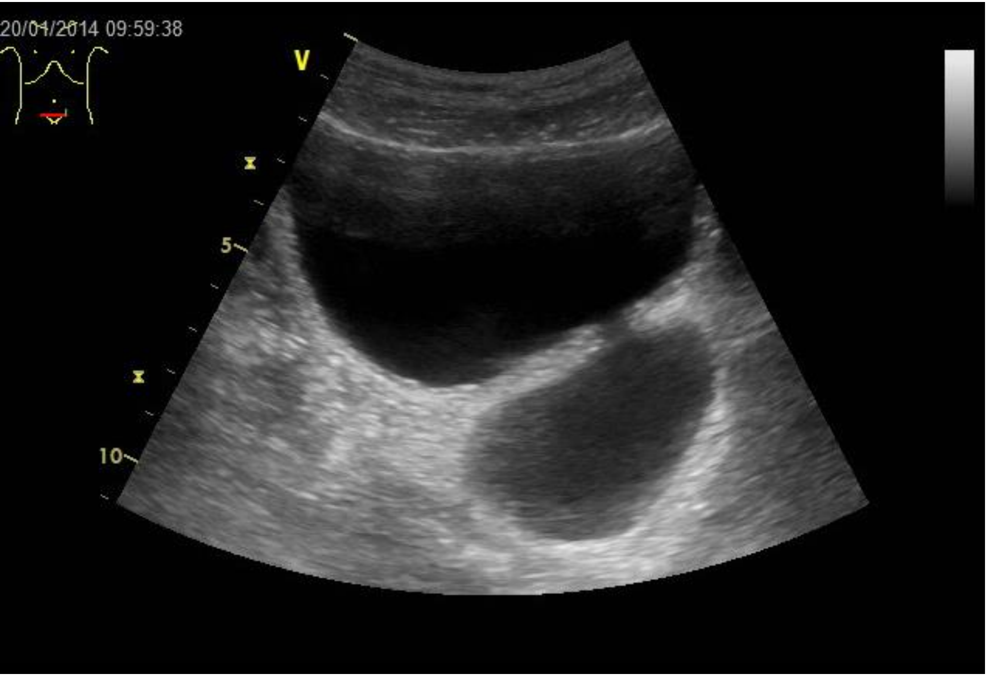
Aortic Dissection

Be careful of Mimics!



How to set yourself up for success

- Morning fasting exams
- If they are gassy in one area come back to it or roll them around
- Look for the aorta to be in a circle not an oval when measuring transverse
- Be careful to look for the vertebral shadow and if you are unsure if you have the Aorta vs. the IVC it is okay to go back to long axis or where you are sure and follow it back down

Once in a Lifetime Abdominal Aortic Aneurysm (AAA)

Use CPT code 76706

To support this CPT code use the following ICD-10 codes for the visit when billing for the AAA screening:

- Z13.6 encounter for screening for cardiovascular disorders

AND

- Appropriate code for tobacco usage: Z87.891, F17.210, F17.211, F17.213, F17.218 and F17.219

OR

- Z84.89 for family history of other specified conditions

https://www.cms.gov/medicare-coverage-database/view/article.aspx?articleId=55071#:~:text=Group%201%20Paragraph-,CPT%C2%AE%20code%2076706%3A%20Ultrasound%2C%20abdominal%20aorta%2C%20real%20time,Us%20abdl%20aorta%20screen%20AAA accessed 1/7/2024

References and resources

ACC guidelines: Isselbacher EM, Preventza O, Hamilton Black J 3rd, et al. 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. Circulation. 2022;146(24):e334-e482. doi:10.1161/CIR.0000000000001106

Christina L. Marcaccio, Marc L. Schermerhorn, Epidemiology of abdominal aortic aneurysms, Seminars in Vascular Surgery, Volume 34, Issue 1, 2021, Pages 29-37, ISSN 0895-7967. https://doi.org/10.1053/j.semvascsurg.2021.02.004.

CMS:https://www.cms.gov/medicare-coverage-database/view/article.aspx?articleId=55071#:~:text=Group%201%20Paragraph-,CPT%C2%AE%20code%2076706%3A%20Ultrasound%2C%20abdominal%20aorta%2C%20real%20time,Us%20abdl%20aorta%20screen%20AAA

LeFevre ML; U.S. Preventive Services Task Force. Screening for abdominal aortic aneurysm: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med. 2014;161(4):281-290. doi:10.7326/M14-1204

USPTF guidelines 2019: https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/abdominal-aortic-aneurysm-screening

Thank you

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AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

AAFP CME

Liver, Spleen and Peritoneal Cavity

Mark Deutchman, MD, FAAFP

Professor, University of Colorado, Department of Family Medicine

Director, Rural Program

Associate Dean for Rural Health

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- Mark Deutchman, MD – Cooper Surgical - royalties or patent beneficiary (medical device); Signostics/Echonous - advisor (ultrasound/physician advisory board; Signostics/Echonous - stock/bond holdings (ultrasound); Signostics/Echonous - researcher (loan of equipment for research)

All other individuals in a position to control content for this activity have indicated they have no relevant financial relationships to disclose

Learning Objectives

1. Recognize the normal sonographic appearance of the liver and spleen
2. Understand the use of point-of-care ultrasound to recognize these abnormalities:
    - Hepatosplenomegaly
    - Cirrhosis
    - Fatty liver
    - Liver tumors, abscesses
    - Liver metastases
    - Free intraperitoneal fluid including ascites
    - Recognize splenic injury

Note: Gallbladder and biliary ultrasound will be covered in a separate module.

Clinical Case Scenario

A 50 year-old male attended a health fair at the urging of his partner who is concerned about his alcohol use, weight gain and family history of diabetes and vascular disease. He is concerned about his increasing abdominal girth. His health fair chemistry panel showed mildly-elevated liver enzymes and blood glucose.

Why Scan the Liver?

Basic applications:

- Ascites
- Guide paracentesis
- Evaluate liver size
- Fatty liver
- Trauma: hemoperitoneum

More advanced applications:

- Right upper quadrant pain and/or jaundice: detect gallstones and biliary obstruction
- Elevated liver enzymes
- Fever - cholecystitis
- Detect metastatic disease
- Guide liver biopsy

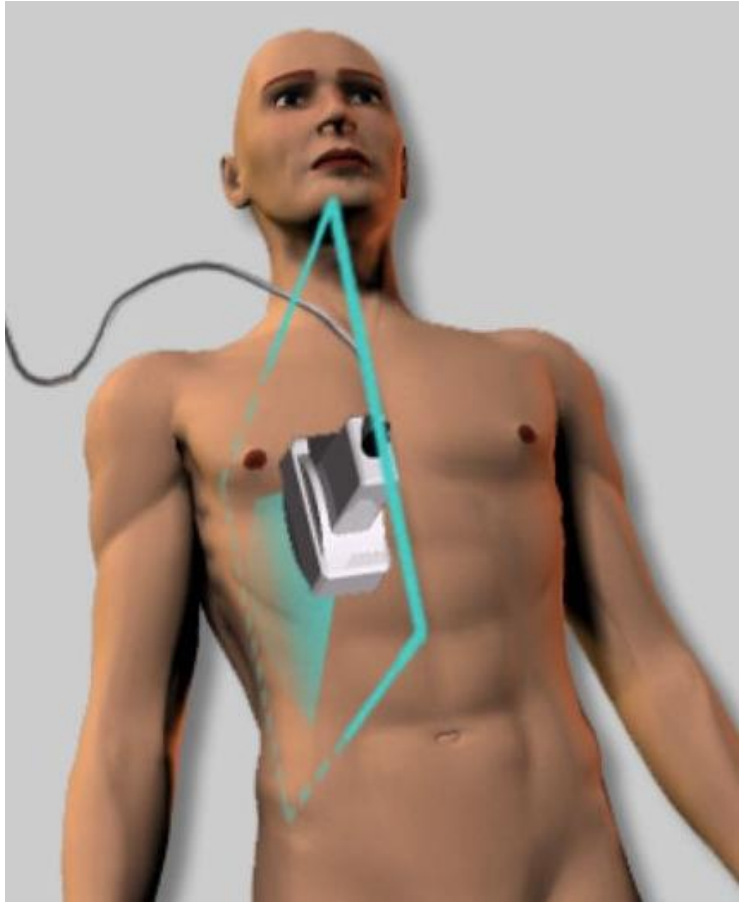
Liver Scanning Technique

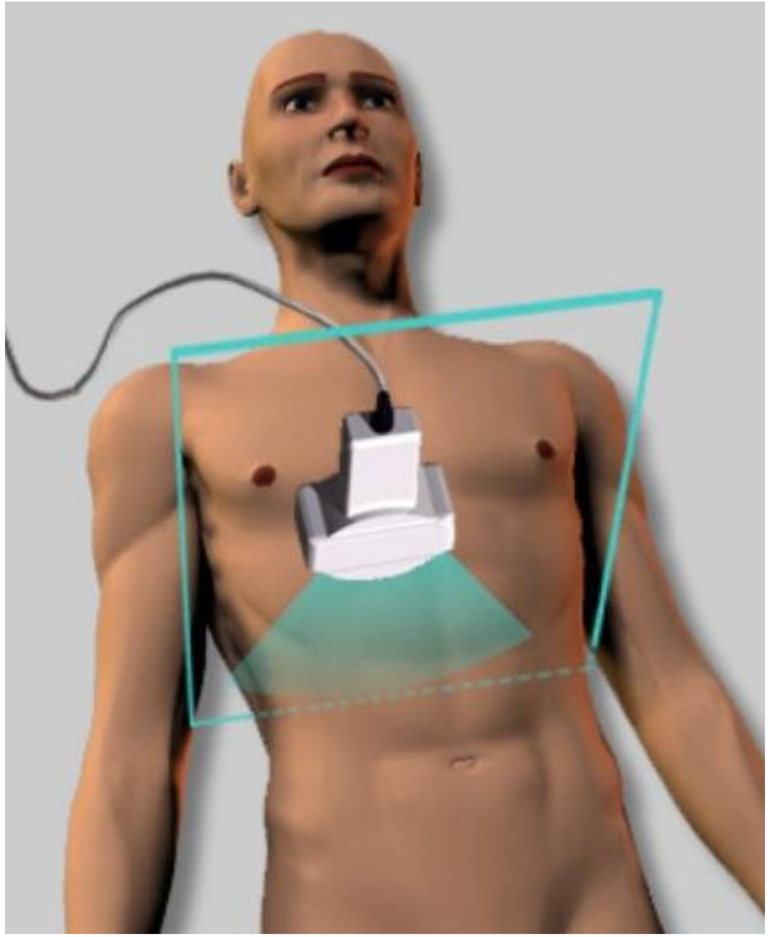
1. Patient Setup: no specific prep required; start with patient supine. Move to upright or tilted right or left if necessary.
2. Probe selection: 3MHz to 5MHz
3. Preset: abdomen
4. Probe planes: Sagittal, transverse or oblique, particularly to avoid rib shadows.

Liver Scan Probe Locations

- ✓ Varies WIDELY based on body habitus
- ✓ Start with patient supine, try varying degrees of sitting upright if needed.
- ✓ Right mid-clavicular line
- ✓ Epigastric
- ✓ Right midaxillary line
- ✓ Intercostal
- ✓ While patient holds a deep inspiration
- ✓ Colon hepatic flexure is an obstacle
- ✓ Obesity makes scanning difficult

Sagittal and Transverse Scan Planes





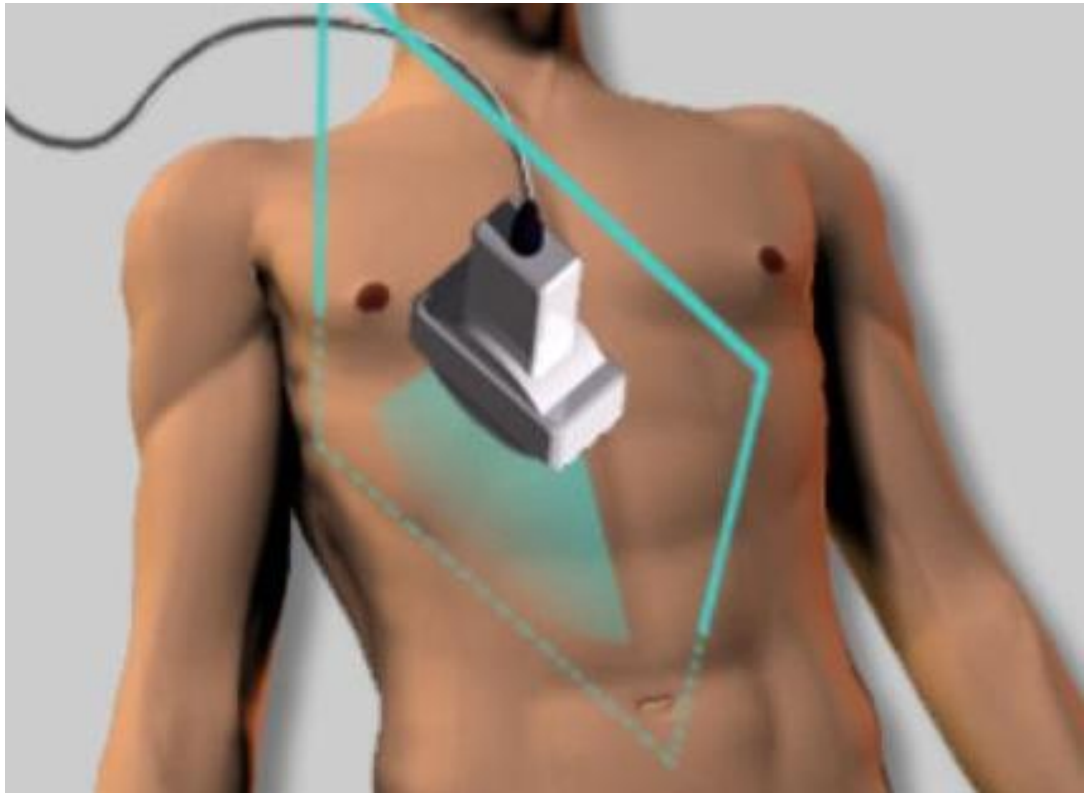
Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Physics Integration

Because the liver is shielded by ribs, acoustic shadowing by ribs often interferes with clear visualization of the liver. Several maneuvers can be used to cope with this problem including:

- Having the patient take a deep breath and/or sitting up to bring the liver below the costal margin
- Rotating the transducer into an oblique plane between ribs
- Rolling the patient to the left and scanning through the left flank

Oblique and Midaxillary Scan Planes



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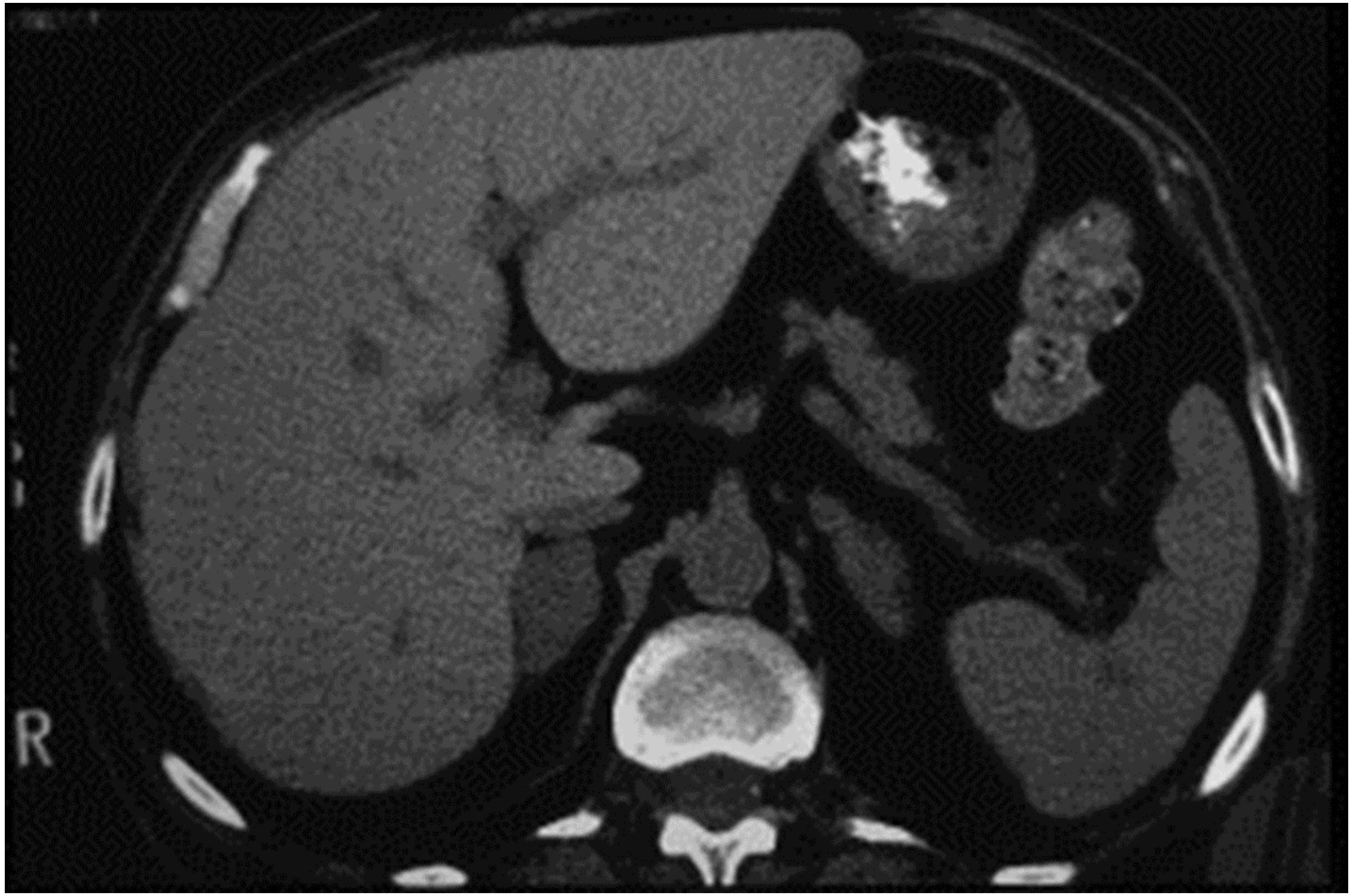
Liver and Spleen: Relative Locations



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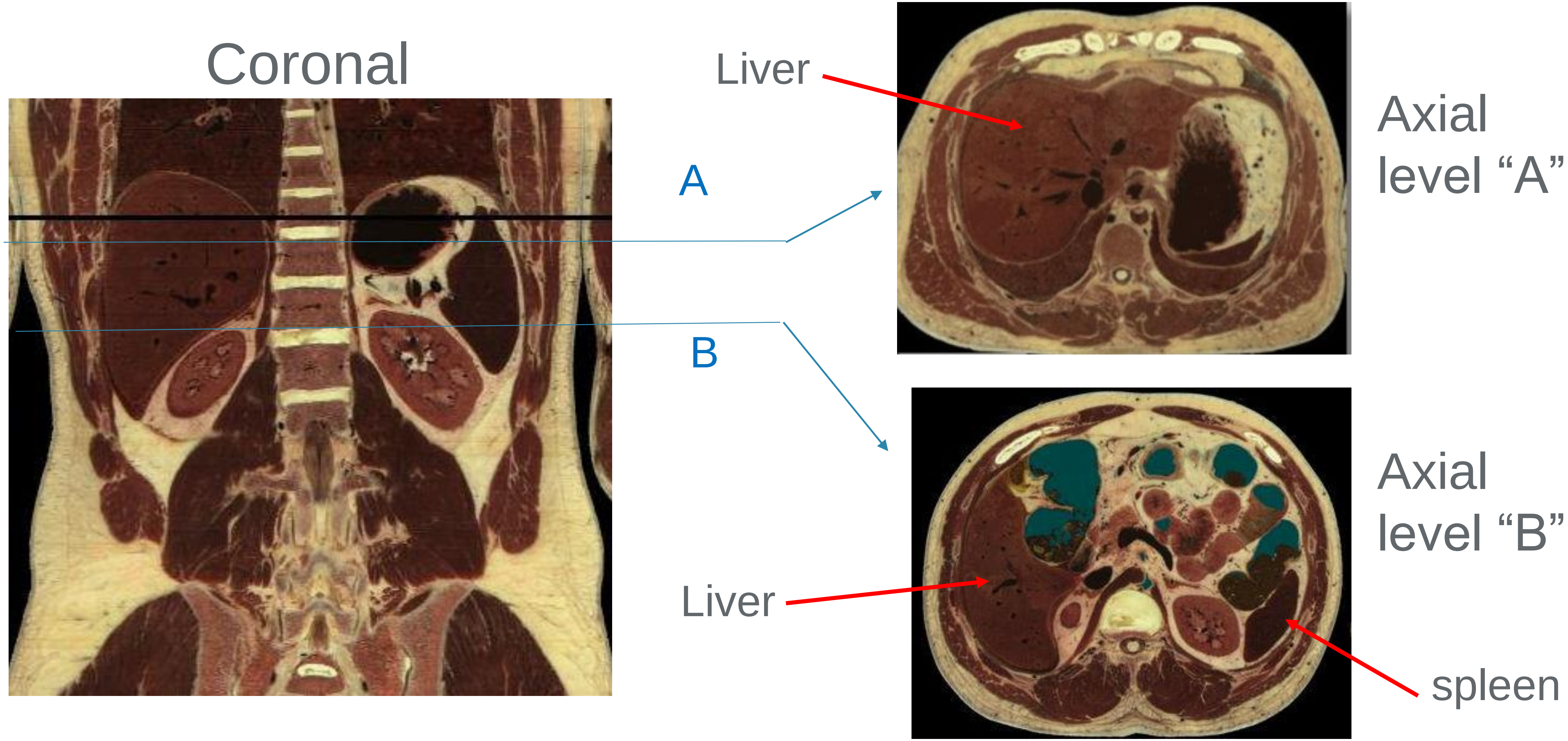
Normal Liver Size (Adults)

- Average craniocaudal liver span in midclavicular line is 15 cm +/- 1.5 cm
- Influencing factors: gender, age, BMI, height, fatty liver waist-to-hip ratio and metabolic syndrome
- Non- influencing: diabetes mellitus, alcohol consumption, tobacco, physical activity, labs

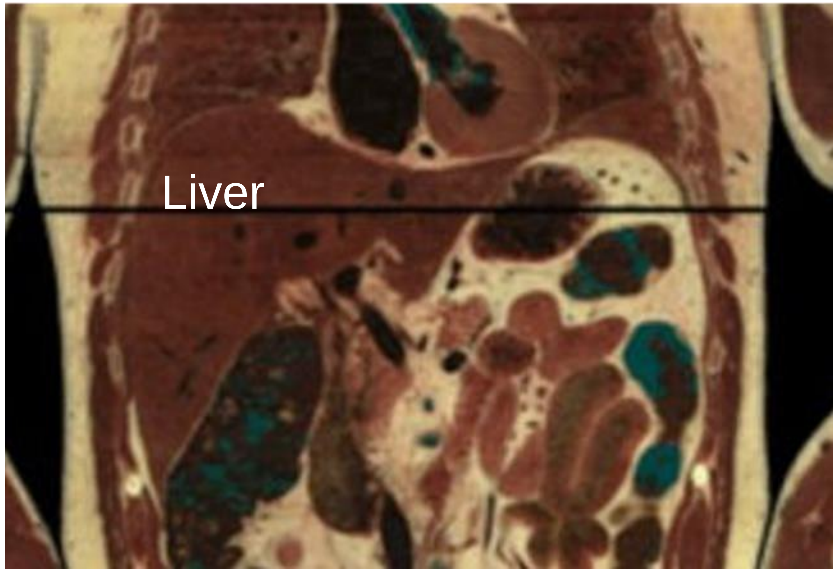
Patzak M, Porzner M, Oeztuerk S, Mason RA, Wilhelm M, Graeter T, Kratzer W, Haenle MM, Akinli AS; EMIL Study Group. Assessment of liver size by ultrasonography. J Clin Ultrasound. 2014 Sep;42(7):399-404. doi: 10.1002/jcu.22151. Epub 2014 Mar 17. PMID: 24638913.

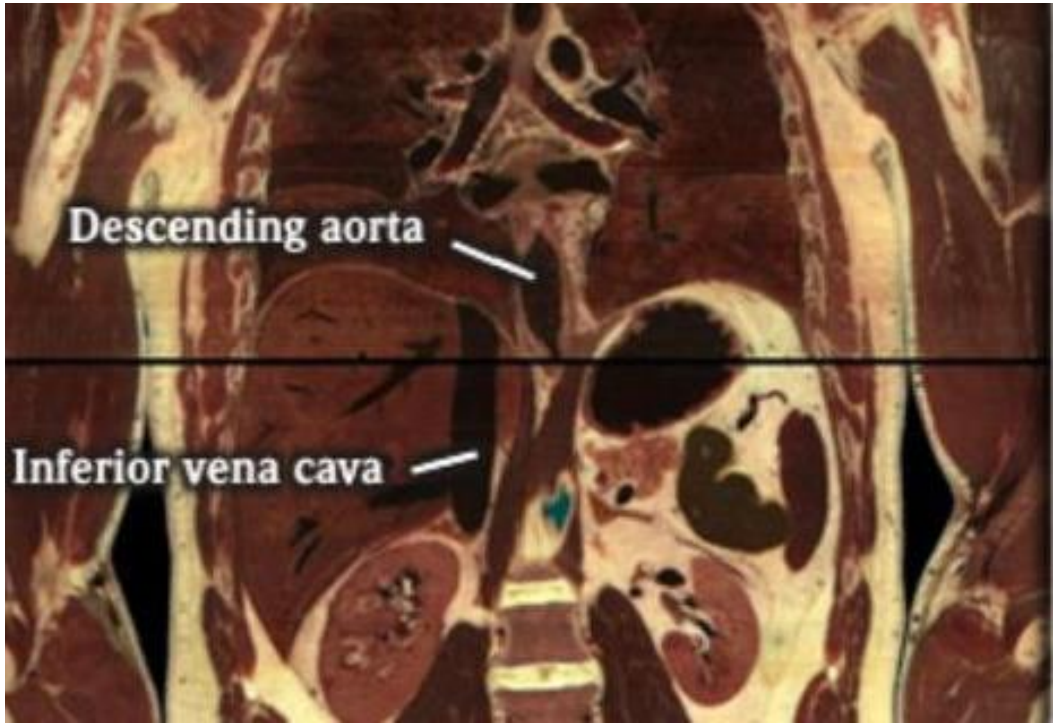
Anatomy review: liver and upper abdomen



Images: U.S. National Library of Medicine, Visible Human Project

Left lobe of liver extends past midline and covers IVC and aorta anteriorly





Images: U.S. National Library of Medicine, Visible Human Project

Liver: Normal Sonographic Findings

Occupies RUQ and left lobe extends to midline

Homogeneous parenchyma

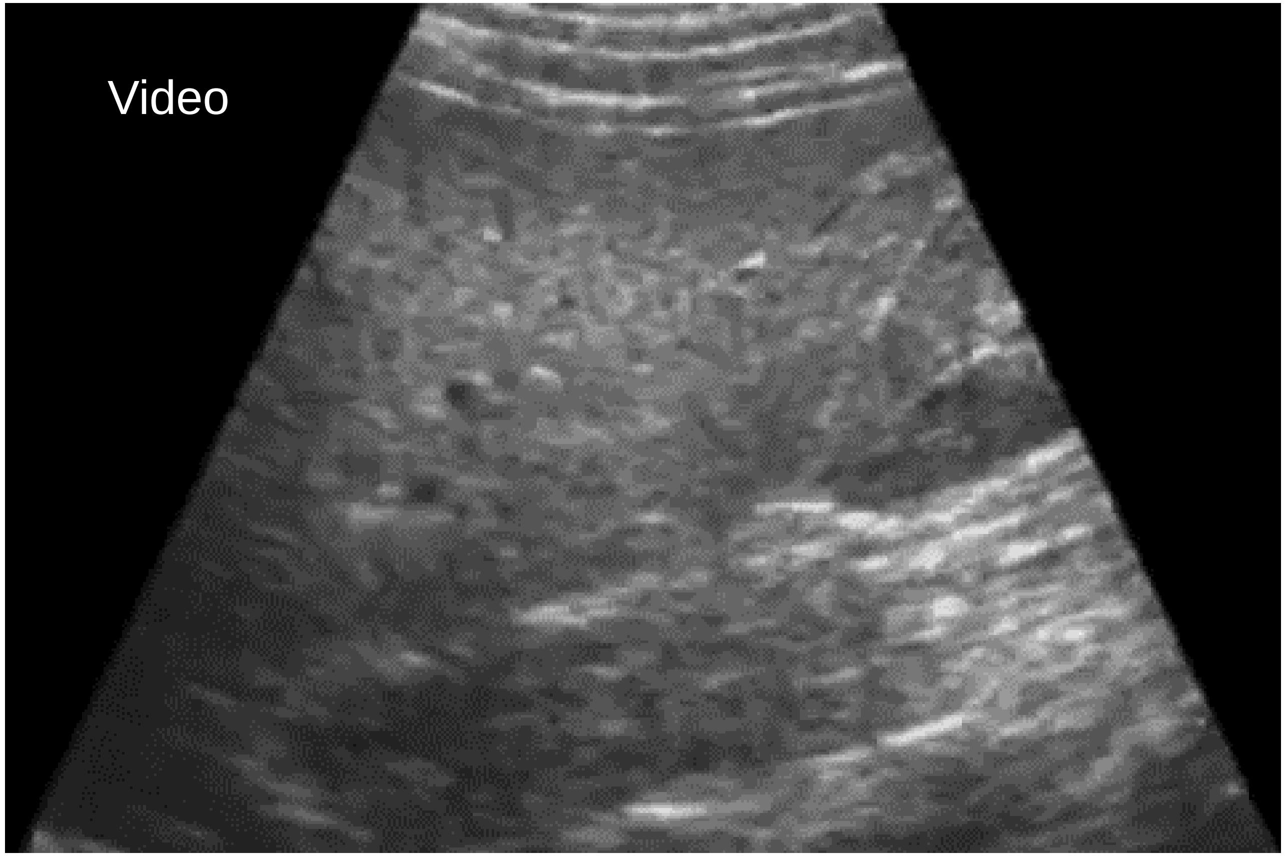
- Hepatic veins lead to IVC (bunny head)
- Portal veins lead to porta hepatis (Mickey Mouse)
- Bile ducts usually not seen

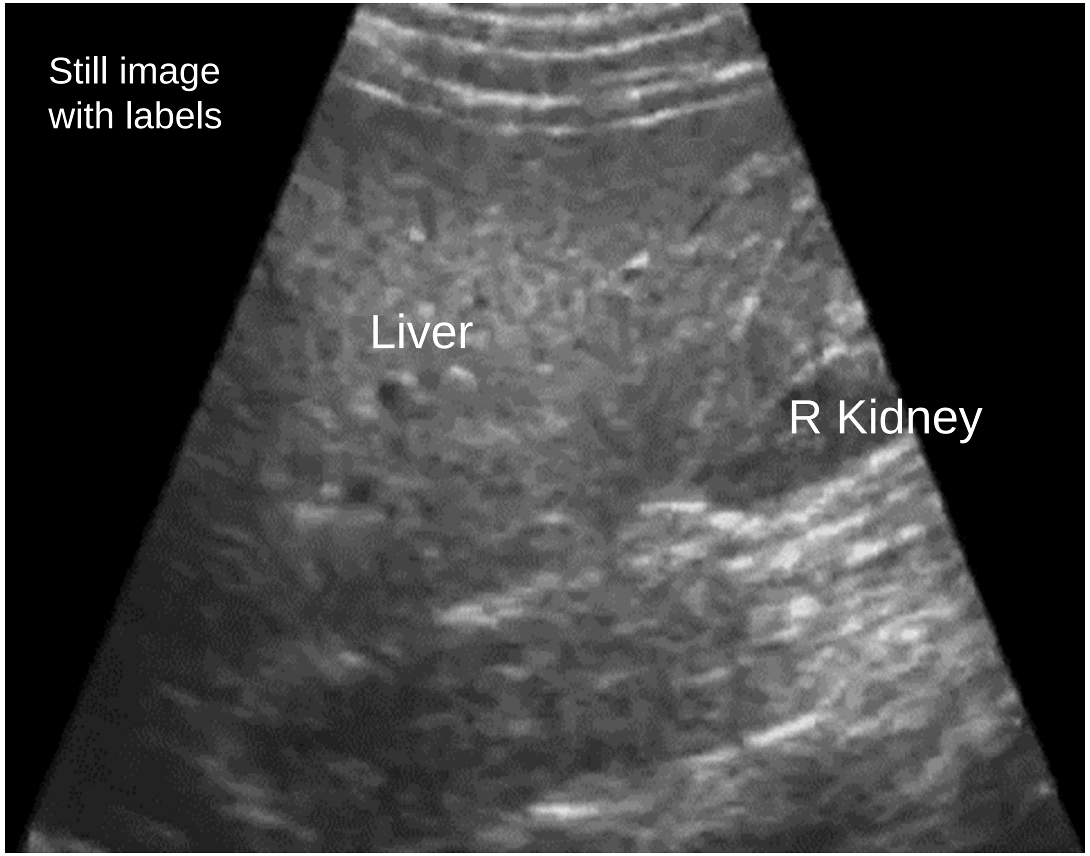
Bounded by diaphragm above and posteriorly

Slides down over right kidney with deep breaths

GB varies in size, shape and location

Video: Liver and Right Kidney





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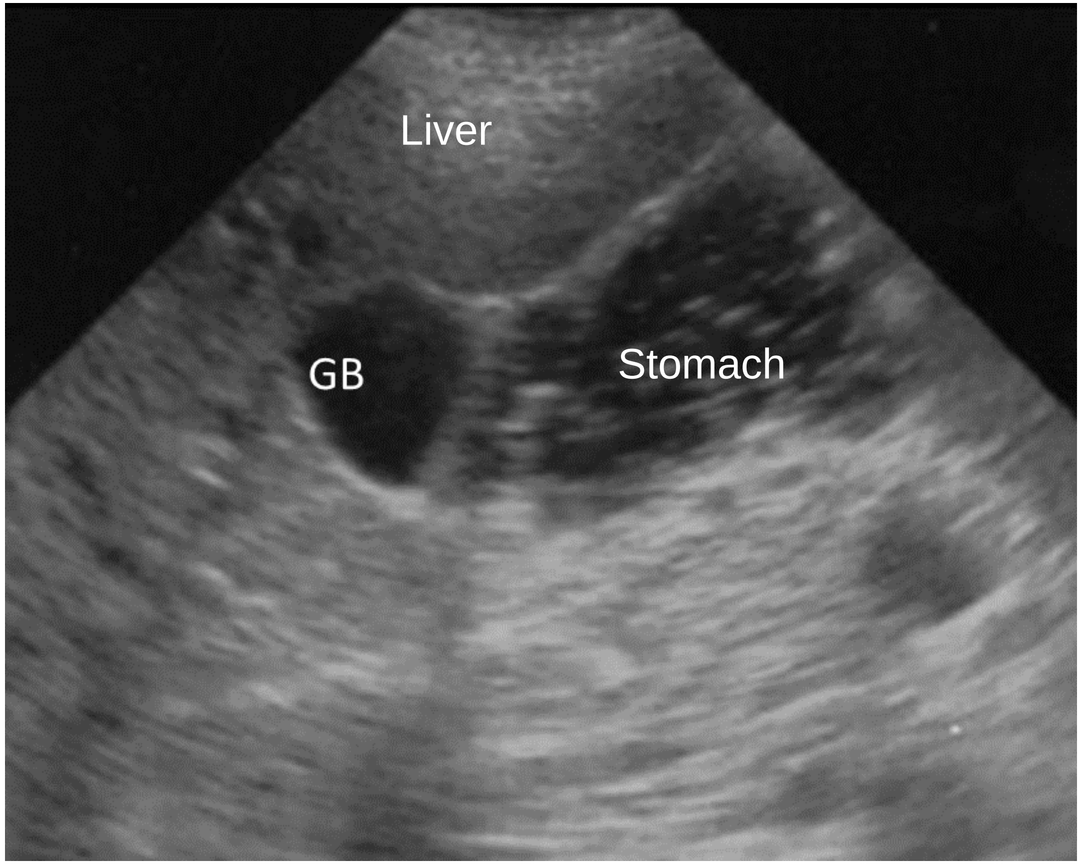
Normal liver and GB relationships - sagittal

Image credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Normal Liver and Close Structures



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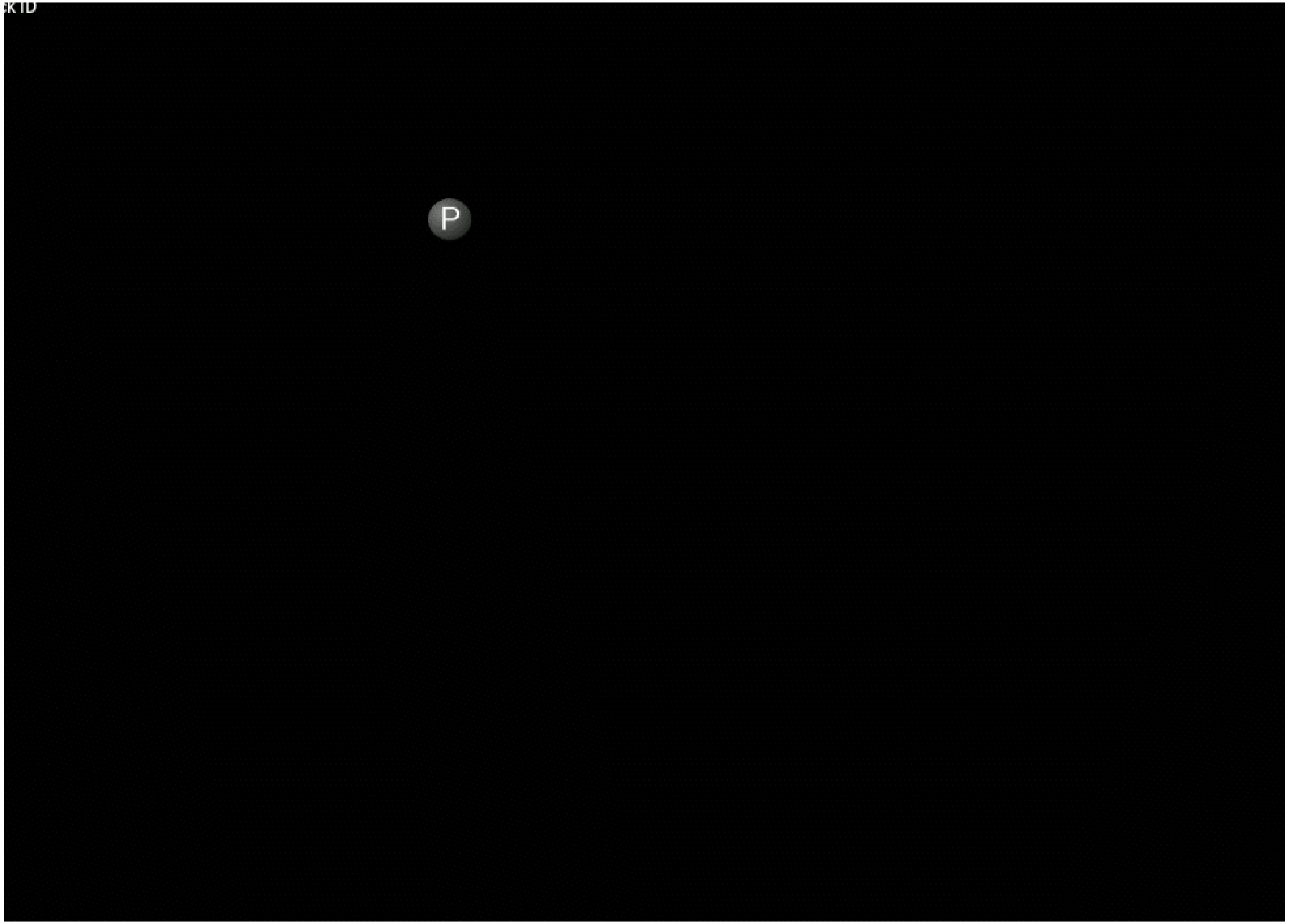
Sagittal Video of Liver, GB and IVC



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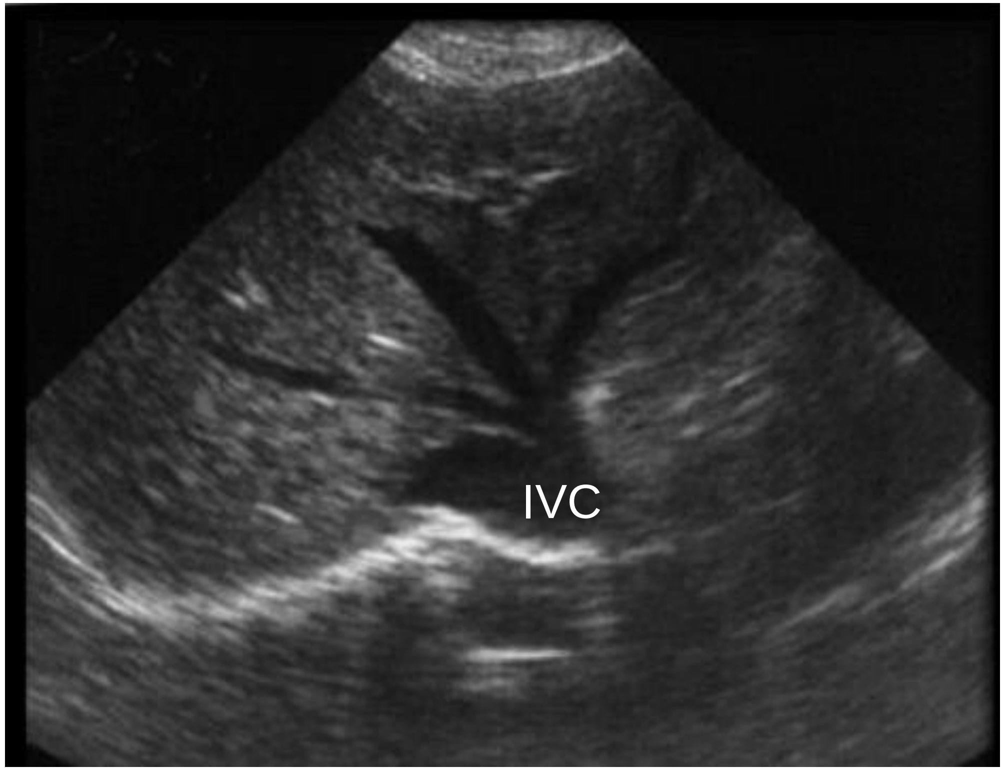
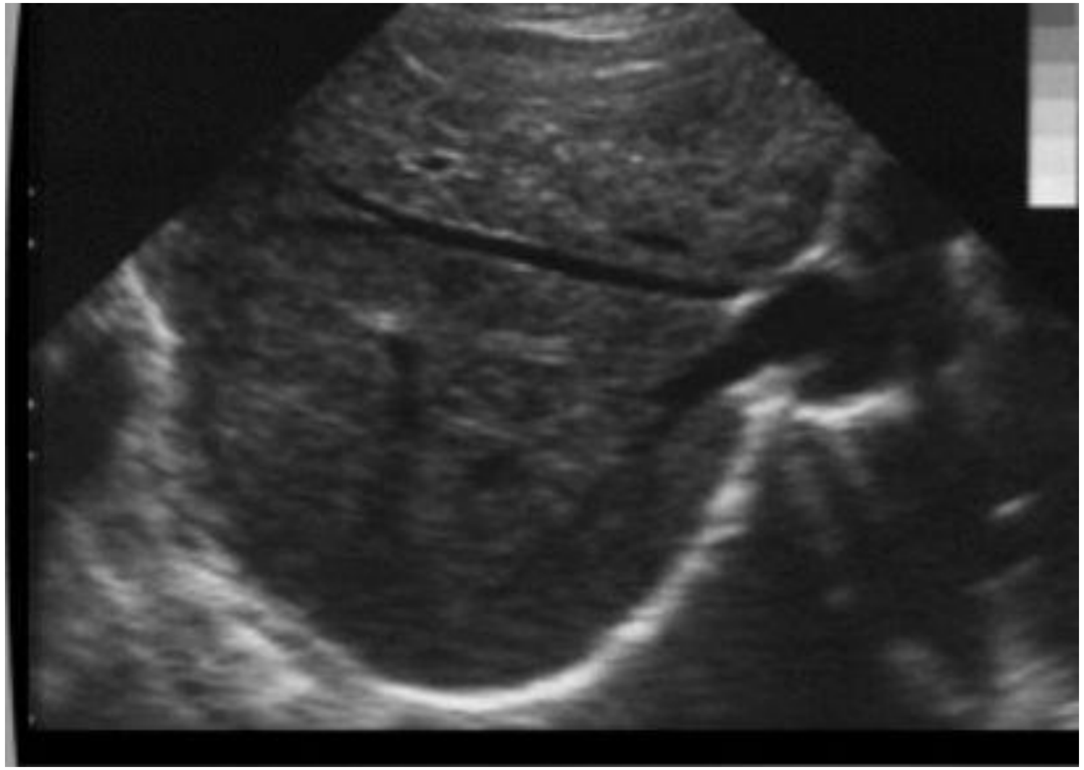
Liver, Hepatic Veins and IVC – Transverse





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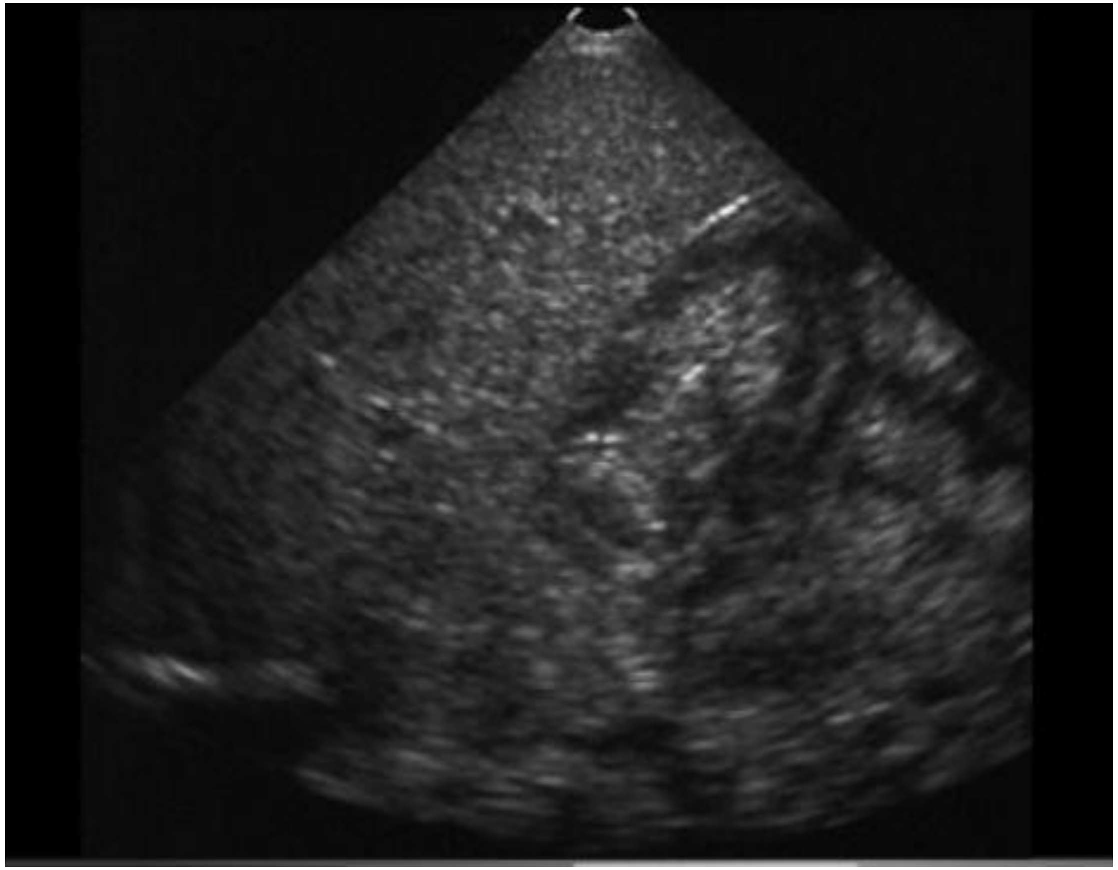
Liver Abnormalities

- Size too big or too small
- Nodularity, echogenicity
- Cysts, tumors, metastases, abscesses
- Dilated vascular structures
- Ascites

Acute hepatitis – "starry sky"



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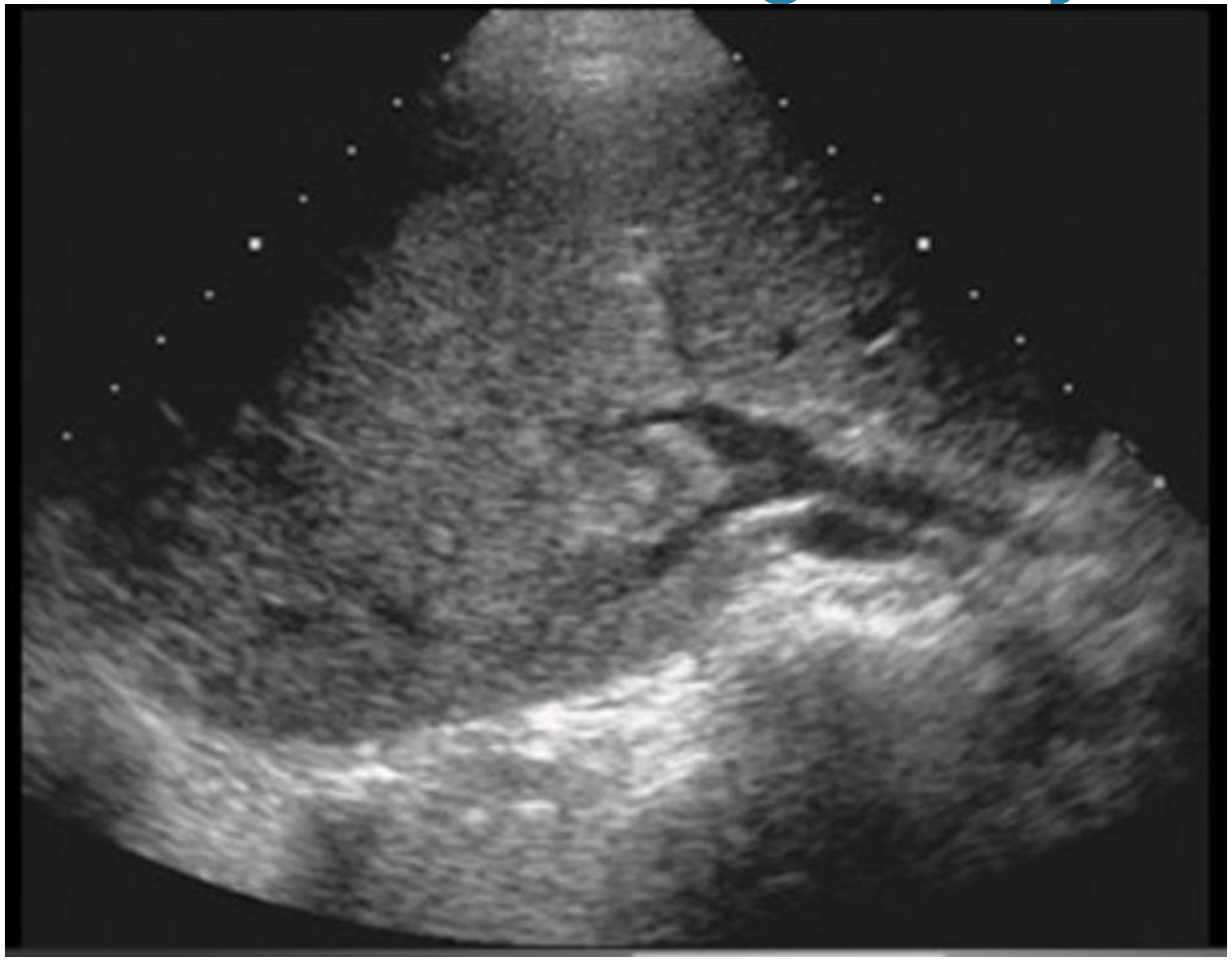
Cirrhosis – increased echogenicity



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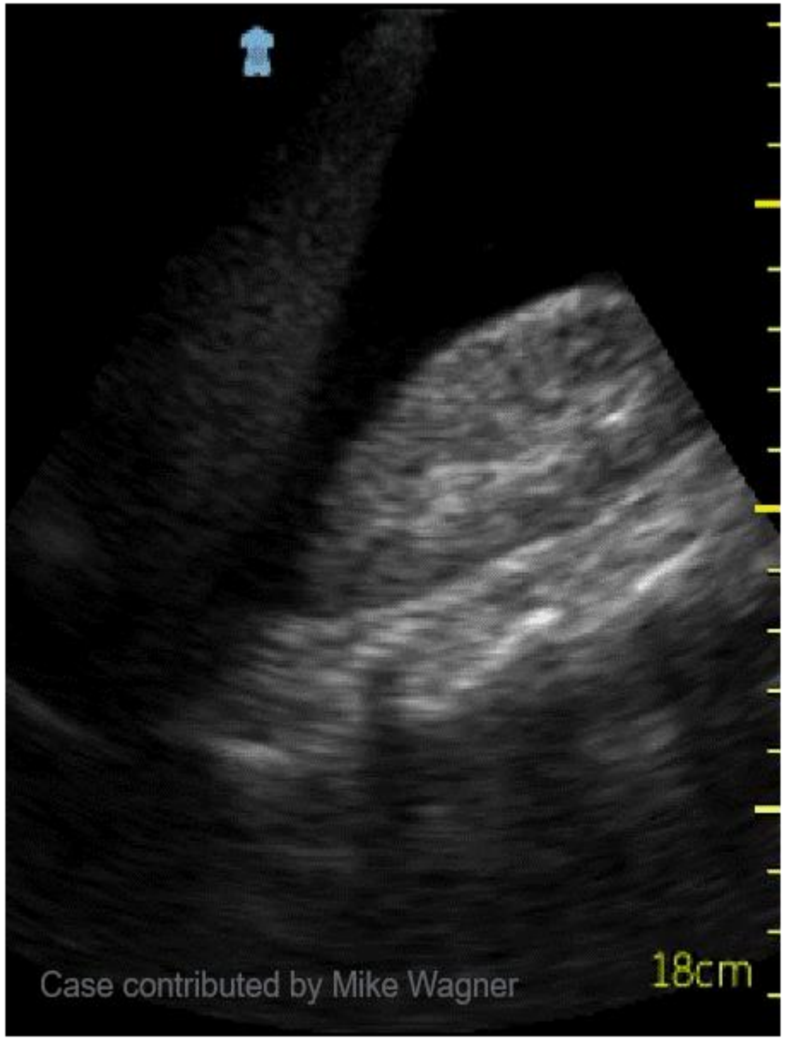
Cirrhosis – Small Liver and Ascites



Fatty Liver: Ultrasound Findings

Grade 1 (mild): Liver appears more echogenic (brighter) than normal. Intrahepatic vessels and diaphragm are visible.

Grade 2 (moderate): Liver appears more echogenic while intrahepatic vessels and diaphragm are less visible.

Grade 3: (severe): Liver is very echogenic while intrahepatic vessel borders, diaphragm and posterior/right lobe of liver are not at all well-seen.

Fatty Liver Videos

Videos: Joy Shen Wagner MD

Fatty Liver

Grade 3

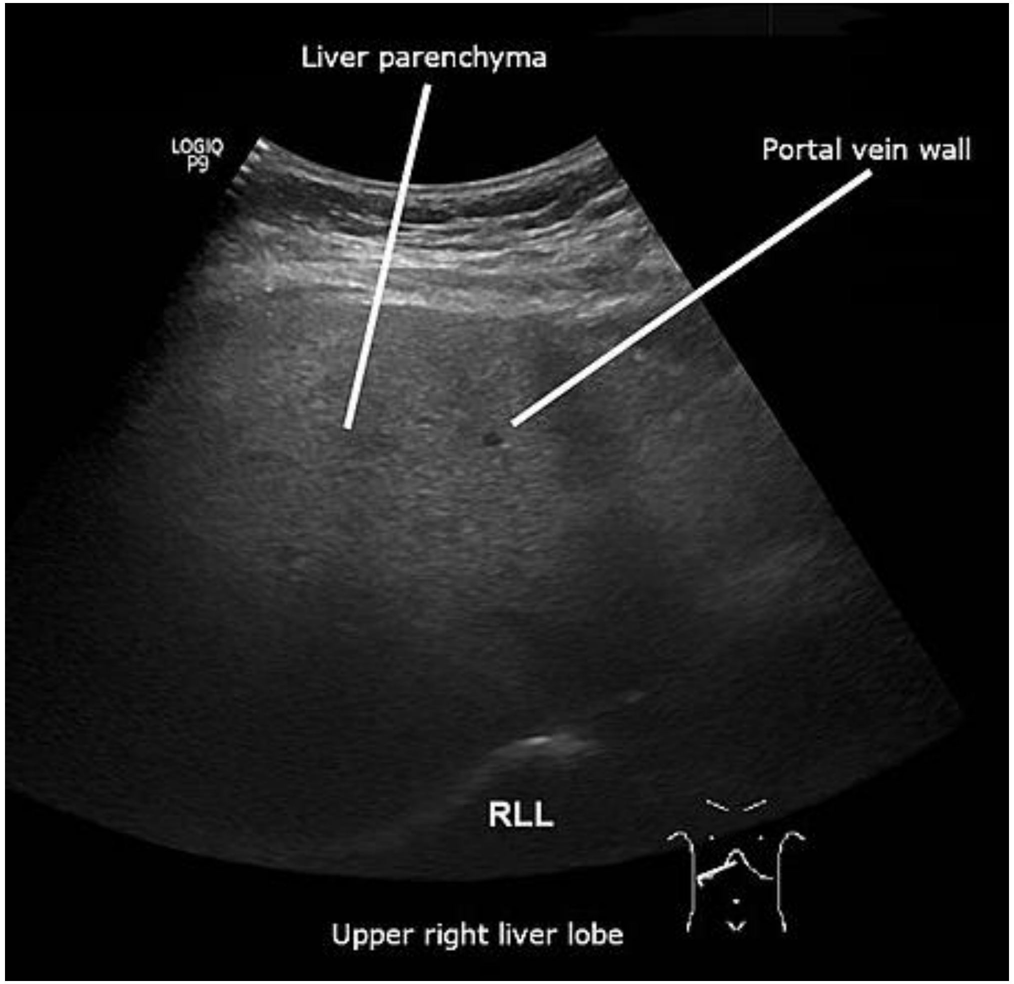
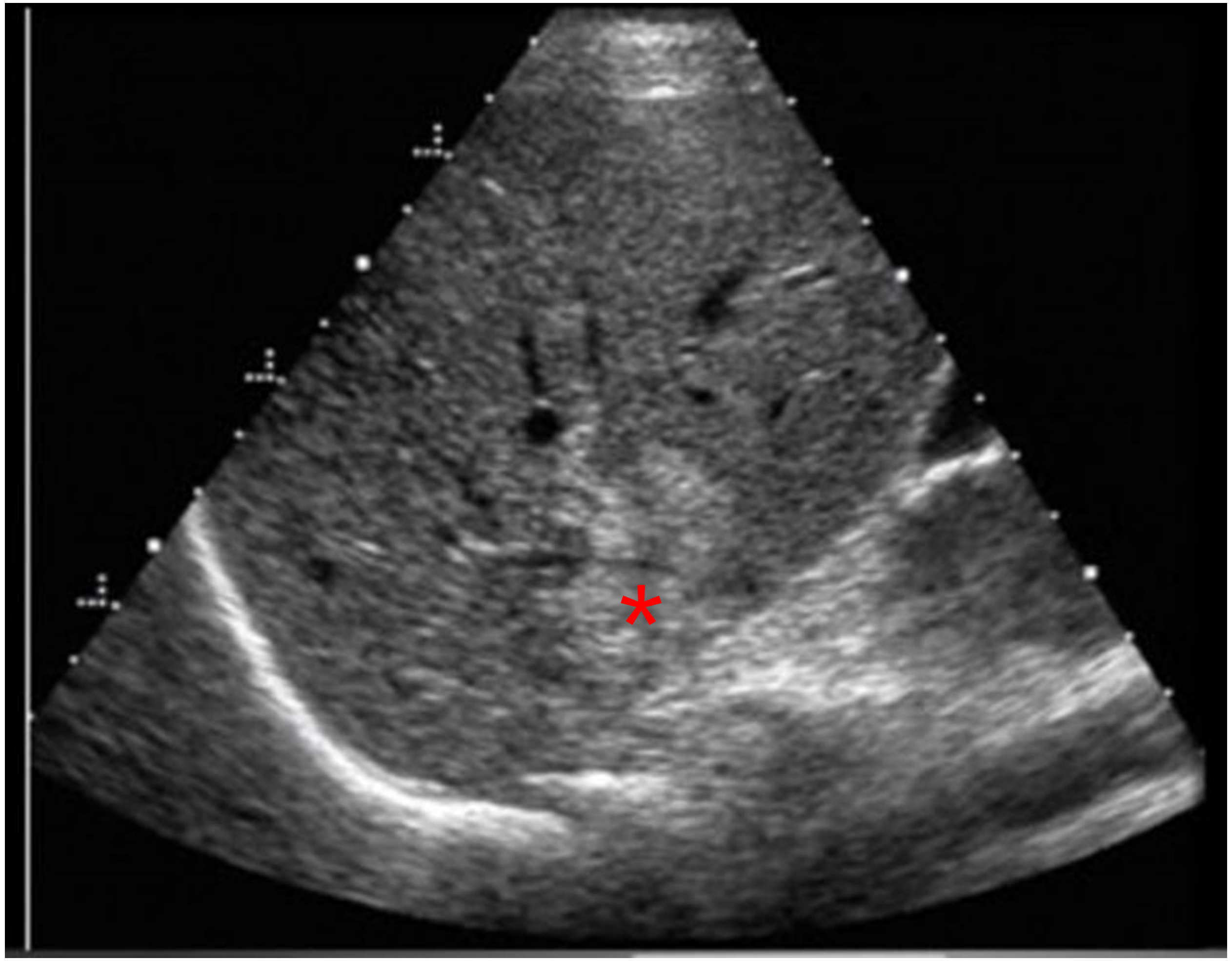


Image credit: Wikimedia Creative Commons

Patchy Pattern



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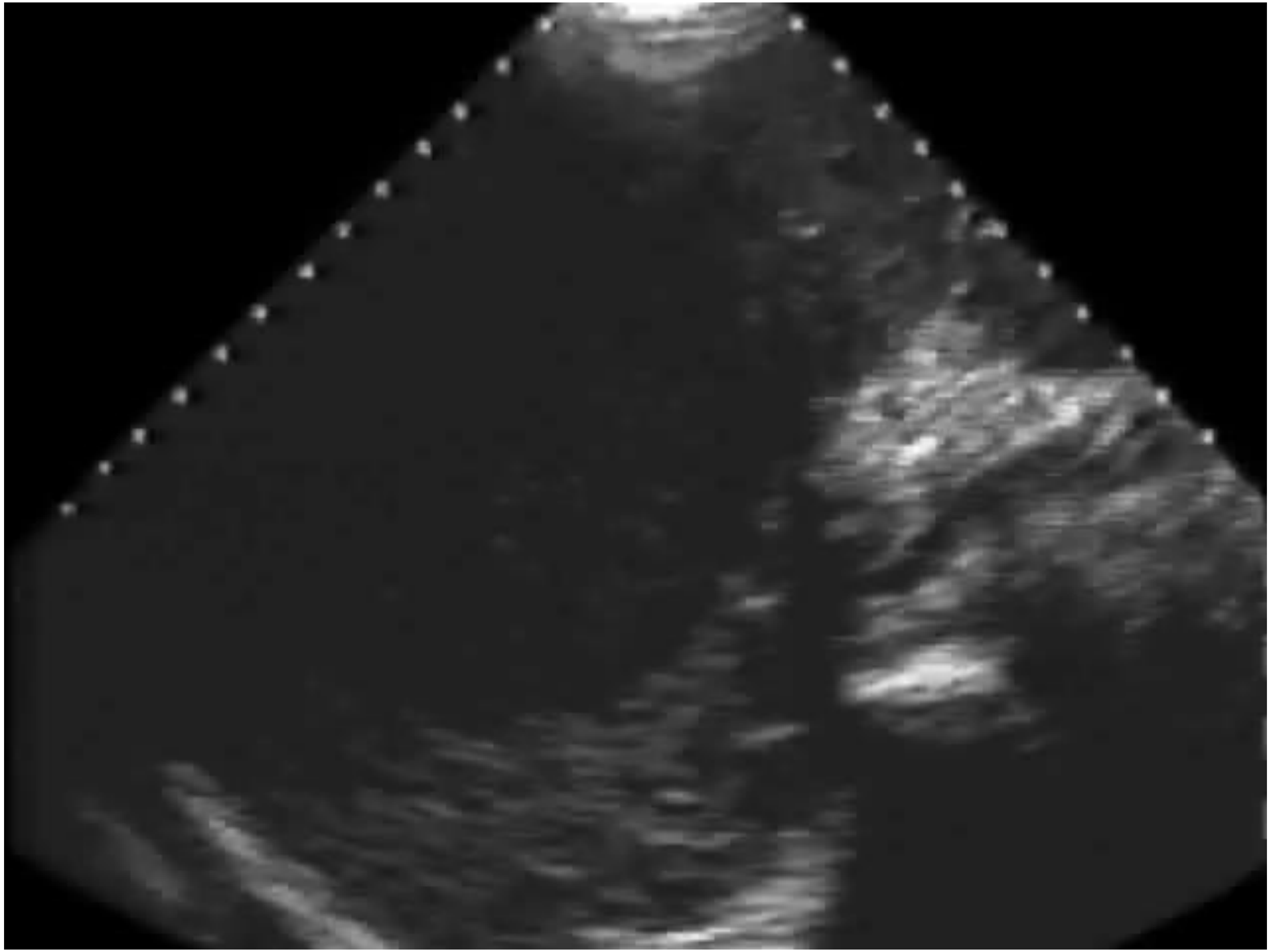
Fatty Liver:
Clinical Significance on Asymptomatic Patients

Sonographic signs of fatty liver are seen on asymptomatic patients suggest the presence of metabolic syndrome.

Liver abscess - parasitic



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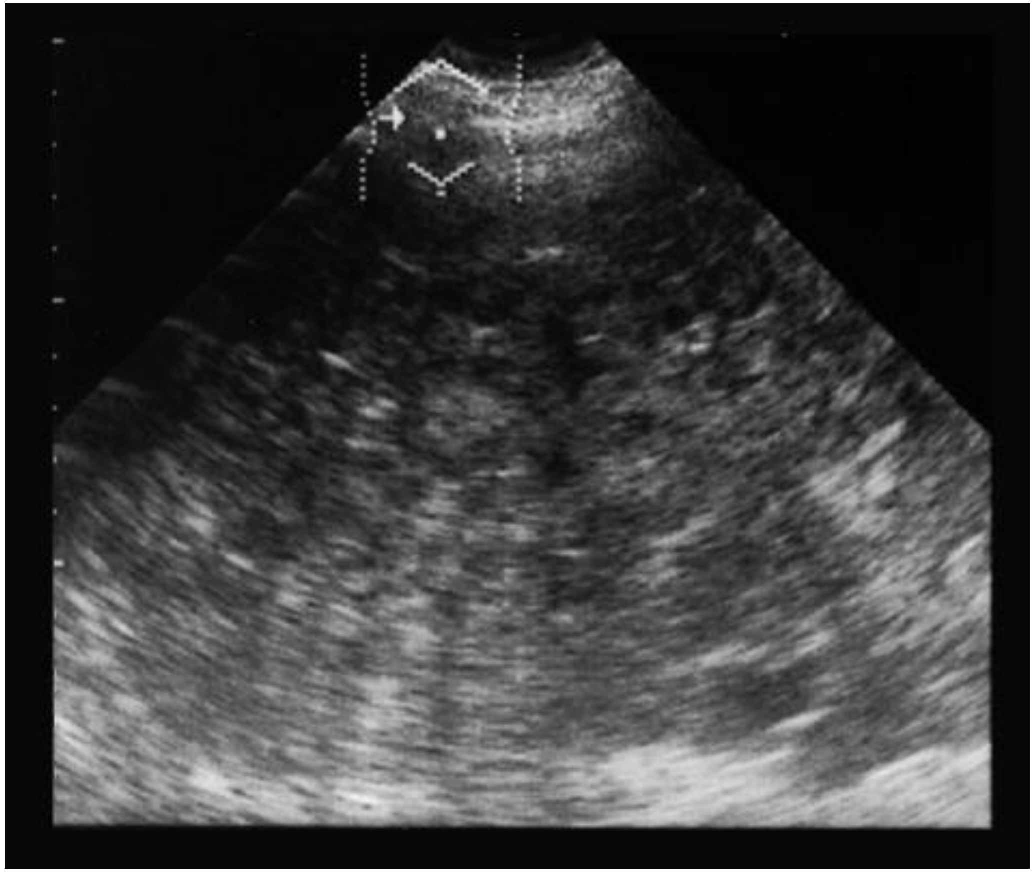
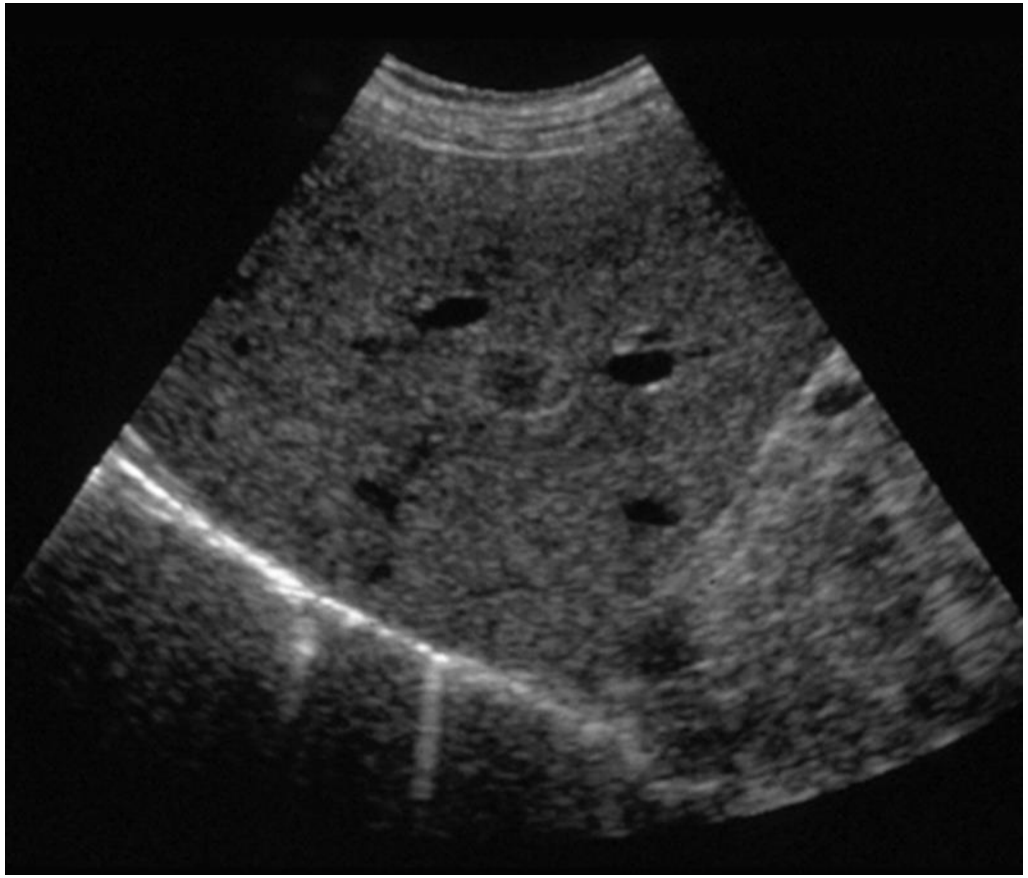
Liver Metastases - 1





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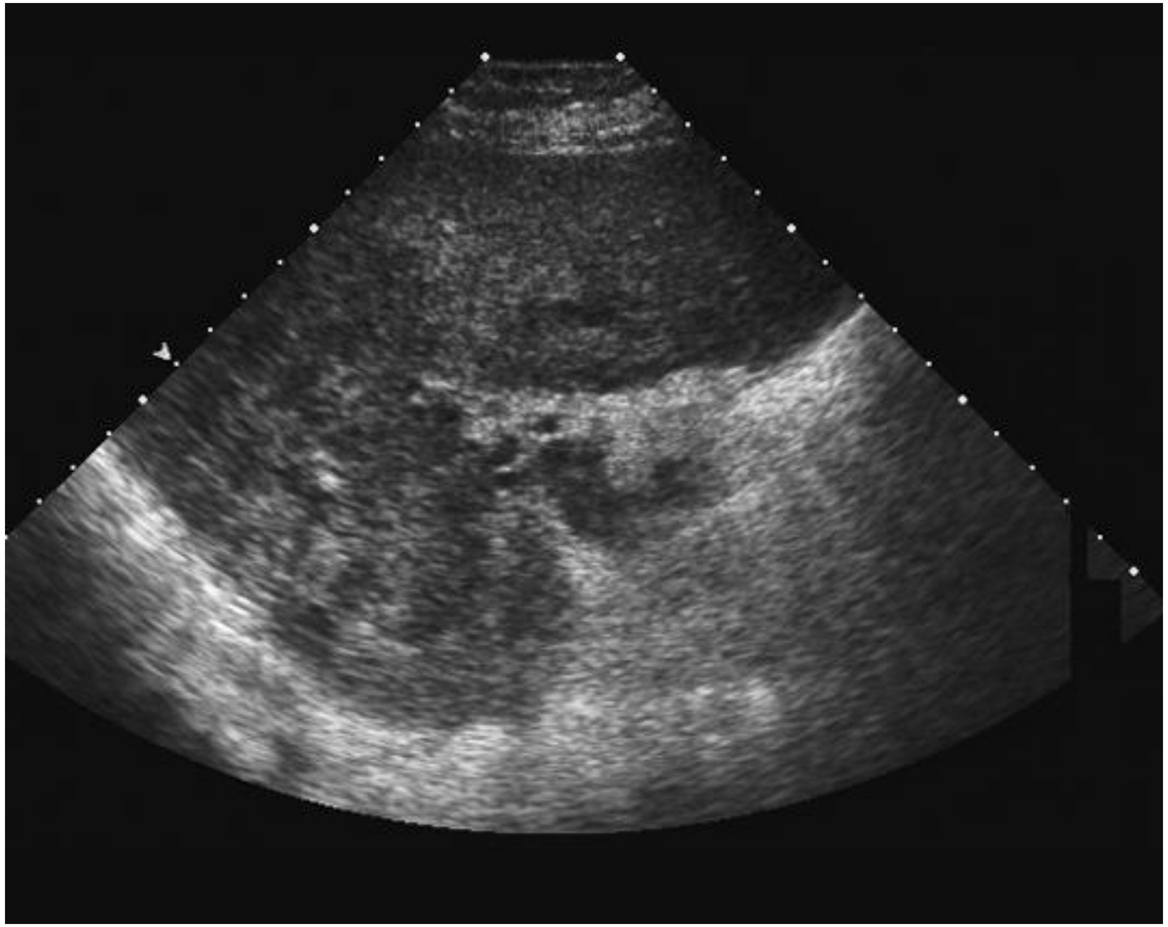
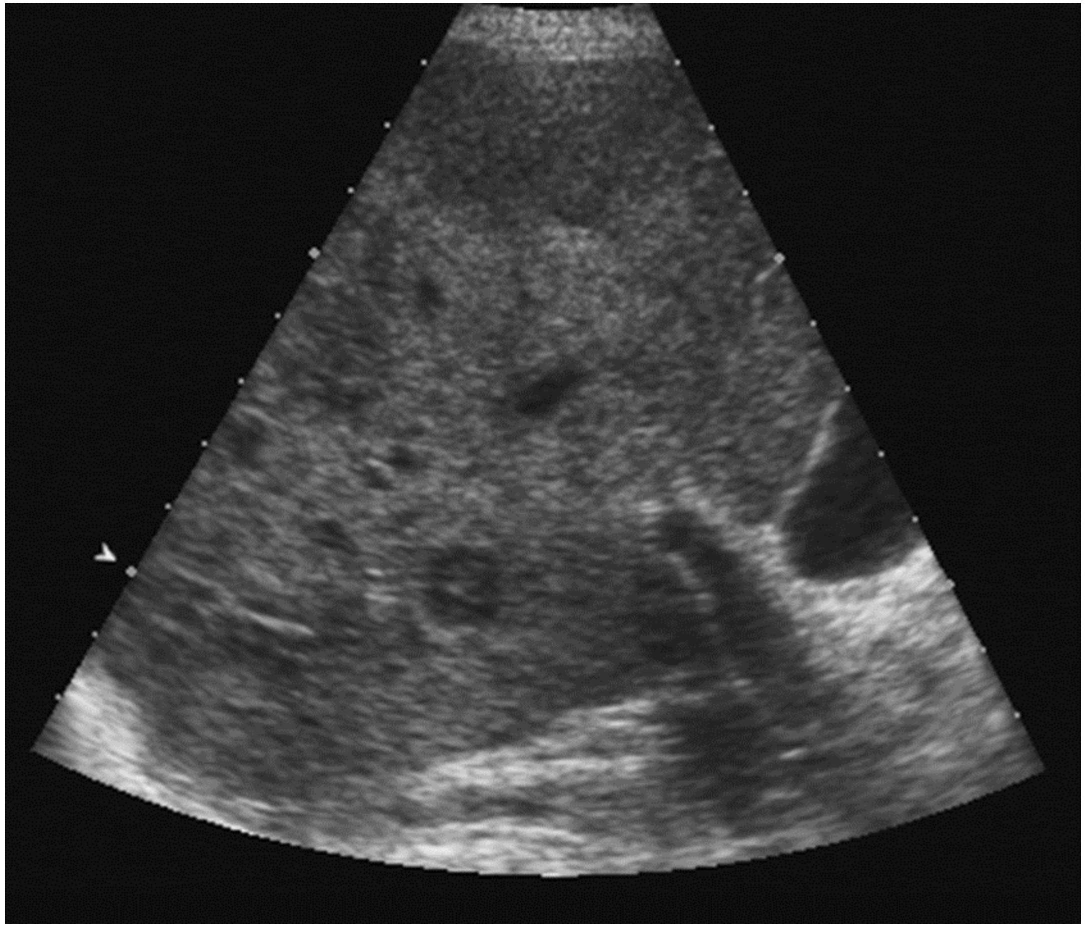
Liver Metastases - 2





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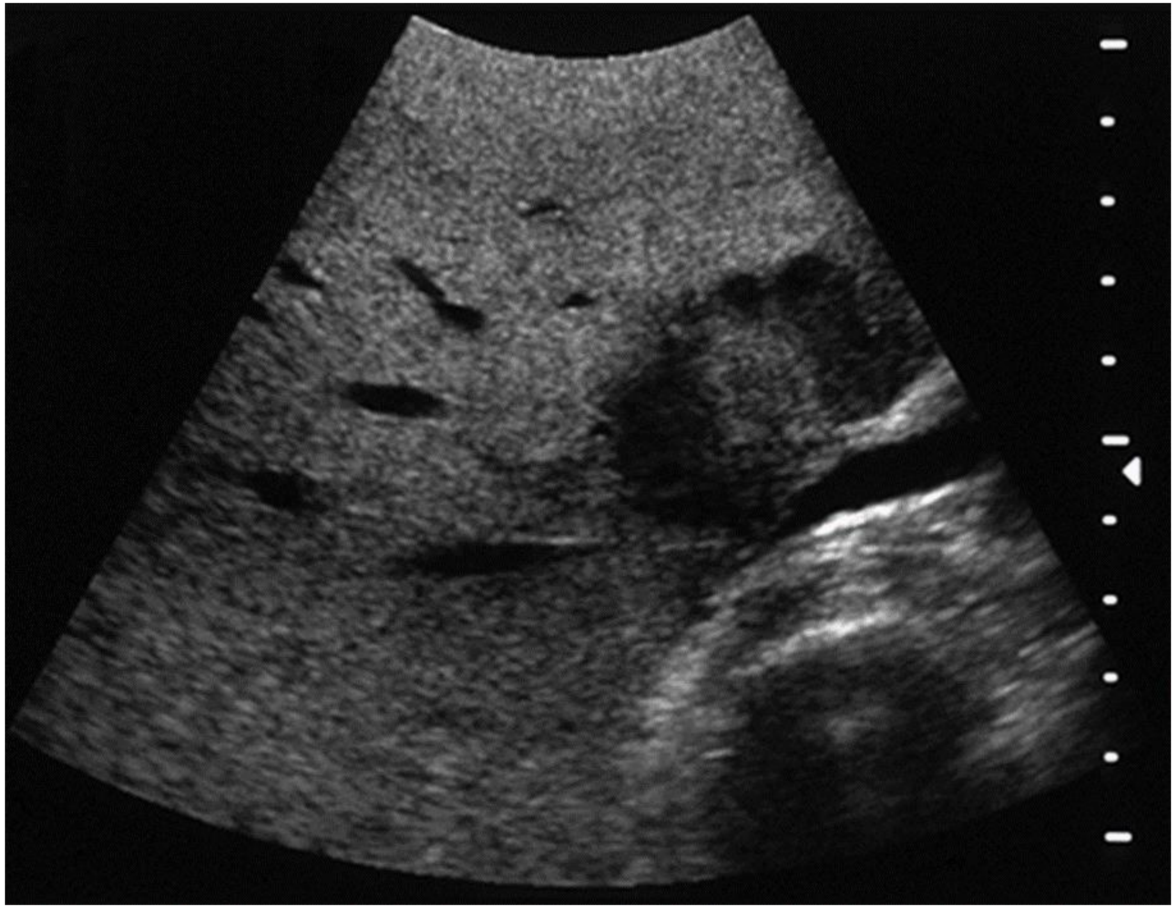
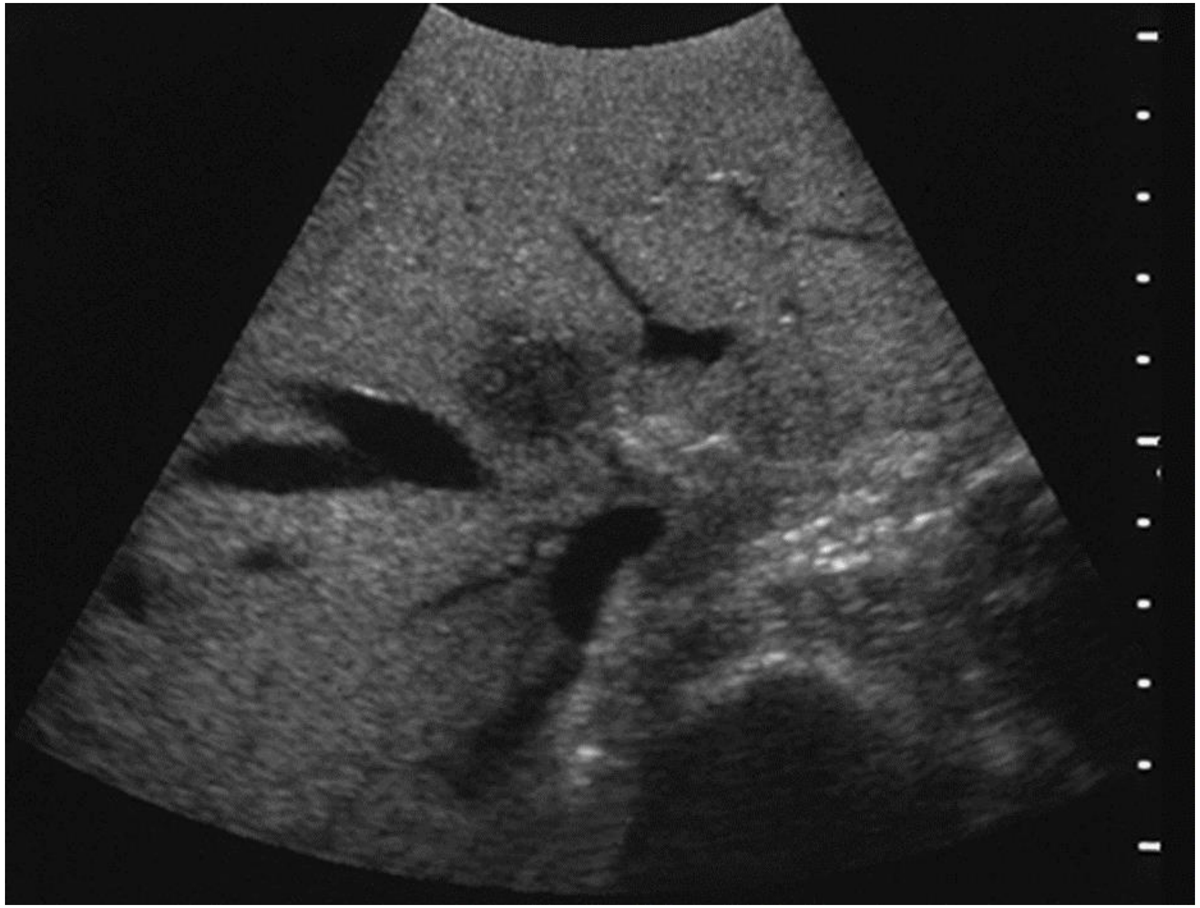
Liver Metastases - 3





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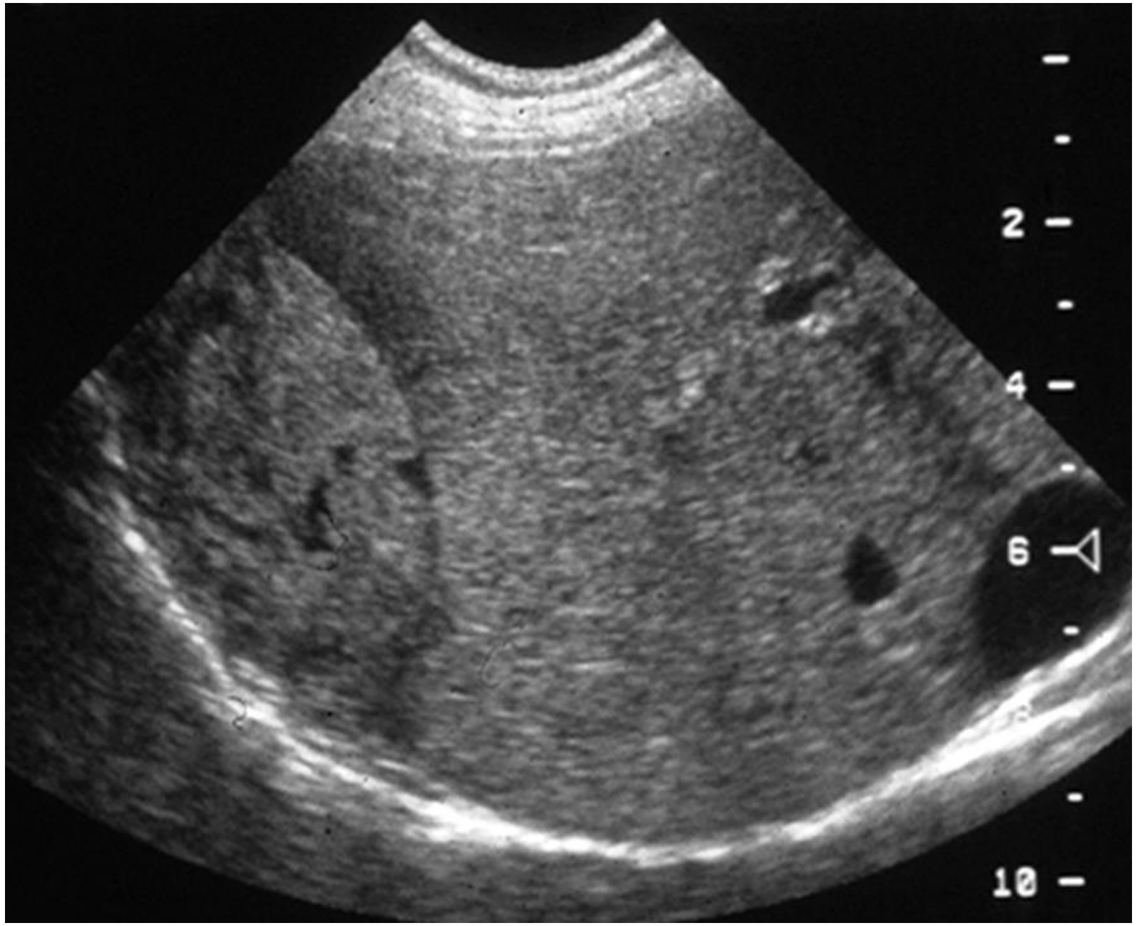
Liver Metastases - 4



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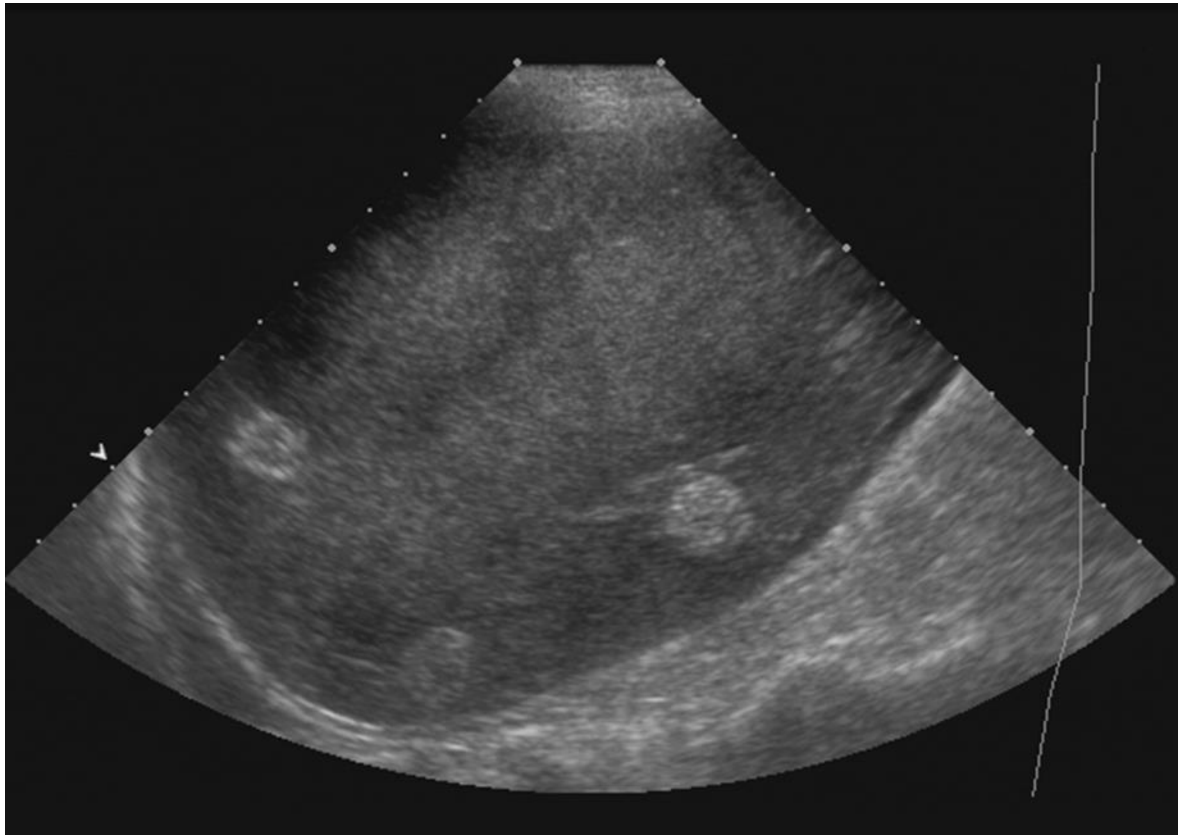
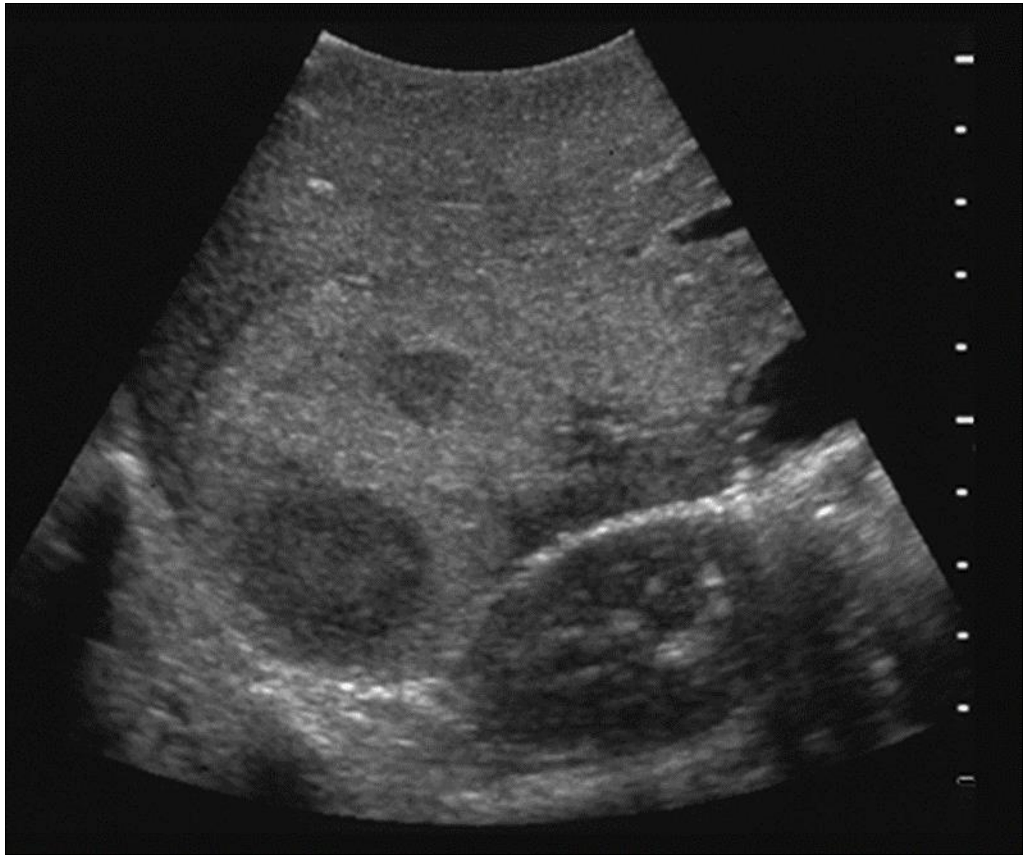
Liver Metastases - 5





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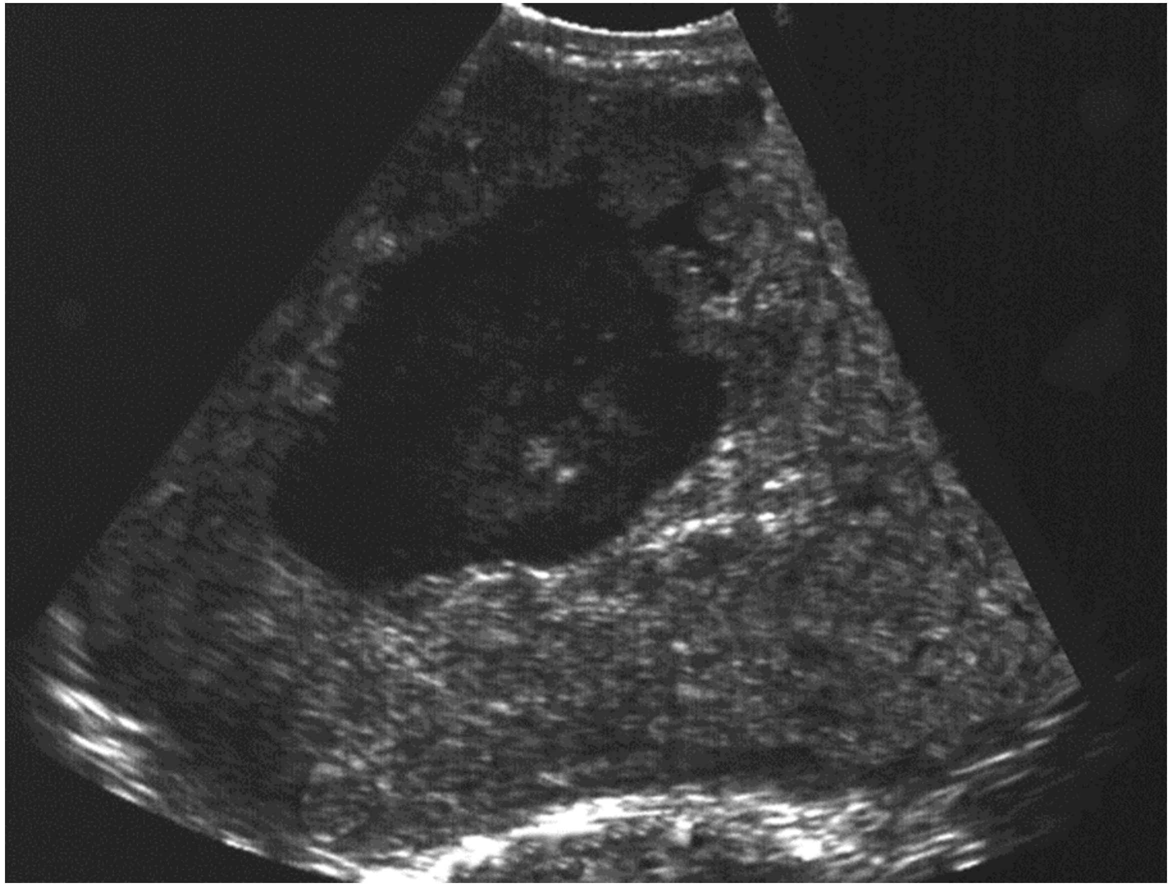
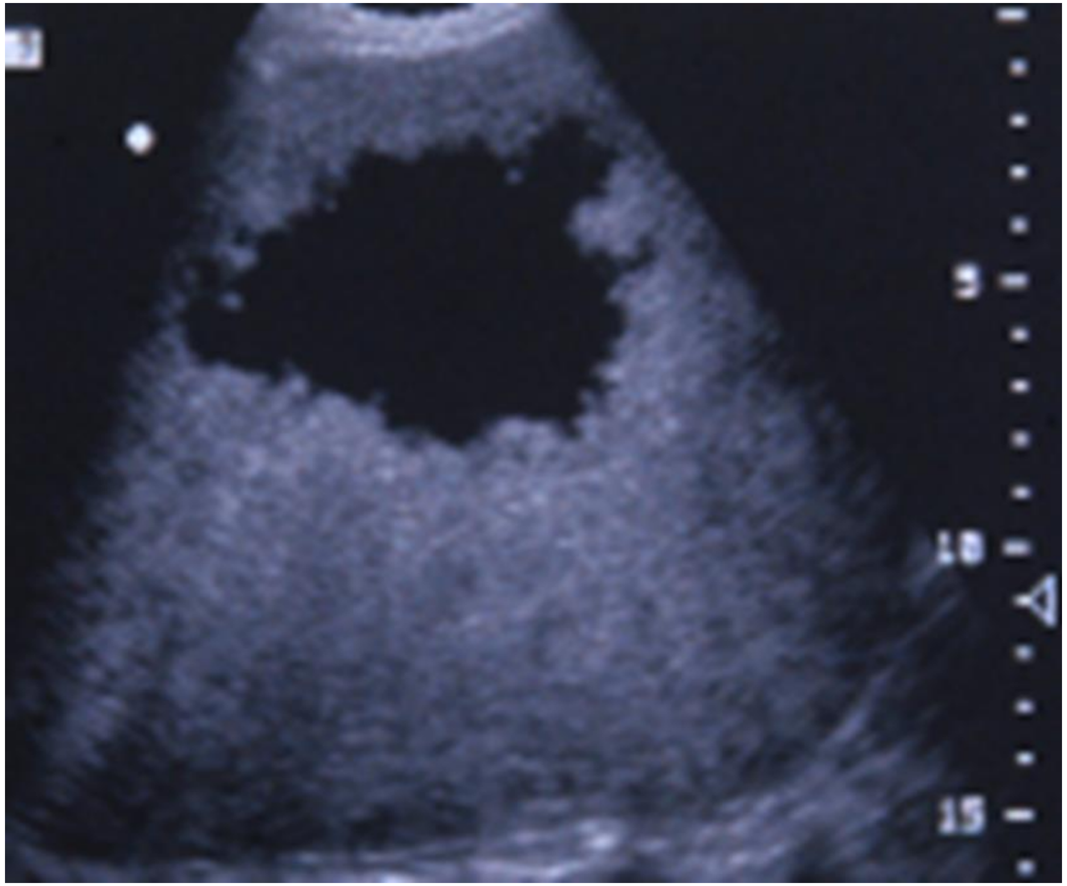
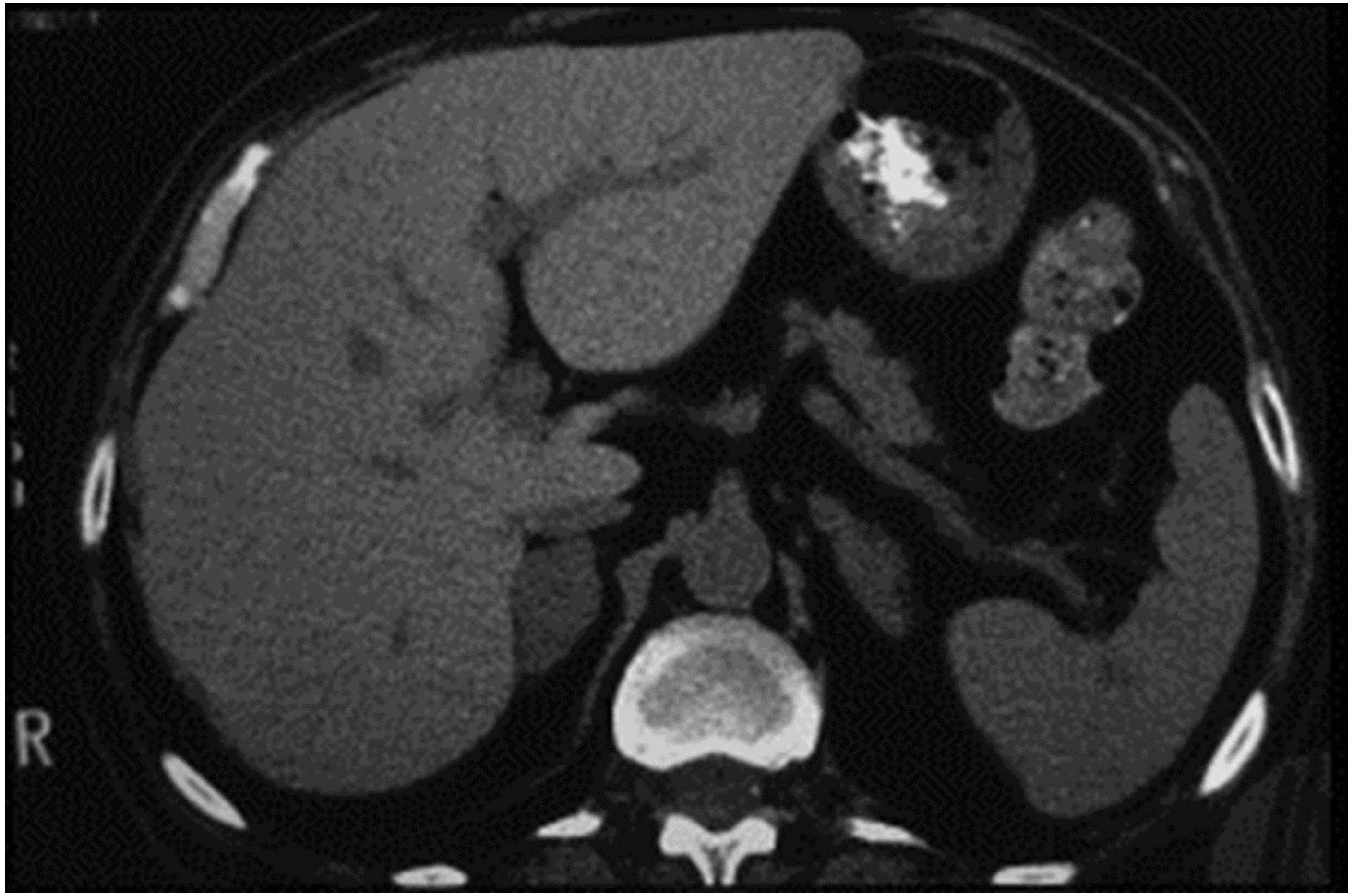
Hepatoma





Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Liver and Spleen: location and normal sizes



Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Normal Spleen Size - Adults

- Length 10.68 ± 1.28 cm
- Thickness, 4.1 ± 0.58 cm
- Width 7.3 ± 0.9 cm
- Volume 174.4 ± 52.4 ml
- Males have larger spleens than females.
- Spleen volume significantly correlated with height and weight

Fateh SM, Mohammed NA, Mahmood KA, Hasan AH, Tahir SH, Kakamad FH, Salih AM, Abdullah HO, Abdalla BA, Mohammed SH, Hassan HA, Hussein DA. Sonographic measurement of splenic size and its correlation with body parameters. Med Int (Lond). 2023 Jan 9;3(1):7. doi: 10.3892/mi.2023.67. PMID: 36742195; PMCID: PMC9895976.

Why Scan the Spleen?

- LUQ pain
- R/O splenomegaly
- Trauma: hemoperitoneum

Approach to Visualizing the Spleen

- Left flank
- Look high posterior
- Adjacent to left kidney
- Scan in oblique planes to see between ribs
- Roll the patient on to their right side

Spleen and Left Kidney

Image credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Lacerated Spleen

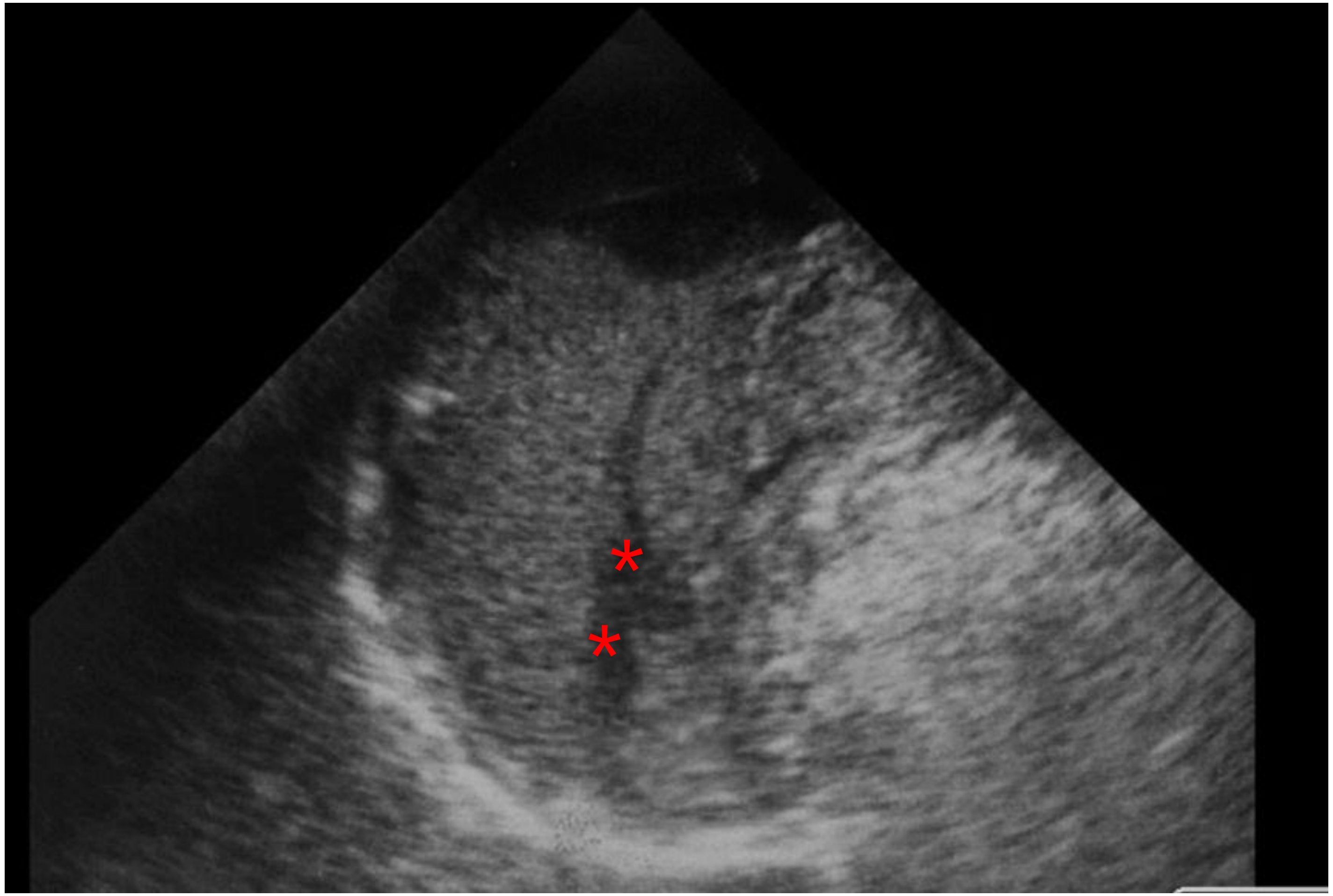
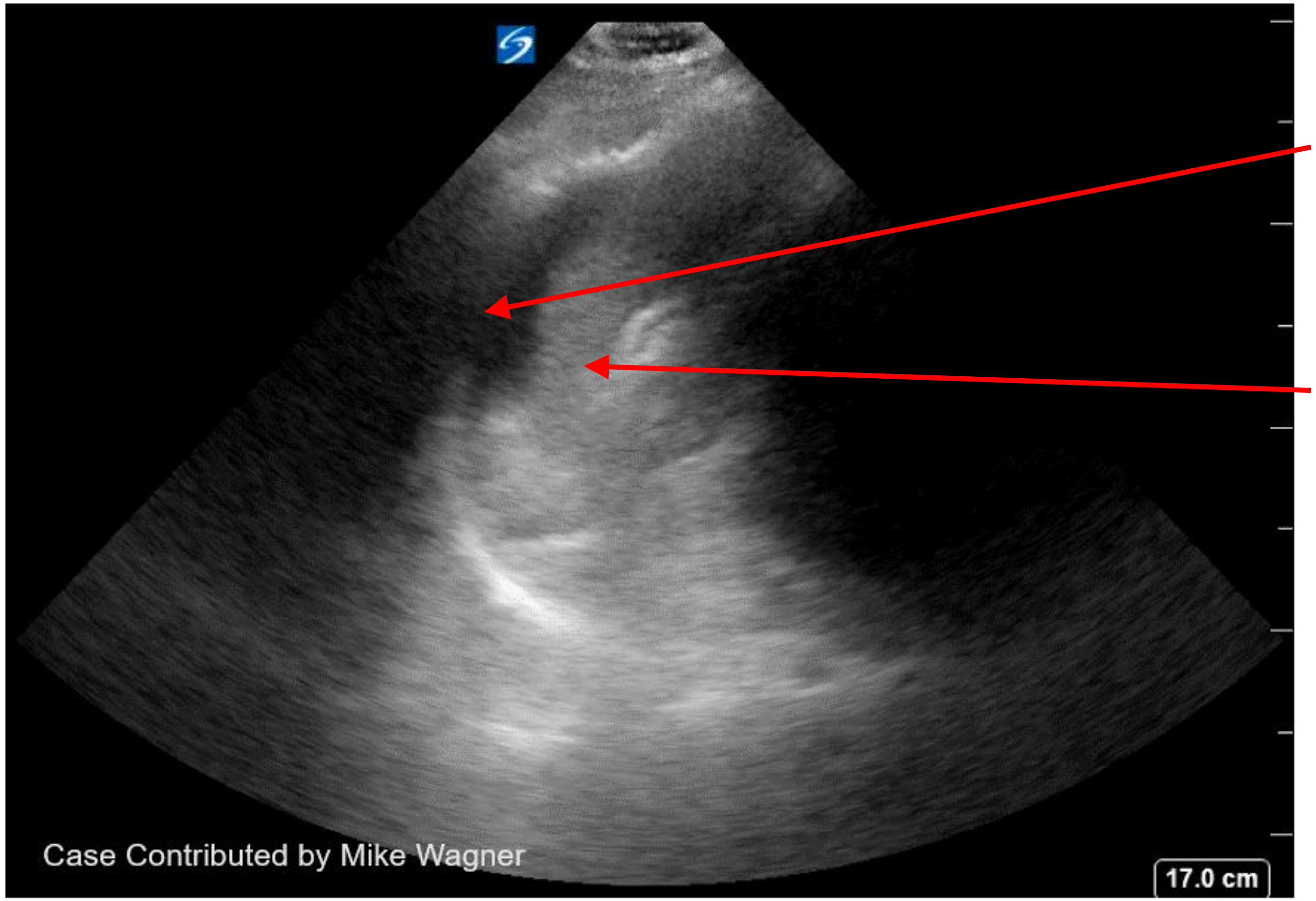


Image credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Free Fluid Between Spleen and Diaphragm



Free fluid

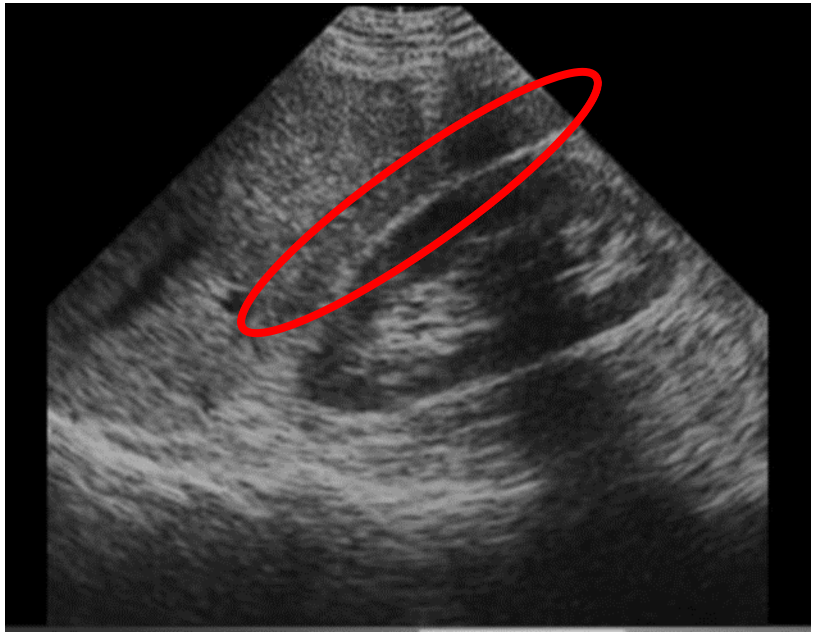
Spleen

Why Scan the Peritoneal Cavity?

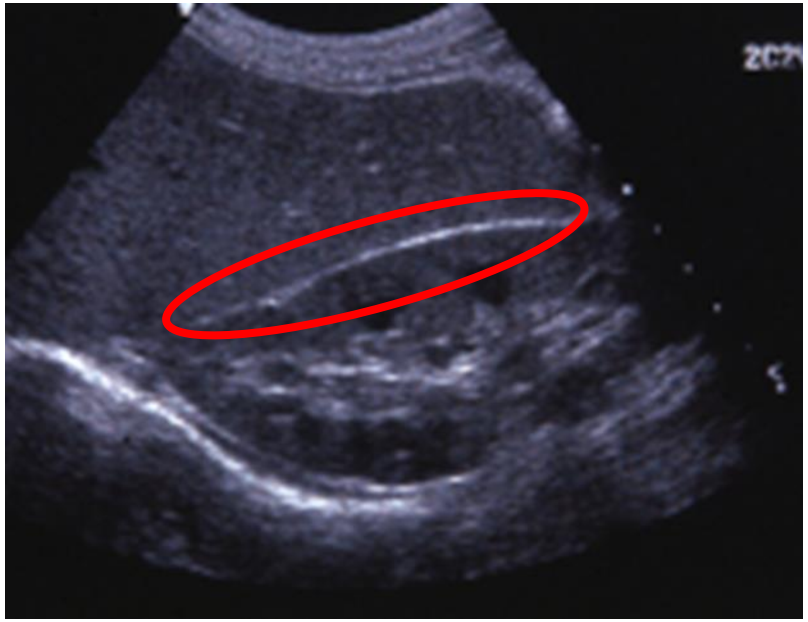
- R/O ascites
- Trauma: R/O hemoperitoneum
- To guide paracentesis
- Caution: scanning for appendicitis and other bowel disease is beyond the scope of this POCUS course

Potential Spaces in the Abdomen

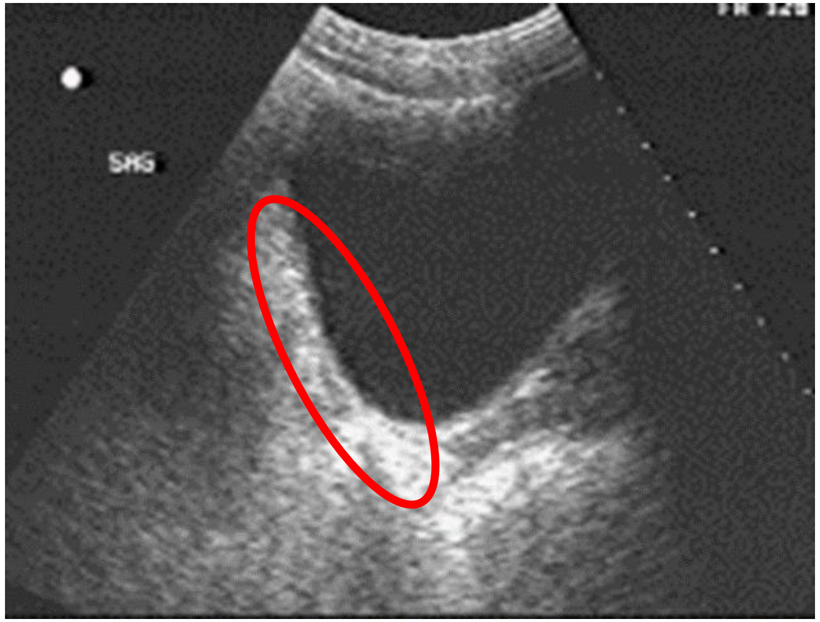
Morrison's Pouch



Splenorenal Recess



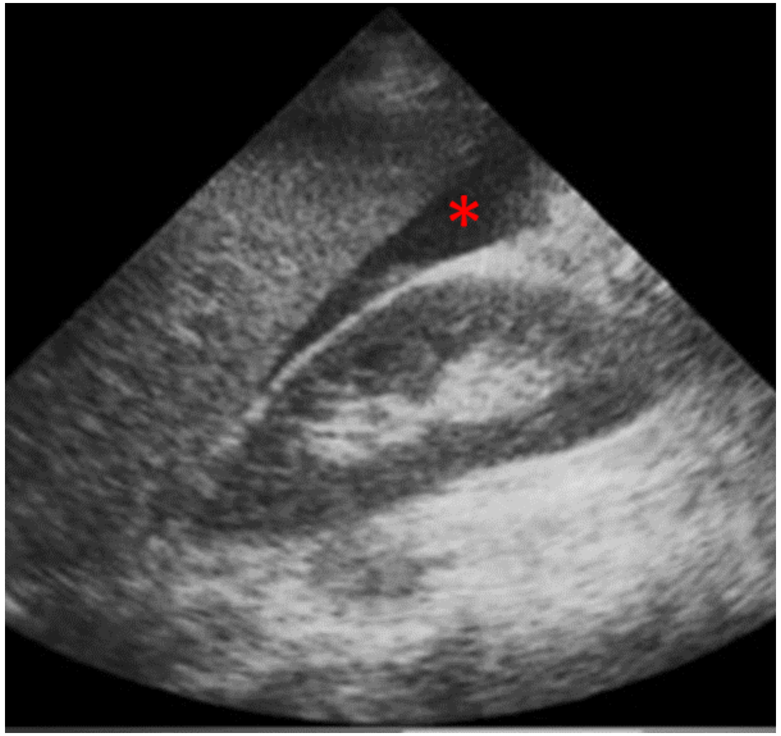
Above Urinary Bladder



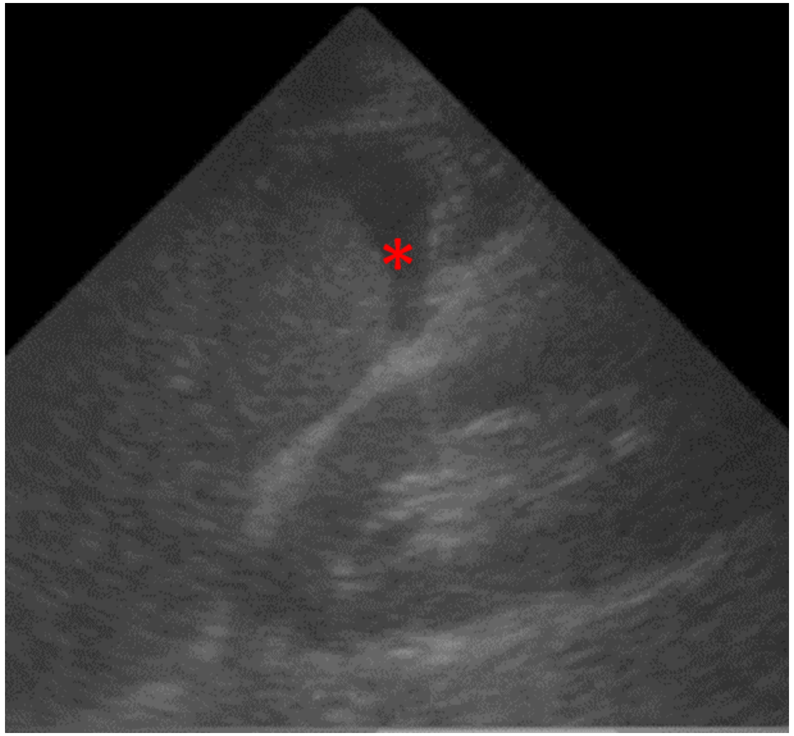
Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Free Fluid in Potential Spaces

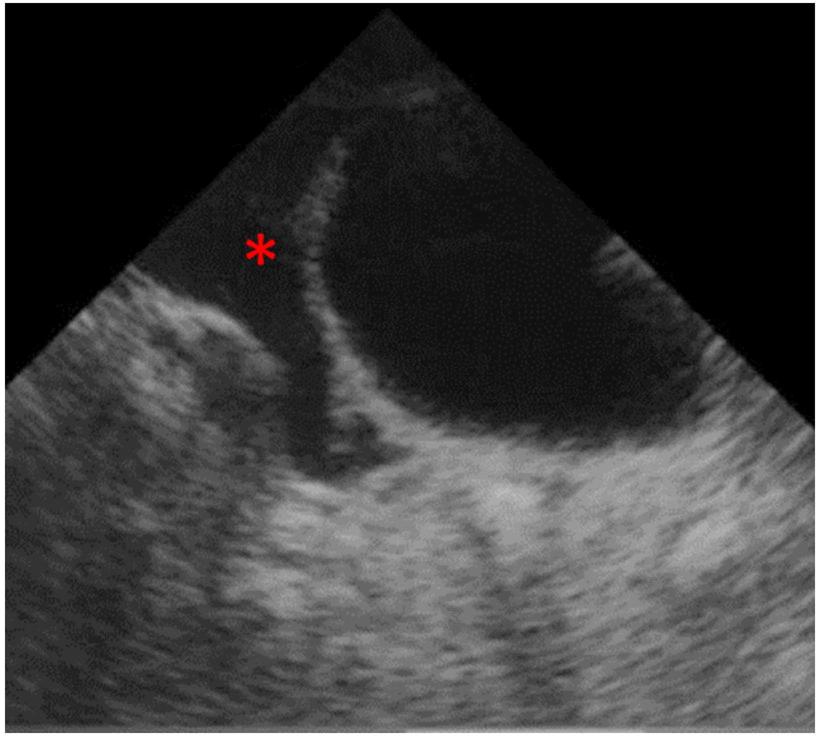
RUQ: Morrison's Pouch



LUQ: Splenorenal Recess



Pelvis: Retrovesical

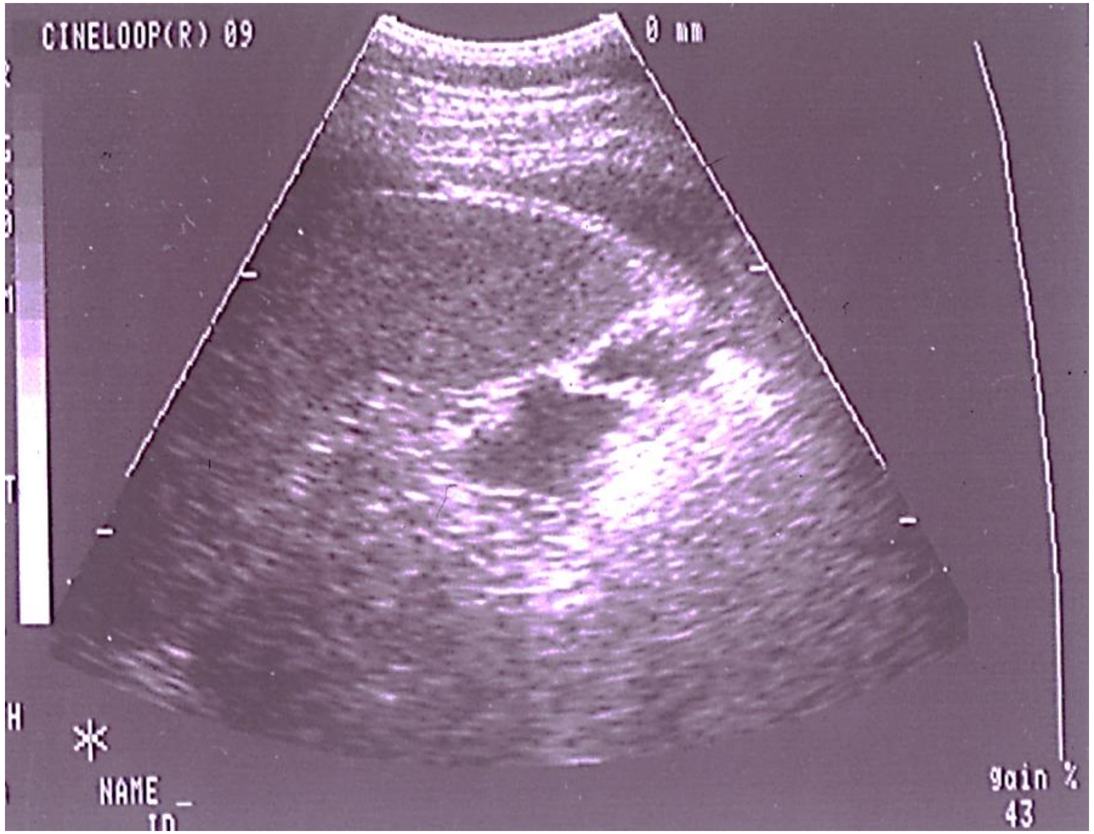


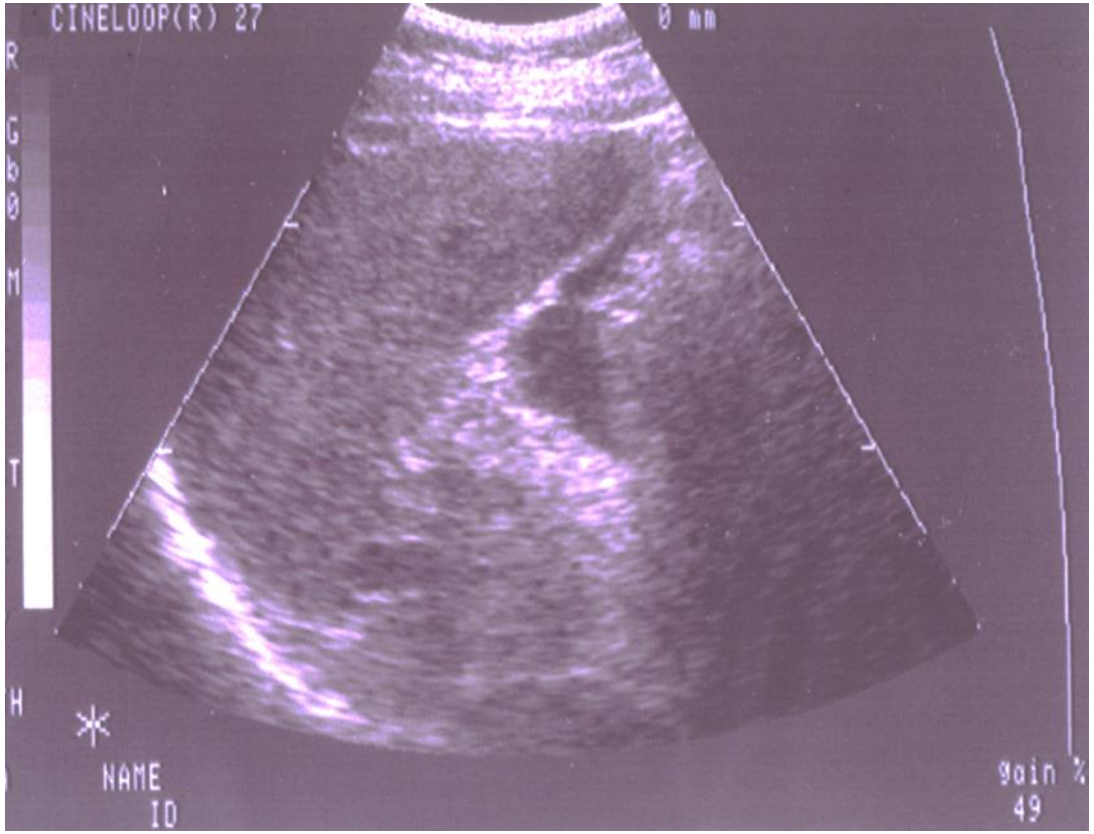
Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Ascites - 1

Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Ascites - 2



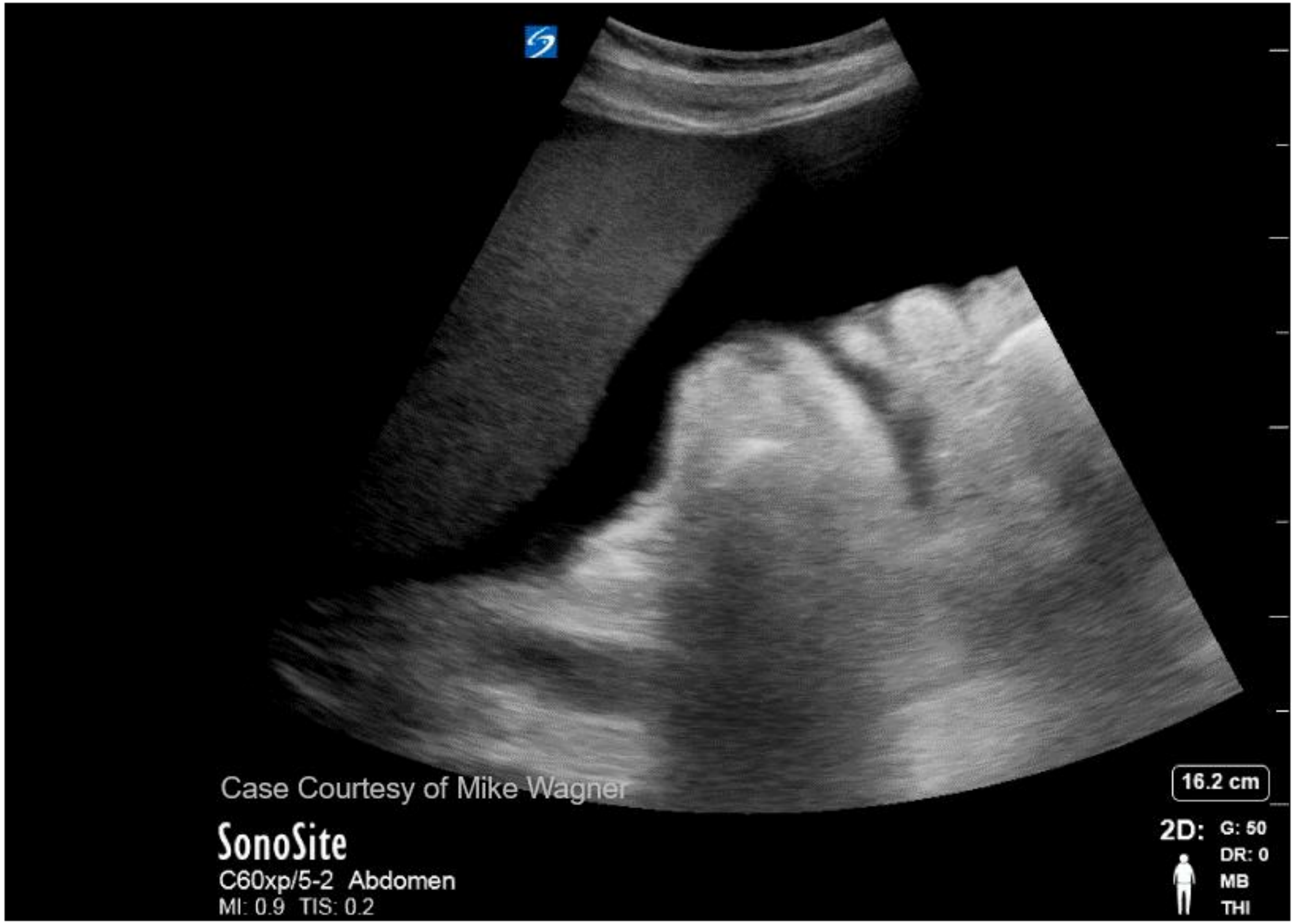


Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Ascites - 3

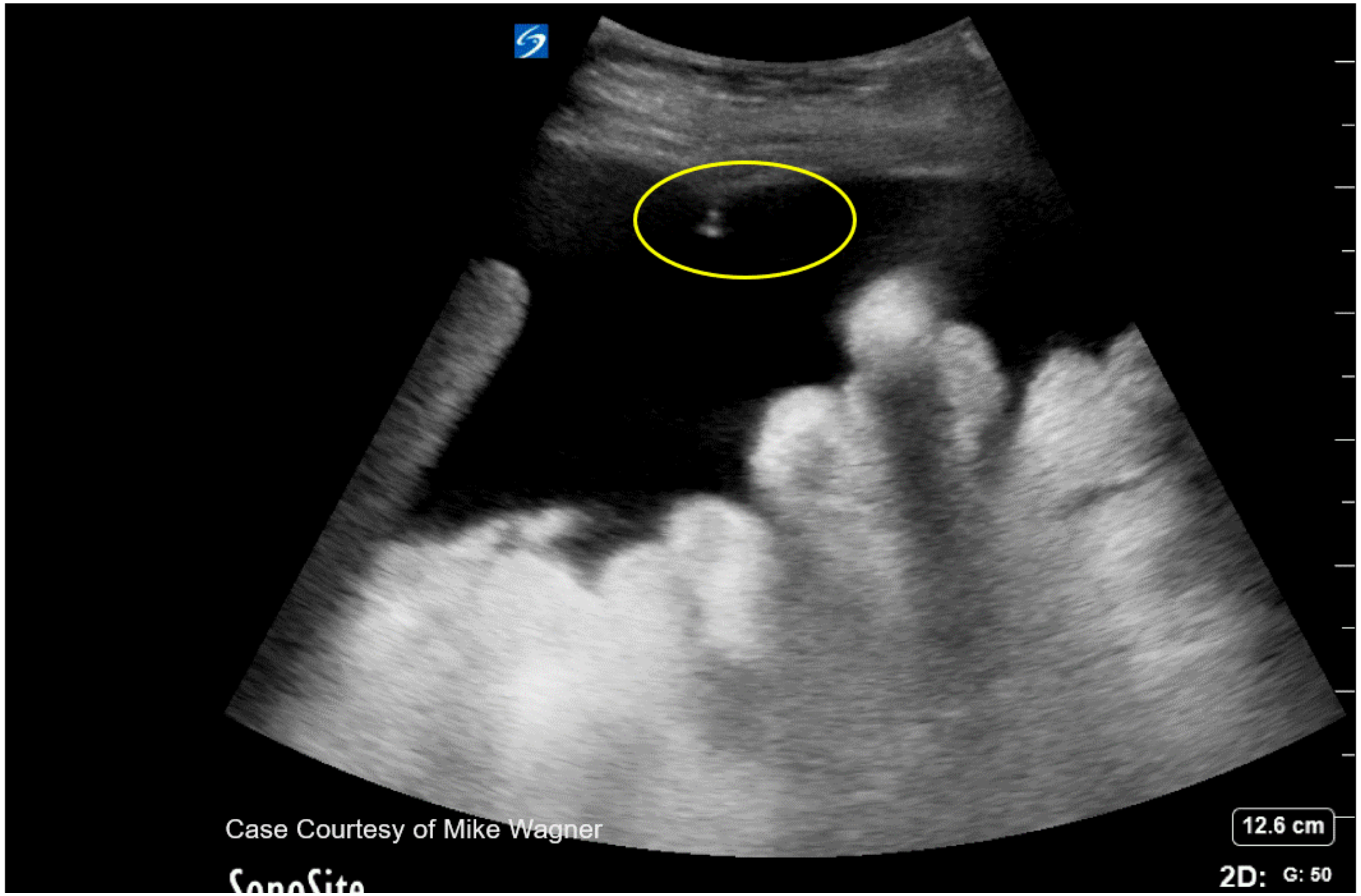
Images credit: Mark Deutchman MD *Abdominal Ultrasound Principles and Techniques*. Used with permission.

Ascites - 4



Case Courtesy of Mike Wagner
SonoSite
C60xp/5-2 Abdomen
MI: 0.9 TIS: 0.2
16.2 cm
2D:
G: 50
DR: 0
MB
THI

Ascites - 5



Ascites – Sweep through the quadrant to ensure wide margins

Paracentesis Guidance

Sonographic guidance makes paracentesis safer, faster and easier.

- Finding bowel-free fluid pockets
- Simultaneous imaging of the needle

Practice on gelatin phantom

Sonographically-Guided Paracentesis Technique Options

1. Identify target, mark location on abdomen and tap “blindly”
2. Use simultaneous visualization of the needle as it enters the target area – usually visualize needle in long axis.

Needle in Transducer Beam:

Larger “X” = larger blind area

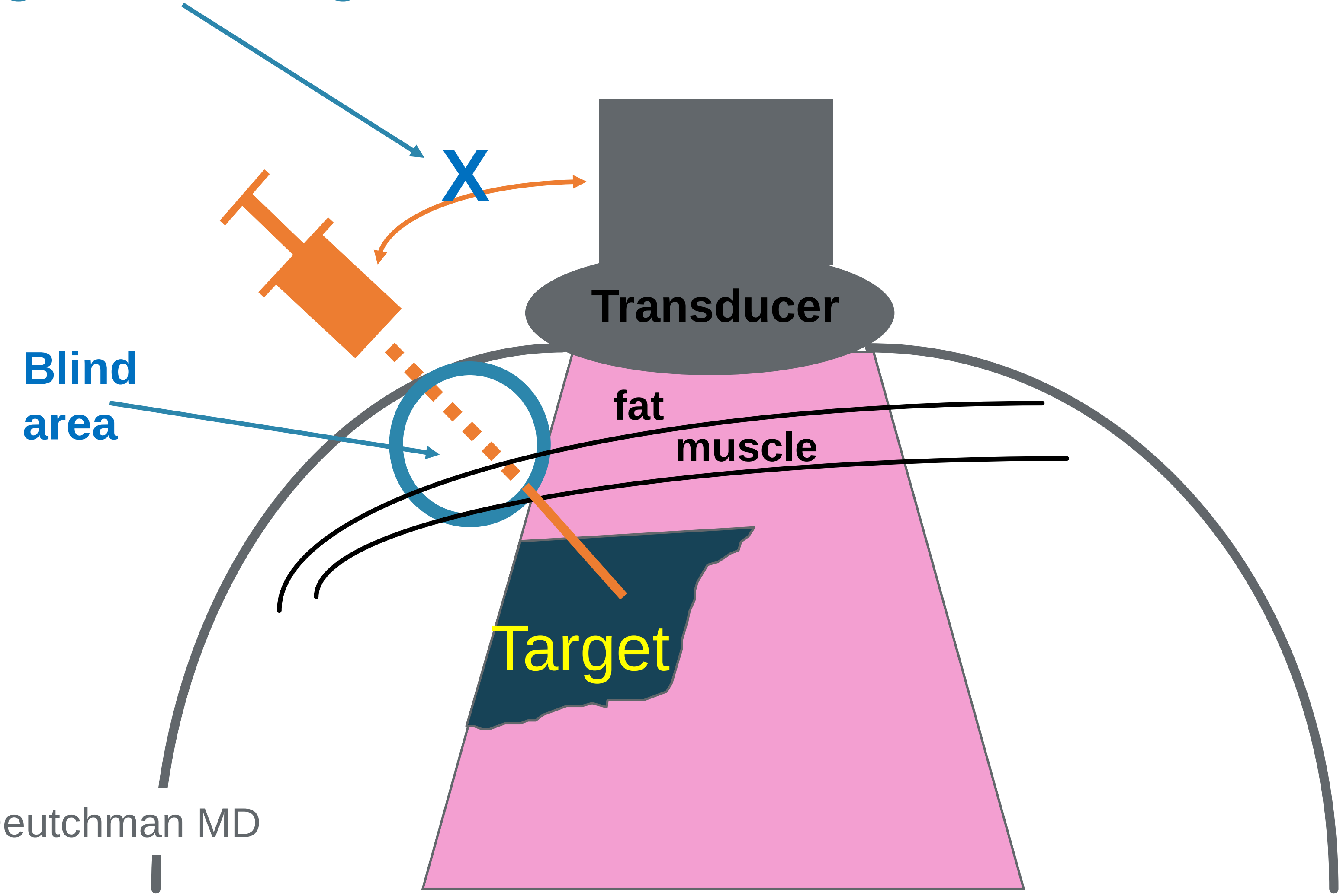


Diagram: Mark Deutchman MD

Guide Line Drawn on Image

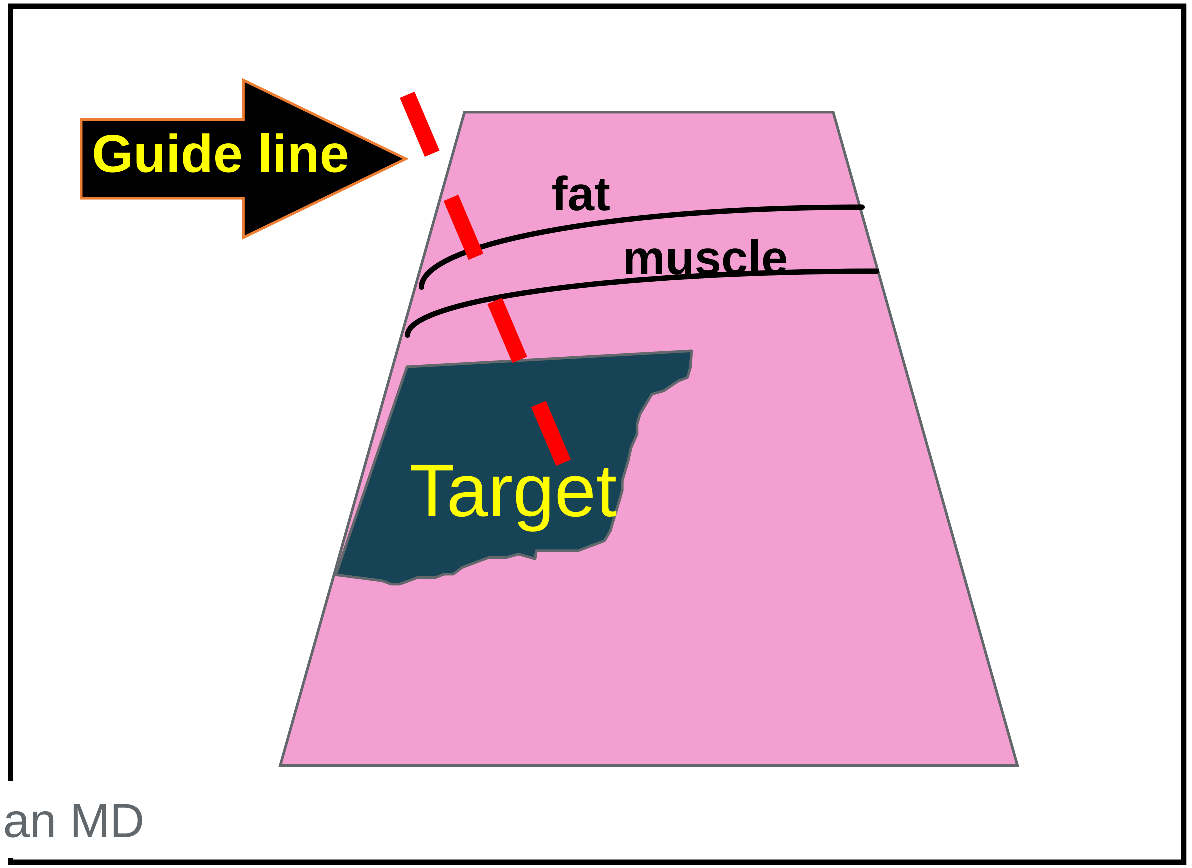


Diagram: Mark Deutchman MD

Flexible Tubing Option

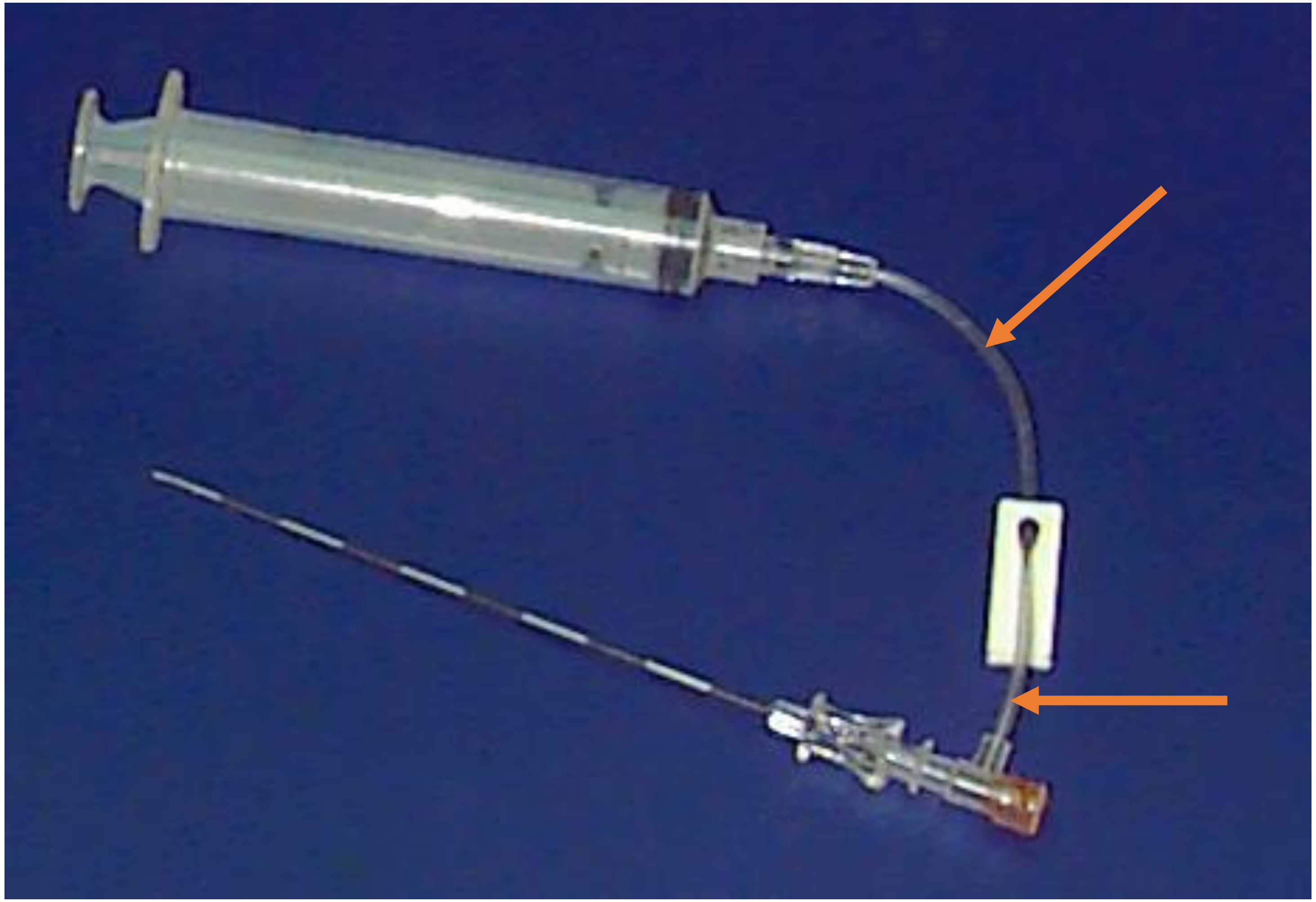


Photo: Mark Deutchman MD

Gelatin practice phantom

Photos: Mark Deutchman MD

Needle Visualization: Long Axis

Photo and video: Mark Deutchman MD

Needle Visualization Short Axis

Photo and video: Mark Deutchman MD

Billing and Coding

CPT codes for ultrasound procedures of the abdomen and retroperitoneum: 76700-76776.

- "Abdomen, Limited Scan" **76705**
- "Abdomen, Complete Scan" **76700** Includes the liver, gallbladder, common bile duct, pancreas, spleen, kidneys, upper abdominal aorta, and inferior vena cava, including any demonstrated abdominal abnormality with stored images and report.

ICD 10 codes: Code based on diagnosis that prompted scan

Learning Resources

http://www.osuultrasound.com/tutorials

https://www.sonosite.com/clinical-media

https://www.pocus101.com/category/ultrasound-tutorials/

Evidence and Clinical Guidelines (SORT)

- Screening using ultrasound for non-alcoholic fatty liver disease has been recommended but there are no consensus guidelines.
  - Indications for screening vary based on the presence of elevated liver enzymes and/or metabolic syndrome.
  - Such screening recommendations are therefore classified as Category C based on Level 3 evidence
- Sonographic guidance for paracentesis is associated with improved success and decreased risk of bleeding complications. Category C, Level 3

Pandyarajan V, Gish RG, Alkhouri N, Noureddin M. Screening for Nonalcoholic Fatty Liver Disease in the Primary Care Clinic. Gastroenterol Hepatol (N Y). 2019 Jul;15(7):357-365. PMID: 31391806; PMCID: PMC6676352.

Smallwood N, Dachsel M. Point-of-care ultrasound (POCUS): unnecessary gadgetry or evidence-based medicine? Clin Med (Lond). 2018 Jun;18(3):219-224. doi: 10.7861/clinmedicine.18-3-219. PMID: 29858431; PMCID: PMC6334078.

References

Caraiani C, Yi D, Petresc B, Dietrich C. Indications for abdominal imaging: When and what to choose? J Ultrason. 2020;20(80):e43-e54. doi: 10.15557/JoU.2020.0008. Epub 2020 Mar 31. PMID: 32320166; PMCID: PMC7266076.

Mahale AR, Prabhu SD, Nachiappan M, Fernandes M, Ullal S. Clinical relevance of reporting fatty liver on ultrasound in asymptomatic patients during routine health checkups. J Int Med Res. 2018 Nov;46(11):4447-4454. doi: 10.1177/0300060518793039. Epub 2018 Sep 5. PMID: 30185098; PMCID: PMC6259408.

Pandyarajan V, Gish RG, Alkhouri N, Noureddin M. Screening for Nonalcoholic Fatty Liver Disease in the Primary Care Clinic. Gastroenterol Hepatol (N Y). 2019 Jul;15(7):357-365. PMID: 31391806; PMCID: PMC6676352.

AAFP

AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

AAFP CME

Introduction to Renal and Bladder Ultrasound

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Disclosure Statement

It is the policy of the AAFP that all individuals in a position to control CME content disclose any relationships with ineligible companies upon nomination/invitation of participation. Disclosure documents are reviewed for potential relevant financial relationships. If relevant financial relationships are identified, mitigation strategies are agreed to prior to confirmation of participation. Only those participants who had no relevant financial relationships or who agreed to an identified mitigation process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Review the current evidence for point of care ultrasound of the kidney and bladder.
2. Assess for urinary obstruction by views of the bladder and kidneys.
3. Distinguish features of the obstruction of the urinary tract from common mimickers.
4. Review common kidney and bladder pathologies that made be seen on point of care ultrasound.

Clinical Case Scenario

Your elderly female w/ CKD stage 3 is called back into the clinic for follow-up on labs for a ***newly elevated creatinine***

- **3.5** (baseline 1.5-1.7)
- She is hydrating as instructed, taking no new medications, has decreased urine output, longstanding incontinence, possible vague right sided abdominal pain.
- VSS, physical exam is unremarkable

Can POCUS be useful here?

Evidence and Clinical Guidelines (SORT)

- Limited evidence suggests ultrasound enhances confidence and is superior to physical exam for detecting elevated bladder volumes- **C** (Ref 1, 2)
- In patients with suspected nephrolithiasis, POCUS is a safe initial imaging modality compared to CT or consultative imaging while resulting in reduced patient radiation exposure and shorter ED length of stay.- **A** (Ref 3)
- Most studies suggest POCUS for any degree of hydronephrosis is associated with modest accuracy when compared to CT (sens/spec 70s-80s)- **A** (Ref 4, 5)
- In ED patients with suspected renal colic the presence of moderate-severe hydronephrosis using POCUS is associated with high specificity (0.94) and +LR (5.22) when compared to CT.- **B** (Ref 4)
- The detection of moderate-severe hydronephrosis in ED patients with suspected renal colic is associated with high sensitivity of detecting patients with large stones or those who will need urologic interventions. **–B** (Ref 6,7)

Bladder POCUS- Common Indications

- Abdominal/Pelvic Pain
- Incontinence
- Nocturia
- Recurrent UTI
- AKI/CKD

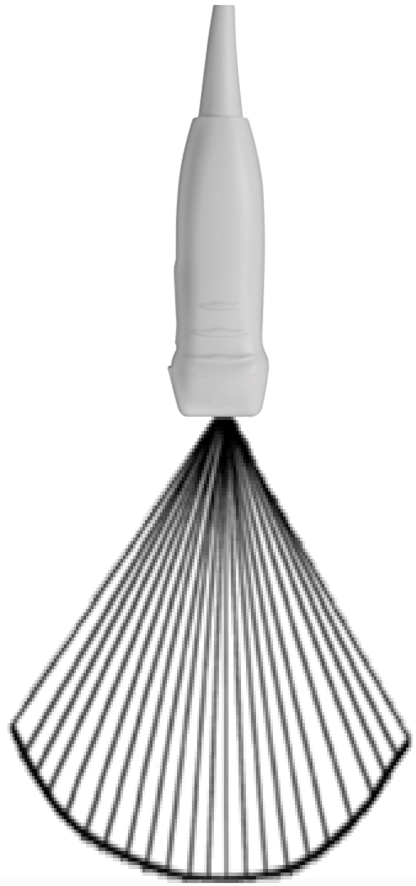
Introduction to Scanning

1. Patient setup
2. Probe selection
3. Preset
4. Probe position
5. Planes of cut (orientation)

Probe Selection

CONVEX (CURVILINEAR)

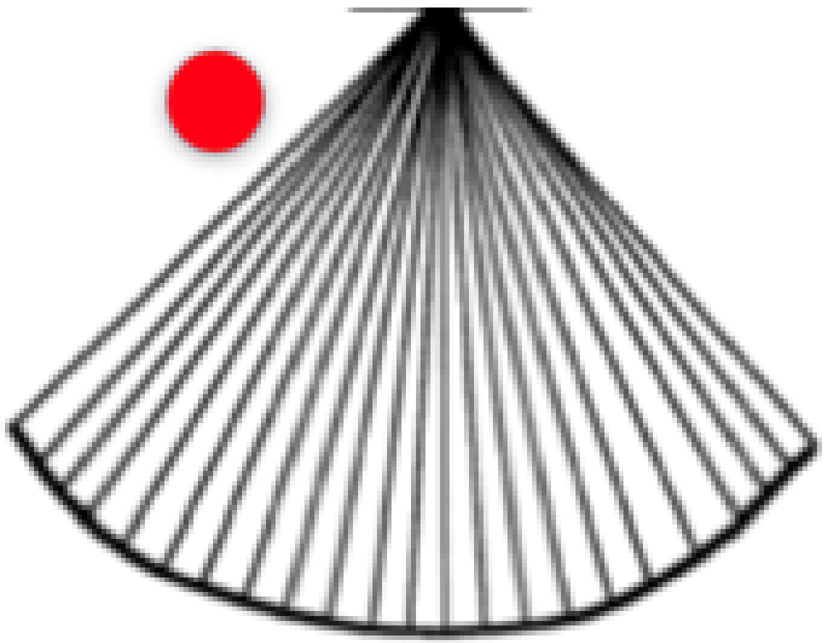
SECTOR (PHASED ARRAY)



LINEAR

Presets

- Abdomen
  - Renal/Bladder
- Cardiac
- OBGYN
- MSK/Small Parts
- Vascular



P.E.A.R.L.S. for *Routine* Use (inpatient and outpatient)

Probe position (not necessarily in order)

Parasternal

Epigastric

Anterior Lung/Apical

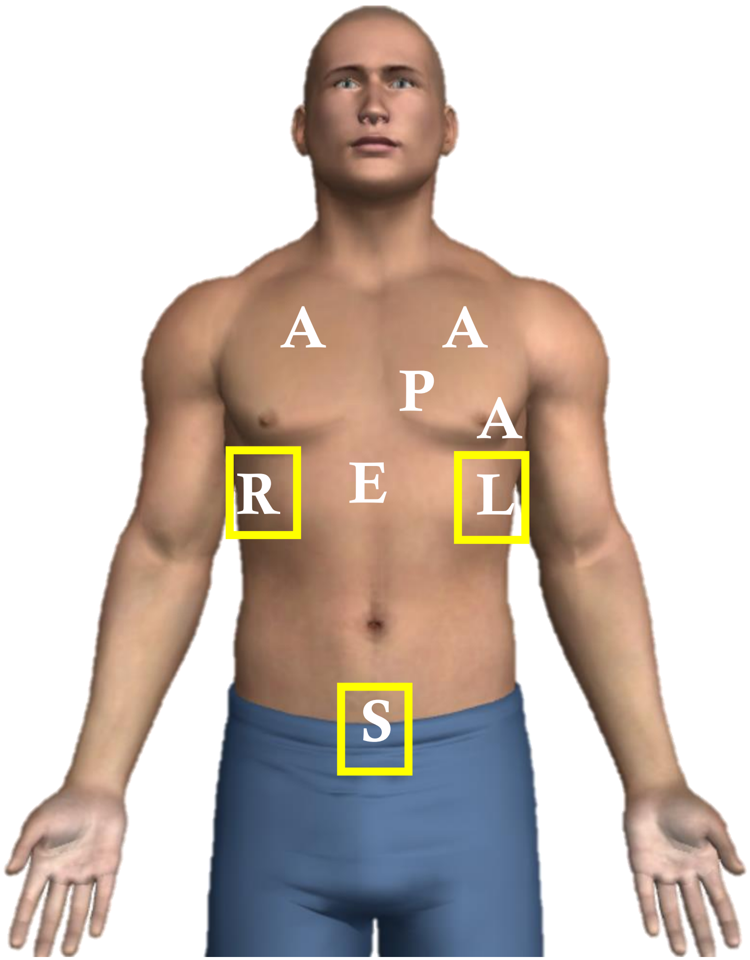
Right Upper Quadrant

Left Upper Quadrant

Suprapubic

SMJ. July 2018.

P.E.A.R.L.S. for *Routine* Use



Probe position (not necessarily in order)

Parasternal

Epigastric

Anterior Lung/Apical

Right Upper Quadrant

Left Upper Quadrant

Suprapubic

Original Article

SMJ. July 2018.

PEARLS for an Ultrasound Physical and Its Routine Use as Part of the Clinical Examination

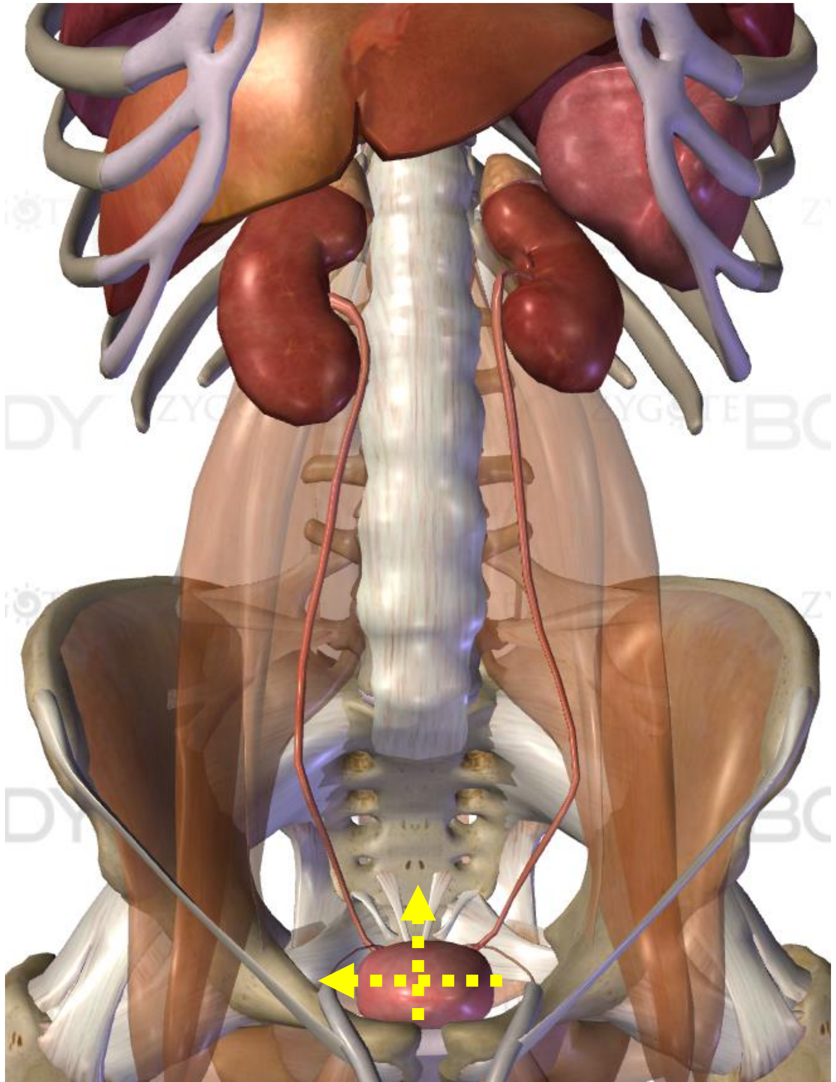
Michael Wagner, MD, and Janice Boughton, MD

Suprapubic View

Bladder

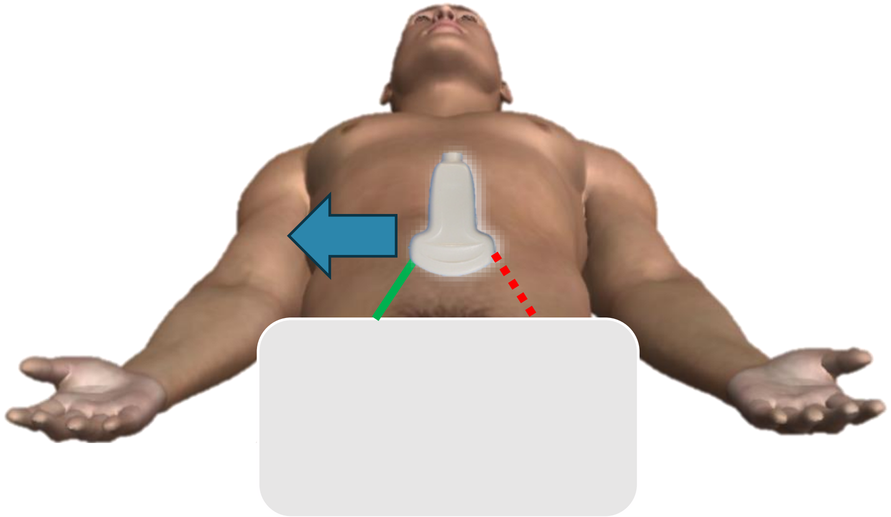
- Obstruction?
- Shape, Size/Volume
  - Pre + Post Void

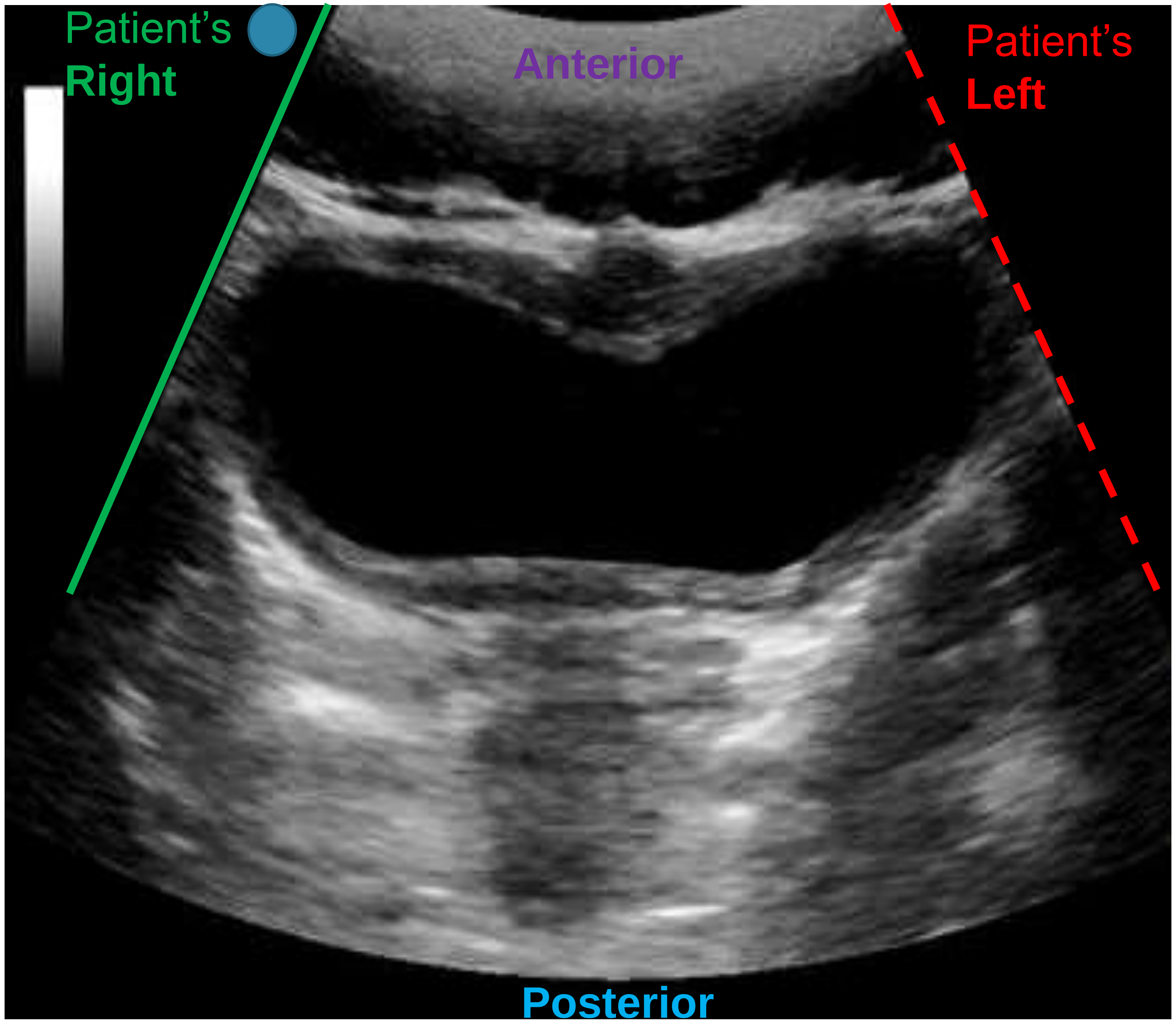
Suprapubic- Orientation and Probe Placement



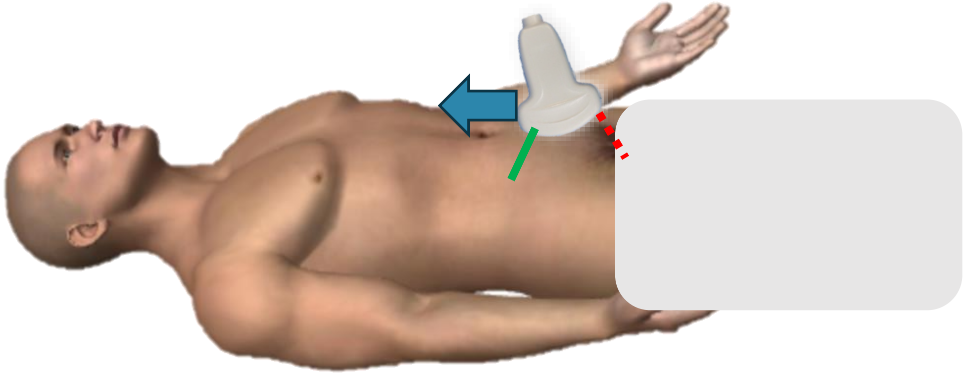
AAFP CME

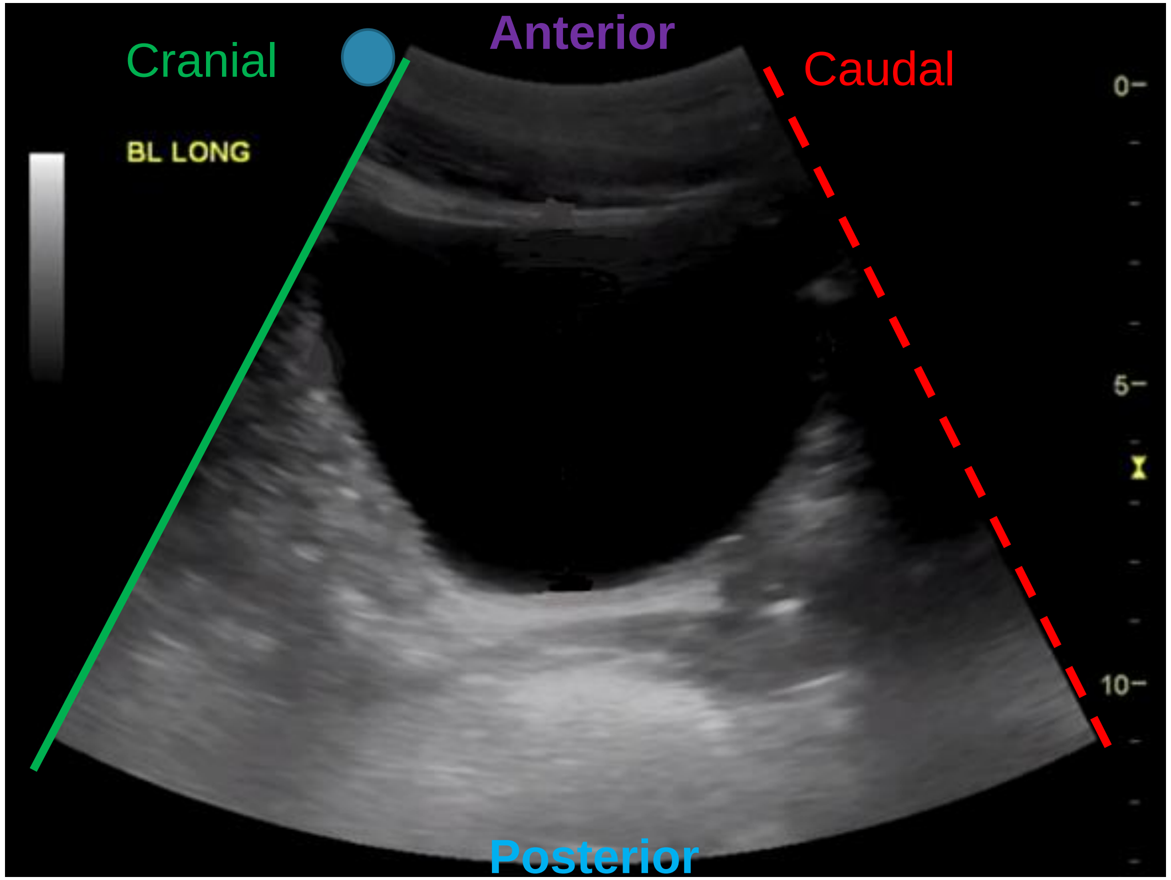
Transverse





Sagittal (longitudinal)

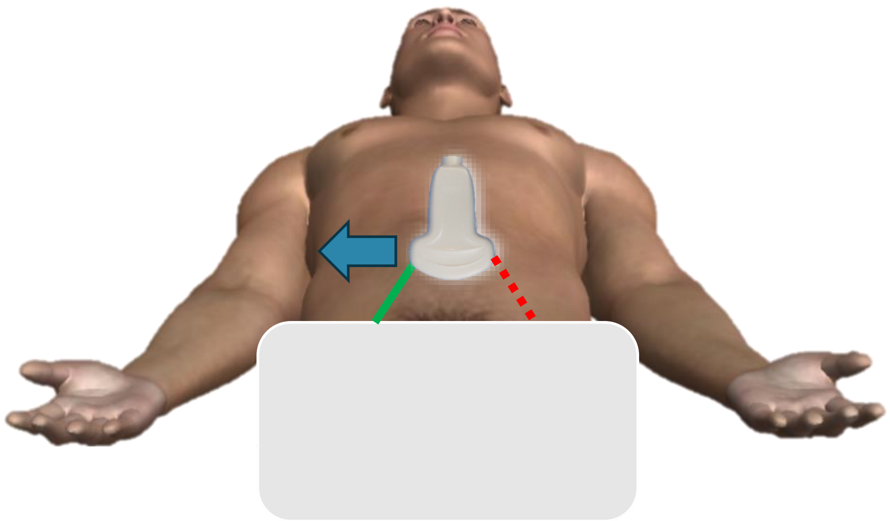


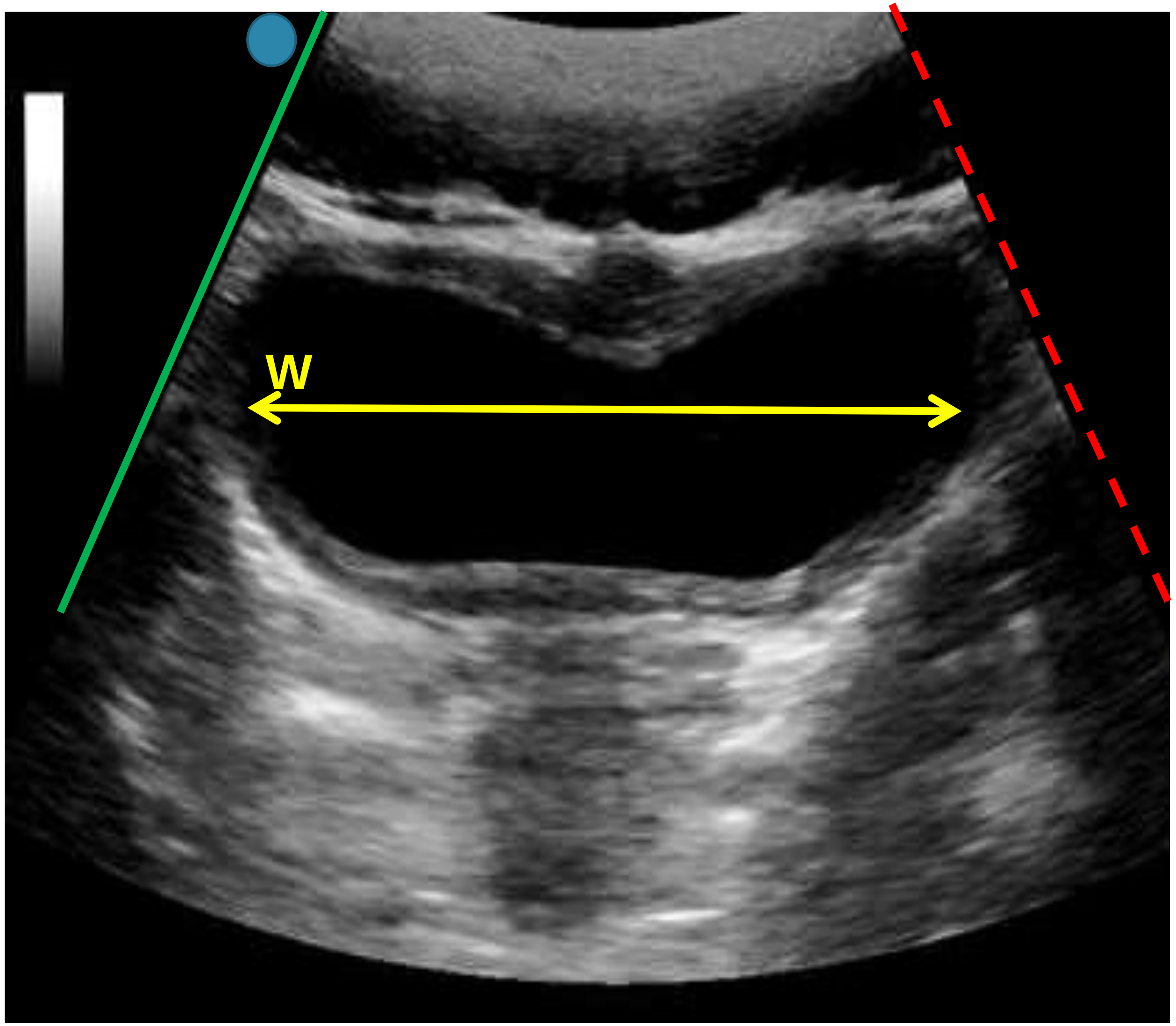


Technique Pearl

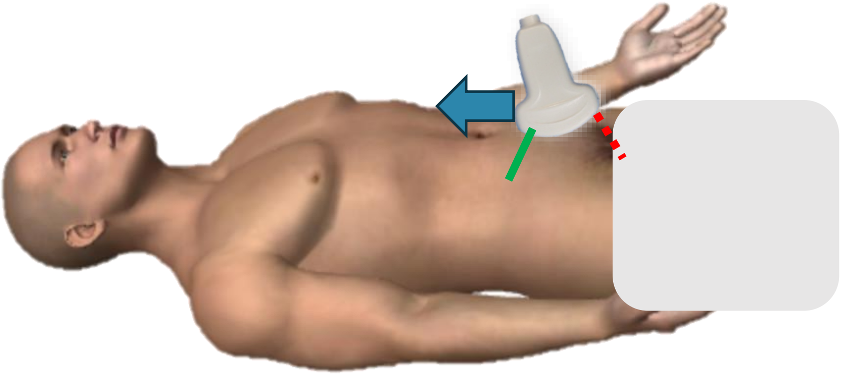
TURN DOWN THE GAIN in the Suprapubic Window

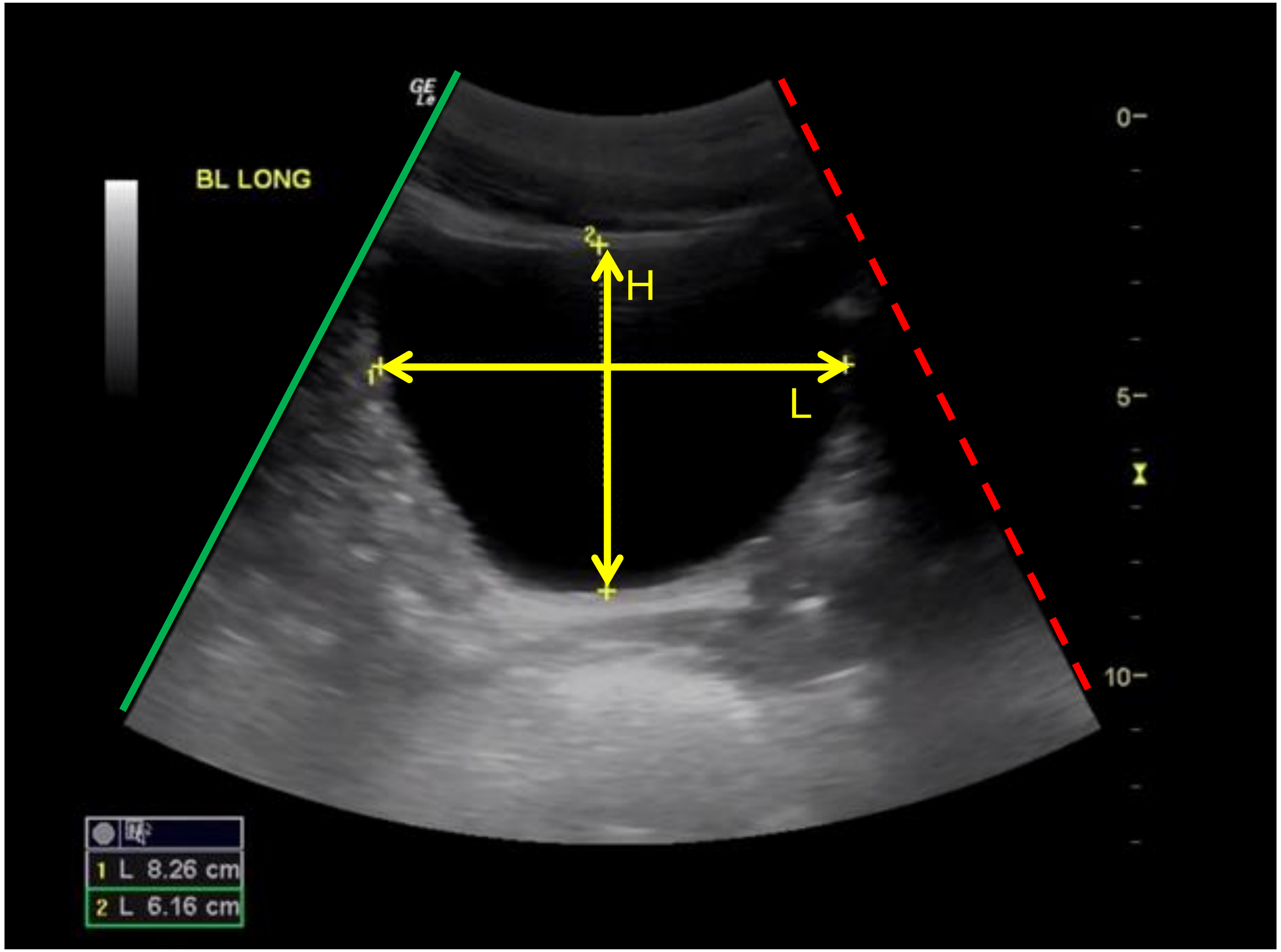
Transverse

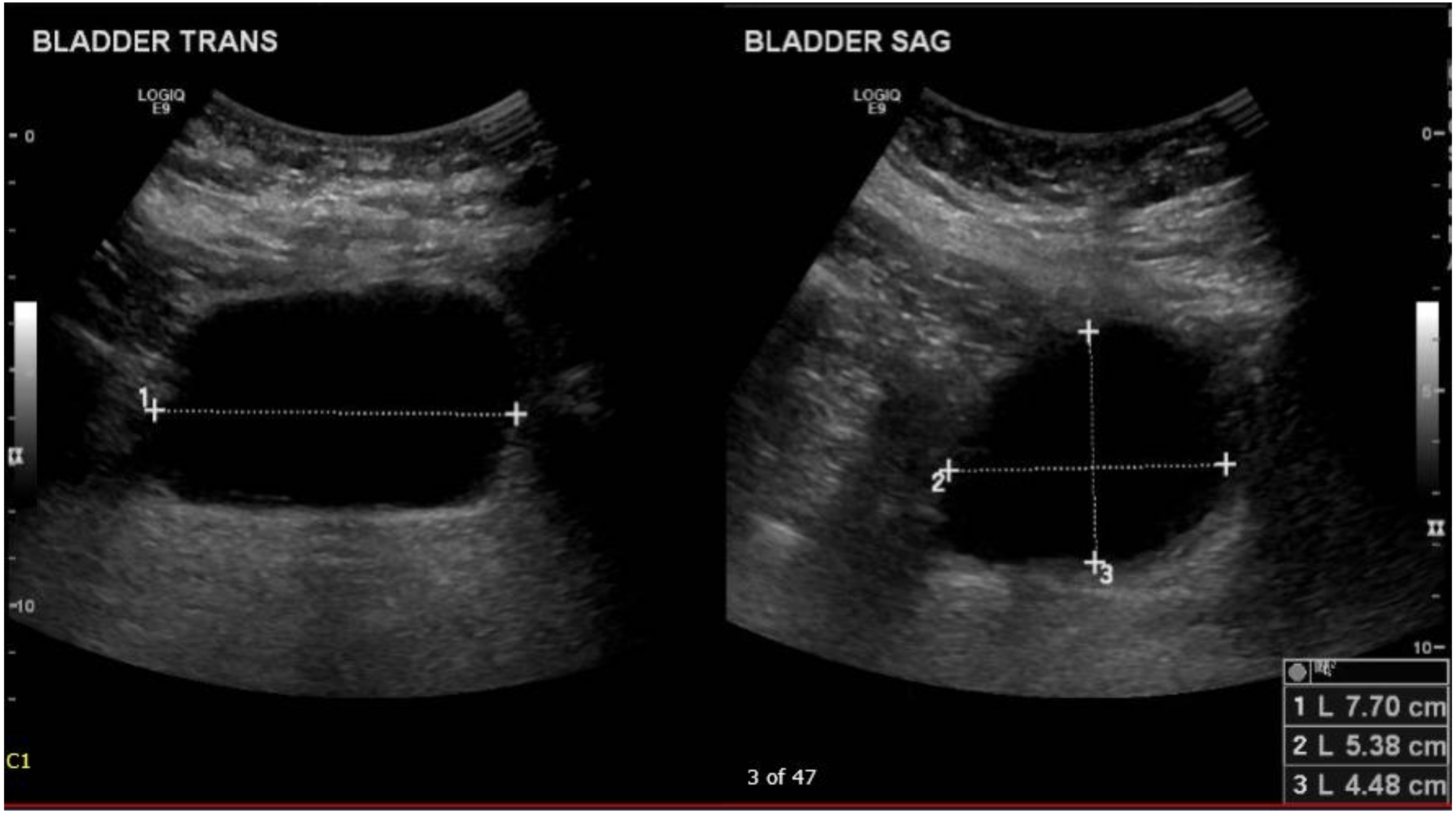




Longitudinal





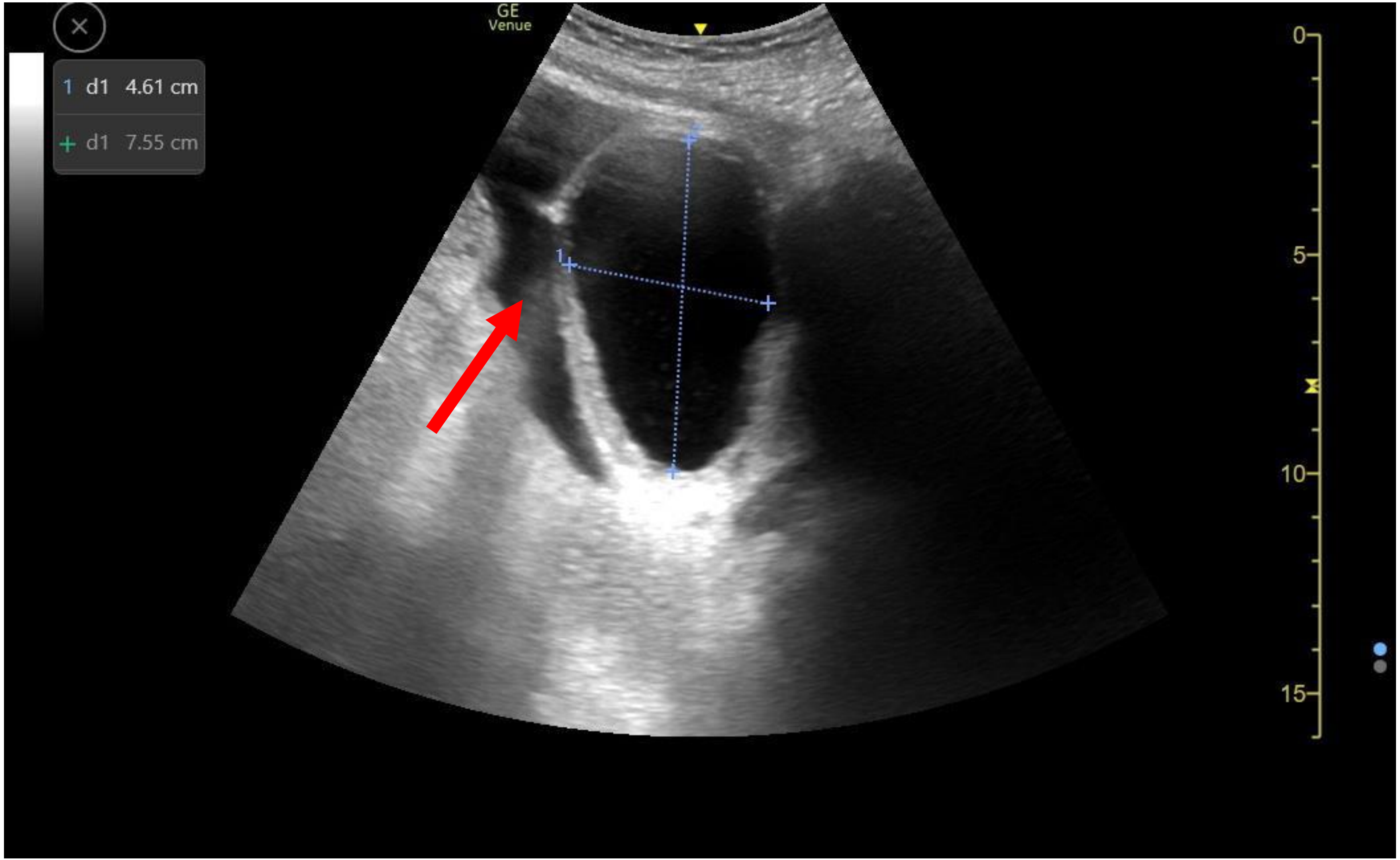

BLADDER TRANS
BLADDER SAG
LOGIQ E9
LOGIQ E9
1 L 7.70 cm
2 L 5.38 cm
3 L 4.48 cm
3 of 47
C1

Bladder Volume

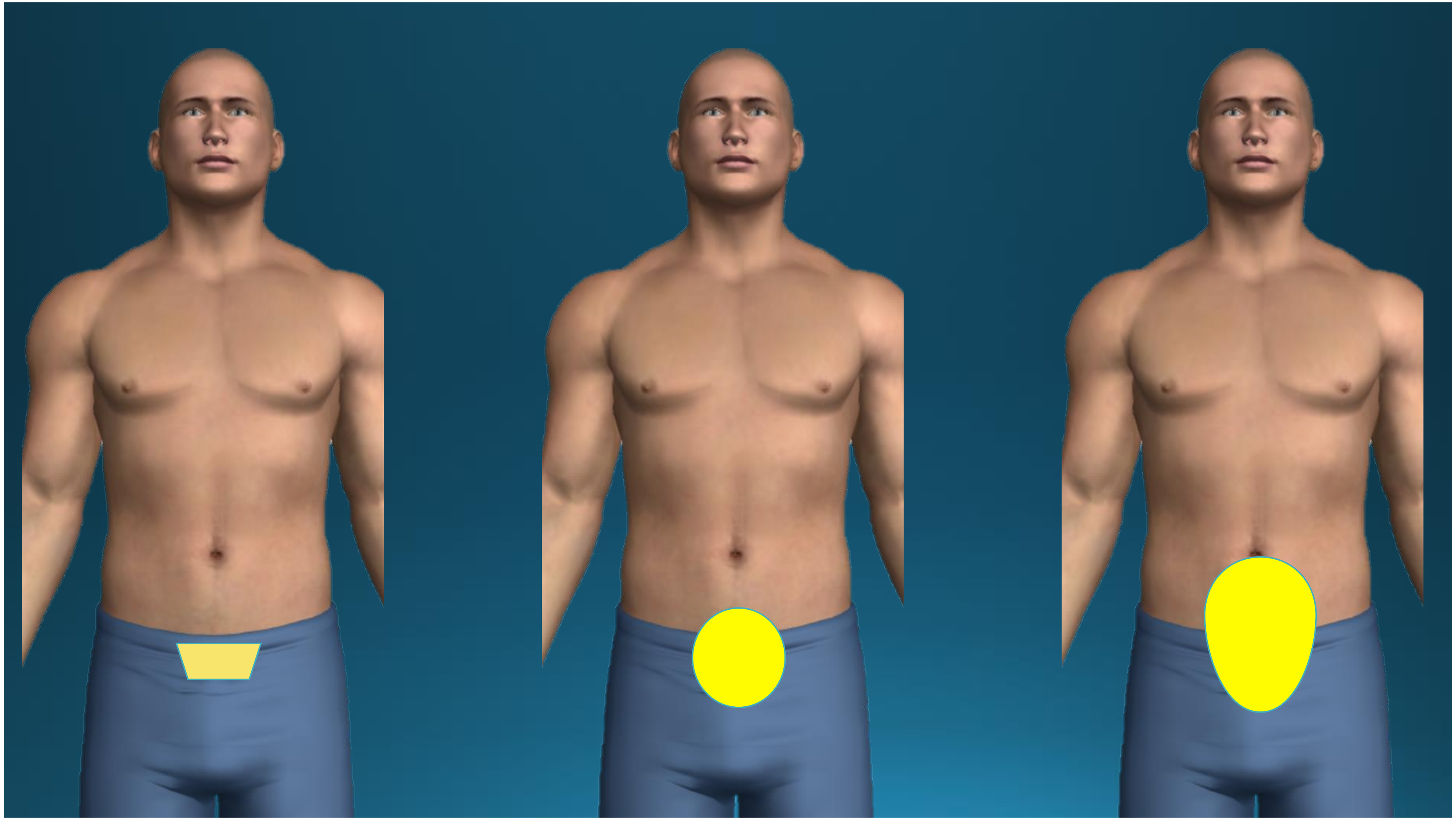
$$W \times L \times H \times 0.7^{*} = \text{Volume}_{(\text{mL})}$$

*some experts use 0.5

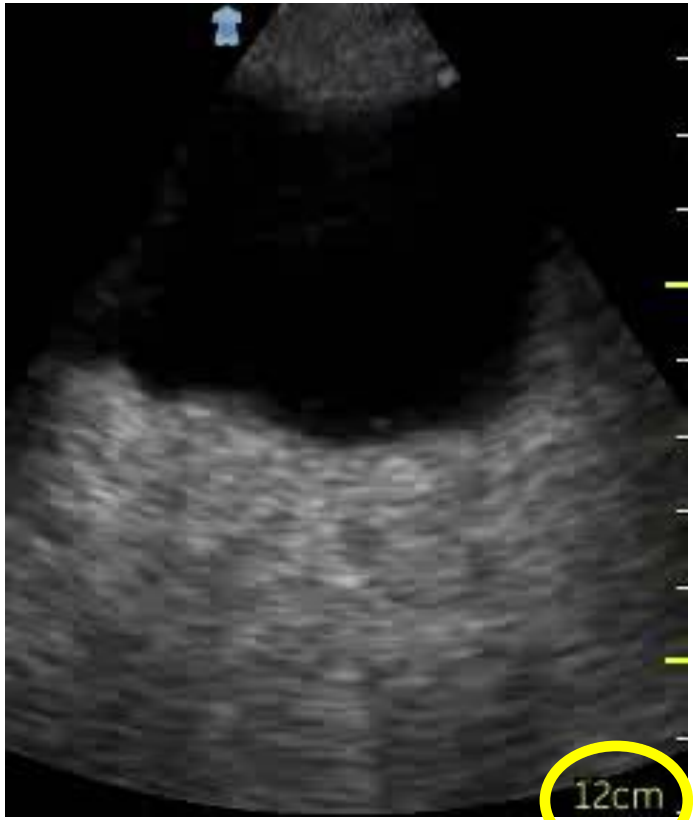
Regarding "Bladder Scanners"



Bladder size and shape



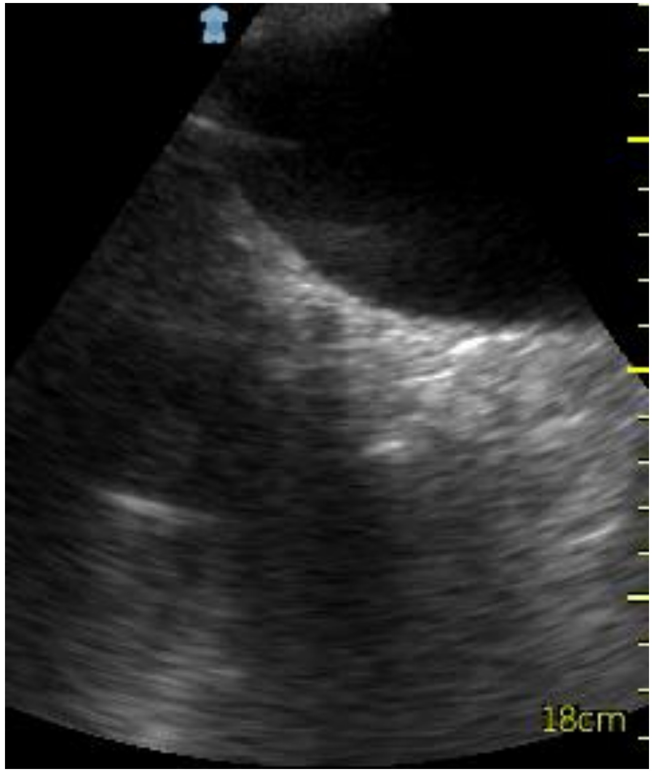
Normal size bladder



Abnormal size bladder

>10cm


18cm

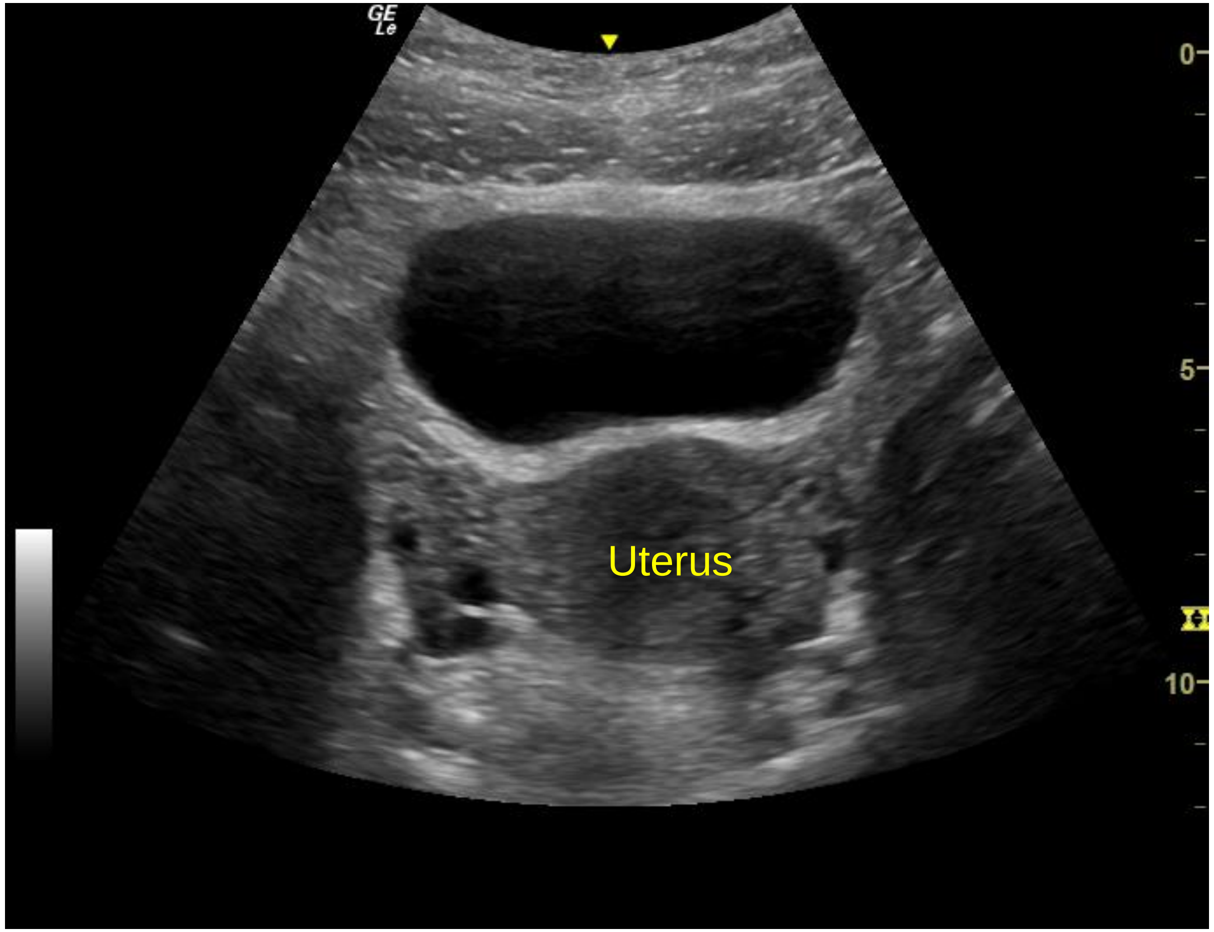

18cm

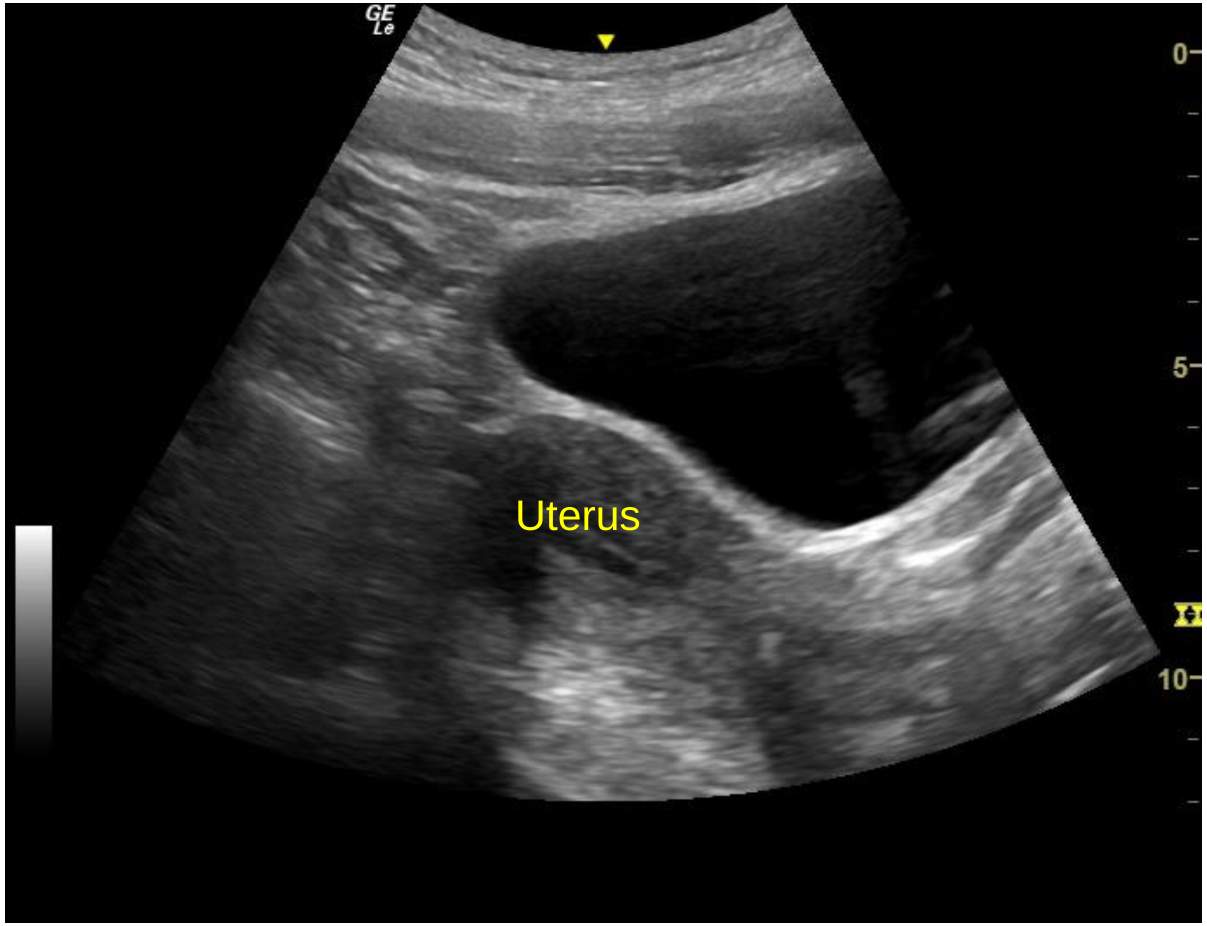
Don’t let this be a CT diagnosis!

Bladder + normal uterus

Transverse

Sagittal

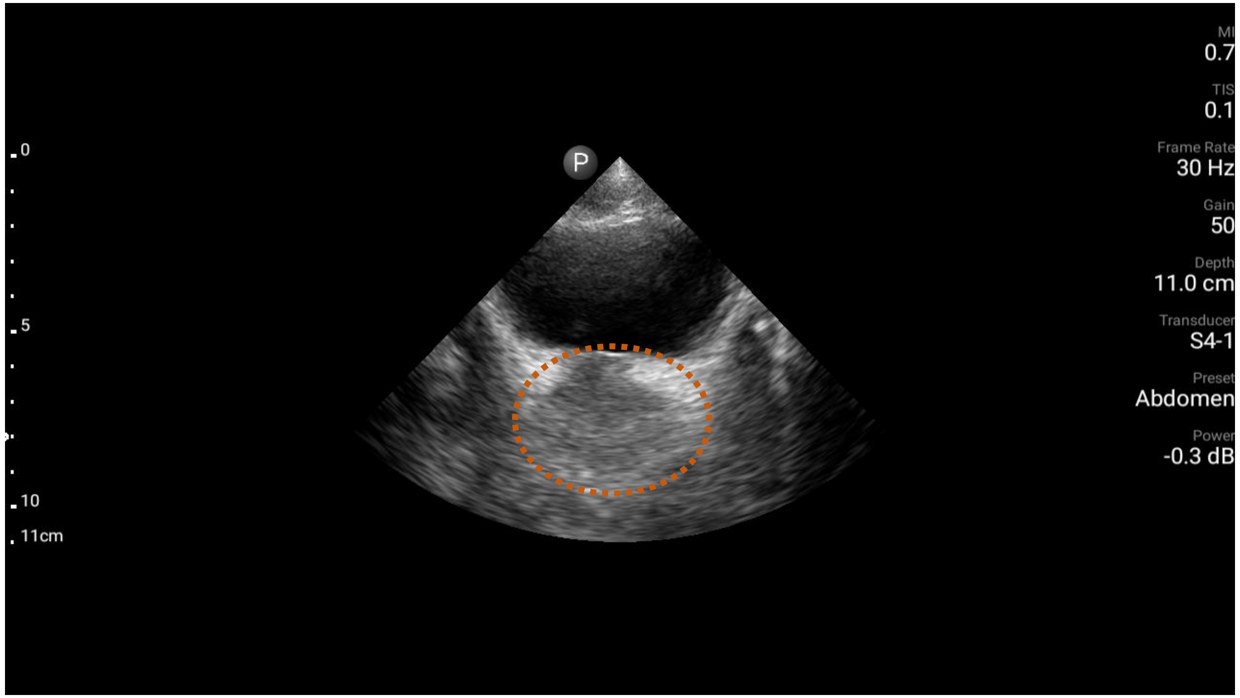




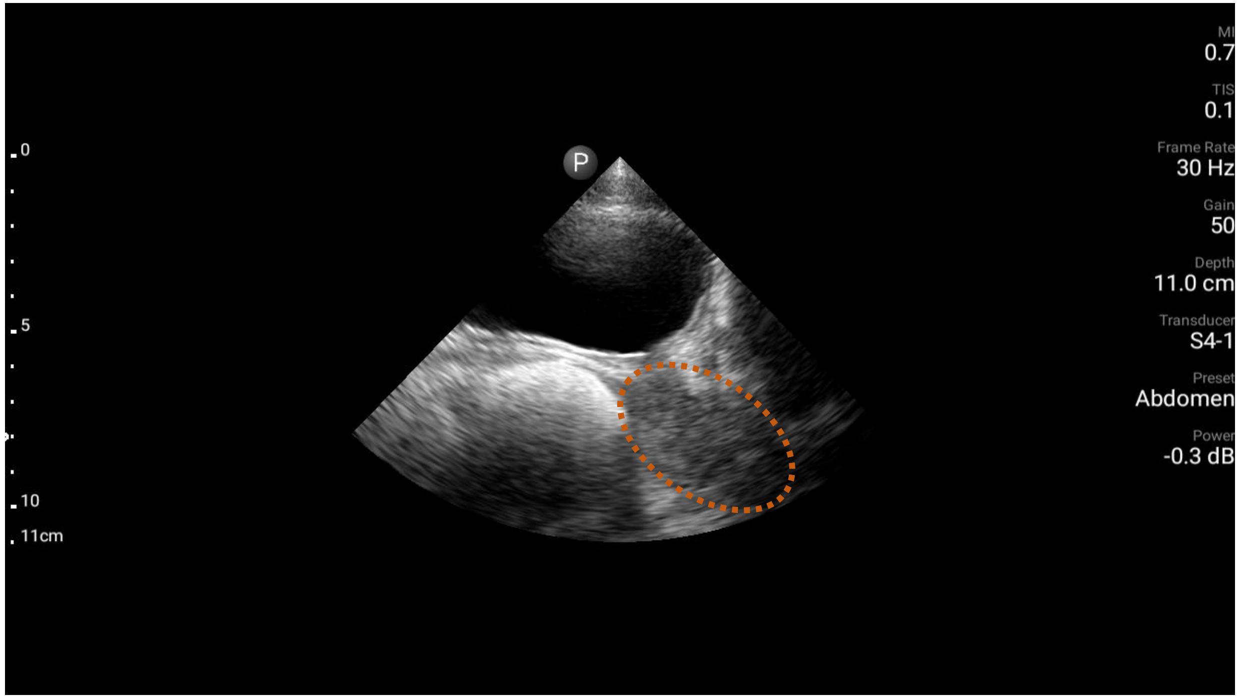
Images credit: Joy Shen-Wagner MD

Bladder and Normal Prostates

Transverse



Sagittal



Suprapubic Window- Next Steps

- Prostate Size (Enlargement)
- Foley Catheter Management
- Features of Chronic Urinary Retention
- Incidental findings in “UTI”
    - Stones
    - Masses
    - Gas

Kidney POCUS- Common Indications

Abdominal/Flank Pain

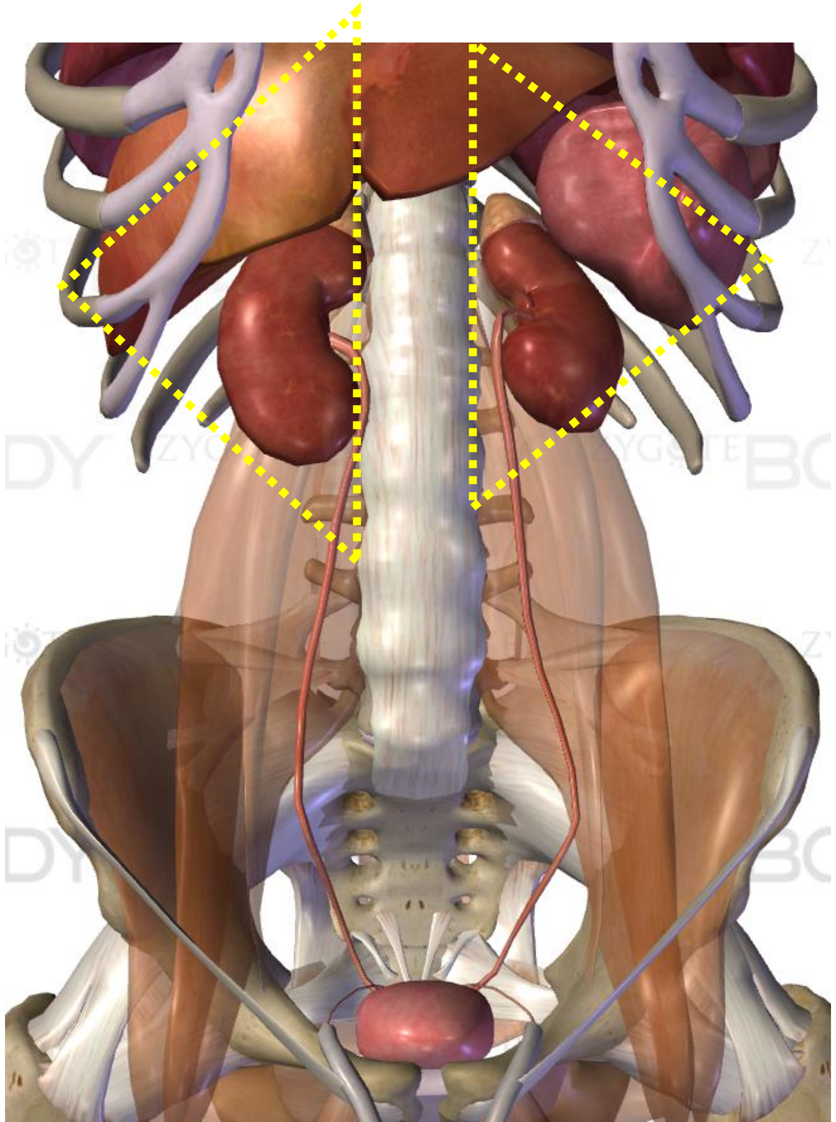
*Back Pain

Hematuria

AKI/CKD

Sepsis

RUQ/LUQ- Orientation and Probe Placement



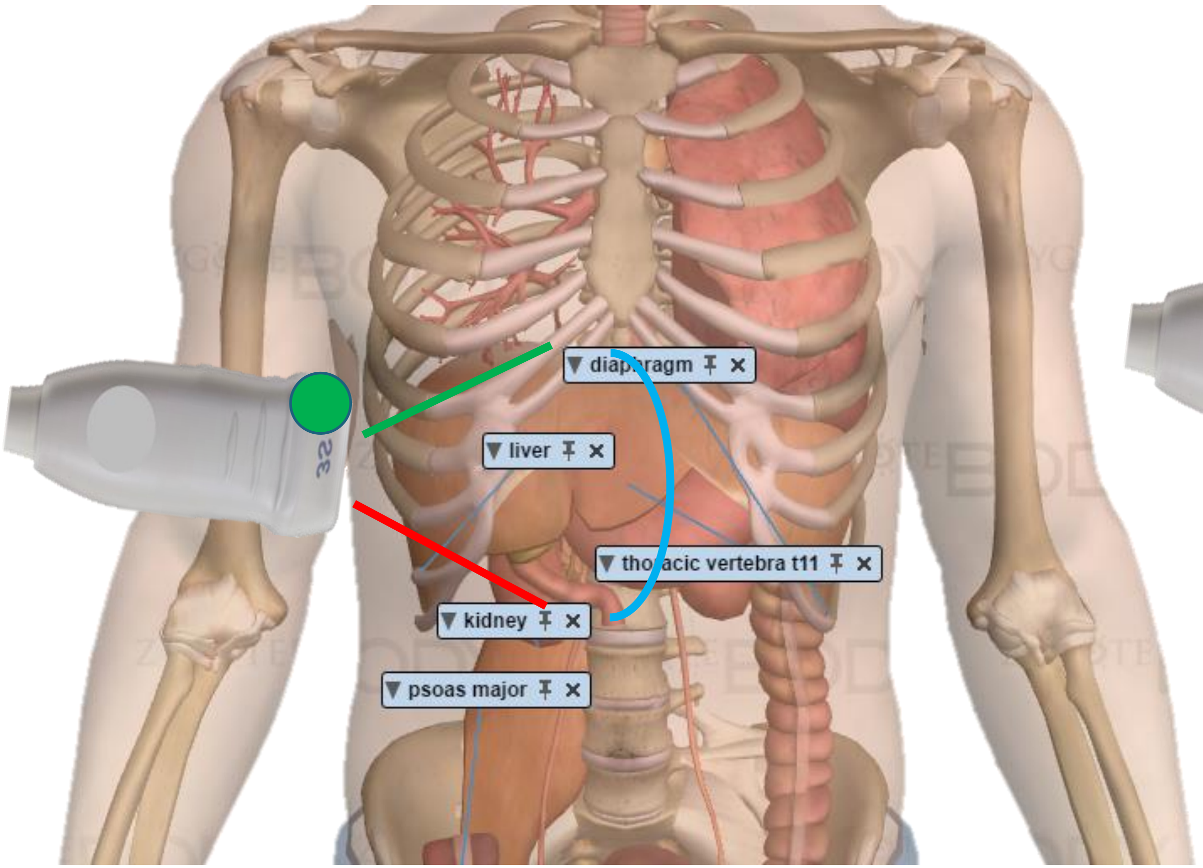
AAFP **CME**

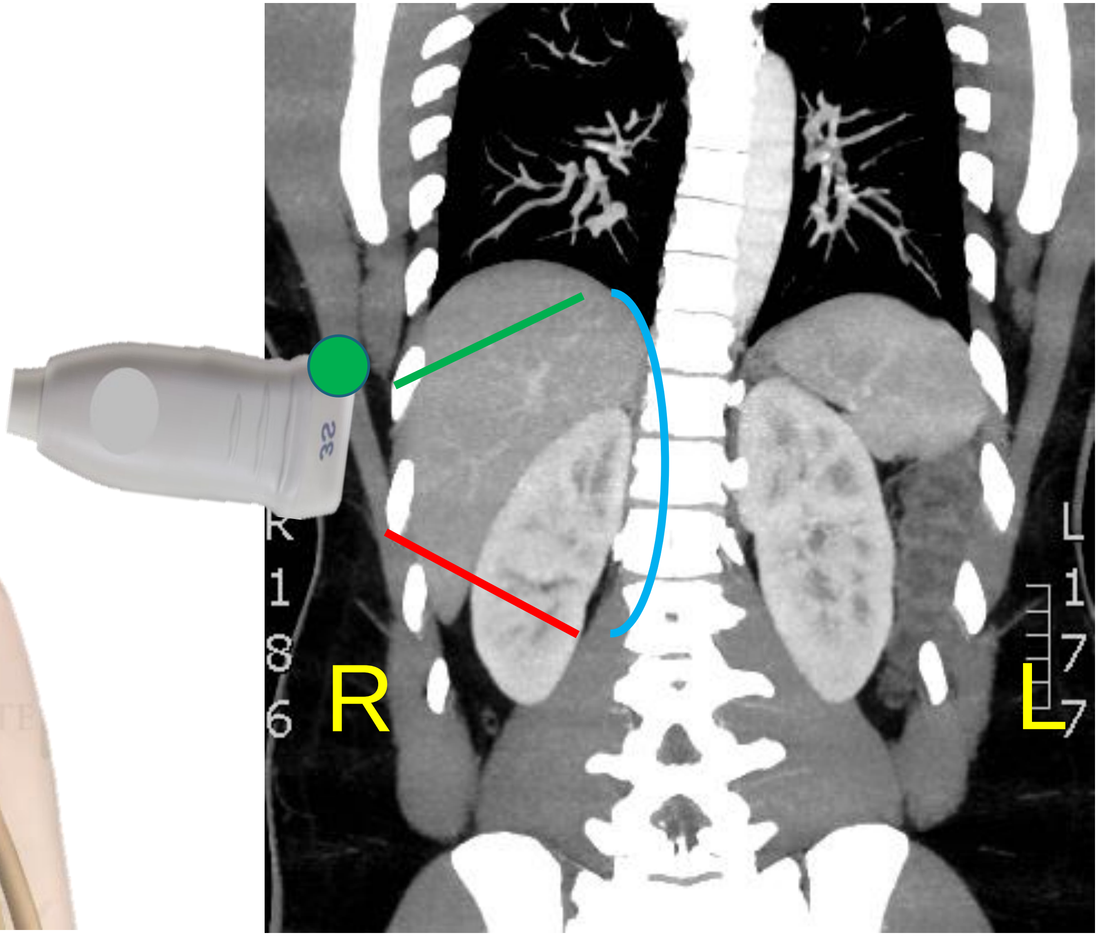
Right Upper Quadrant (RUQ)

Liver

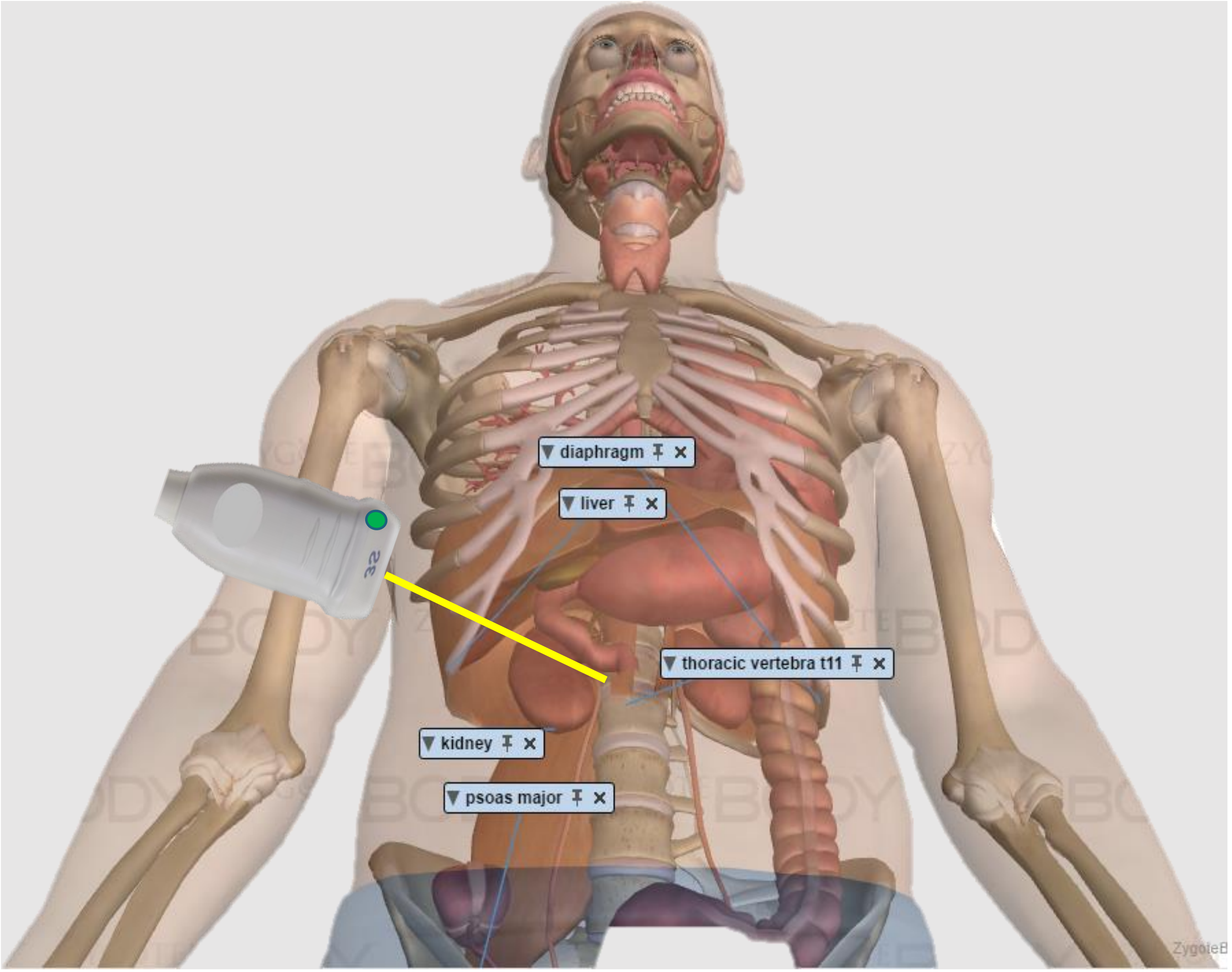
Right Kidney

RUQ- Coronal Plane



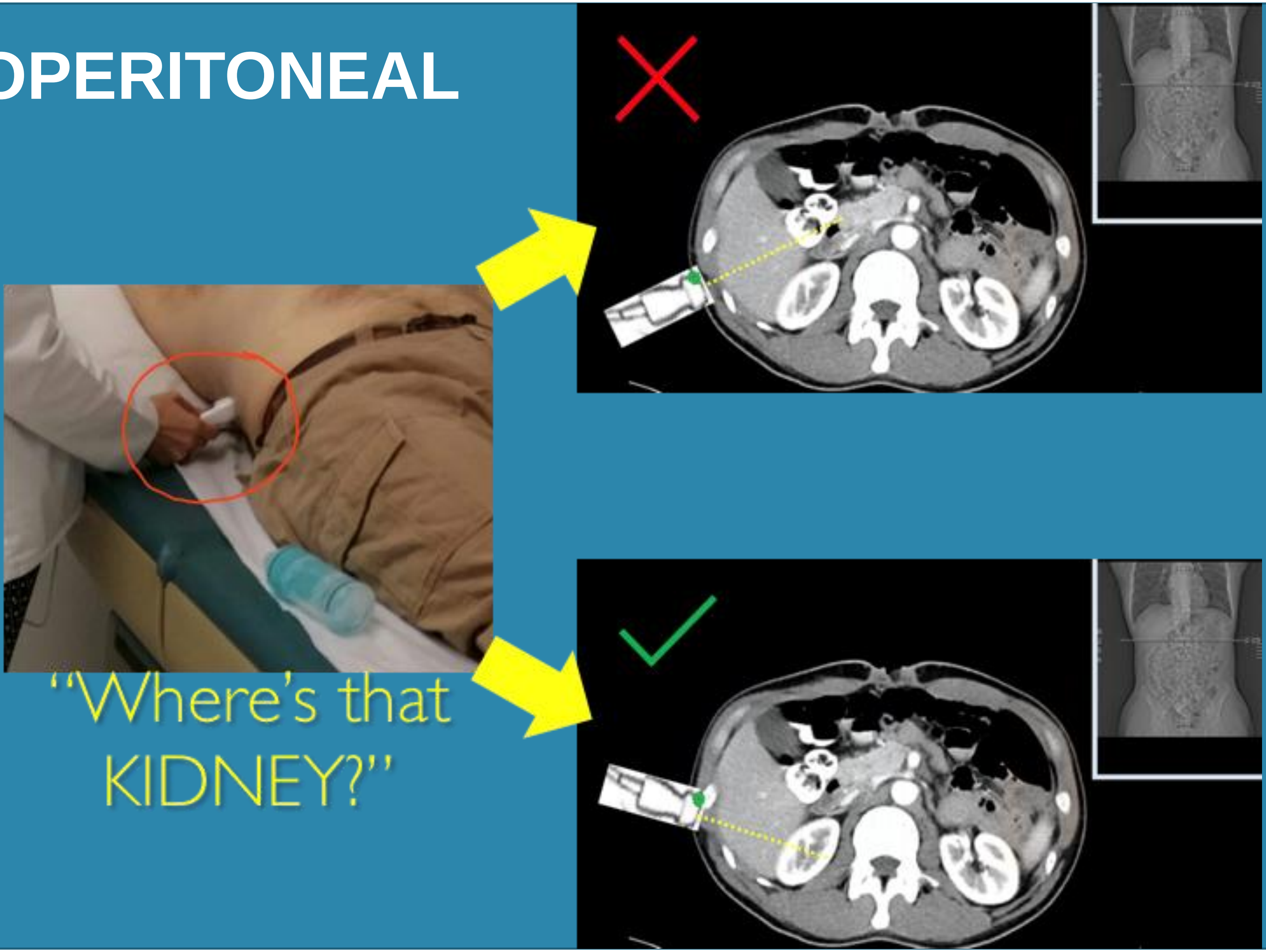


Liver, Kidney and Spine



Beam angled through **liver**, **kidney** and **spine**

Kidney is RETROPERITONEAL



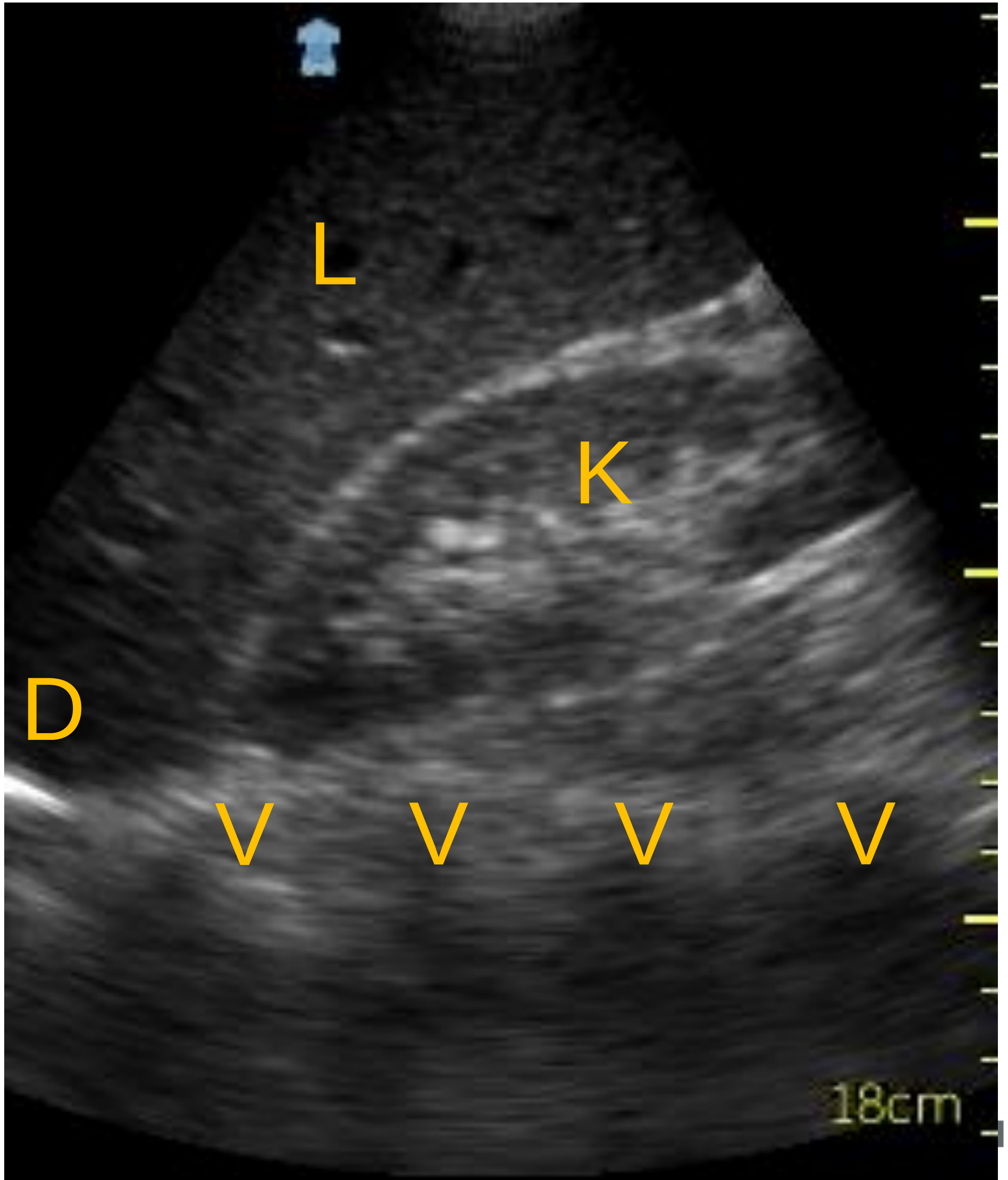
4 Key Landmarks

Liver

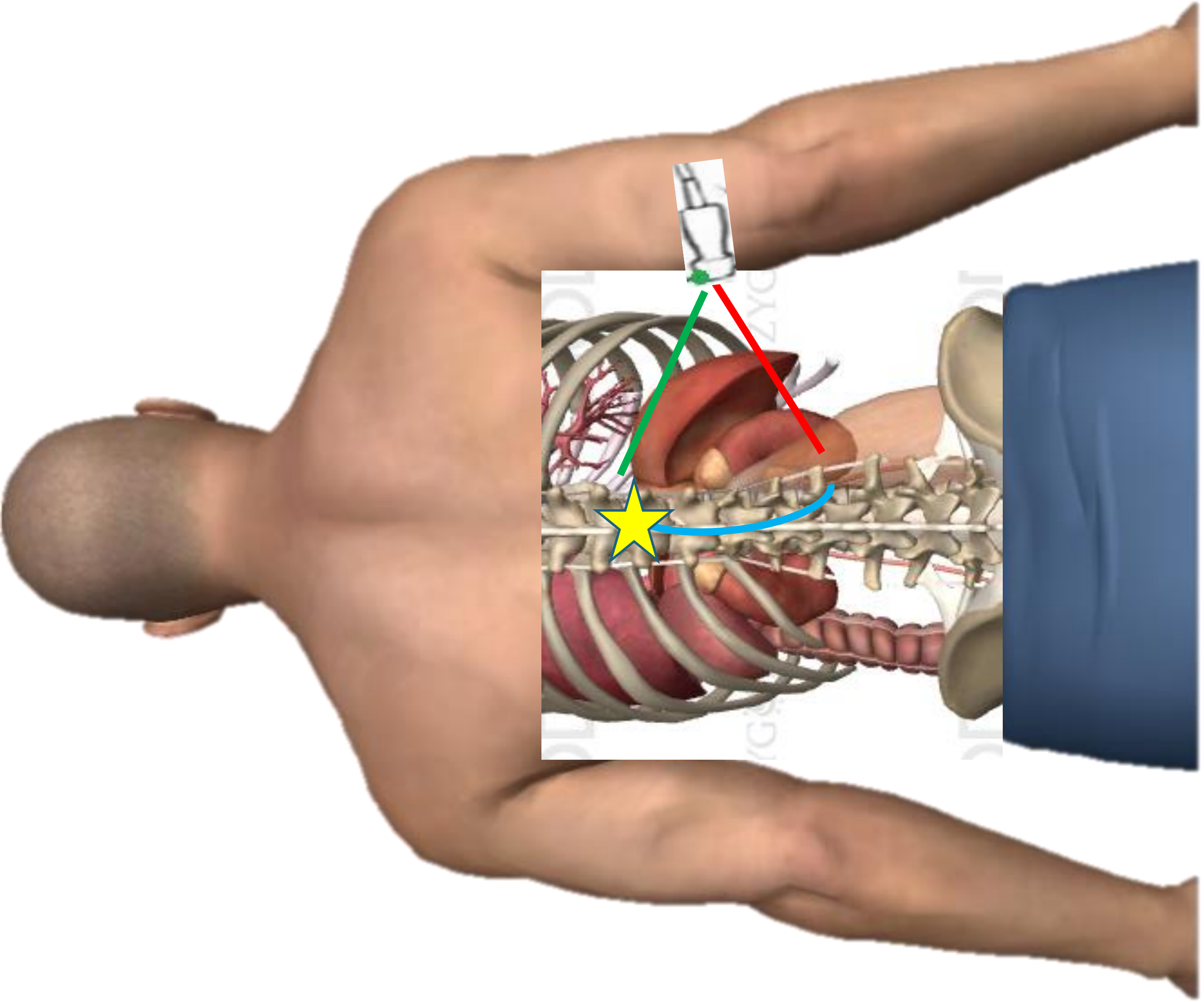
Kidney

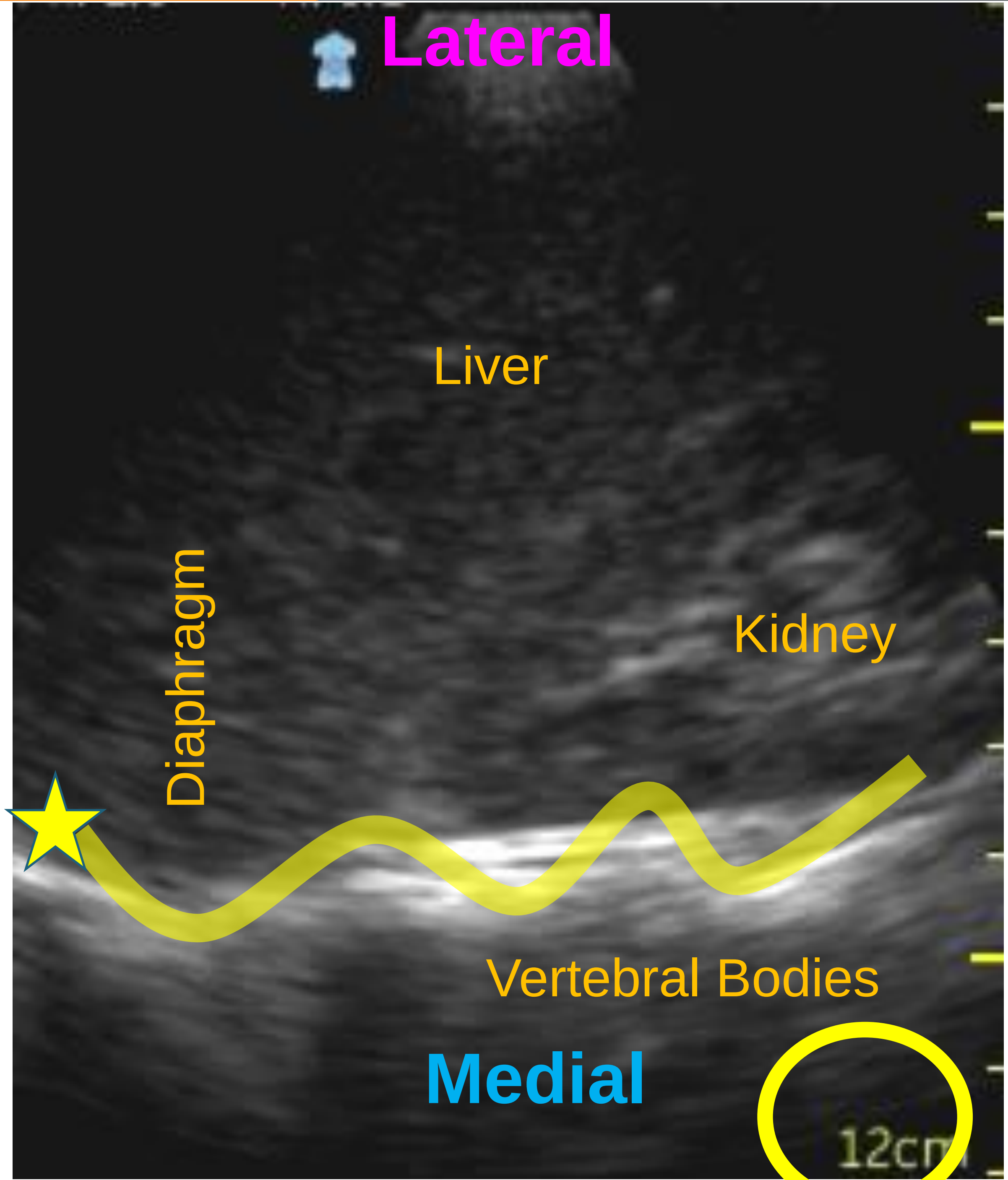
Vertebrae/Spine

Diaphragm



Orientation and Depth



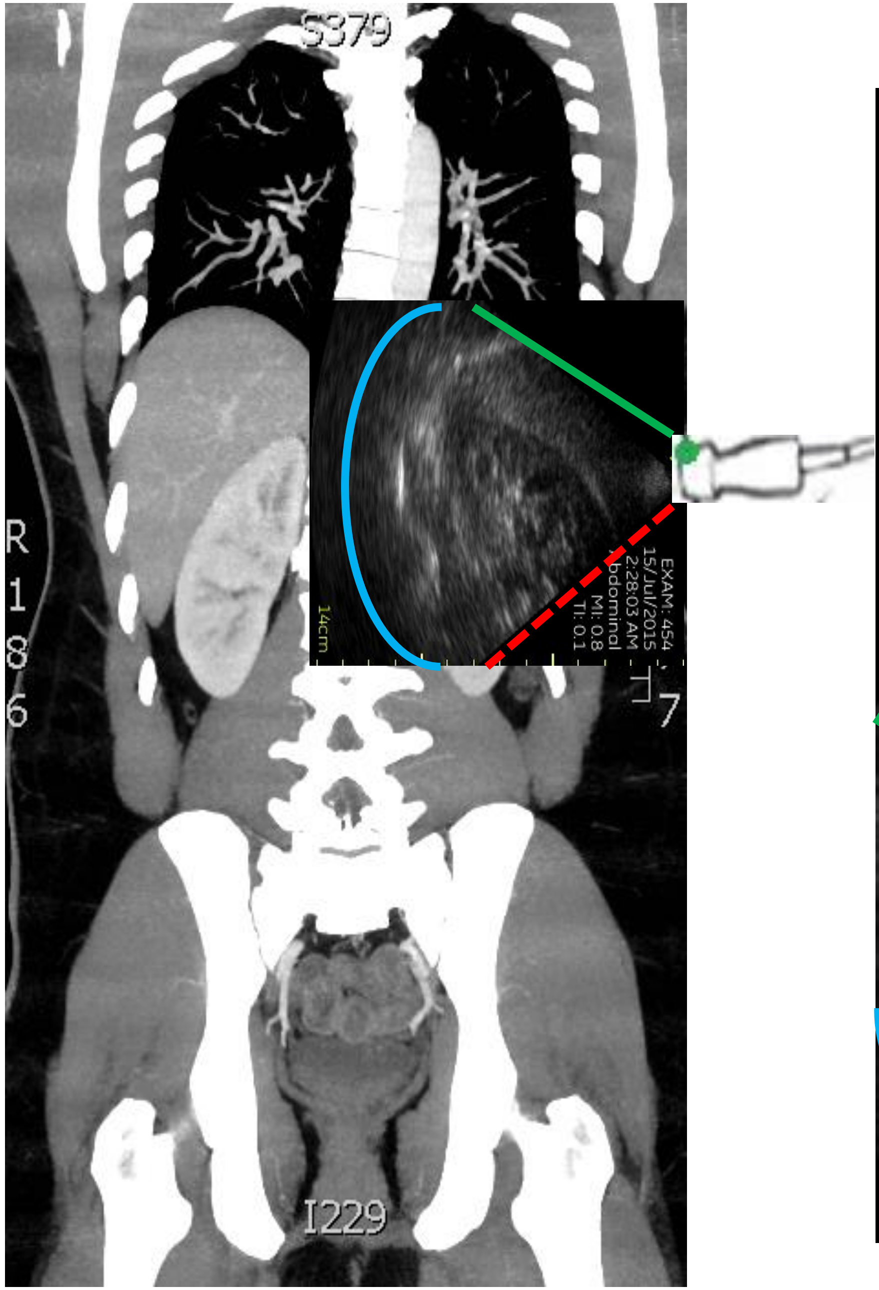


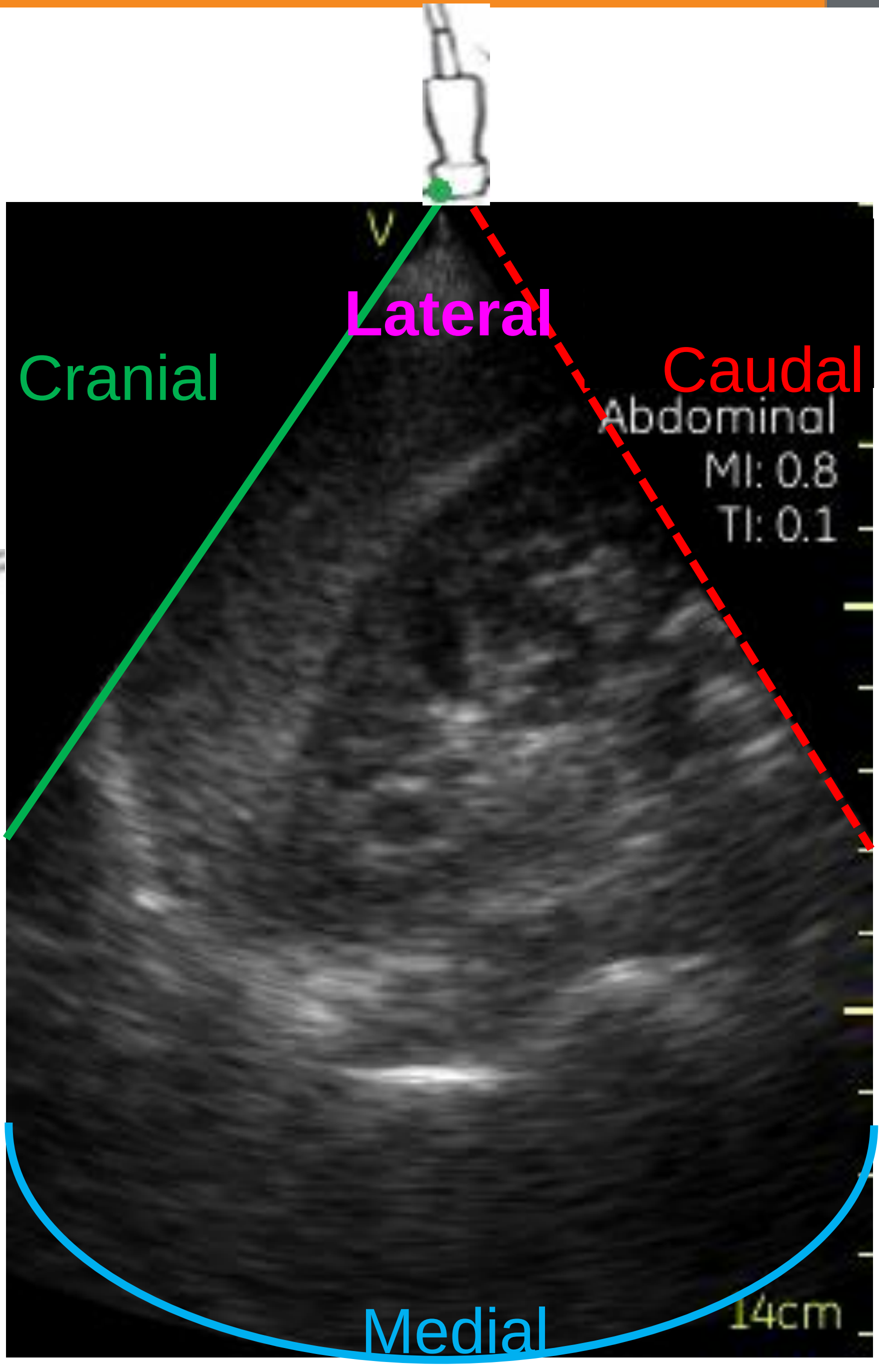
Left Upper Quadrant (LUQ)

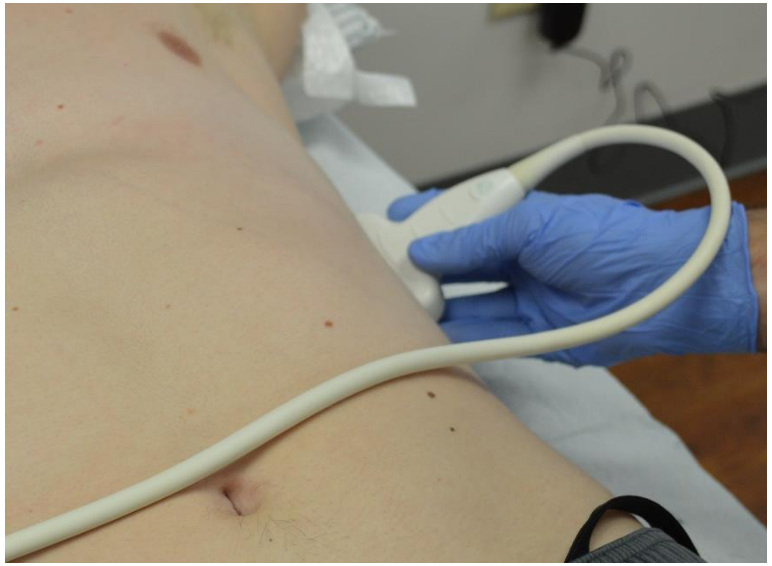
Spleen

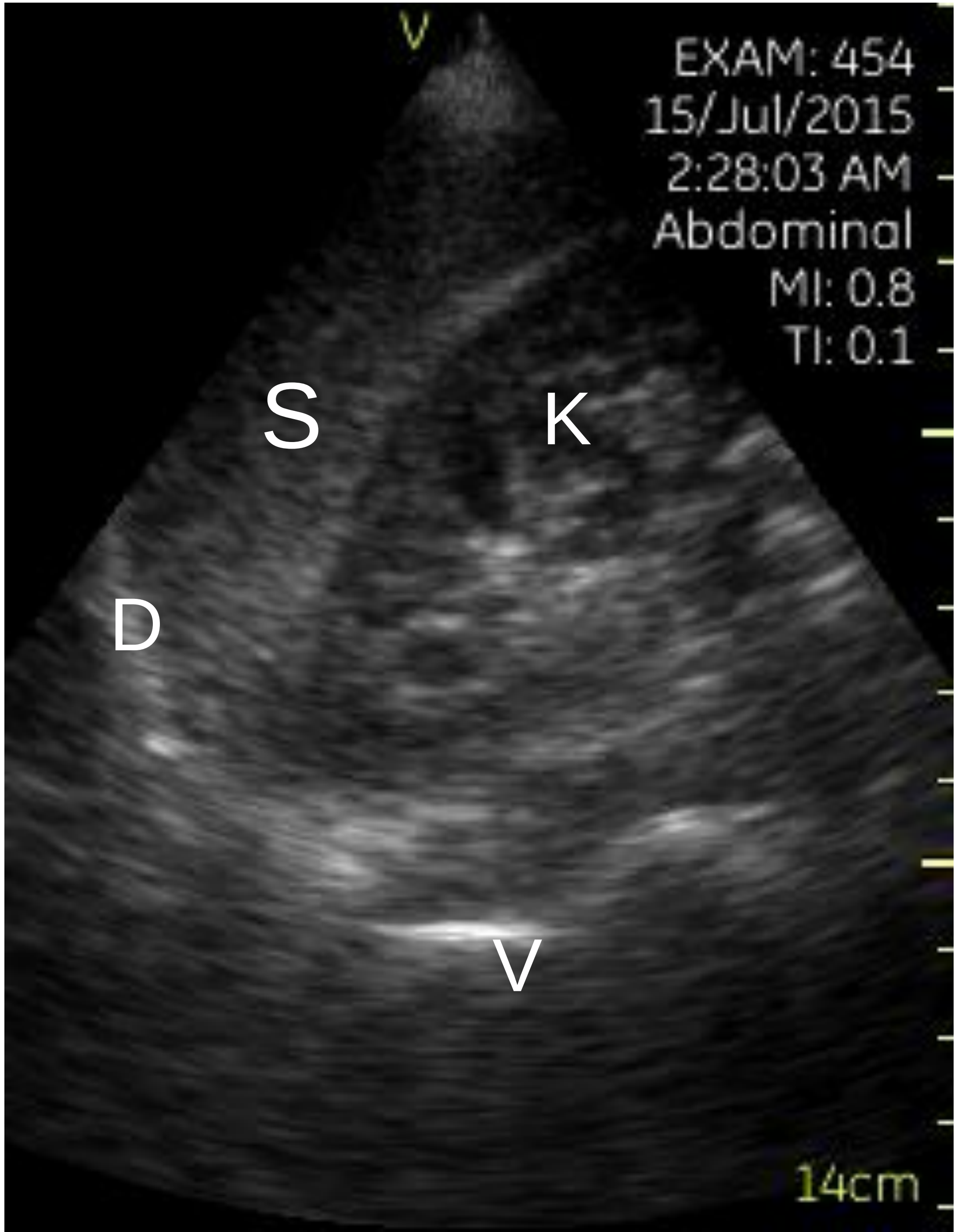
Left Kidney

LUQ- Coronal Plane









4 Structures

Spleen

Kidney

Vertebral Body

Diaphragm

Renal POCUS 1st Steps

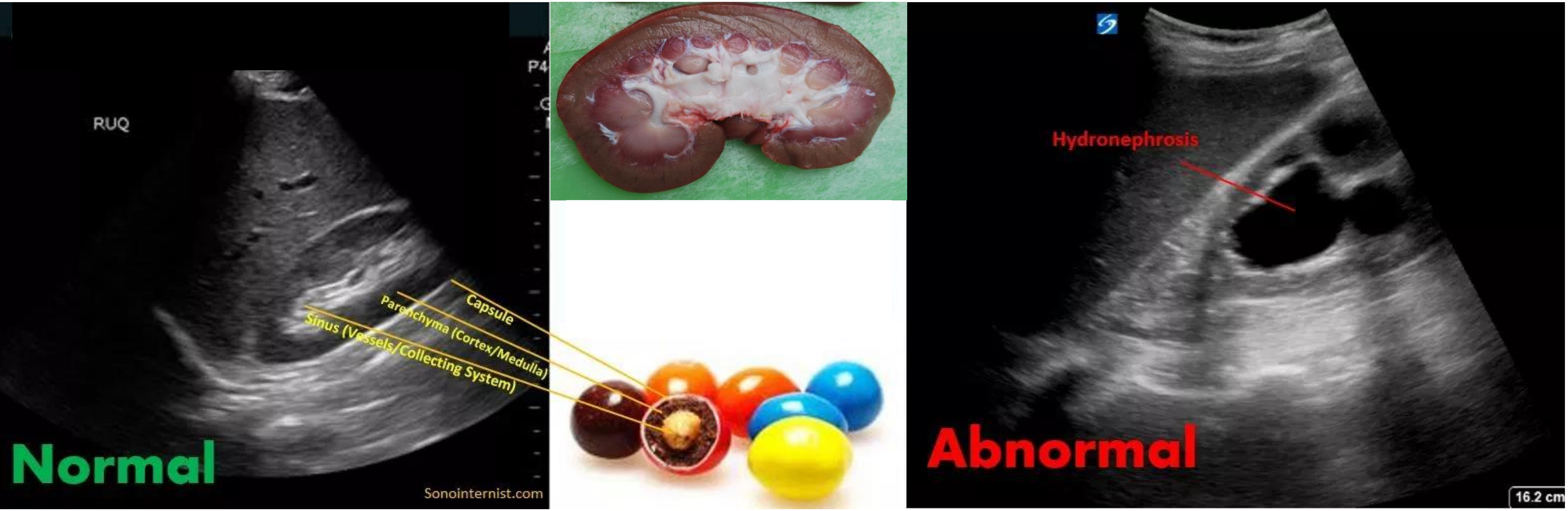
Renal Obstruction

Hydronephrosis

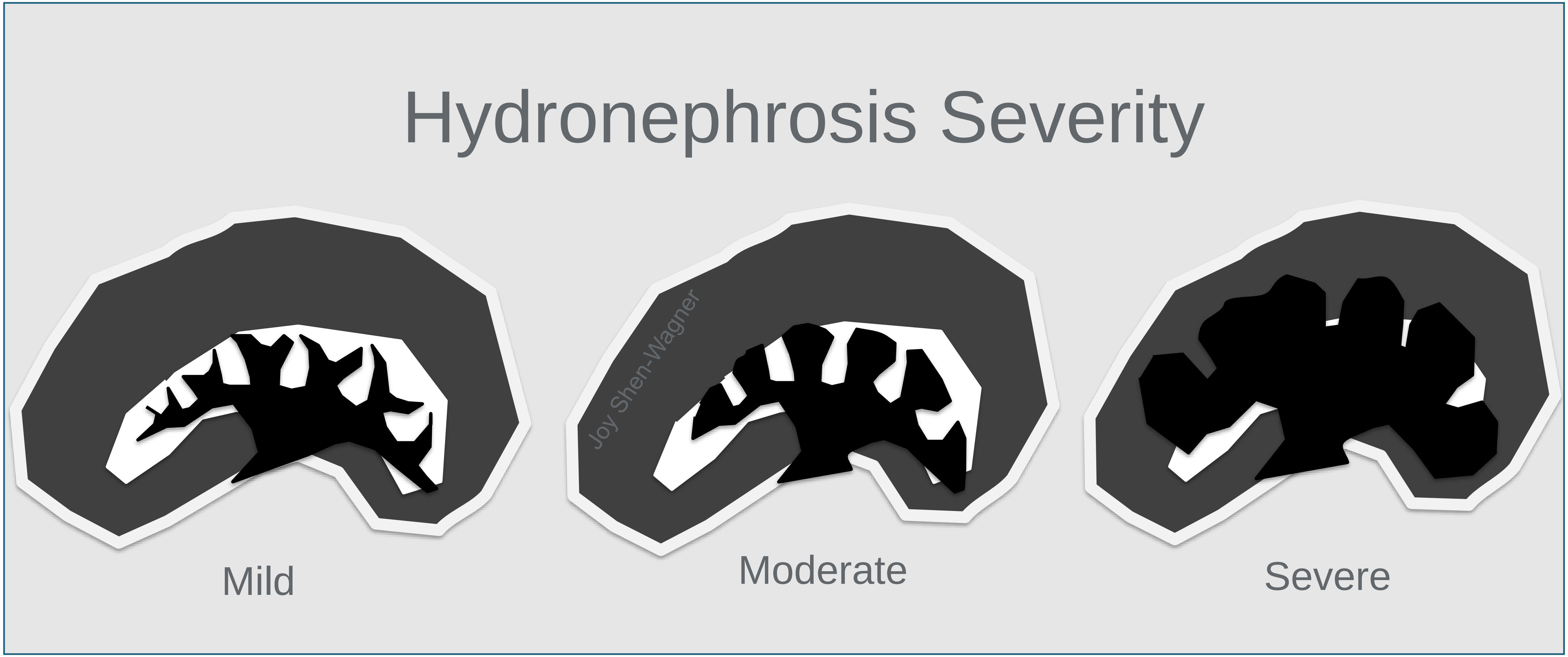
Cysts

Normal Anatomy/Physiology

Normal Anatomy and Analogies

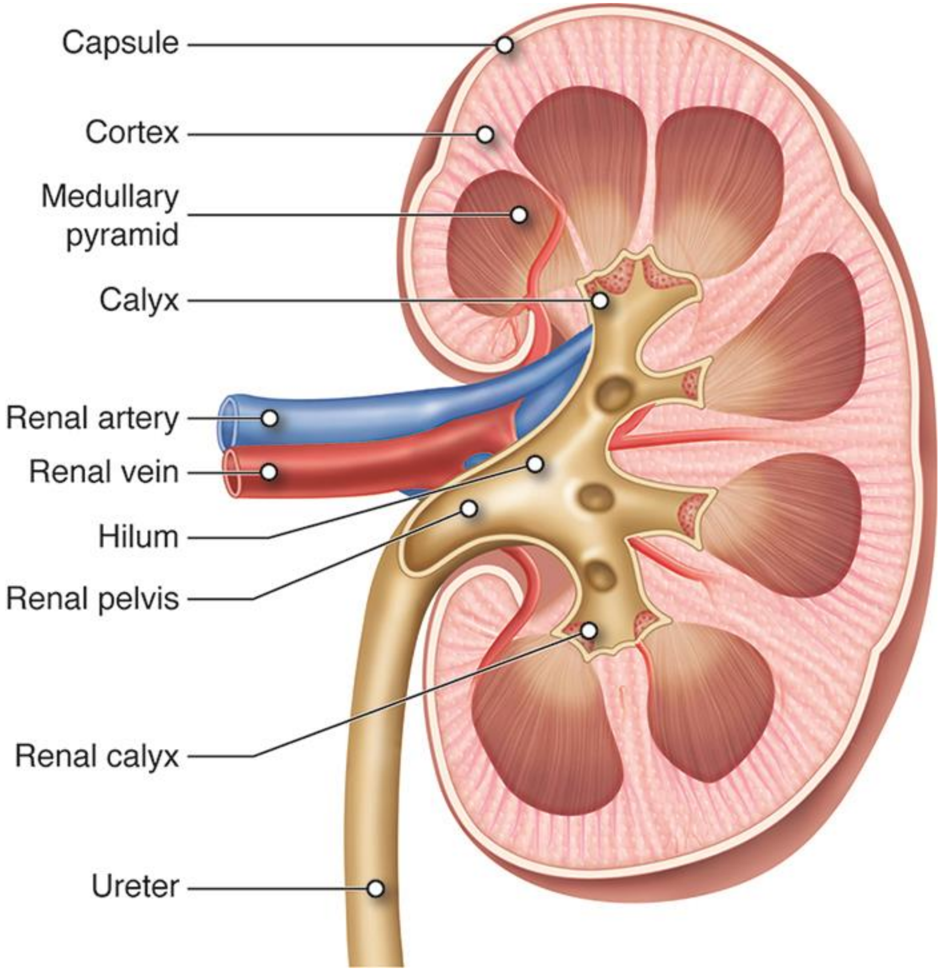


Hydronephrosis



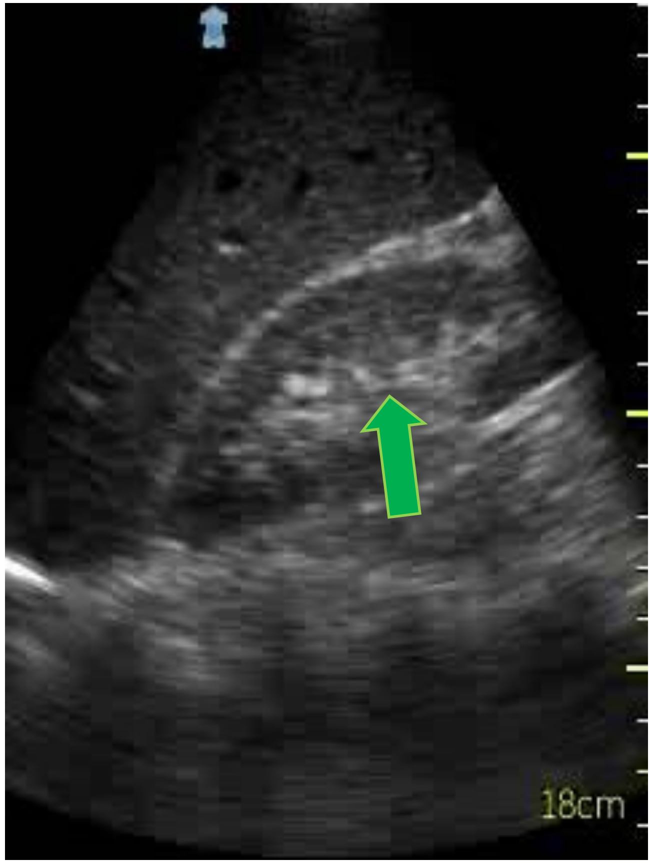
Terms and Definitions

- Pyelectasis and hydronephrosis are often used interchangeably
- Pyelectasis (pelviectasis) refers more specifically to dilation of just the renal pelvis
- Caliectasis refers to dilation of single calyx (intrarenal obstruction)
- Hydronephrosis is usually used when the pelvis and calyces are dilated
- Clinical pearl: Not all dilation of the collecting system is abnormal
    - E.g. Pregnancy

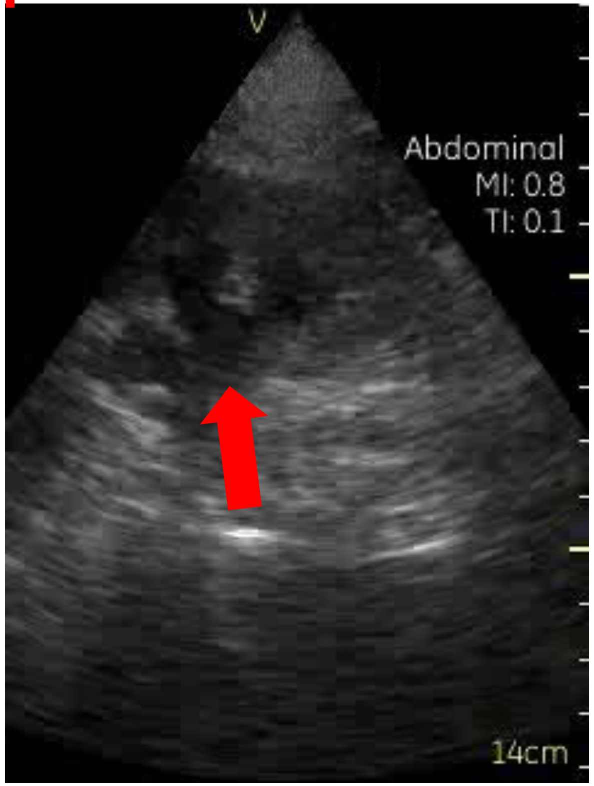


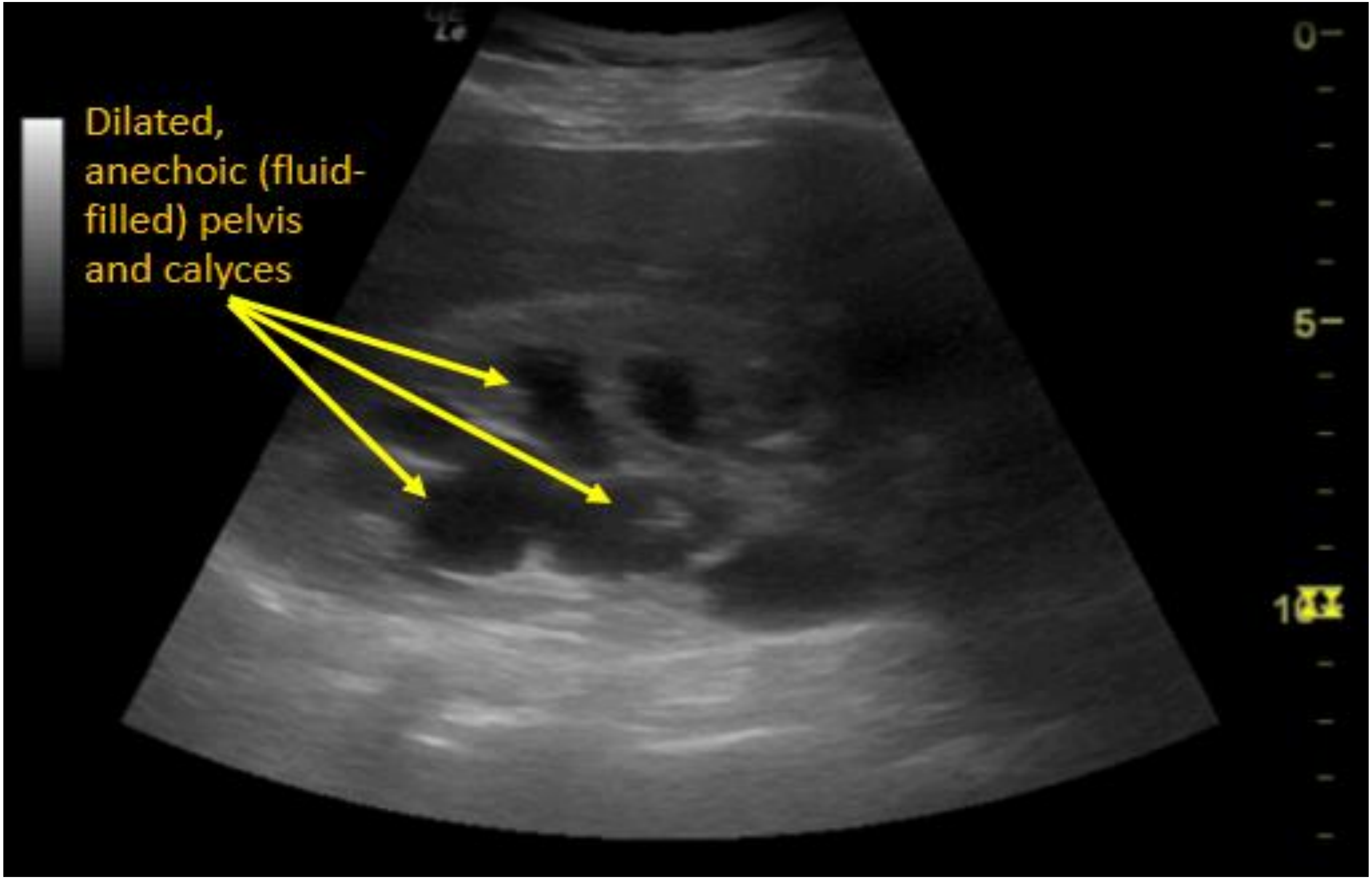
R.UQ and L.UQ- Hydronephrosis

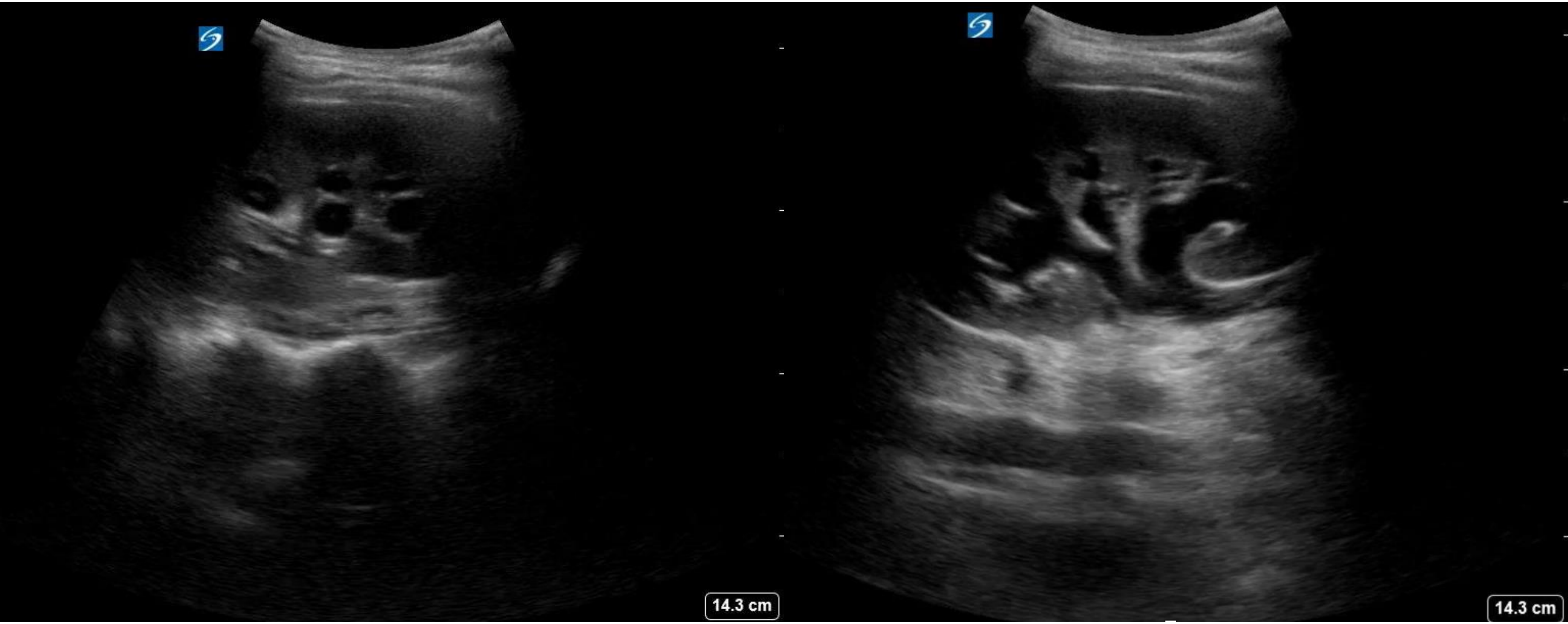
Normal



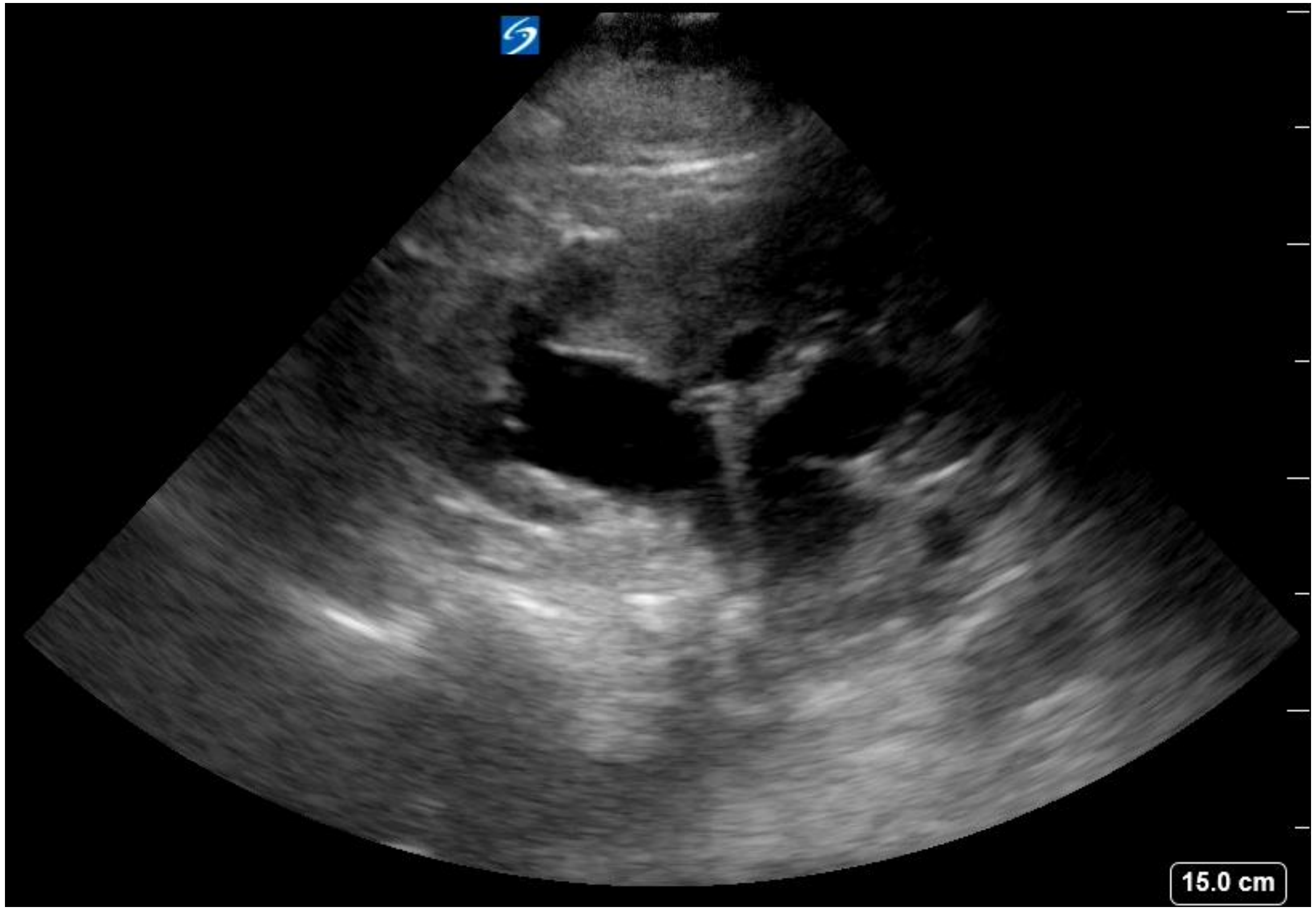
Abnormal Hydronephrosis

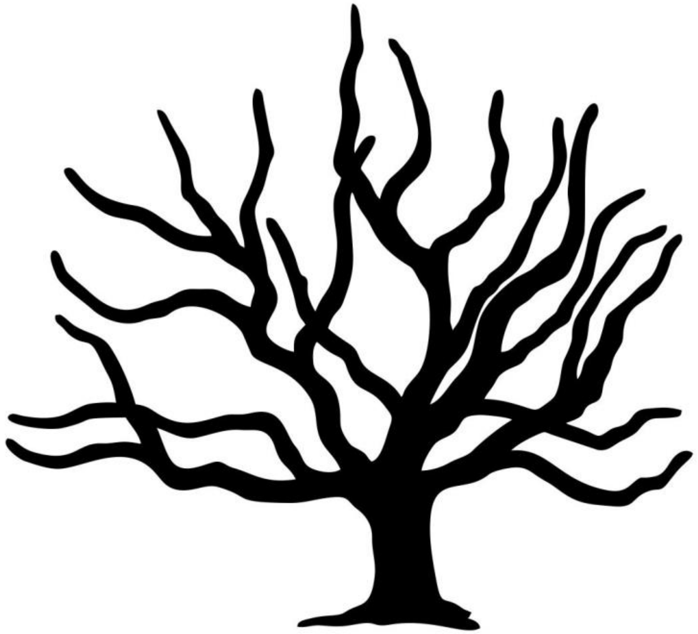



Dilated, anechoic (fluid-filled) pelvis and calyces
0
5

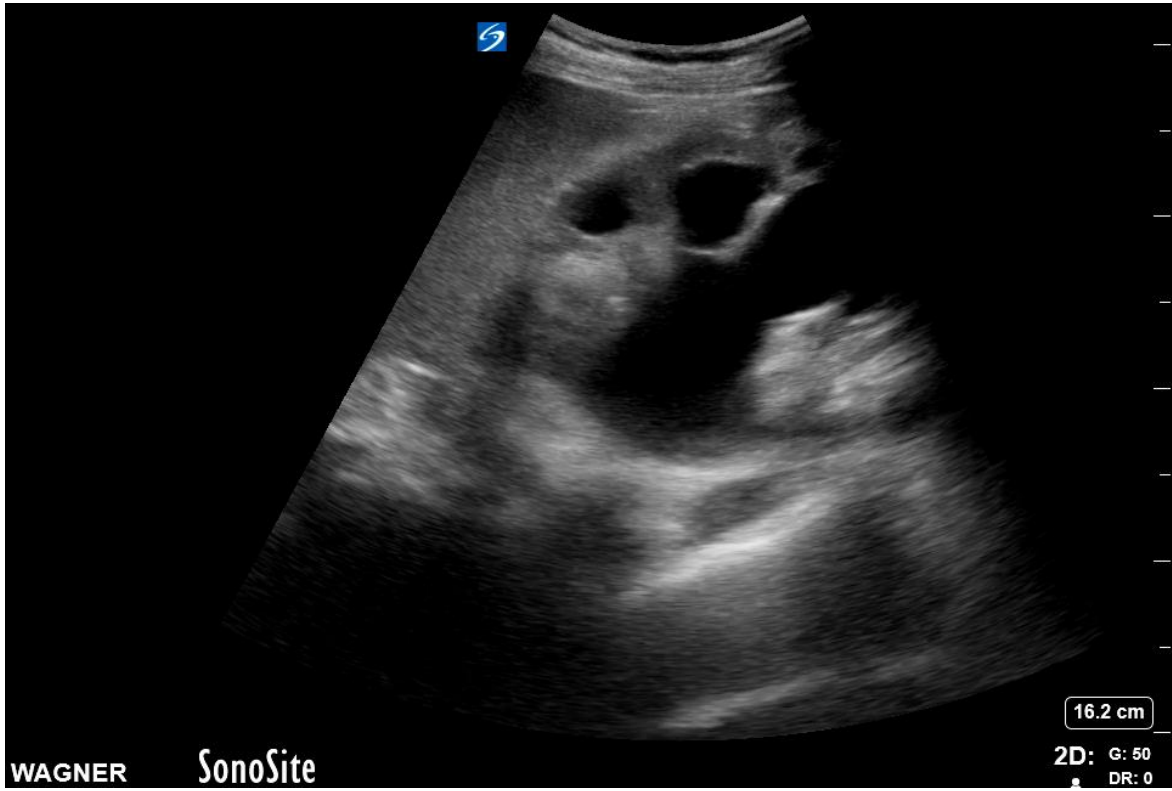

14.3 cm
14.3 cm

Ensure "trunk" connects with "branches"

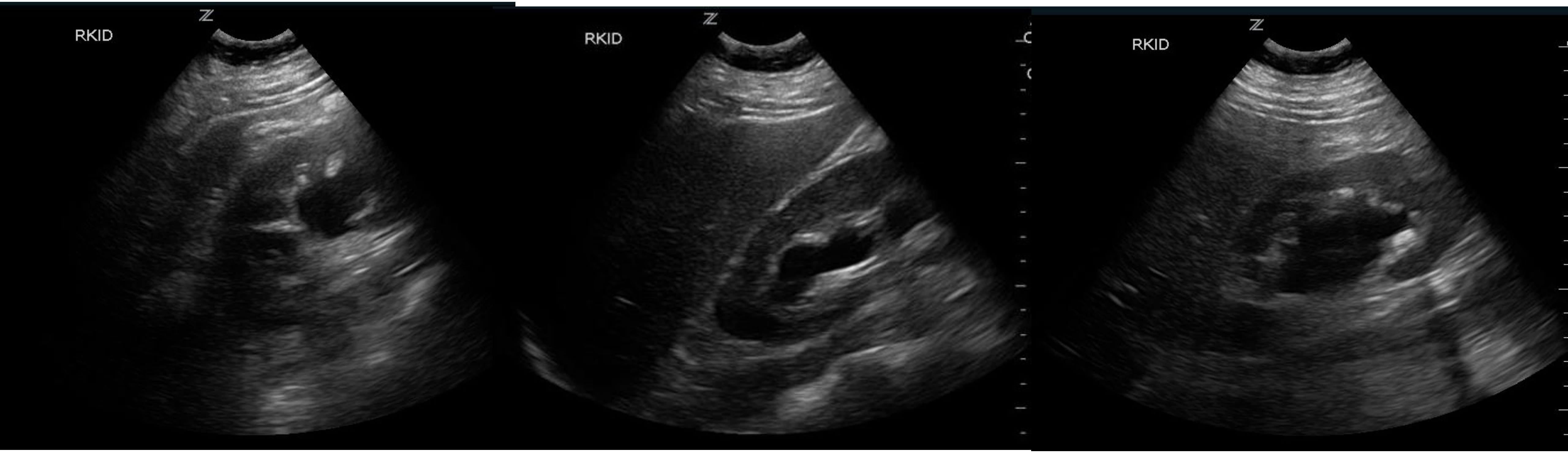


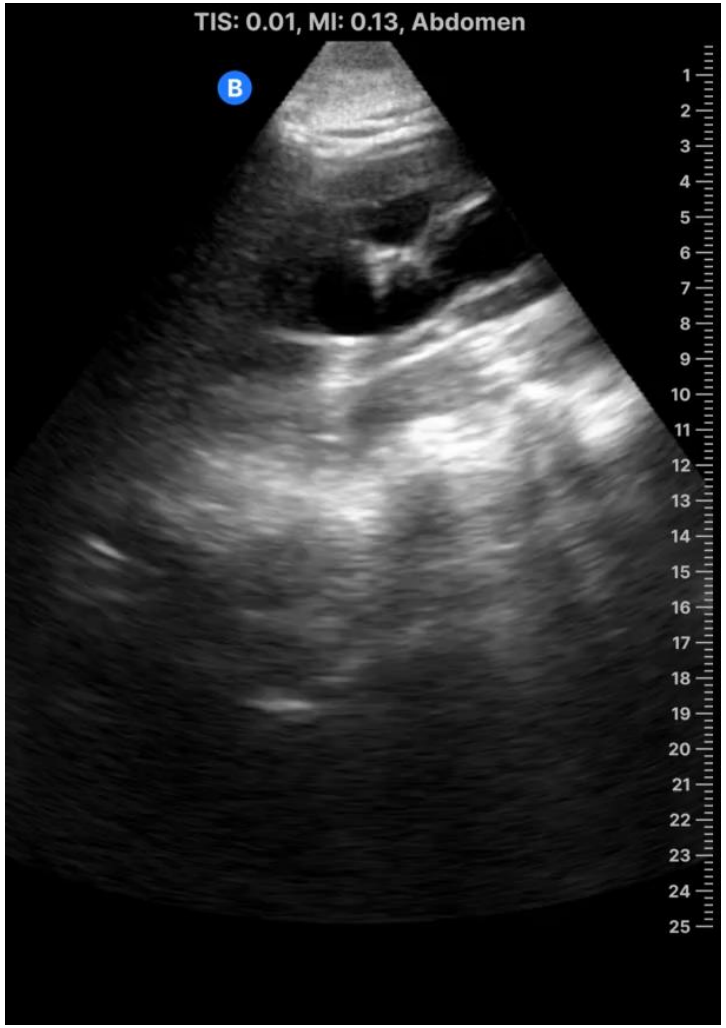


Technique- Importance of Fanning



Hydronephrosis




TIS: 0.01, MI: 0.13, Abdomen
B
1
2
3
4
5
6
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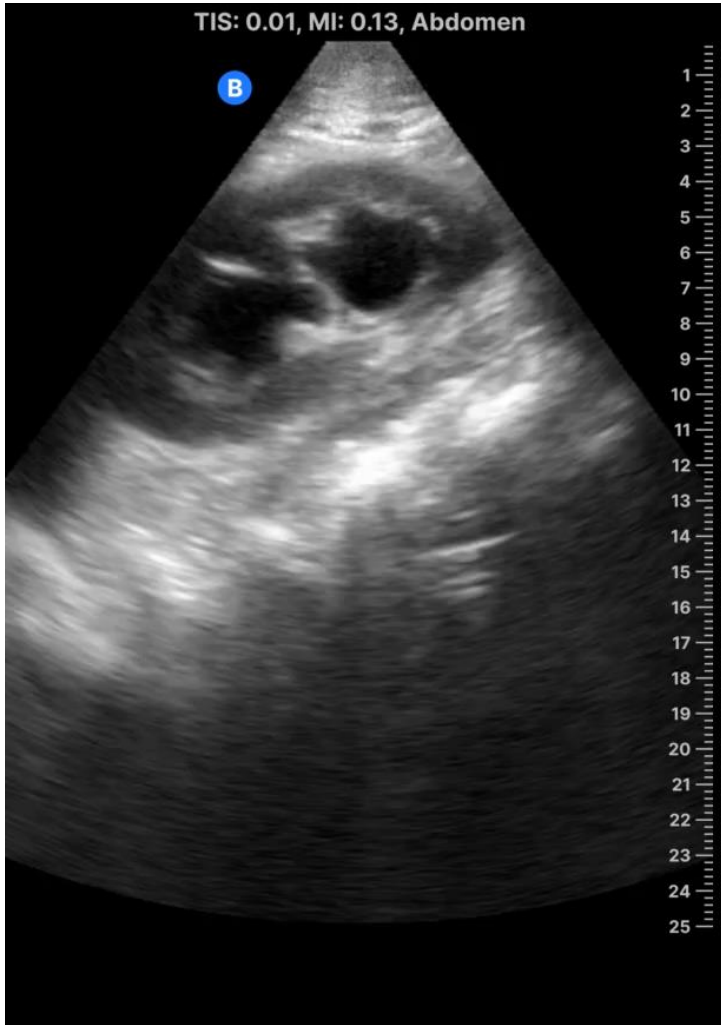
TIS: 0.01, MI: 0.13, Abdomen
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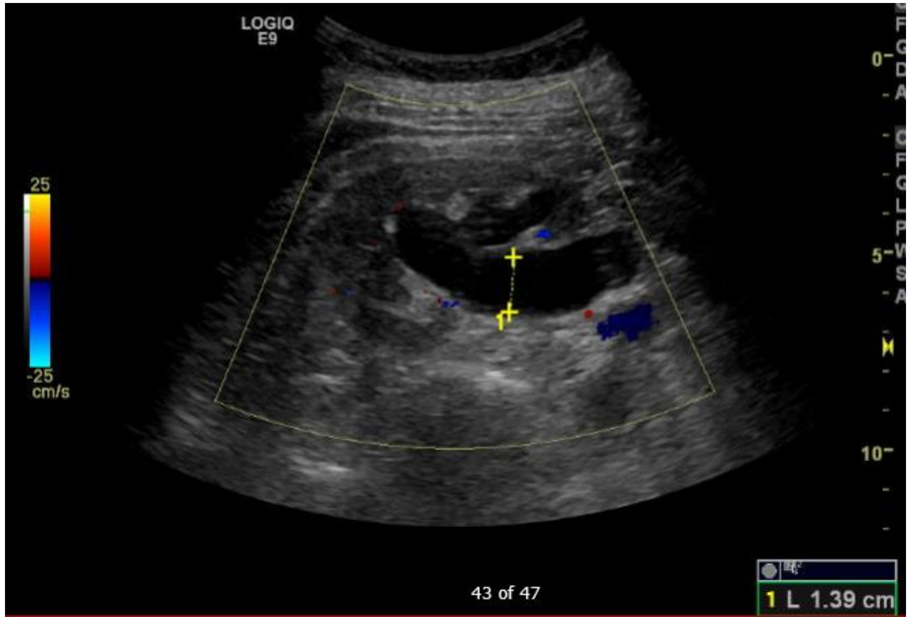
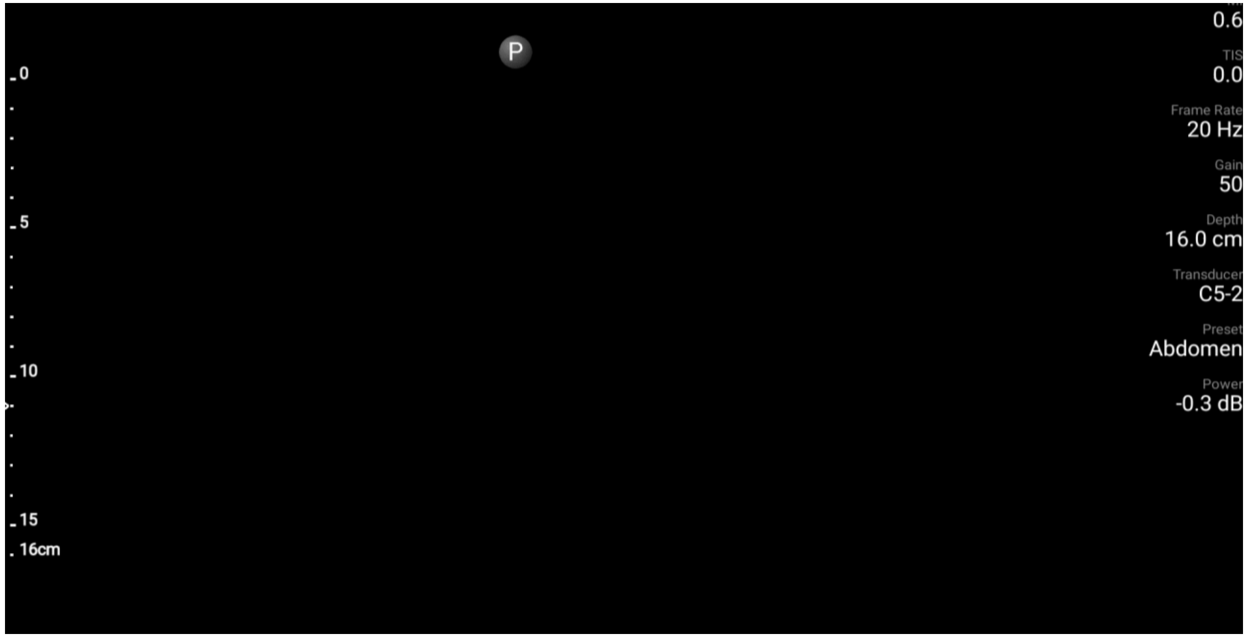
RT KIDNEY SAG
LOGIQ E9
0
5
10
15


LT KIDNEY SAG
LOGIQ E9
0
5
10

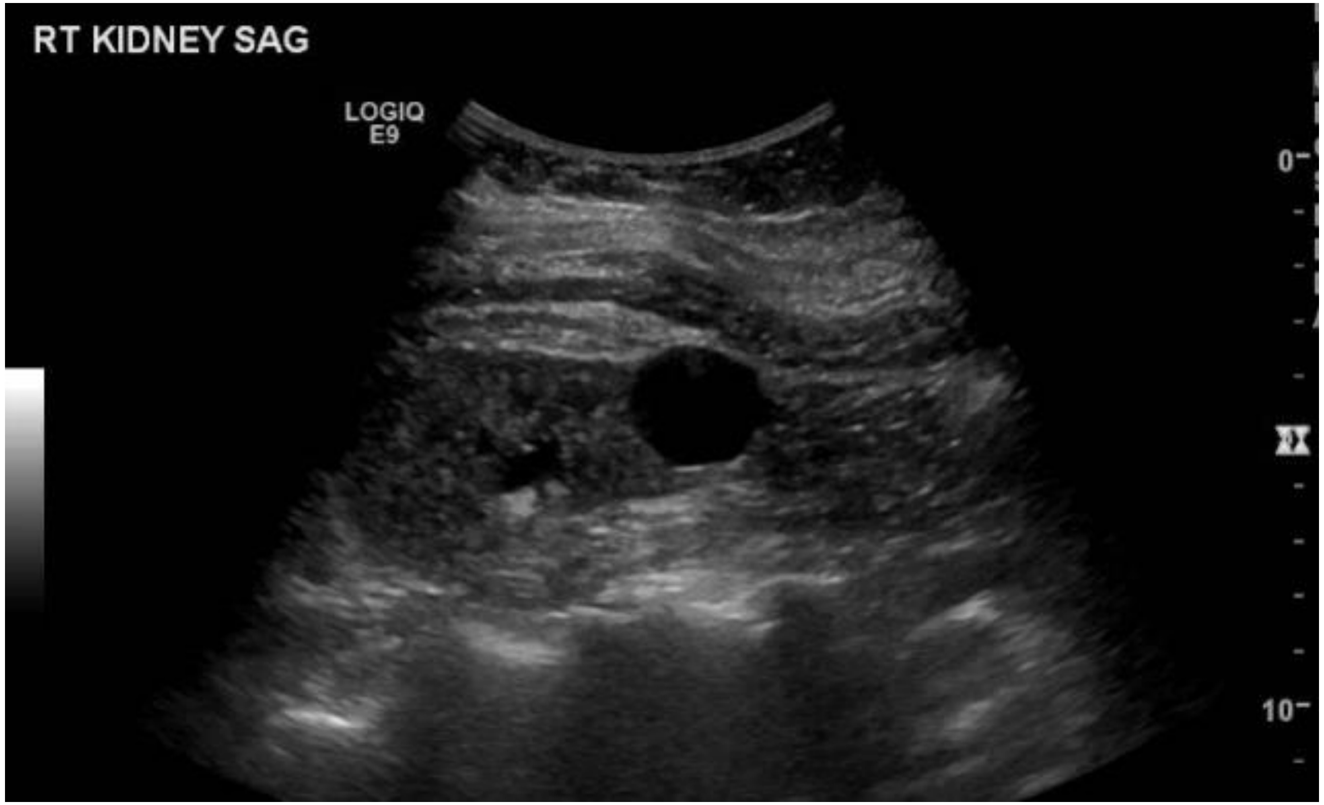

LOGIQ E9
25
-25 cm/s
0
5
10
43 of 47
1 L 1.39 cm

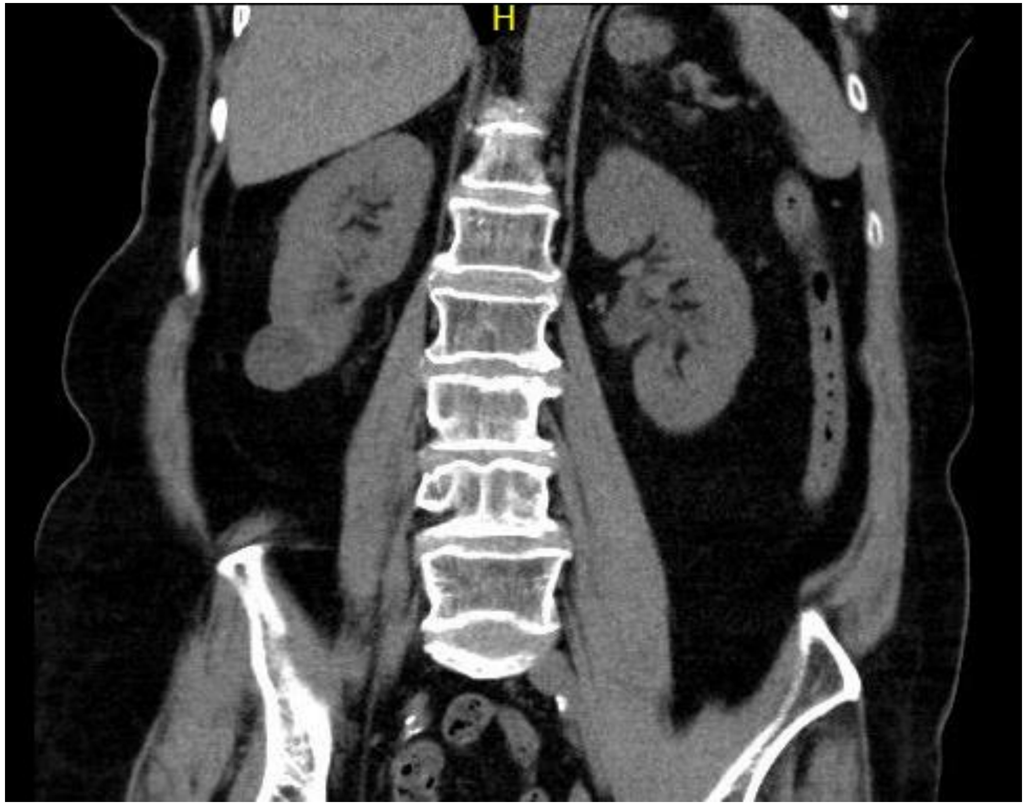

LT KIDNEY TRANS MID
LOGIQ E9
0
5
10

Is this Hydronephrosis?

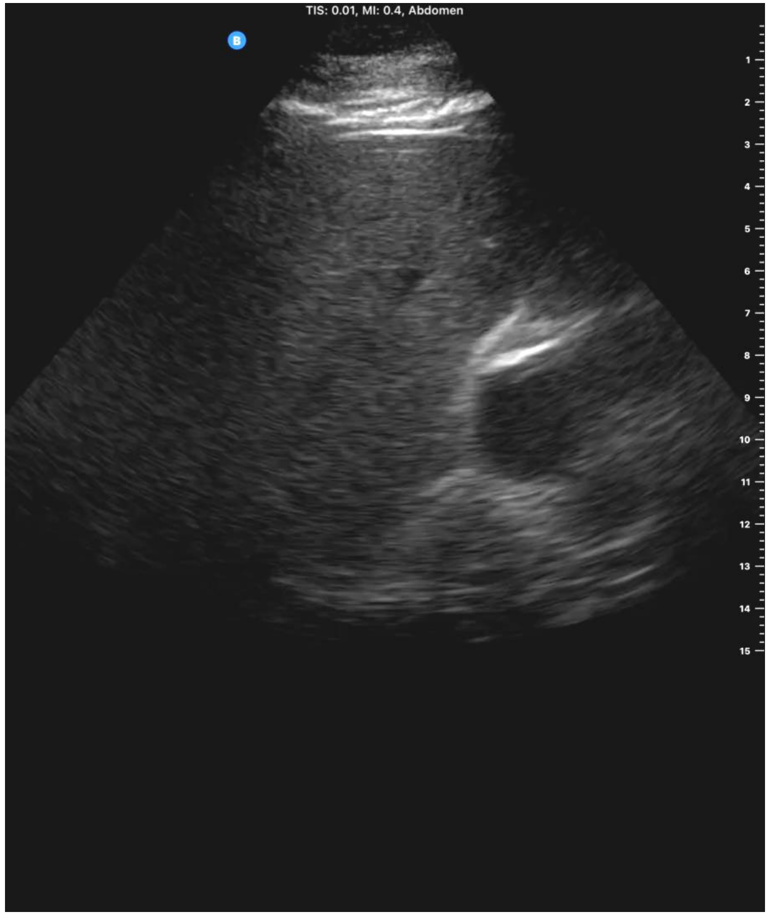


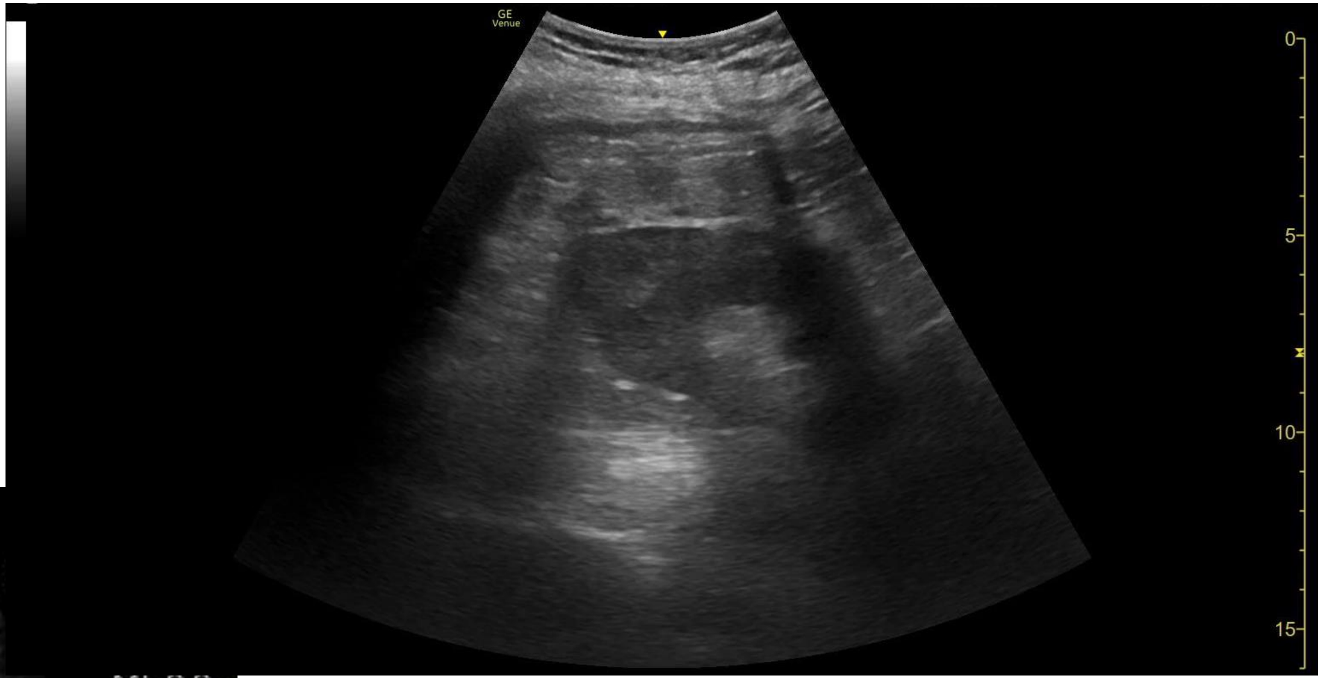
Simple Cysts



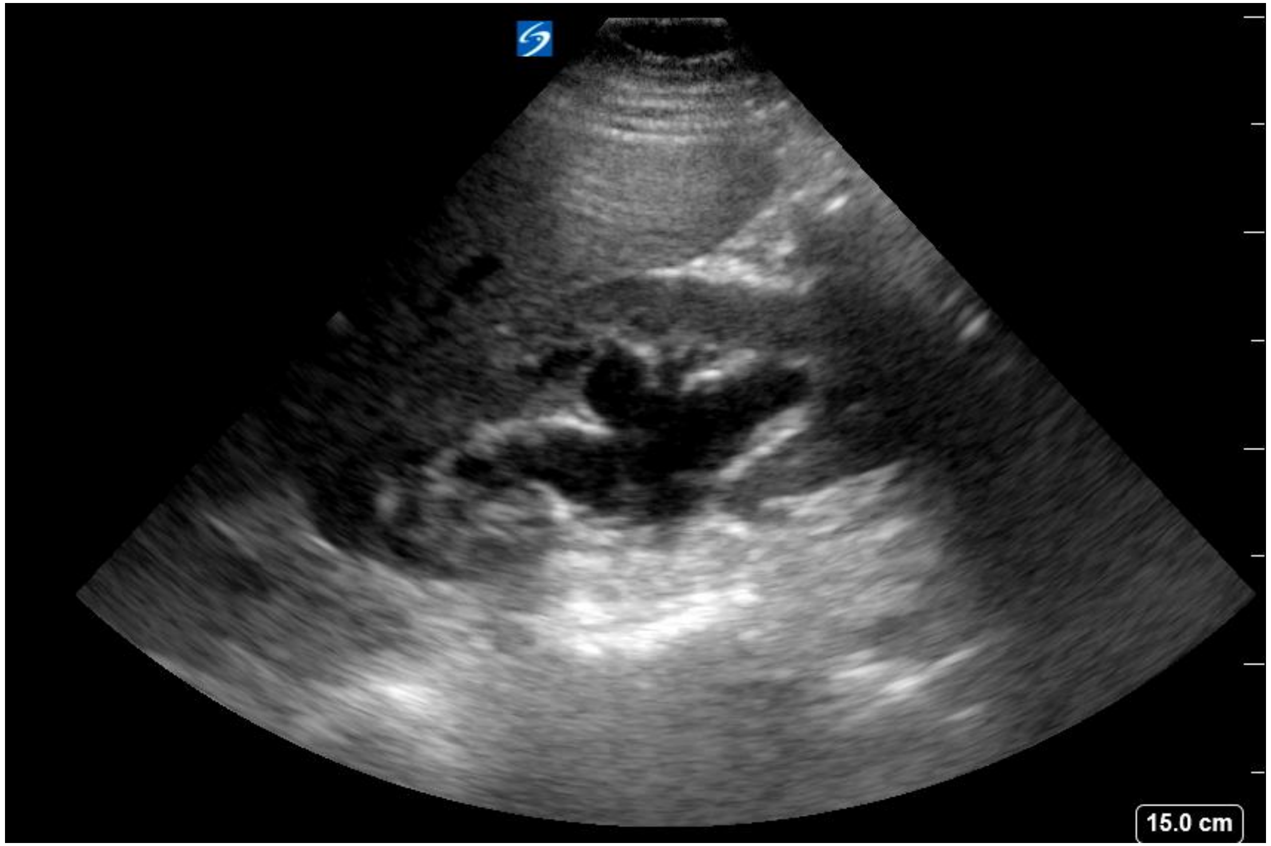


Simple Cysts





It can get tricky…



TIPS, PEARLS, PITFALLS

- Visualize Branching to distinguish from cysts
- Look initially only for Moderate or Severe Hydronephrosis
- Consider hydration status/physiology when interpreting findings
- Can use Doppler to assess for prominent vasculature
- Check both sides (Unilateral vs Bilateral), pair Renal with Bladder findings

RUQ/LUQ Windows- Next Steps

- Measuring Kidney Size
    - Signs of chronic kidney disease
- Autosomal Dominant Polycystic Kidney Disease
- Renal and Ureteral Stones
- Gross Distortions of Architecture/Masses
- Renal Blood Flow

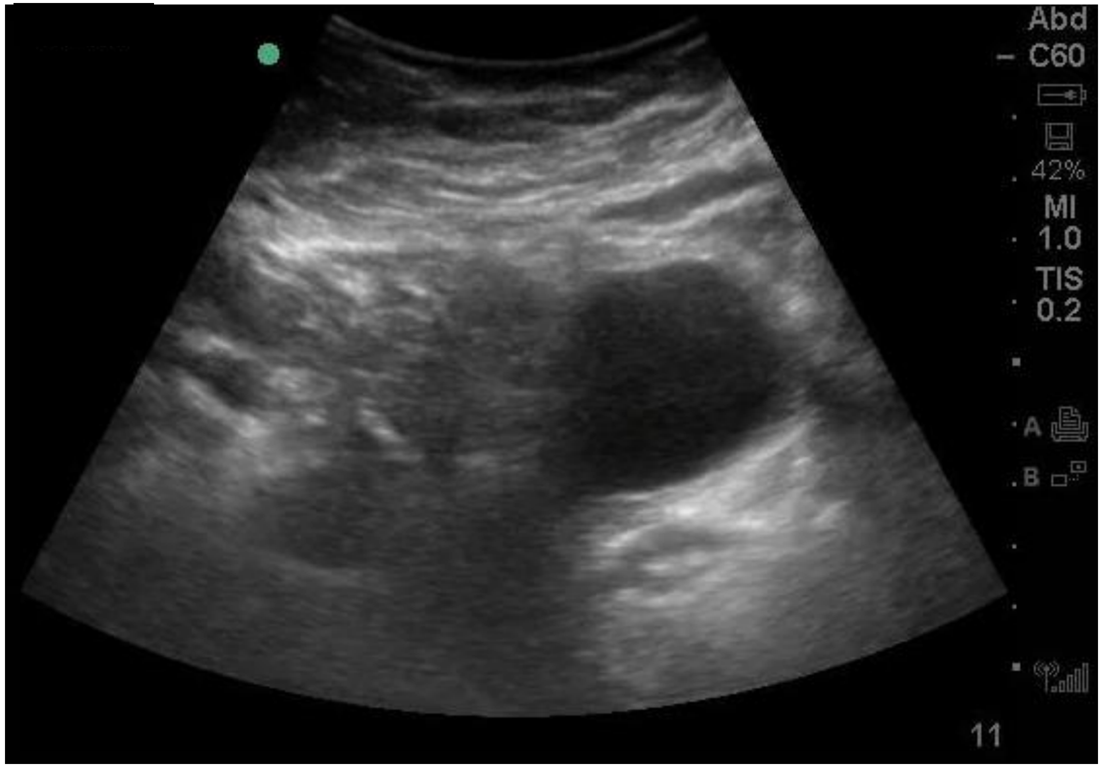
Case – wrap up

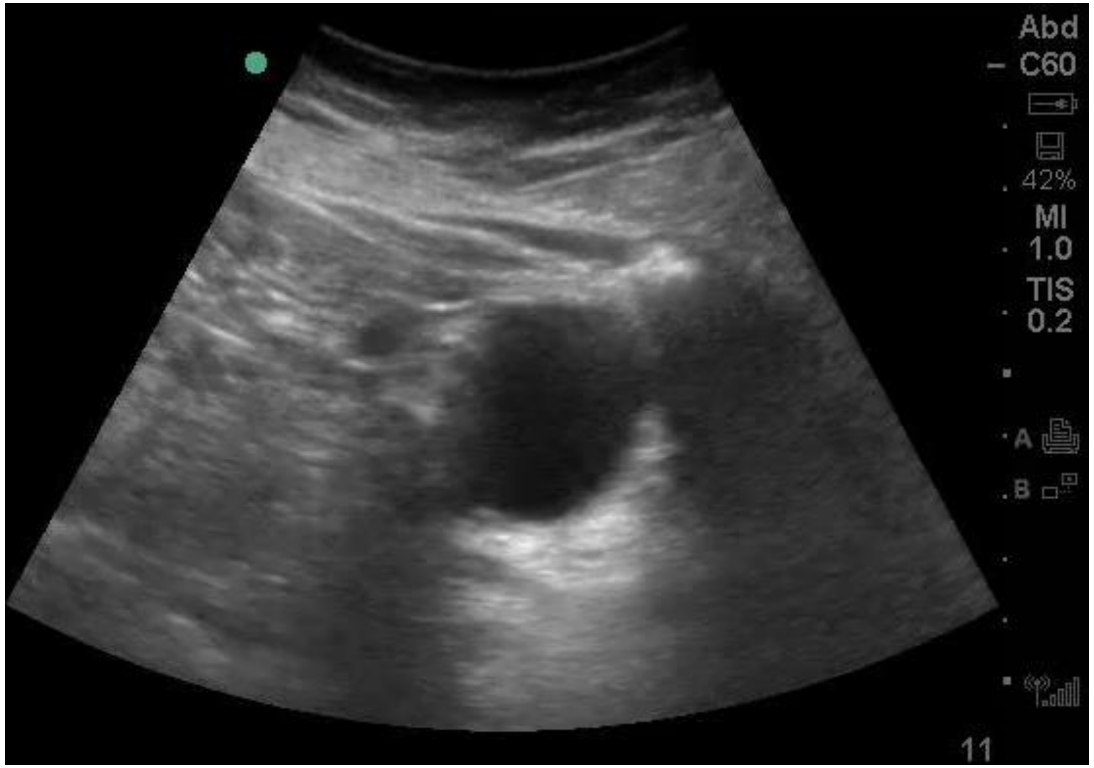
Female clinic patient with AKI/?abd pain

POCUS

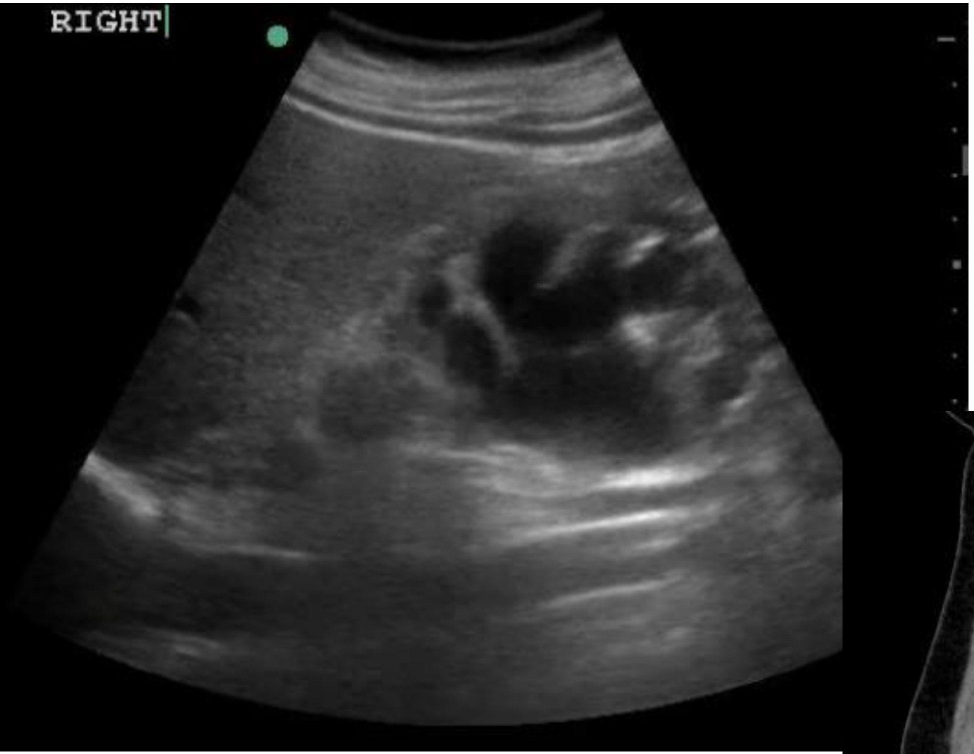
- Suprapubic Window
- RUQ Window
- LUQ Window

Suprapubic





RUQ and LUQ



Case – wrap up

Grossly Normal Bladder Volume
R. Hydronephrosis -> urgent non-contrast CT
unilateral obstructing large ureteral stones
Urology consultation, stenting, ultimately stones extracted

Follow up 3 months later with creatinine of 1.7

Practice Recommendations

- Bladder
  - Measure all until comfortable with size and shape
  - Measurements: PVR > 200-300mL warrant intervention
- Renal
  - Ultrasound first strategy seems reasonable in most
  - For high pretest probability, use as **rule in** not rule out

Billing and Coding- Bladder

https://www.cms.gov/medicare-coverage-database/view/article.aspx

accessed Jan/2024

CPT code: 76705 (Limited ultrasound, abdominal) ; 76857 (Limited ultrasound, pelvic);

Note 51798 (bladder volume study/PVR) is really for *Bladder Scanners*

Supportive ICD 10 codes:

R10.9- Unspecified abdominal pain

R31.0- Gross hematuria

N32.9- Bladder disorder, unspecified

Billing and Coding- Kidney

https://www.cms.gov/medicare-coverage-database/view/article.aspx

accessed Jan /2024

CPT code: 76775 (Limited ultrasound, retroperitoneal)

Supportive ICD 10 codes:

R10.9- Unspecified abdominal pain

R94.4- Abnormal results of kidney function studies

R31.0- Gross hematuria

R34- Anuria and oliguria

N19- Unspecified kidney failure

N13.30- Unspecified hydronephrosis

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2. Nixon G, et al. Rural point-of-care ultrasound of the kidney and bladder: quality and effect on patient management. J Prim Health Care. 2018;10(4):324–330.
3. Smith-Bindman R et al.: Ultrasonography versus computed tomography for suspected nephrolithiasis. N Engl J Med. 2014;371(12):1100-10.
4. Wong C et al. The accuracy and prognostic value of point-of-care ultrasound for nephrolithiasis in the emergency department: a systematic review and meta-analysis. Acad Emerg Med. 2018;25(6):684-98.
5. Dalziel PJ, Noble VE. Bedside ultrasound and the assessment of renal colic: a review. Emerg Med J. 2013;30(1):3–8.
6. Taylor M et al. Ultrasonography for the prediction of urological surgical intervention in patients with renal colic. Emerg Med J. 2016;33(2):118-23.
7. Riddell J et al. Sensitivity of emergency bedside ultrasound to detect hydronephrosis in patients with computed tomography-proven stones. West J Emerg Med. 2014 Feb;15(1):96-100.

AAFP

AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

Introduction to GYN

Andrea Lewis, DO, RDMS, FAAFP
Assistant Professor
Southern Colorado Family Medicine

Disclosure statement

It is the policy of the AAFP that all individuals in a position to control CME content disclose any relationships with ineligible companies upon nomination/invitation of participation. Disclosure documents are reviewed for potential relevant financial relationships. If relevant financial relationships are identified, mitigation strategies are agreed to prior to confirmation of participation. Only those participants who had no relevant financial relationships or who agreed to an identified mitigation process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Review the evidence or current guidelines behind the most common conditions for which point of care ultrasound can be used to evaluate abnormal uterine bleeding and IUD location.
2. Recognize ultrasound physics and general principles of ultrasound equipment use and image acquisition relevant to GYN imaging.
3. Consider how to use point-of-care ultrasound for basic applications in the female pelvis with both transabdominal and transvaginal ultrasonography.
4. Develop appropriate coding and documentation practices for pelvic ultrasound examinations.

Indications for POCUS in Non-Pregnant Female

Introductory

Bladder Obstruction

Uterine Size, Position

Intrauterine IUD

Large Fibroids

Large ovarian cysts

Pelvic Free Fluid

Advanced

Endometrial Hypertrophy

Adenomyosis

Smaller Fibroids

Ovarian Malignancy

Ovarian Torsion

Hydrosalpinx

Setup

Transabdominal

Patient position

Patient comfort

Draping

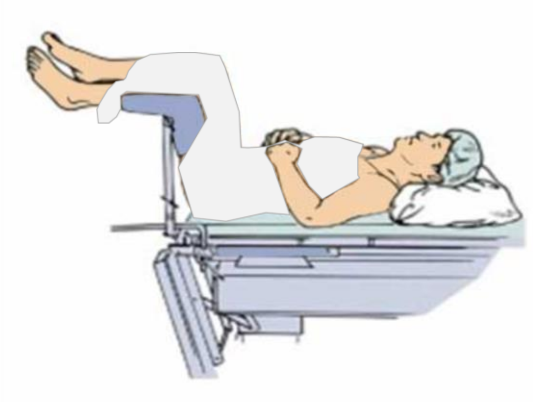
Bladder

Lighting

Preparing Probe

Cleaning probe

Transvaginal



http://en.wikipedia.org/wiki/lithotomy_position

Transabdominal (Sagittal)

Normal Pelvic Anatomy

Bladder

Uterus

Adnexa

Cul-de-sac

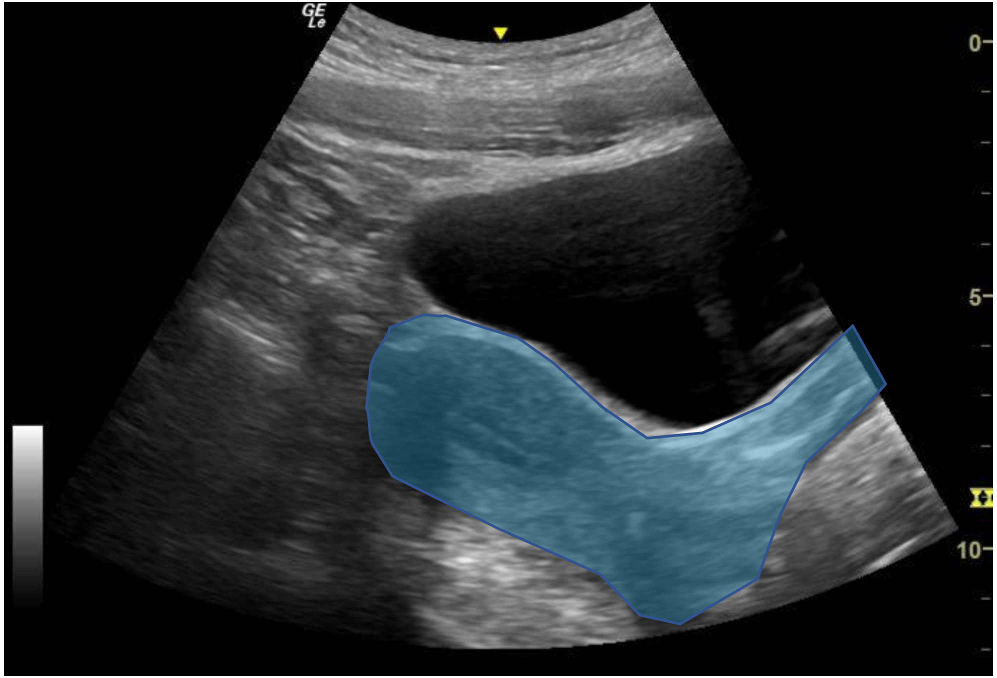


Image Credit Joy Shen-Wagner (Used with Permission © Bornemann, Ultrasound for Primary Care, 2021)

Uterus

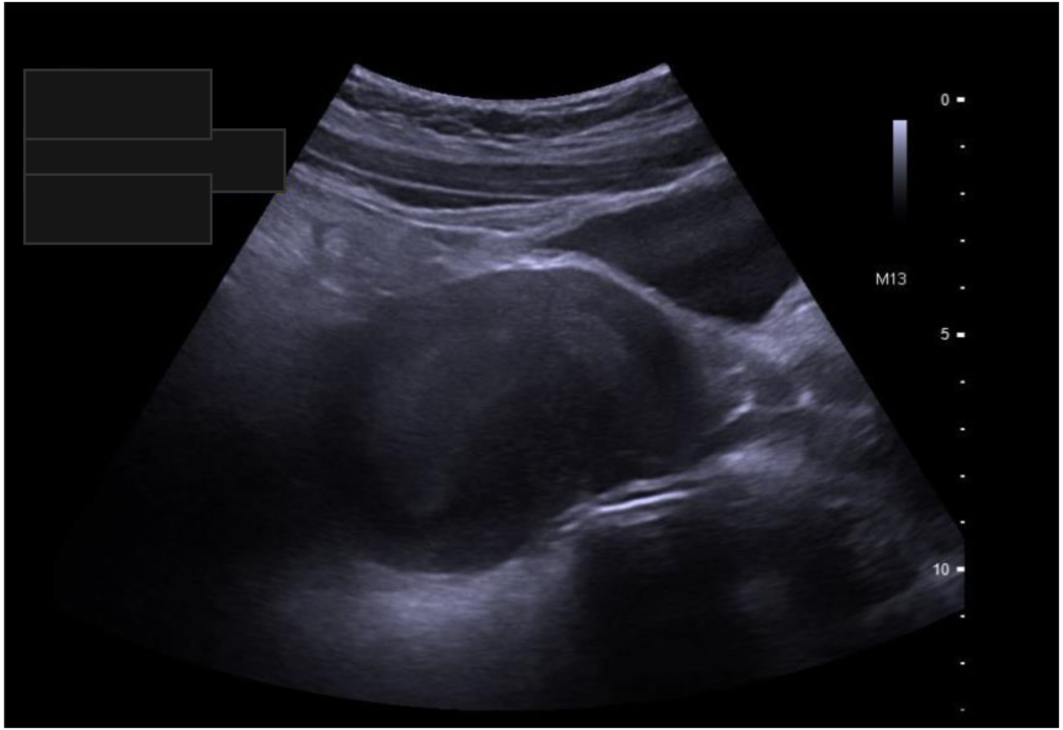


Image Credit Joy Shen-Wagner, (Used with Permission @ Paul Bornemann, MD, Ultrasound for Primary Care, 2021)

Normal Pelvic Anatomy (Transverse)

Anechoic

Acoustic Window

Measurements

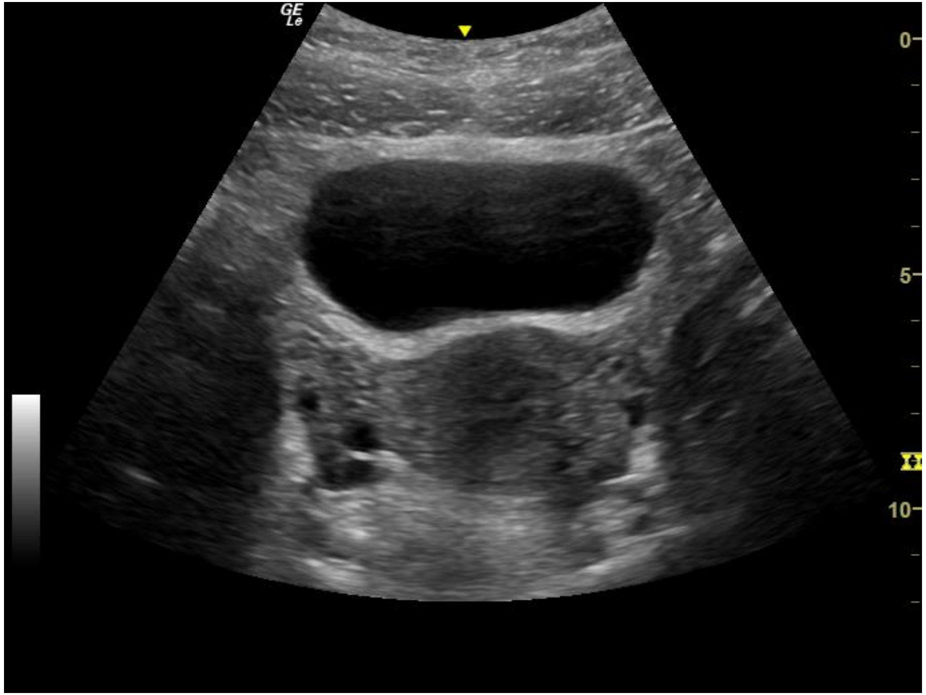
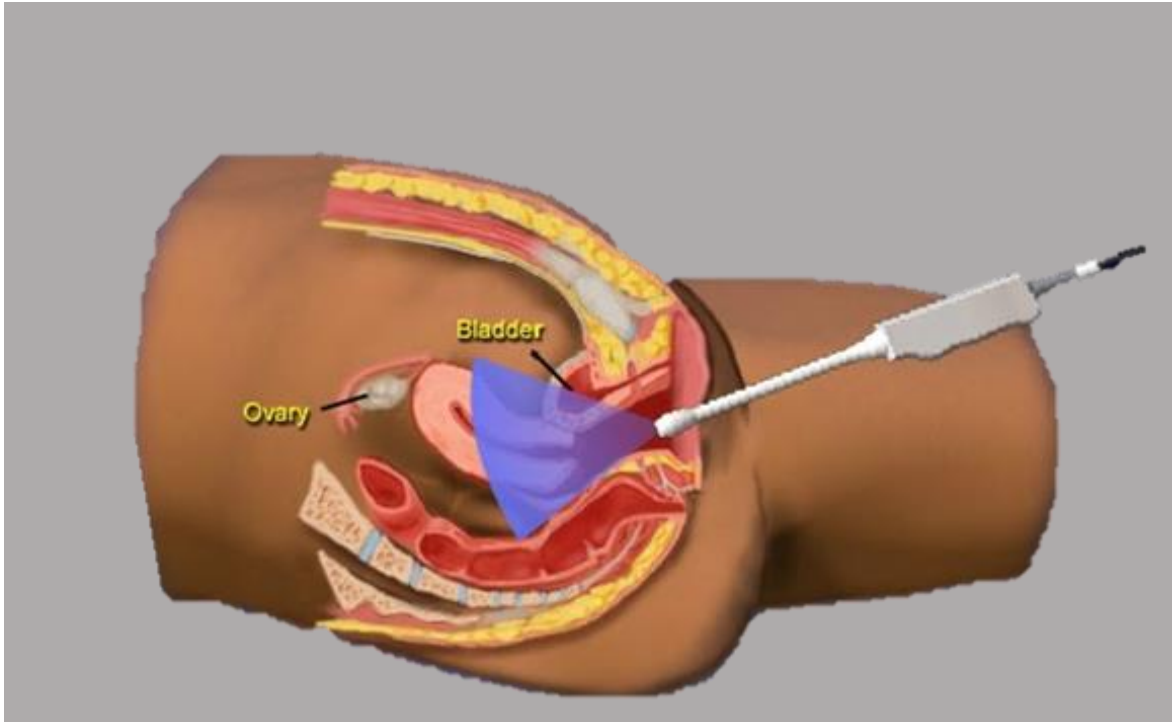


Image Credit: Joy Shen-Wagner (Used with permission © Bornemann, Ultrasound for Primary Care, 2021)

Transvaginal (TV) Ultrasound Sagittal



Uterus Normal

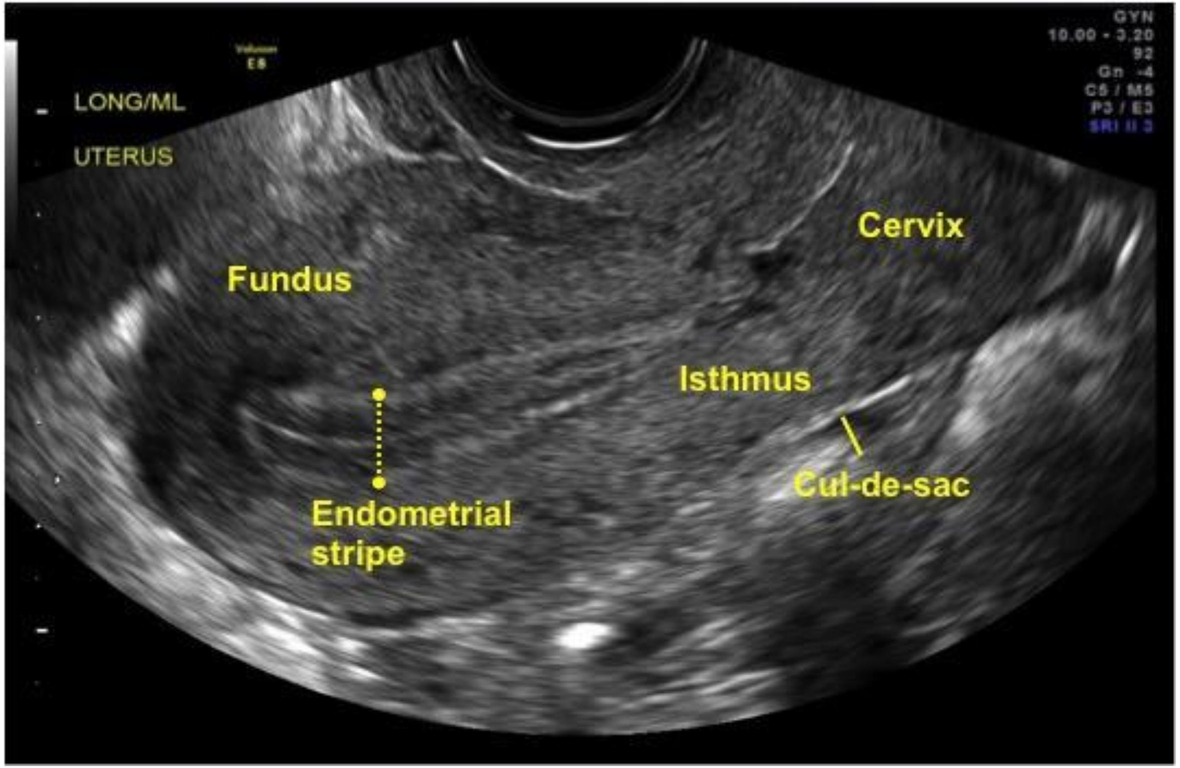


Image Credit Joy Shen-Wagner (Bornemann, Ultrasound for Primary Care, © 2021)

Transvaginal Coronal

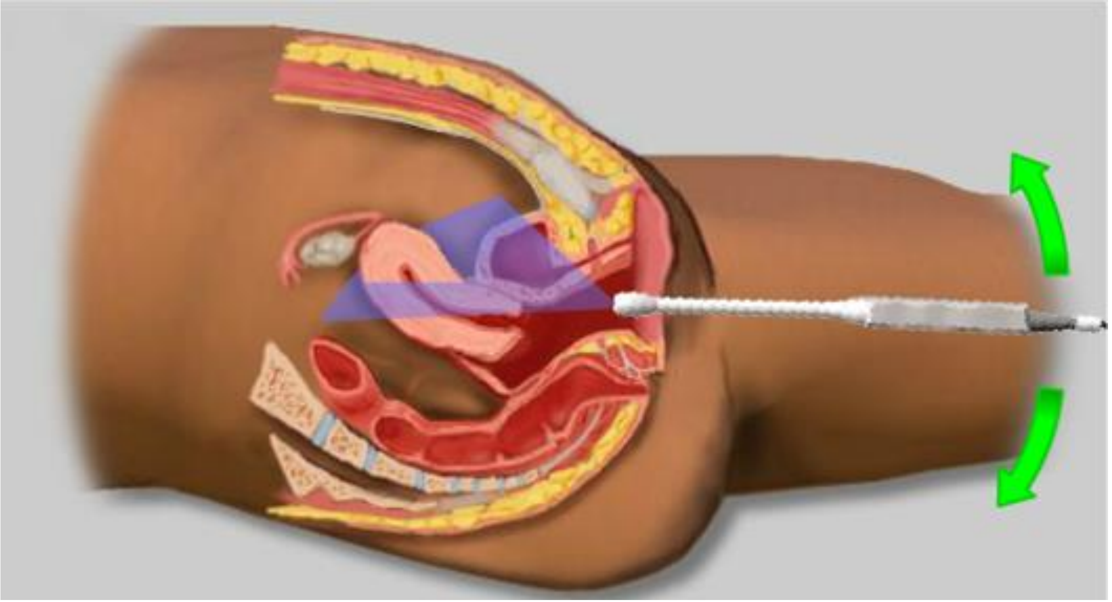


Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

Abnormal Uterine Bleeding – Non-Pregnant

Structural: PALM

- Polyp
- Adenomyosis
- Leiomyoma
- Malignancy/hyperplasia

Non-Structural: COEIN

- Coagulopathy
- Ovulatory Dysfunction (PCOS)
- Endometrial
- Iatrogenic
- Not yet classified

SPECIAL COMMUNICATION

FIGO classification system (PALM-COEIN) for causes of abnormal uterine bleeding in nongravid women of reproductive age

Malcolm G. Munro [a,b,*], Hilary O.D. Critchley [c], Michael S. Broder [d], Ian S. Fraser [e]; for the FIGO Working Group on Menstrual Disorders

Int J Gynaecol Obstet. 2011 Apr;113(1):3-13. doi: 10.1016/j.ijgo.2010.11.011. Epub 2011 Feb 22. PMID: 21345435.

Evidence Post-Menopausal Bleeding

ACOG Committee Opinion #734 May 2018

The Role of Transvaginal Ultrasonography in Evaluating the Endometrium of Women with Postmenopausal Bleeding

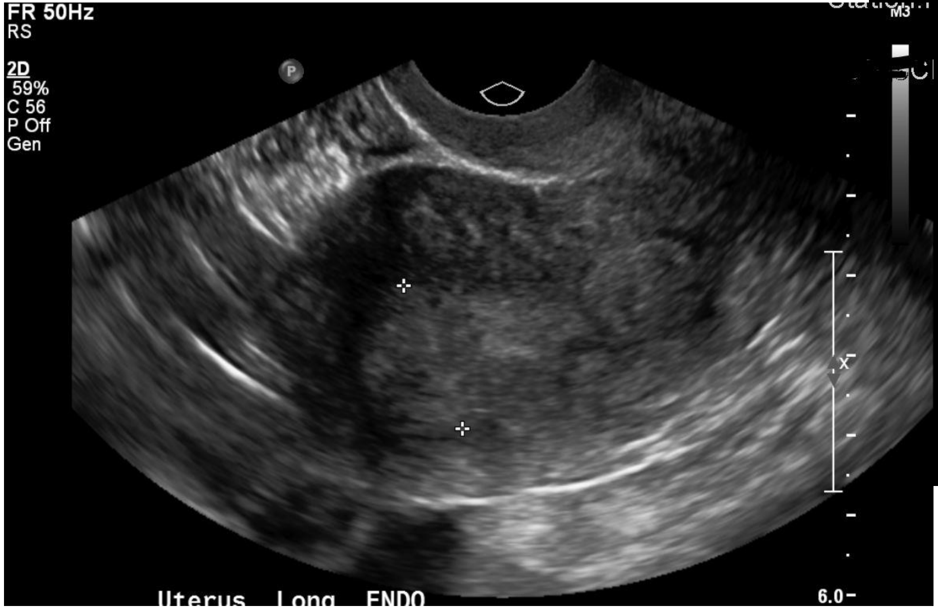
"Transvaginal ultrasonography is appropriate for an initial evaluation of postmenopausal bleeding if the ultrasound images reveal a thin endometrial echo (less than or equal to 4 mm), **given that an endometrial thickness of 4 mm or less has a greater than 99% negative predictive value for endometrial cancer."**

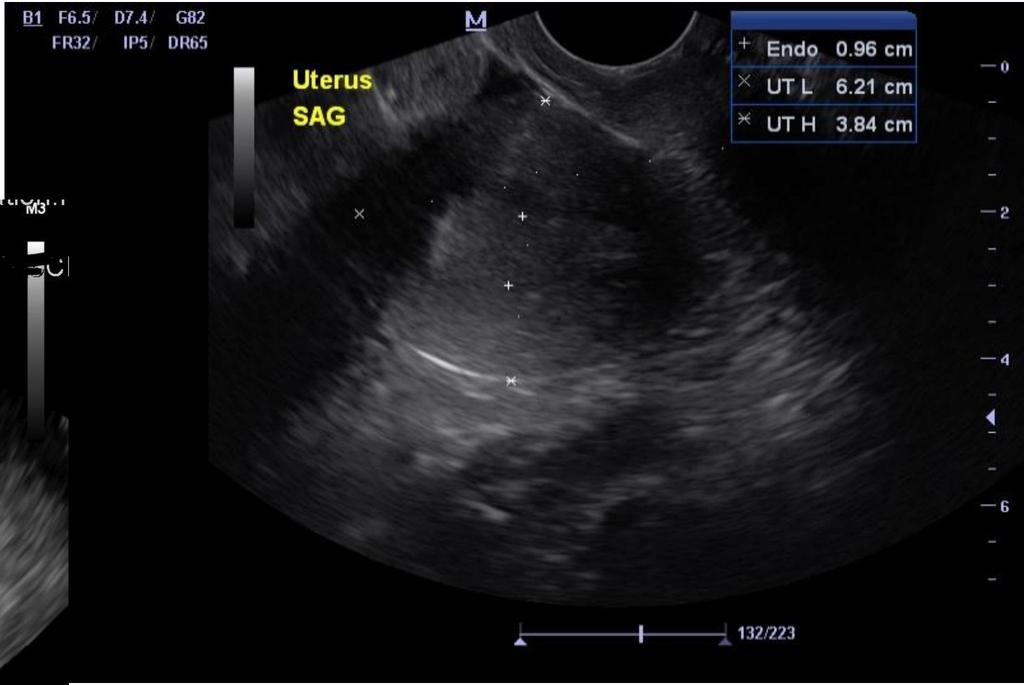
Endometrial Thickness ≤ 4mm

Abnormal Uterine Bleeding – Non-Pregnant

Structural: PALM

- **M**alignancy/hyperplasia



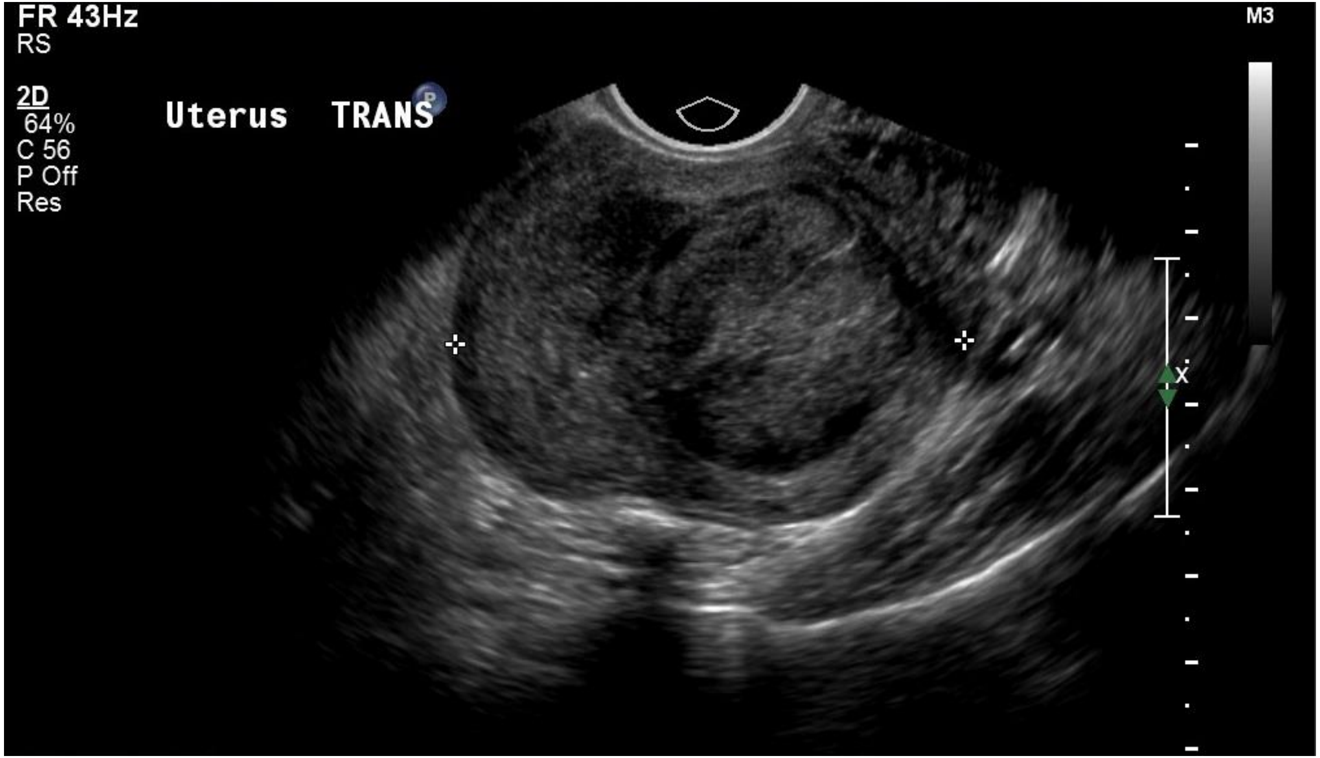


Images used with permission © Paul Bornemann, MD, RMSK, RPVI

Abnormal Uterine Bleeding – Non-Pregnant

Structural: PALM

- **L**eiomyoma (aka Fibroids)



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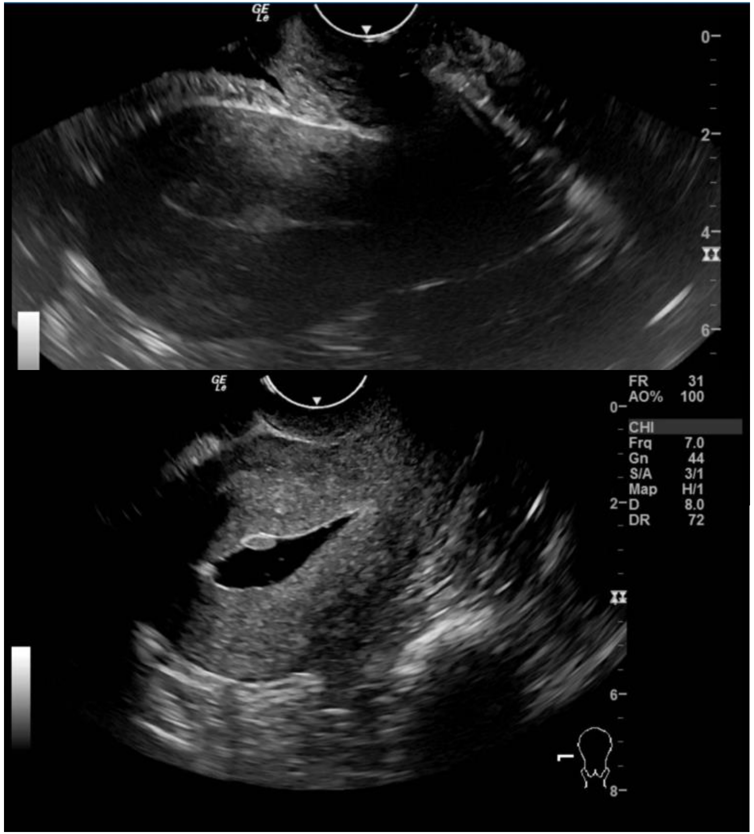
Abnormal Uterine Bleeding – Non-Pregnant

Structural: PALM

- **P**olyp
- **A**denomyosis

Polyp: difficult to see on POCUS, usually needs hysterosonogram (SIS) to visualize.

Adenomyosis: overall enlargement of uterus with asymmetric thickening of myometrium. Diagnosis is by path after hysterectomy.



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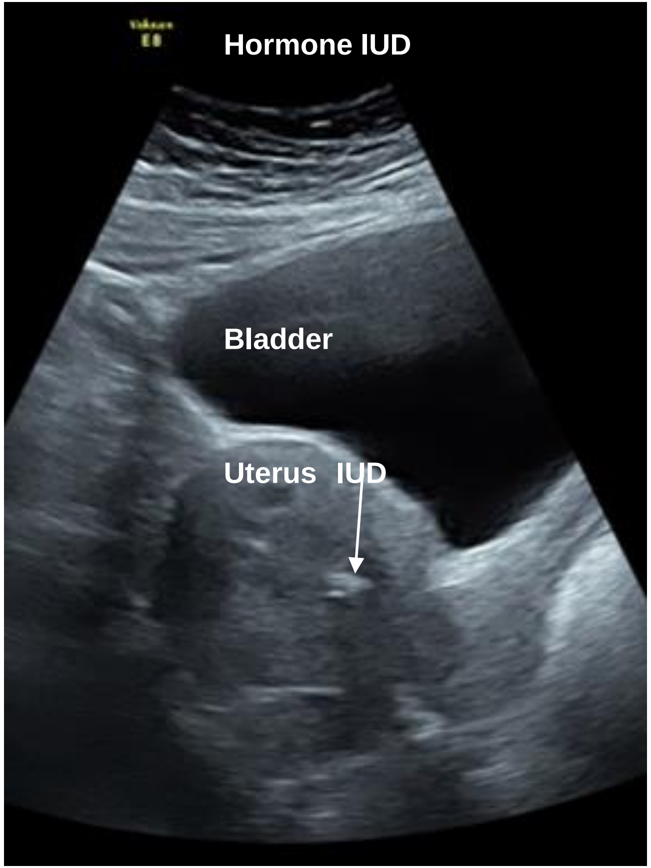
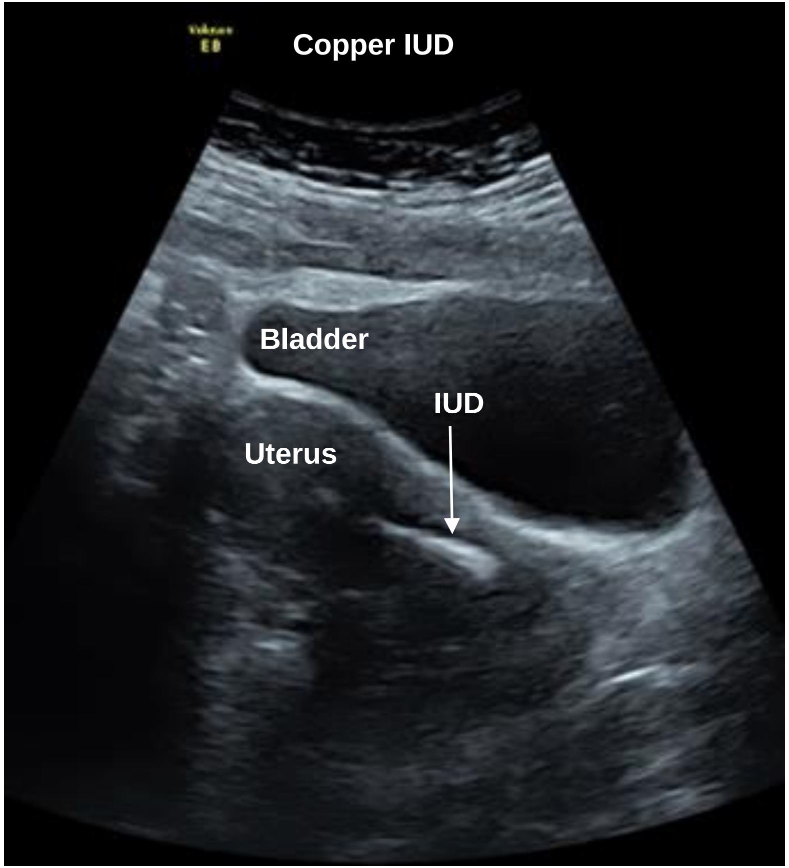
COIN

- **I**atrogenic





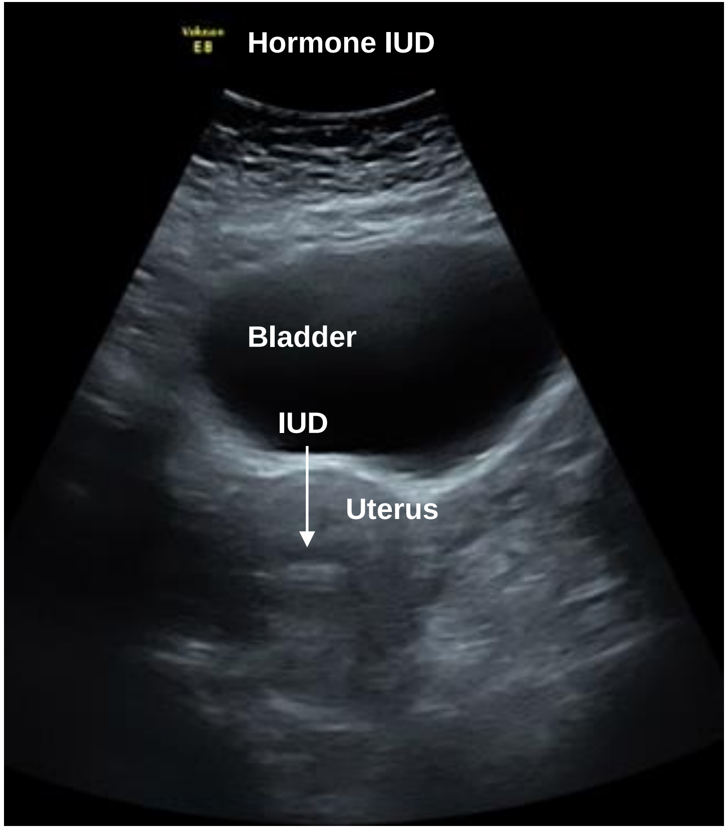
Transabdominal ultrasound appearance of T-shaped intrauterine device (IUD).

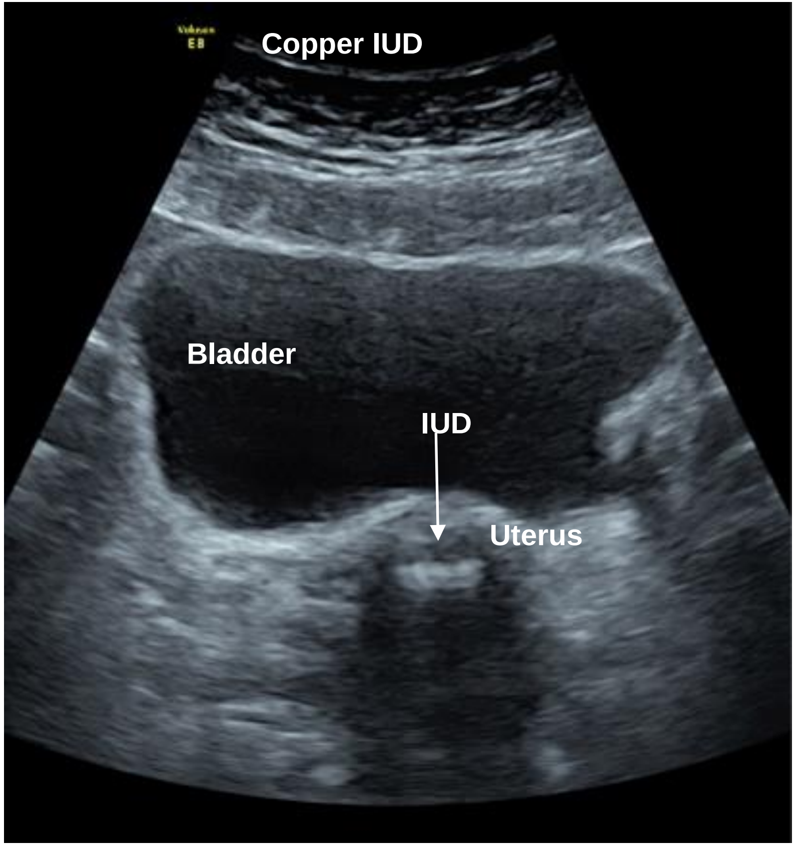
Comparing Levonorgestrel-releasing IUD vs. Copper IUDs

Image used with permission from Andrea Lewis, DO, RDMS

COIN

- Iatrogenic





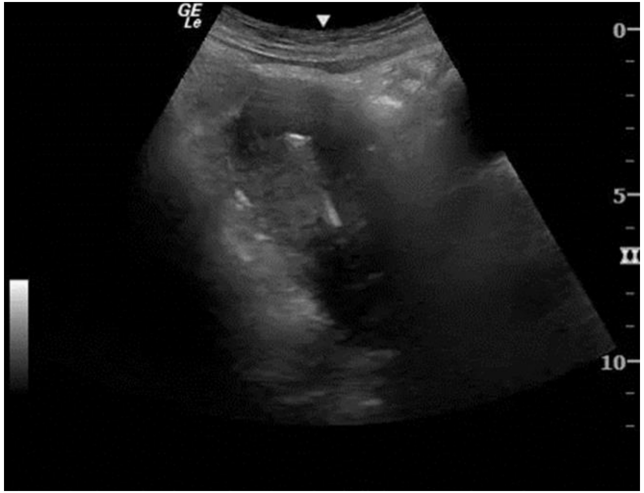
Transabdominal ultrasound appearance of T-shaped intrauterine device (IUD).

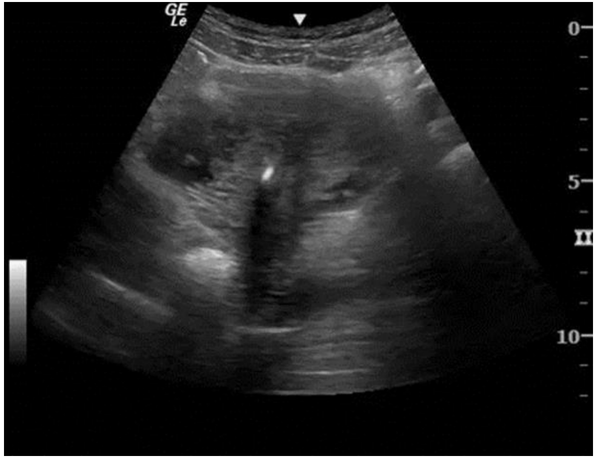
Comparing Levonorgestrel-releasing IUD vs. Copper IUDs

Image used with permission from Andrea Lewis, DO, RDMS

IUD displacement

IUD displaced from uterus fundus to lower uterine segment





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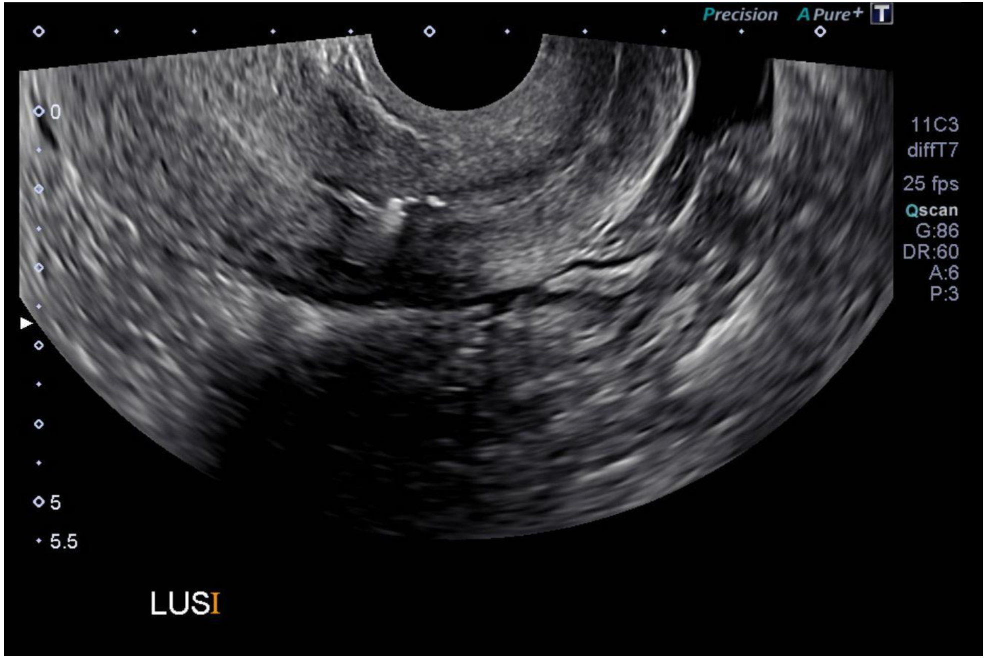
IUD displacement

IUD displaced from uterus fundus to lower uterine segment



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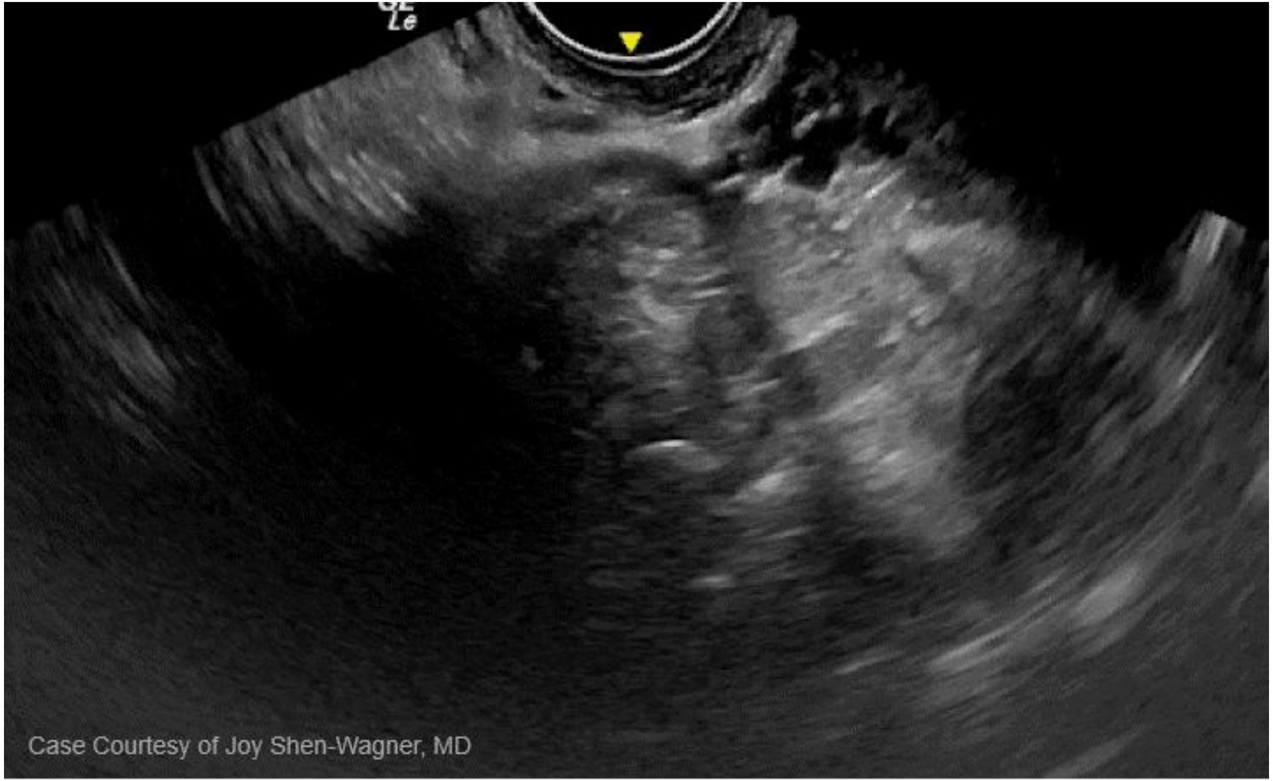
Adnexa Normal



Adnexa Abnormal

Introductory Topics

- Ovarian Cyst (simple)
- PCOS
- Tubal masses
  - Ectopic
  - Tubal ovarian abscess

Advanced Topics

- Complex Cysts
- Ovarian Torsion
- Teratoma
- Hydrosalpinx
- Ectopics in Atypical Locations

Other Pelvic Masses!

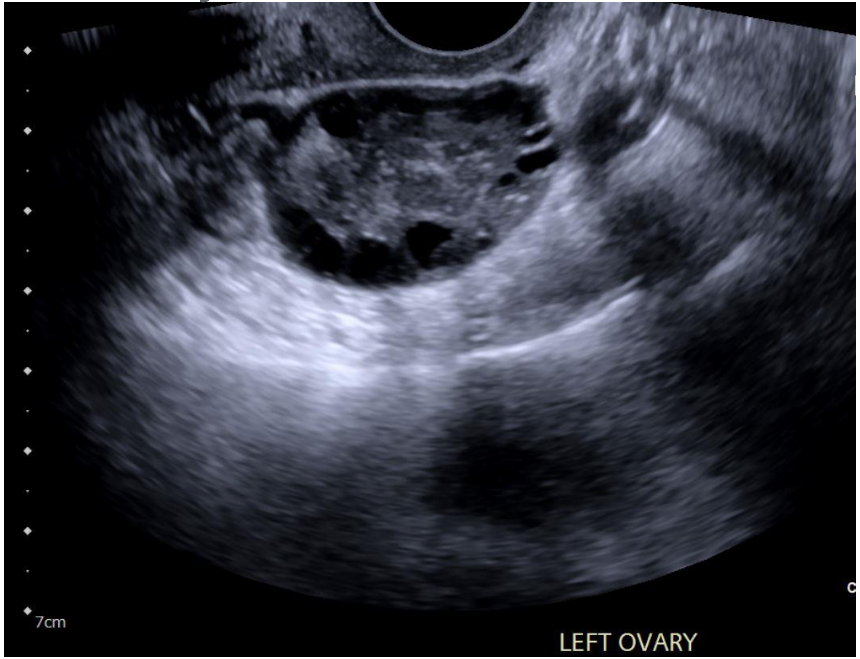
Hernias

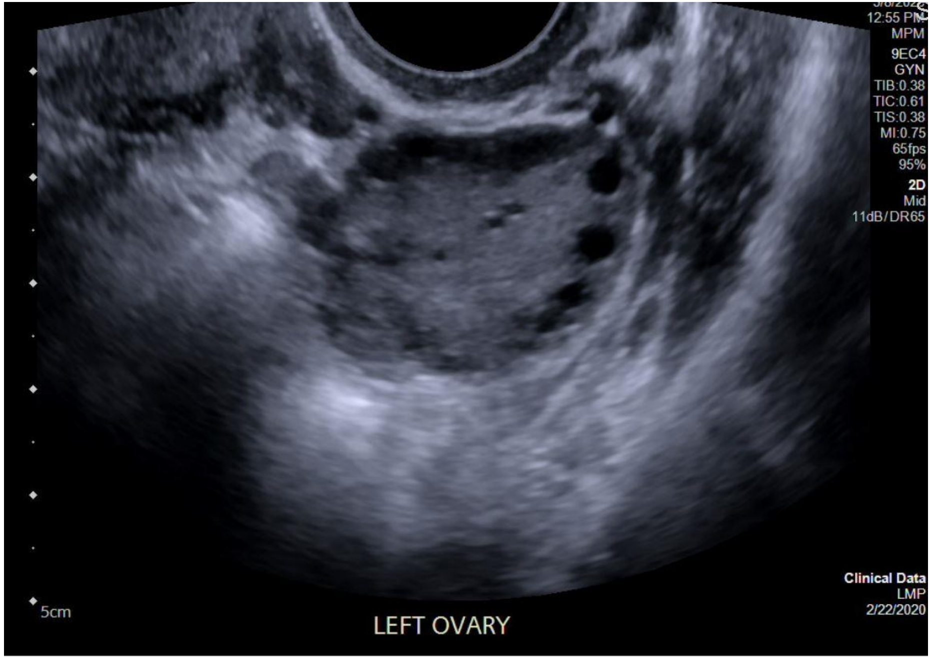
SBO, Meckels, Intussusception

Appendicitis

Adnexa Abnormal

Ovary: PCOS





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Adnexa Abnormal

Ovary: Simple Cyst

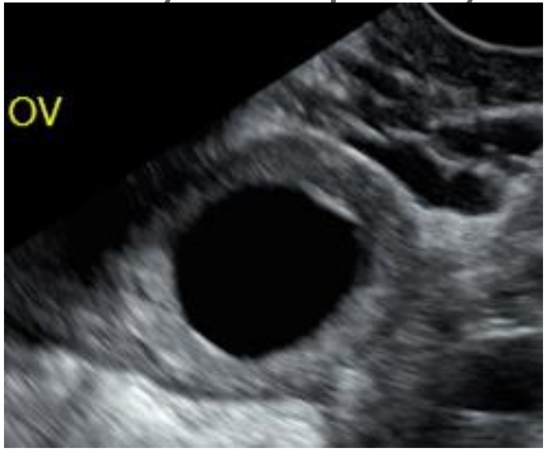
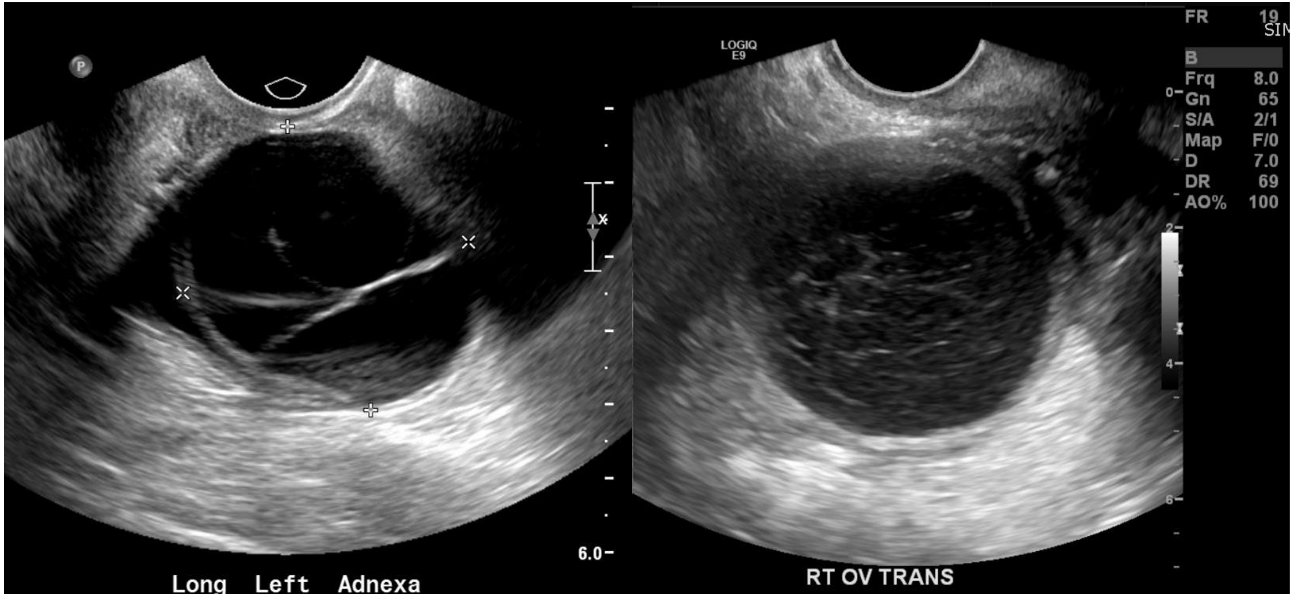


Image used with permission
Andrea Lewis, DO, RDMS

Vs. Complex Cyst



Images used with permission © Paul Bornemann, MD, RMSK, RPVI

Free fluid in the Pelvis

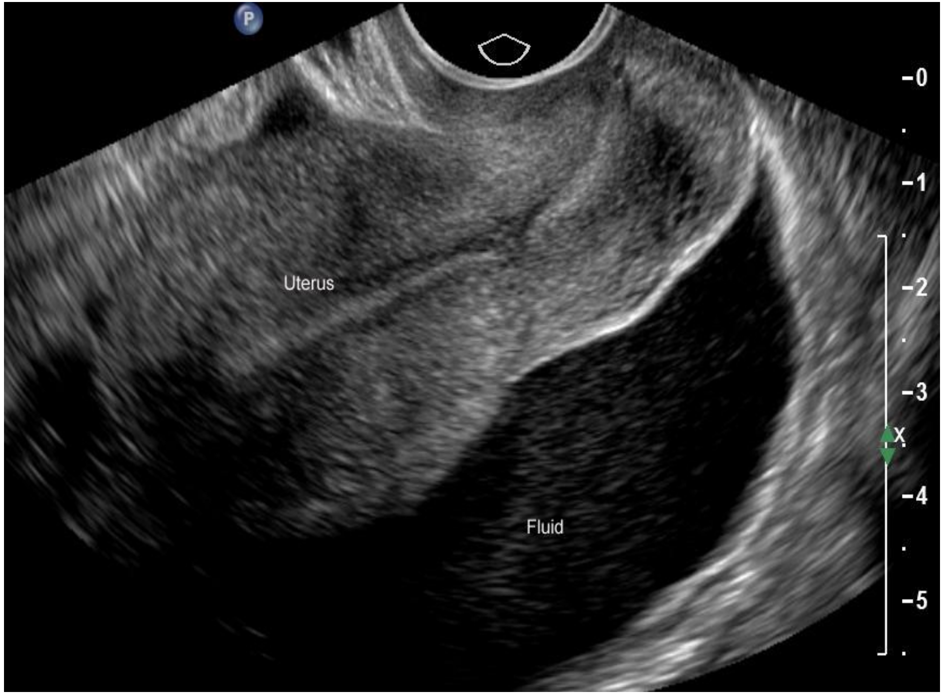


Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

Bonus topic: migrated subdermal contraceptive implant

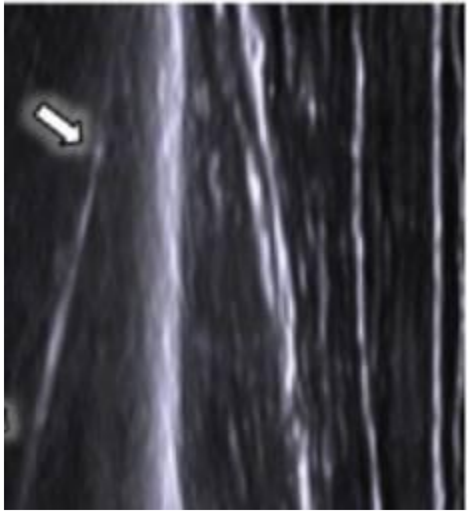
POCUS can be very helpful in located subdermal implant before attempting removal if difficult to palpate.

Use a linear probe for high frequency, high resolution, shallow penetration imaging.

Bonus topic: migrated subdermal contraceptive implant

The implant is echogenic compared to surrounding tissues generally. Although since it is plastic and not metal, do not expect much shadowing or ring down artifact.

It should be a straight line, unless it is broken.



Johnson TZ, Annis T, Kennedy A, Kobes P, Mills M. Intramuscular Placement of Birth Control Device: A Multimodality Case and Review. Cureus. 2019 Jan 7;11(1):e3835. doi: 10.7759/cureus.3835. PMID: 30891376; PMCID: PMC6411344.

CPT Codes

76857 US Transabdominal Limited Pelvis Non-OB

76830 US Transvaginal Pelvis Non-OB

76882 Soft Tissue Extremity or Axillary Limited

(Remember you need a separate image saved and US report to bill for this outside of implant removal)

Practice Recommendations

Documentation requirements for billing:

- Document an indication for the study
- Create an independent report
- Permanent storage of retrievable images
- Follow rules per your institution for credentialing and probe disinfection

Shen-Wagner J, Deutchman M, “POCUS: A Practical Guide for Primary Care,” Family Practice Management. 2020 Nov/Dec;27(6):33-40.

Summary

Abnormal uterine bleeding (AUB) causes can be divided into

- structural **PALM** (polyp, adenomyosis, leiomyoma, malignancy/hyperplasia)
- nonstructural **COEIN** (coagulopathy, ovulatory dysfunction, endometrial, iatrogenic, not yet classified)

IUD placement check can be quick and helpful

References and resources

Int J Gynaecol Obstet. 2011 Apr;113(1):3-13. doi: 10.1016/j.ijgo.2010.11.011. Epub 2011 Feb 22. PMID: 21345435.

ACOG Committee Opinion #734 May 2018
The Role of Transvaginal Ultrasonography in Evaluating the Endometrium of Women with Postmenopausal Bleeding

Shen-Wagner J, Deutchman M, "POCUS: A Practical Guide for Primary Care," Family Practice Management. 2020 Nov/Dec;27(6):33-40.

Thank you

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Assistant Professor

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AAFP

AMERICAN ACADEMY OF FAMILY PHYSICIANS

STRONG MEDICINE FOR AMERICA

AAFP CME

Early Pregnancy Ultrasound

Joy Shen-Wagner, MD, FAAFP

Associate Professor, Department of Family Medicine

University of South Carolina School of Medicine Greenville

Disclosure Statement

It is the policy of the AAFP that all individuals in a position to control CME content disclose any relationships with ineligible companies upon nomination/invitation of participation. Disclosure documents are reviewed for potential relevant financial relationships. If relevant financial relationships are identified, mitigation strategies are agreed to prior to confirmation of participation. Only those participants who had no relevant financial relationships or who agreed to an identified mitigation process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

Learning Objectives

1. Confirm an intrauterine pregnancy using transabdominal and transvaginal techniques.
2. Recognize the normal progression of first trimester sonographic milestones.
3. Identify embryonic cardiac activity and discuss usage of M-mode to calculate a fetal cardiac rate following the ALARA principle.
4. Measure a crown-rump-length correctly to estimate the gestational age.

Case

Your 32-year-old patient has a history of polycystic ovarian syndrome with irregular menses. She is here today because she took a home pregnancy test and it is positive. She would like to know how far along is the pregnancy, as she is uncertain of the date of her last menstrual period. She also warns you that twins and triplets are common on her side of the family!

Can you help her today?

Evidence for Ultrasound in Early Pregnancy

(Whitworth, 2015) Cochrane Database Systemic Review 11 RCT with 37,505 pregnant women.

*"Early ultrasound improved the early **detection of multiple pregnancies** and **improved gestational dating**, **which may result in fewer inductions for post maturity**. The detection of fetal malformation was addressed in detail in only two of the trials. There was no evidence of a significant difference between the screened and control groups for perinatal death."*
(Whitworth, 2015)

Cochrane Library
Trusted evidence.
Informed decisions.
Better health.

Cochrane Database of Systematic Reviews

[Intervention Review]

Ultrasound for fetal assessment in early pregnancy

Melissa Whitworth[1], Leanne Bricker[2], Clare Mullan[3]

[1]St Mary's Hospital, Manchester, UK. [2]Corniche Hospital, Abu Dhabi, United Arab Emirates. [3]Department of Obstetrics & Gynaecology, St Mary's Hospital, Manchester, UK

(Agten, 2021) Cochrane Database Systemic Review 2021

- 13 RCTs with 85,265 pregnant women who had routine ultrasounds US < 24 weeks vs selective, none or concealed

Evidence in First Trimester Ultrasound

		Cochrane Review 2015	Cochrane Review 2021
1.	**Early Detection of Multiple Gestation Pregnancy**	☑	☑
2.	**Accurate Dating**	☑	☑
4.	Difference in Perinatal Death	⊘	Uncertain
3.	Reduce induction for post-maturity	hypothesized	Uncertain
5.	**Reduce short term maternal anxiety**	**N/A**	☑
6	Difference in Pregnancy Termination for fetal abnormalities	N/A	Not reported

Guidelines

ACOG: First trimester ultrasound measurement of a fetus is the most accurate to establish or confirm gestational age (<14 weeks of gestational age)

Gestational Age Range*	Method of Measurement	Discrepancy Between Ultrasound Dating and LMP Dating that Supports Redating
< 9 wk 9 wk to <14 wk	CRL	More than 5 d More than 7 d
14 wk to <16 wk	BPD, HC, AC, FL	More than 7 d
16 wk to <22 wk	BPD, HC, AC, FL	More than 10 d
22 wk to <28 wk	BPD, HC, AC, FL	More than 14 d
28 wk and beyond◦	BPD, HC, AC, FL	More than 21 d

Abbreviations: AC, abdominal circumference; BPD, biparietal diameter; CRL, crown-rump length; FL, femur length; HC, head circumference; LMP, last menstrual period.

*Based on LMP

◦Because of the risk of redating a small fetus that may be growth restricted, management decisions based on third trimester ultrasound alone are especially problematic and need to be guided by careful consideration of the entire clinical picture and close surveillance.

Committee Opinion No. 700 Summary: Methods for Estimating the Due Date Obstetrics & Gynecology: May 2017 - Volume 129 - Issue 5 - p 967-968

Indications (AIUM-ACR-ACOG)

- **Confirmation of the presence of an intrauterine pregnancy**
- **Confirmation of cardiac activity**
- **Estimation of gestational age**
- **Diagnosis or evaluation of multiple gestations including determination of chorionicity**
- Evaluation of a suspected ectopic pregnancy
- Evaluation of the cause of vaginal bleeding
- Evaluation of pelvic pain
- Evaluation of suspected gestational trophoblastic disease
- Assessment for certain fetal anomalies, such as anencephaly
- Measurement of the NT when part of a screening program for fetal aneuploidy
- Imaging as an adjunct to chorionic villus sampling, embryo transfer, and localization and removal of an intrauterine device
- Evaluation of maternal pelvic masses and or uterine anomalies.

Early Pregnancy Ultrasound

Introductory

Verify Intrauterine Pregnancy

Identify Multiple Gestation

Identify Cardiac Activity

Dating with Crown Rump Length

Next Level

Pregnancy Loss

Pregnancy of Unknown Location

Ectopic Pregnancy

Fetal anomalies

Chorionicity and Amnionicity

Subchorionic Hemorrhage

Early Pregnancy vs First Trimester US

Limited "Early Pregnancy US"

5 to <12 weeks

More Limited

IUP confirmation

Confirm Cardiac Activity/FHR

Detect Multiple Gestation

"First trimester Dating US"

12w to <14w

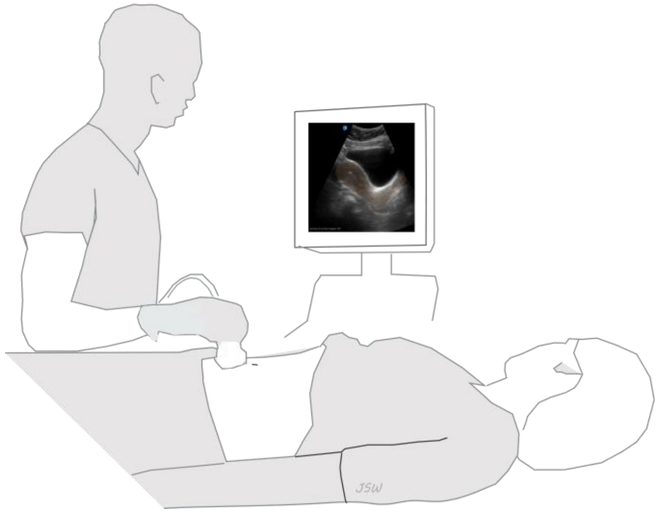
More Comprehensive

1st Tri "Anatomy Scan"

Detection of some congenital abnormalities

Setup

Transabdominal



Preparing probe

Cleaning probe

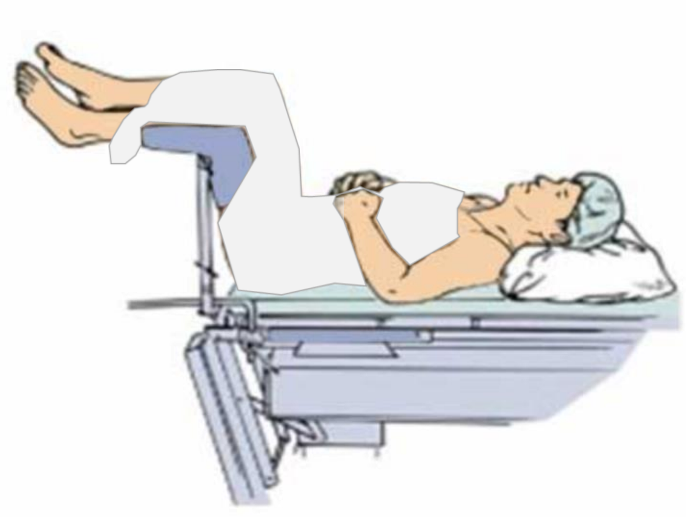
Patient bladder

Patient position

Draping

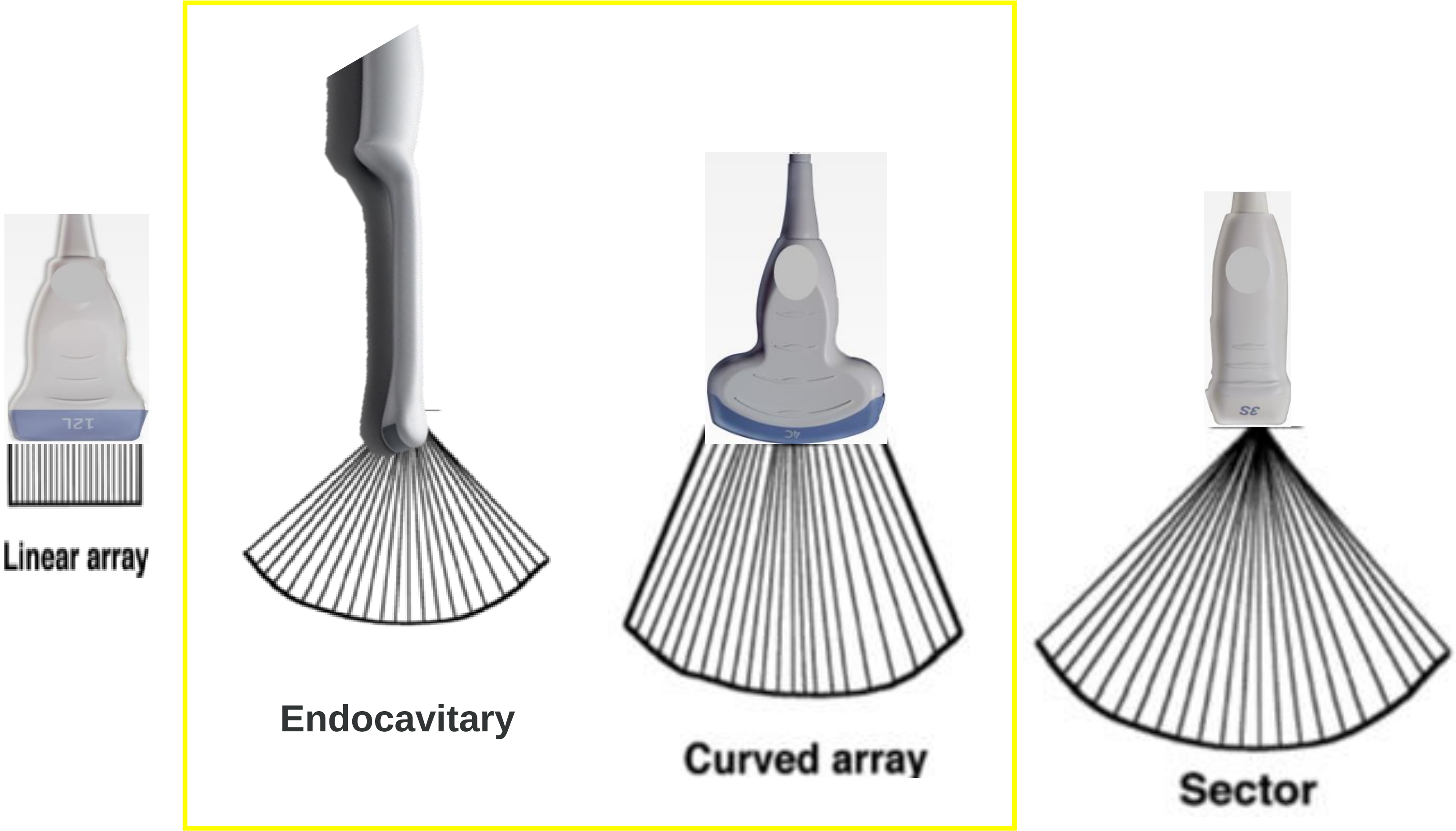
Lighting

Transvaginal

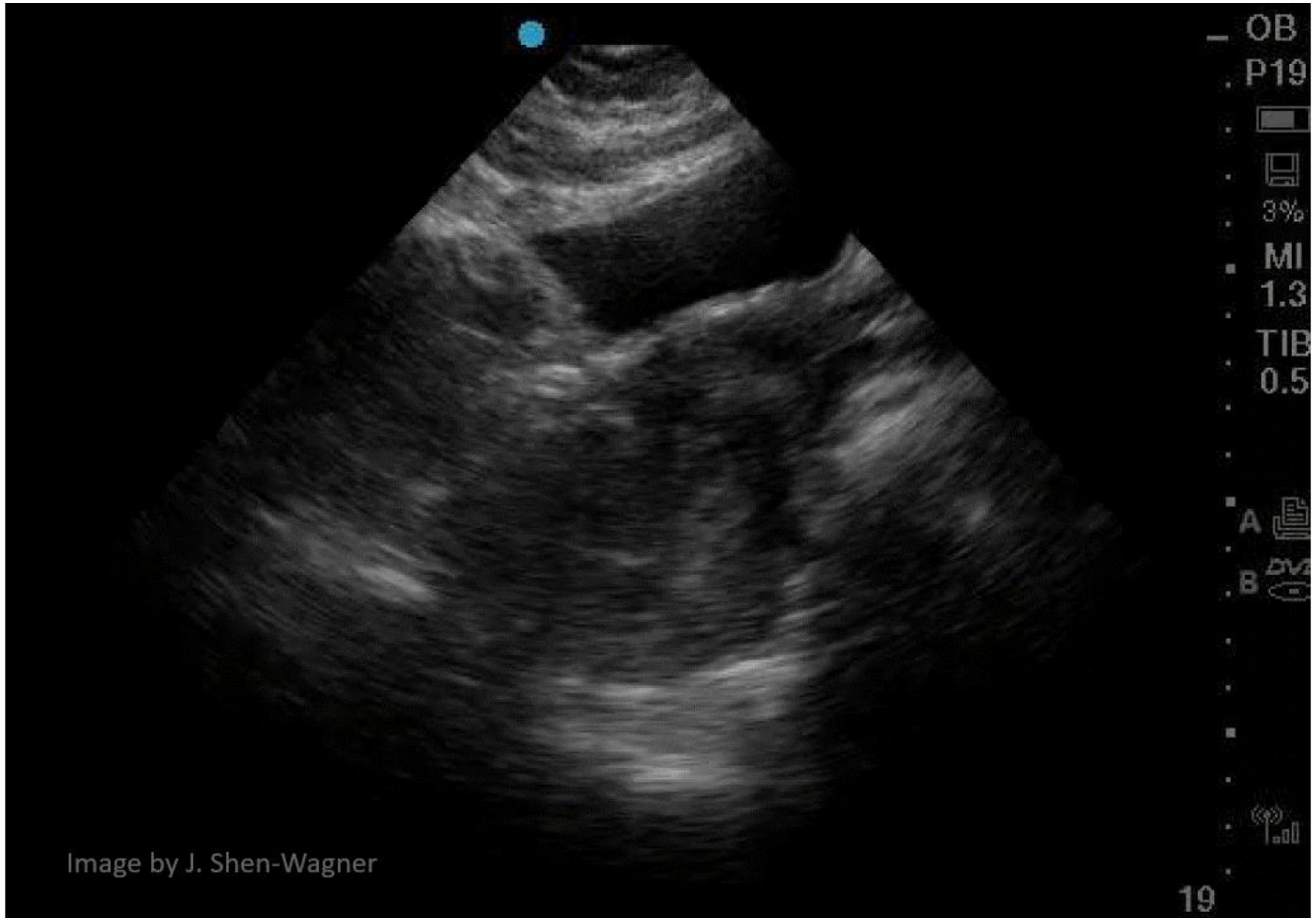


http://en.wikipedia.org/wiki/lithotomy_position

Probe Selection

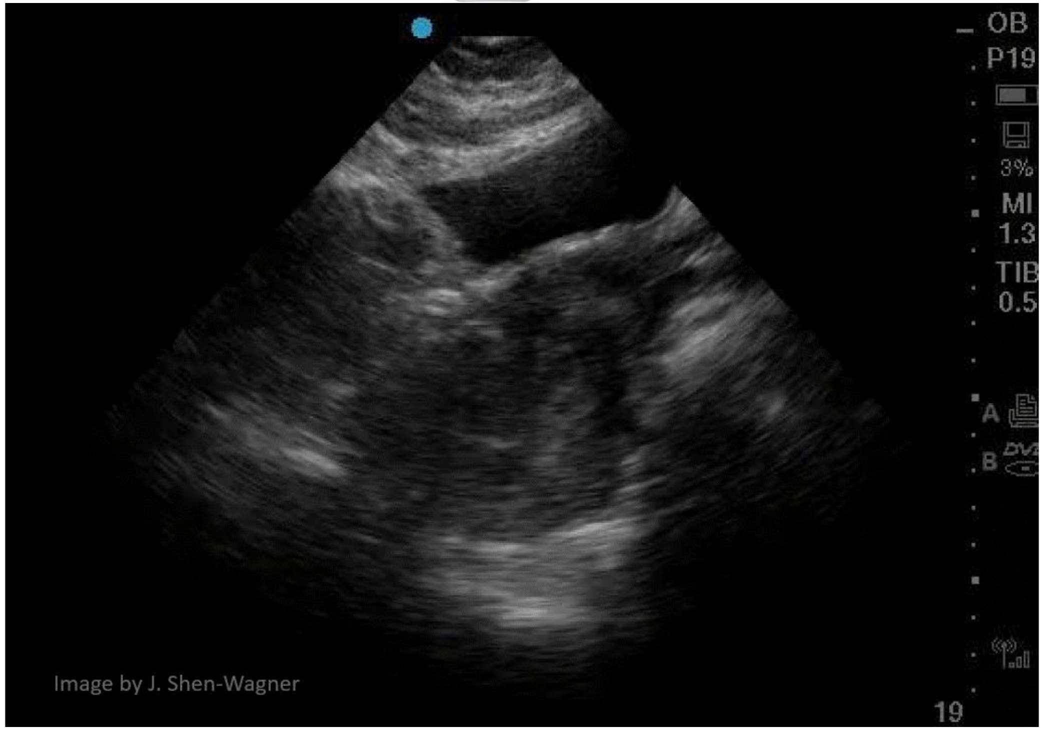


Probe Selection



Sector or “Cardiac” Probe

Probe Selection



Sector or “Cardiac” Probe

Endocavitary or “Transvaginal” Probe

Endocavitary probes and HPV

Multiple small studies showed endocavitary transducers are infected with high-risk HPV despite LLD and Probe Covers and recommend that endocavitary transducers should be high-level disinfected (5/198 transducers showed high-risk HPV after use; Kac, 2010) (Casalegno, 2012) (Rutala 2016)

One small study compared compared bacterial load on ultrasound transducers (n = 36, 53 CFU), bus poles (n = 11, 28 CFU), and toilets (n = 10, 4 CFU). (Sartoretti, 2017 Switzerland)

Probe Cleaning

External Transducers -> Noncritical
*Low Level Disinfection (LLD)

Endocavitary Transducers-> Semicritical
*LLD AND Probe Cover AND
High Level Disinfection (HLD)

aium | Official Statements

Guidelines for Cleaning and Preparing External- and Internal-Use Ultrasound Transducers and Equipment Between Patients as well as Safe Handling and Use of Ultrasound Coupling Gel

03/05/2021

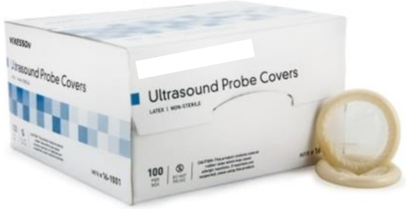
Transvaginal

Transabdominal

LLD

Condoms > probe covers
(Rooks 1996)

Covers



HLD

Or

Transabdominal- Normal Pelvic Anatomy

Bladder

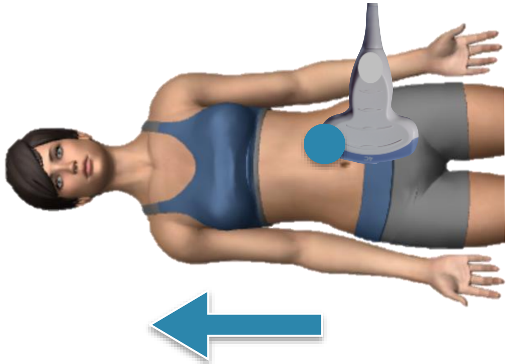
Uterus

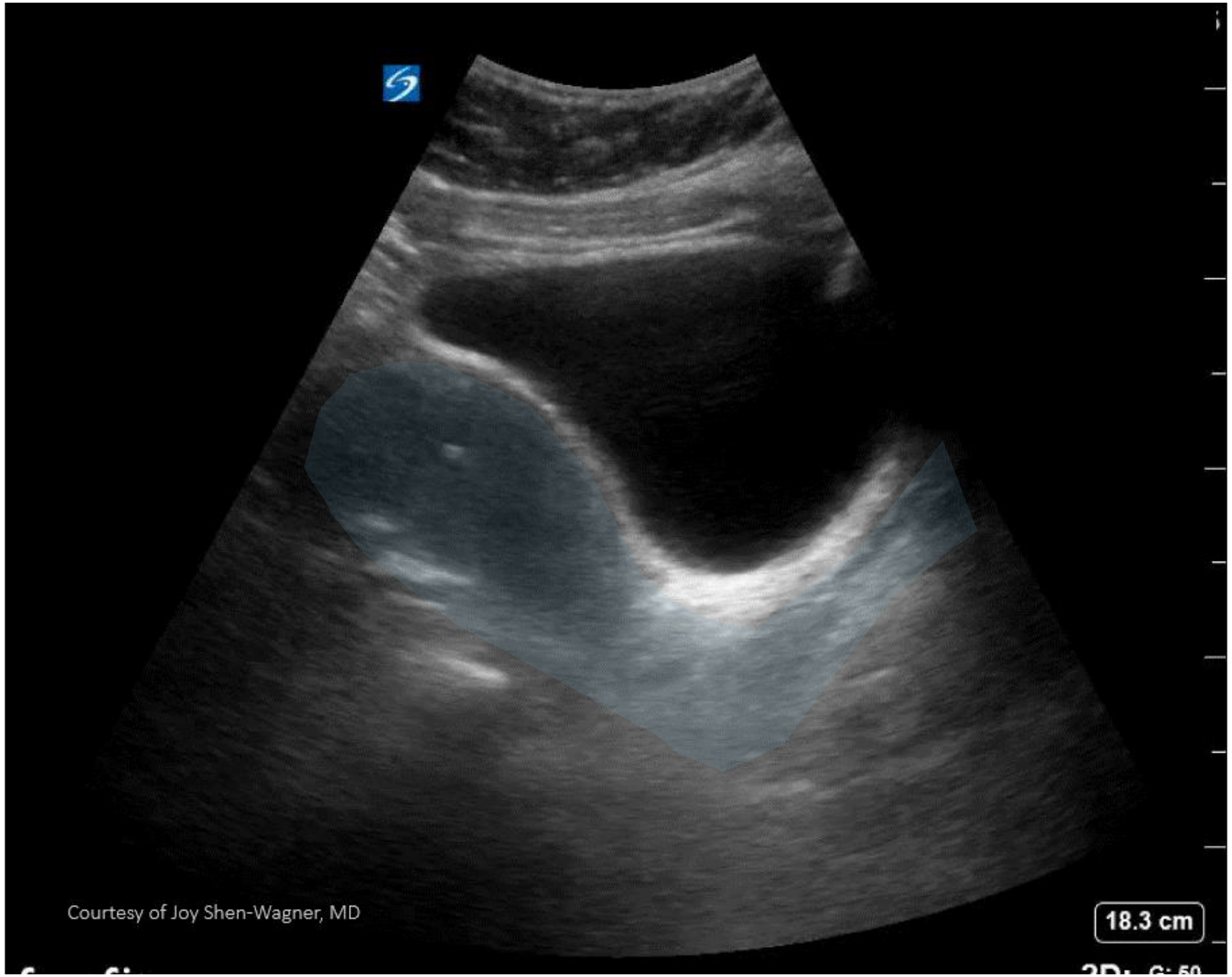
Cervix

Endometrium

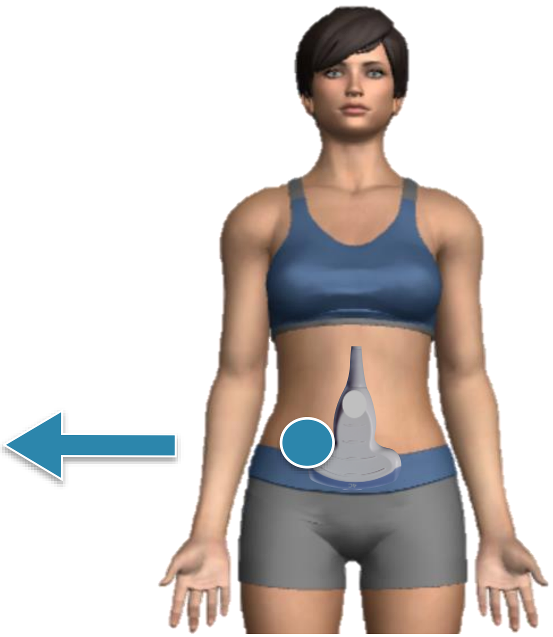
Adnexa

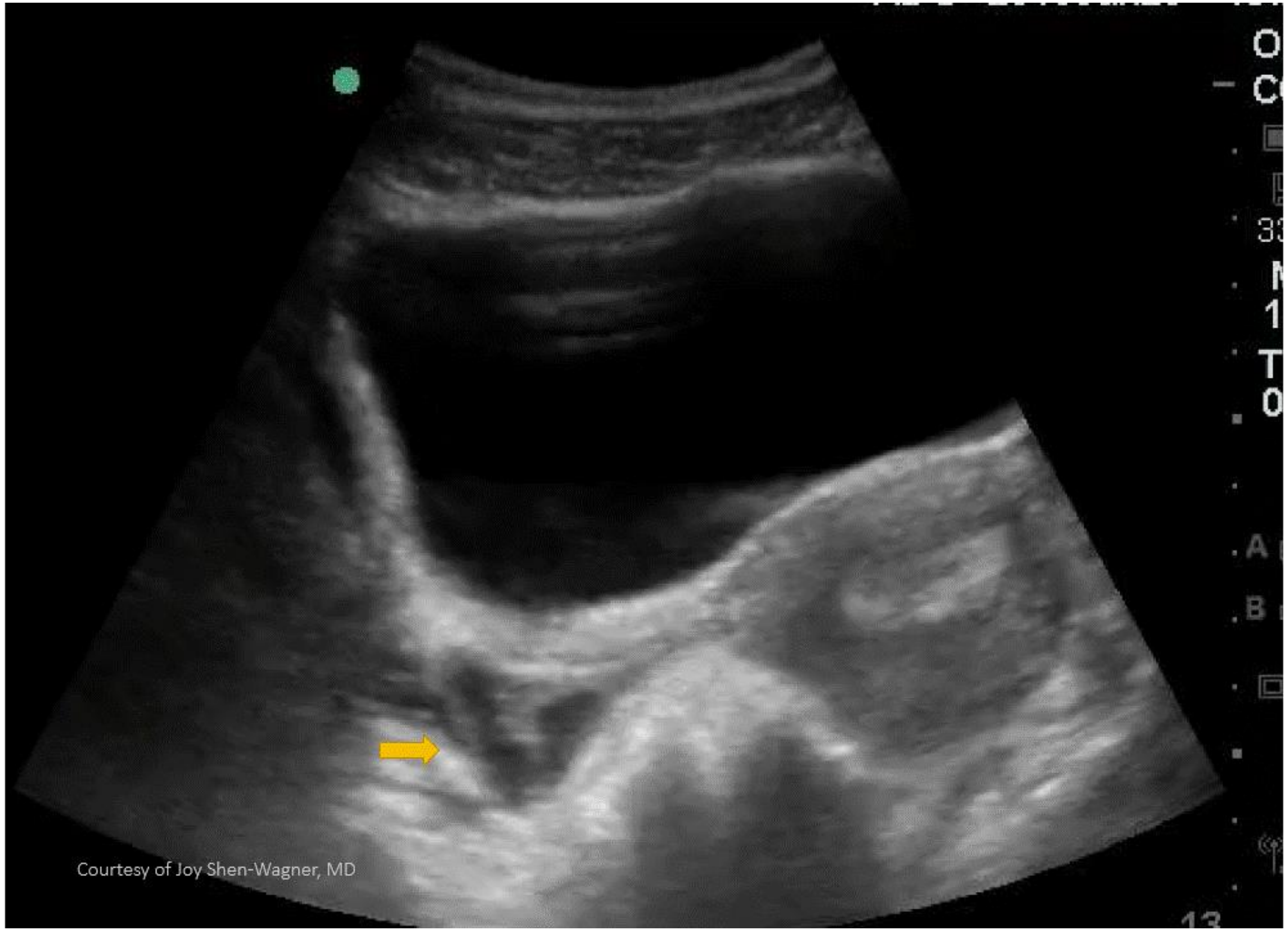
Cul-de-sac



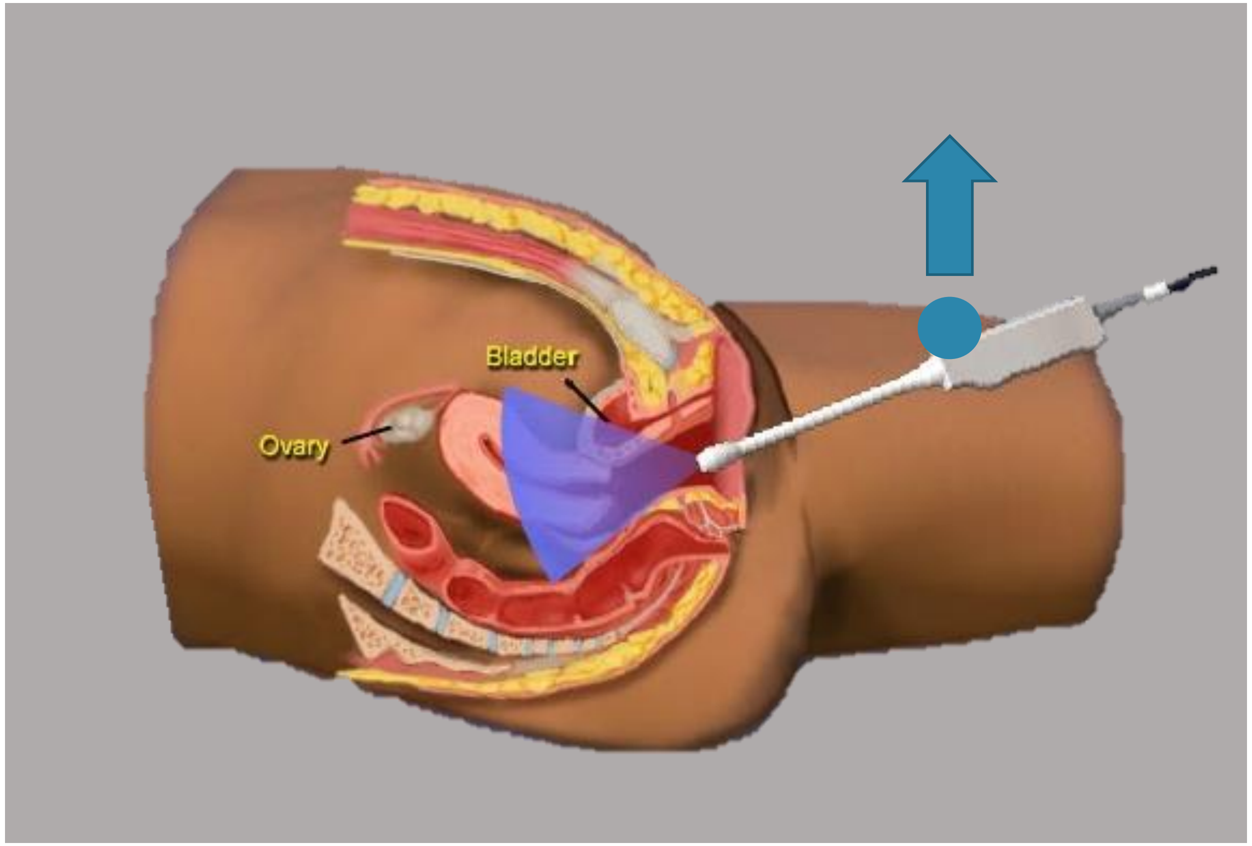


Transverse





Transvaginal TVUS Sagittal



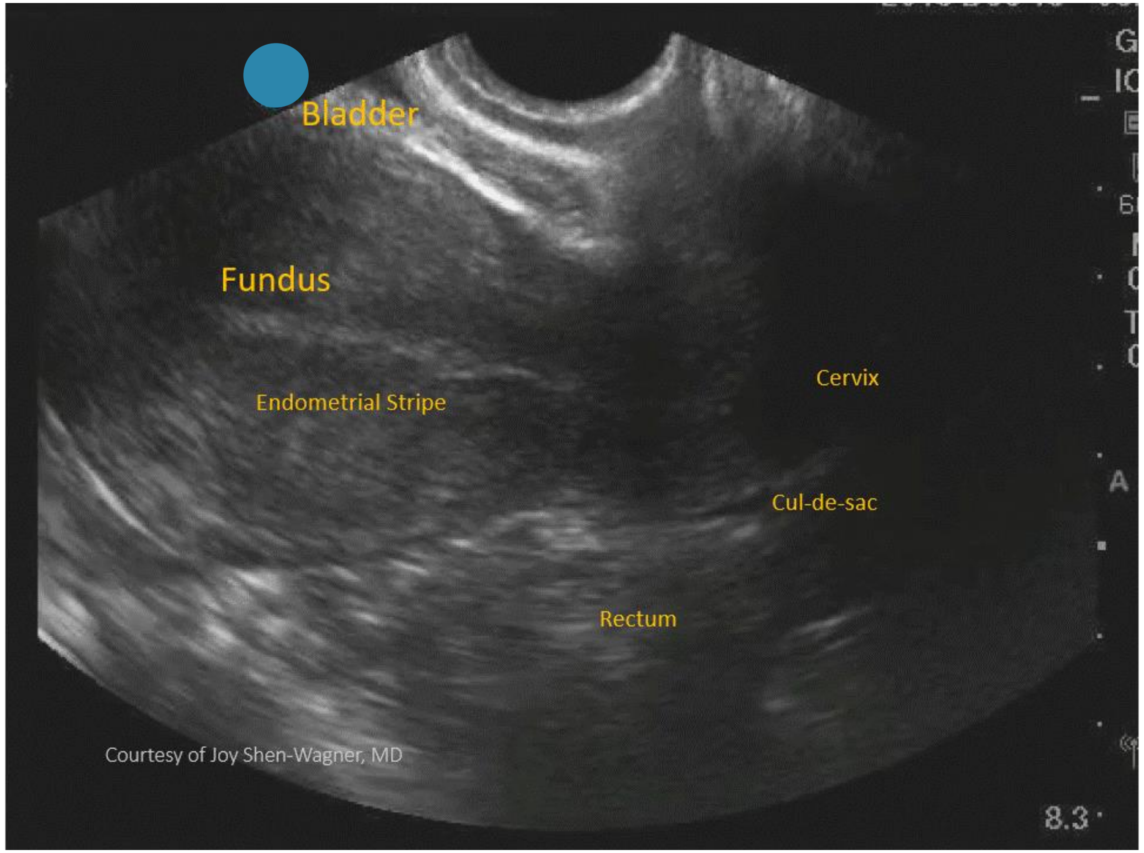
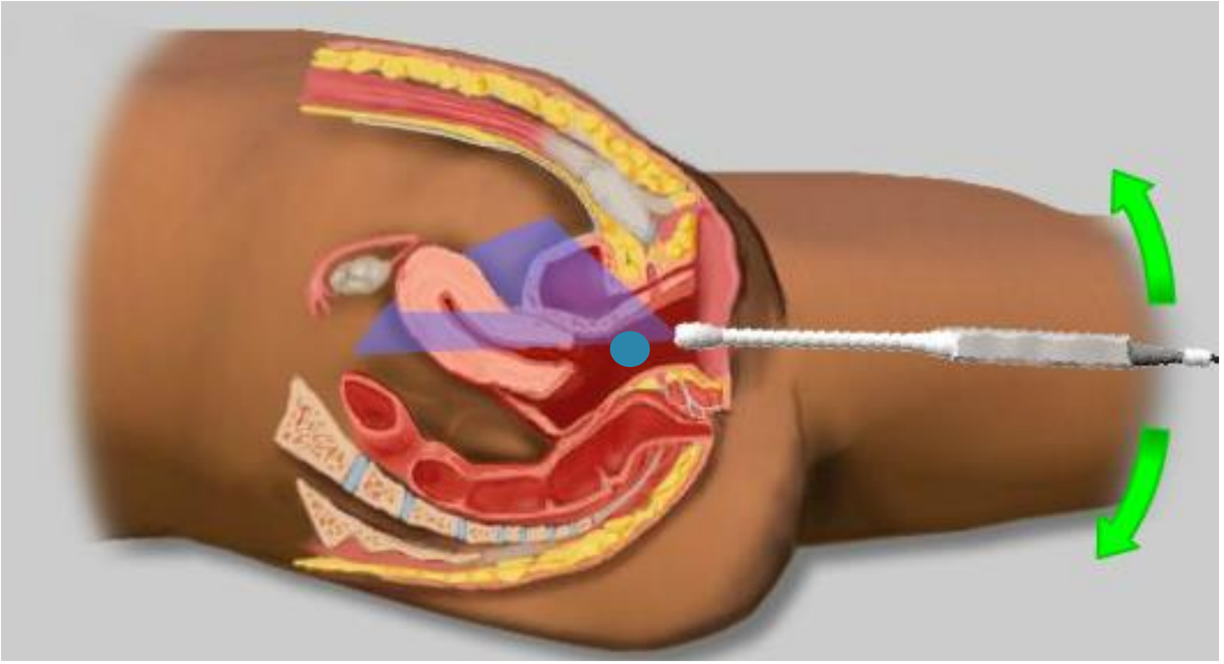


Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

Transvaginal Coronal (Transverse)



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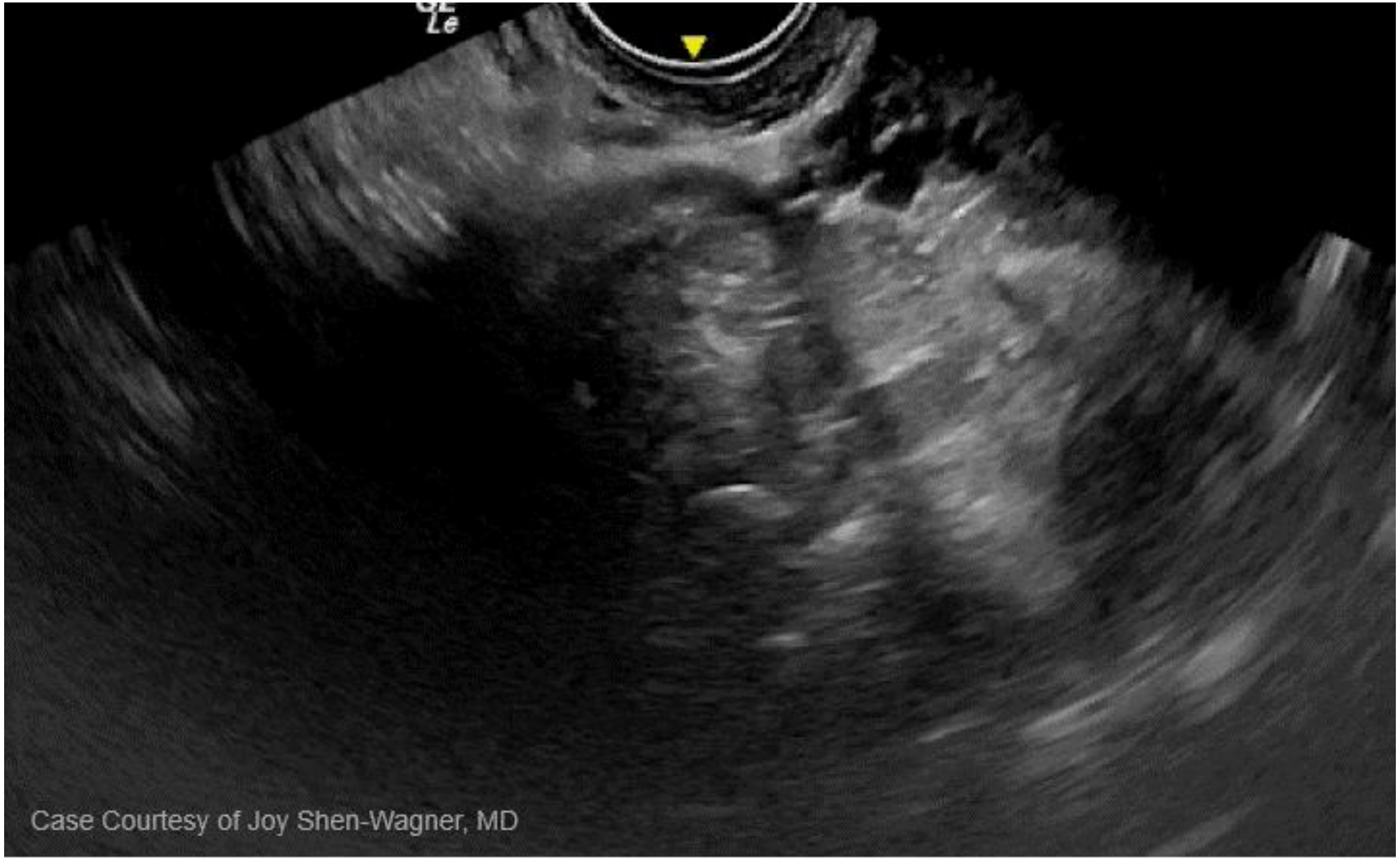
Adnexa

Transvaginal

Location

Appearance

Size



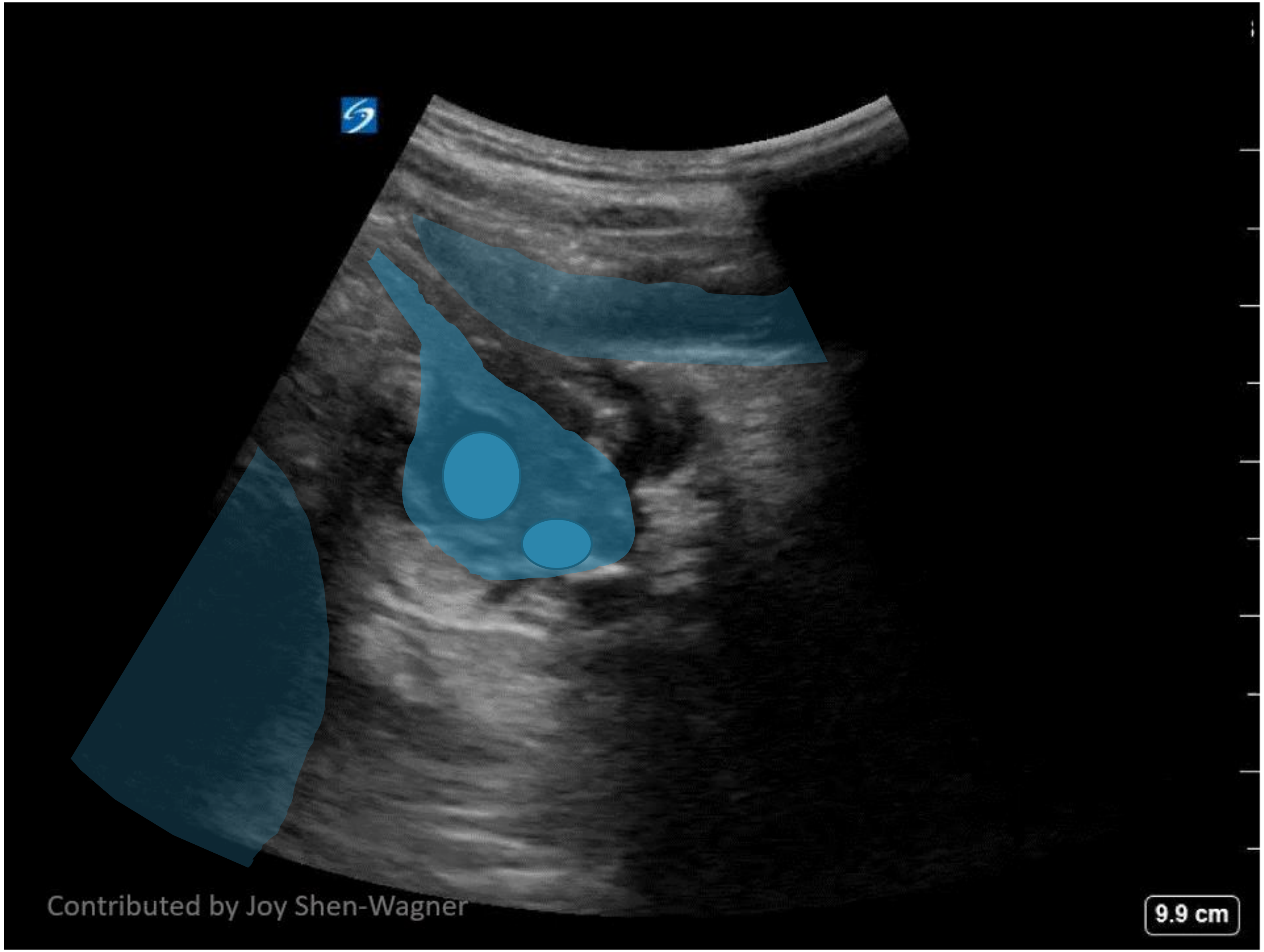
Adnexa

Transabdominal

Location

Appearance

Size



Confirmation of Intrauterine Pregnancy

Sonographic Progression

Gestational Sac	4-5	weeks ◊
Yolk Sac*	5-6	weeks ◊
Fetal Pole	5-6	weeks ◊
Cardiac Activity#	5-6	weeks ◊
Embryo Movement#	6-7	weeks

◊ Visible on Transvaginal scan. Add 1 week for transabdominal (TAB).

TAB typically visualizes embryo by 6 weeks

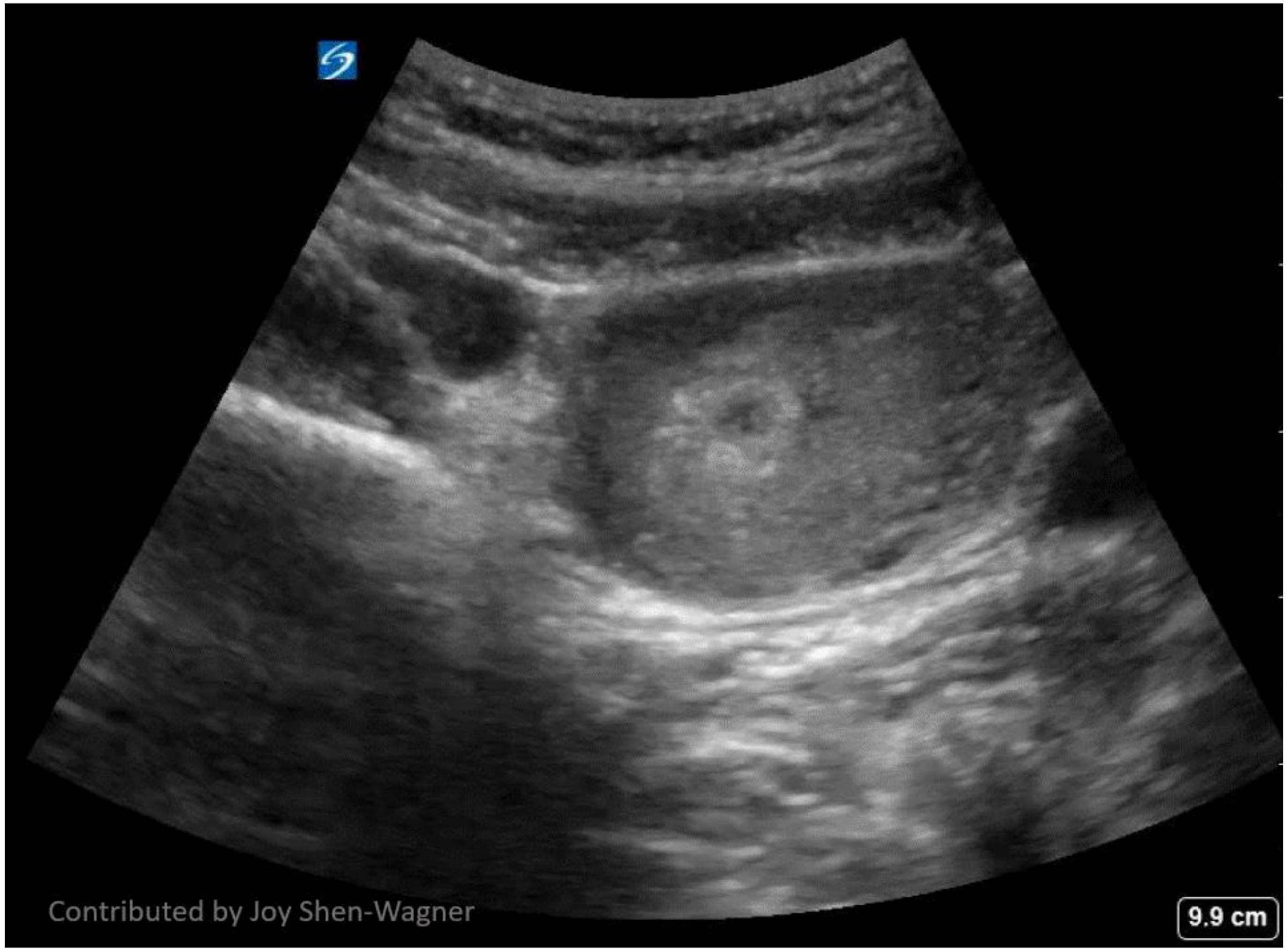
<10 weeks = “Embryo”
≥10 weeks = “Fetus”

*First Confirmation of Intrauterine Pregnancy

#Confirms Viability

Endometrial Thickening

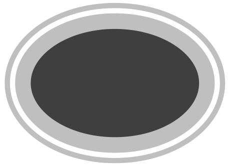
Gestational Sac



Gestational Sac with fluid in cul-de-sac

Gestational Sac

- Round, without pointy edges
- Uterine fundus
- Echogenic “rind” surrounding sac
- Acentric from the lining



5th menstrual week, transvaginal scan

Yolk Sac (Confirms Intrauterine Pregnancy)

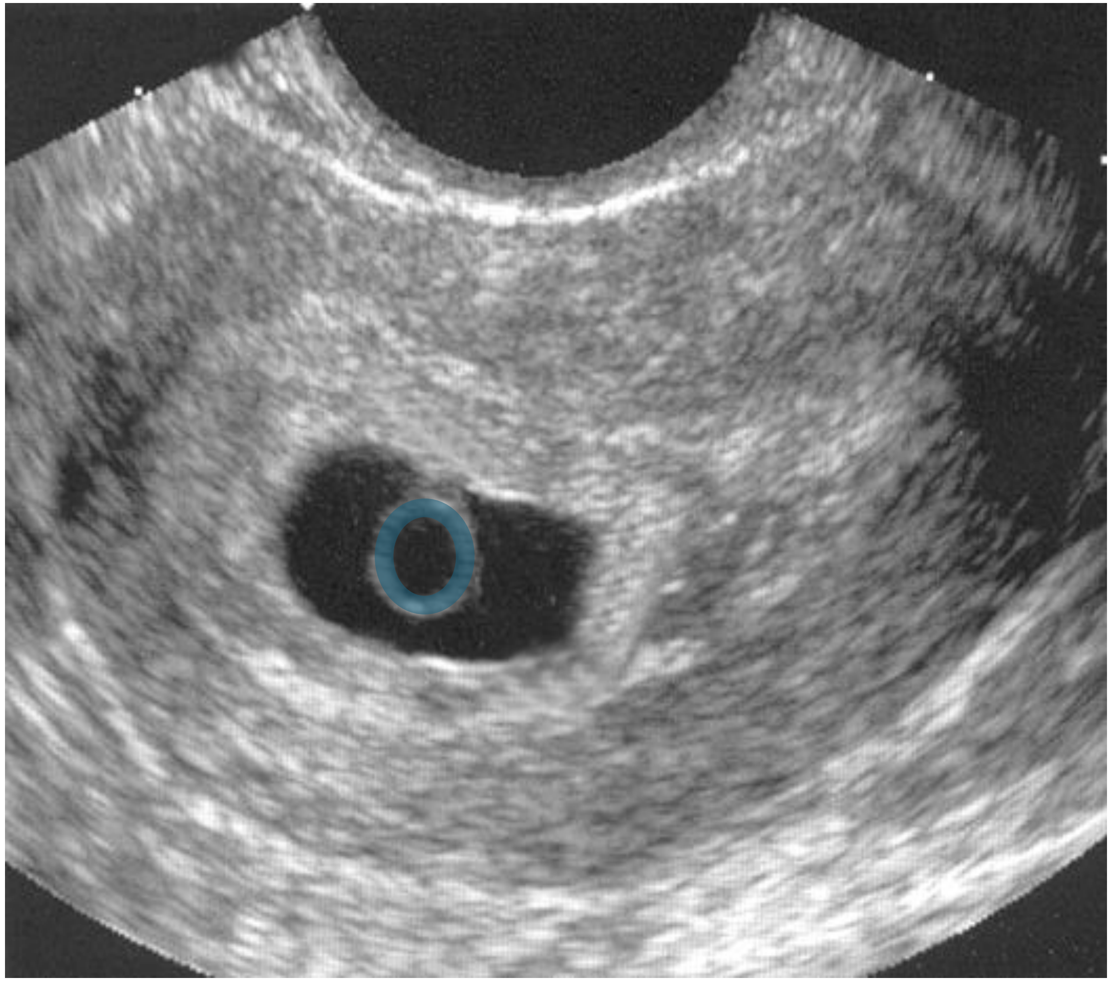
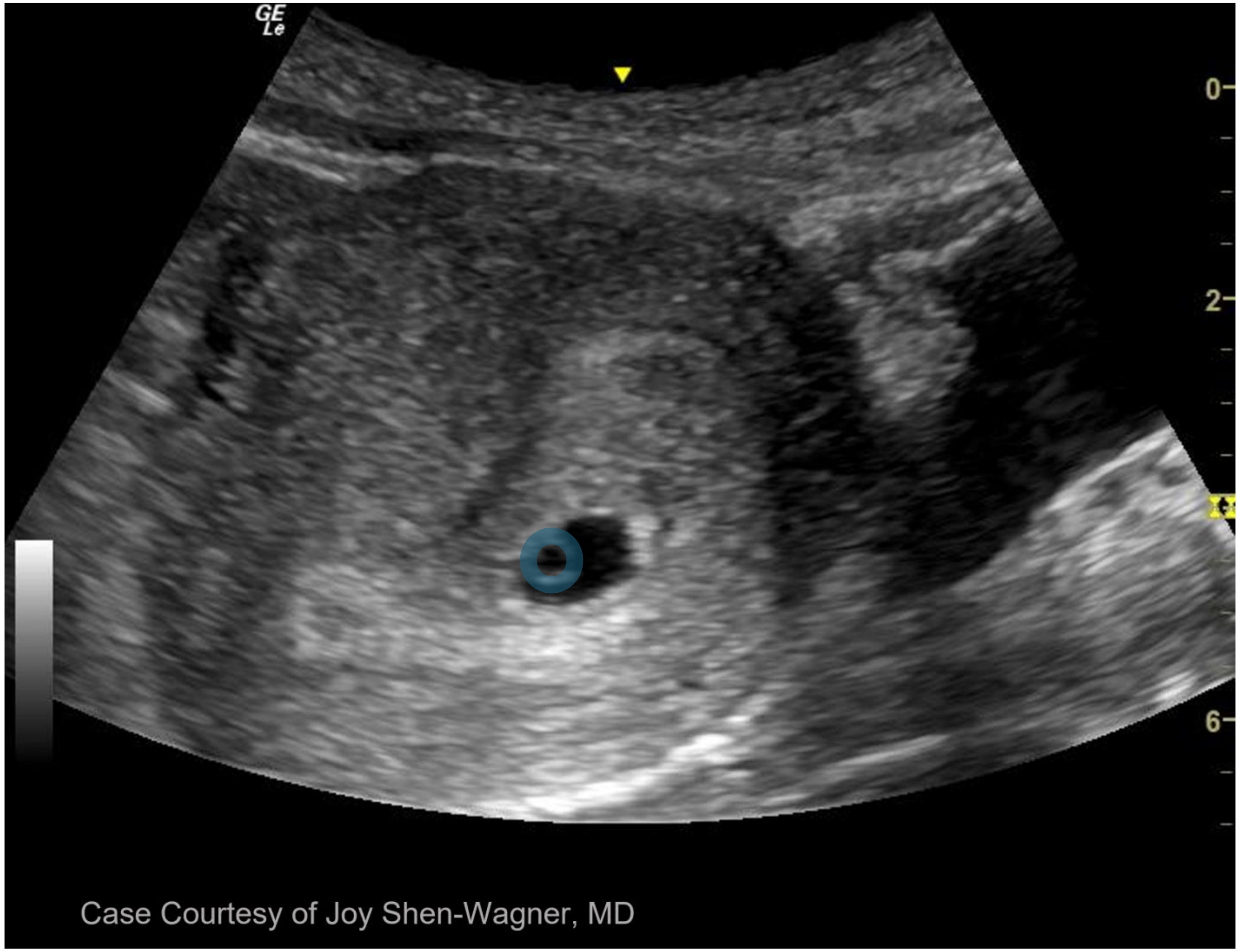


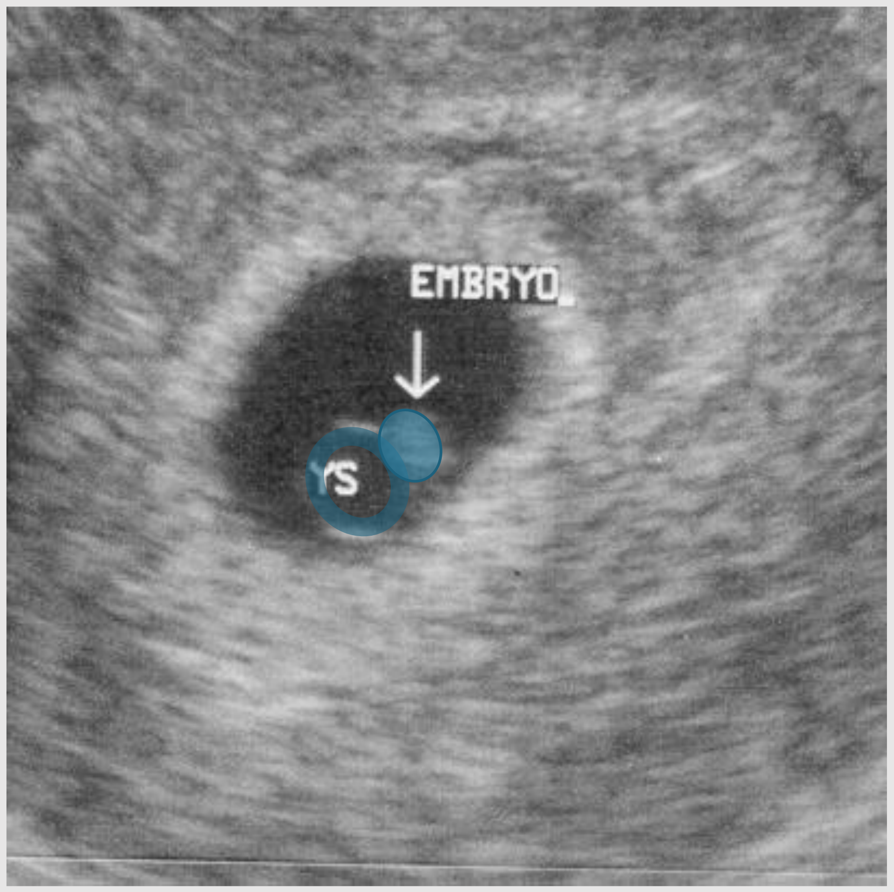
Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

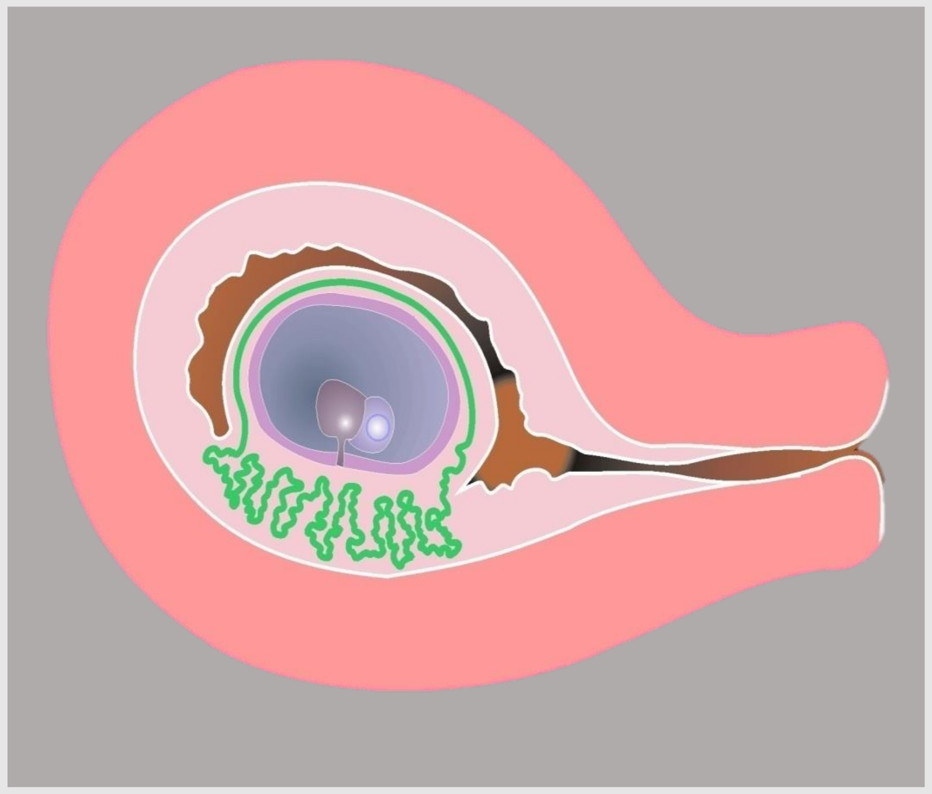
Yolk Sac (Confirms Intrauterine Pregnancy)



- Check Fundal Location
- Check for surrounding myometrium.

6 to 7 Week Embryo





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6 to 7 Week Embryo

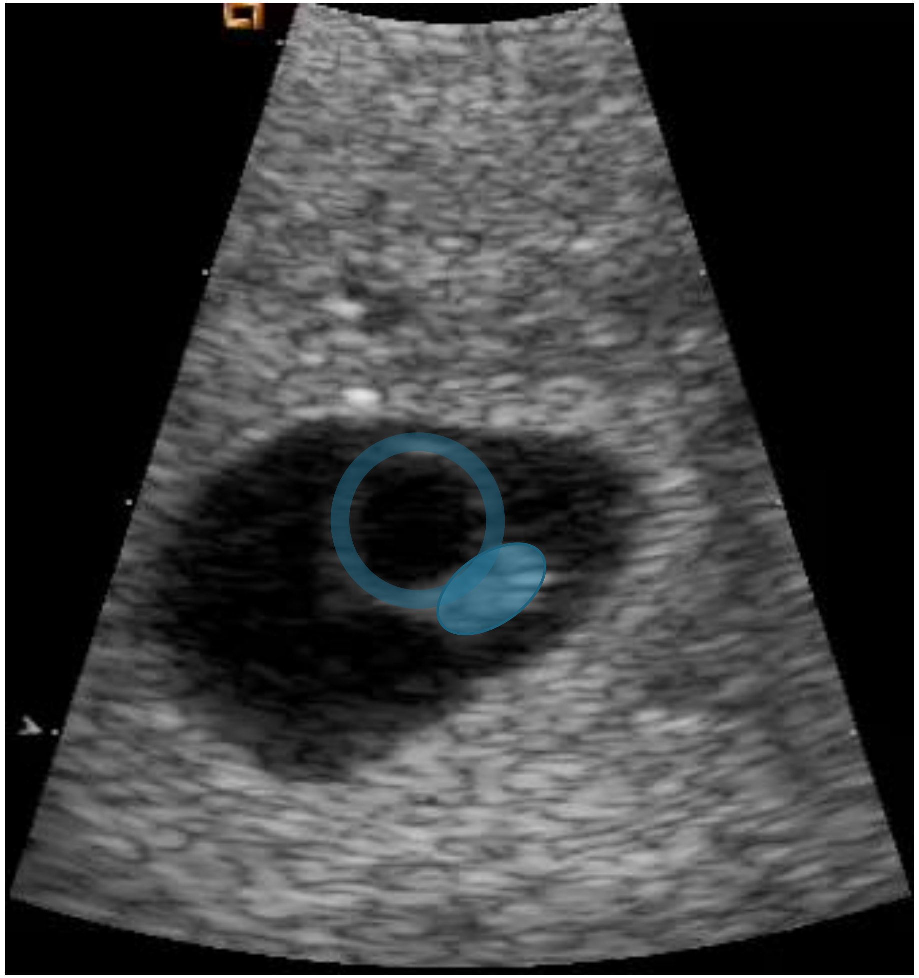


Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

8 to 9 week Embryo

Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

Estimating Gestational Age

Early Pregnancy Dating

- **Gestational Sac (MSD)** in mm + 30 = days of pregnancy
- **Fetal Pole or Embryo (CRL)**
  - CRL in cm + 6.5 = menstrual weeks.
  - Accurate between 8 and 13 weeks
  - Take an Average of 3x measurements in 3 different scans

GA by Crown-Rump Length

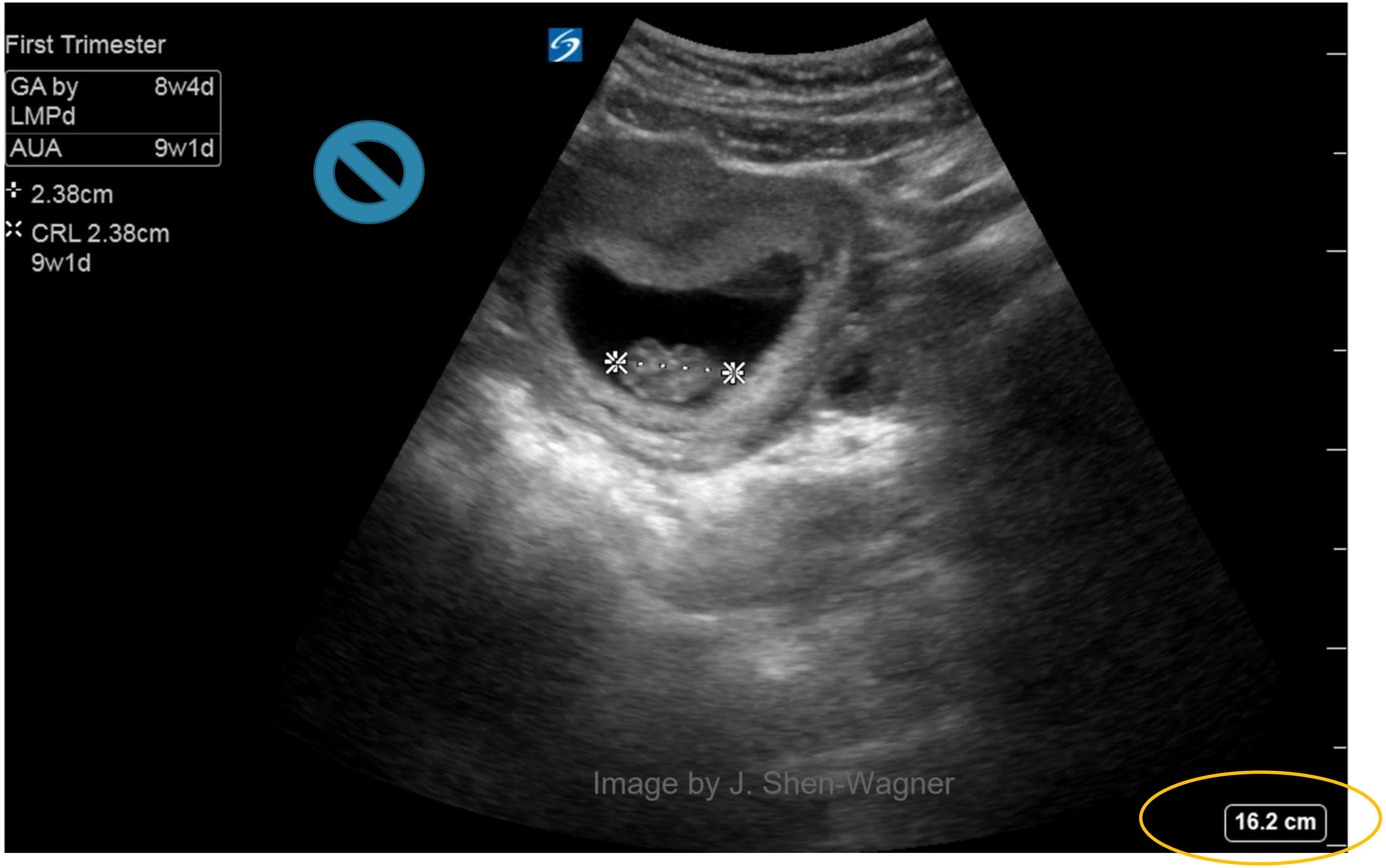
Image used with permission © Mark Deutchman MD Obstetric Ultrasonography; Normal and Abnormal

-> Choose OB Preset
-> Freeze
-> Calcs
-> Measure from Crown to Rump

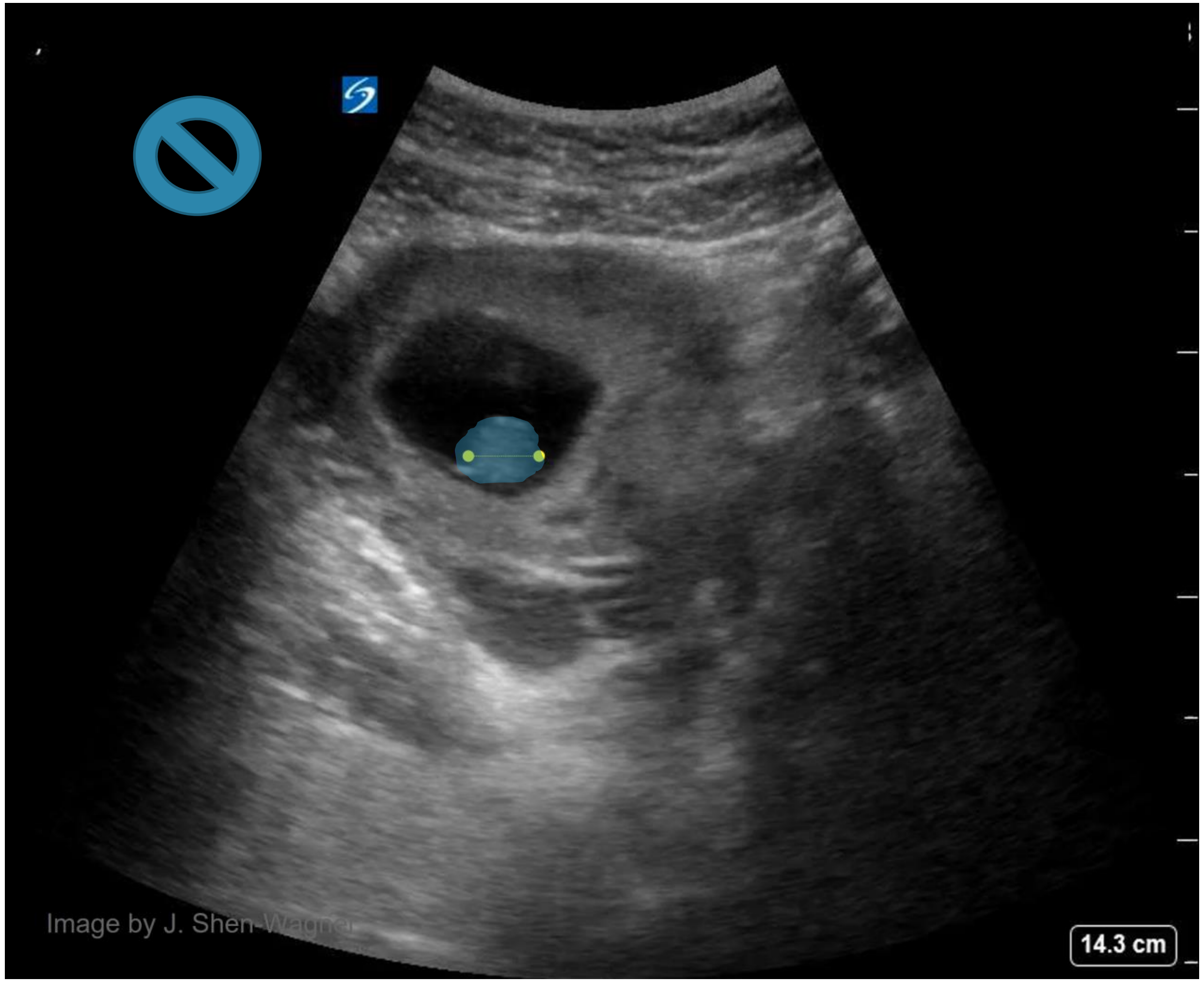
GA Dating will be calculated for you!

Tip: Zoom in!
Decrease depth

CRL – Adjust the Depth

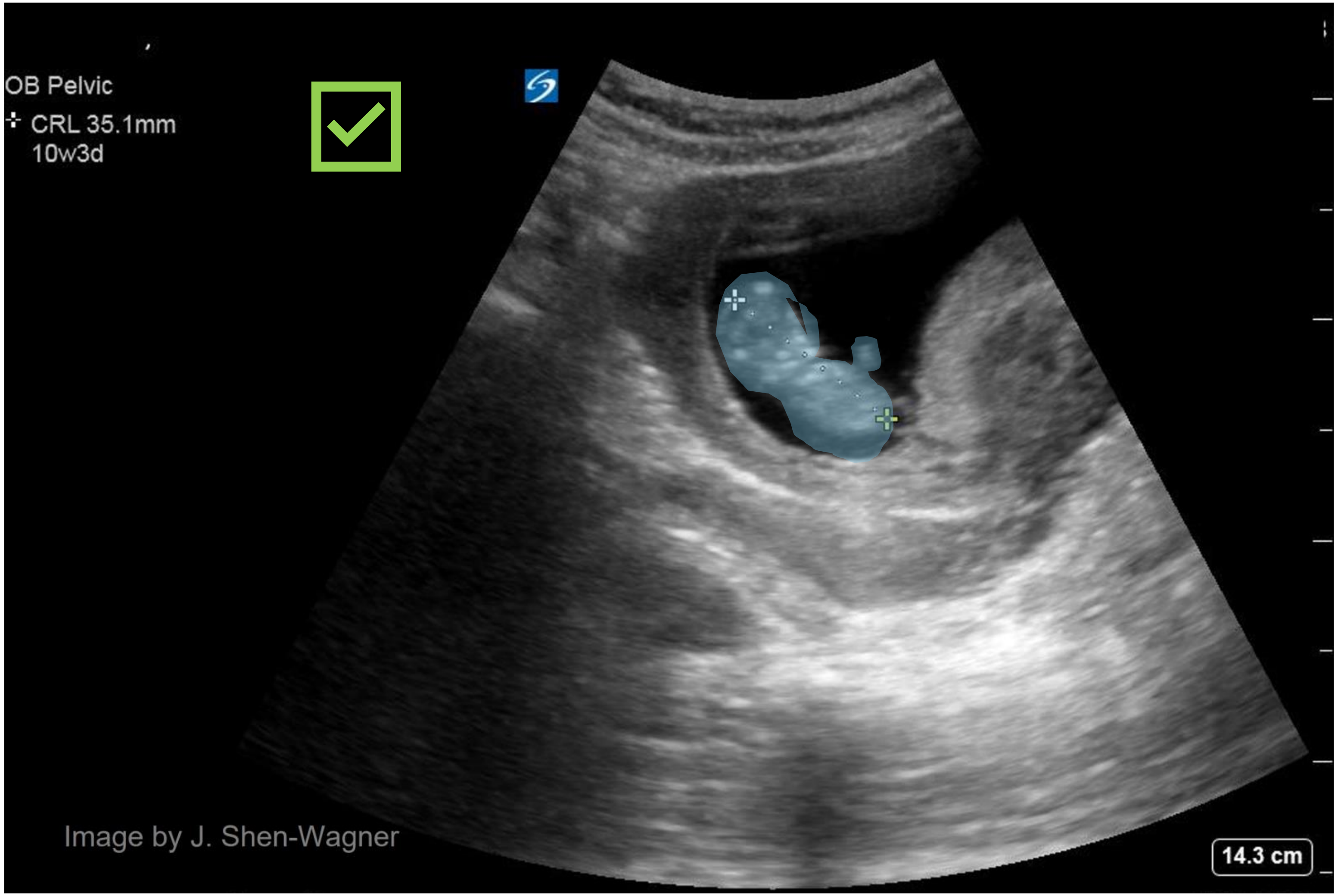


CRL- Measure in Sagittal Plane

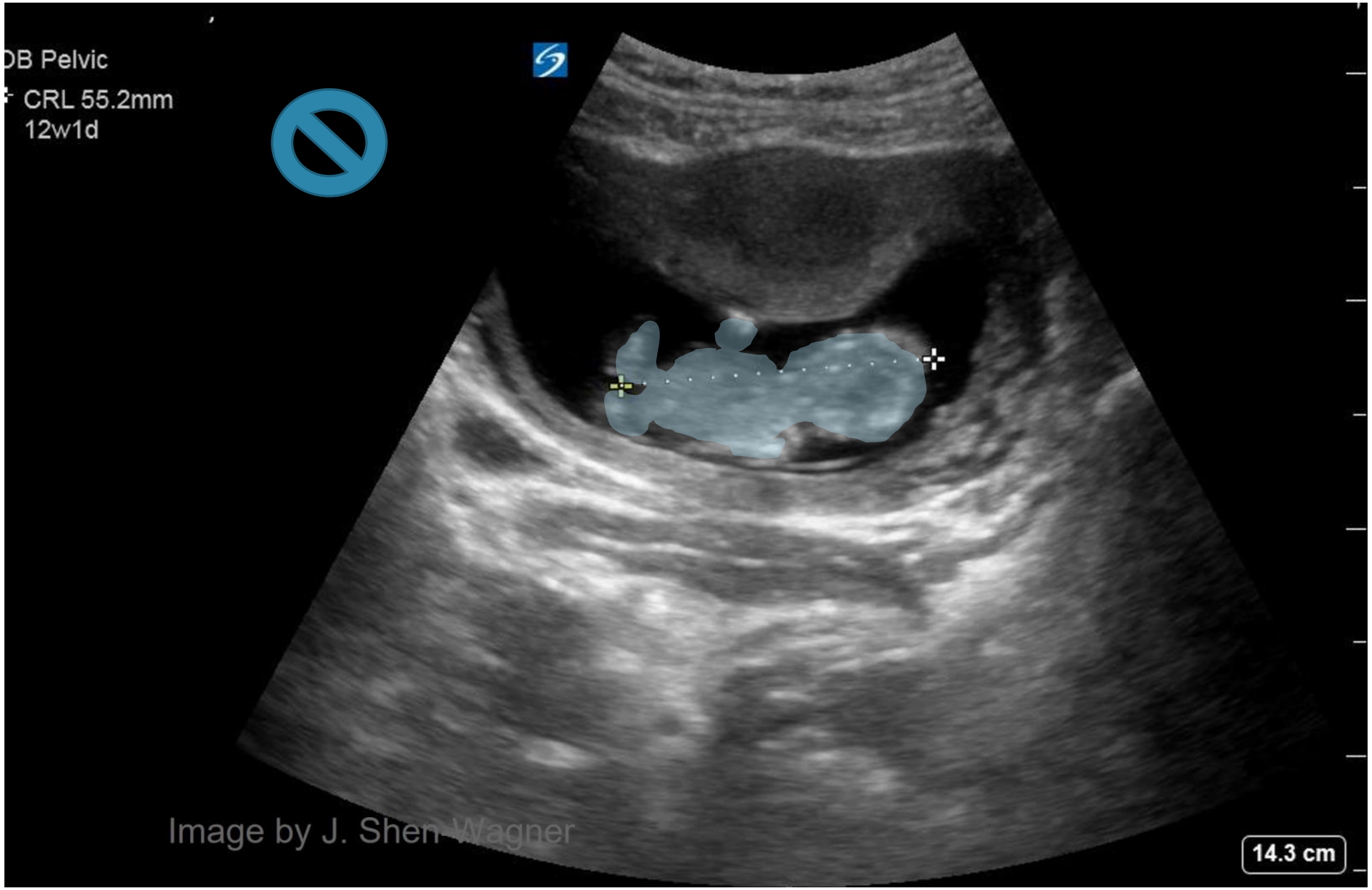


Transverse Plane

CRL- Measure in Sagittal Plane

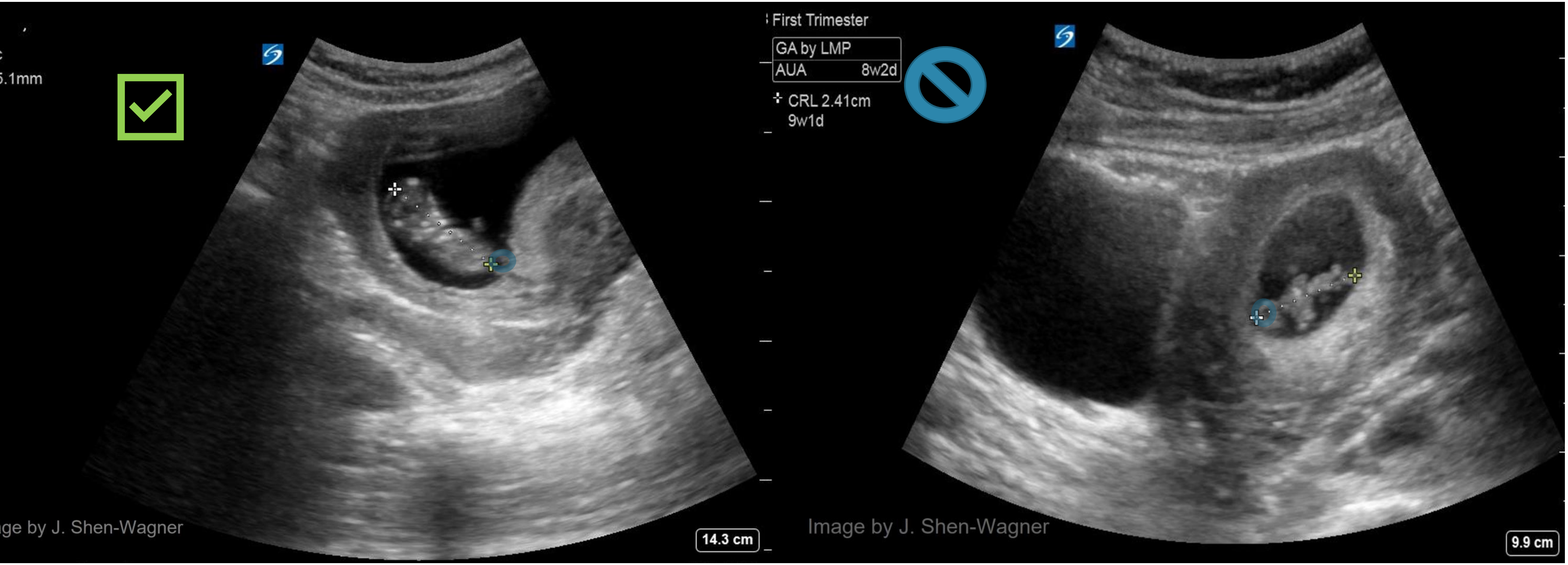


CRL- Measure in Sagittal Plane



Coronal Plane

CRL- Exclude the Yolk Sac



Detecting Cardiac Activity

ACR-ACOG-AIUM-SMFM-SRU

Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound

“A standard obstetrical ultrasound examination in the first trimester includes evaluation of the presence, size, location, and number of gestational sac(s). The gestational sac is examined for the presence of yolk sac and embryo/fetus (a fetus is generally defined as greater than or equal to 10 weeks gestational age) [5]. When an embryo/fetus is detected, it should be measured, and the cardiac activity should be recorded by 2-D video clip or M-mode. The routine use of pulsed Doppler ultrasound to either document or “listen” to embryonic/fetal cardiac activity is discouraged [6,7]. The uterus, cervix, adnexa, and cul-de-sac region should be examined.”

-2018 Practice Parameter for the performance of standard Diagnostic Obstetric Ultrasound Examinations

ALARA

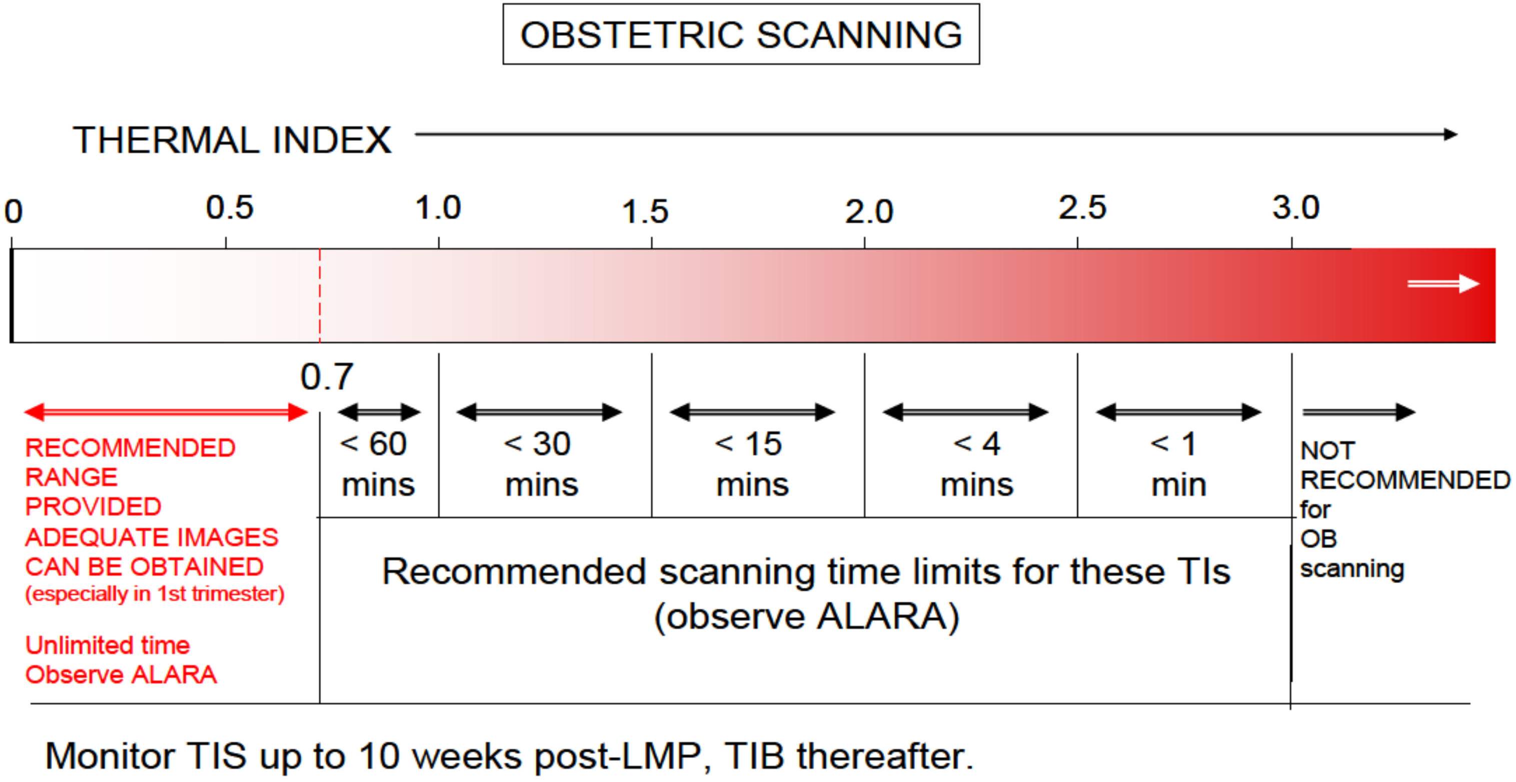


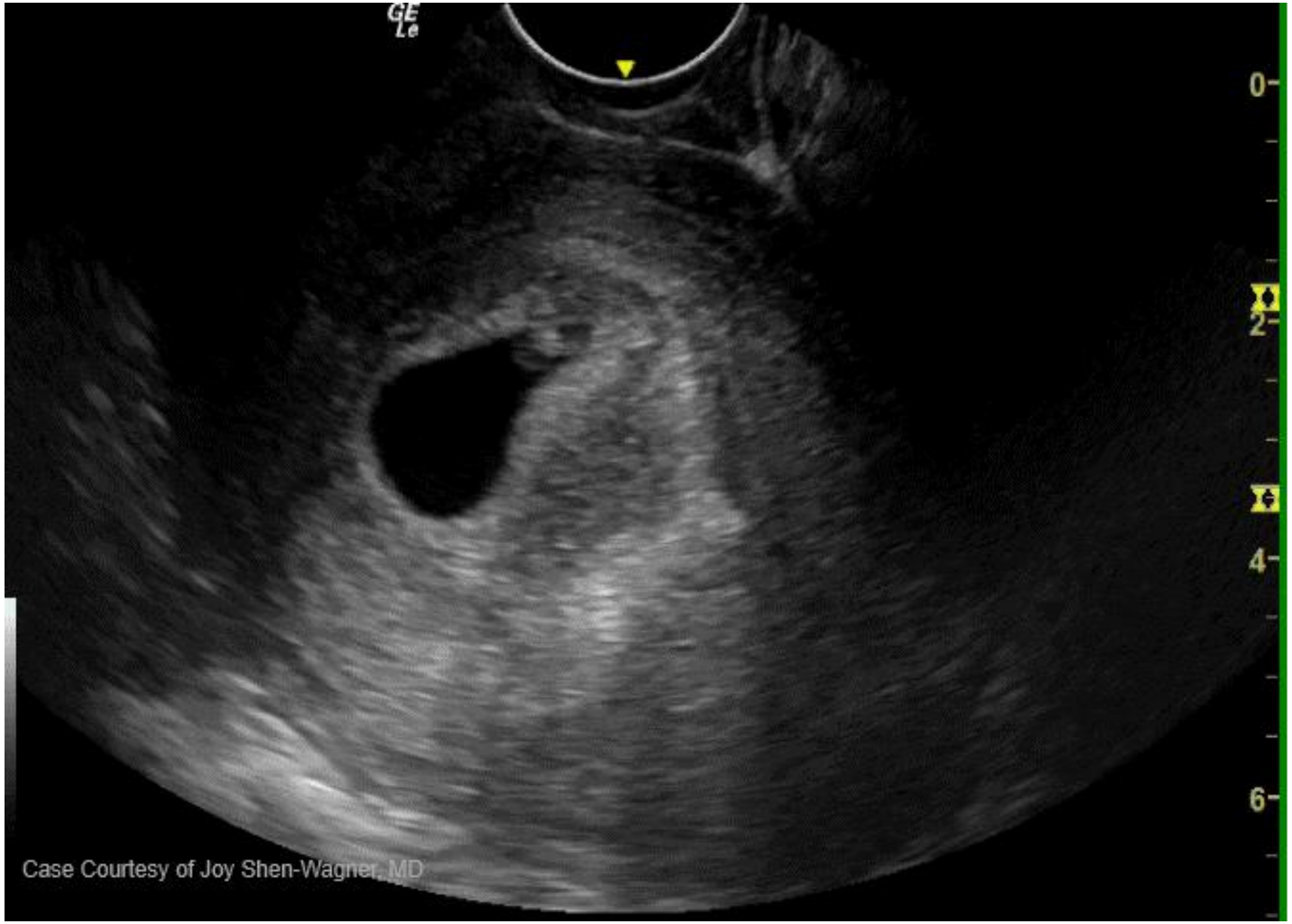
Figure 1. Recommended maximum scanning times for obstetric examinations conducted with different displayed Thermal Indices (TI). Full information on the recommendations for obstetric and non-obstetric examinations can be found in the Detailed Guidelines.

2009 the British Medical Ultrasound Society (BMUS)

aium | Official Statements

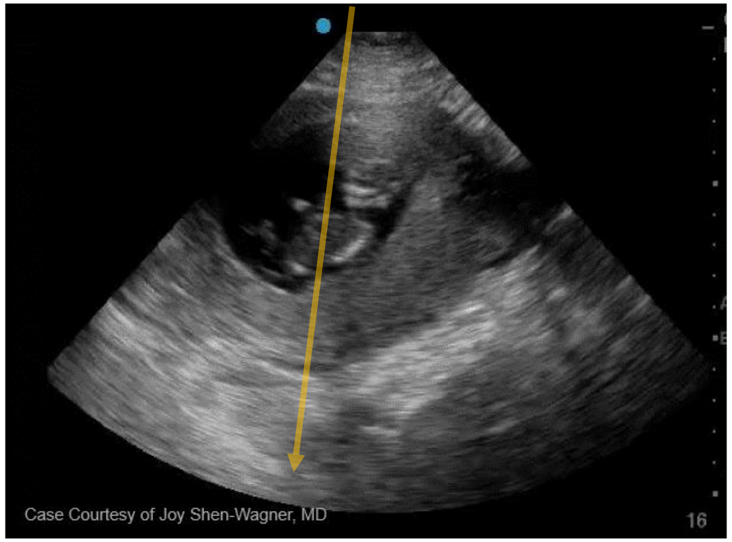
Recommended Maximum Scanning Times for Displayed Thermal Index (TI) Values

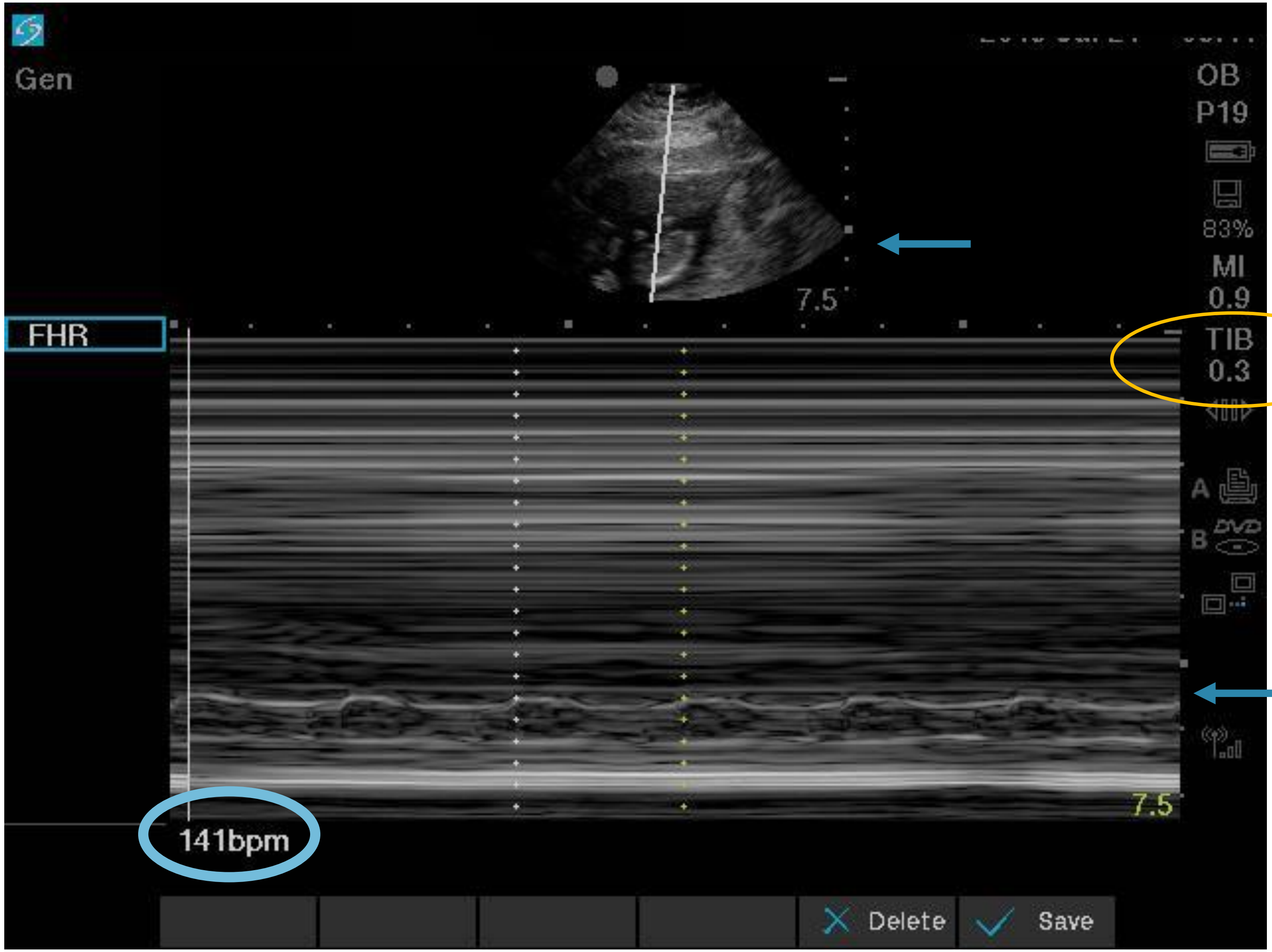
Record Cardiac Activity



Calculate Cardiac Rate

Cardiac Rate and M-Mode





TIB
0.3

Measure Peak to Peak

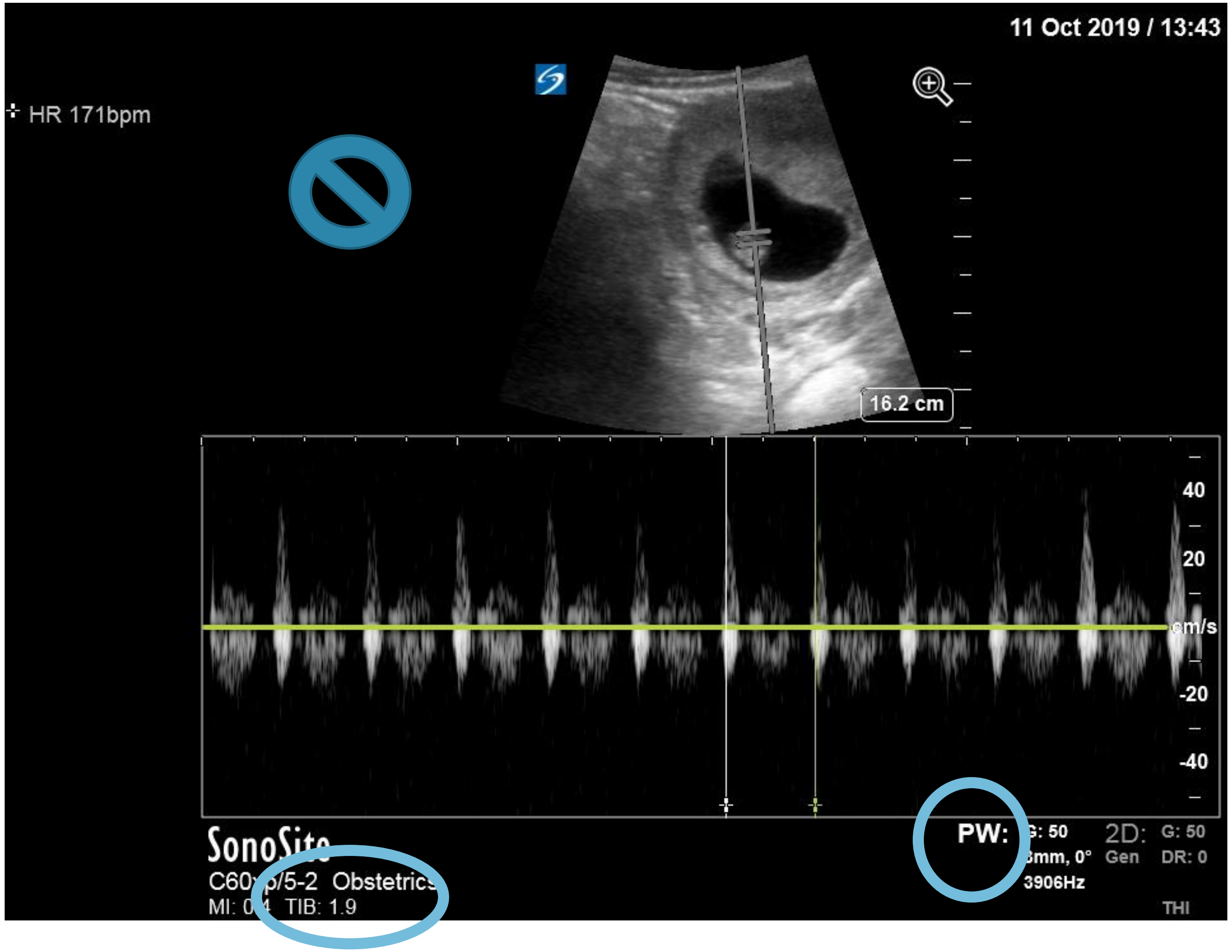
Or

Peak to Next Peak

Avoid Pulse Wave Doppler in First Trimester

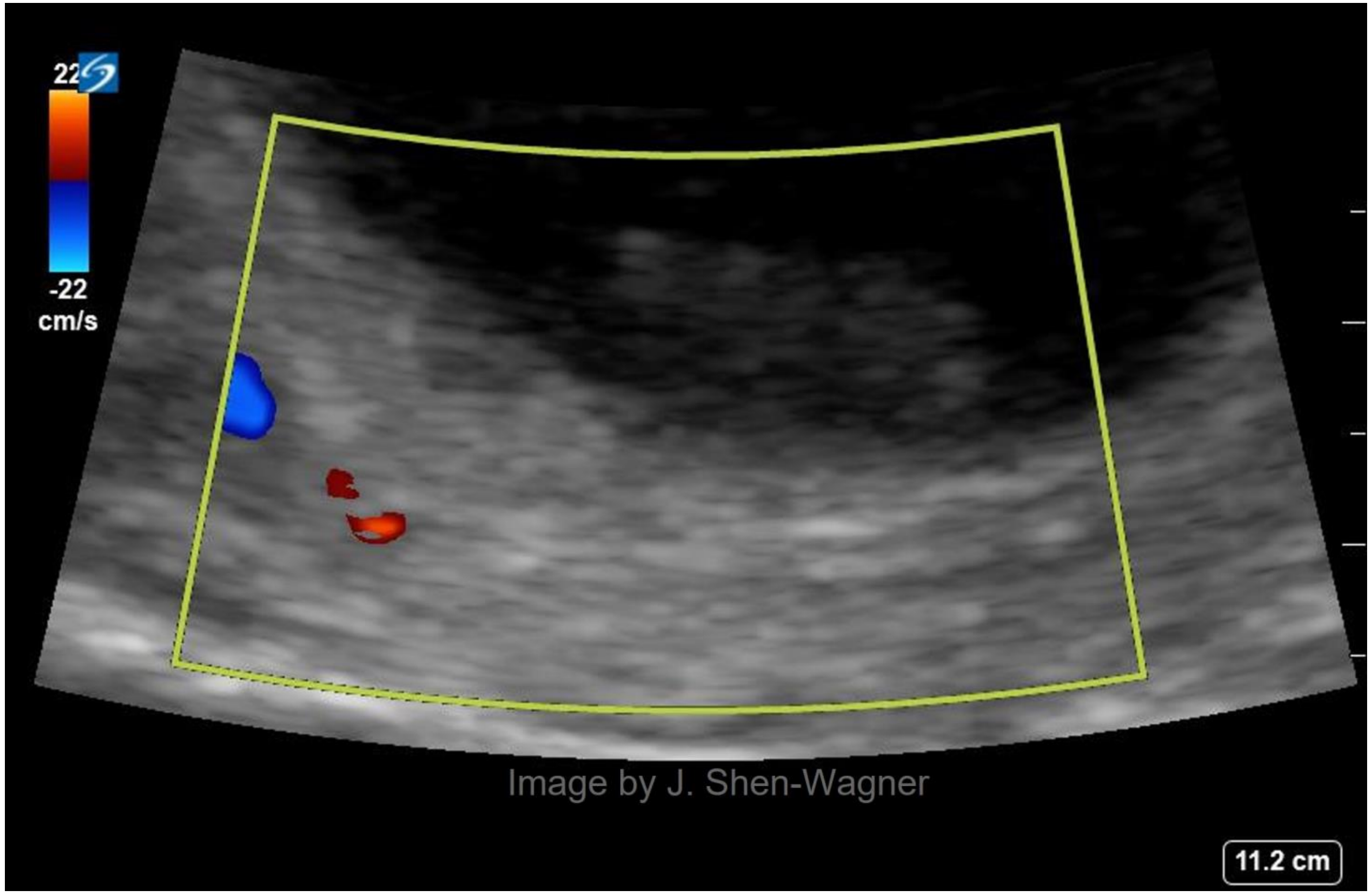
-ALARA Principle:

As Low As Reasonably Achievable



TIB
1.9

Color Flow



Determine Embryo/Fetal Number

Scan through the Uterus

Multiple Gestation

Late First Trimester (12 to <14 weeks)

AAFP CME

Next Steps- Abnormal Pregnancy

- Early pregnancy loss (spontaneous abortion/miscarriage)
- Threatened spontaneous abortion
- Subchorionic hemorrhage
- Ectopic pregnancy
    - (Interstitial, ~~Cornual~~ now Interstitial, Cervical, Cesarian Scar, Tubal, Ovarian)
- Heterotopic pregnancy
- Gestational trophoblastic disease
- First trimester anomalies

CPT Codes

76815 US pregnant Transabdominal Limited

(Early pregnancy dating, vaginal bleeding, ectopic, miscarriage, fetal heartbeat, placenta location)

76816 US Transabdominal limited follow-up

76817 US pregnant Transvaginal

76801 First Trimester Transabdominal US <14 weeks, 1 gestation (1 per pregnancy)

(Not a limited code, comprehensive study)

(If Transvaginal, use 76817)

76802 First Trimester Transabdominal US <14 weeks, each additional gestation (1 per pregnancy)

Documentation

- Document an Indication for the study
- Create an independent report
- Permanent storage of retrievable images
- Follow rules per your institution for credentialing and probe disinfection

Shen-Wagner J, Deutchman M, “POCUS: A Practical Guide for Primary Care,” Family Practice Management. 2020 Nov/Dec;27(6):33-40.

Helpful Resources

AIUM Practice Parameter for the Performance of Limited Obstetric Ultrasound Examinations by Advanced Clinical Providers

https://pubmed.ncbi.nlm.nih.gov/30133848/

©2018 by the American Institute of Ultrasound in Medicine | J Ultrasound Med 2018; 37:1587–1596 | 0278-4297 | www.aium.org

Ultrasound Obstet Gynecol 2018; **52**: 128–139
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.19072

isuog.org GUIDELINES

ISUOG Practice Guidelines: intrapartum ultrasound

Summary

- Obtaining a crown rump length measurement early in pregnancy is the most accurate method for confirming or establishing gestational age. (SORT A)
- Ultrasound detects multiple gestation pregnancies early! (SORT A) Don't forget to fan through. If you find two, look for a third!
- The yolk sac is the first definitive confirmation of an intrauterine pregnancy, essentially ruling out ectopic pregnancy outside (outside of assisted reproductive therapy). (SORT C)
- M-mode is the preferred method to document cardiac activity over pulse wave doppler. (SORT C)

Additional Resources

Lazarus, Elizabeth and Deborah Levine. “The First Trimester” in *Diagnostic Ultrasound* (Elvesier, 2018). Chapter 30, 1048-1087.

Doubilet PM, Benson CB, Bourne T, et al. Diagnostic Criteria for nonviable pregnancy early in the first trimester. N Engl J Med. 2013;369(15):1443-1451.

ISUOG: https://www.isuog.org/education/learning-modules.html

UCSD: https://emultrasound.sdsc.edu/index.php/curriculum-2/pregnancy/

References/Resources

- ACR-ACOG-AIUM-SMFM-SRU-2018 Practice Parameter for the performance of standard Diagnostic Obstetric Ultrasound Examinations
- AIUM. Official Statements: Guidelines for cleaning and preparing external- and Internal- Use Ultrasound Tranducers and Equipment Between Patients as well as Safe Handling and Use of Ultrasound Coupling Gel.
- Casalegno JS, Le Bail Carval K, Eibach D, et al. High risk HPV contamination of endocavity vaginal ultrasound probes: an underestimated route of nosocomial infection? *PLoS One* 2012; 7:e48137.
- Committee Opinion No. 700 Summary: Methods for Estimating the Due Date Obstetrics & Gynecology: May 2017 - Volume 129 - Issue 5 - p 967-968
- Kac G, Podglajen I, Si-Mohamed A, et al. Evaluation of ultraviolet C for disinfection of endocavitary ultrasound transducers persistently contaminated despite probe covers. *Infect Control Hosp Epidemiol* 2010; 31:165–170.
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- Lazarus, Elizabeth and Deborah Levine. “The First Trimester” in *Diagnostic Ultrasound* (Elvesier, 2018). Chapter 30, 1048-1087.
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- Rooks VJ, Yancey MK, Elg SA, Brueske L. Comparison of probe sheaths for endovaginal sonography. Obstet Gynecol. 1996 Jan;87(1):27-9.
- Sartoretti T, Sartoretti E, Bucher C, et al. Bacterial contamination of ultrasound probes in different radiological institutions before and after specific hygiene training: do we have a general hygienical problem? *Eur Radiol* 2017; 27:4181–4187.
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- Whitworth M, Bricker L, Mullan C. Ultrasound for fetal assessment in early pregnancy. Cochrane Database Syst Rev. 2015 Jul 14;2015(7):CD007058.

Thank You!

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Join the AAFP POCUS MIG

https://www.aafp.org/membership/welcome-center/involve/connect/mig.html

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AAFP CME

Limited Obstetric Ultrasound in Labor and Delivery

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Disclosure Statement

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Learning Objectives

1. Recognize the difference between a limited ultrasound examination of the type performed intrapartum in labor and delivery to answer a specific question and a standard antepartum sonogram .
2. Review the “5 P’s” of L&D ultrasound to identify fetal **presentation**, fetal heart rate (**pulse**), **placental** location, AFI (**pocket**), fetal number (**para)**
3. Identify imaging both normal and clinically significant variants of the 5 P’s
4. Demonstrate methods of calculating amniotic fluid index (AFI)

Difference between a Limited Intrapartum and the Standard Antepartum Sonogram

- In the labor and delivery setting, a limited point of care scan is performed to answer specific questions needed for clinical care. This is the type scan that is the subject of this module.
- Standard antepartum ultrasound examinations include:
  - ✓ Complete biometry of standard structures
  - ✓ Growth assessment
  - ✓ Complete fetal anatomic survey appropriate for gestational age
  - ✓ Placenta, fluid, maternal structures
  - ✓ Comparison to previous scans
  - ✓ Written report including stored images

ALARA Principle and Thermal Index Reminder

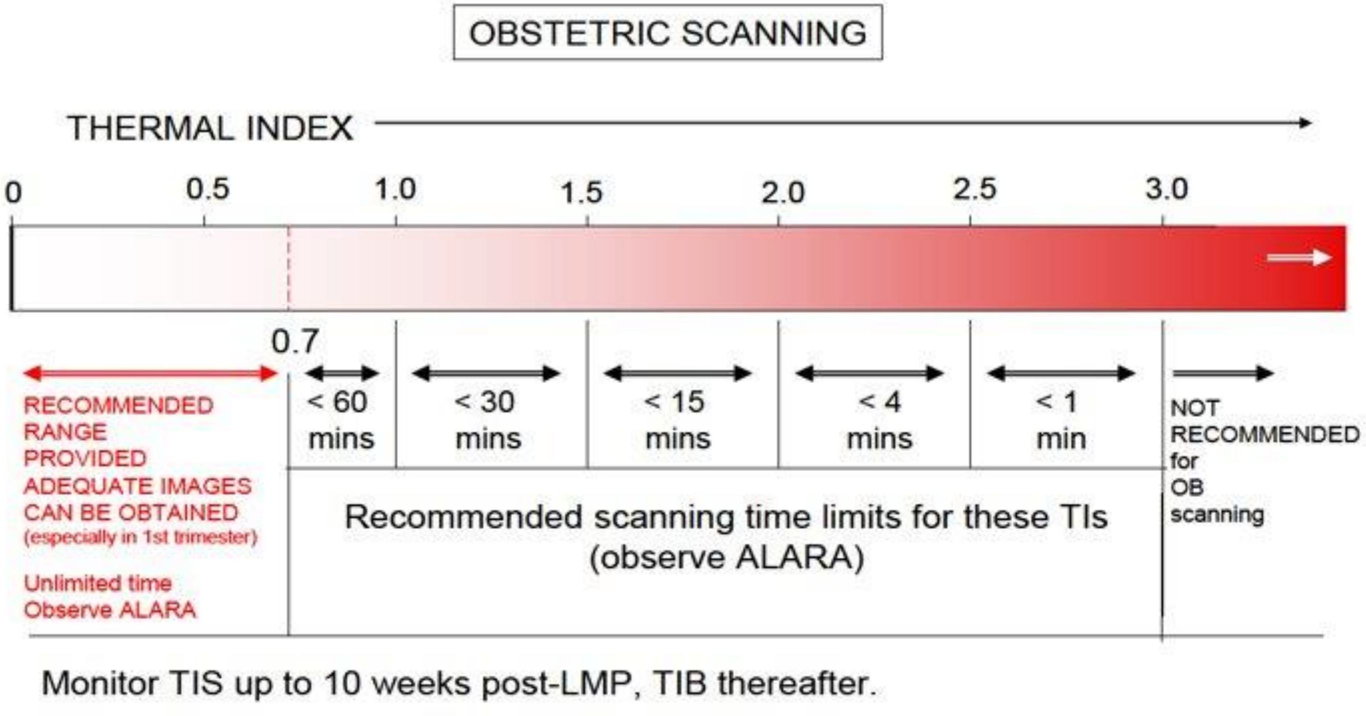


Figure 1. Recommended maximum scanning times for obstetric examinations conducted with different displayed Thermal Indices (TI). Full information on the recommendations for obstetric and non-obstetric examinations can be found in the Detailed Guidelines.

2009 the British Medical Ultrasound Society (BMUS)

Clinical Case Scenario

A 24-year-old patient in their third trimester with limited prenatal care presents to OB triage reporting decreased fetal movement and minimal vaginal leakage of clear fluid. Using limited labor and delivery ultrasound techniques how could this patient be rapidly assessed for clinical intervention?

Clinical Application : Limited Labor and Delivery Ultrasonography: 5 P's

- Fetal life (Pulse)
- Fetal number (Parity)
- Fetal position and presentation
- Amniotic fluid assessment by amniotic fluid index or largest vertical pocket
- Basic placental location

Introduction to Scanning

1. Patient Setup
2. Probe selection
3. Preset
4. Probe position
5. Planes of cut (orientation)
6. Protocol

Challenges in Late Pregnancy Ultrasound

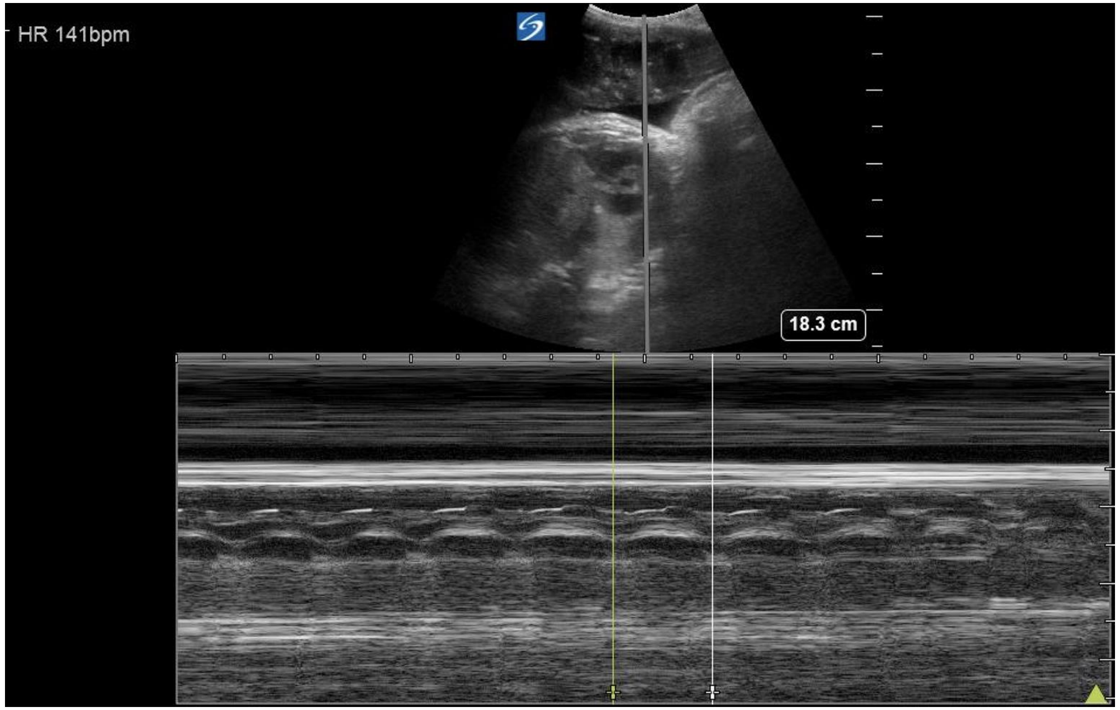
- Pressure of uterus on vena cava
  - Use lateral pelvic tilt to prevent nausea and fainting due to supine hypotension
- Physical crowding
- Low station of presenting part, shadowed by pubic symphysis
- Oligohydramnios: either physiologic or after rupture of membranes (ROM)
- Pain of active labor may limit the ability to complete the examination.

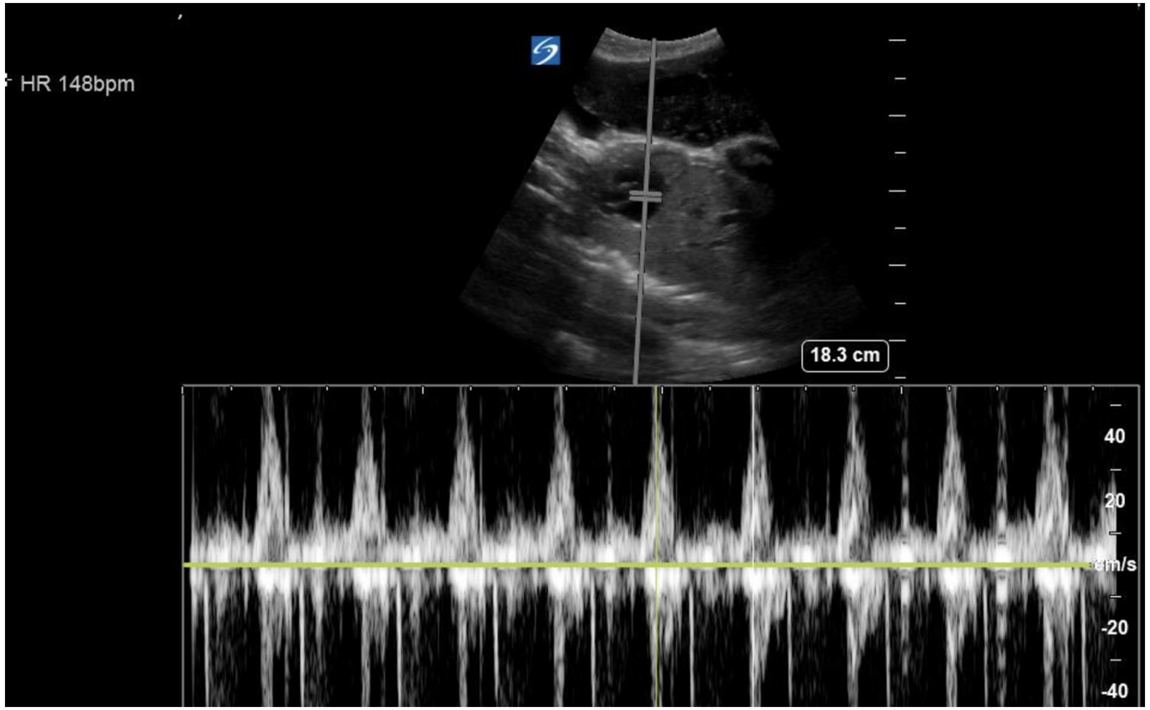
1. Fetal Life (Pulse)

- Requires observation of fetal cardiac motion
- Supported by fetal body and limb motion
- If in doubt, obtain consultation

http://www.aium.org/resources/guidelines/obstetric.pdf

M-Mode and Pulse Wave Doppler



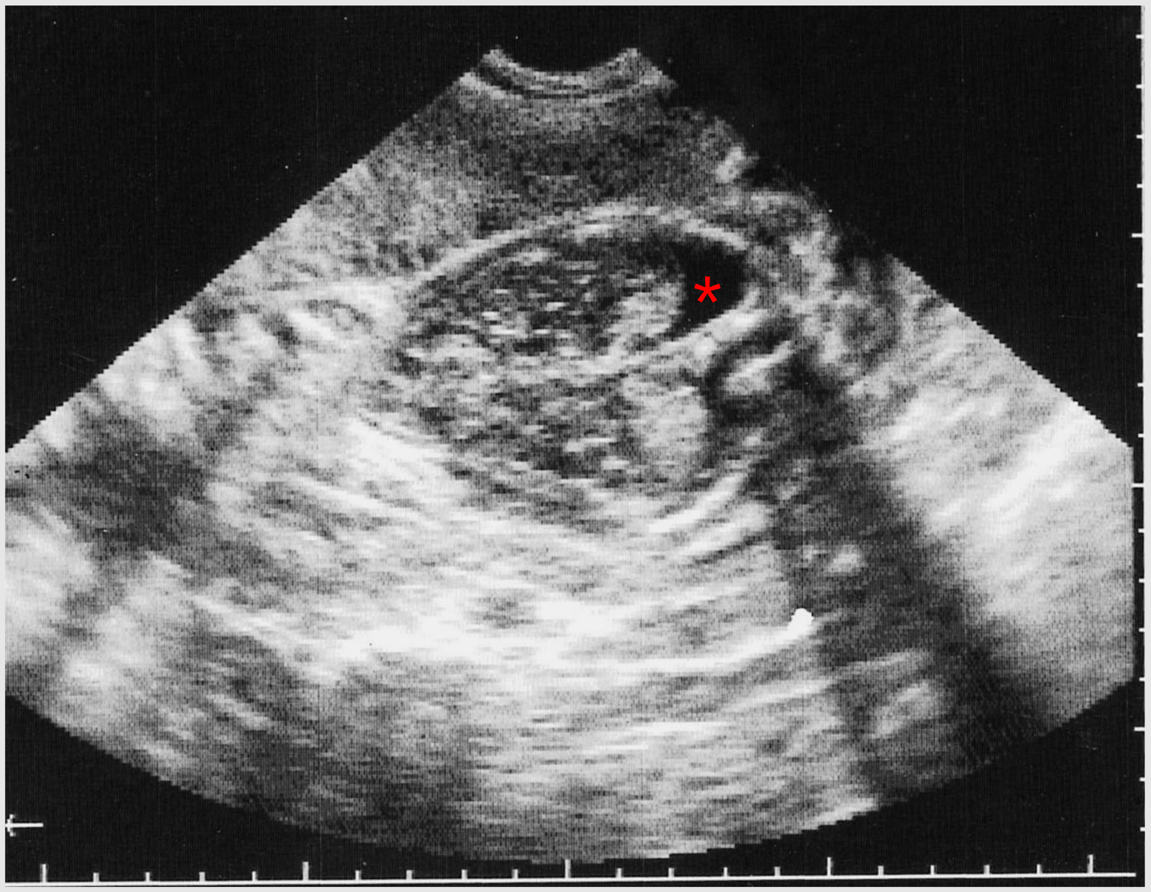


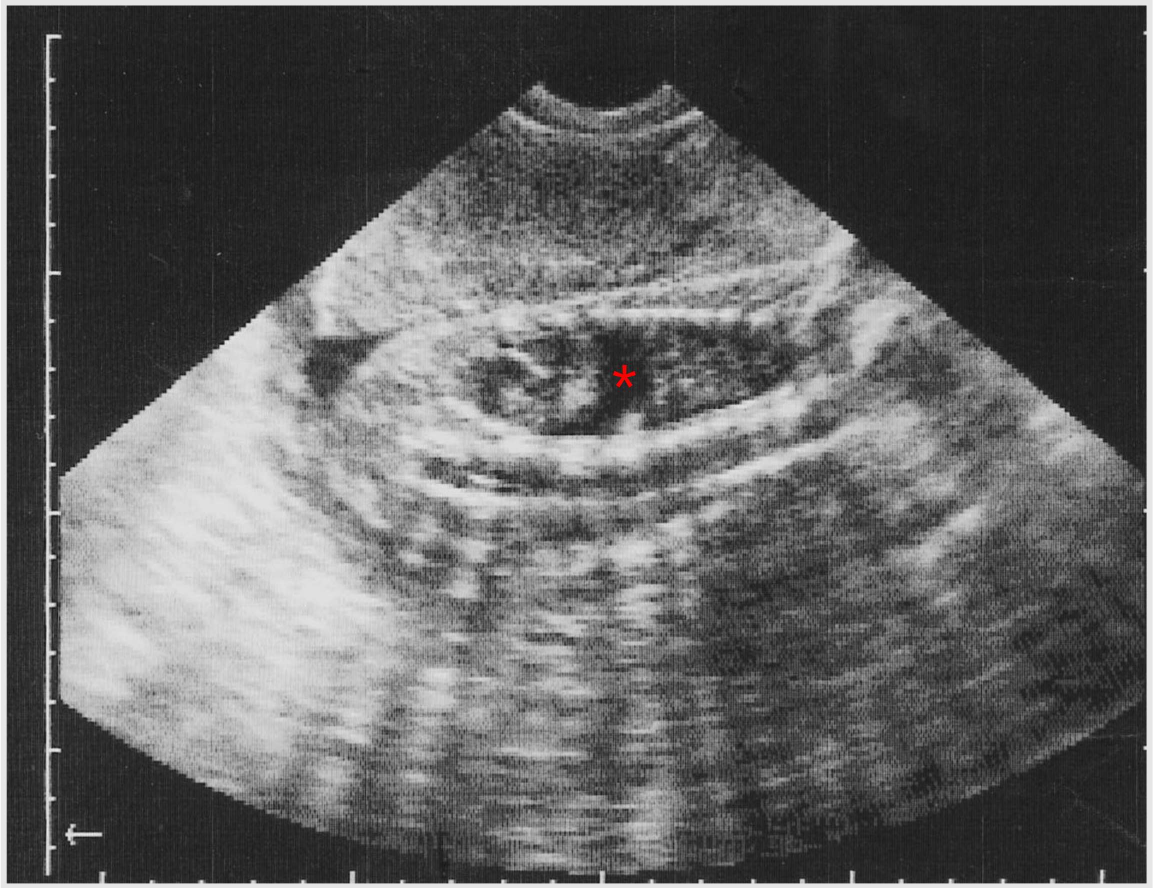
Images credit: Joel Amidon MD

Features of Fetal Demise

- No cardiac motion
- No fetal movement
- Hydropic changes
  - edema, pleural/pericardial effusion, placental edema
- Abnormal lie
- Overlapping skull bones
- Oligohydramnios

Oligohydramnios with Hydropic Changes





Images credit: Mark Deutchman MD

2. Fetal Number (Parity)

- Requires thorough search of all quadrants
- Best done in both sagittal and transverse planes
- Possible errors
  - A small, demised twin (stuck twin)
  - Viewing the same structure from different angles
- If diagnosis is uncertain, obtain consultation
- If find two, look for three (or more)!

Twins: Two Separate Heads

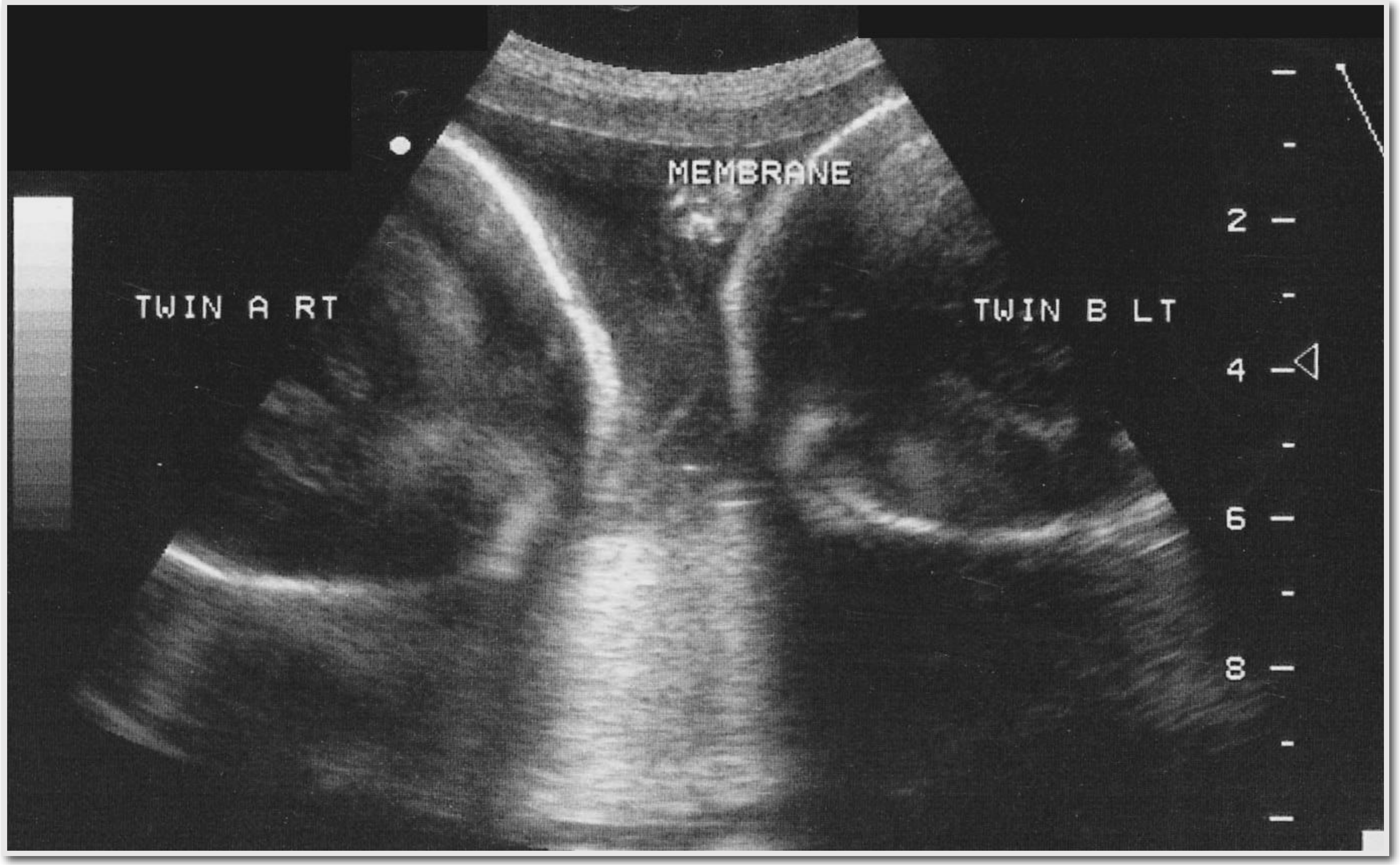


Image credit: Mark Deutchman MD

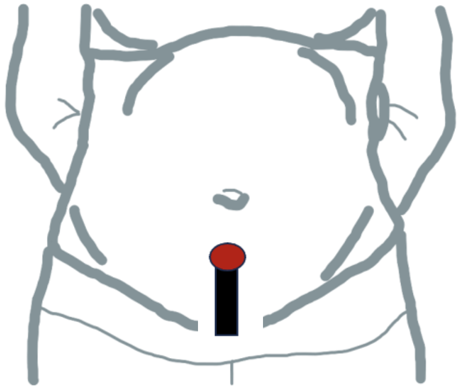
Twin Gestation Video

Video credit: Andrew Lane, MD

3. Fetal Presentation

- Lie
  - Orientation of the fetal spine to the maternal spine (eg.,longitudinal or transverse)
- Presentation
  - Fetal part over the pelvic inlet (eg., cephalic, breech)
- Position
  - Orientation of presenting part to the maternal pelvis (eg., Left Occiput Anterior (LOA), Right Occiput Posterior (ROP) etc.)

Cephalic Presentation- Sagittal plane



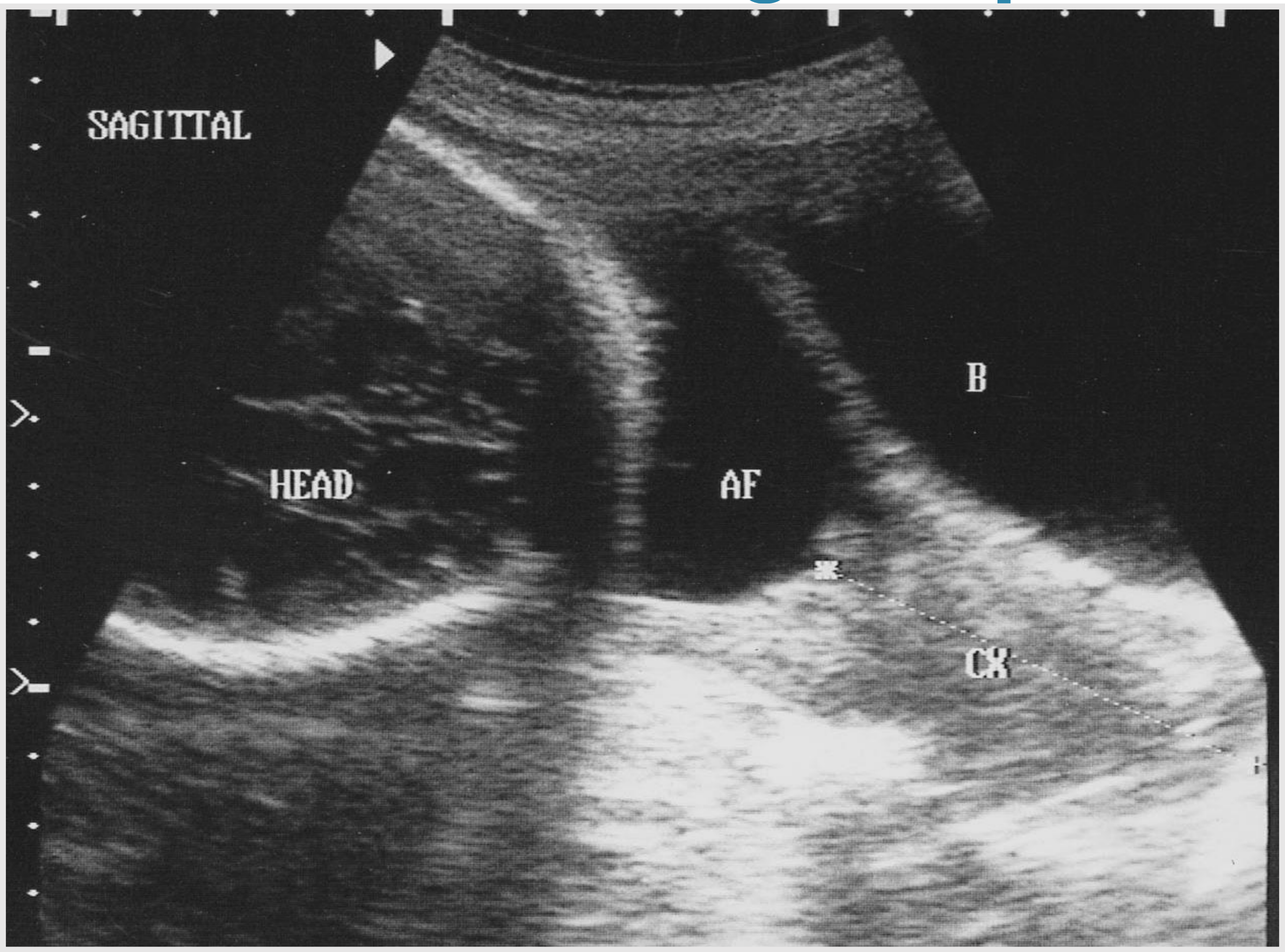
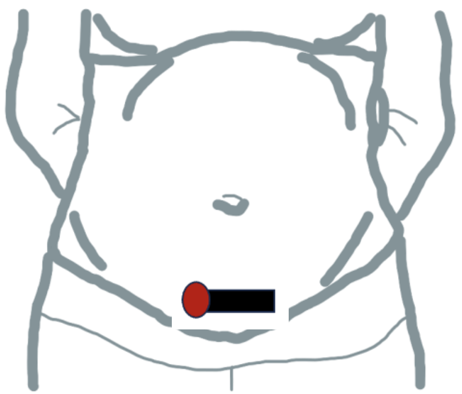


Image credit: Mark Deutchman MD

Cephalic Presentation- Transverse



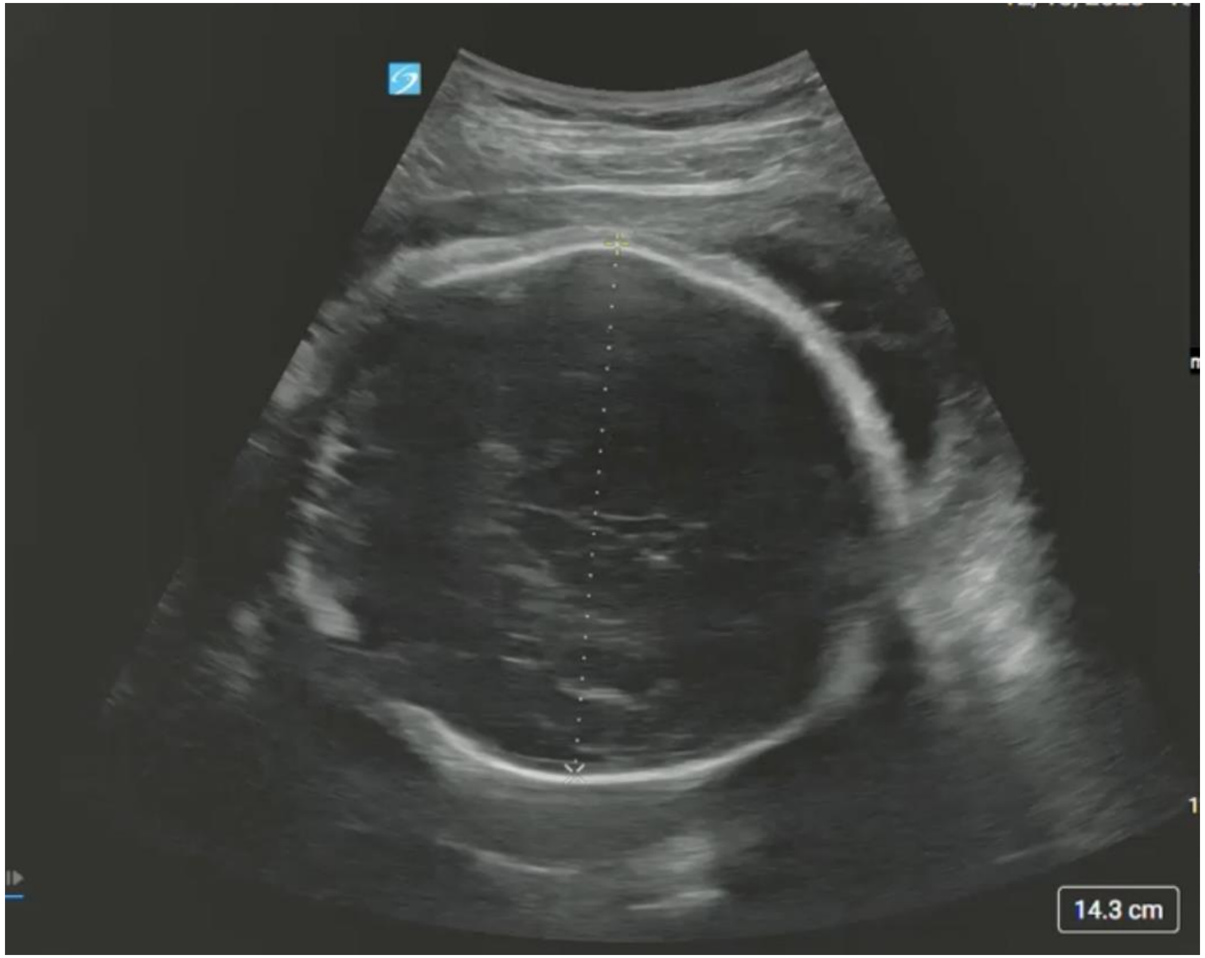
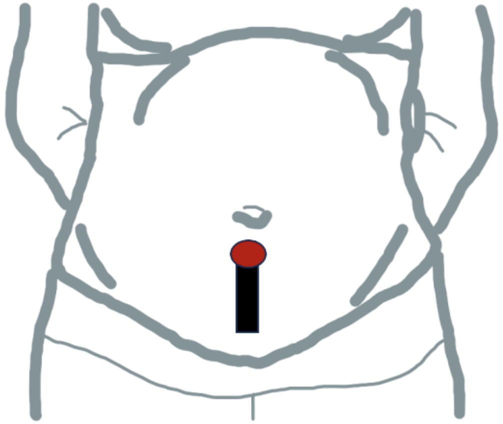


Image credit: Joel Amidon MD

Breech Presentation



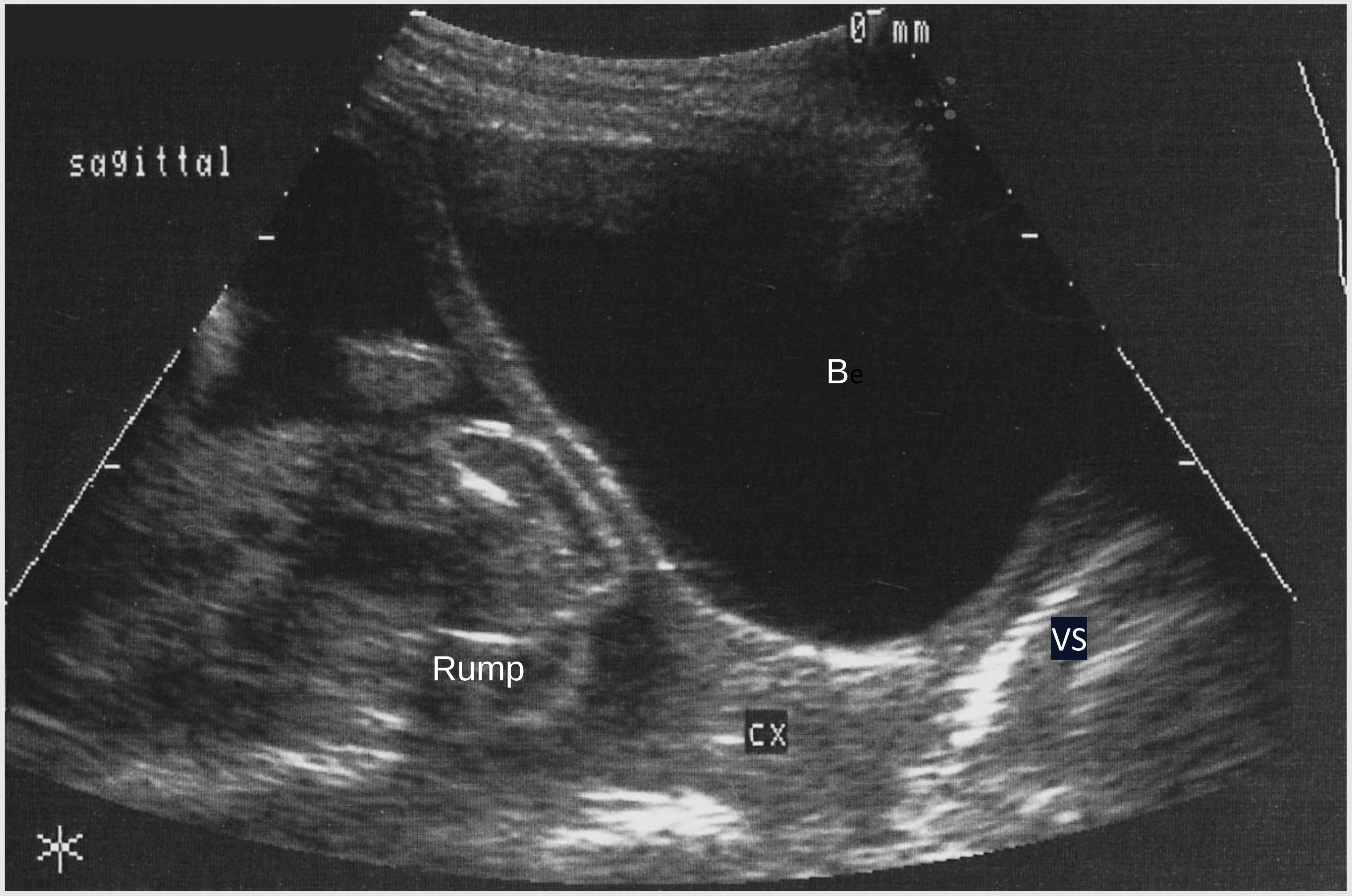
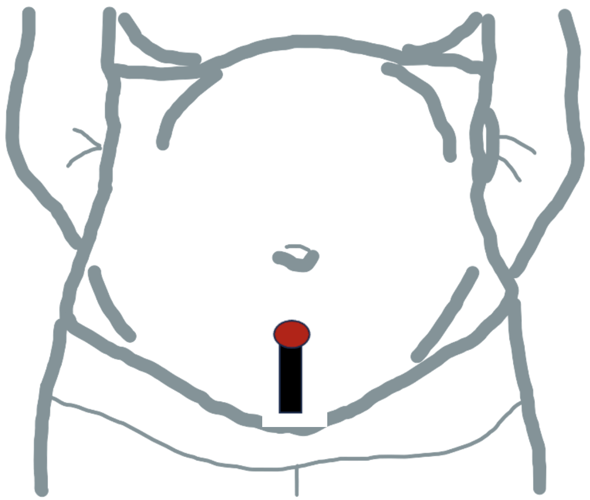


Image credit: Mark Deutchman MD

Cord Presentation



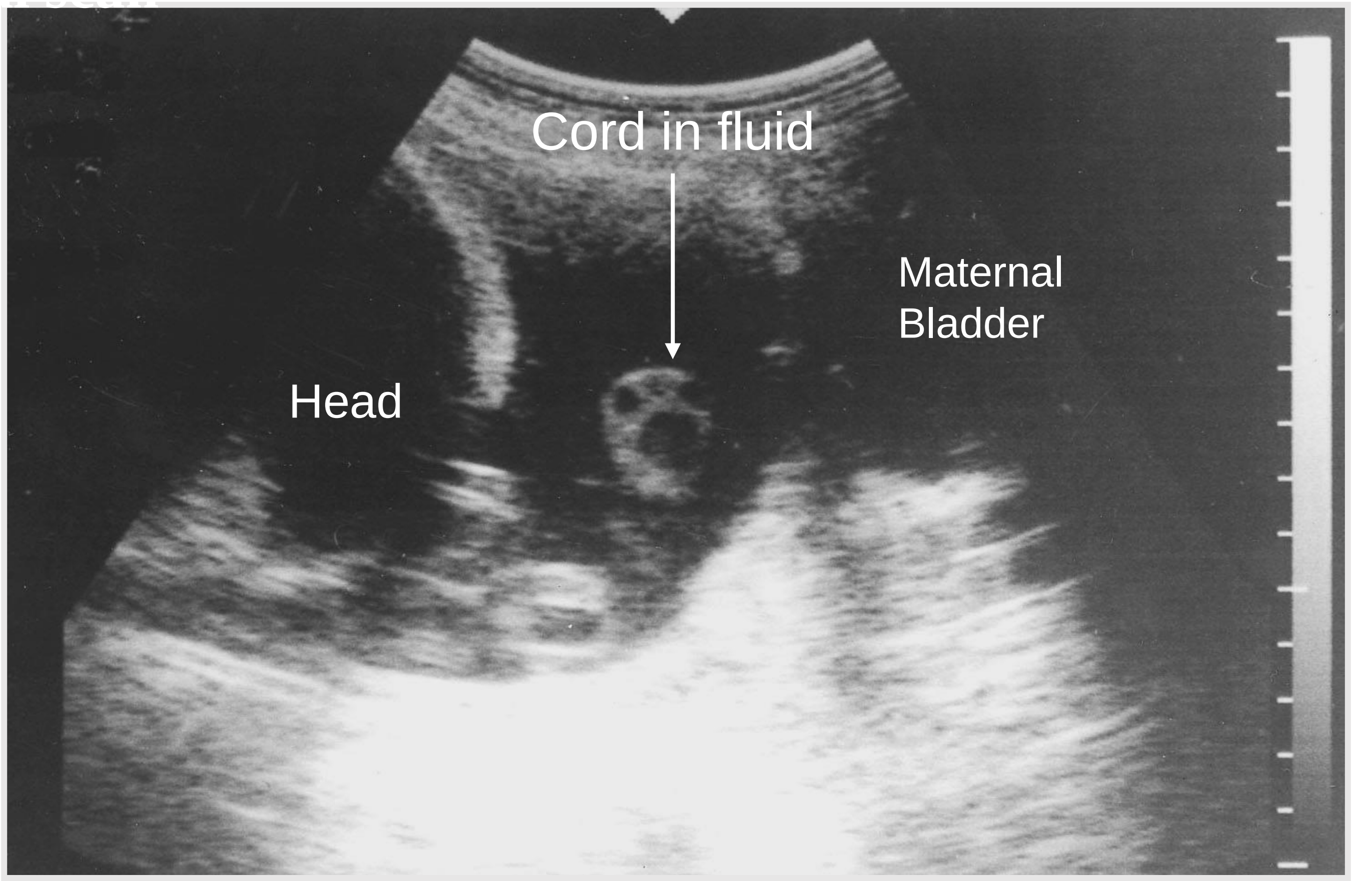
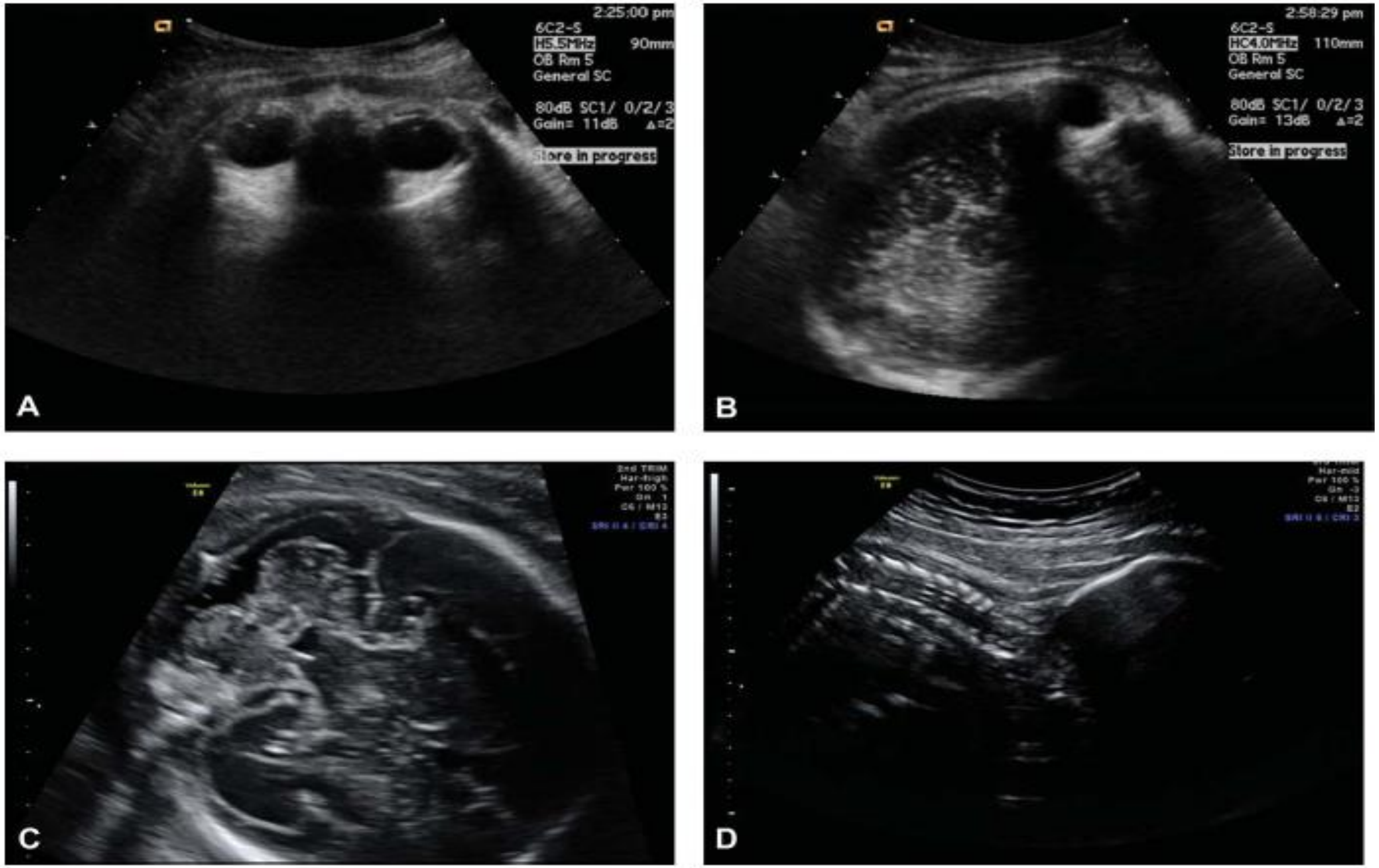


Image credit: Mark Deutchman MD

Fetal head position



Barth WH Jr. Persistent occiput posterior. Obstet Gynecol. 2015;125(3):695-709.

4. Fluid assessment (Pockets)
Amniotic Fluid Index (AFI)

- Divide abdomen into 4 quadrants using umbilicus as the center
- Measure vertical depth of greatest pocket of fluid in each quadrant avoiding cord & limbs
- Sum the 4 measurements
  - <5 cm = oligohydramnios
  - 5 to 8 cm = borderline oligohydramnios
  - 8 to 20 cm = normal AFI
  - >20 cm = polyhydramnios

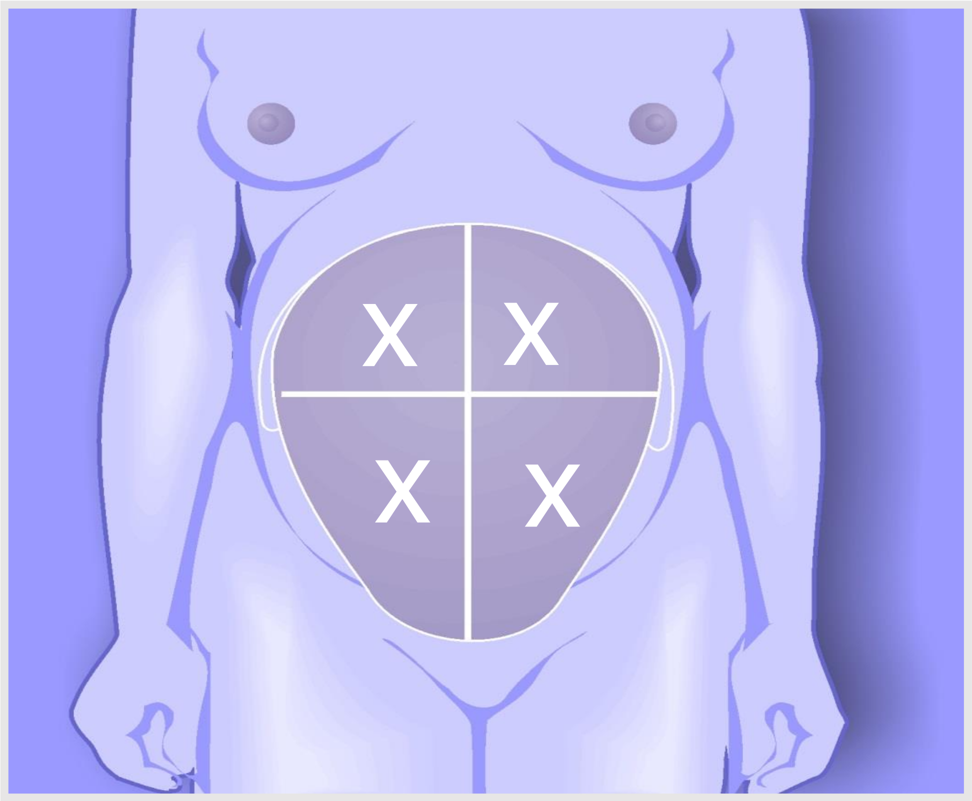


Image credit: AAFP ALSO Program, L&D US chapter slide #

Amniotic Fluid Index

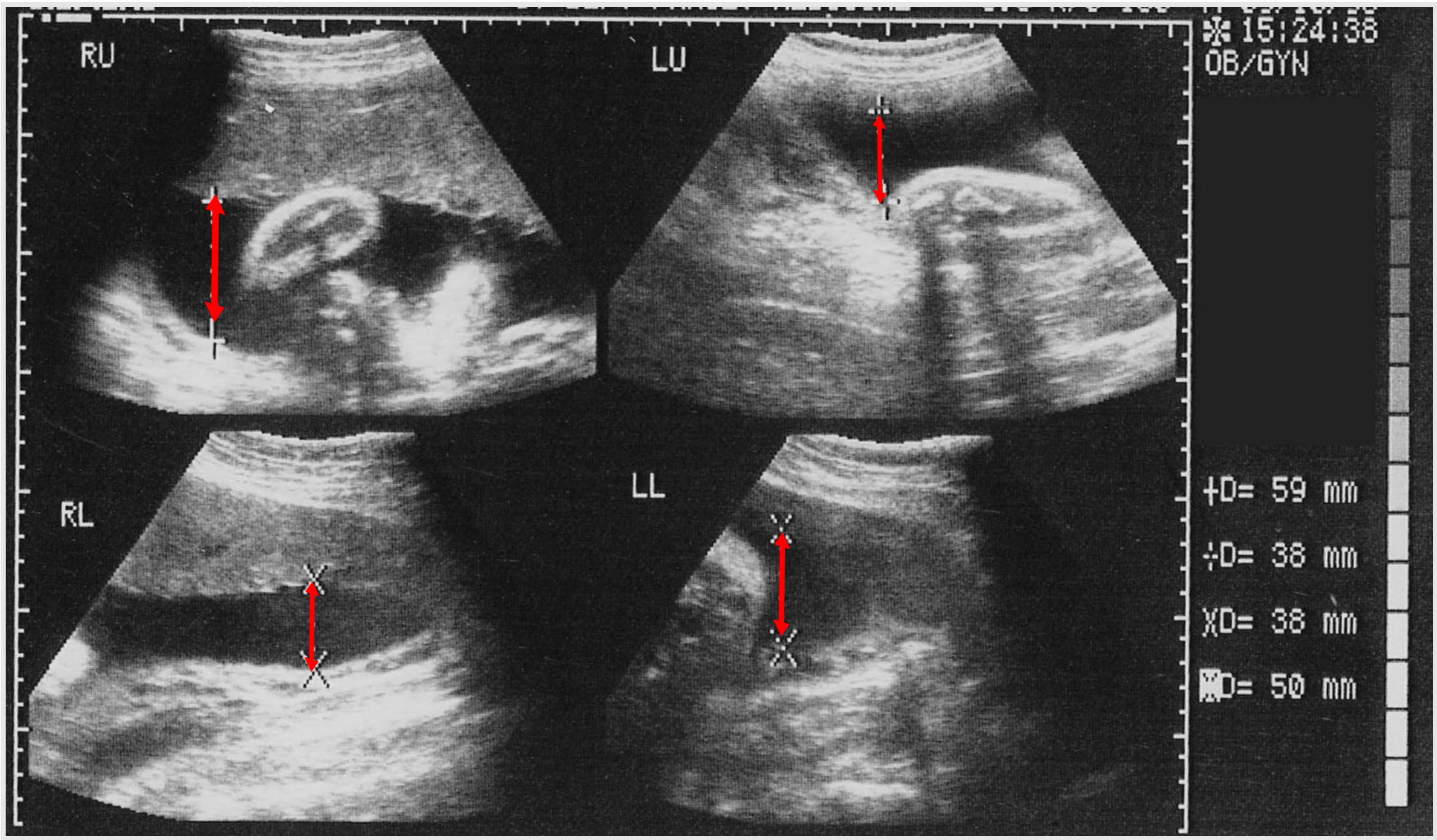


Image credit: Mark Deutchman MD

Amniotic Fluid Assessment: Maximum Vertical Fluid Pocket

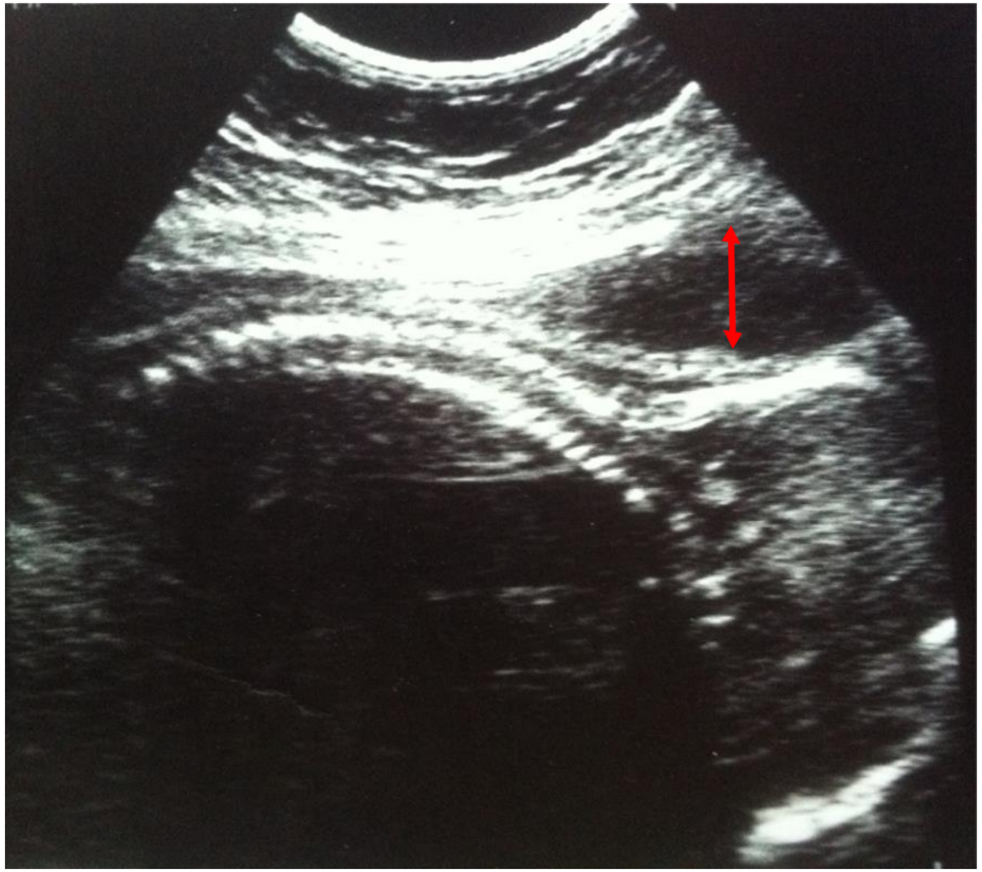


Image credit: Mark Deutchman MD

Late third trimester scan showing fetal spine and head with small fluid pocket in neck area shown by red arrow.

Polyhydramnios: Fetus Floating Free or Touching Only One Side of Uterus - AFI > 20 cm

Image credit: Mark Deutchman MD

Oligohydramnios fetus extremely crowded AFI<5cm or MVP <1cm

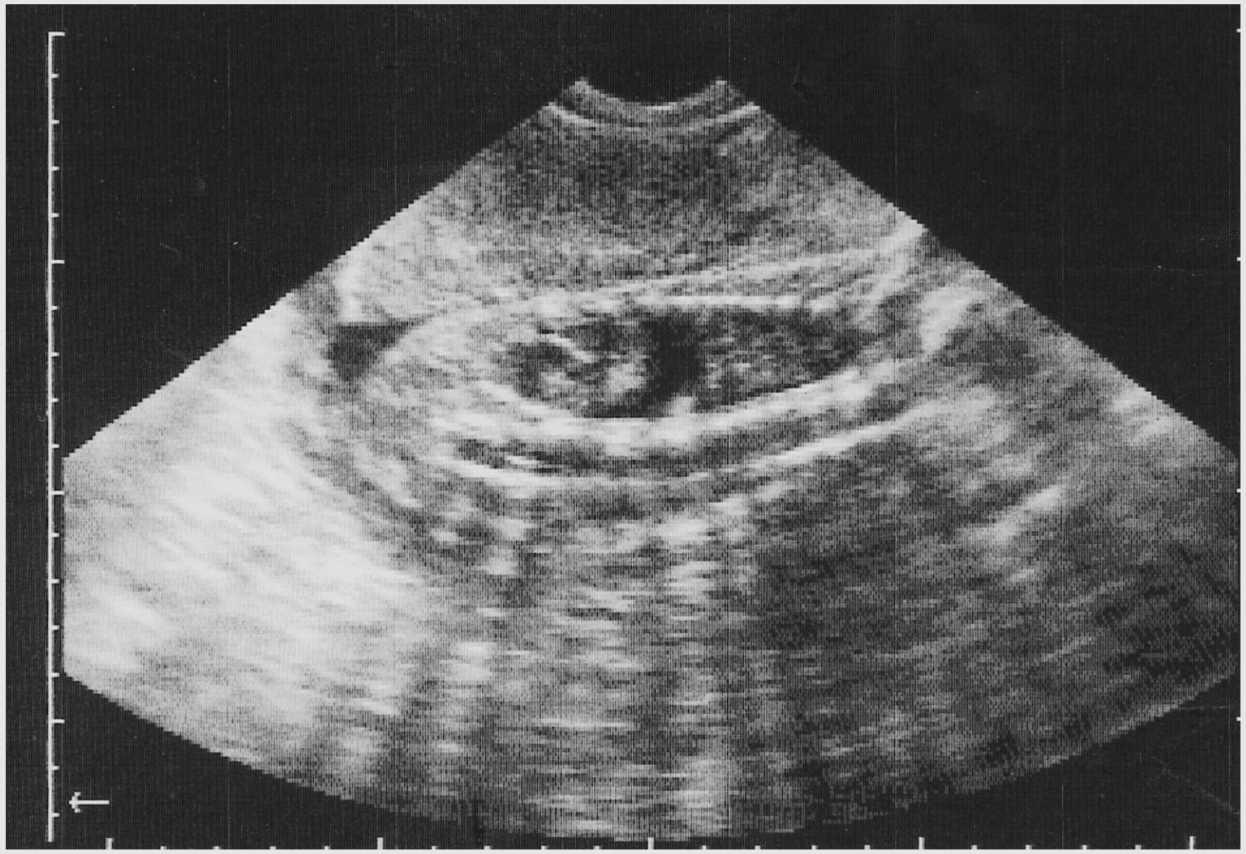


Image credit: Mark Deutchman MD

5. Placental Location

- Requires multiple views searching entire uterus.
- Detailed assessment of placenta location requires advanced skills to assess:
  - Bleeding
  - Placenta previa
  - Placental abruption
  - Low anterior placenta if cesarean delivery is planned
- Consultation and additional imaging (e.g. MRI) may be required

Normal Placenta

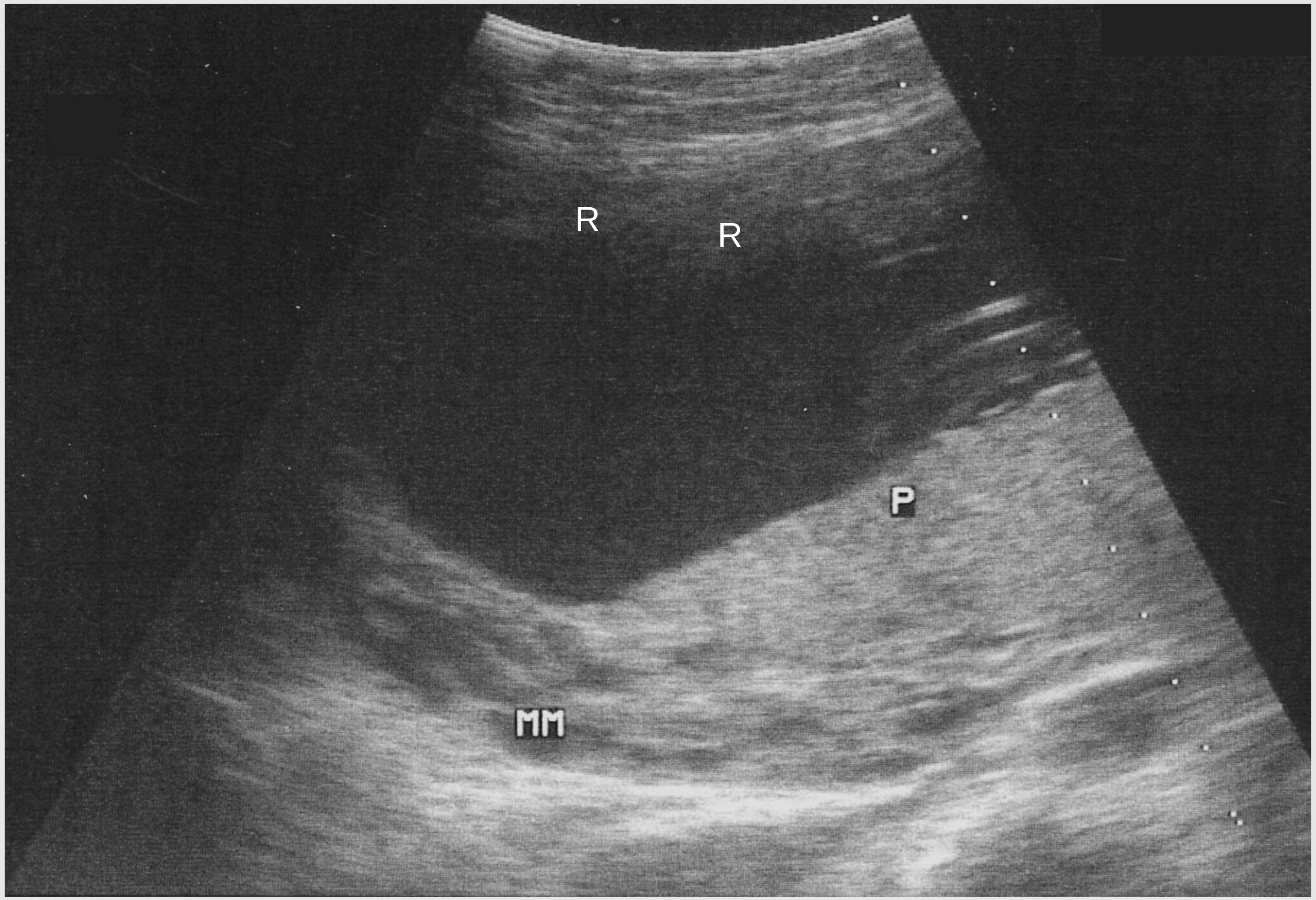


Image credit: Mark Deutchman MD

Posterior Fundal Placenta Video- Sagittal

Video credit: Joel Amidon MD

Placenta Previa –Sagittal trans-perineal

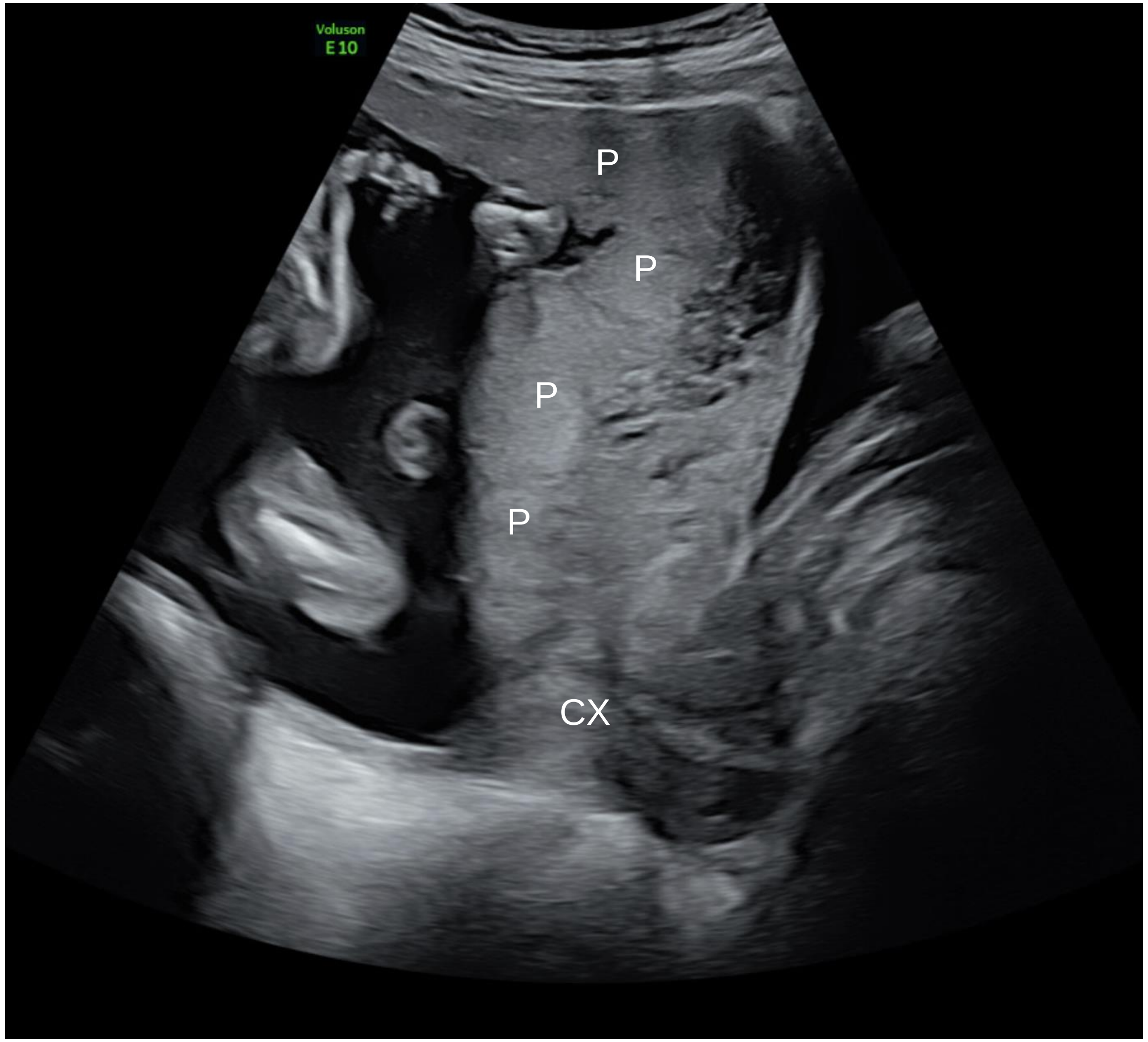


Image credit: Andrew Lane MD

Placental Abruption

- Retroplacental appearance:
  - Fresh blood: anechoic
  - After clot: more echogenic
- **Negative scan should not alter clinically indicated intervention**

Practice Recommendations

- L&D point-of-care scanning can rapidly answer specific questions pertaining to:
  - Fetal life, number, presentation, fluid assessment, and basic placental location
- Abruption and previa diagnosis are advanced skills
- Ultrasound cannot rule out abruption
- Skills required for performance of the standard exam exceed those required for the limited exam
  - Fetal survey
  - Fetal biometry
  - Placental location

Limited OB ultrasound coding

- CPT code: 76815
- ICD 10 codes: Use appropriate clinical diagnosis code

Evidence and Clinical Guidelines (SORT)

1. Routine ultrasound scanning before 24 weeks improves recognition of clinically unsuspected multifetal pregnancy. (Grade A, Reference 1)

2. Routine ultrasound scanning after 24 weeks in unselected low-risk patients does not reduce perinatal mortality. (Grade A Reference 2)

3. Maternity care clinicians can learn the basic sonographic skills in a short time. Sonographic applications including fetal biometry, anatomic survey, examination for placental abruption and previa, and assessment of the cervix are extended skills that require significantly more study and practice than the basic skills. (Grade C, References 11-13)

More learning resources

OB: MedicalAidFilms: The Basic Steps of an Obstetrical Ultrasound (https://www.medicalaidfilms.org/film/the-basic-steps-of-an-obstetric-ultrasound-examination/)

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10. Salomon LJ, Alfirevic Z, Berghella V, Bilardo CM, Chalouhi GE, Da Silva Costa F, Hernandez-Andrade E, Malinger G, Munoz H, Paladini D, Prefumo F, Sotiriadis A, Toi A, Lee W, on behalf of the ISUOG Clinical Standards Committee. ISUOG Practice Guidelines (updated): performance of the routine mid-trimester fetal ultrasound scan. *Ultrasound Obstet Gynecol* 2022; 59: 840–856.
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12. Smith CB, Sakornbut EL, Dickinson LC, Bullock GL. Quantification of training in obstetrical ultrasound: a study of family practice residents. J Clin Ultrasound. 1991;19(8):479-483.
13. Rodney WM, Deutchman ME, Hartman KJ, Hahn RG. Obstetric ultrasound by family physicians. J Fam Pract. 1992;34(2):186-194, 197-200.

Thank you

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Practice Management

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Learning Objectives

1. Define certification, accreditation and credentialing as they pertain to point-of-care ultrasound.
2. Identify documentation requirements for point-of-care ultrasound billing.
3. Review the different codes and reimbursement rates used in point-of-care ultrasound billing.

Credentialing

- Accreditation
  - External, Practice or institution level
- Certification
  - External, Practitioner level
- Credentialing/Privileging
  - Local, Practitioner level
  - Hospital Committee, Professional Guidelines

Credentialing

I. Practice Track
   1. CME Course
   2. Document Supervised Scans
      A. 25 per exam (10 for guided procedure) or 150 for global point-of-care ultrasound
      B. Directly supervised , Images reviewed, or compared to formal exams
   3. Approval by credentialed provider

II. Residency Track

American College of Emergency Physicians 2008 Emergency Ultrasound Guidelines
SCCM . Critical Care Ultrasound Credentialing Guidelines.

Billing

Requirements for accreditation, certification or credentialing

- Medicare and Medicaid
  - No specific requirements
  - A licensed physician must perform or supervise
- Private Insurances
  - May have additional requirements

ASK FPM. *Fam Pract Manag.* 2003 Oct;10(9):72. http://www.aafp.org/fpm/2003/1000/p72.html

Report Requirements for CPT Codes

1. Patient Identifying Information
2. Who performed and interpreted
3. Indication (Medically Necessary)
4. Description of the exam (Limited?)
5. Findings (Including measurements)
6. Impression
7. Permanent image storage

Emergency Ultrasound Coding and Reimbursement Update. American College of Emergency Physicians. 2012

Medicare National Average

EXAM		CPT	Global	Prof Comp*
Limited transthoracic echo		93308	$126.19	$26.15
Limited chest ultrasound		76604	$89.21	$27.59
Screening Ultrasound for AAA		76775	$117.16	$29.74
Limited extremity venous		93971	$114.74	$22.93
Arthrocentesis with ultrasound,	small joint	20604	$73.81	n/a
	medium joint	20606	$81.69	n/a
	large joint	20611	$93.51	n/a
FNA with image guidance		10022	$142.95	n/a
Vascular access		76937	$31.89	$14.69

* Modifier-26, professional (interpretation) component only (reimburses about 1/3 of total fee)

Equipment Costs

- Basic Laptop with 4 probes
  - $50 – 75 K to purchase
  - $400 - $500 per month for 5-year lease
- Pocket Ultrasound
  - $5 – 10 K to purchase
  - $150 per month for 5-year lease
- Section 197 Tax Deduction

https://www.irs.gov/publications/p946/ch02.html

Start Up Model

- Lease least expensive machine
- Start with ultrasound billing to supplement something you are already doing
- Practice other applications
- Expand what you bill for as you develop comfort or credentialing necessary
- Upgrade equipment later

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