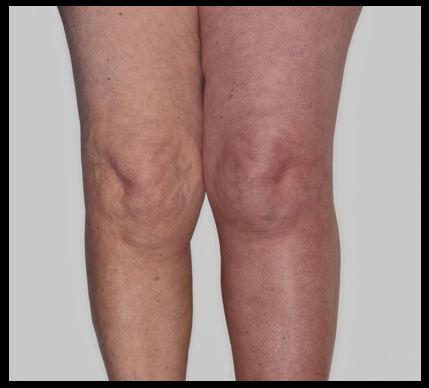
Focused Lower Extremity DVT Assessment Using POCUS

Mike Wagner, MD FACP

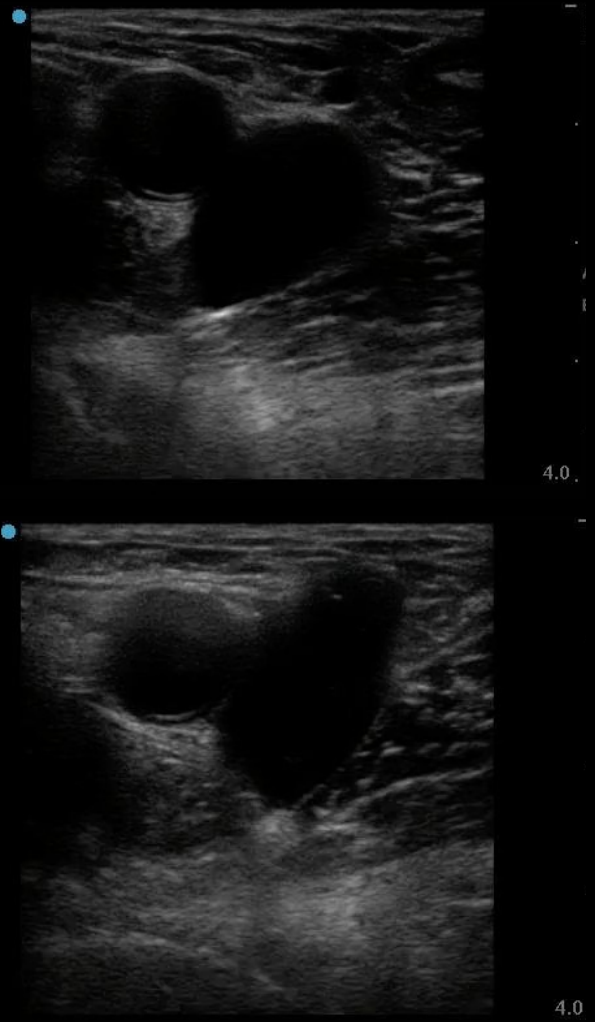


Objectives

- Become familiar with key principles of using POCUS to evaluate for Lower Extremity Deep Vein Thrombosis (LE DVT)
- Describe the key anatomic landmarks and techniques used for limited compression ultrasound for DVT
- Recognize sonographic features of DVT using POCUS
- Become familiar with the current evidence surrounding POCUS for LE DVT

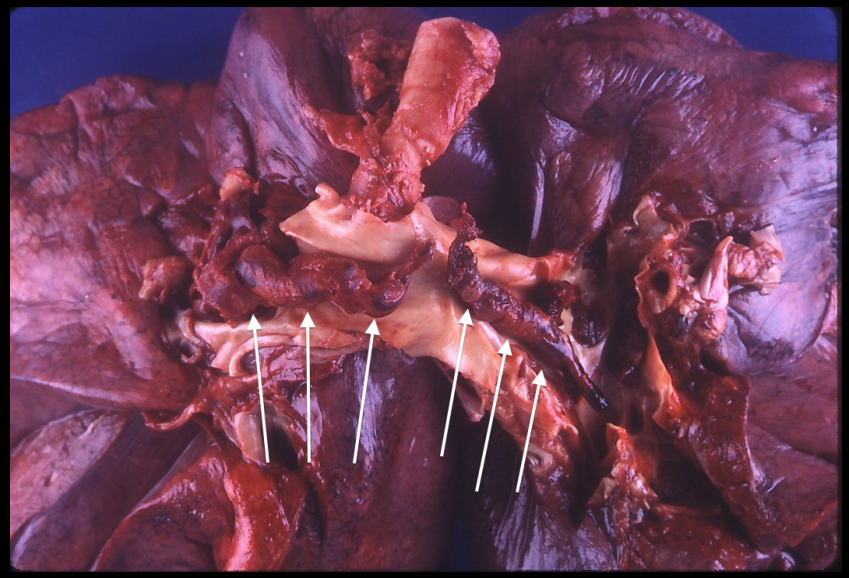
General Principles

- What are core IMPOCUS skills?
  - *Follow things* with US
  - Distinguish VEIN from ARTERY
    - Shape
    - No pulsations
    - Thin walls
    - **COMPRESSIBILITY**
  - Exclude Venous Thrombus at a *specific site*
    - E.g. compression prior to CVL placement



General Principles

- Most POCUS users perform a LIMITED LE DVT exam
  - Proximal deep veins (not distal)
  - Variations in practice
- This POCUS application is *high stakes*
  - Learn and begin practice early
  - Incorporate into clinical practice late



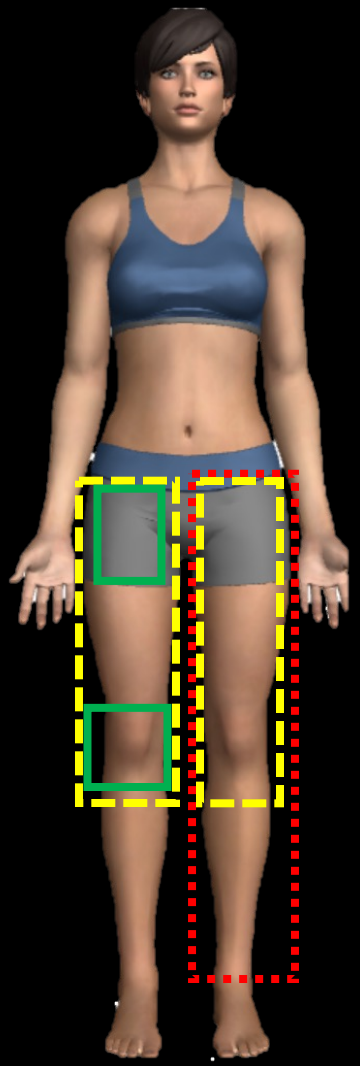
1. **Echogenic thrombus may be seen in the lumen to diagnose DVT**
2. **Dynamic compression of a deep vein is adequate to exclude DVT (at that spot)**
   - Color flow and Doppler waveforms NOT necessary to answer simple question "is DVT present?"
     - Are useful for more advanced questions (e.g. "is DVT acute or chronic", "is it causing complete obstruction vs partial", etc.)
3. **Limited exam excludes proximal DVT but not necessarily distal DVT**
4. **Limited LEDVT exam is often limited to two regions/DVT "hotspots" (Common Femoral and Popliteal)**
   - **There is controversy regarding what constitutes an *adequate* POCUS exam**

DVT Protocols

POCUS

-2 Zone/Region

-Full proximal

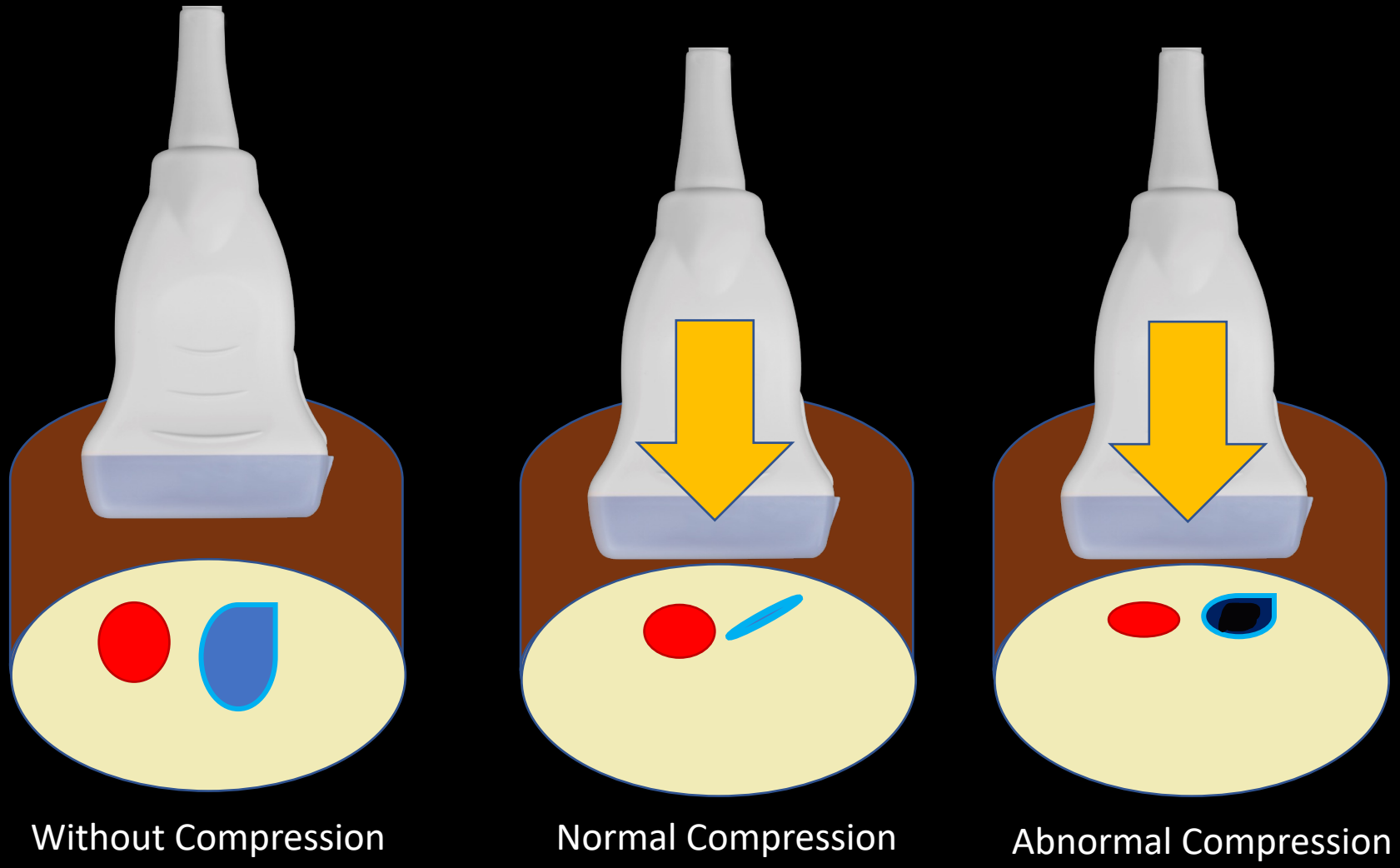


Imaging Specialists

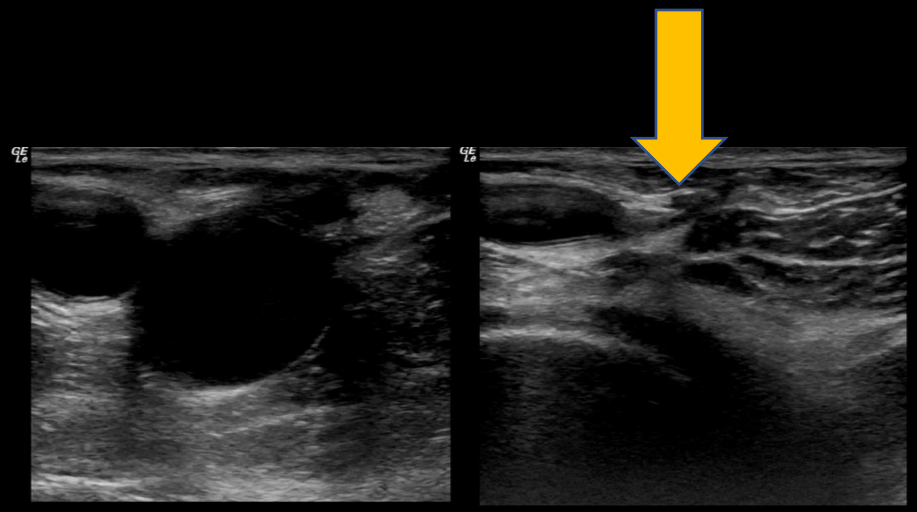
-Complete Lower Ext

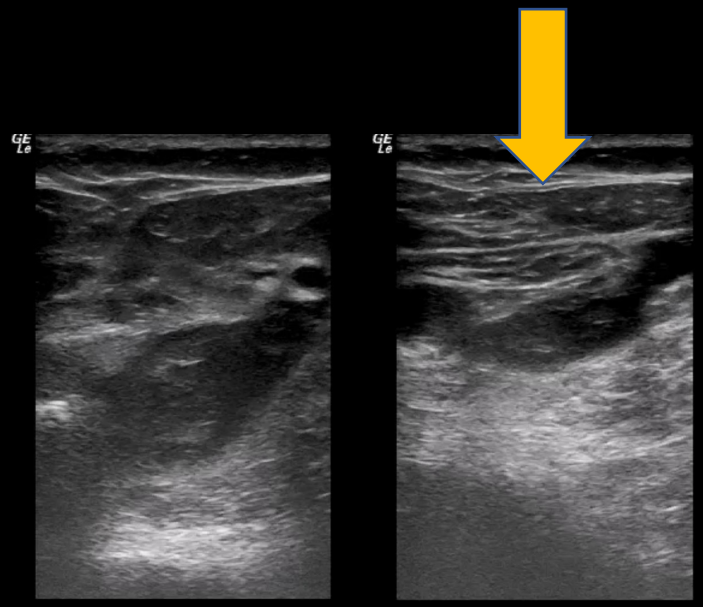
-Full proximal

Venous Compressibility is the KEY



Negative study vs Positive study





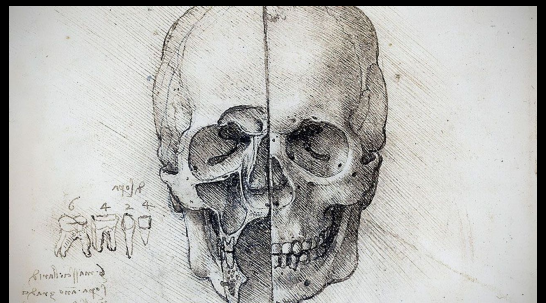
Proximal LE DVT vs Complete LE DVT

- Emergency US and many radiology protocols evaluate for proximal DVT only!
  - =Any DVT in the popliteal vein or above
- ↑↑↑ risk of embolization than if just distal (calf) DVT
  - Proximal DVT: Requires anticoagulation if not contraindicated!
  - Distal DVT: anticoagulation *optional*, depends on many factors

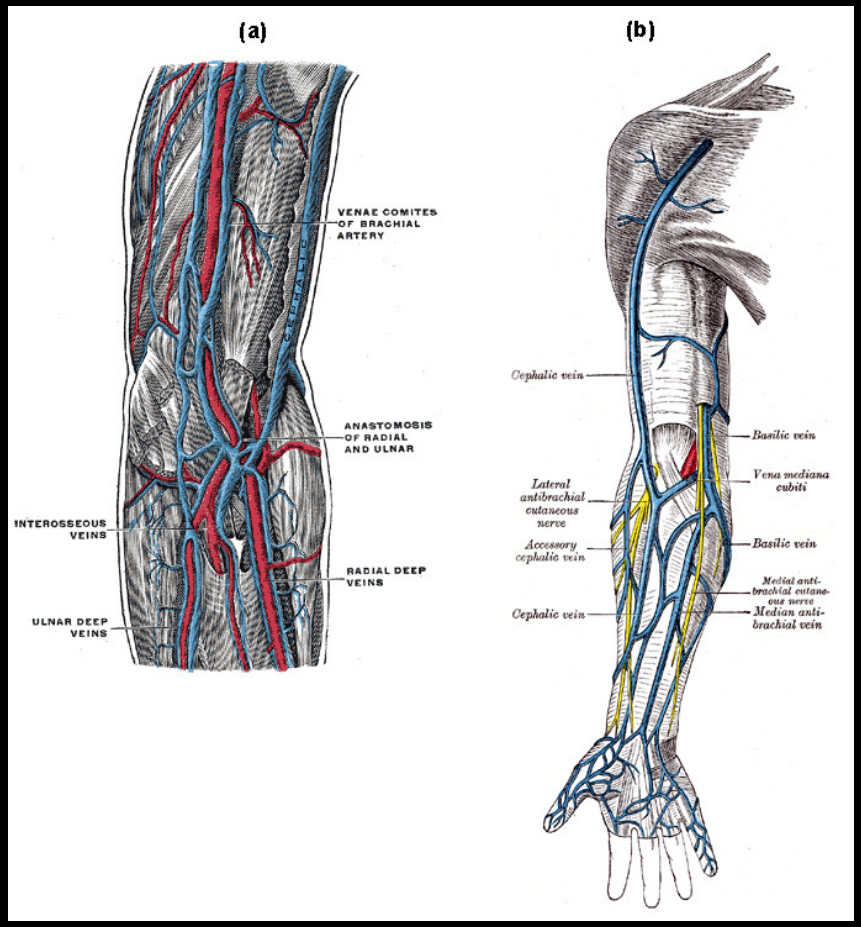
A Word on Distal DVT (Calf Veins)

- Lower risk of embolization (PE)
- Left untreated, 15% extend into proximal system
- ACCP Recommendations (**2021 update**):
  - Favor Treatment
    - **+ D-dimer**
    - Extensive or close to proximal veins (>5cm length, involves multiple veins, >7mm max diameter)
    - No reversible provoking factor for DVT
    - Active Cancer
    - Hx of VTE
    - **INPATIENT STATUS**

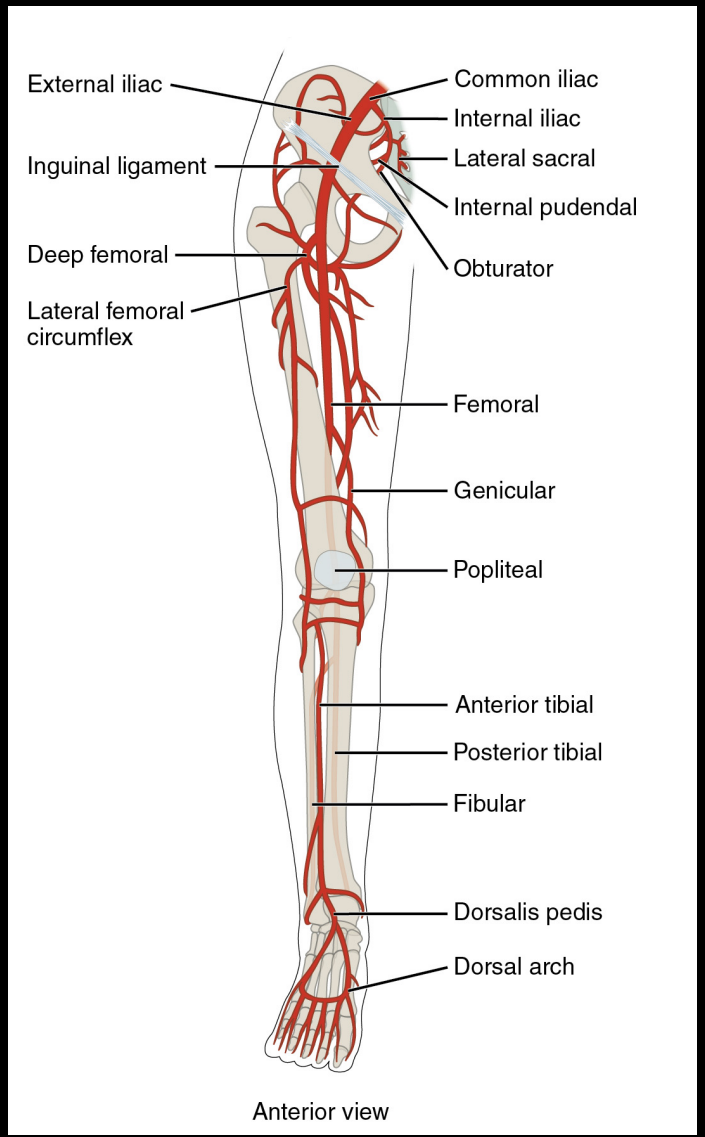
Knowing
the
ANATOMY
is
CRUCIAL

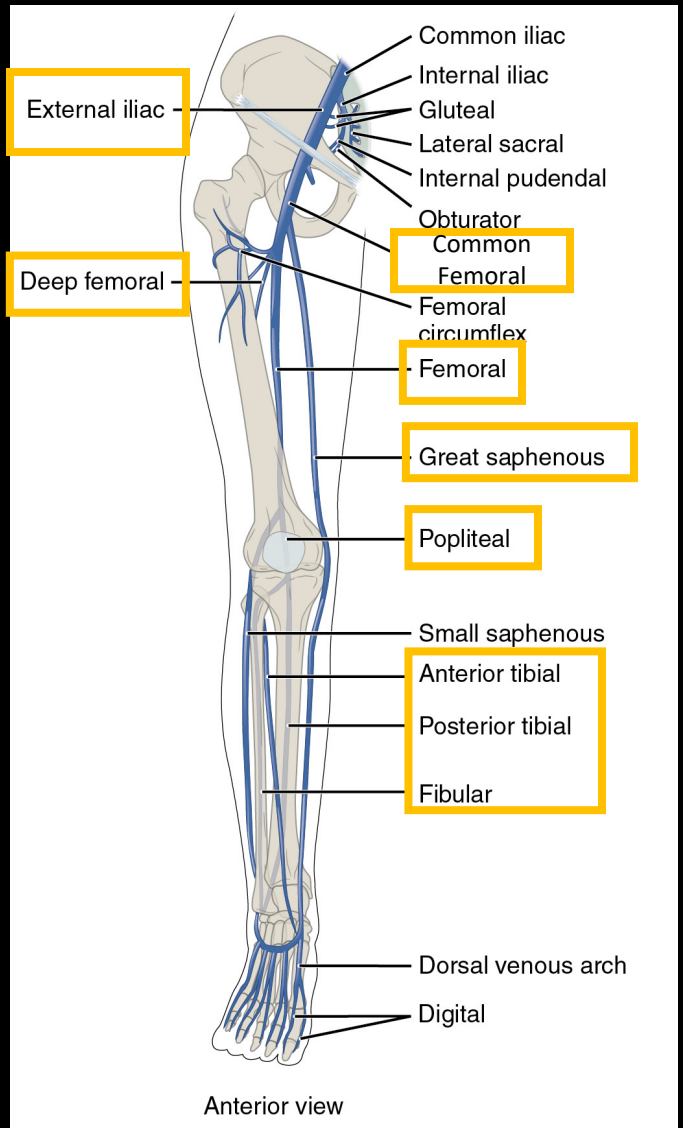


How do you distinguish deep veins from superficial veins on ultrasound?

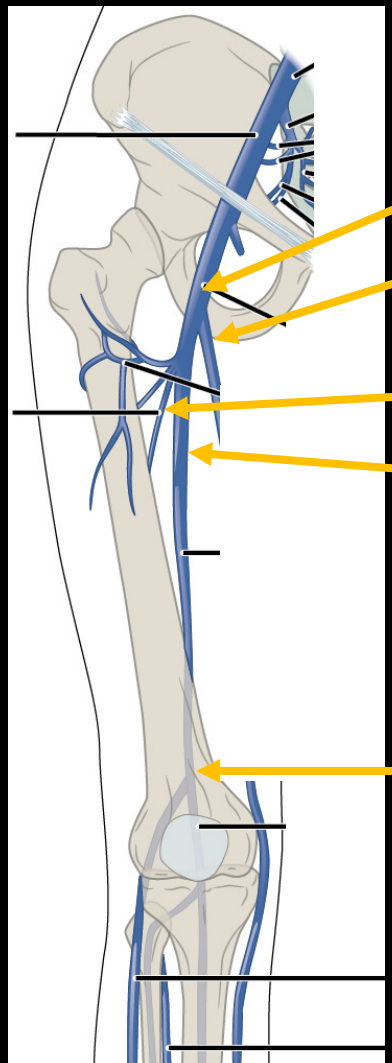


Arterial and Venous Anatomy





What Veins do you *NEED* to know?



- Common Femoral Vein
- *Greater Saphenous Vein*
- Deep Femoral Vein
- (Superficial) Femoral Vein
- Popliteal Vein

Case 1

- 45 y.o. female presents for routine visit
- unilateral pain behind the knee
- PMH: DM, HTN, obesity, anxiety
- Meds: OCPs, metformin, atorvastatin, sertraline
- Allergies: none
- FH: aunt with PE
- SH: recently started smoking again, completed cross country trip one week ago
- PE: VS nml, pain with palpation over popliteal region

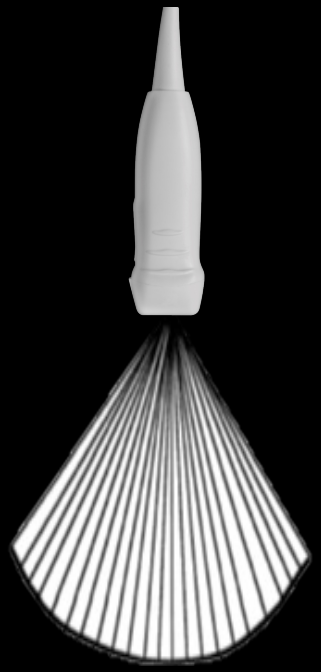
Does this patient have a DVT?

Can POCUS help answer this question?

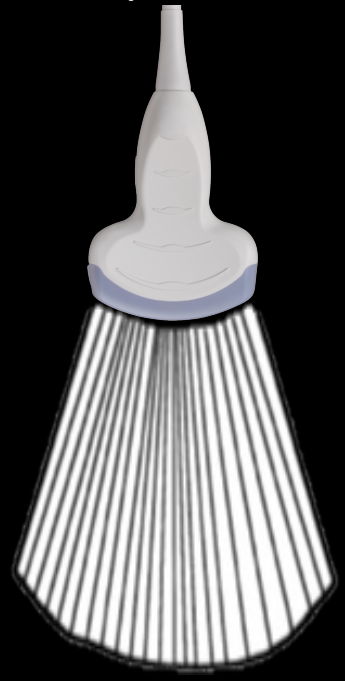
TECHNIQUE

Probe Selection

SECTOR (PHASED ARRAY)



CONVEX (CURVILINEAR)



LINEAR

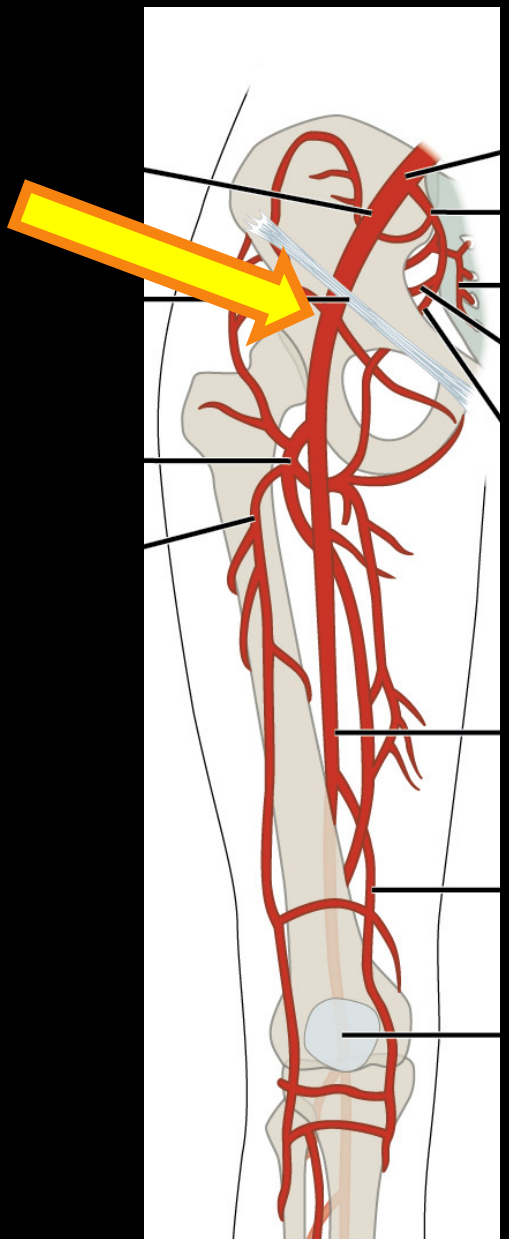
Patient Setup

- *Raise* head of bed 30-45 degrees
  - **NOT FLAT**
- Bend knee and externally rotate hip

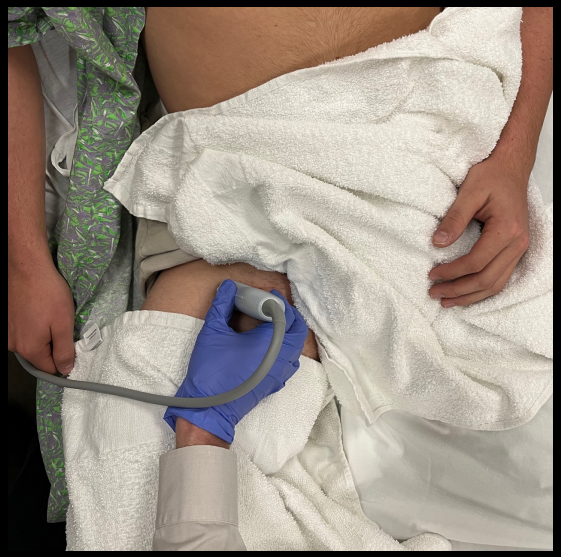
- Alternate position for popliteal is leg dangling off table or in prone position, even standing!

Draping

STEP 1: Find the FEMORAL *ARTERY*



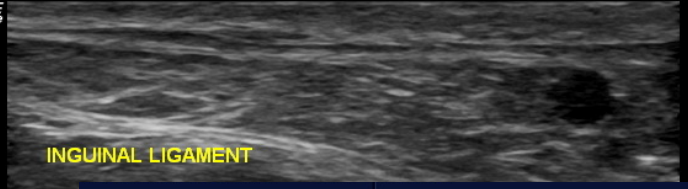
Correct Technique

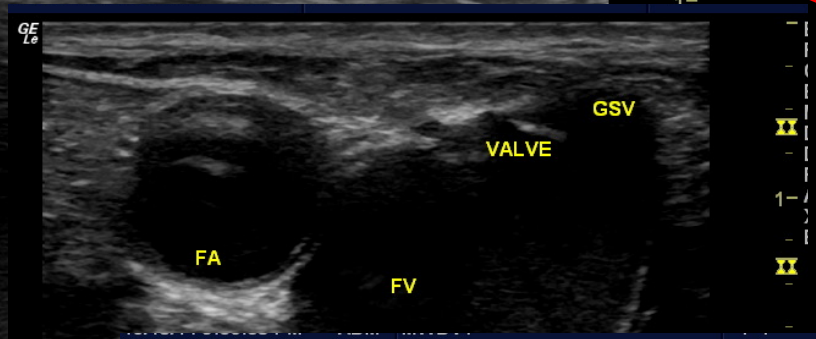


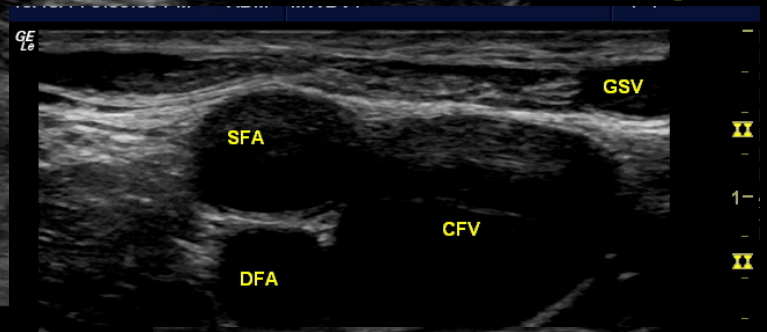
Incorrect Technique

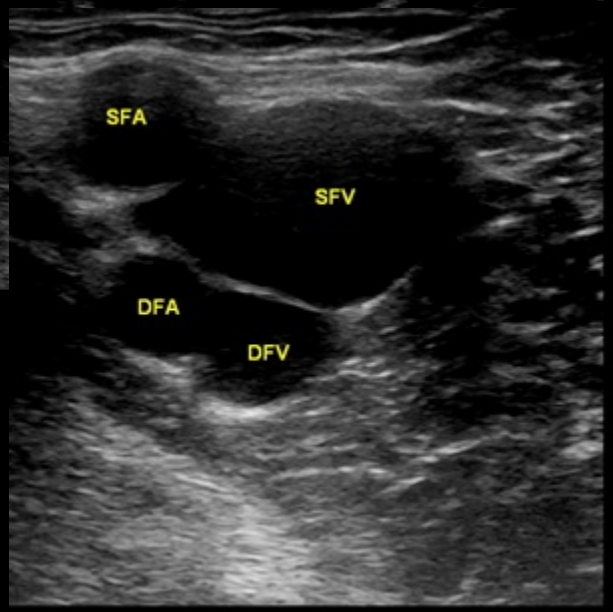
- AKA “the timid tail grab”

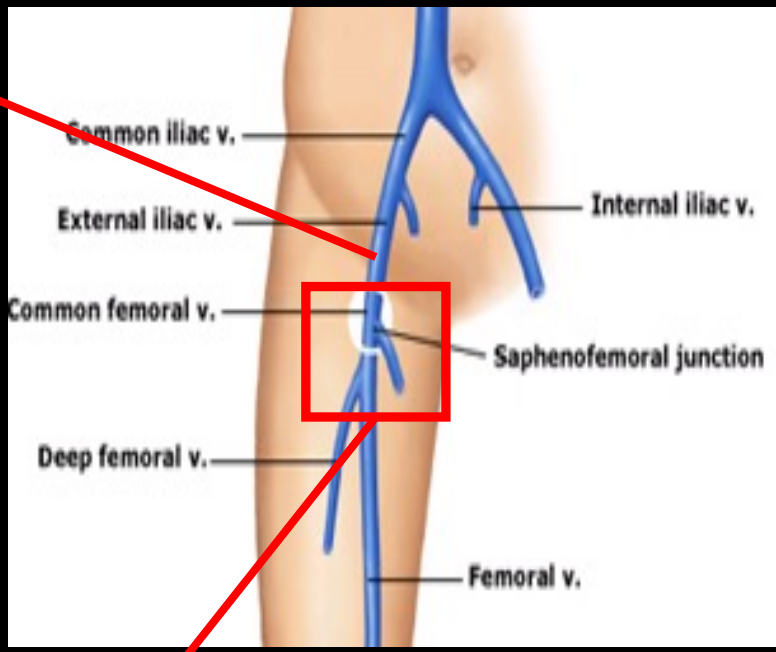
CFV Proximal -> Distal











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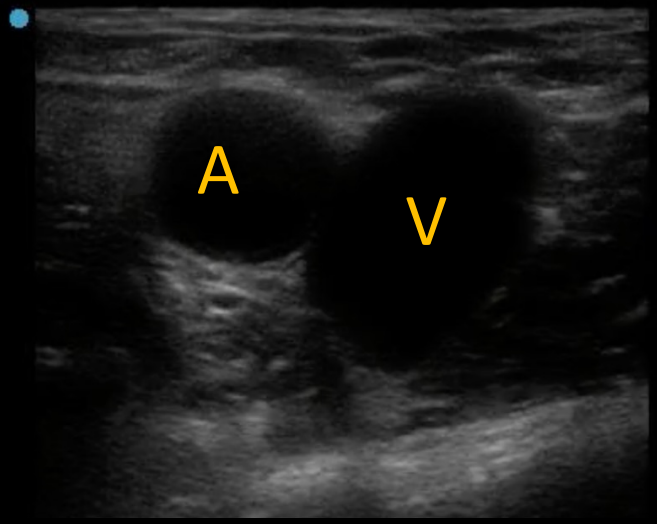
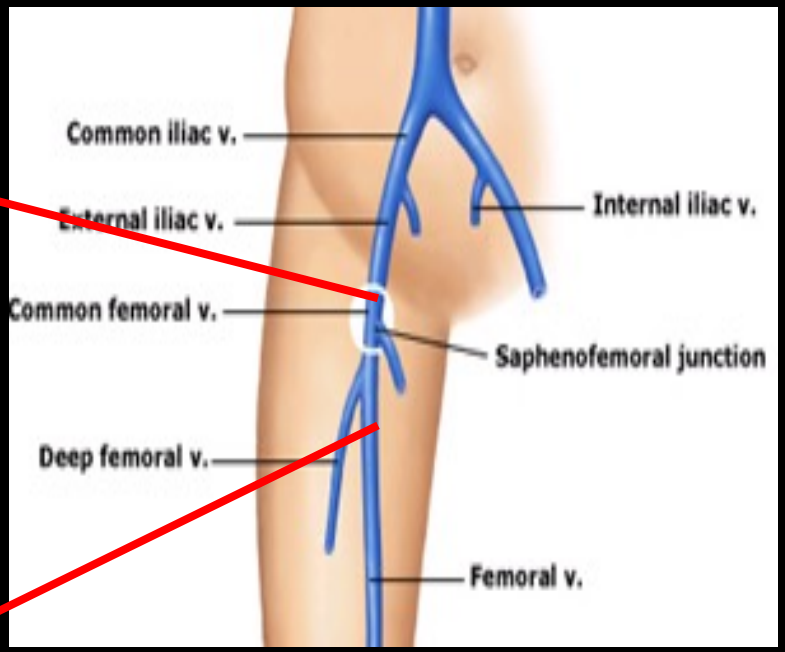
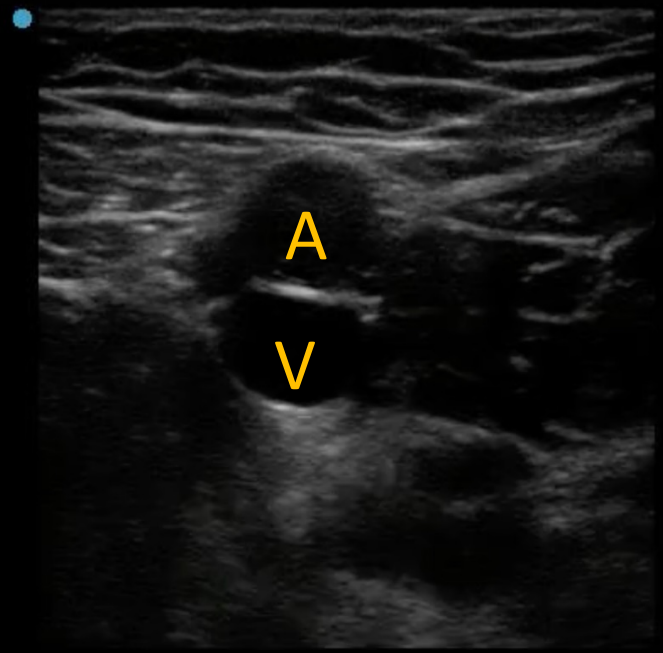






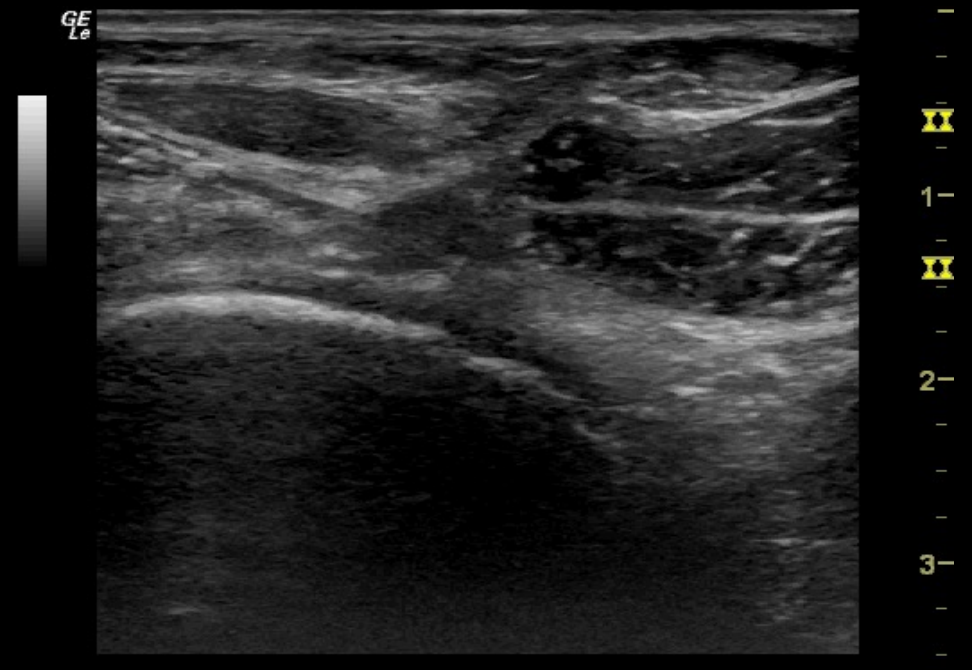
2-*Zone* Scanning Protocol – #1-Common Femoral Region

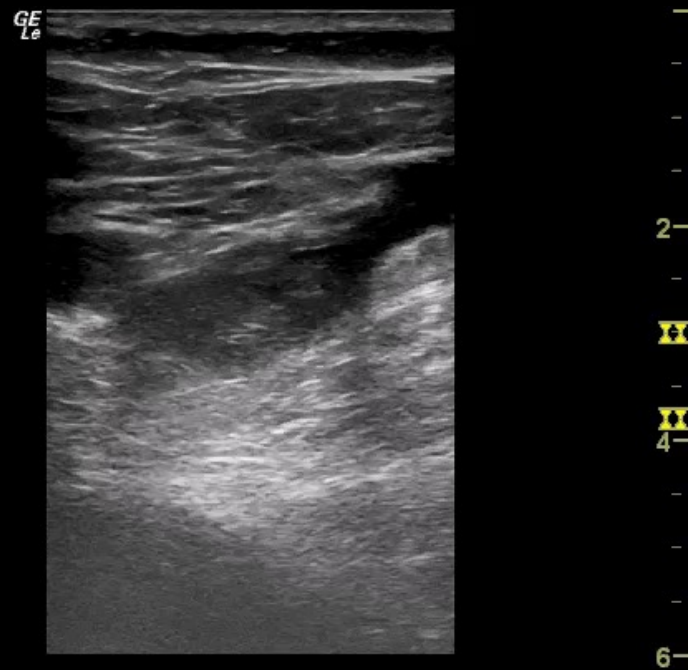
- Start at junction of **saphenous and common femoral veins** in transverse plane, probe perpendicular to vessel wall
- Compress to ensure complete collapse
- Proceed distally compressing every 1 cm
- Stop when have visualized and compressed jxn of **deep femoral vein and superficial femoral vein**
- Usually no more than 2-3 inches/5cms

How Much Pressure When Compressing?

- In theory vein should collapse easily with gentle pressure
- Artery should deform minimally or not at all
  - Artery should not fully collapse before vein
- Large patients or areas with more tendons/muscles require more pressure
  - Hand underneath tissue pushing up towards probe can assist

Common Femoral Compression





Tip: Don’t MASH on OBVIOUS thrombus!

Echogenic Clot?

Which of the following statement is true?

A. Pressure with the probe is insufficient to assess for DVT

B. The depth setting is insufficient to assess for DVT

C. The use of color Doppler is necessary to assess for DVT in this case

D. A DVT is present despite lack of echogenic material in the lumen

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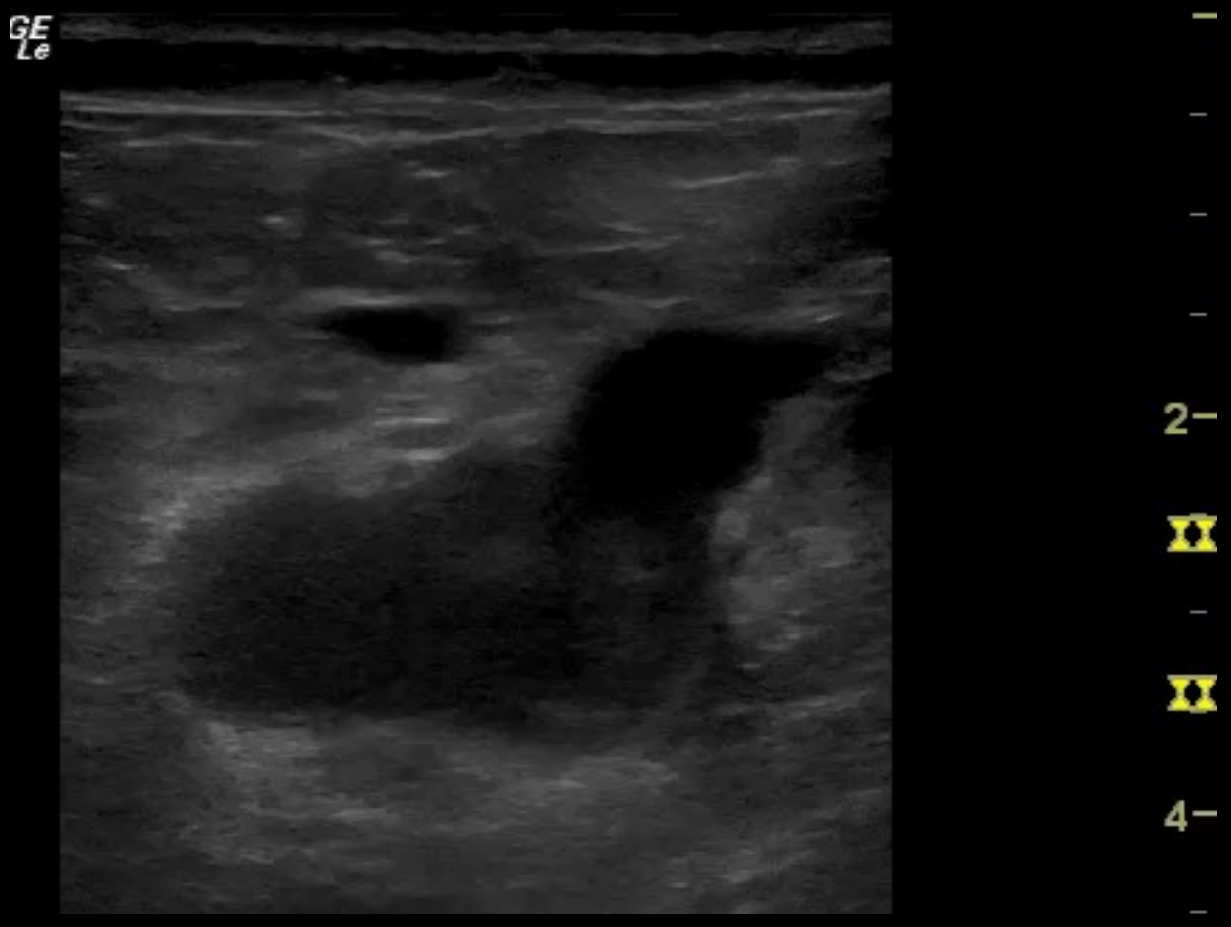
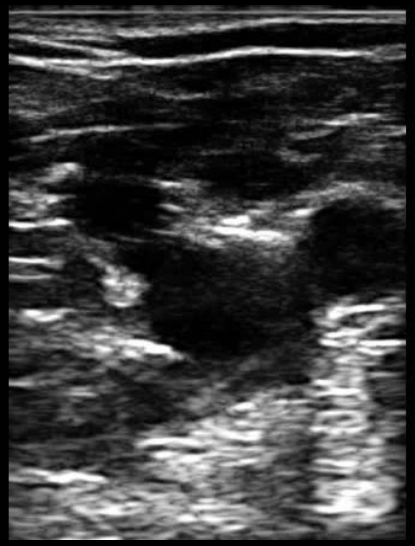
Clot or not?

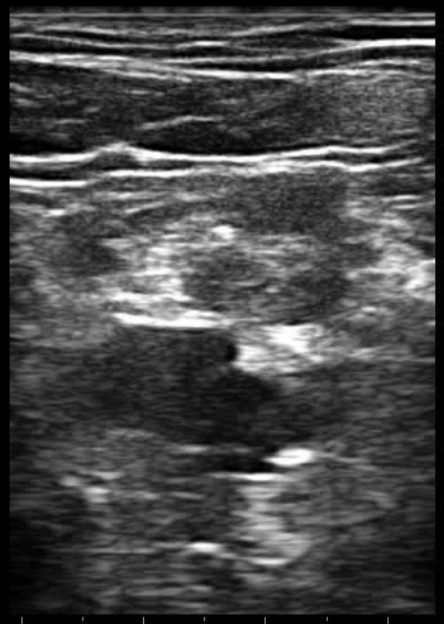


Clot or not?

The clips to the right best demonstrate which of the following?

A. Clot in the greater saphenous vein
B. Clot in the femoral vein distal to the sapho-femoral junction
C. Clot in the popliteal vein
D. Compressible femoral vein and a non-compressible lymph node mimicking clot





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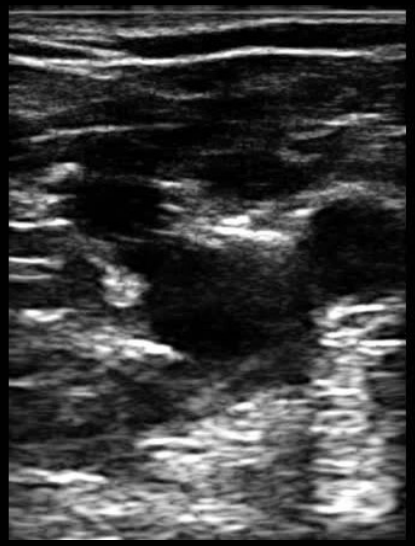
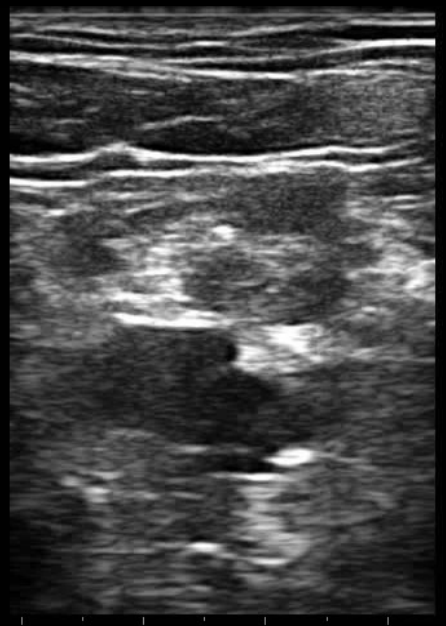
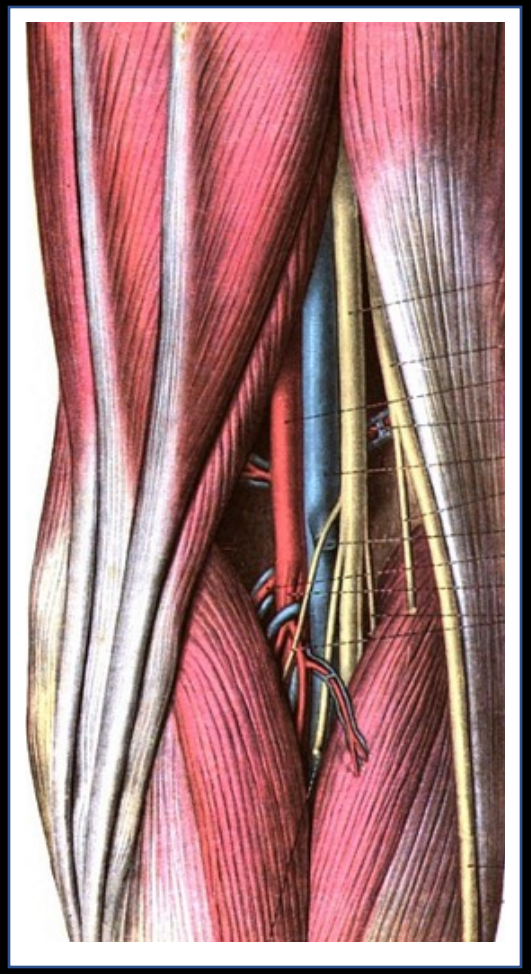


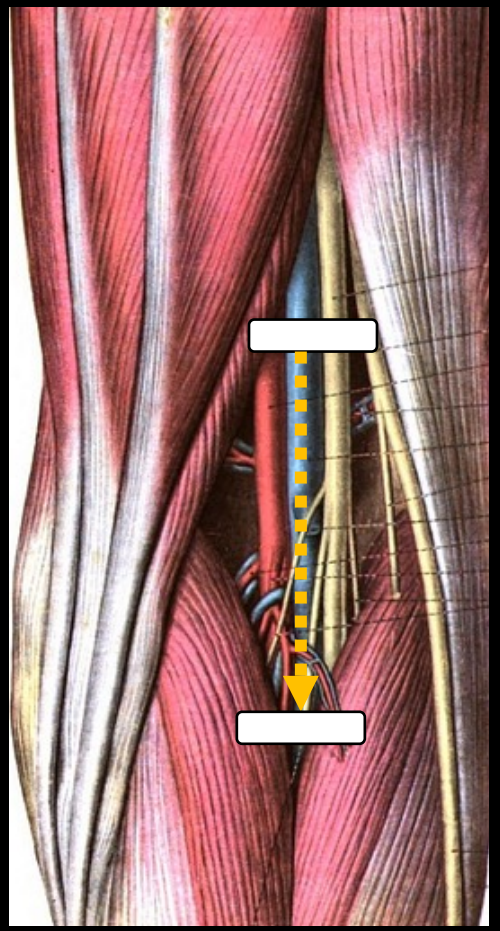


Popliteal Zone

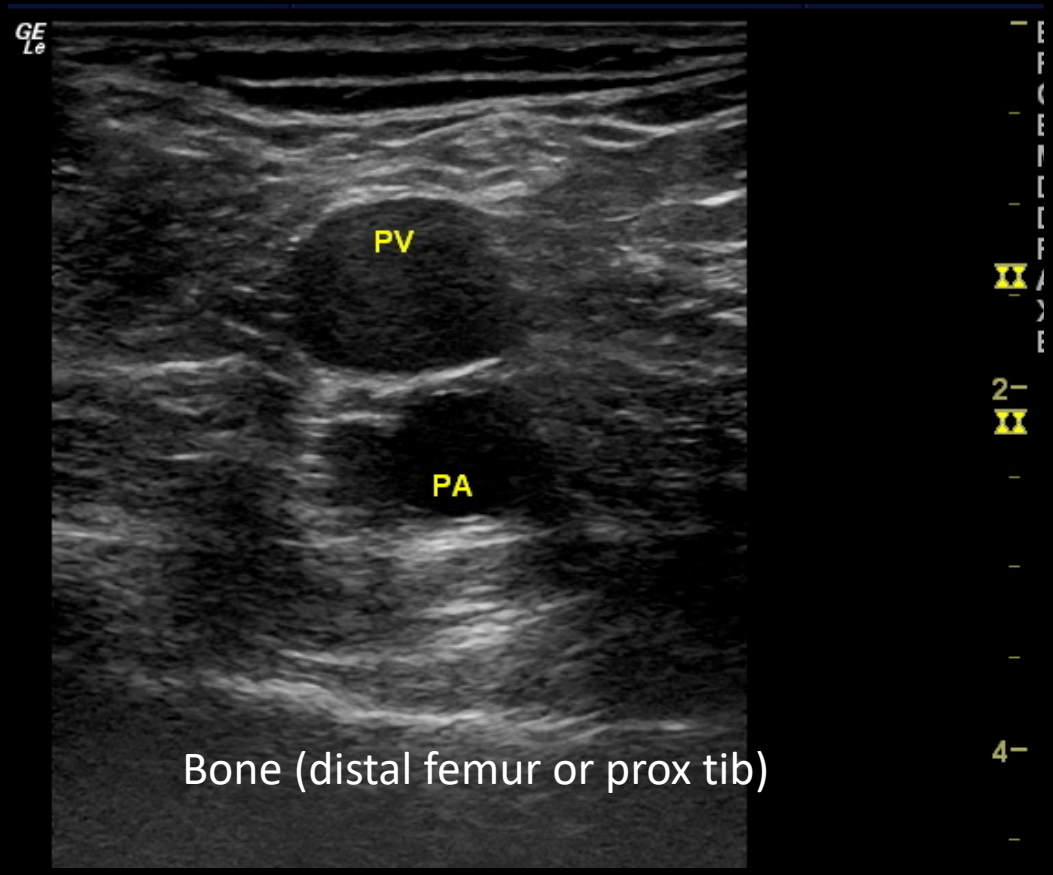


2-Zone Scanning Protocol – #2-Popliteal Region

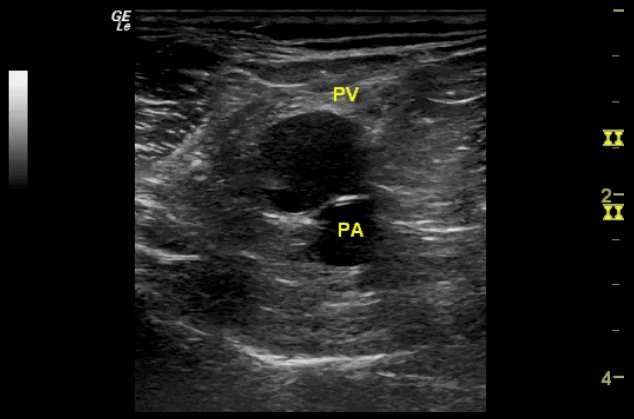
- Start at top of popliteal fossa
- Compress to ensure complete collapse
- Proceed distally compressing every 1 cm
- Stop at bottom of popliteal fossa (should have visualized and compressed "trifurcation" (Ant Tib, Post Tib, and Fibular/Peroneal)
  - Usually no more than 2-3 inches/5cms
  - Look for muscle in near field



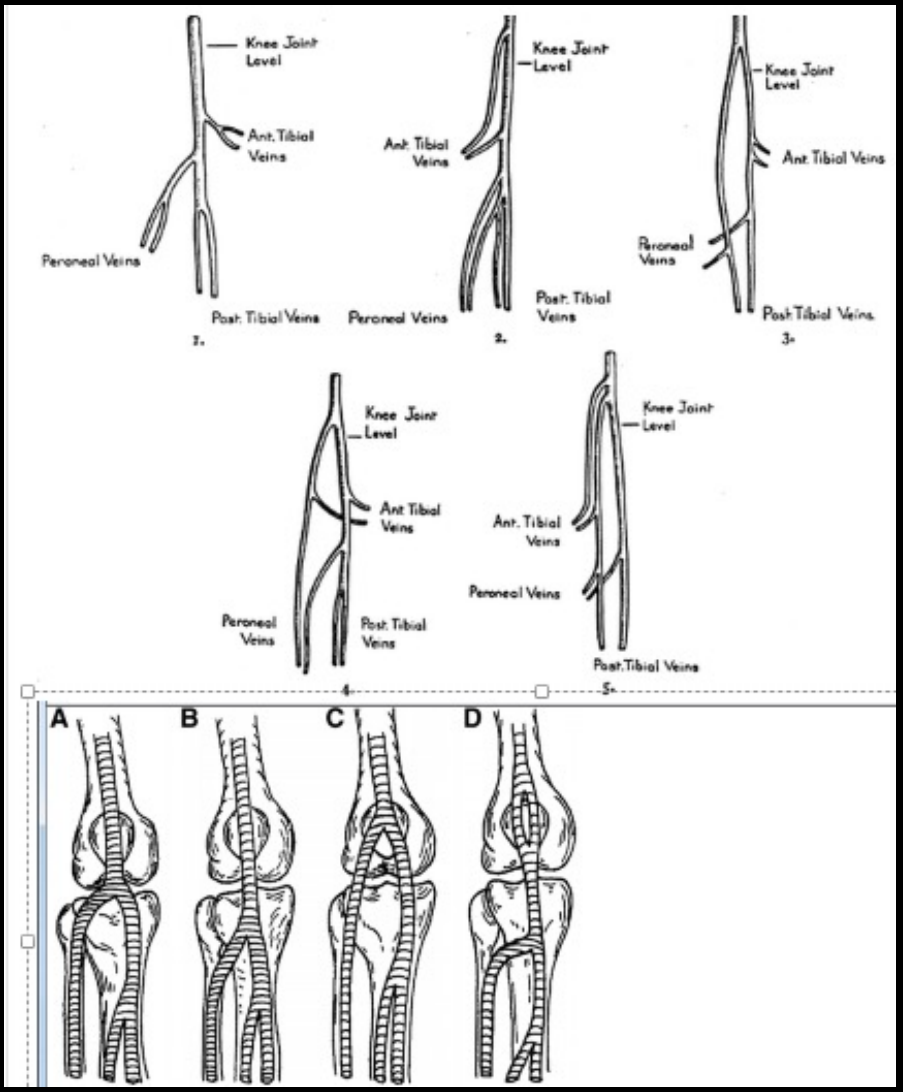
Vein=more superficial
Artery=deeper



Popliteal Anatomy



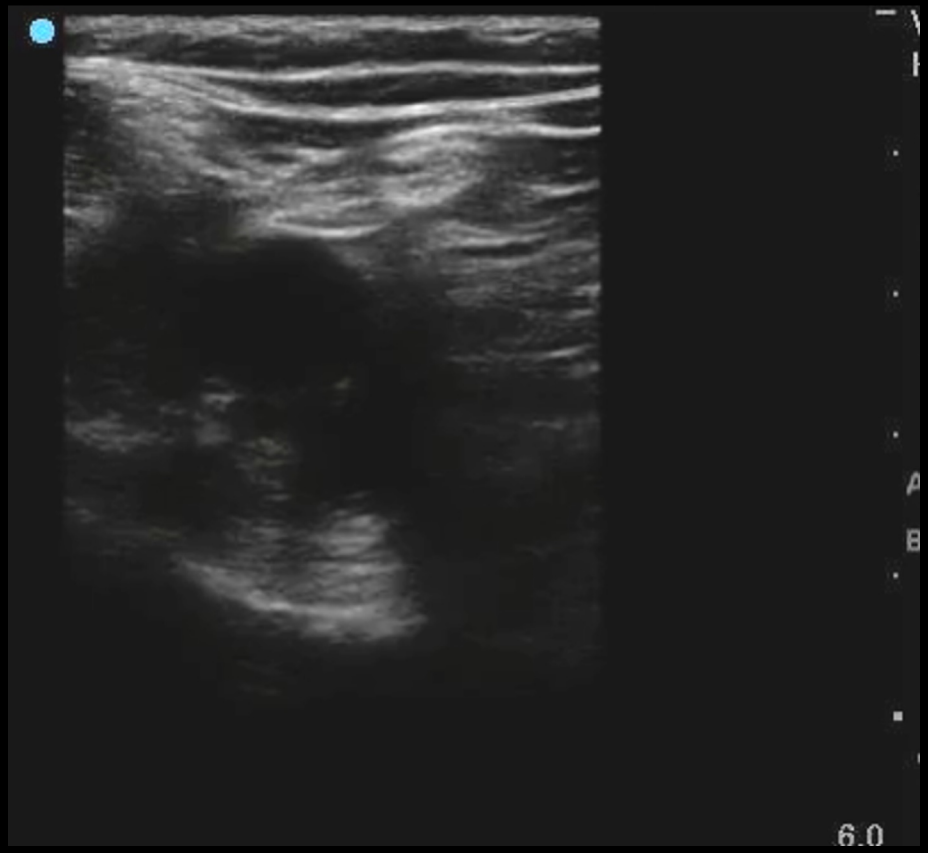
Be aware of Normal Variations of Venous Anatomy

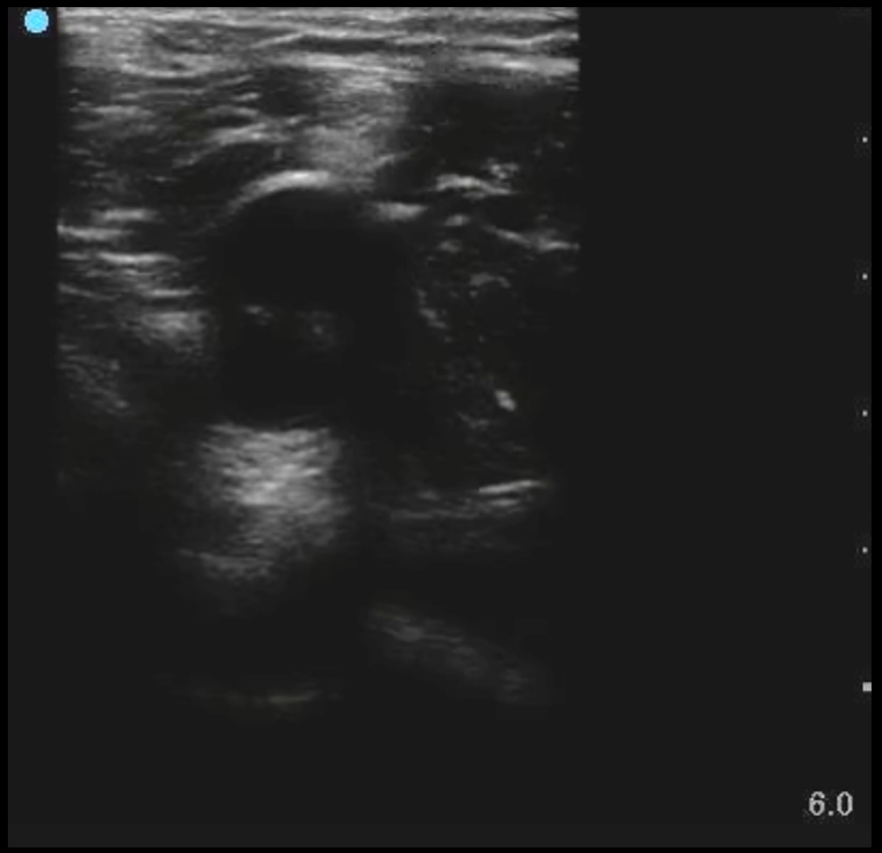


- If multiple *deep* veins exist ensure BOTH compress
  - Deep veins will be still *paired with arteries*
- Don’t confuse superficial veins with deep veins
  - But some superficial veins join with deep veins so ensure they compress at junction (i.e. perforators)

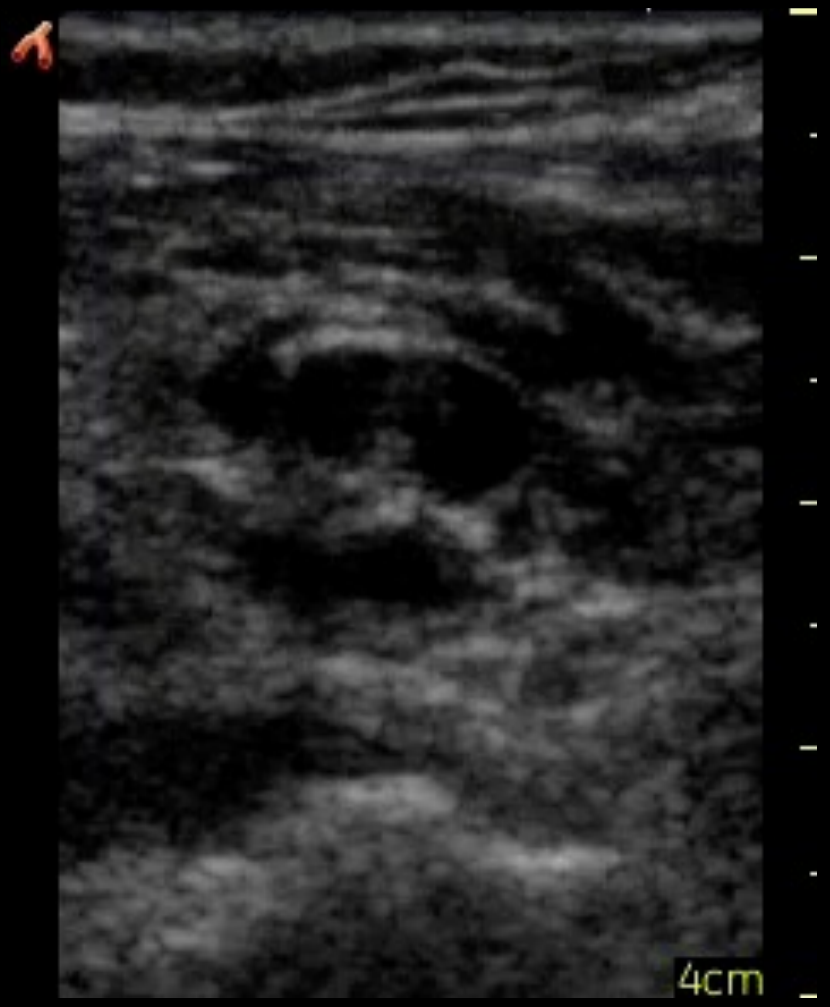
Popliteal

Probe Pressure
Inadequate vs Adequate





Clot or not?



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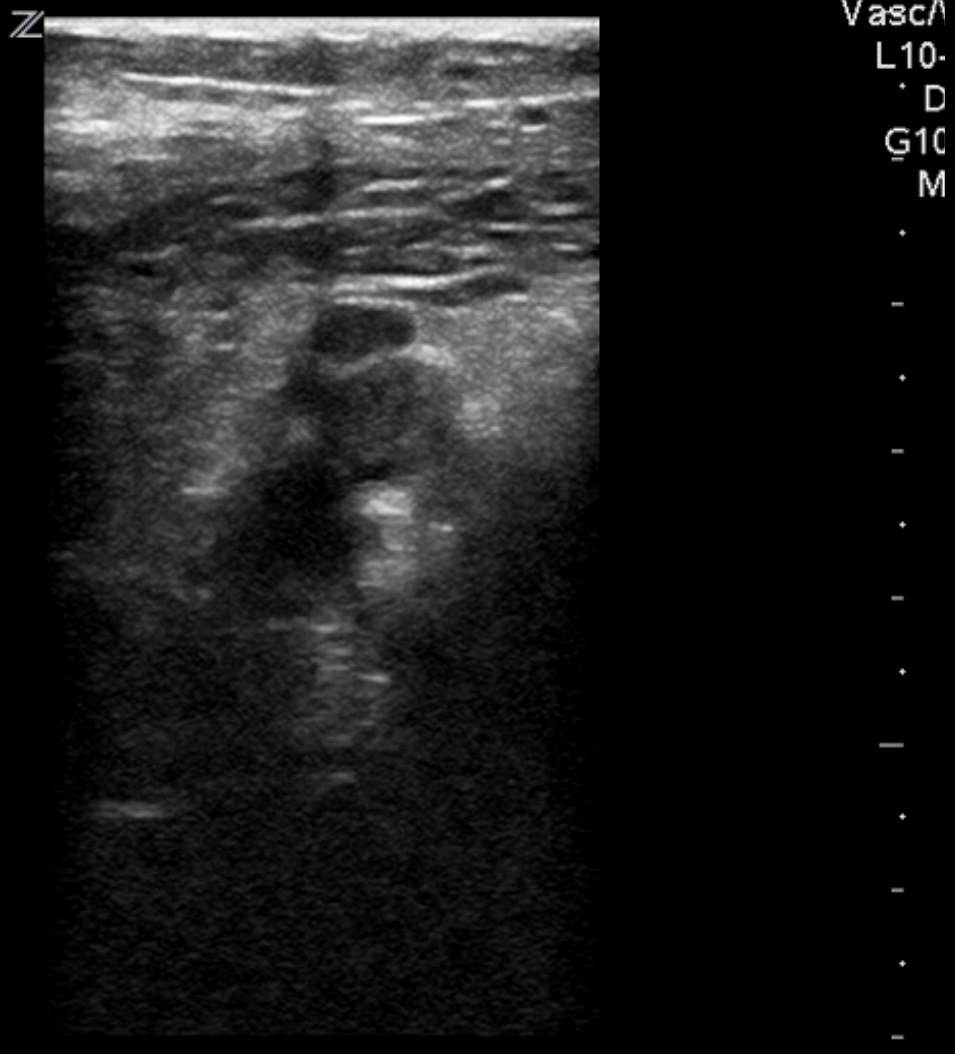
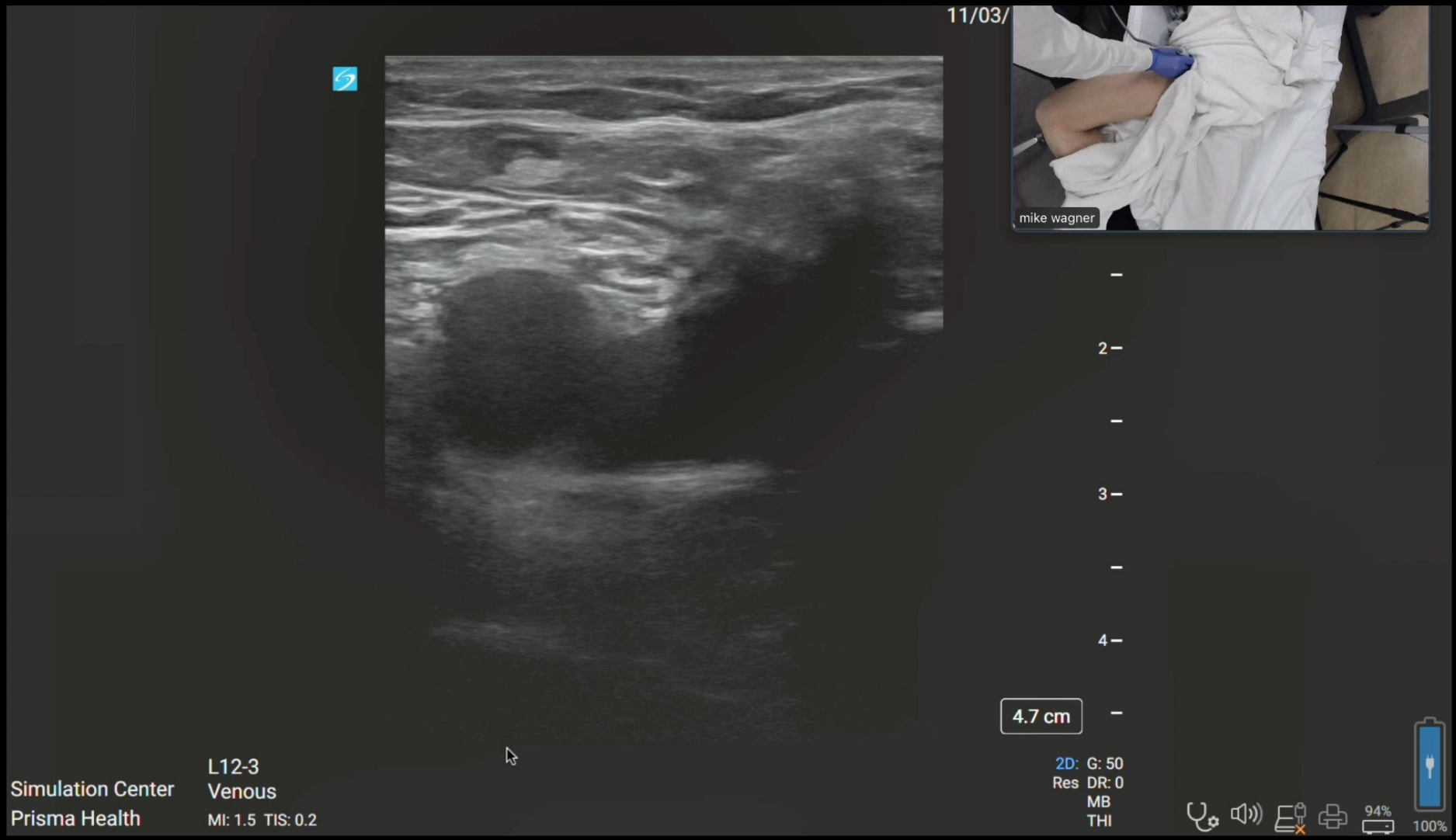


2 Region Video



Technique PEARLS + PITFALLS

- Compression improves image quality
  - Slide while compressing gently
  - Ensure vein remains visible

- Equipment sometimes matters

- **False positives:** inadequate compression technique, mistaking artery for vein, superficial vein for deep vein, lymph nodes and Bakers cysts

- **False negatives:** thrombus in region not scanned, mistaking noncompressible vein with artery An artery may be mistaken for a non-compressible vein, leading to a false positive result.

- A negative scan for a lower extremity DVT does not **rule out** the presence of pulmonary embolism.
  - Can have clots proximally in pelvis/abdomen (iliac veins, IVC)- consider MRV

- Maintain a sense of humility
  - Practice conservatively

Older Literature Review

DVT Study Review											
Year	1st Author	Setting	Patients	Technique	Operator	Gold Standard	# Pos (%)	Sensitivity	Specificity	Time	Comments
1993	Cogo	Radiology	542	venogram	Radiologists	Na					No isolated SFC or iliac clot, all prox DVT involved either PV or CFV
1995	Poppiti	vascular lab	72 (141 limbs)	2-point	RVTs	Full Leg	15 (11%)	100	98	5.5 min	full study 37 min; no isolated SFV clot in this study
1996	Trottier	Inpt	100	3-Point	ICU physicians (#2)	Formal vasc US	34 (34%)	94	98		self trained physicians (35 scans prior to study), scans performed AFTER formal scan
2000	Blaivas	ED	112	2-Point	ED physicians (#5)	Radiology US (full leg)	33(30%)	100	99	3.5min	5 hrs training, 98% agreement with radiology ultrasound, 3 were"highly trained" >350 us exams
2001	Frazee		76	2-Point	ED physicians (#6)		18(24%)	89	76		
2004	Jang	ED	72	Proximal	ED residents (#8)	formal vasc US, venogram, CT venogram	23(32%)	100	92	11.7 min	pgy1-4 very limited ultrasound experience, minimal training. Not consecutive-convenience sample. 1/23 positive exams were isolated SFV clot
2004	Theodoro		156				32(21%)	100	98		
2007	Jacoby		121				9(7%)	89	97		
2007	Magazzini	ED	399	Whole Leg	ED physicians (#2)	formal vasc US	72(18%)	100	98	13 min	SFV assessed 3 spots. 6h lectures and 1 day training by radiologist on DVT, after 30 hr general us course. prospective observational study performed on nonconsecutive patients
2008	Burnside										Systematic Review Article of 6 studies (blaivas, frazee, jang, thodoro, jacoby,magazzini)- conculsion further study needed before routine use
2008	Kline	ED	183	3-Point	ED faculty residents, "midlevel providers"- >50 sonographers	Radiology US	27(15%)	70	89		3 hrs lecture/practice on normal subjects, accuracy markedly increased in physicians after enrolling more than 3 pts in study suggesting learning curve important
2008	Bernardi	US Labs (From ED and Primary Care)	2098	2-Point	Physicians with Vascular ultrasound expertise	Formal vasc US					multicenter, prospective, randomized consecutive. Italian study. serial 2point exam with ddimer equal outcomes single full leg ultrasound (note: pts excluded once ruled in on either arm to include calf vein dvt)
2010	Crisp	ED	199	2-point	Physicians in ED (residents(includes FP and IM), fellows, staff) 47 sonographers	Radiology US	45	100%	99%		only 10 min standardized training
2011	Kory	ICU	128	3-point	ICU fellows and staff	Formal vasc US	26 (20%)	86%	96%	12.5 min	convenience sample, retrospective, 20/26 CFV, 4/26 PV, 2/26 had isolated SFV DVT. After showing study images to radiologist in discordant results, changed study result in 4/9 discordant cases (88% sen 98% spec c/t FVS 85%sens, 100%spec
2014	Caronia	ICU	143	2-point	IM residents	Formal vasc US	12(16%)	86%	97%		6 isolated SFV clots missed (authors conclusion- 2 point not adequate in ICU)

Lit Notes

- High degree of study variability
- Pooled accuracy: sens 90-95% spec 91-98%
  - Some outliers
- FN/FP in approx. 4%

Serial 2-Point Ultrasonography Plus D-Dimer vs Whole-Leg Color-Coded Doppler Ultrasonography for Diagnosing Suspected Symptomatic Deep Vein Thrombosis

A Randomized Controlled Trial

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for the Erasmus Study Group

Context Patients with suspected deep vein thrombosis (DVT) of the lower extremities are usually investigated with ultrasonography either by the proximal veins (2-point ultrasonography) or the entire deep vein system (whole-leg ultrasonography). The latter approach is thought to be better based on its ability to detect isolated calf vein thrombosis; however, it requires skilled operators and is mainly available only during working hours. No randomized comparisons are yet available evaluating the relative values of these 2 strategies.

Objective To assess if the 2 diagnostic strategies are equivalent for the management of symptomatic outpatients with suspected DVT of the lower extremities.

Design, Setting, and Patients A prospective, randomized, multicenter study of consecutive symptomatic outpatients (n=2465) with a first episode of suspected DVT of the lower extremities who were randomized to undergo 2-point or whole-leg ultrasonography. Data were taken from ultrasound laboratories of 14 Italian universities or civic hospitals between January 1, 2003, and December 21, 2006. Patients with normal ultrasound findings were followed up for 3 months, with study completion on March 20, 2007.

Main Outcome Measure Objectively confirmed 3-month incidence of symptomatic venous thromboembolism in patients with an initially normal diagnostic workup.

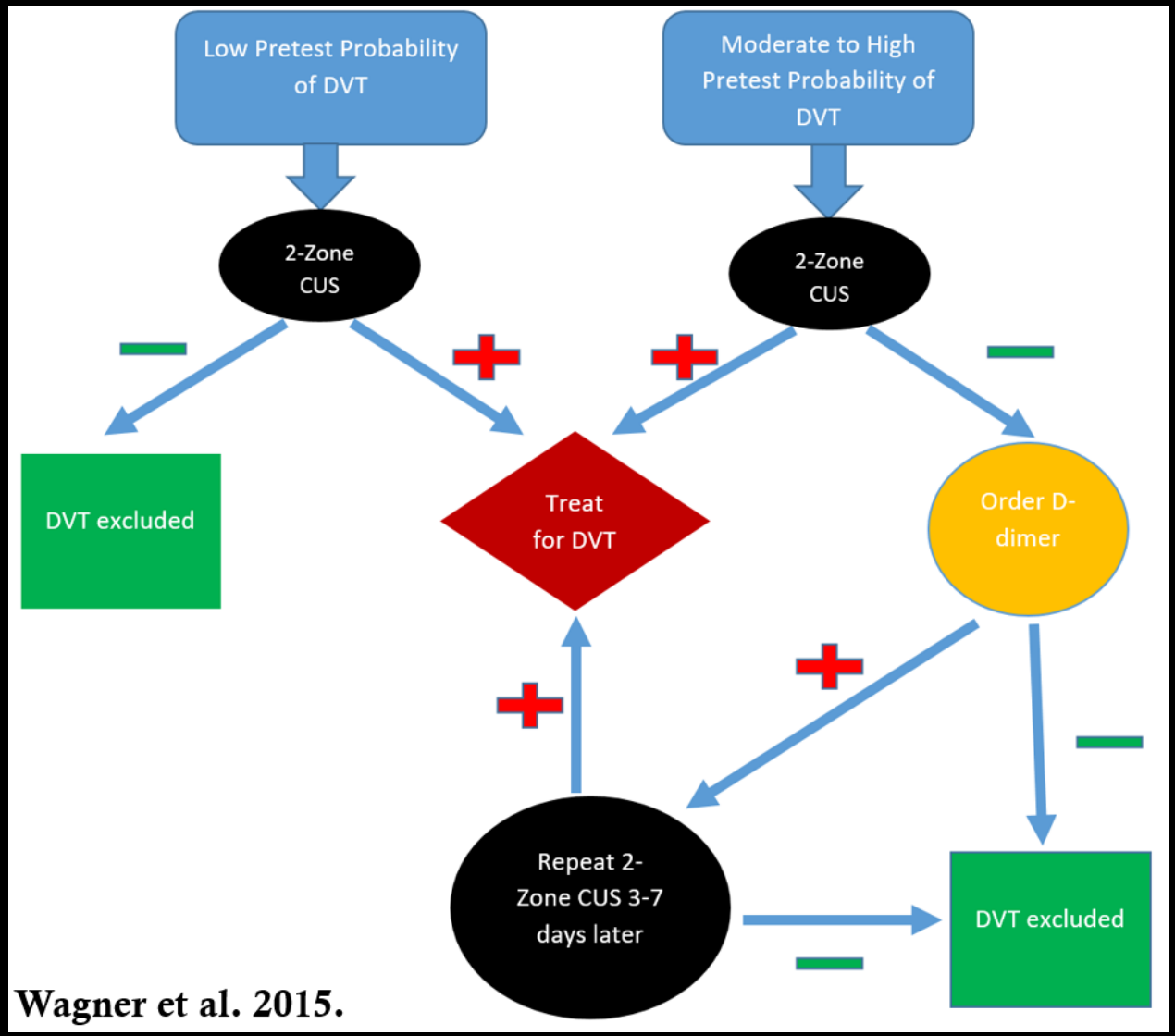
Results Of 2465 eligible patients, 345 met 1 or more exclusion criteria and 22 refused to participate; therefore, 2098 patients were randomized to either 2-point (n=1045) or whole-leg (n=1053) ultrasonography. Symptomatic venous thromboembolism occurred in 7 of 801 patients (incidence, 0.9%; 95% confidence interval [CI], 0.3%-1.8%) in the 2-point strategy group and in 9 of 763 patients (incidence, 1.2%; 95% CI, 0.5%-2.2%) in the whole-leg strategy group. This met the established equivalence criterion (observed difference, 0.3%; 95% CI, −1.4% to 0.8%).

Conclusion The 2 diagnostic strategies are equivalent when used for the management of symptomatic outpatients with suspected DVT of the lower extremities.

Trial Registration clinicaltrials.gov Identifier: NCT00353093

JAMA. 2008;300(14):1653-1659 www.jama.com

My Practice: Outpatient POCUS for DVT



ANNALS OF FAMILY MEDICINE

Research Article | Original Research

General Practitioner–Performed Compression Ultrasonography for Diagnosis of Deep Vein Thrombosis of the Leg: A Multicenter, Prospective Cohort Study

Nicola Mumoli, Josè Vitale, Matteo Giorgi-Pierfranceschi, Silvia Sabatini, Renato Tulino, Marco Cei, Eugenio Bucherini, Carlo Bova, Daniela Mastroiacovo, Alberto Camaiti, Gerardo Palmiero, Luca Puccetti and Francesco Dentali; for the PRACTICUS Study Investigators

The Annals of Family Medicine November 2017, 15 (6) 535-539; DOI: https://doi.org/10.1370/afm.2109

1,107 Patients
18% prevalence DVT
Sens 90%, spec 97%
2 zone (GP) vs Full Proximal (vasc specialist)

What about hospital medicine?

Home > Journal of General Internal Medicine > Article

Hospitalist-Operated Compression Ultrasonography: a Point-of-Care Ultrasound Study (HOCUS-POCUS)

Original Research | Published: 06 August 2019

Volume 34, pages 2062–2067, (2019) Cite this article

Journal of General Internal Medicine

Sensitivity: 100%
Specificity: 95.8%
(Full Proximal Protocol)

Limitations: Low numbers (125 extremities); low prevalence (6.4%)

Isolated FV (SFV) Thrombus?

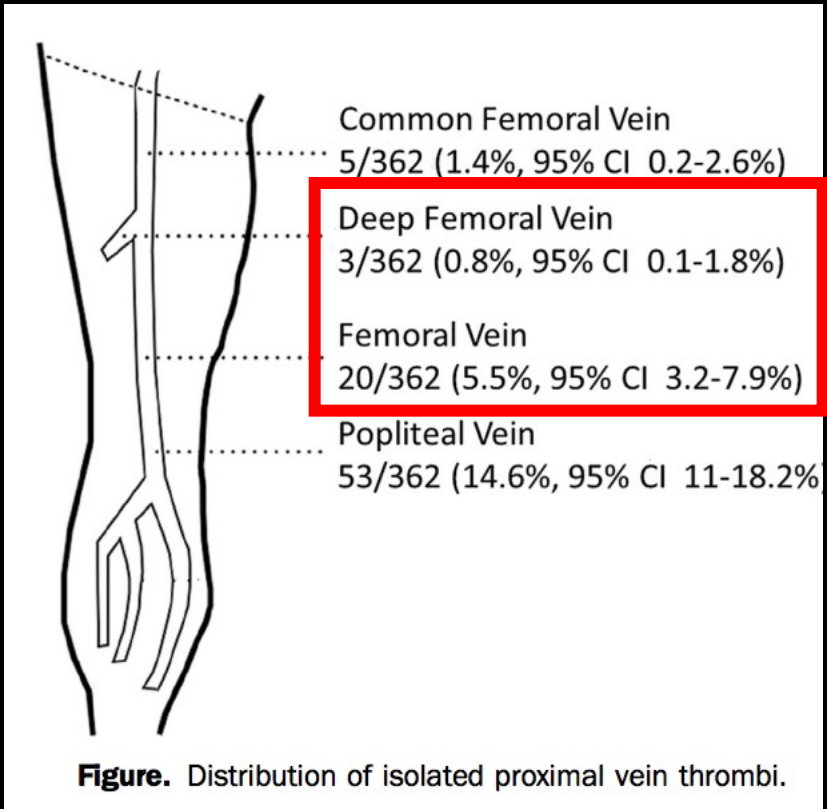


Figure. Distribution of isolated proximal vein thrombi.

Adhikari et al. 2014.

Guidelines?

Circulation
Volume 137, Issue 14, 3 April 2018; Pages 1505-1515
https://doi.org/10.1161/CIRCULATIONAHA.117.030687

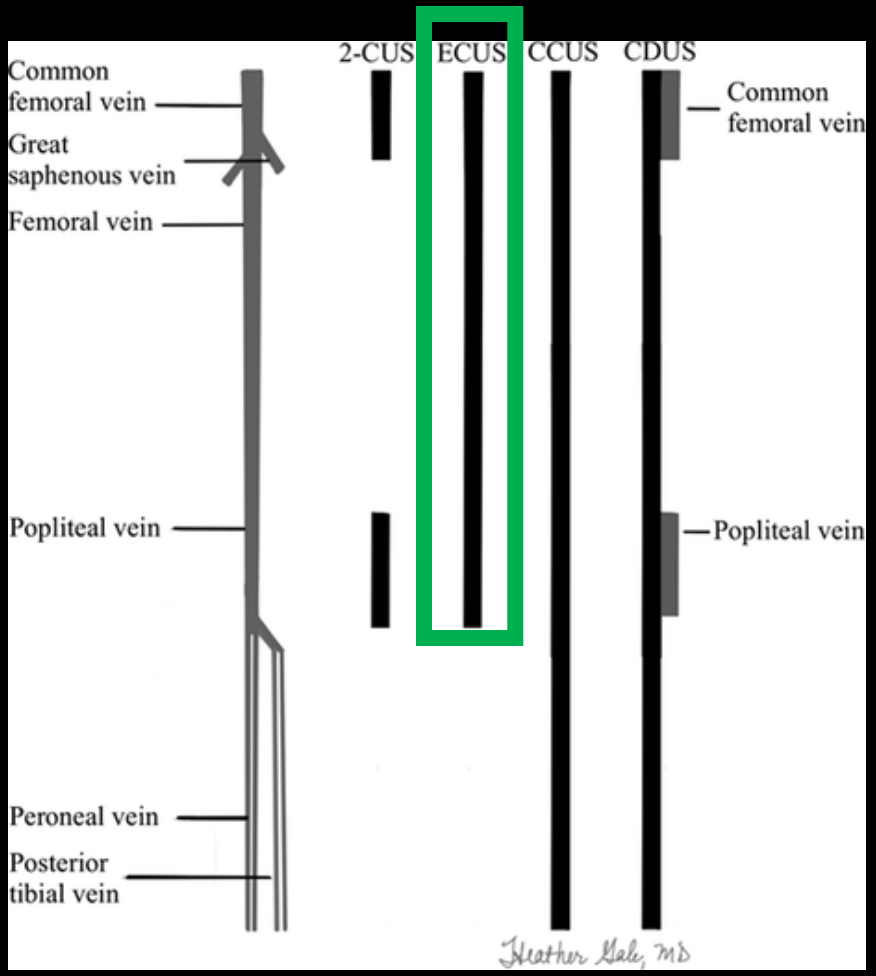
American Heart Association.

CONSENSUS REPORT

Ultrasound for Lower Extremity Deep Venous Thrombosis

Multidisciplinary Recommendations From the Society of Radiologists in Ultrasound Consensus Conference

Laurence Needleman, MD, John J. Cronan, MD, Michael P. Lilly, MD, Geno J. Merli, MD, Srikar Adhikari, MD, Barbara S. Hertzberg, MD, M. Robert DeJong, RDMS, RVT, Michael B. Streiff, MD, and Mark H. Meissner, MD



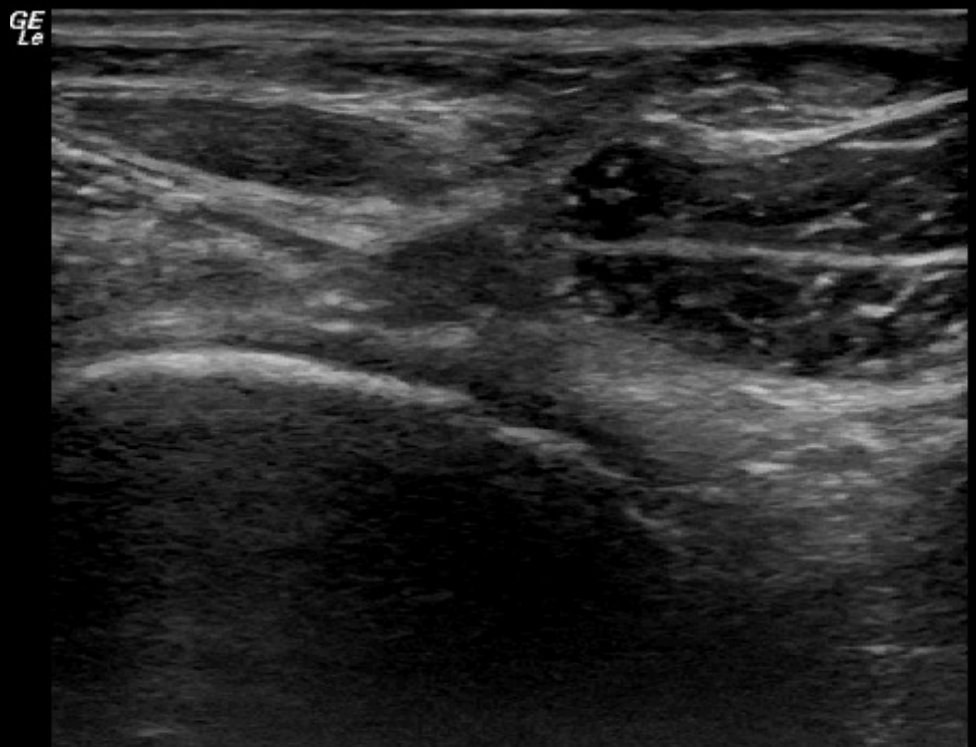
Needleman et al. 2018

Conclusions

Literature Review w/ Personal Experience

- Prevalence of “Isolated” SFV DVT variable in studies
  - May relate to pt setting (inpt >> outpt)
- Prognostic significance of isolated SFV or distal DVT (?)
- Inpatients should probably get full study if readily available or full proximal scan for POCUS
  - 2 zone protocols should be a **rule-in** study
- Likely safe for *outpatient setting* especially if combined with *D-dimer*

Case Conclusion



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Questions/Feedback

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