Chapter 10: Limited Vascular Compression Ultrasound for Deep Venous Thrombosis (DVT)

KEY IMAGES

Start just below the inguinal ligament. Locate the common femoral vein (CFV) and femoral artery (FA). The great saphenous vein (GSV) enters from the medial side.

Hand position and anatomy

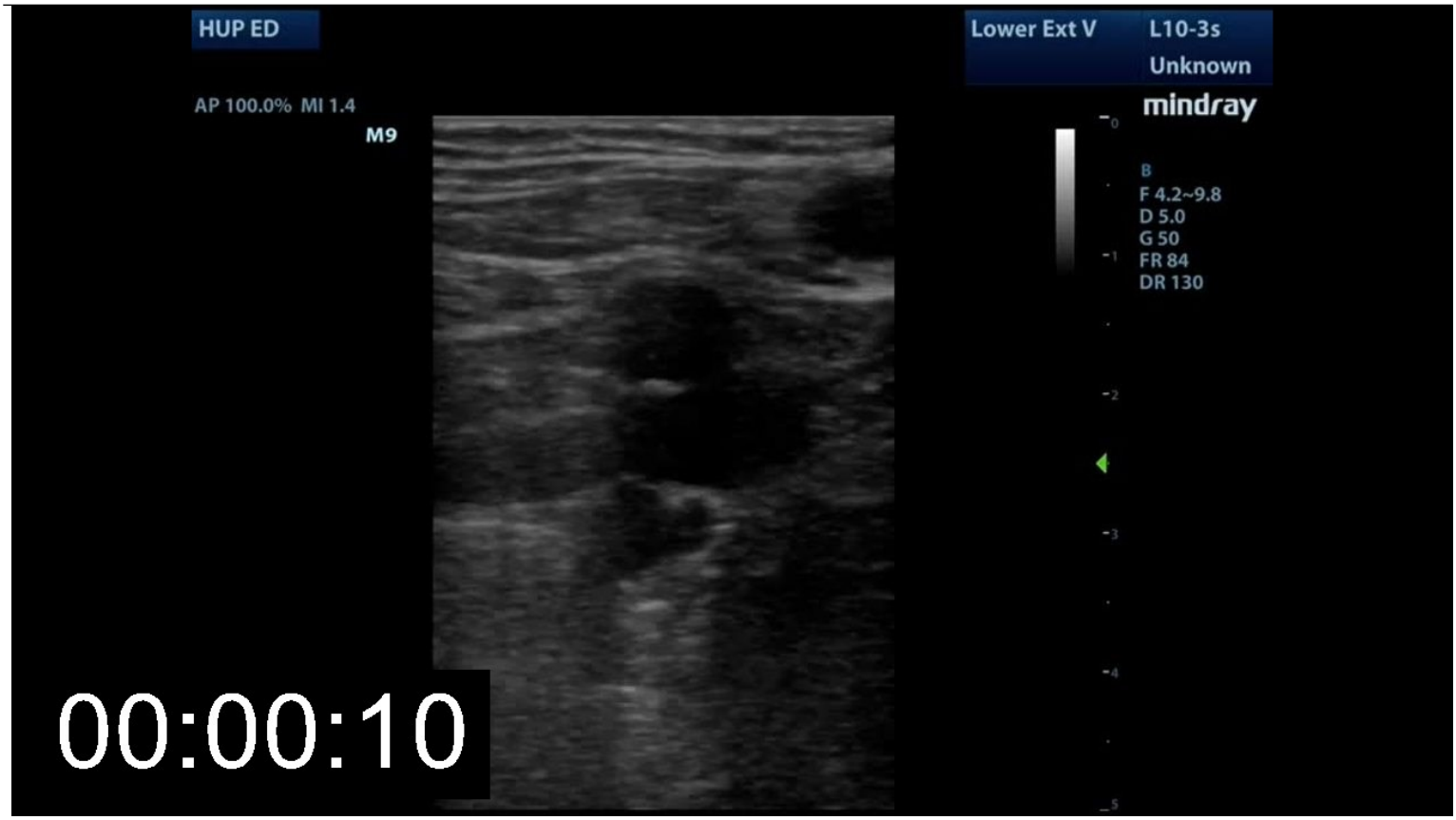
Figure 10-1

Source: C. M. Baston, C. Moore, E. A. Krebs, A. J. Dean, N. Panebianco:
Pocket Guide to POCUS: Point-of-Care Tips for Point-of-Care Ultrasound, 1st edition.

Ultrasound

Video 10-01: Anatomy scan of normal femoral vessels

This video shows the complete vascular of the femoral veins. The great saphenous can be seen coming off to the right initially, just after the bifurcation of the femoral artery. The lateral perforator vein can be seen going left through the space between the two arteries. The end of the video shows the femoral vein splitting into the deep and superficial femoral veins. Just after the lateral perforator a lymph node is visible superficial to the vascular bundles.



Play Video

Ultrasound with compression

Video 10-02: Compression of normal femoral vessels

This zoomed in video shows compression of the femoral vein at the level of the great saphenous takeoff, at the level of the lateral penetrator, and then just before the bifurcation of the femoral vein. The arteries are compressed just to the point of mild deformation, and the walls of the vein can clearly be seen to touch completely.

Play Video

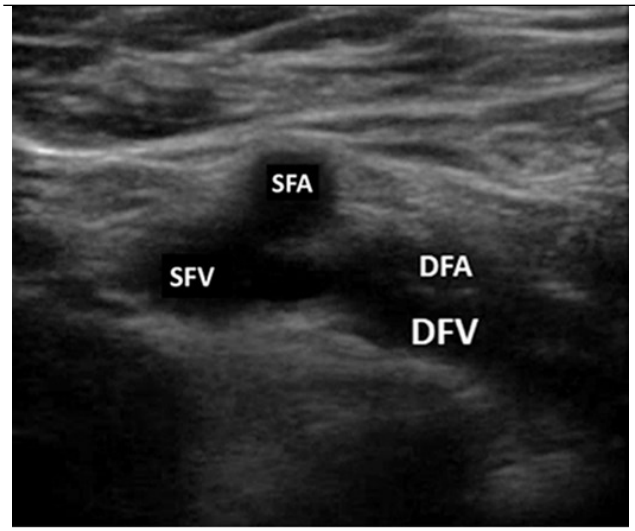
Split of the common femoral vein into the deep femoral vein (DFV) and superficial femoral vein (SFV), and common femoral artery (CFA) into deep femoral artery (DFA) and superficial femoral artery (SFA).

Hand Position and Anatomy

Figure 10-2

Ultrasound

Figure 10-3



Ultrasound with Compression

Figure 10-4

Popliteal vein (PV) superficial to the popliteal artery (PA), with visible femoral condyle (FC)

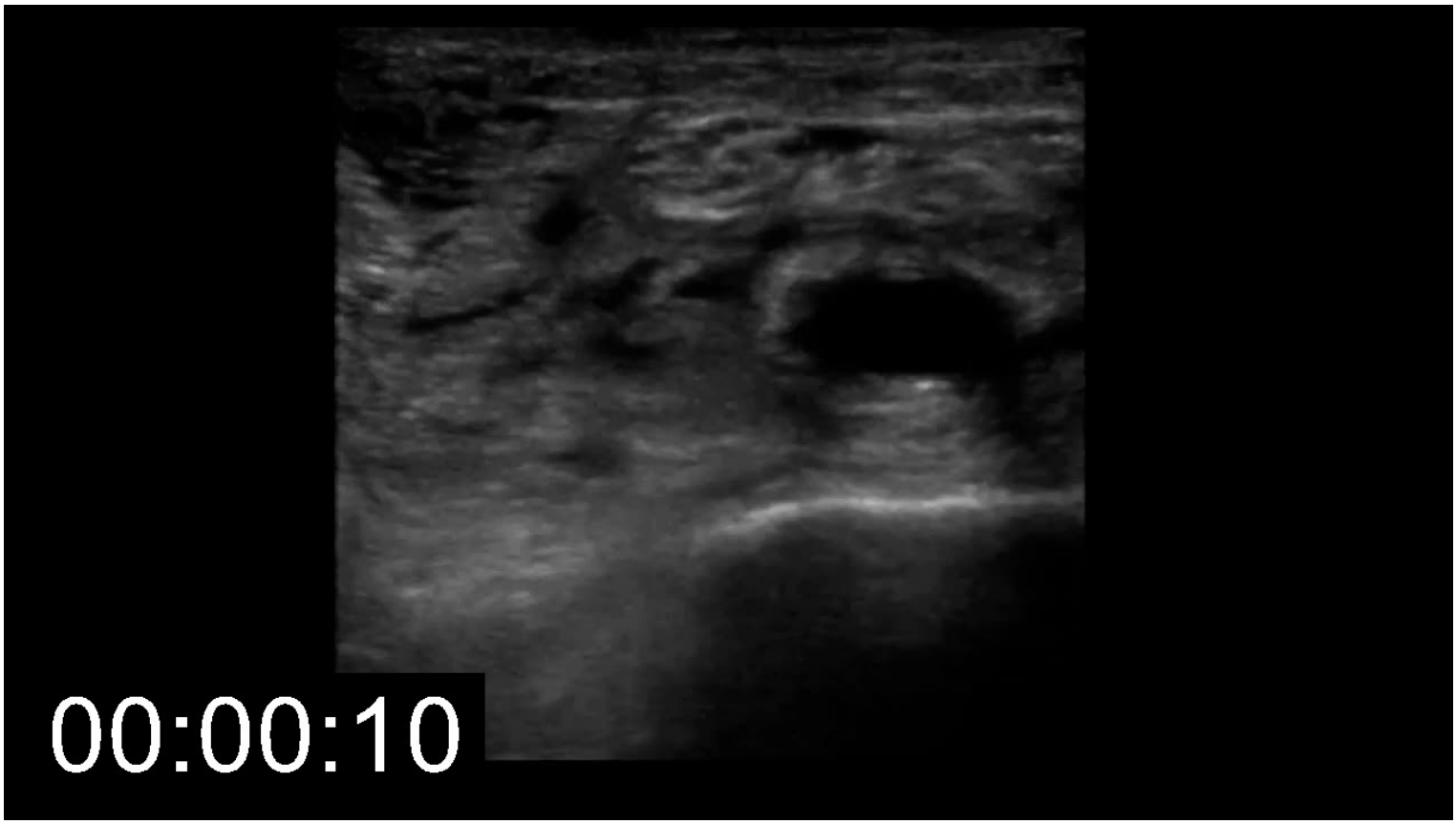
Hand Position and Anatomy

Figure 10-5

Ultrasound

Video 10-03: Anatomy scan of normal popliteal vessels

The tibial plateau provides anatomic anchoring at the bottom of the screen in this normal compression study of the popliteal fossa. The popliteal vein is just superficial to the artery, and can be seen to bifurcate and then trifurcate as the operator fans inferiorly. Every time compression is applied the vein can be seen to completely collapse. The nerve bundle can be seen just superficial to the vein and is incompressible throughout the study.



Play Video

Ultrasound with Compression

Video 10-04: Compression of normal popliteal vessels

This video of the right popliteal space shows the bony prominence of the tibial plateau at the bottom of the screen. The vein is just superficial to the artery and compresses normally throughout at the bifurcation and trifurcation. The nerve is superficial to the vein and is incompressible.

Play Video

Popliteal vein trifurcation into the peroneal, anterior, and posterior tibial veins

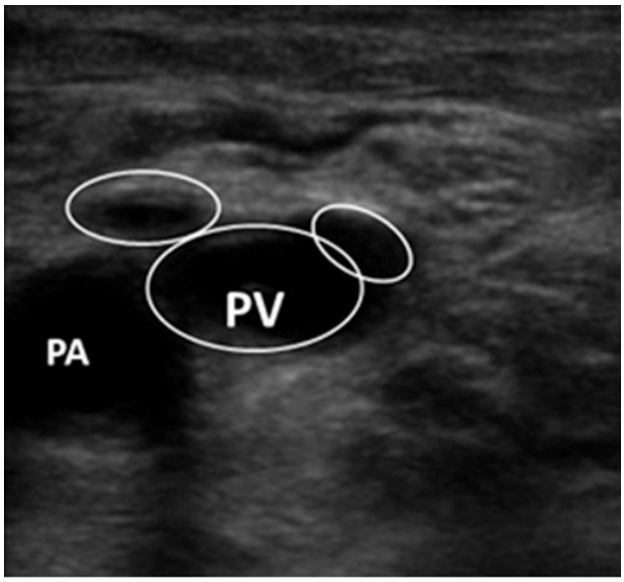
Hand Position and Anatomy

Figure 10-6

Source: C. M. Baston, C. Moore, E. A. Krebs, A. J. Dean, N. Panebianco: *Pocket Guide to POCUS: Point-of-Care Tips for Point-of-Care Ultrasound,* 1st edition.

Ultrasound

Figure 10-7

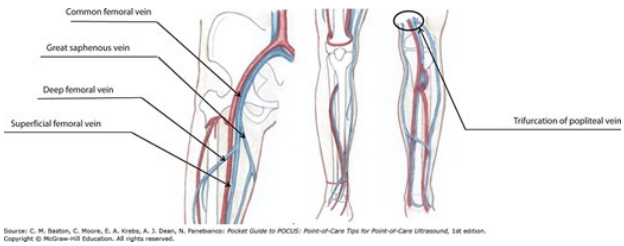


Ultrasound with Compression

Figure 10-8

ANATOMY

Figure 10-9



ACQUISITION TIPS

- Two-region compression—femoral and popliteal.
- Use high-frequency linear probe for most patients. For those with high BMI, it may be necessary to use the cardiac or curvilinear (set to highest frequency).
- Patient positioning options (to maximize leg vein filling).
  - Flatten the bed if the patient can tolerate it.
  - Raise the bed and then position in reverse Trendelenburg to pool blood in the lower extremities (always remember to bring patients back to a comfortable position after scanning).
  - Externally rotate hip and bend at knee (frog leg).
- Prone or lateral decubitus position, if tolerated, can be used for popliteal images.
- Compress downward, perpendicular to vein, looking for complete venous collapse with opposite walls touching.
- Compression must be along the axis of the transducer.
- Warn the patient that compression may be uncomfortable.
- If the vein moves with compression, follow with the probe to keep it on screen.
- Compress with enough pressure to slightly deform the adjacent artery.
- Start proximally and work distally, compressing every centimeter.
- Without counterpressure from hand or underlying bone, a normal vein may not collapse.

Femoral Region

- Flatten bed so pannus does not sit on the upper thigh.
- Start scanning at the level of the inguinal ligament.
- Locate the CFA and CFV in transverse view (vein is medial). Start compression just cephalad to the entry point of the GSV.
- Slide distally, compressing every centimeter until past the bifurcation of DFV and FV. Pay special attention to the branch points.

Popliteal Region

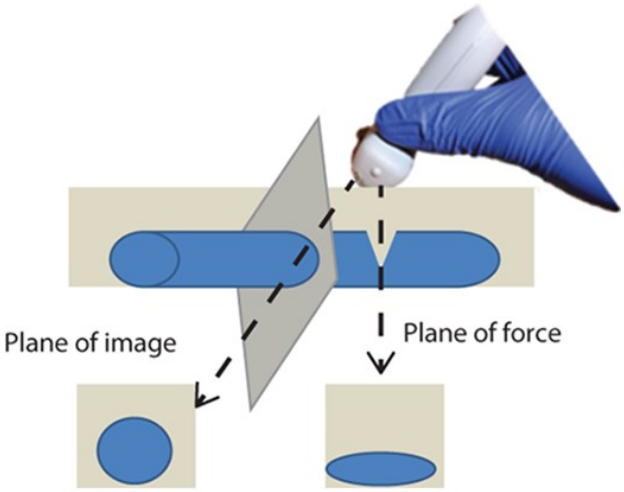
- The anchoring anatomy in this view is provided by the underlying bone: the femoral condyles and posterior tibia.
- The popliteal vessels should immediately overlie the bone. This prevents misidentification of a superficial collateral vessel that is providing venous drainage with a thrombosed and occluded PV.
- The PV is typically superficial to the artery (“pop on top”).
- Scan distally, compressing every centimeter, through the trifurcation of the PV.

INTERPRETATION AND PITFALLS

- Complete venous collapse with compression in each region excludes proximal lower extremity thrombosis.
- Inability to completely compress the vein while applying enough pressure to deform the artery is diagnostic for a DVT.

- Ensure that FV is visualized from the inguinal ligament to the FV bifurcation.
- A negative study does *not* exclude isolated distal calf thrombi.
- Failure to compress along the axis of the probe results in visualization of an area of the vessel different from the area being compressed. This can cause a false positive as seen in the figure.
- Visualization of echogenic thrombus inside the vein is also diagnostic of a DVT. Confirm with compression.
- Avoid overgain that can give the appearance of an echogenic clot in a normal vein. Confirm with compression.
- Modern machines sometimes can visualize mobile echogenic material in normal veins. This is referred to as Rouleaux flow or “smoke.” It is not a sign of pathology.
- A patient with a prior DVT may have scarred vessels that are difficult to differentiate from new thrombotic disease. These vessels can be difficult to compress.
    - Have a low threshold to obtain full Duplex evaluation with these patients.
    - Scarred vessels often compress circumferentially instead of flattening.
- Fresh clots can vary in appearance from an anechoic noncompressible vessel to a dilated echogenic visible thrombus in the vessel. Do not depend on seeing echogenic material in the vessel to diagnose DVT.
- Superficial thrombophlebitis can cause symptoms that mimic a DVT and can be visualized on ultrasound. This diagnosis must be accompanied by clear visualizations of the deeper veins to ensure that there isn't an accompanying DVT.
- Lymph nodes are hypoechoic structures with echogenic medullae that can be mistaken for DVT. They are distinguished from DVT by having a nontubular structure as the transducer slides over the leg.
- Venous valves sometimes appear to be mobile clots. They occur at predictable locations and collapse completely under compression.
- Baker's cysts are fluid-filled structures that originate from the joint and do not have the tubular structure of a vein. Remember to identify the expected popliteal vascular anatomy and deeper bony landmarks.
- Especially in patients with low BMI and those with low blood pressure, the artery can be made to collapse in the presence of a noncompressible vein. This will result in a false negative result. Positively identify the artery by pulsations and compress only until the artery begins to deform.
- A partially occlusive clot is still a clot. The entire anterior and posterior wall of the vein must “kiss” to be considered negative.

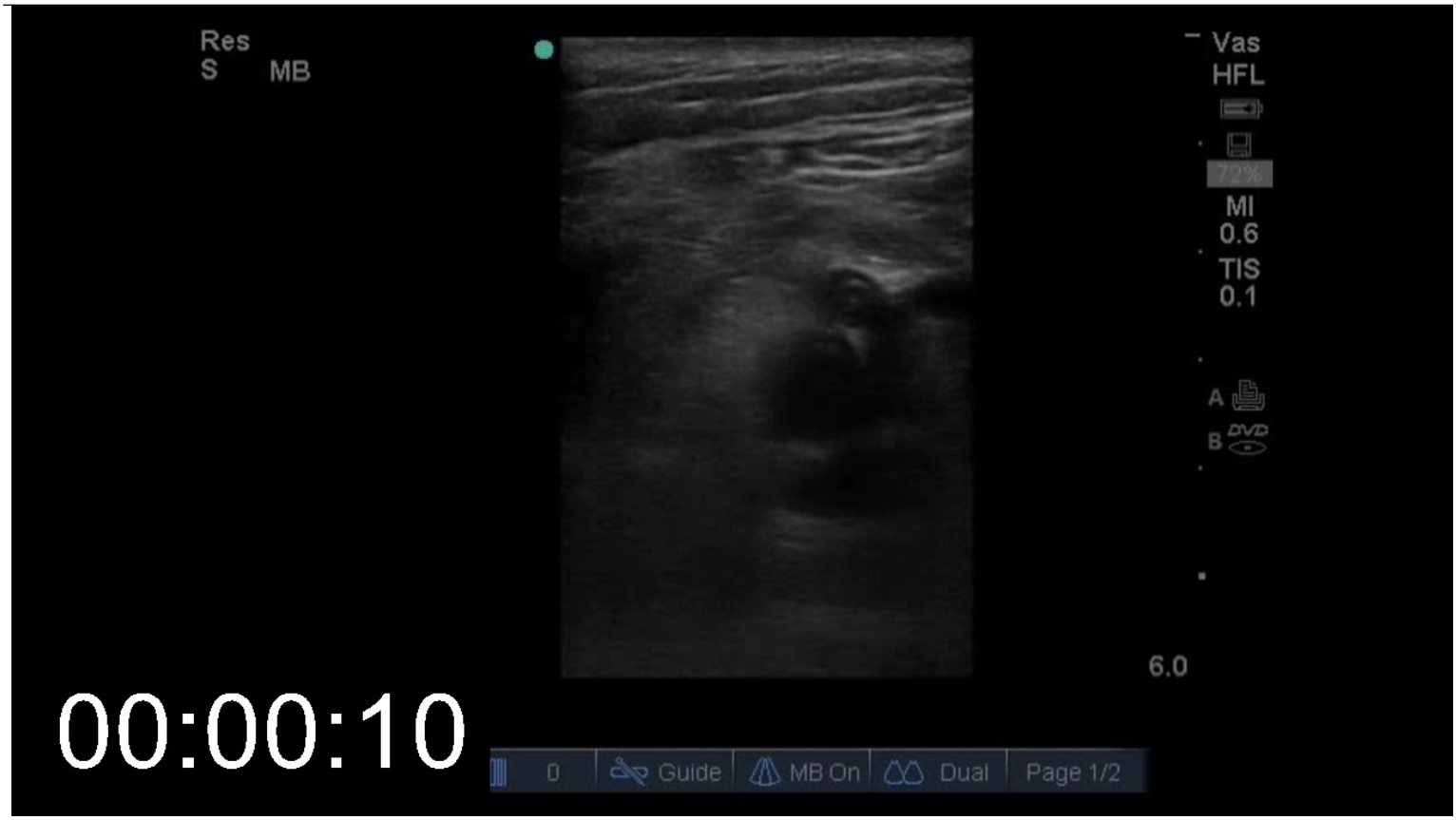
Figure 10-10



EXAMPLES OF PATHOLOGY AND OTHER FINDINGS

Video 10-05: Incompressible femoral vein

This visualization of the femoral vein just after the level of the great saphenous vein can be seen to maintain the shape under compression (visible when all of the superficial veins collapse). Pressure is applied until the artery just begins to deform, but the vein does not change at all.



Play Video

Video 10-06: Incompressible popliteal vein

This video shows the popliteal vein just lateral to the popliteal artery. There is some echogenic material visible in the vessel, but more importantly, when pressure is applied the vein incompletely collapses. This is a positive study.

Play Video

Video 10-07: Visible thrombus in multiple vessels

This patient has thrombi in multiple vessels, including the femoral and a superficial vein as well as the great saphenous. That alone does not confirm a DVT, but the compression applied at the end of the clip demonstrates a completely non compressing femoral.

Play Video

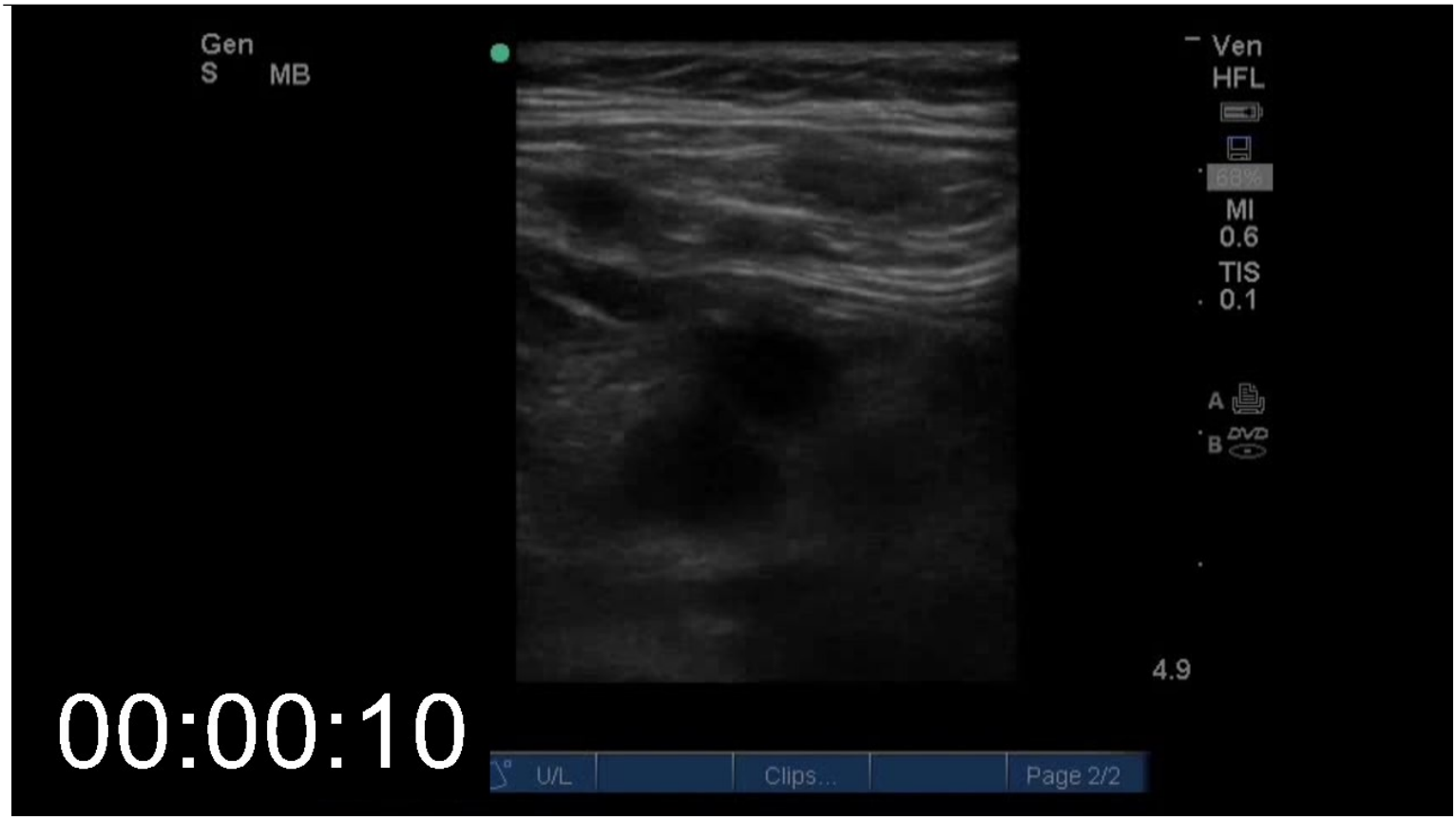
Video 10-08: Baker's cyst

Sometimes a dilated anechoic structure in the popliteal fossa is assumed to be a deep vein thrombus, when in actuality it is a baker's cyst. This video shows a baker's cyst and demonstrates the irregular course and beginning and end that allows differentiation of a cyst from the vessels. Most importantly, the depth of this video prevents identifying the anchoring anatomy needed to confirm that the popliteal vein and artery are being examined.

Play Video

Video 10-09: Lymph node

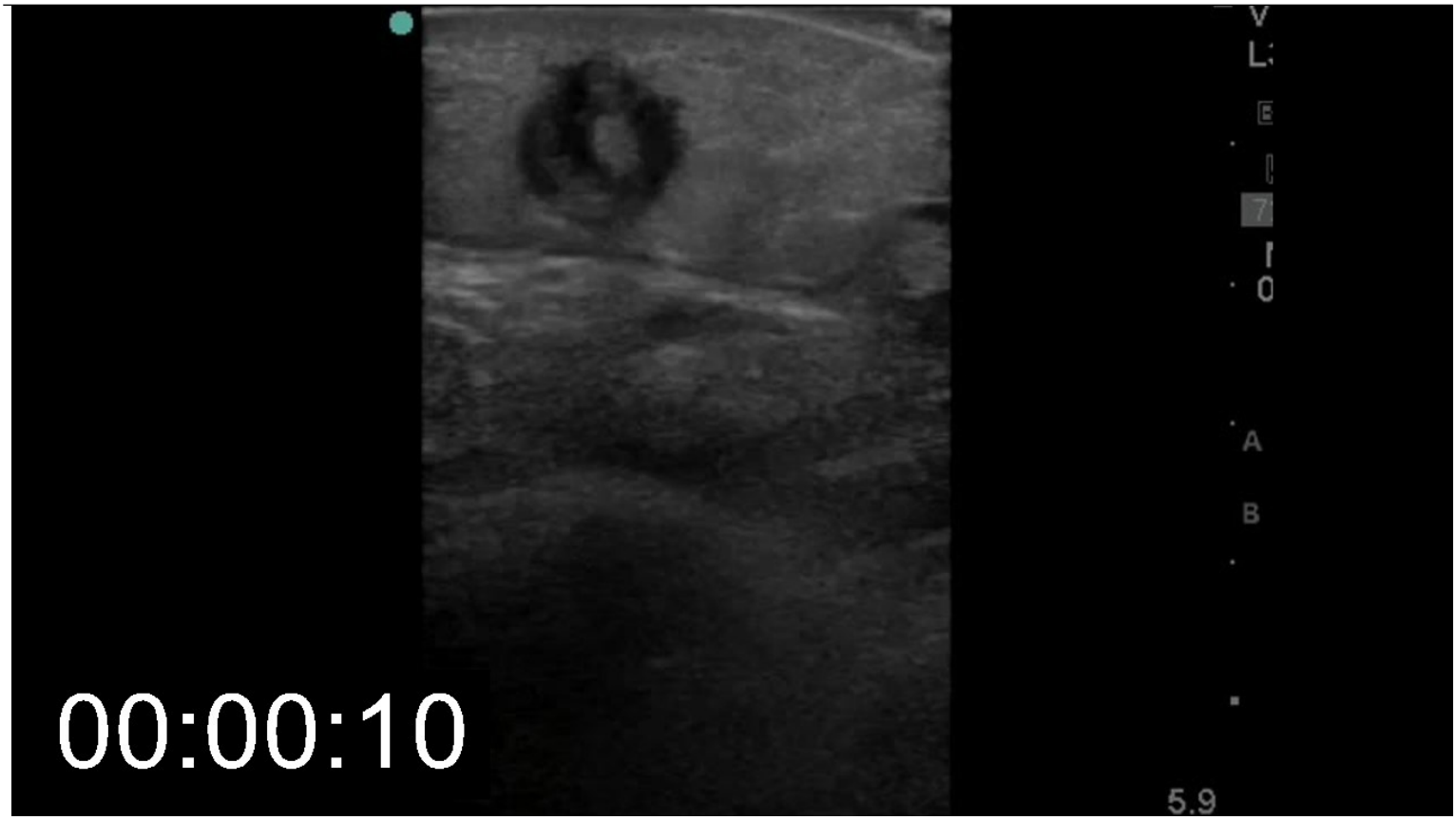
This video demonstrates a large lymph node superficial to the artery that could potentially be mistaken for a thrombus in the vessel until sliding inferiorly past the bifurcation of the vein demonstrates the ending of the lymph node in contrast to the continuation of the tubular venous structures.



Play Video

Video 10-10: Superficial Thrombophlebitis

In this video several superficial veins are dilated and have echogenic material inside. Importantly, however, the depth does not allow visualization of the femur or any other anchoring anatomy.



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