Chapter 3: Ultrasound-Guided Peripheral Intravenous Access

KEY IMAGES

Patient and provider setup

Figure 3-1

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.

Hand position, longitudinal

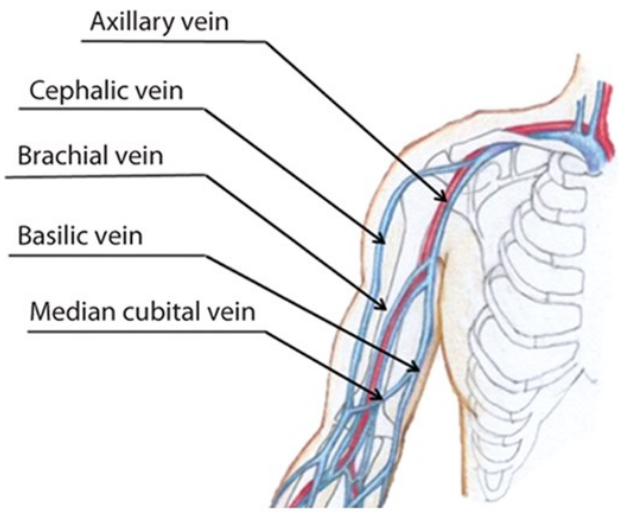
Video 03-01: Hand Position Longitudinal

Using the hand position in the still image, the needle can be guided into the vessel while maintaining visualization of the entirety of the vein and needle throughout the procedure.

Play Video

Venous anatomy of the upper extremity

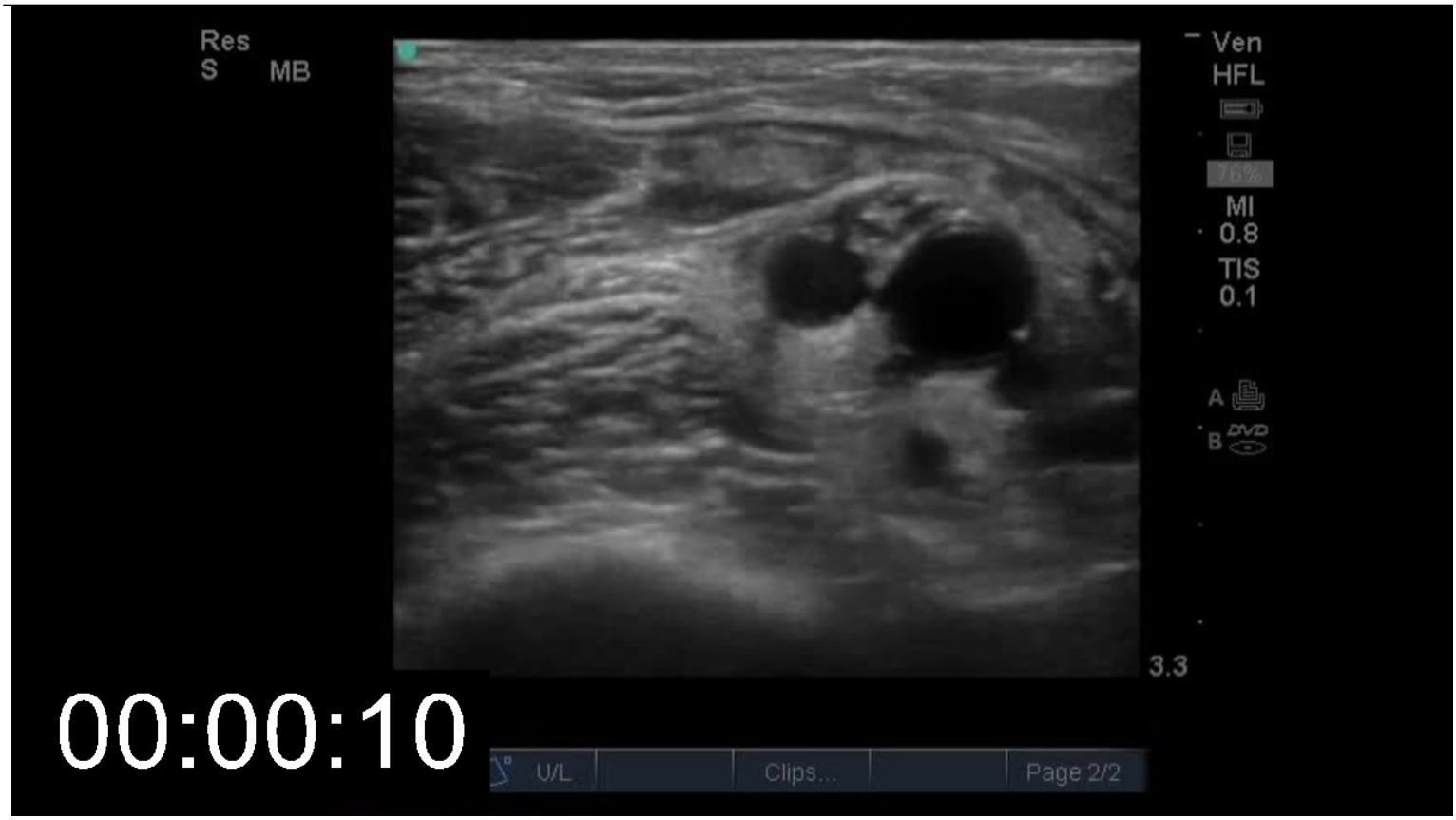
Figure 3-2



Hand position, transverse

Video 03-02: Hand Position Transverse

Using the hand position in the still image, the needle can be guided into the vessel using the follow-the-tip technique. This means that the needle is advanced until visible on the screen, then the probe is moved away from the needle until the bright white dot disappears. This process is repeated until the needle is well into the vessel.



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US anatomy, proximal arm

Video 03-03: Upper Arm Anatomy

In the anterior upper arm, the humerus can be seen as the landmark deep on the screen. The brachial vein and artery can be seen running between the bicep and triceps muscles. Also visible is the basilic vein splitting off of the brachial, and the brachial nerve between the artery and vein.

Play Video

US anatomy, forearm

Video 03-04: Forearm Anatomy

In the forearm the vein can be seen running superficial to the muscle body, and deep to the dermis. The radius can be seen as a landmark deep on the screen. Notice that it takes very little pressure to compress these veins (on the right side of the screen an uncompressed gel layer is a marker of the amount of pressure being applied).

Play Video

Catheter in vessel, transverse view (target sign)

Video 03-05: Accessing the Vessel in Transverse

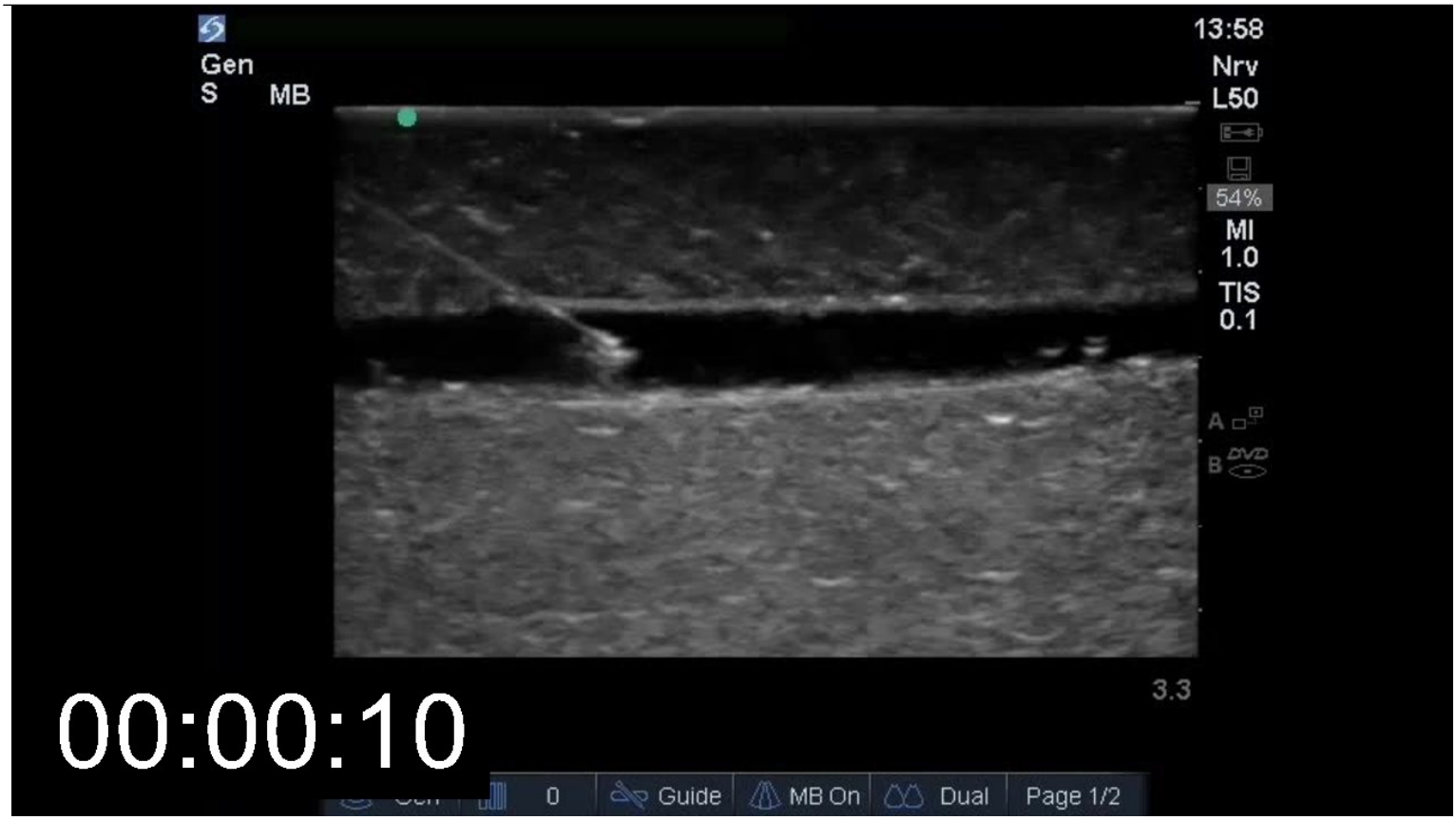
This video shows the process of following the needle tip in the transverse or out-of-plane technique. As soon as the needle tip becomes visible (as a bright white dot), the operator stops advancing the needle and moves the probe away until the needle tip disappears. This process continues until the needle is hubbed in the vessel.

Play Video

Catheter in vessel, longitudinal view

Video 03-06: Accessing the Vessel in Longitudinal

This video shows the vein and needle with the transducer being held in the same plane while the needle is advanced into the vessel. This video also demonstrates that rotating and fanning the transducer can cause the needle or the vessel to move out of plane.



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ACQUISITION TIPS AND INTERPRETATION

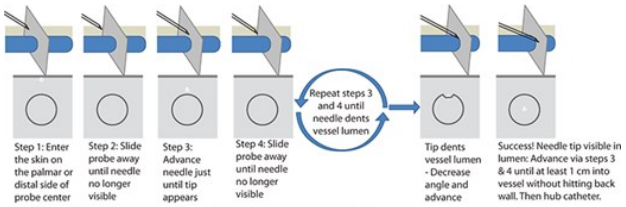
- Indications: Any patient needing an intravenous line that has had two or more failed attempts, has a history of poor venous access, or has no visible veins on physical exam.
- Use a high-frequency linear probe and a protective barrier over the probe (nonlatex glove, sterile glove, or sterile commercial probe cover).
- As for any procedure, setup and operator comfort are essential to success.
  - Align the machine so that it is easily in view while scanning the extremity.
  - Place a table or hard surface under the extremity, adjusted to the correct height for comfort, as a location for supplies.
  - Prior to final setup, perform an “exploratory ultrasound” to identify an appropriate target vessel. Ideally it should be straight and >3 mm diameter.
  - Use a stool with wheels if available. If not available, raise the bed (if standing) so that the procedure can be performed with minimal stooping and twisting.
  - Dim the lights to improve the visibility of the screen.
- Use an IV catheter that is at least 1 cm longer than the diagonal depth to the vessel.
- Use probe compression to distinguish vein from artery.
- Color Doppler may be helpful, but it requires advanced technical skills.
- The transverse plane (out-of-plane) approach is typically easier to learn.
- Brace your probe hand with the transducer wire behind your wrist and make very small, controlled movements.
- Only one hand moves at a time, either the probe hand or the needle hand.
- Once the catheter is placed, ultrasound can confirm placement.

Technique

Transverse Plane (Out-of-Plane)—Tracking the tip

- Line up the vessel in the center of the viewing screen.
- Warn the patient and insert the needle just through the epidermis and slide the probe toward the needle until you can identify the needle on the screen.
- Slide the probe away from the needle tip until it disappears.
- Holding the probe still, advance the needle tip until it is seen again on the screen.
- Holding the needle still, slide the probe away from the needle until the tip disappears.
- Continue this technique until the needle tip is through the proximal wall of the vessel.
- A flash in the catheter does NOT confirm needle placement!
- Flatten the angle of the catheter and track the tip of the needle in the vein until the catheter is hubbed or cannot be advanced without going through the back wall.
- We recommend confirming placement with a longitudinal view (described next).

Figure 3-3



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.

Longitudinal Plane

- Scan the vein until it is seen longitudinally across the entire screen.
- Place the needle at the center of the short axis of the probe, noting the exact angle.
- Do not move your scanning hand.
- Slowly advance the needle, watching it come into view. If you don't see the needle after piercing the skin, make small motions with the needle until it is visible on the screen.
- Once the needle and vein are visible at the same time, advance the needle into the vein.
- Advance the needle until it is hubbed or cannot be advanced without penetrating the back wall.
- If you fall off plane and cannot see the needle and vessel in the same image, the procedure may need to be restarted.
- Many practitioners start in the transverse plane and rotate to the longitudinal plane to see the benefit of both techniques.

Relative advantages and disadvantages of different "angles of attack" for IV insertion

	Advantages	Disadvantages
Shallow angle of attack (30°) 	Less likely to puncture posterior wall of vessel with needle tip Less likely to have kinking of the catheter in the vessel	Need longer catheter to reach vessel May be harder to engage and pierce front wall of vein
Steep angle of attack (45°) 	Shorter subcutaneous path allows for shorter catheter and greater stability Easier to engage vessel and get through near wall	More likely to damage posterior wall Catheter more likely to kink and become nonfunctional

COMMON PITFALLS

- Failure to track the needle tip—This is by far the most common reason for failed ultrasound-guided venous access.

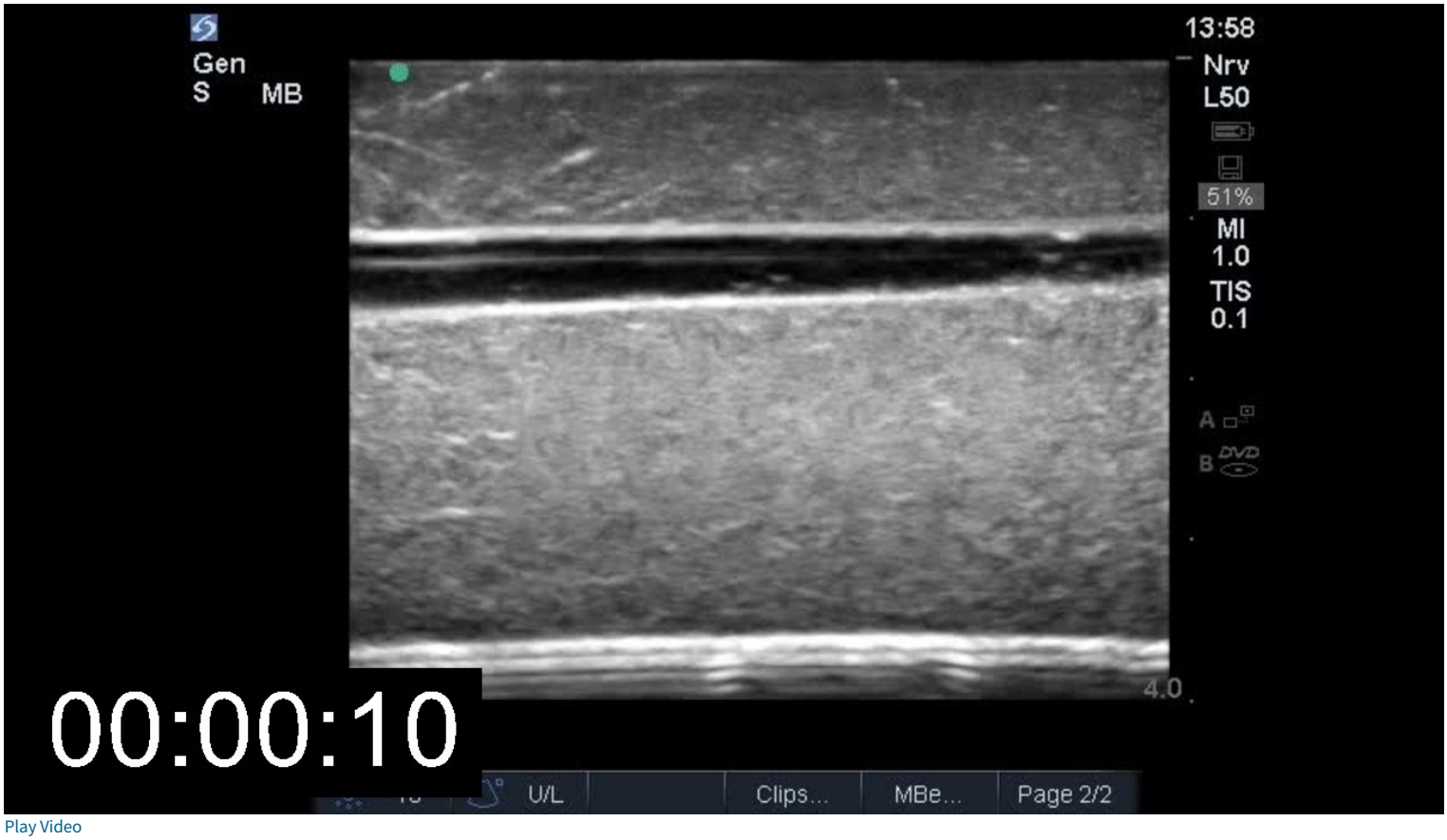
- Misidentifying the artery as the vein—Apply gentle pressure to the vessel; if it collapses without pulsating, it is the vein. Be particularly careful of this in hypotensive patients. Color Doppler and spectral Doppler can be used to assess pulsatility.
- Failing to puncture the skin exactly above the vein—It is often possible to make compensatory movements to the vein, but it becomes difficult to advance the needle tip in the vein.
- Misidentifying the nerve as the vein—Nerves have a “honeycomb” appearance and a fairly consistent anatomic distribution. Apply compression, use color Doppler, and adjust gain if unsure.
- Mistaking a lymph node for a vessel—Slide the probe to demonstrate that your target is a continuous tube.
- Failure to recognize that a vessel is thrombosed—Use compression and ensure collapse.
- Damaging or penetrating the back wall—track the tip of the needle in the vessel keeping a clear “target sign” in view, and decrease the angle of the needle once in the vessel.
- Catheter dislodgment—If the line does not flush, rescan the vessel and look for the location of the catheter and for hematoma. Saline flush can be used to look for bubbles within the lumen of the vein.

EXAMPLES OF PATHOLOGY

Needle through back wall, long

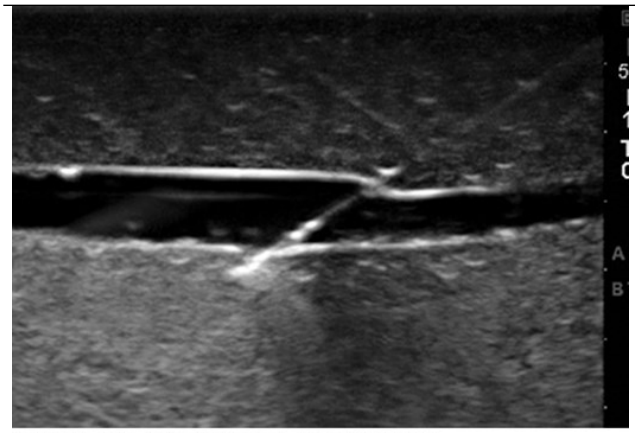
Video 03-07: Needle through the Posterior Wall

This video demonstrates an operator who fails to flatten the angle of approach in the longitudinal plane, resulting in the needle tip penetrating the posterior wall of the vessel.



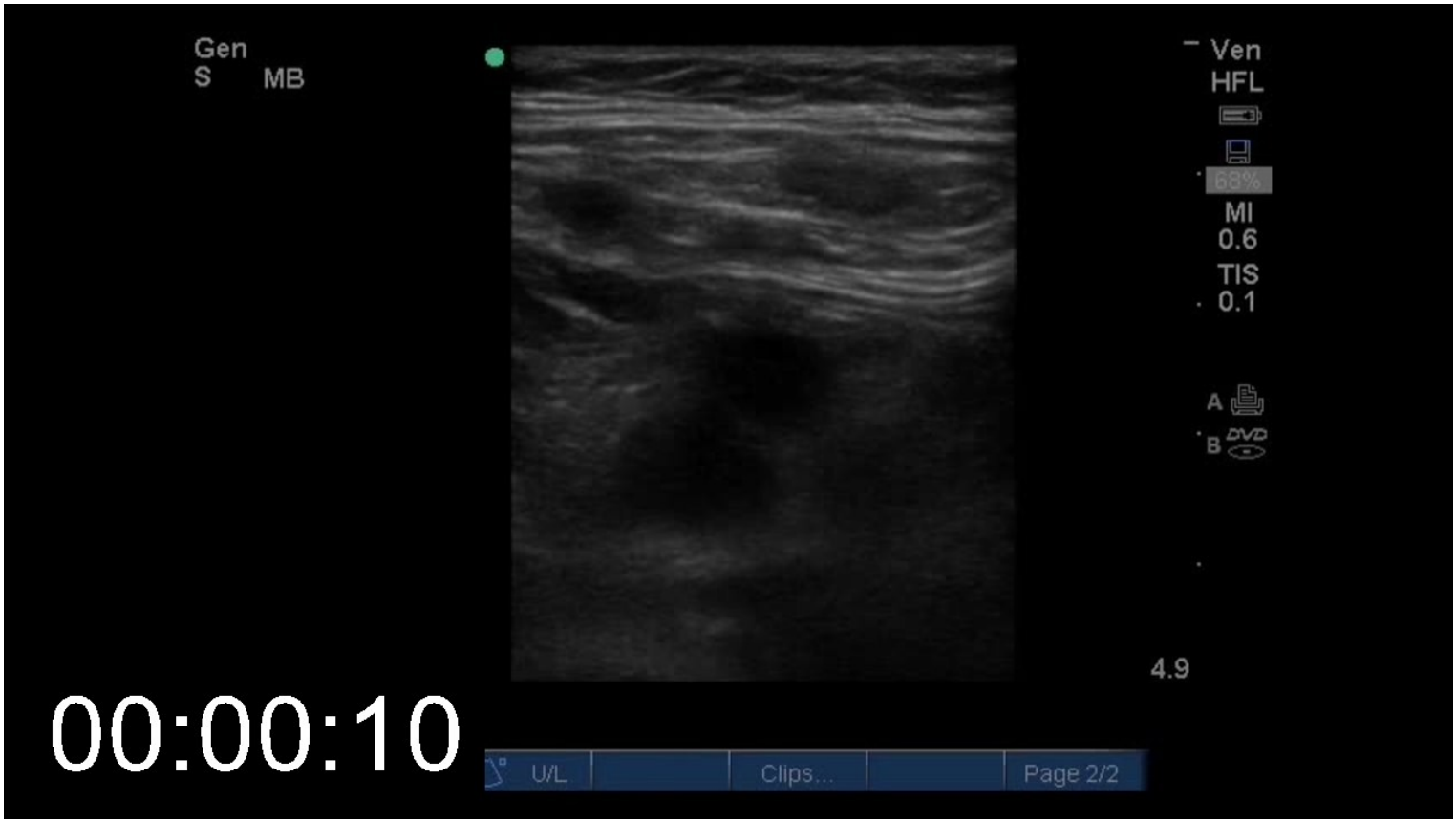
Play Video

Figure 3-4



Video 03-08: Lymph Node

This video demonstrates the primary differences between lymph nodes and vessels: as the probe slides over the skin, initially you can see a superficial vein, a deeper vein, and deep to that vein an artery. In the near field can be seen a round structure, that's actually a lymph node. As the probe slides over the skin, the tubular veins and artery remain circular, while the spherical lymph node shrinks and disappears.



Play Video

Video 03-09: Superficial Thrombophlebitis

The superficial veins in this video can be seen to be dilated with echogenic material inside (reflecting thrombus). The thickened dermis and mild cobblestoning are consistent with thrombophlebitis (see the abscess and cellulitis chapter for more details).

Play Video

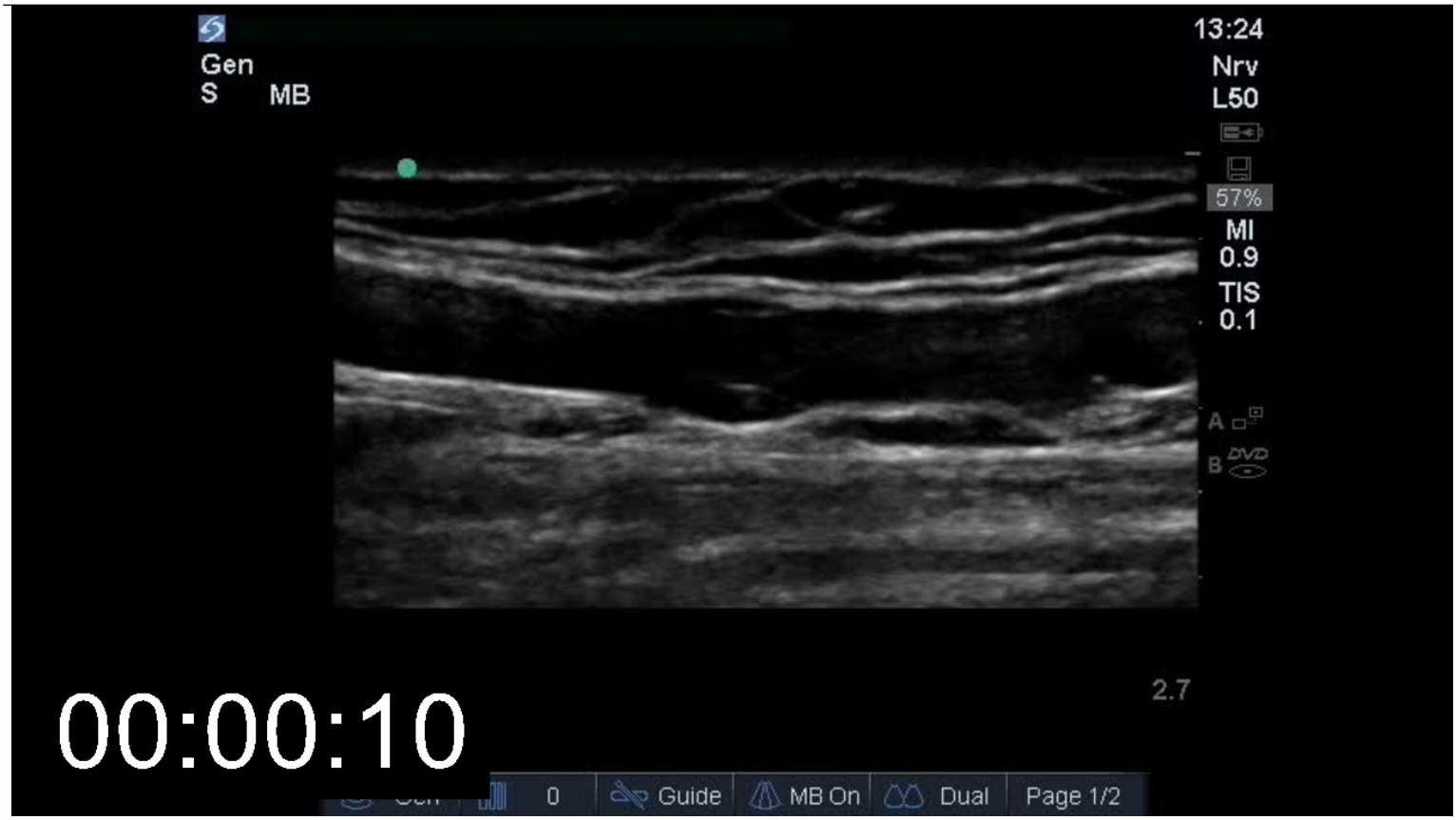
Video 03-10: Infiltrated Line - Longitudinal

In this video, a catheter has been placed through the posterior wall of the (my) vein. As fluid is instilled through the catheter, turbulent flow can be seen dissecting the tissue planes

Play Video

Video 03-11: Valve

This vein can be seen to have a small region of dilation with a thin echogenic structure inside. This is a valve, and will easily compress. Passing a catheter past this valve, however, can be challenging.



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