

Ultrasound Guided Vascular Access

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Objectives

- Evaluate vasculature
 - ID your vessels
- Preparation prior to procedure
- Basic approaches
 - Short vs Long axis
- Technique
 - IJ, Subclavian, Femoral
 - Peripheral lines
- Recovery from failure
- Pitfalls and tricks

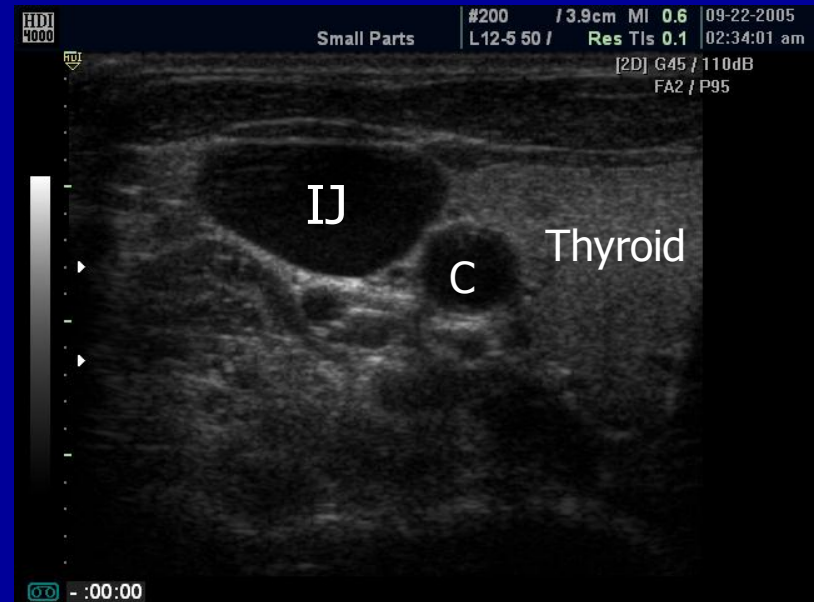


Conflicts of Interest

- None relevant to this lecture
- Sonosim
- Verathon
- Philips
- PocketSonics
- Headsense
- Orcasonics

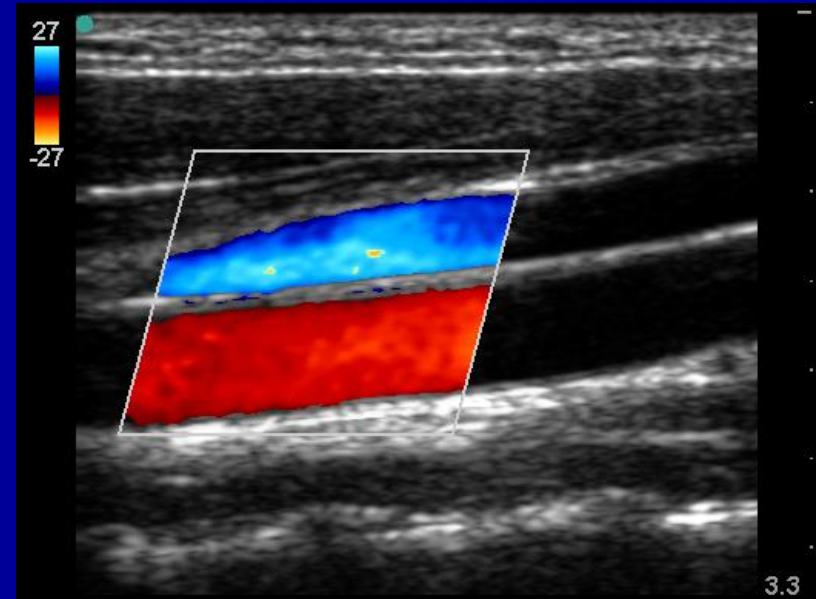
Normal US Appearance

- You now know basic US physics
- Vessels carry fluid so are dark when not scarred or thrombosed
- Veins should collapse under pressure, while arteries won't so easily
- Are there other ways to evaluate vessels?



Doppler Usage

- Color Doppler is a useful adjunct
 - Shows blood flow and direction of flow
 - Standard is blue for blood flowing away from the transducer
 - Red for blood flowing toward the transducer



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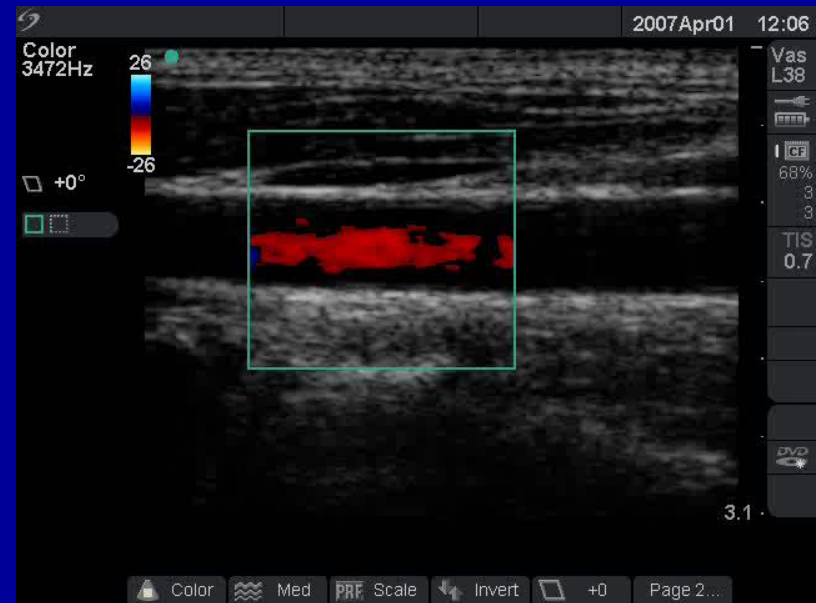
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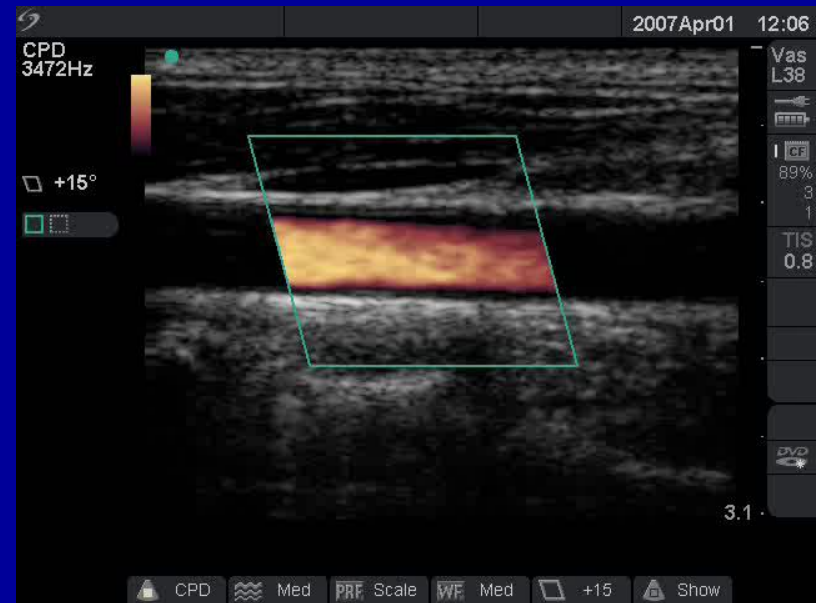
Doppler Usage

- Color Doppler is a useful adjunct
 - Shows blood flow and direction of flow
 - Standard is blue for blood flowing away from the transducer
 - Red for blood flowing toward the transducer
 - Improper settings can be confusing



Doppler Usage

- Power Doppler
- Does not show direction in general
- More sensitive
- Can really use either



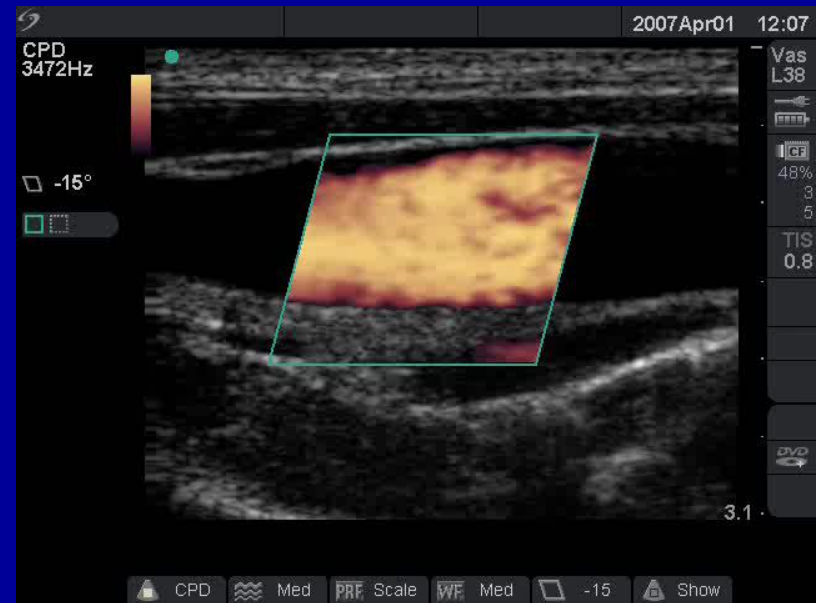
Doppler Usage

- Be careful about relying on color or power Doppler only
- May be tricky to differentiate artery from vein
- IJ can also give a signal in color or power



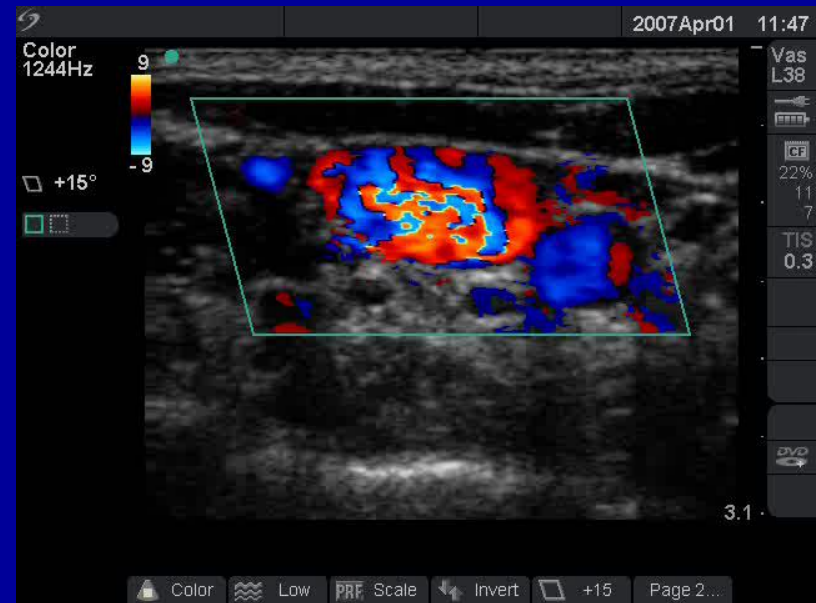
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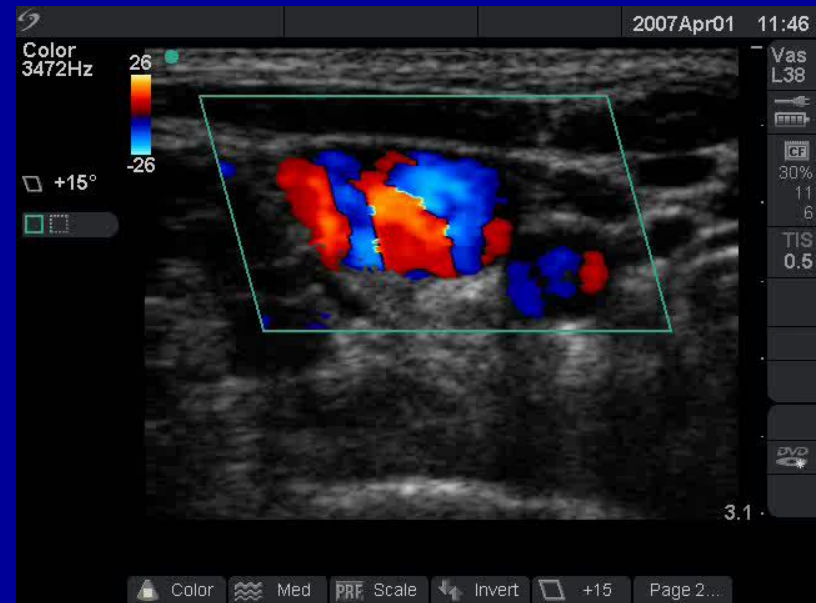
Doppler Usage

- Color Doppler sensitivity can be changed on most machines



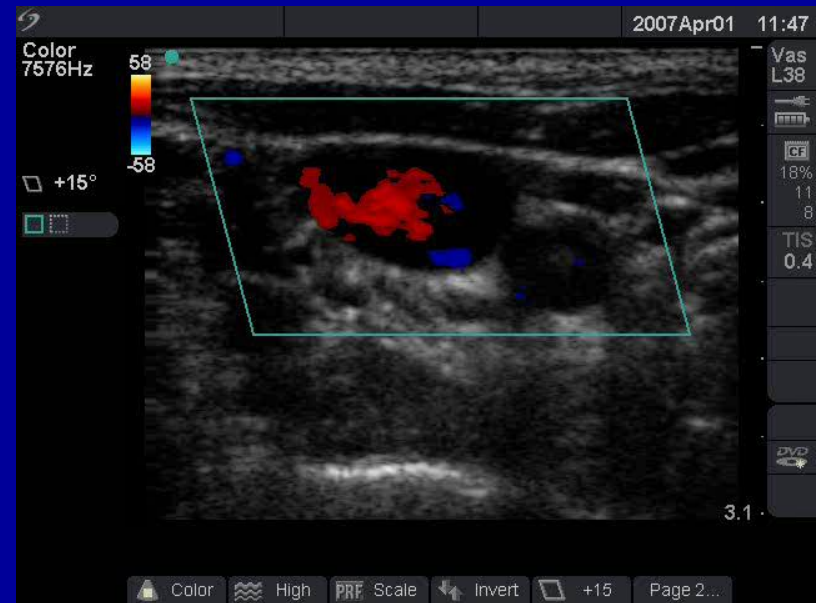
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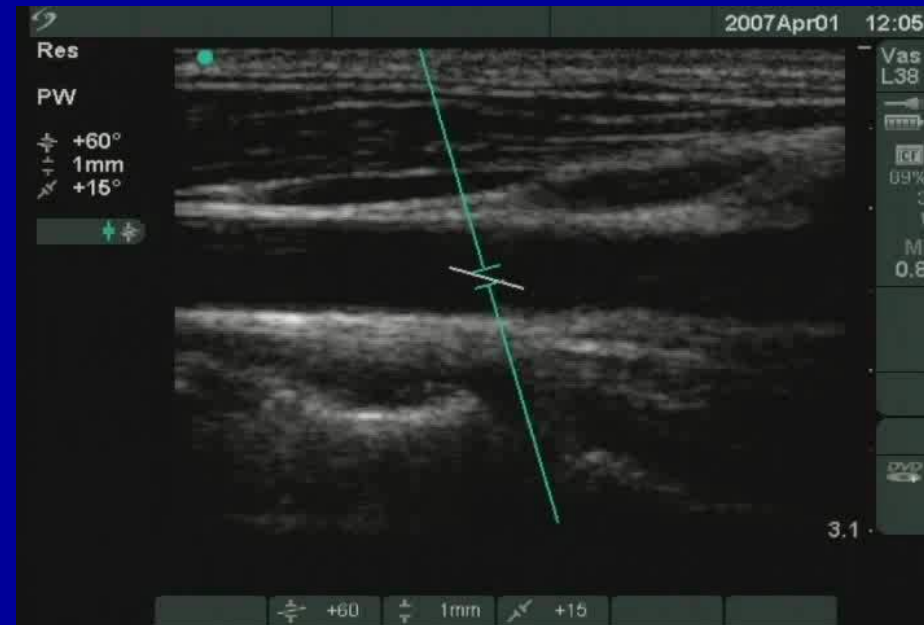
Doppler Usage

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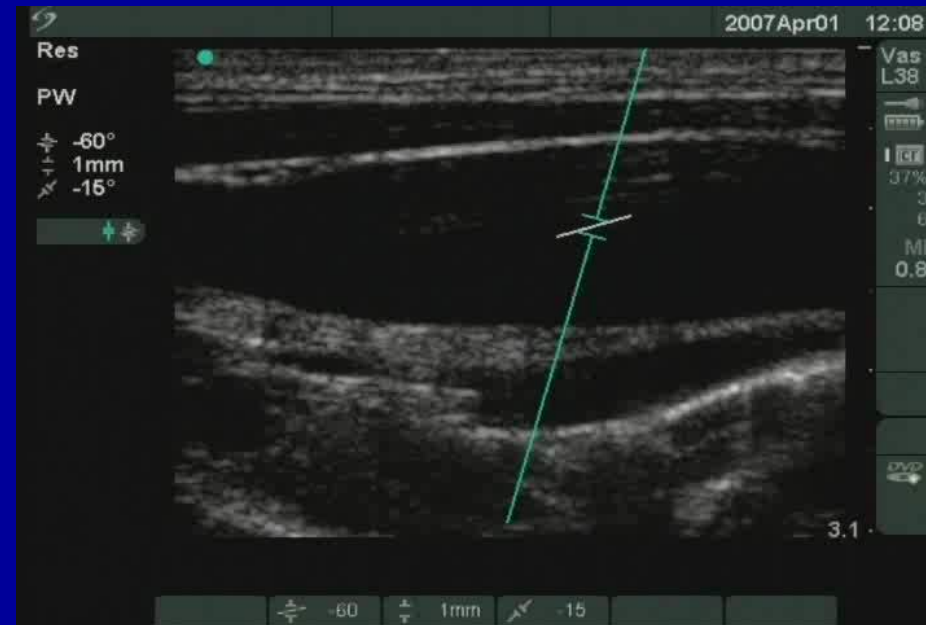
Doppler Usage

- Pulse Wave Doppler
- The real deal for blood flow
- Shows direction
- Helps differentiate arterial from venous flow
- Specific wave forms with some overlap



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- Specific wave forms with some overlap



Doppler Usage

- Subclavian artery and vein can be differentiated by pulse wave Doppler
- Proximity to the heart and to the artery alters the flow wave pattern in the subclavian vein



Doppler Usage

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Basic Principles of US Guidance

- The same regardless of central, peripheral vein or arterial access
- Peripheral can actually be harder



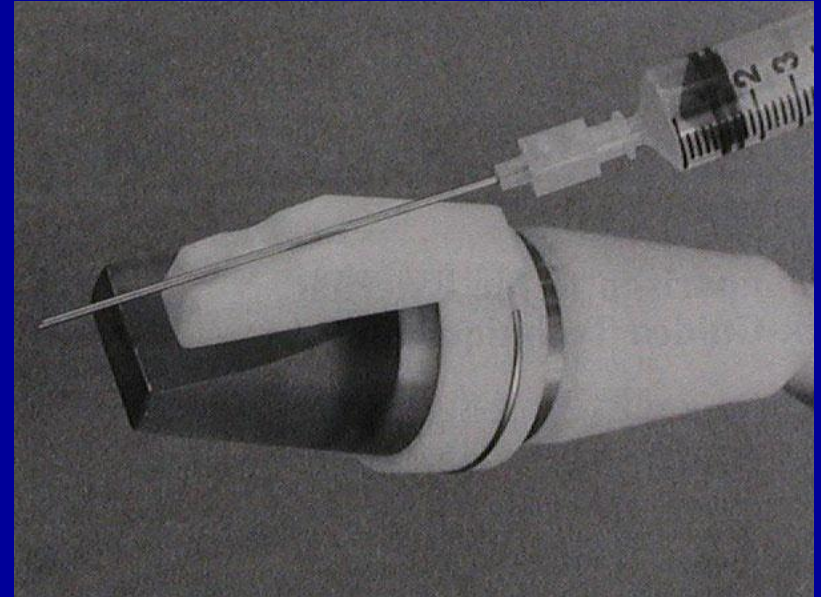
What Are the Tools You Need?

- A high resolution linear probe
- One that ranges from 5 to 13 MHz is typical
- An ultrasound machine
 - One with color Doppler can be very helpful for finding vascular structures in difficult patients
 - Spectral Doppler can also be of great help



What Are the Tools You Need?

- Sterile field and probe cover as needed
- Some practice
- Needle guide may be used
 - Most people do not use them
 - Can be done freehand, and usually is
 - Needle guides have some drawbacks



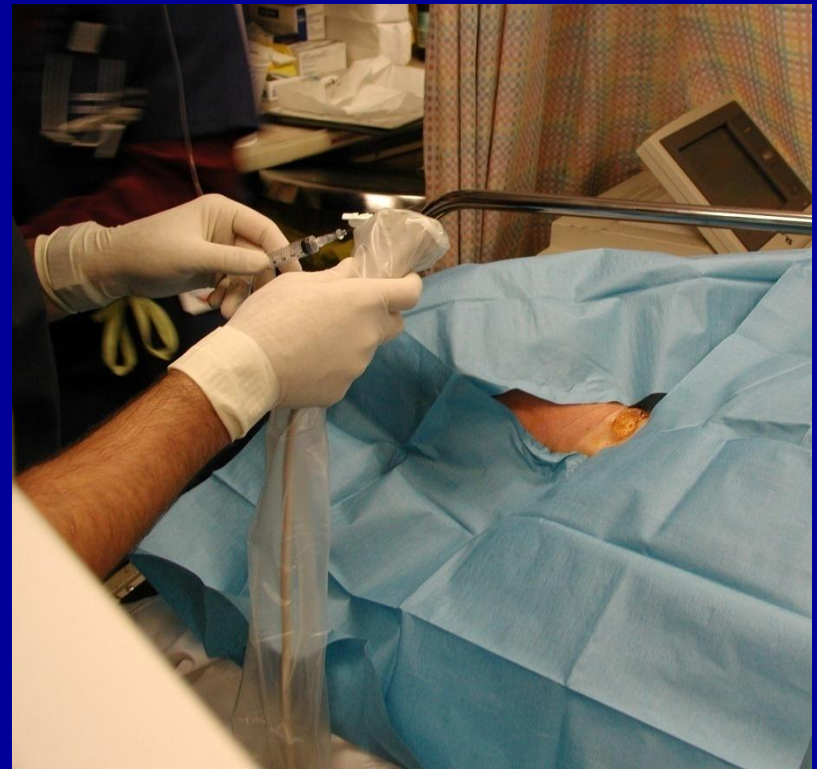
Sterile Probe Sheath

- Can be simple such as sterile glove
- Ideally an actual sterile probe cover can be obtained
- The rest is your standard sterile technique with the addition of sterile gel
- The sterile gel goes on the outside of the probe cover



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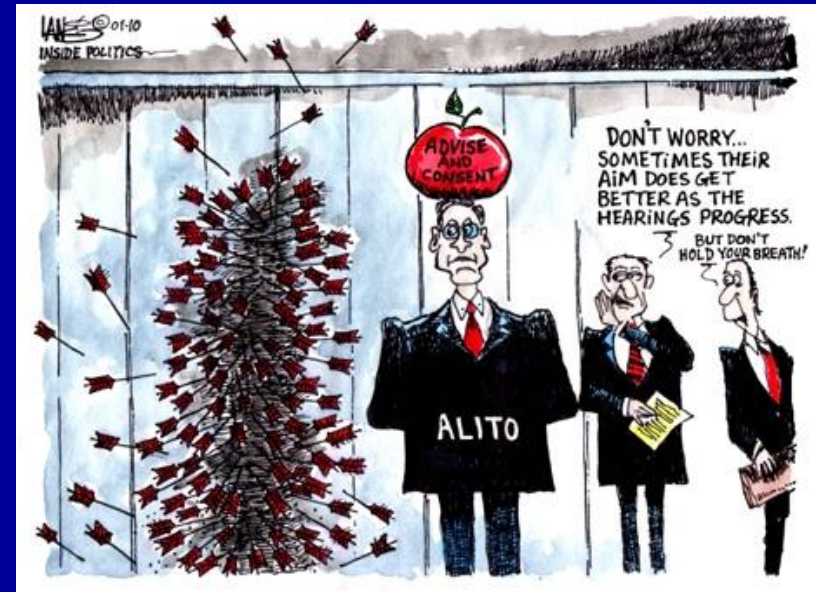
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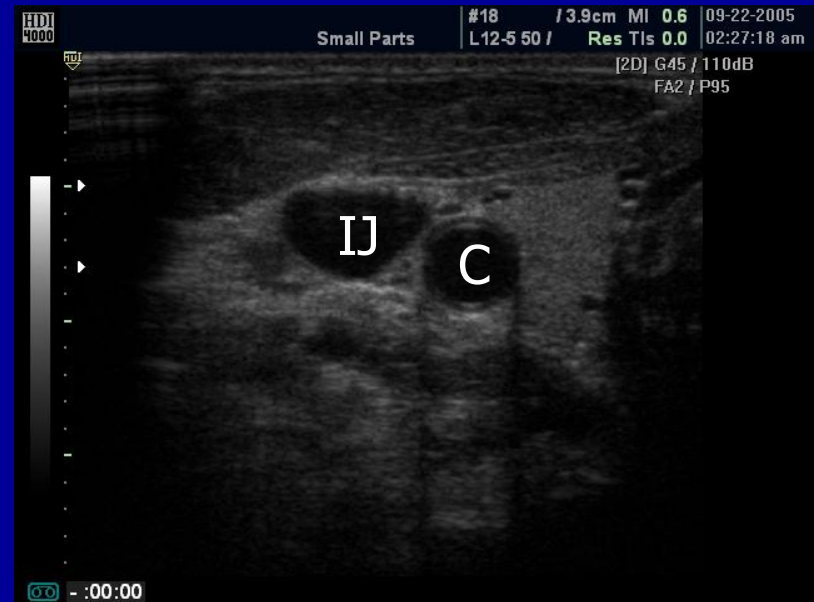
Why Not Just Mark Anatomy (static guidance)?

- AHRQ says no, must use dynamic
- Lower first pass success rate and lower over all success rate
- Milling TJ et al. Randomized, controlled clinical trial of point-of-care limited ultrasonography assistance of central venous cannulation: the Third Sonography Outcomes Assessment Program (SOAP-3) Trial. Crit Care Med 2005; 33:1764-1769.



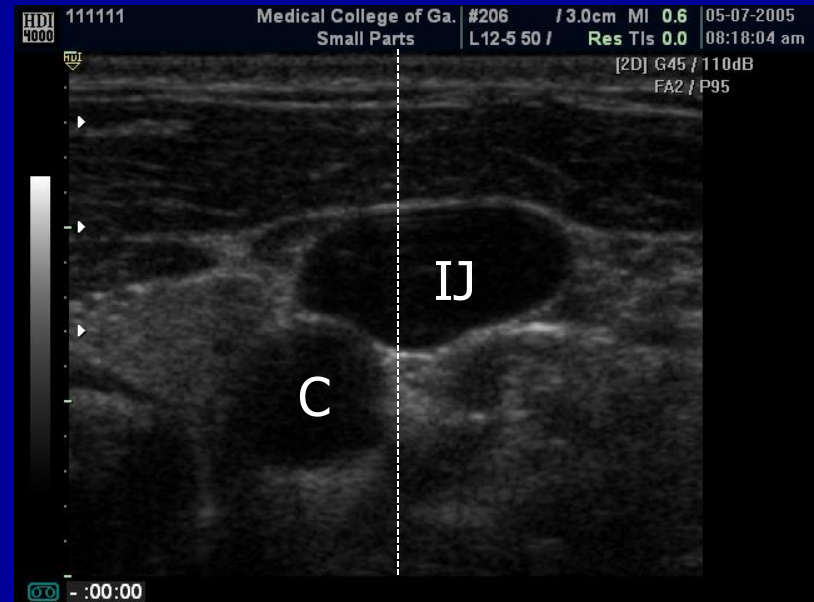
Approach To A Vessel

- In general there are two approaches to a vessel: longitudinal (long axis) or transverse (short axis or cross section)
- Transverse gives you a cross sectional view of the vessel, or a circle
- In-plane or out of plane needle visualization
- Such as in this view of the carotid and IJ



Transverse Approach

- Easiest to find a vessel in short axis (transverse)
 - This is out of plane visualization typically
- Even the long axis approach technically starts with vessel localization in short axis
- Scan across the expected vessel path
- Once you have found the vessel align the transducer so the vessel is directly in the middle of the screen

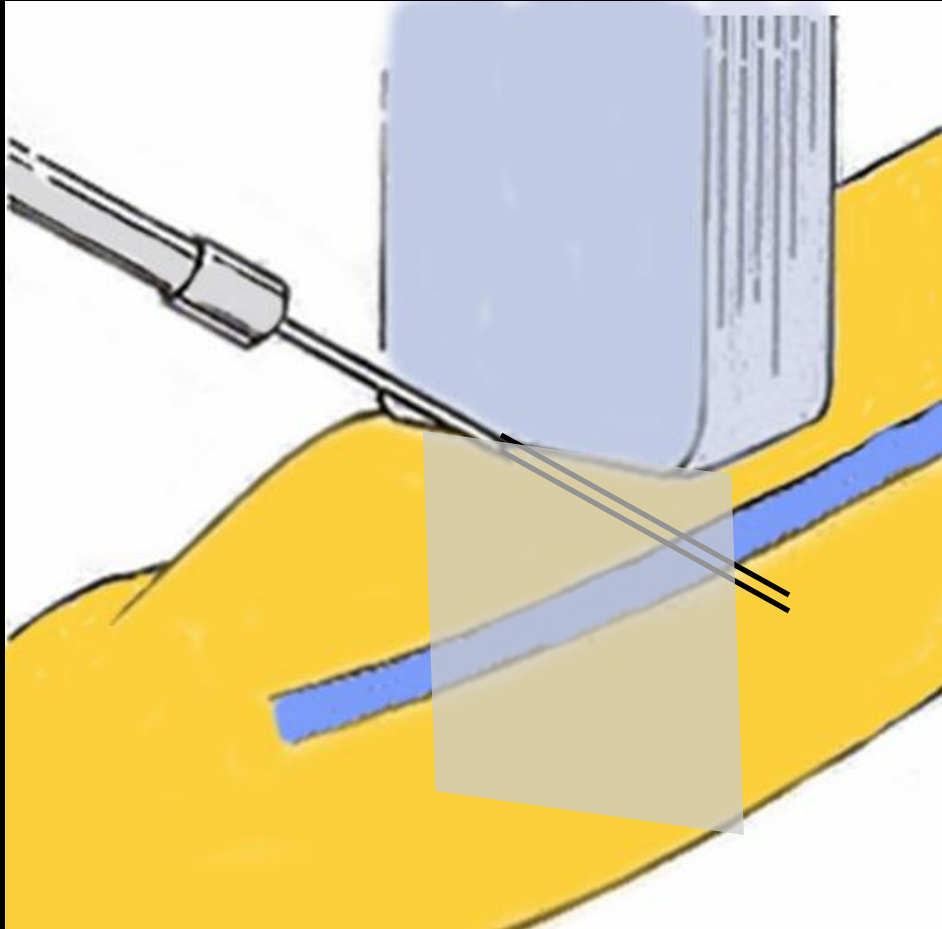


Transverse Approach

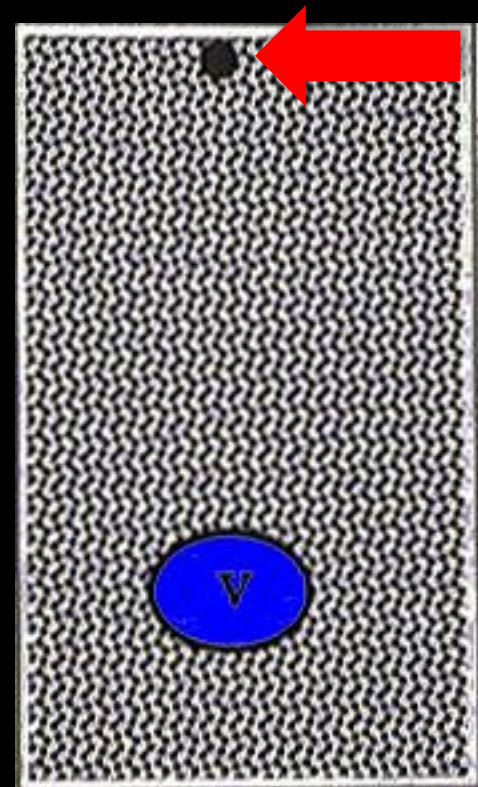
- Line the needle up directly in the center of the transducer and push the needle through the skin
- Locate the needle just under skin (on the screen) and then push the transducer back, away from skin penetration point
- Continue to watch needle in cross-section
- It should slowly connect with the vessel as it goes deeper
- Must adjust transducer to keep track of needle



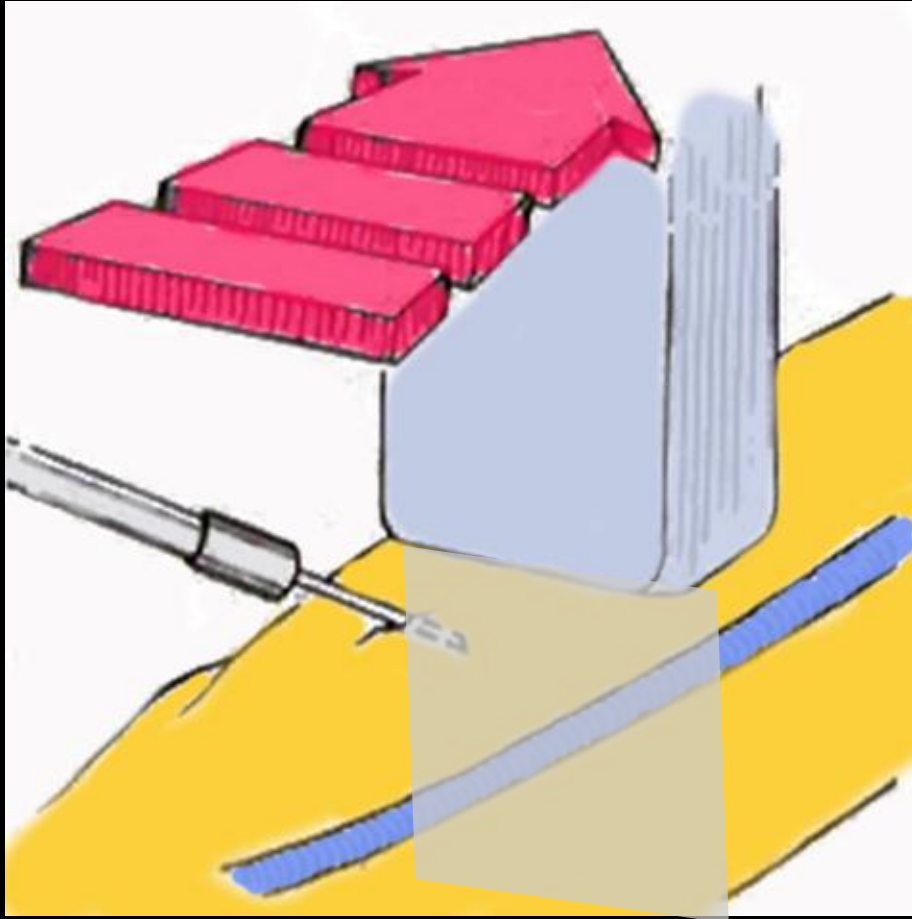
Transverse approach



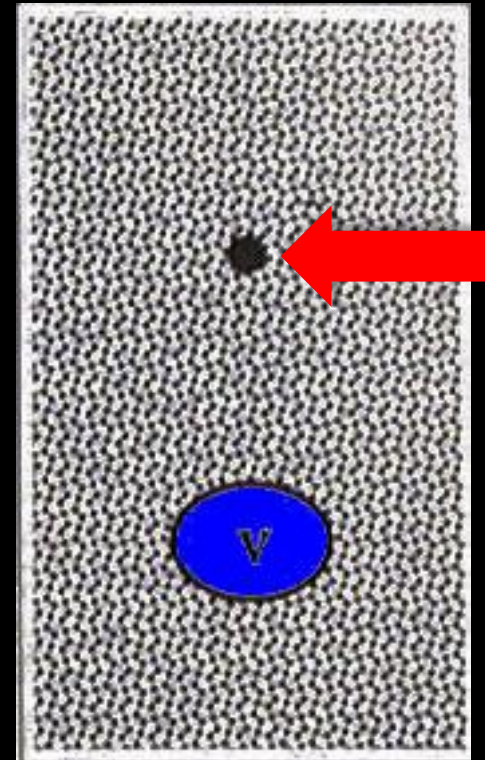
What you see on the
Ultrasound screen



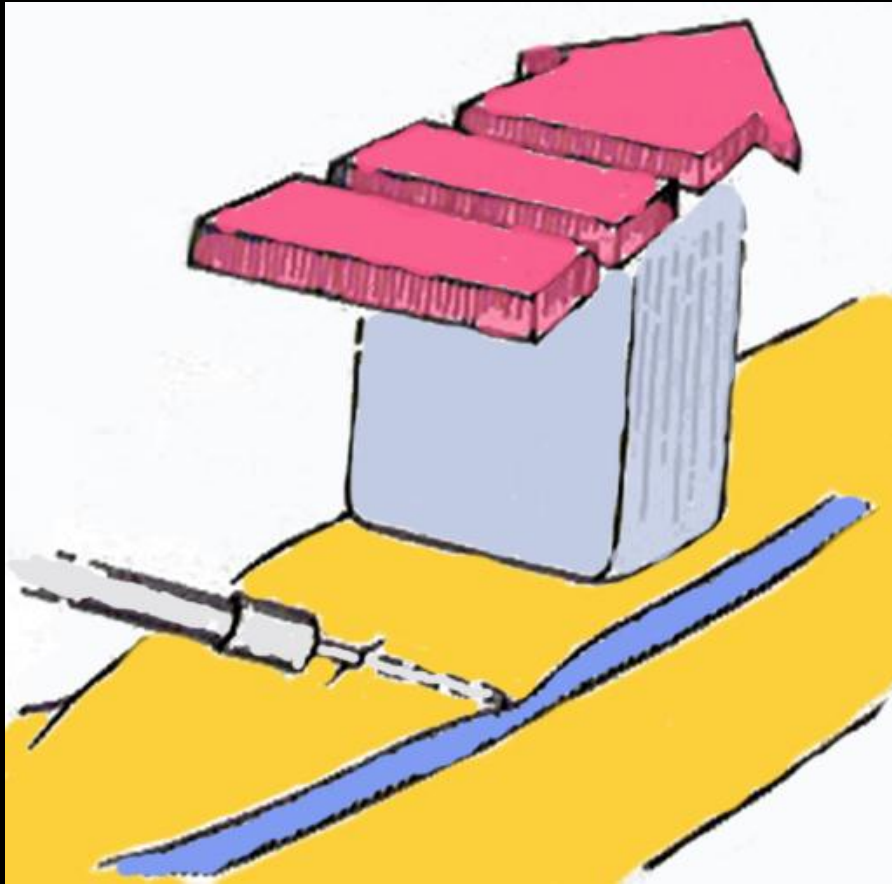
Push back transducer and push
in the needle



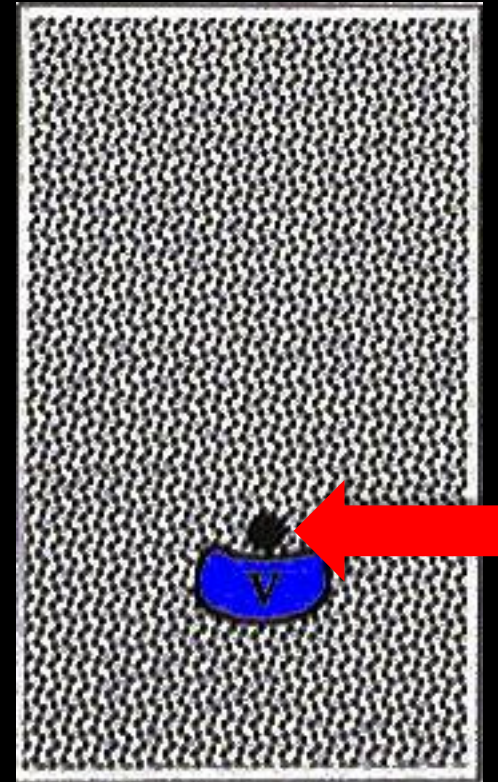
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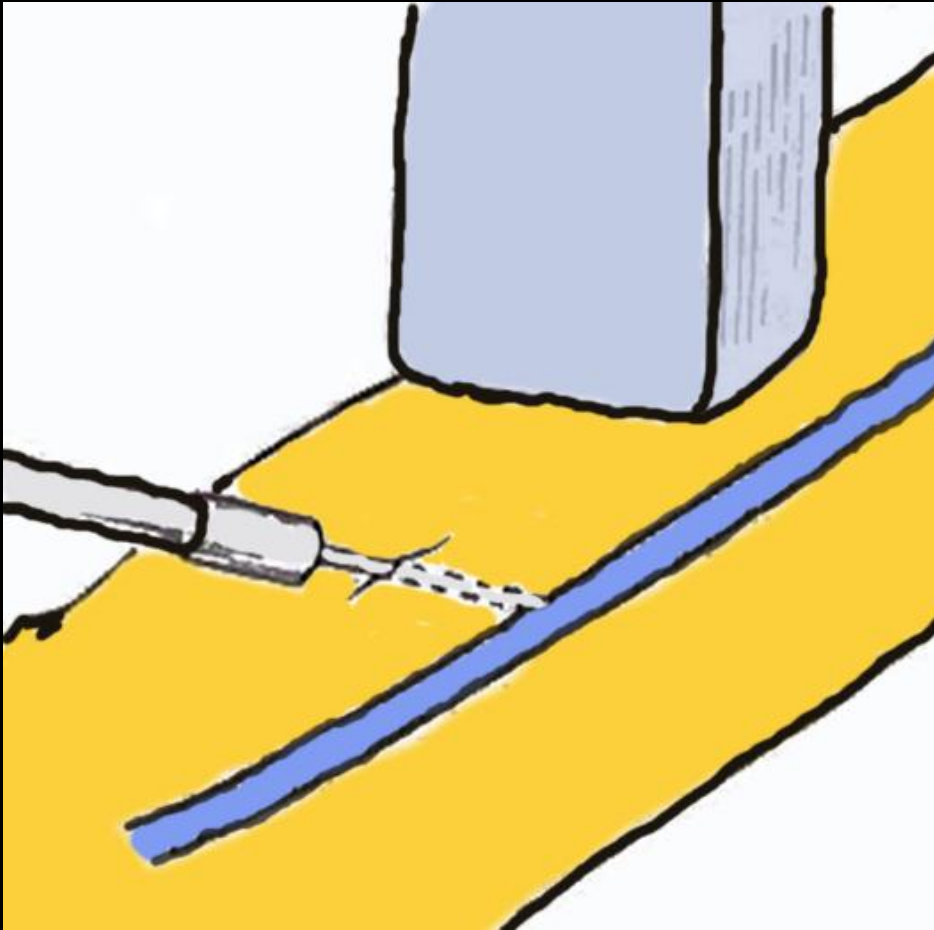
Needle impinges on vein



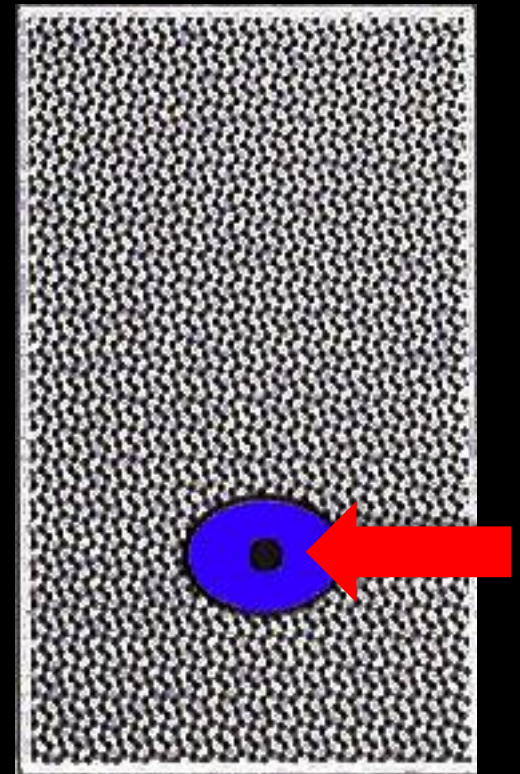
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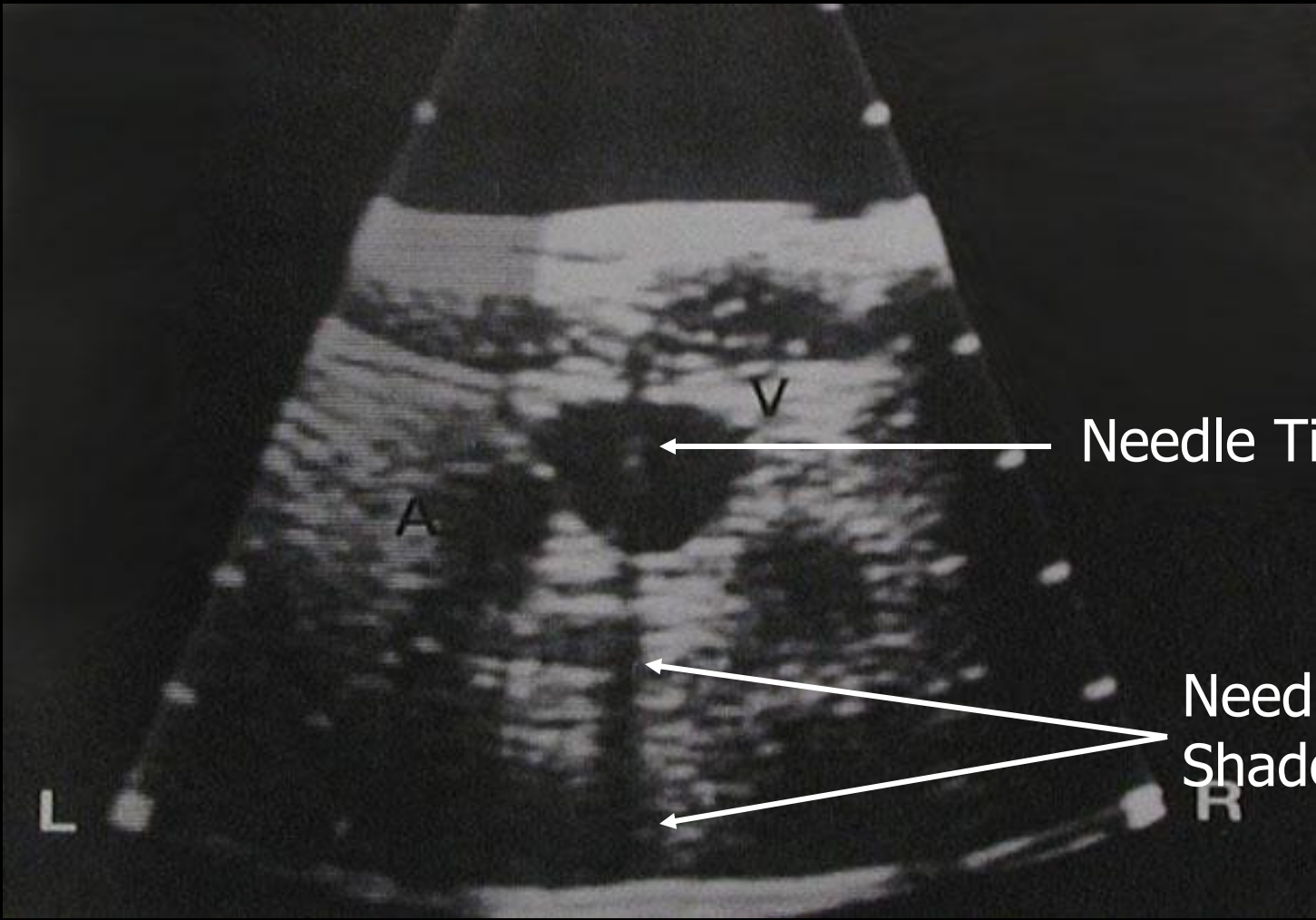


Needle enters vein



What you see on the
Ultrasound screen





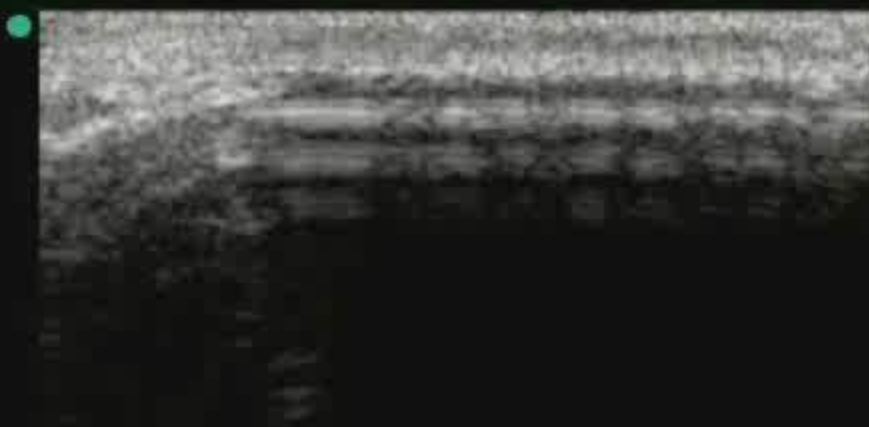
Needle Tip

Needle Shadow



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Dual

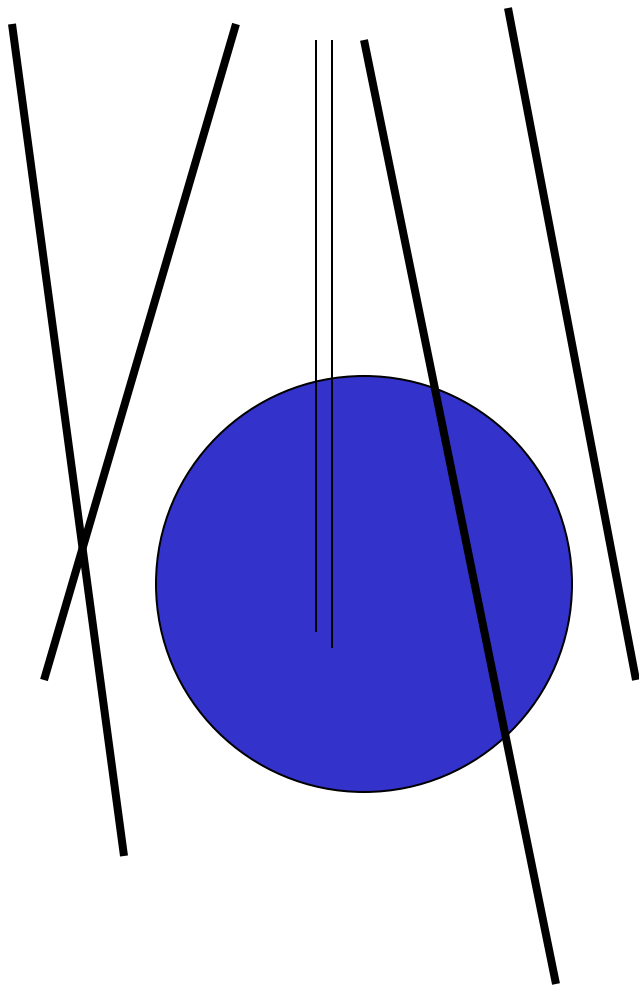
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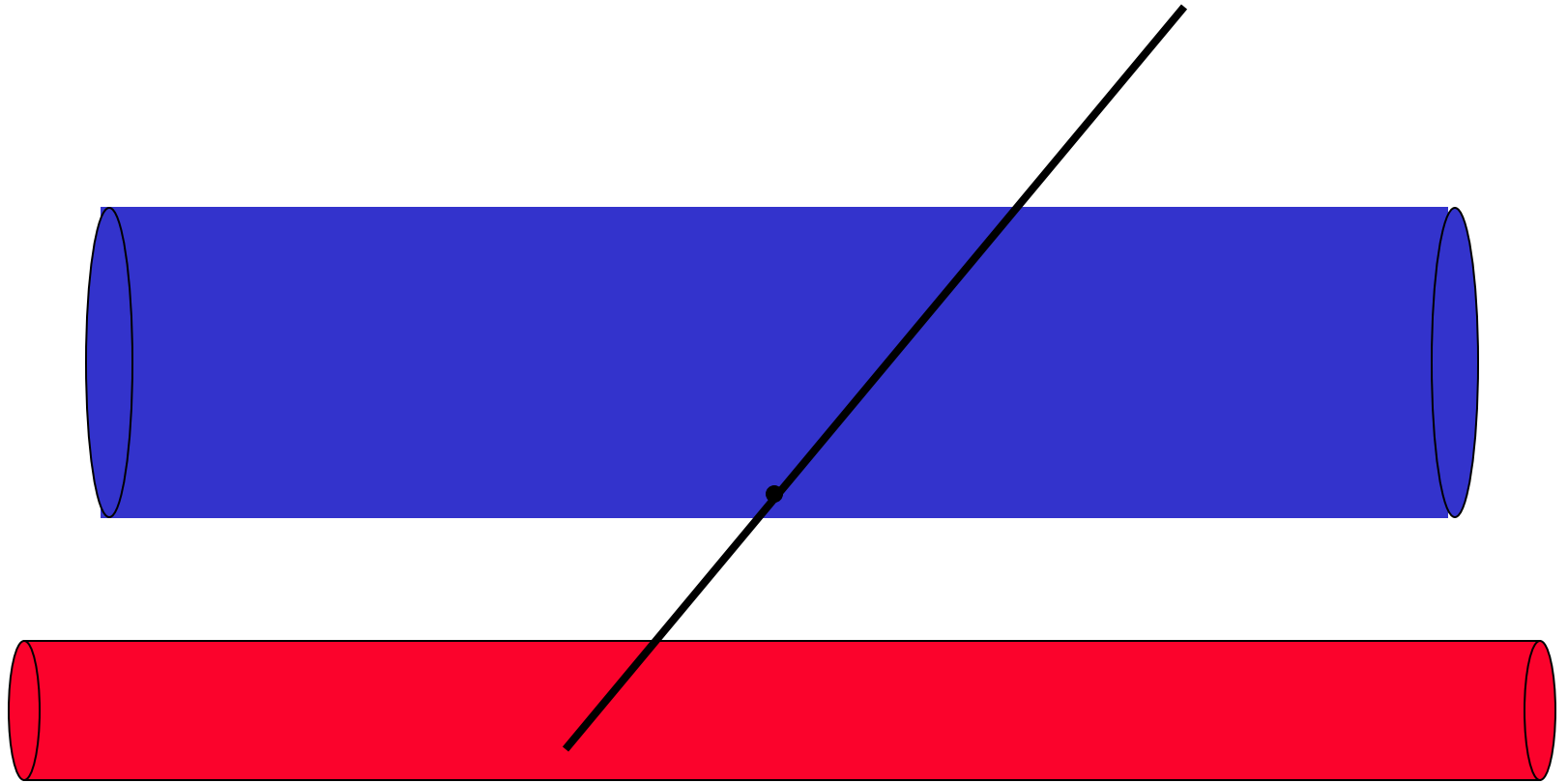
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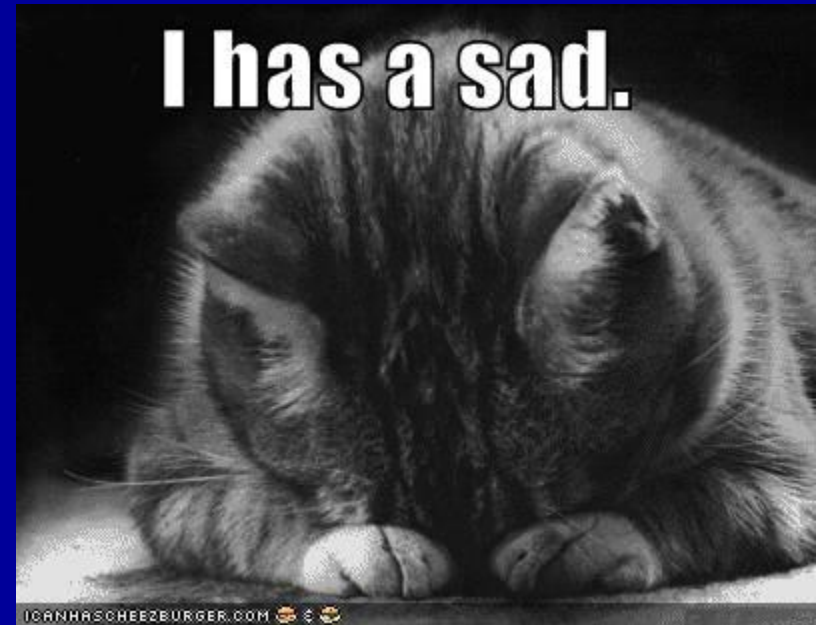
Short Axis versus Long Axis Approaches

- Novices tend to gravitate to the short axis or transverse approach
- **Mean time to vein cannulation was less in SA than LA ($p = 0.03$)**
- Blaivas M, Brannam L, Fernandez E. Short-axis versus long-axis approaches for teaching ultrasound-guided vascular access on a new inanimate model. *Acad Emerg Med.* 2003 ; 10:1307-11.



Short Axis versus Long Axis Approaches

- Mean numbers of skin breaks was same for SA and LA ($p = 0.49$)
- Mean numbers of needle redirections was same for SA and LA ($p = 0.51$)
- Mean difficulty scores for SA and LA were same ($p = 0.17$)
- Blaivas M, Brannam L, Fernandez E. Short-axis versus long-axis approaches for teaching ultrasound-guided vascular access on a new inanimate model. *Acad Emerg Med.* 2003 ; 10:1307-11.



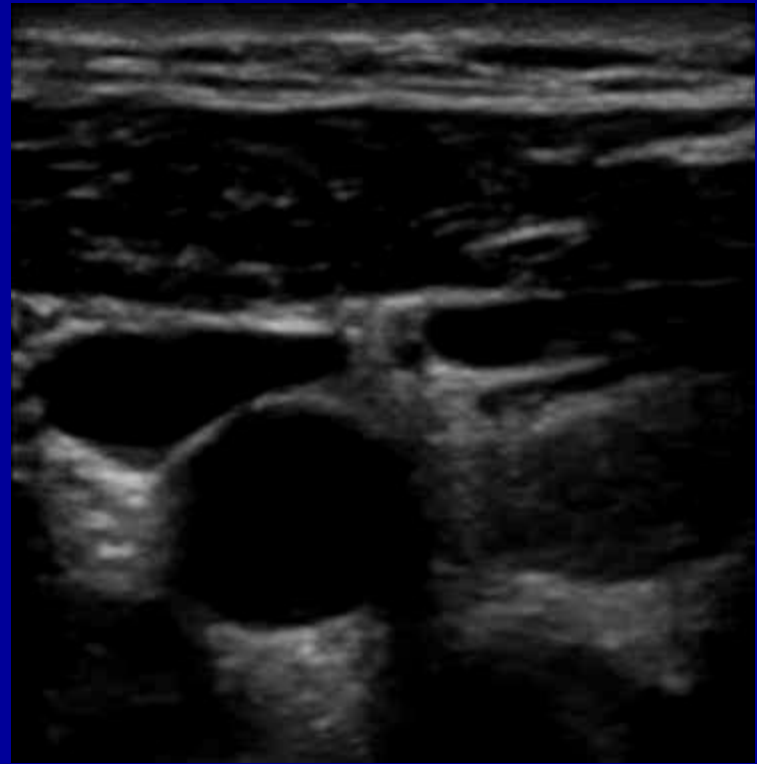
How Much Trouble Can You Really Get Into With US?

- Six cases of accidental arterial cannulation under ultrasound guidance
- All in short axis
- Video QA available for procedure or post procedure evaluation
- All patients critically ill, hypotensive and hypoxic
- Two airway losses, one death
- Blaivas M. Video Analysis of Accidental Arterial Cannulation With Dynamic Ultrasound Guidance for Central Venous Access. *J Ultrasound Med.* 2009 In Press.



Short Axis Pitfalls

- Needle to watch needle carefully
- In this case a novice attending and resident successfully cannulated a carotid in a hypotensive, hypoxic patient



Short Axis Pitfalls

- Another case of needle tip loss and penetration of the carotid



Short Axis Pitfalls

- How can you miss a femoral vein and get the artery?
- Watch the cordis as it travels deeper



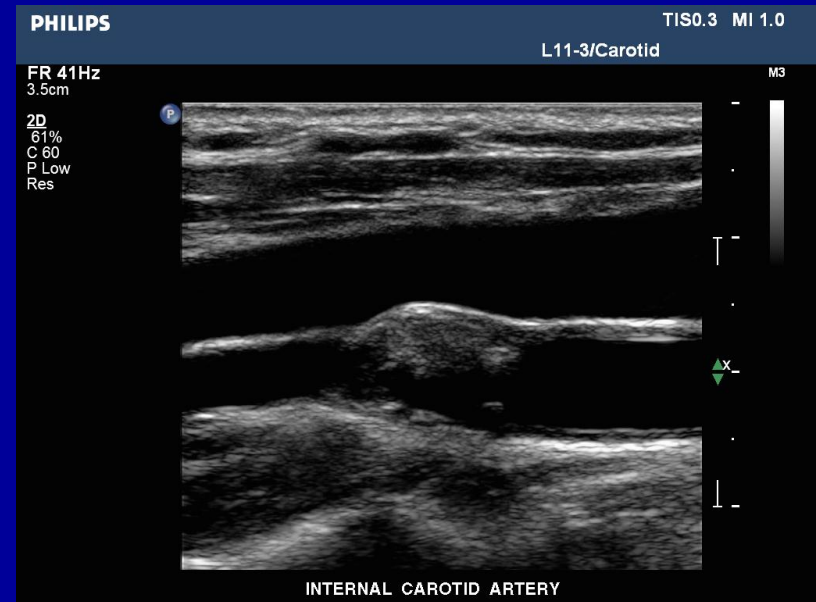
Short Axis Pitfalls

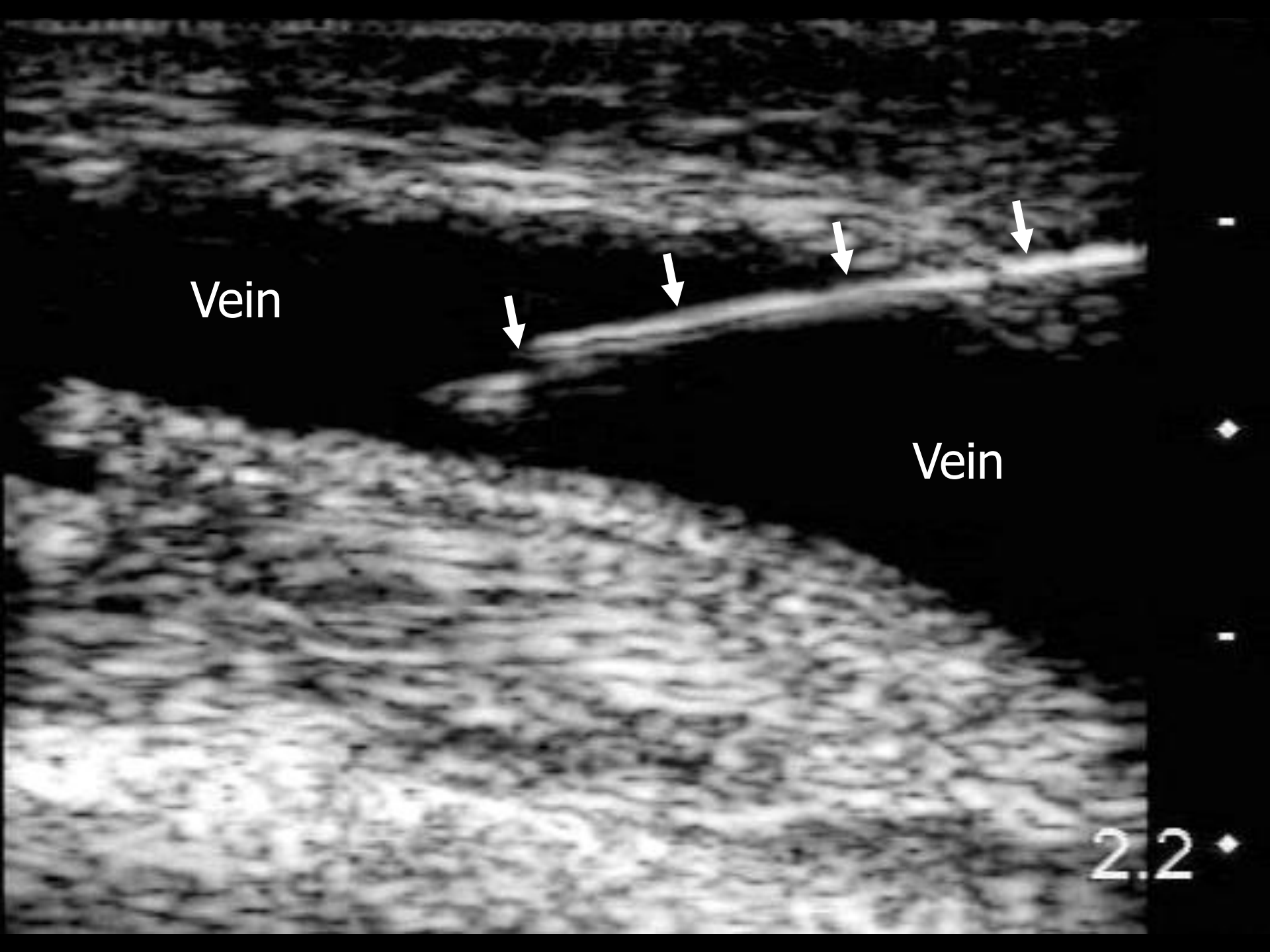
- Good looking vein
- Hypoxic and hypotensive patient
- Watch the wire travel down



Longitudinal Approach to a Vessel

- The vessel is seen in its long axis and appears as thick line
- You need to angle the transducer slightly from side to side not “push it up the vessel”
- This provides you with a three dimensional mental image and the needle can be steered to the vessel if it is lateral or medial to the vessel





Vein

Vein

2.2

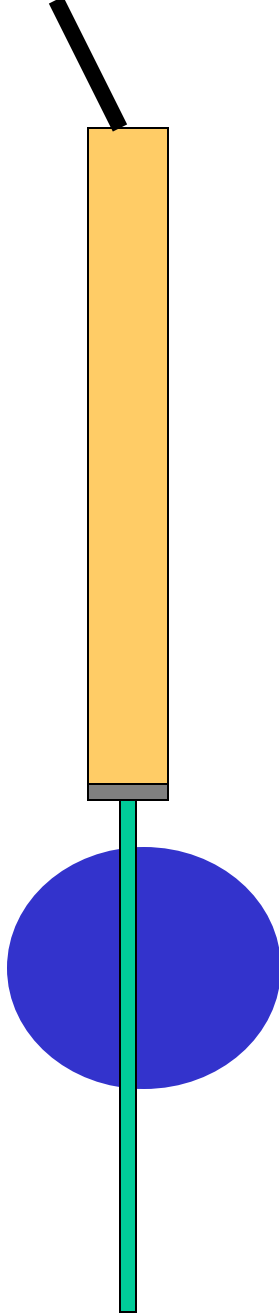
Going From Short To Long Axis

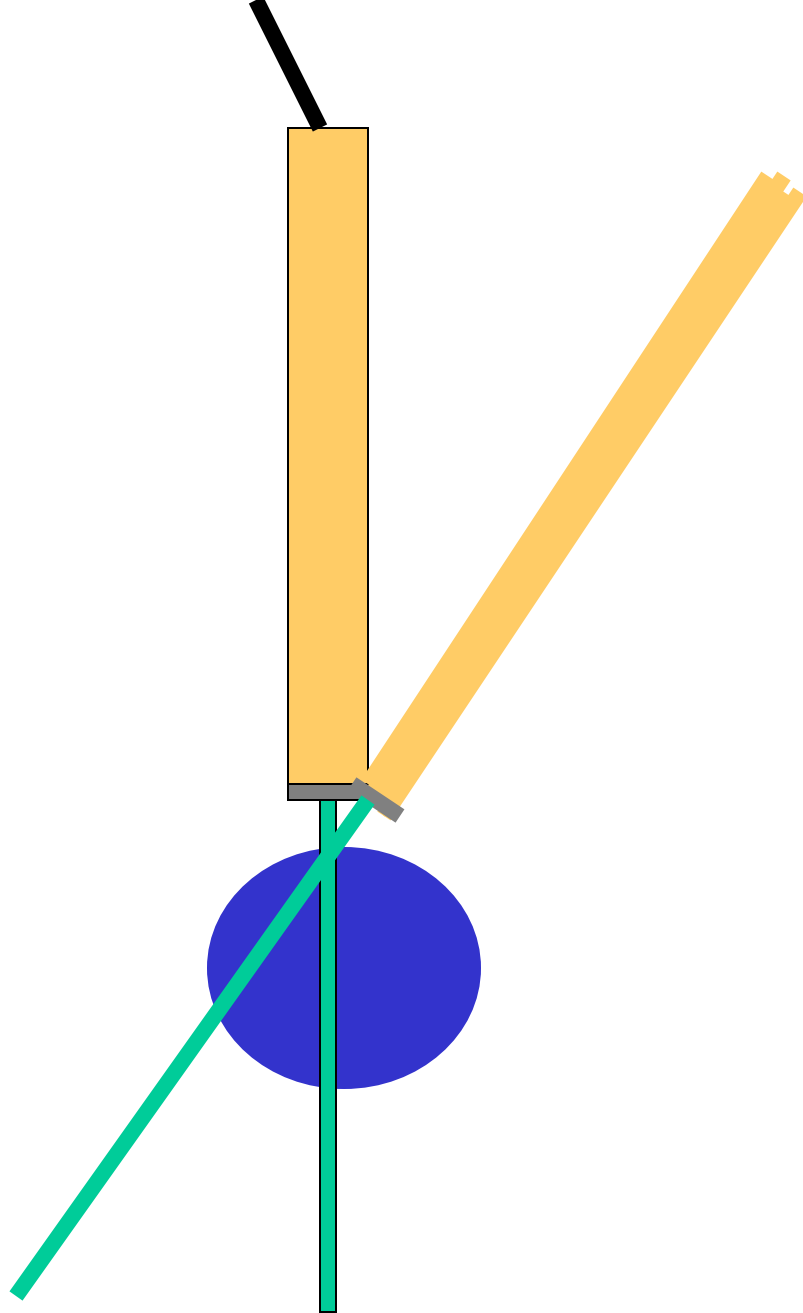
- The turn is performed slowly the first few times
- Adjust as you turn the transducer
- Do not need to go back to short axis each time if you slide off





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Key Things To Remember

- Do not move transducer and needle at the same time!
- When you move the needle: withdrawing or moving deeper, moving from side to side or wiggling to make the needle movement obvious. **LEAVE TRANSDUCER FROZEN.**



Key Things To Remember

- When you move the transducer (ultrasound probe): side to side, panning or rotating or any movement **LEAVE THE NEEDLE FROZEN.**



One Smooth Process?

- Can be a very smooth process
- Even watch catheter being pushed off
- Explains why short axis catheter may not float

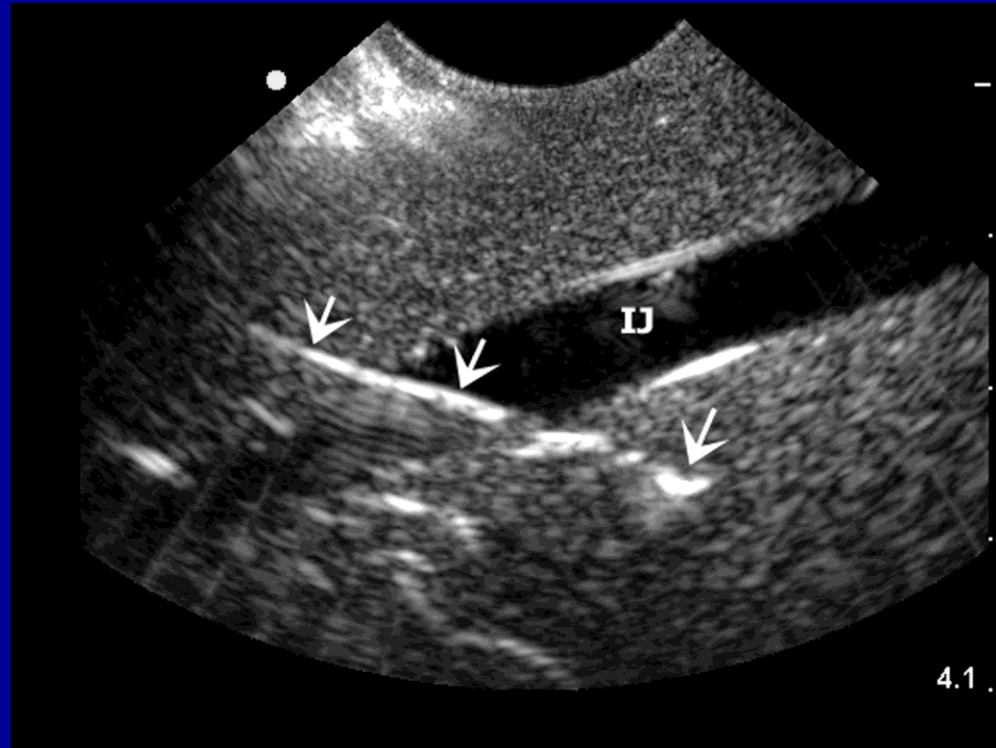


Should You Really Use Long Axis?

- Clinicians are better at identifying needle tip location in long axis than short axis.
- Clinicians have an easier time tracking needle tip in long versus short axis
- Sierzenski P, et al. Long-Axis Orientation of the Ultrasound Transducer is More Accurate for the Identification and Determination of Vascular Access Needle-Tip Location. *Ann Emerg Med.* 2008; 52:S170-171.
- Baty G, et al. Emergency Physicians More Accurately Identify the Potentially Critical, Posterior Vessel Wall Needle-Tip Location by Using a Long-Axis Orientation of the Ultrasound Transducer. *Ann Emerg Med.* 2008; 52:S127-128.

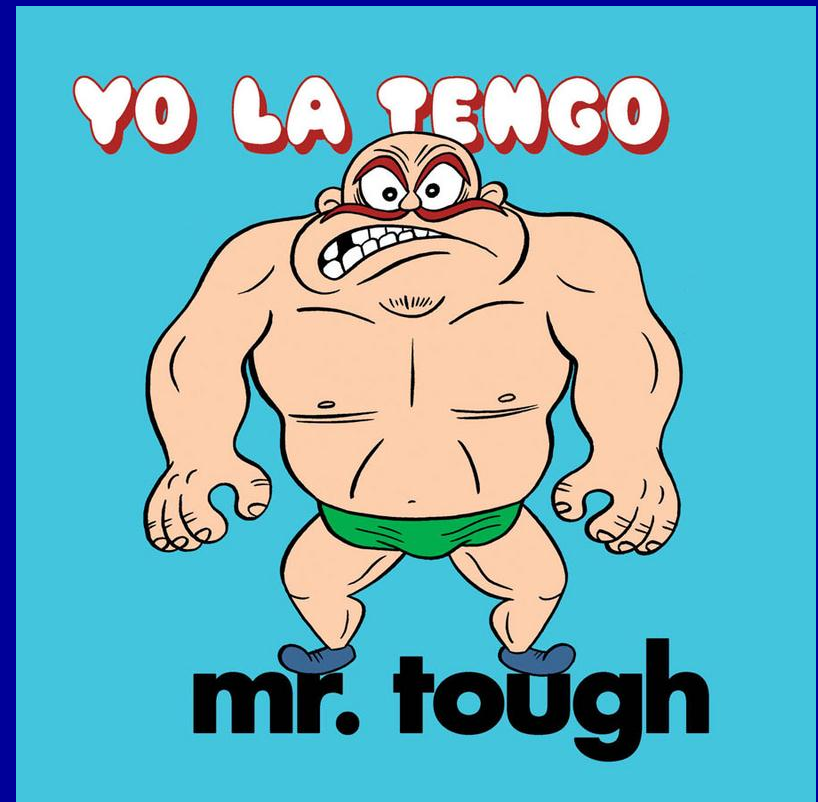
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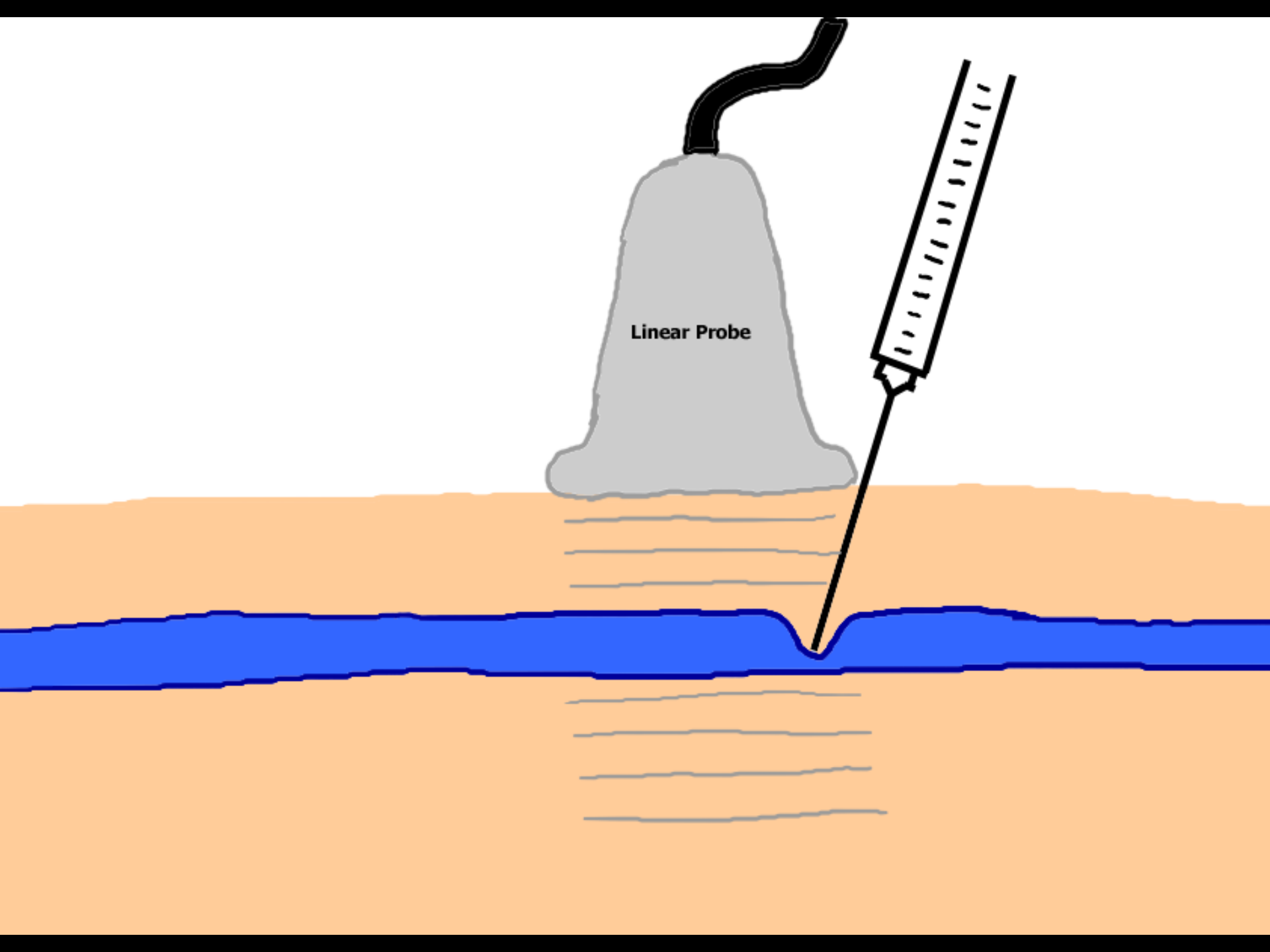
- 25 EM residents, previous US guided cannulations was 8.0
- **Sixteen (64%) residents accidentally penetrated the posterior wall of the IJ**
- In 6 cases the final location of the needle was through the posterior wall and deep to the venous lumen
- **In 5 of these cases the carotid artery was actually mistakenly penetrated**
- Median confidence regarding appropriate needle placement 8.0 out of 10



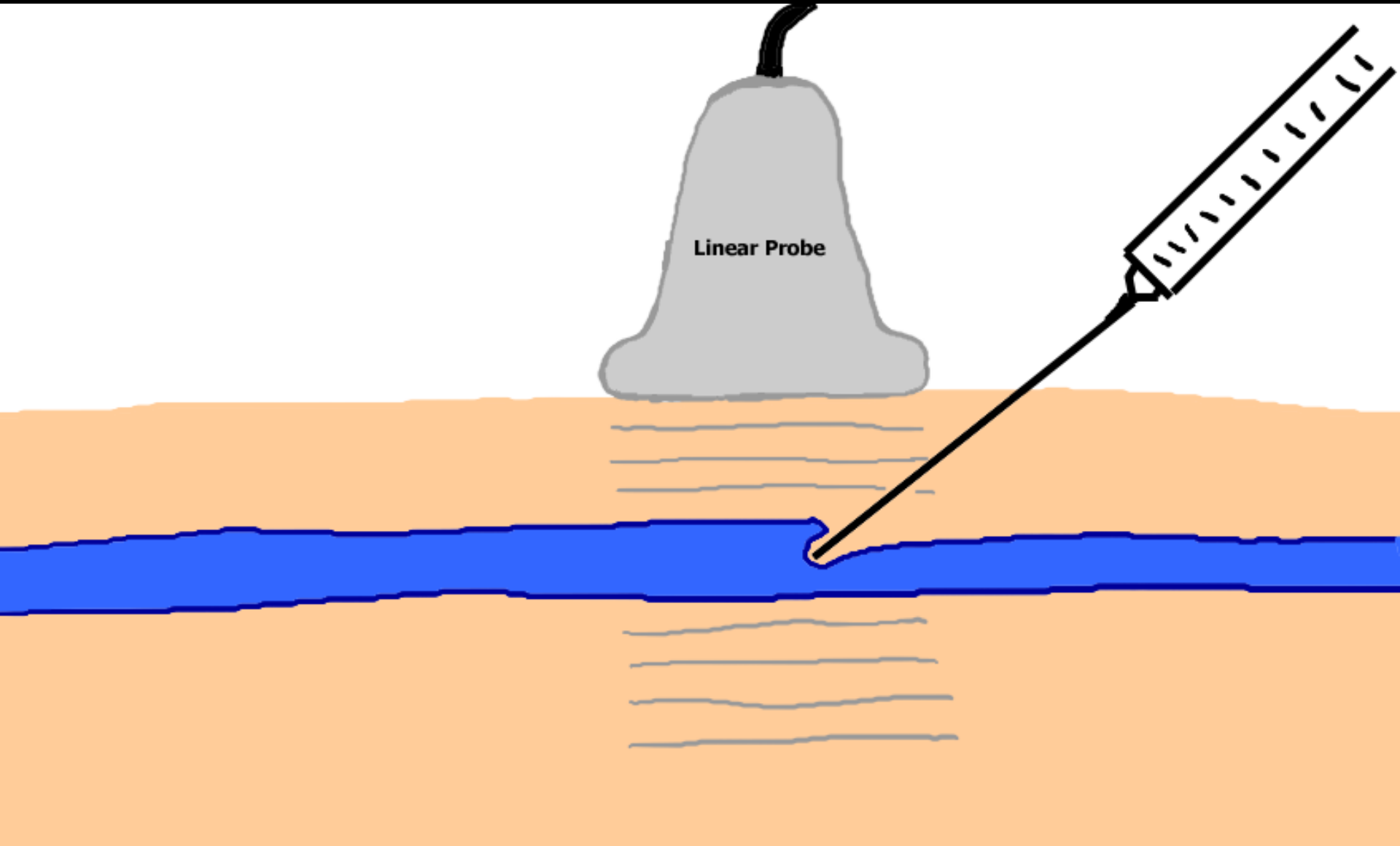
Veins Can Be Tough

- We tend to think of arteries as being resilient and harder to penetrate with a needle
- Venous walls can be extremely resilient and very hard to penetrate
- If the vein collapses easily due to low volume the needle may collapse the vein before penetrating the vessel wall

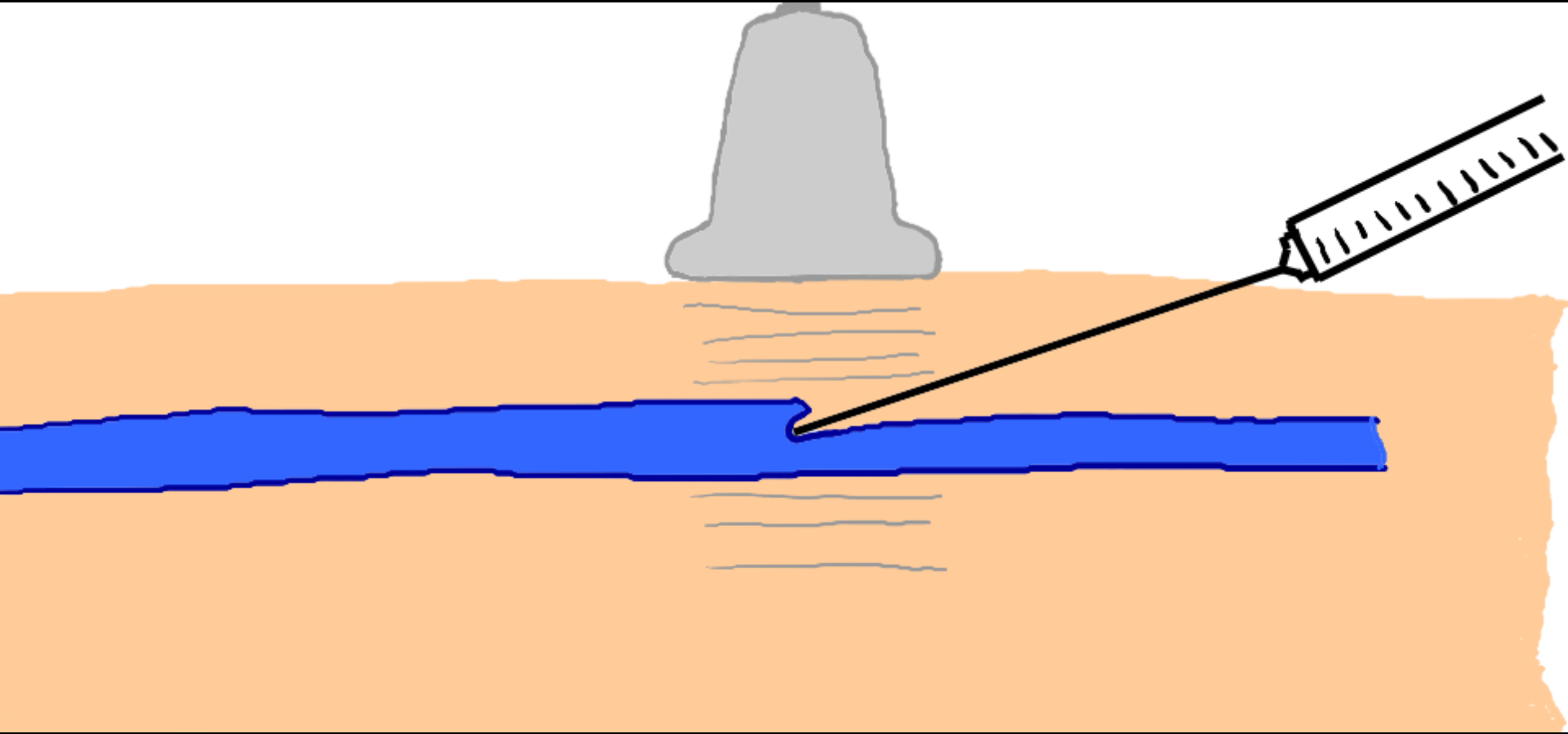


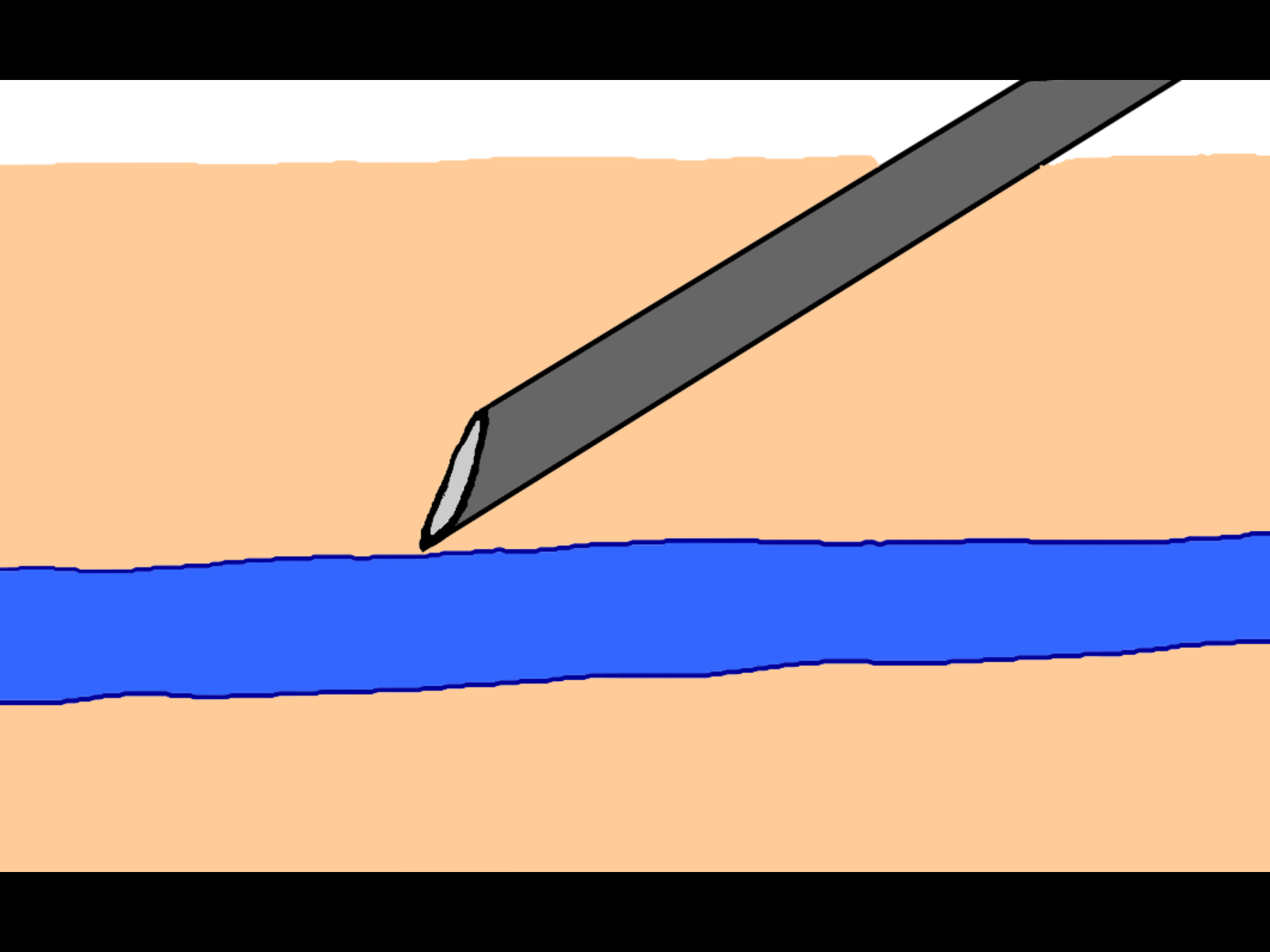


Linear Probe



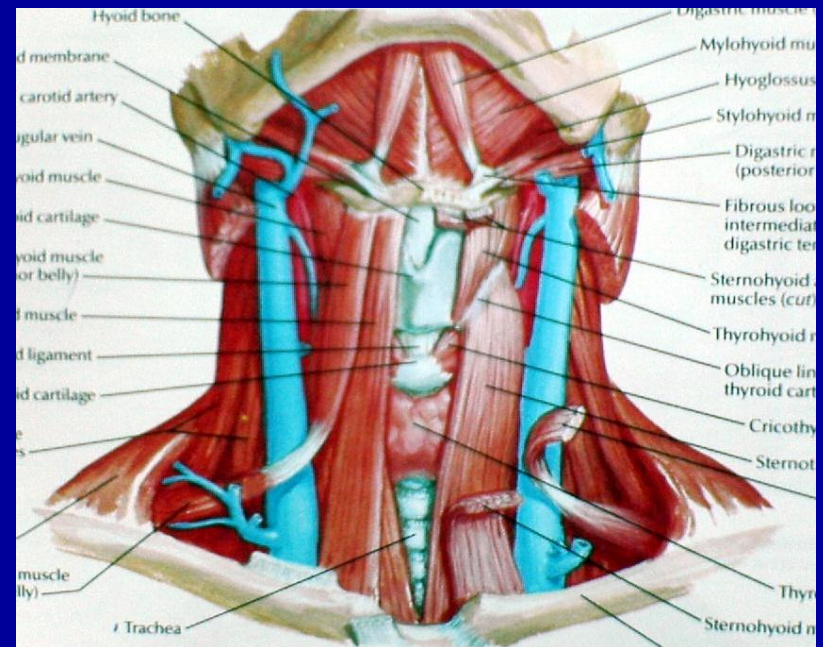
Linear Probe





Going for the Jugular

- Good choice in many patients
- Safe area
- US guidance is great for IJ
- Occasionally find some unexpected surprises



Jugular Anatomy

- Can vary greatly
- Depends on
 - Respiration
 - Patient positioning
 - Hydration status



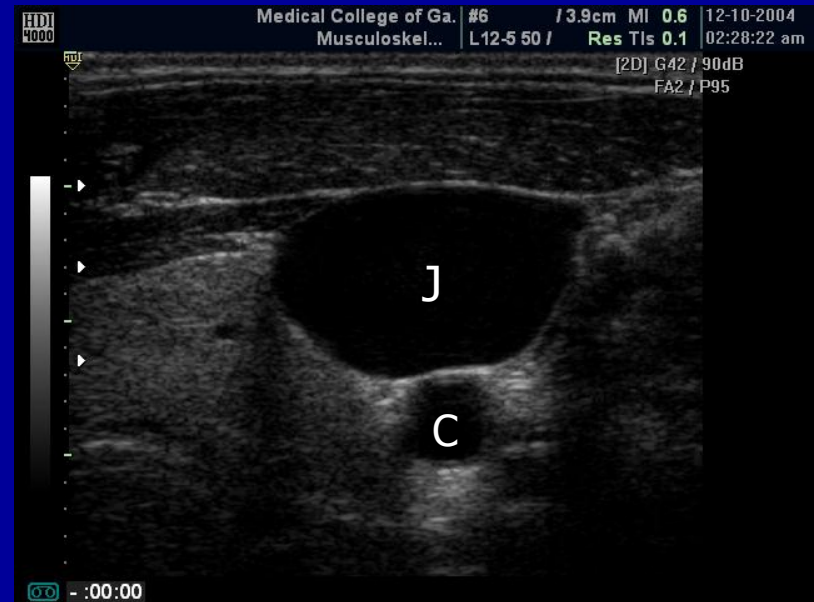
Jugular Anatomy

- Turning the head will move the vessels
- More significant in some patients than others



Jugular Anatomy

- Won't always have vessels side by side
- Can be much more difficult, one on top of the other



Jugular Cannulation

- First, find your target vessel in short axis
- Make sure it is the jugular
- Turn long axis on it, in preparation for cannulation



Jugular Cannulation

- Line your needle up under the center of the transducer and drive in at a 30 to 45 degree angle
- Make sure to visualize needle
- If lost, scan side to side
- If off axis, withdraw slightly and realign
- Then drive in further while visualizing



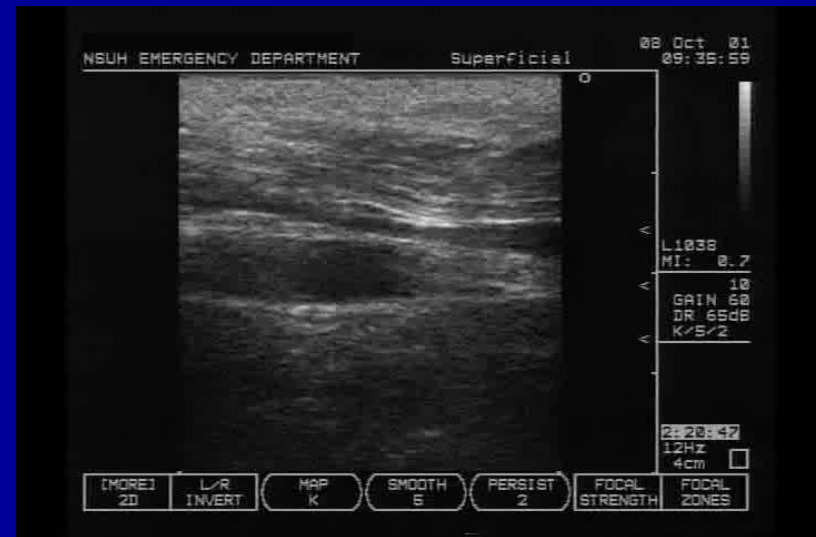
What Can Possibly Make This Harder?

- The hypovolemic and tachypnic patient make require timing
- The vessel may disappear completely with each inspiration, which come quickly
- This presents a challenge
- This applies to subclavian/axillary as well



What Can Possibly Make This Harder?

- The needle penetration must be timed with respiratory variation
- This assumes trendelenberg, any patient cooperation etc.
- Sometimes have to hook the anterior vessel wall and flatten out needle, then drag wall into vessel to finally pop through



Other Benefits of Direct Guidance

- Recurrent feed into right subclavian from right IJ approach, left is scarred
- Can visualize directly and approach IJ closer to clavicle
- US allows assurance of wire placement in this case



Harder To Doubt What You Can See

- Nurse: None of these ports will flush! Is this line even in?
- Take a look under ultrasound
- Can avoid timely manipulation and replacement



Flash But No Bang?

- I get a flash but cannot feed the wire
- A thing of the past with dynamic guidance
- There was a good reason the wire did not feed!



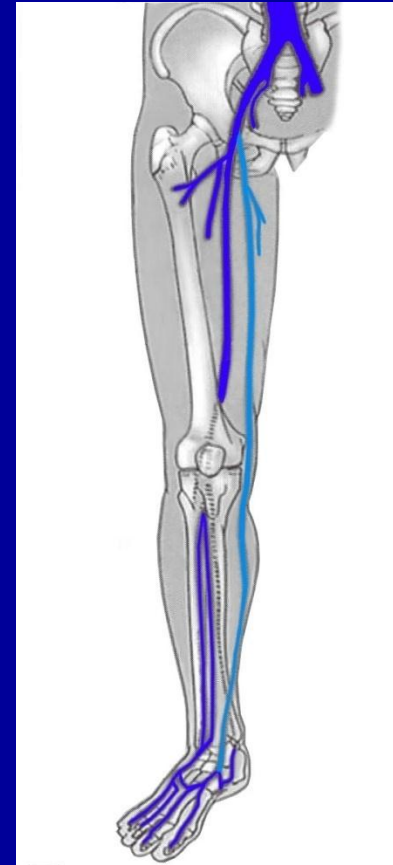
Try This One Without Ultrasound!

- Patient could not move from this position
- Performed just like this, with lots of extra draping and a very sore back
- Long axis for safety and precision

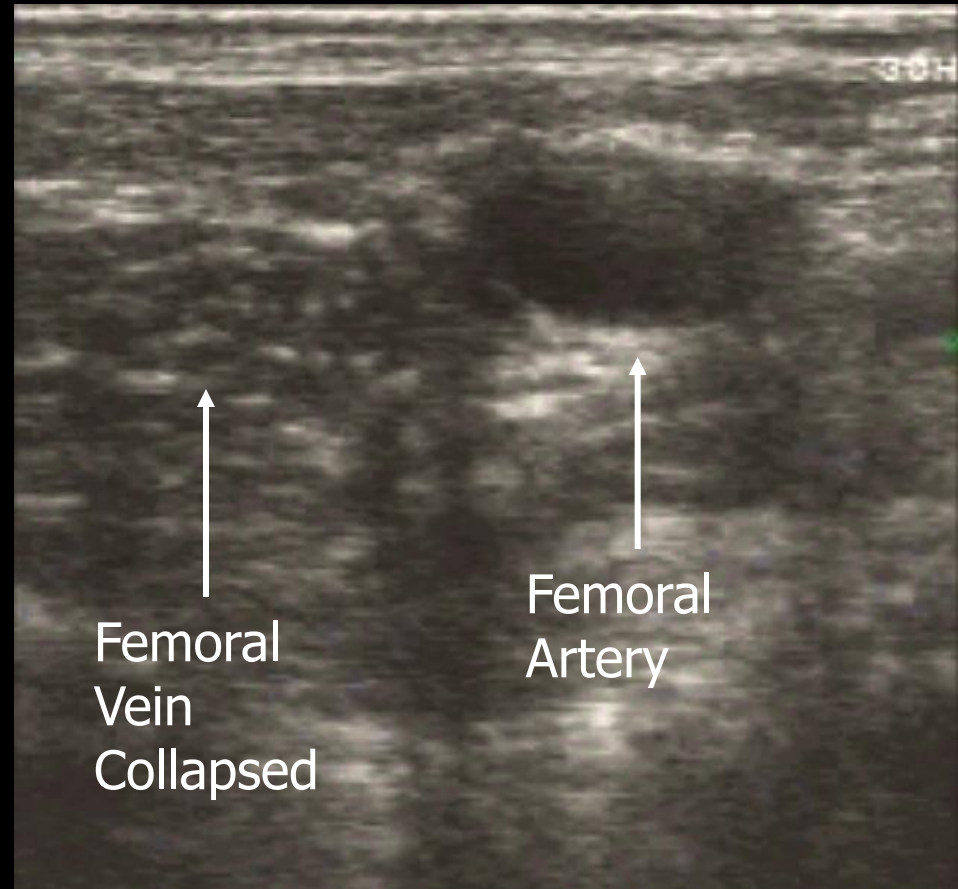
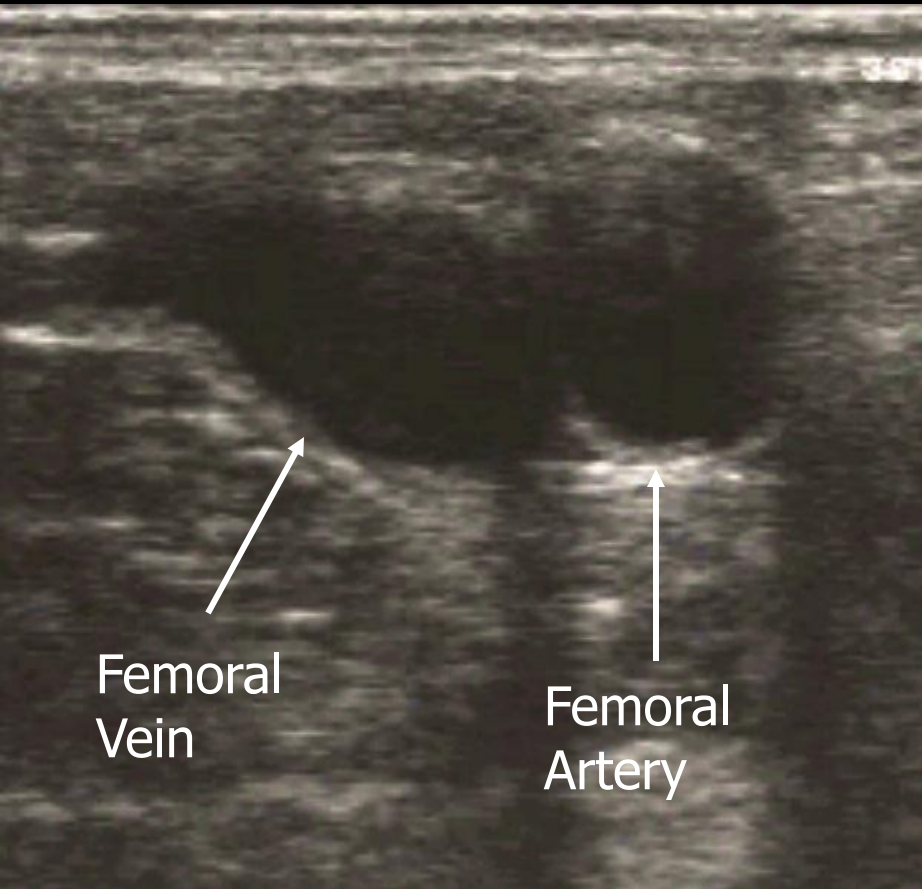


Femoral Lines

- Can be very useful here too
- Femoral vessels can vary in their arrangement
- Make sure vessel is patent



Pressure with transducer

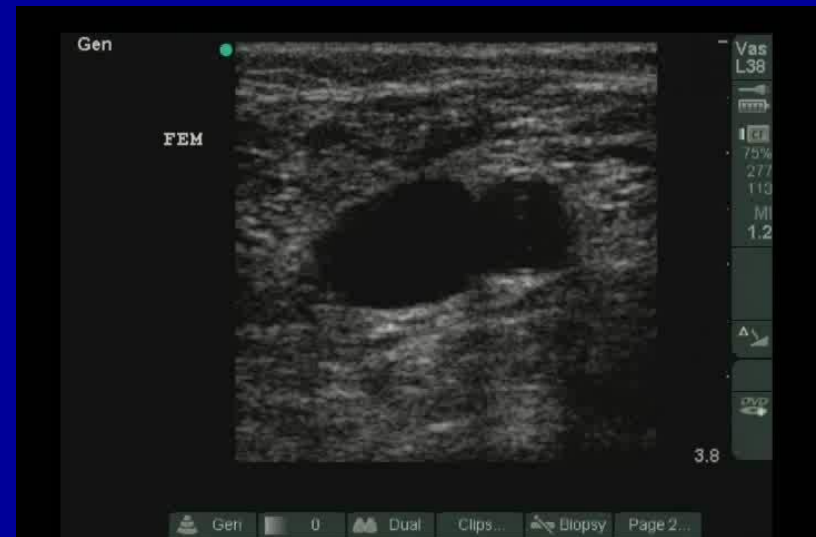


Choosing A Good Target

- Make sure vein is patent
- Compress just like for LE DVT evaluation
- Artery or thrombosed vein will not compress



Compression Should Yield Collapse



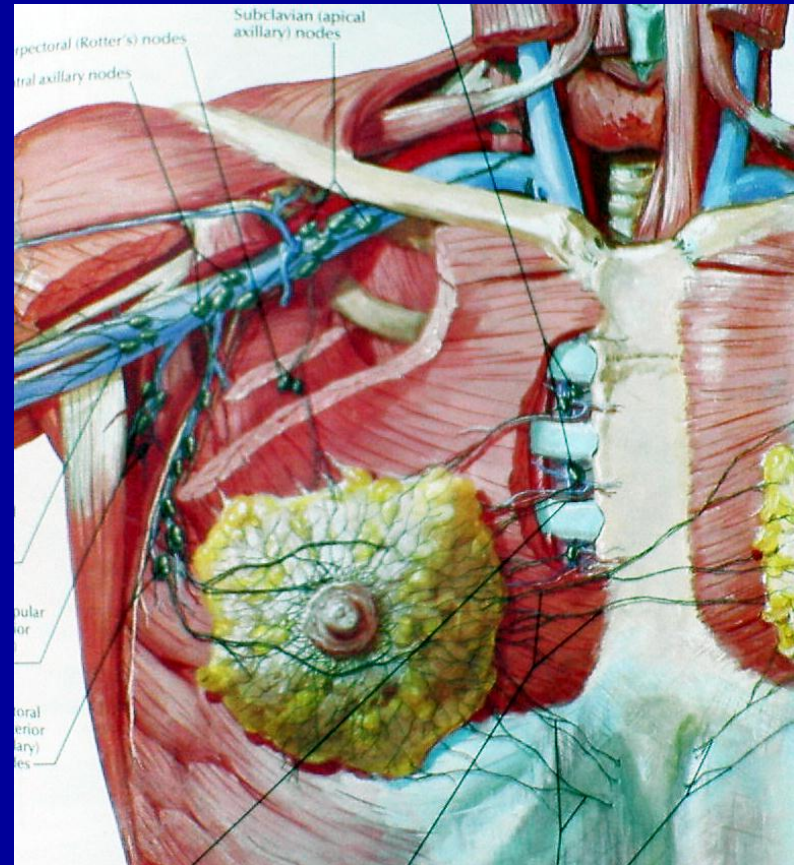
Femoral Trouble

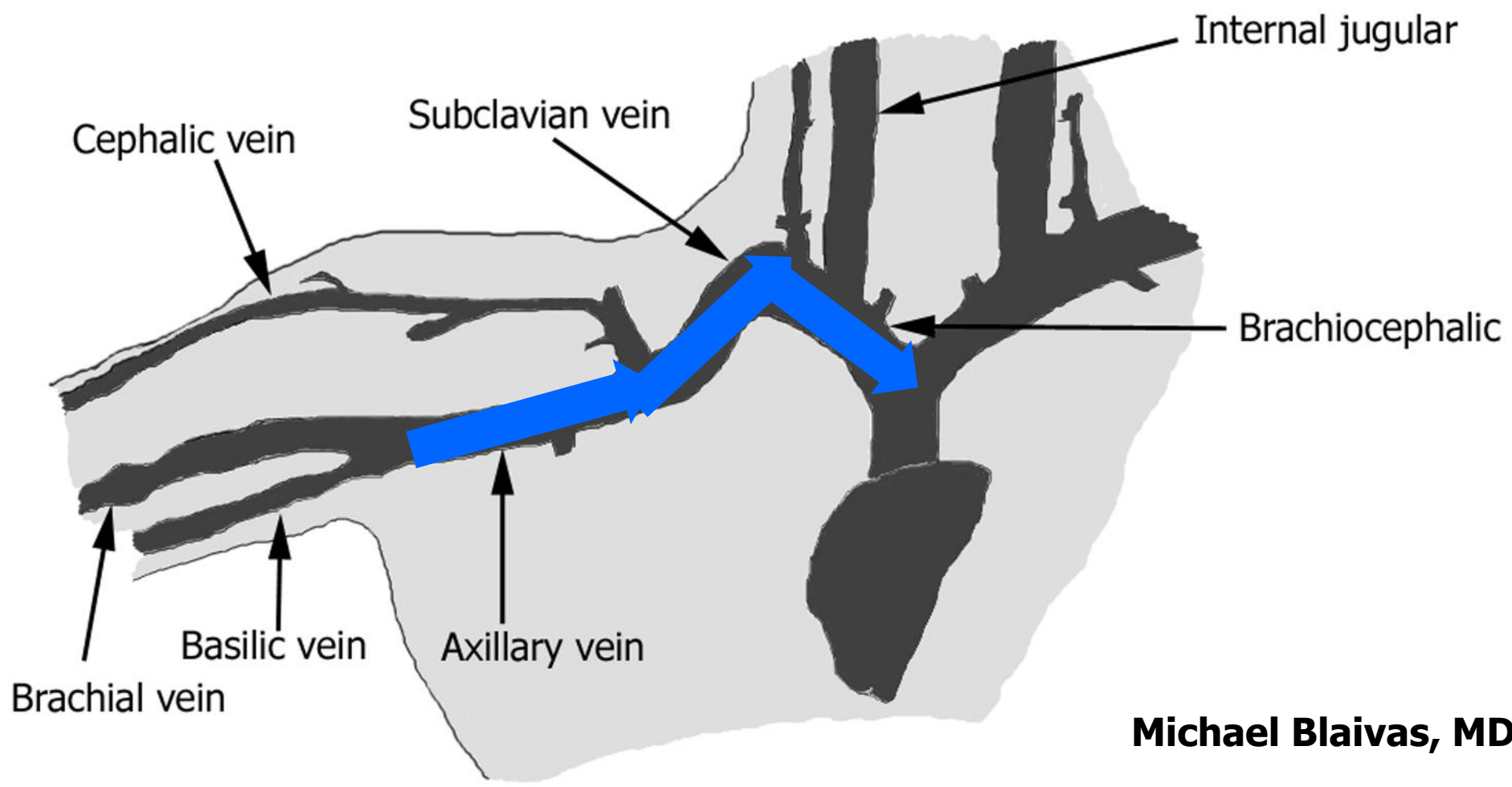
- Occasionally the artery sits directly on top of the vein for much of its course
- Can pick a different target or come in from the side, off angle



Subclavian Lines

- Some people avoid due to increased PTX risk and lack of compression for arterial bleed
- However, there is a renewed interest in subclavian lines in critical care setting
- Driven by infection data and patient comfort





Michael Blaivas, MD





Gen



+ 0.71cm

Vas
L38



CF

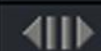
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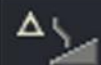
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DVD

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+ Cal 1

X Cal 2

○ Ellipse

Manual

X Delete







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Dual

Clips...

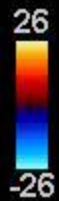
Blopsy

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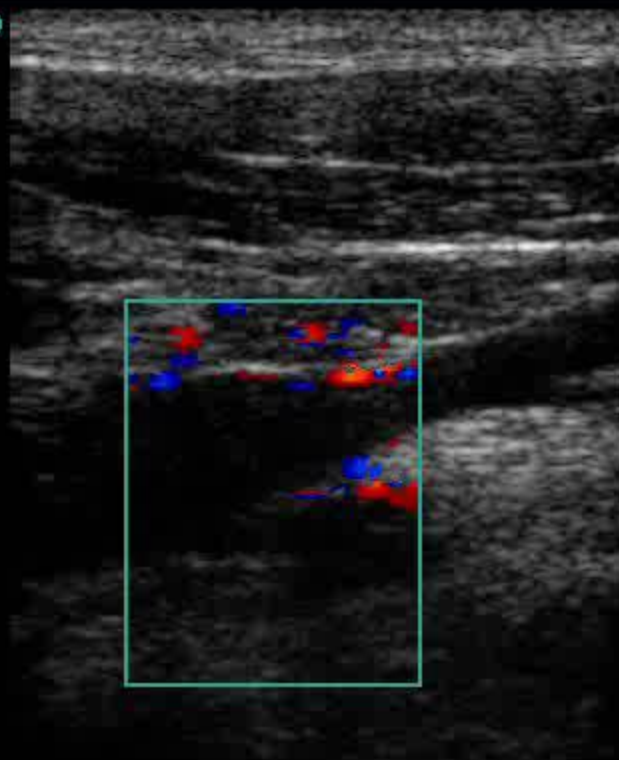


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Color
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Vas
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146

TIS

1.0



4.7

Color

Med

PRF Scale

WF Med

+0

Invert



Gen

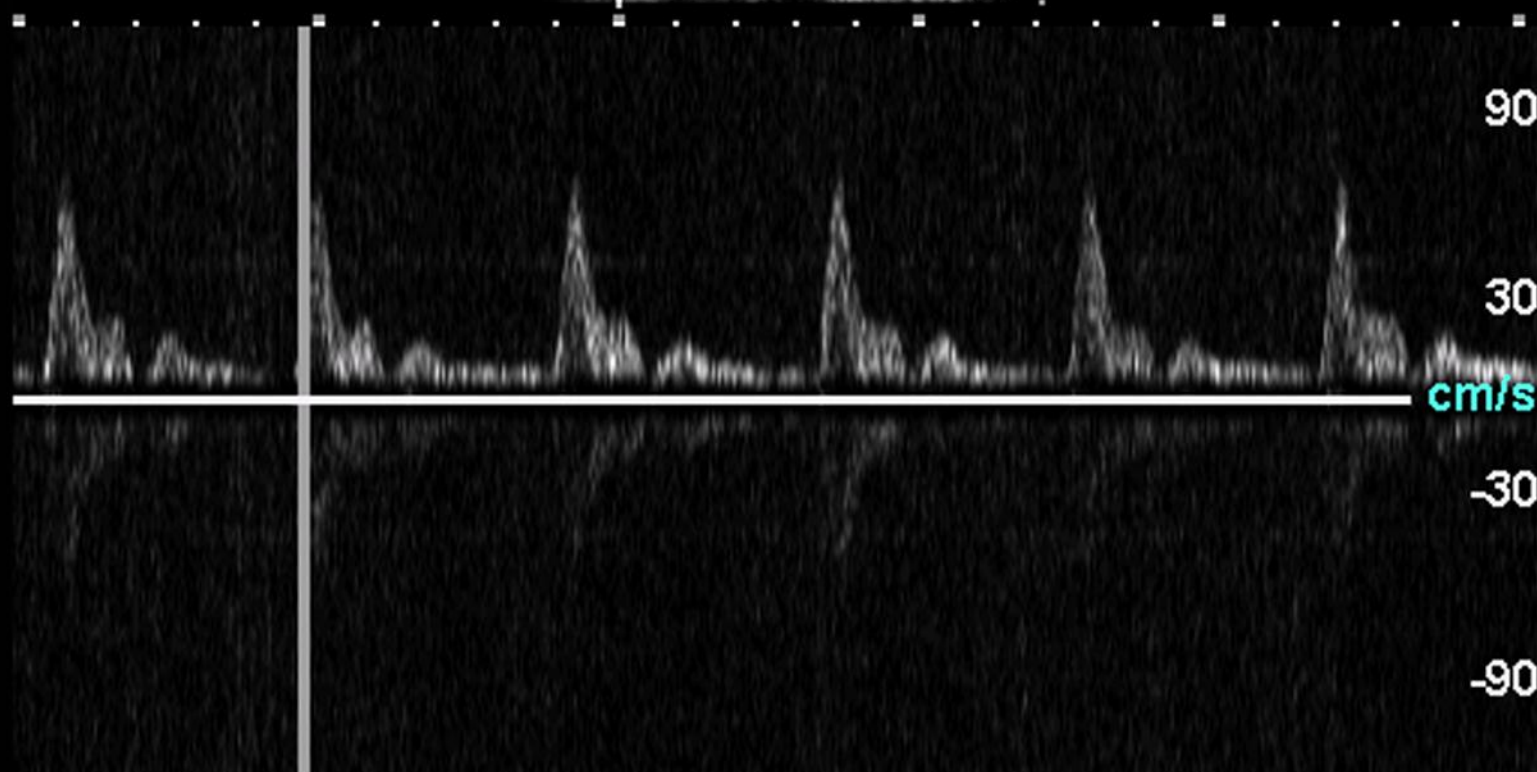
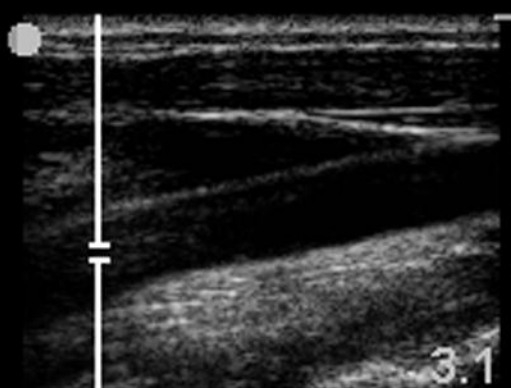
PW

15625Hz

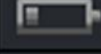
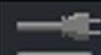
+0°

1mm

+0°



Vas
L38



63%

332

149

TIS

0.2



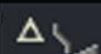
90

30

cm/s

-30

-90



Line



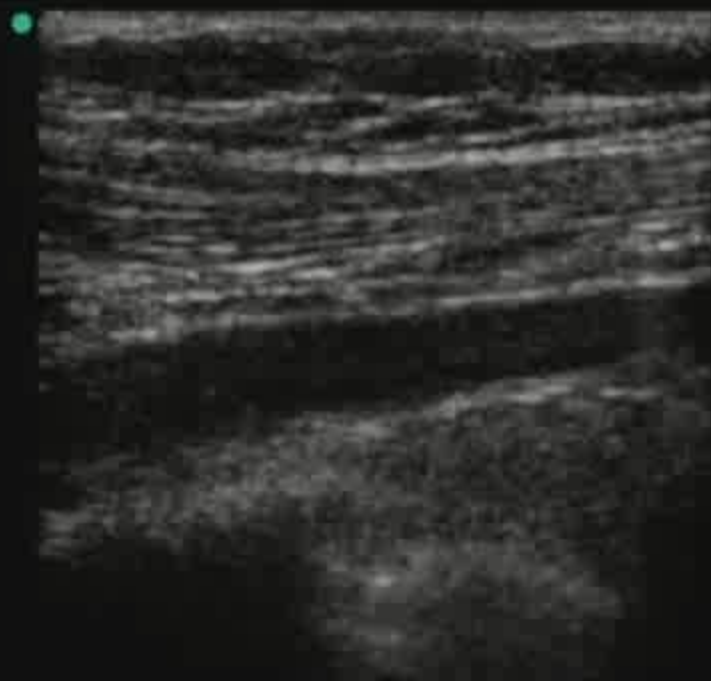
Invert



Trace



Gen



Vas
L38



5d7%

404

178

Ml

0.9



3.8



Gen



0



Dual



Off

Clips...

Page 2...

Local Anesthetic Under US

- For awake patients can put down local anesthetic directly along planned soft tissue track, right on top of vein



The Collapsing Subclavian

- In a hypotensive patient the subclavian may collapse very easily
- A collapsing vein makes it easier to penetrate all the way through with a needle
- Requires hooking anterior wall and then flattening approach angle
- Watch as needle flattens and moves into the long axis of venous lumen



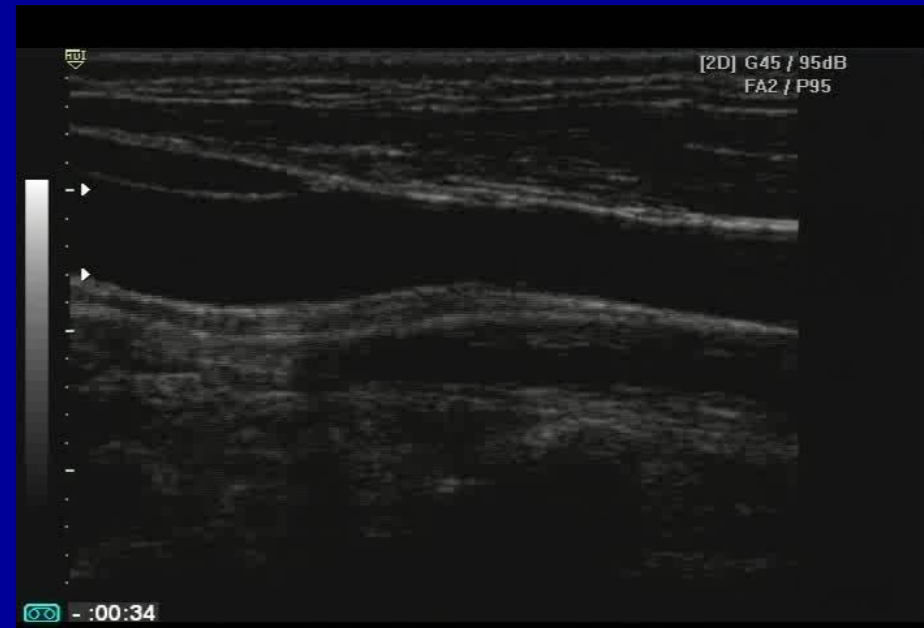
The Collapsing Subclavian

- Careful timing may be required, but completely collapsing veins may be accessed
- The wire in this video appears to go into soft tissue
- With expiration, the vein is revealed



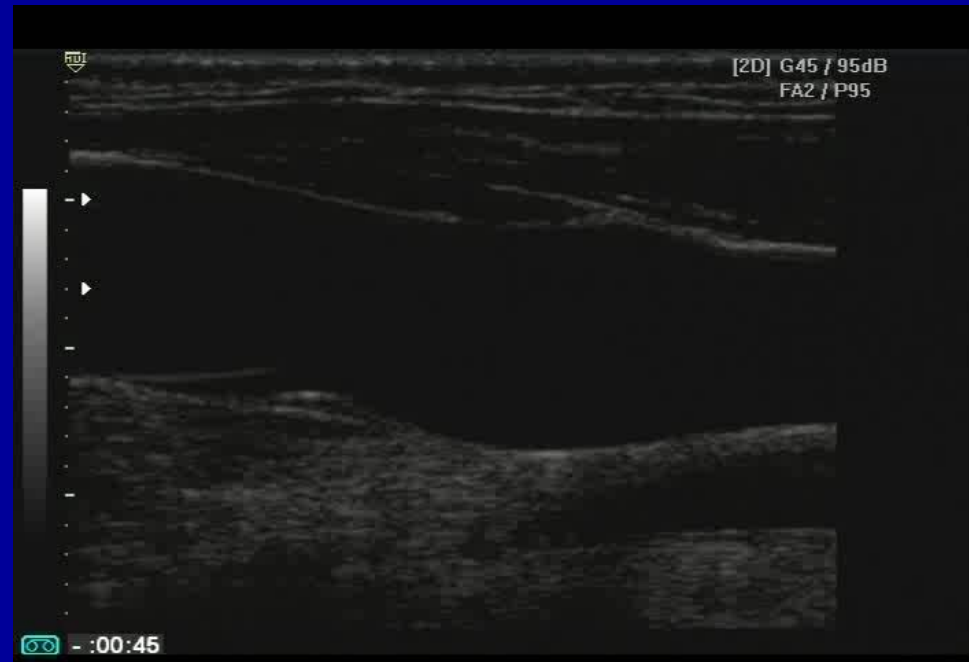
It Seemed To Work, But Then...

- If the guide wire is not feeding in well
- The line will not pass
- Other complication
- Even in a placement that seemed to go well like in this patient



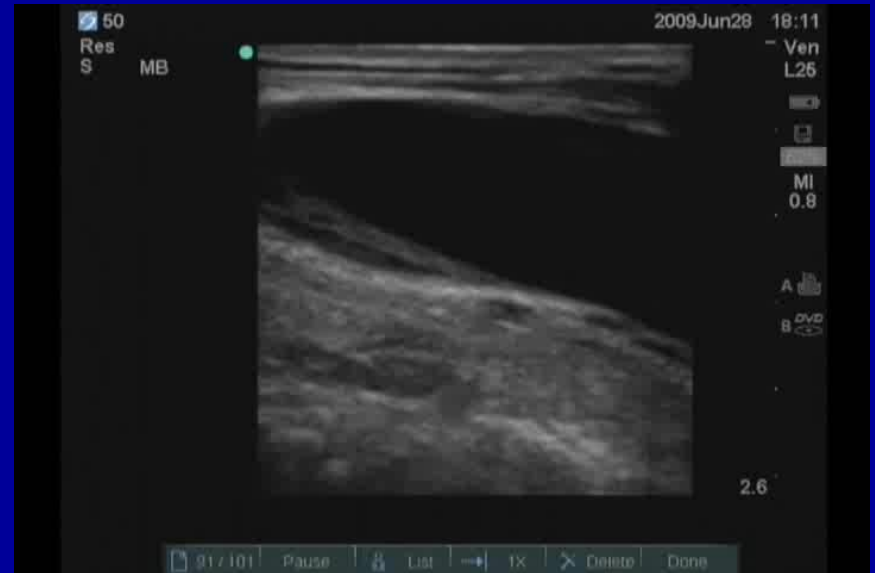
It Seemed To Work, But Then...

- Don't despair
- Take a look again
- In this patient the guide wire cannot be pulled back
- Blaivas M. A rare look at a cause for vascular access failure after correct needle placement under ultrasound guidance. *J Ultrasound Med.* 2008; 27:311-2.



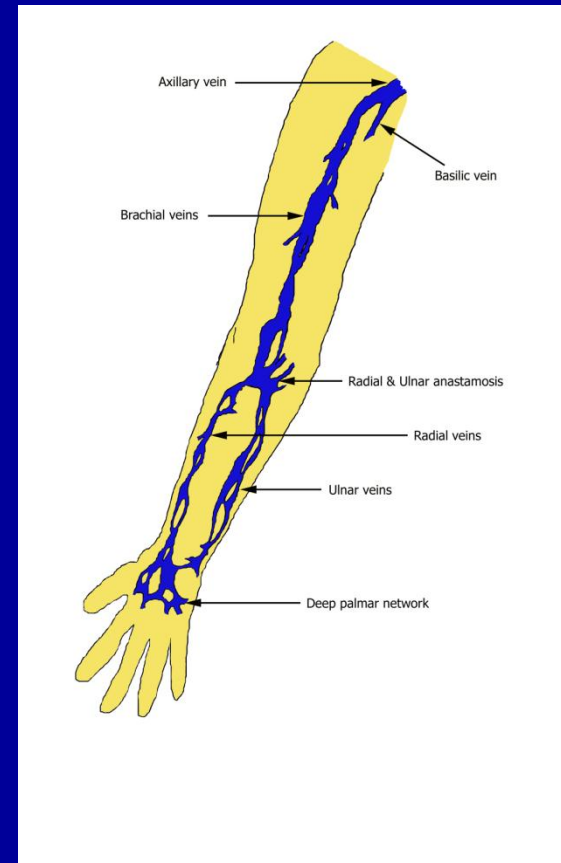
Precision Needle Manipulation

- How precise can you really be with a needle in someone's neck?
- Since the needle can be seen in length, fine manipulation is possible



Peripheral US Guided Access

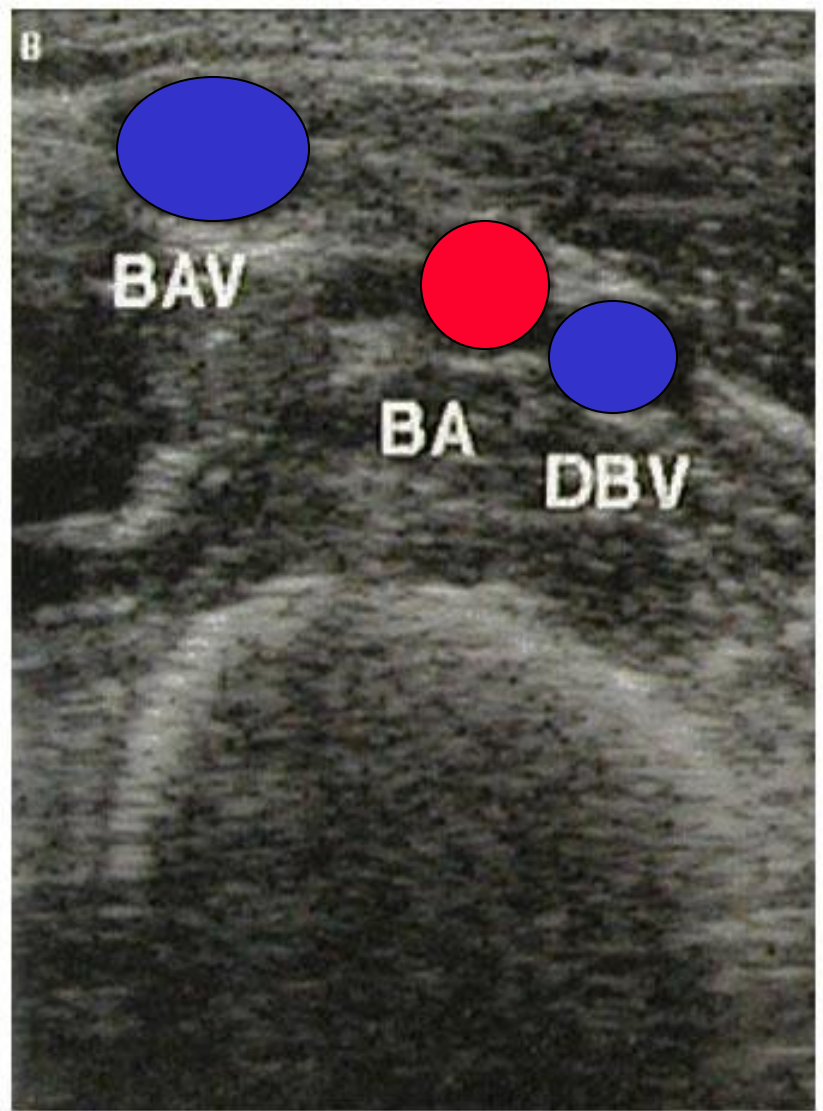
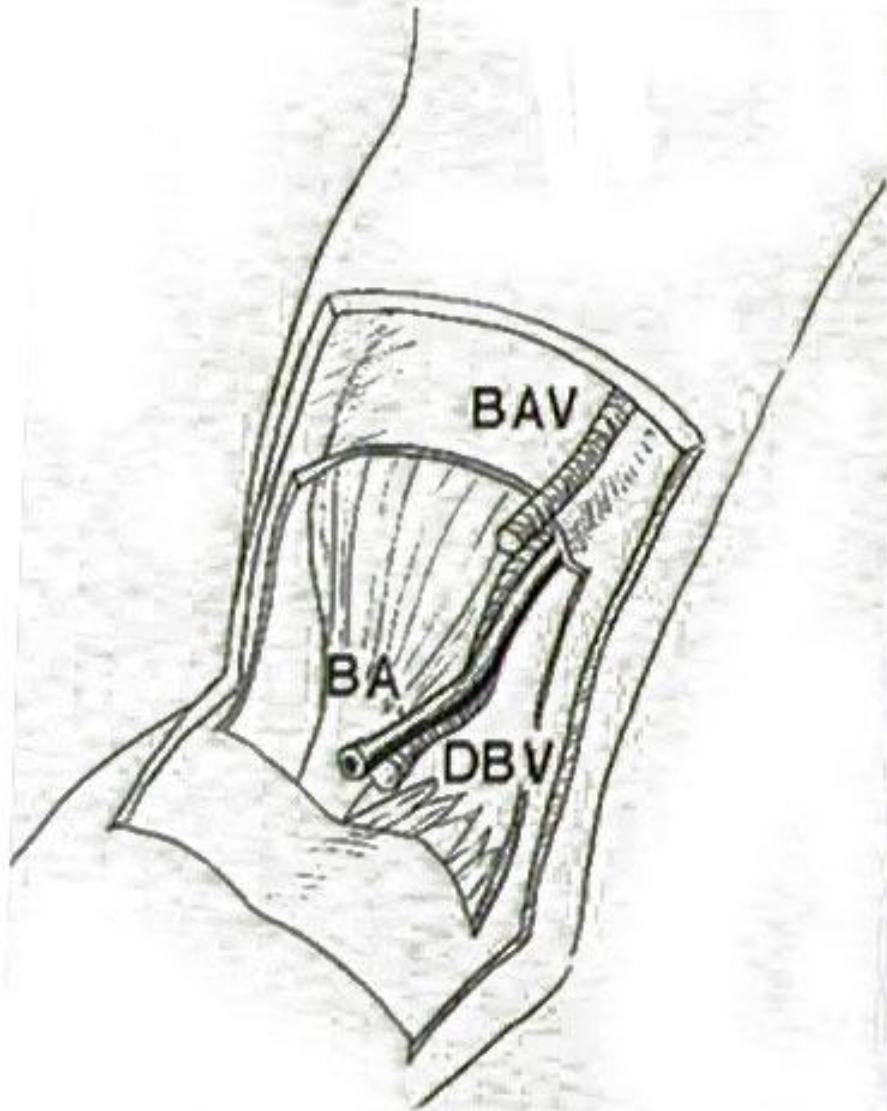
- Can be quite challenging
- Vessels may be smaller than central veins, but may still be relatively deep
- Often plenty of territory to choose from
- In many cases can substitute for a central line
- Consider PICC line type of catheter



Set Up For Peripheral Lines

- Fairly simple
- Don't forget your tourniquet
- Should only be done with one person holding both the probe and needle





Wide Range of Peripheral Targets

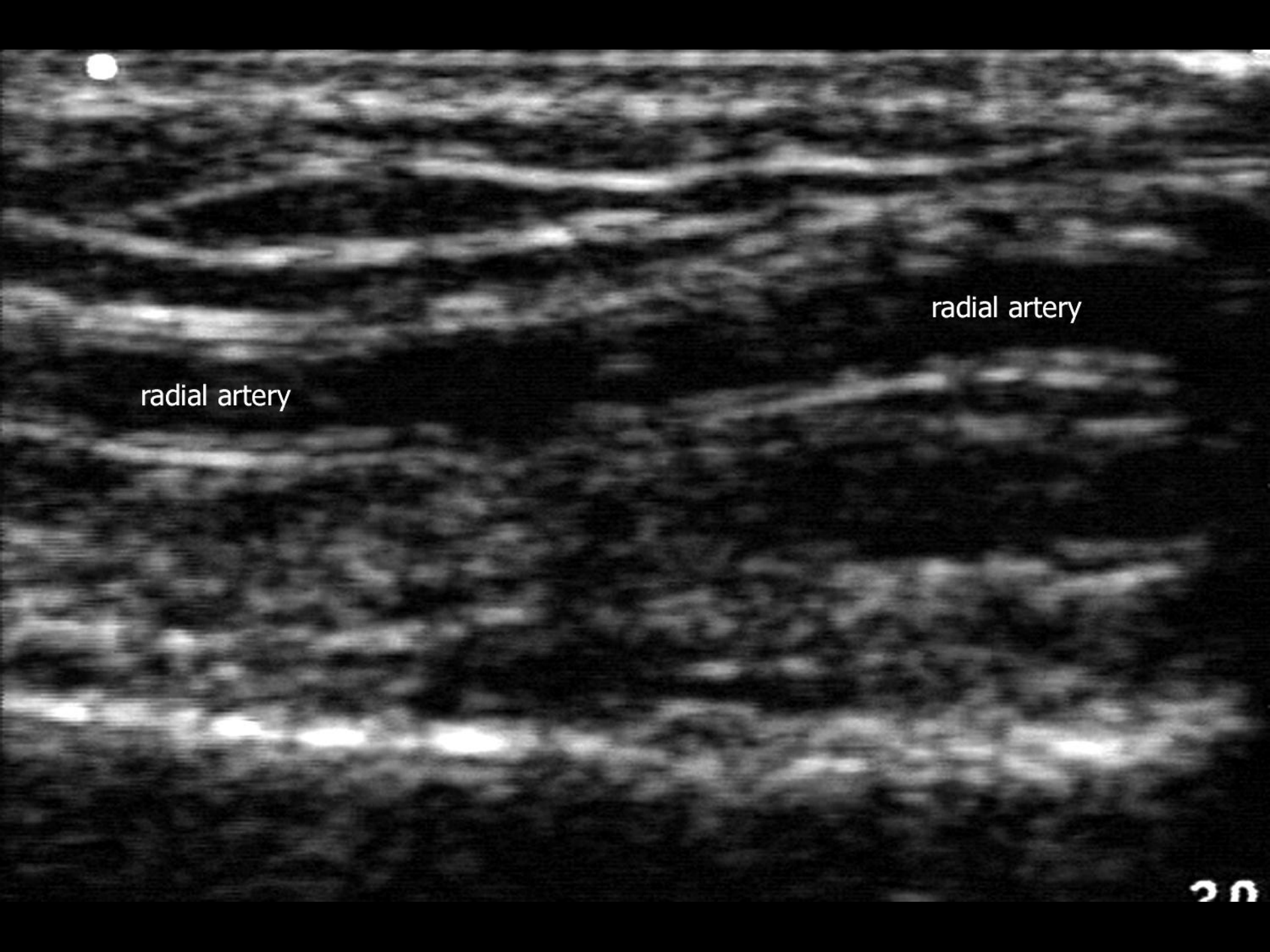
- Some of these veins are very large and make great targets
- Can easily feed in a long central line
- Not all peripheral veins are difficult targets



Radial Artery?

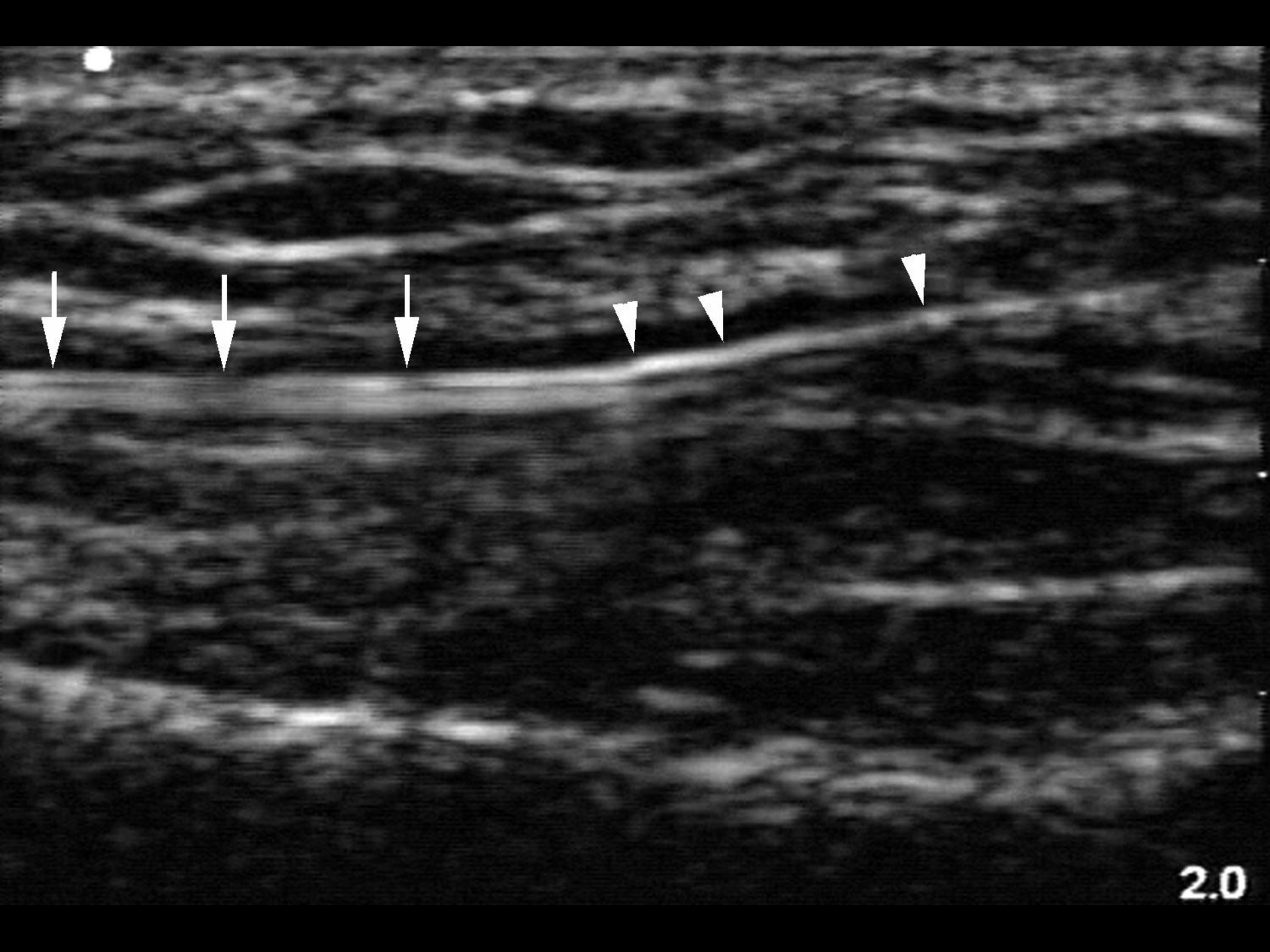
- Gone are the fun days of old
- Increased first pass success
 $p = 0.0004$
- Also decreases time to placement
- Fewer minor complications
- Shiver S, Blaivas M, Lyon M. A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters. *Acad Emerg Med.* 2006; 13:1275-9





radial artery

radial artery



2.0

Arterial Line Guidance

- For very small arteries may need an assistant to float guide wire, but mostly just a luxury
- Much flatter approach typically
- Guide needle into length of artery
- Deploy guide wire, then catheter



Summary

- Ultrasound greatly improves first pass success and safety
- Landmarks? HA!
- Use long axis for improved safety and precision
- If you see the needle and vein you can cannulate almost anything, almost no limits anymore
- Think peripheral when you just need good access, not central



US: A Weapon Against Disease

- Ultrasound guidance, as with much of point of care ultrasound can make a drastic impact on your patient care
- It really is a weapon against complications, vascular access troubles and care delays



Any Questions?

- Catch me during hands on or
- E-mail at [**mike@blaivas.org**](mailto:mike@blaivas.org)

