

Central Venipuncture (CVP)

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Fundamental Principles of Ultrasound Guidance

- Central line complications are potentially fatal
- Ultrasound guidance has become the standard of care for central venous access
- Ultrasound guidance advantages:
 - Identify and locate the target vessel
 - Identify and differentiate non-targets

Required Knowledge

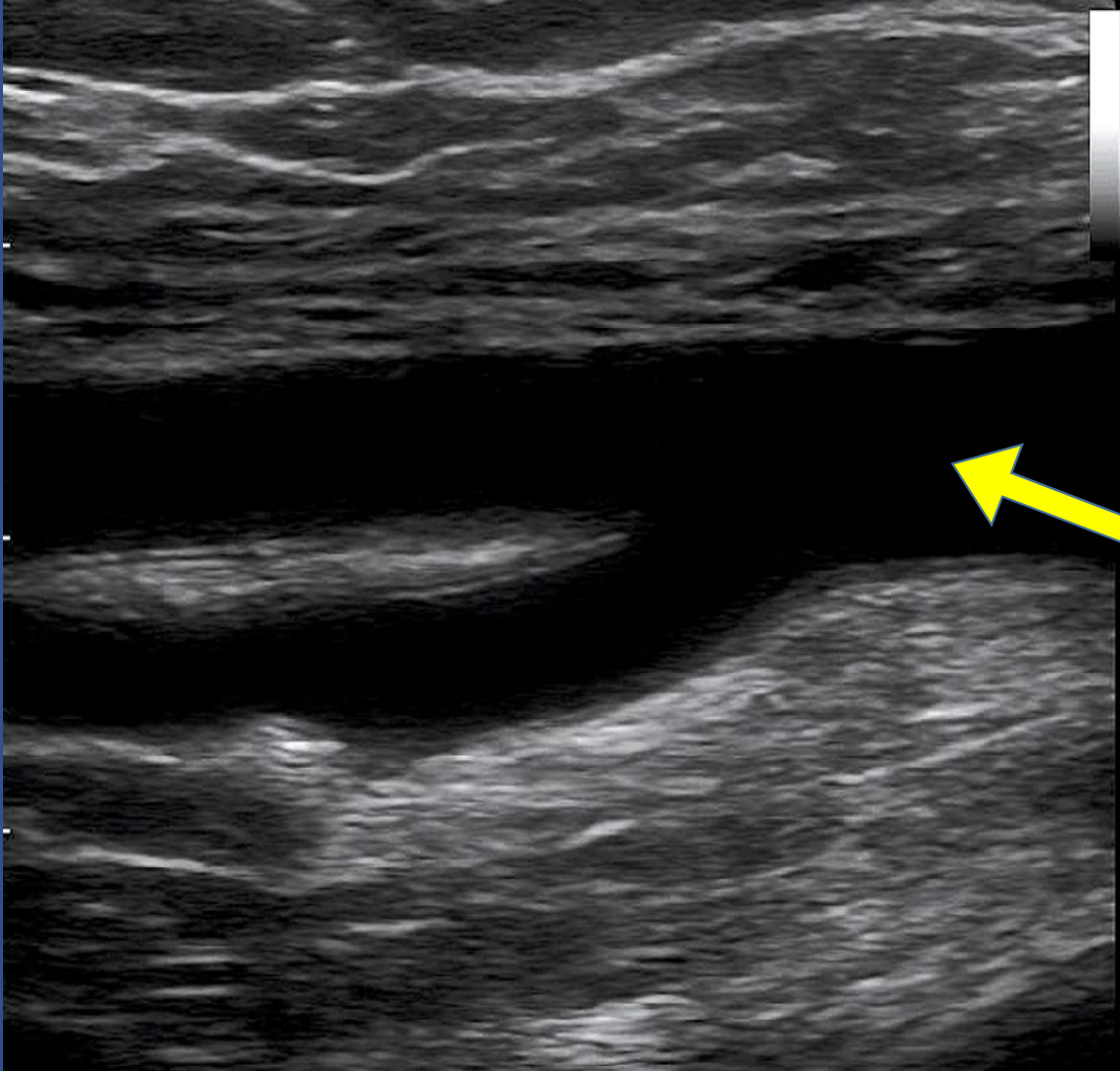
- Aseptic technique
- Seldinger technique: “over the wire”

Target Vein Identification

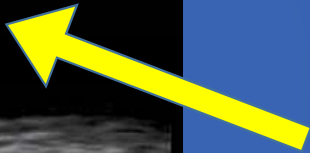
- Pre-ultrasound Era:
 - Anatomic landmarks: “nipples, notches, NAVEL”
- Ultrasound guidance
 - Appearance, size, compressibility, phasicity, Doppler flow

Appearance / Orientation

- Image orientation: CT convention (looking up from below)
 - Except: Int jug vein with proceduralist at head of bed
- Homogenous fluids: BLACK on U/S
 - Blood, urine, bile
- Distinct interfaces: WHITE on U/S
 - Tissue: tissue
 - Steel: blood / tissue

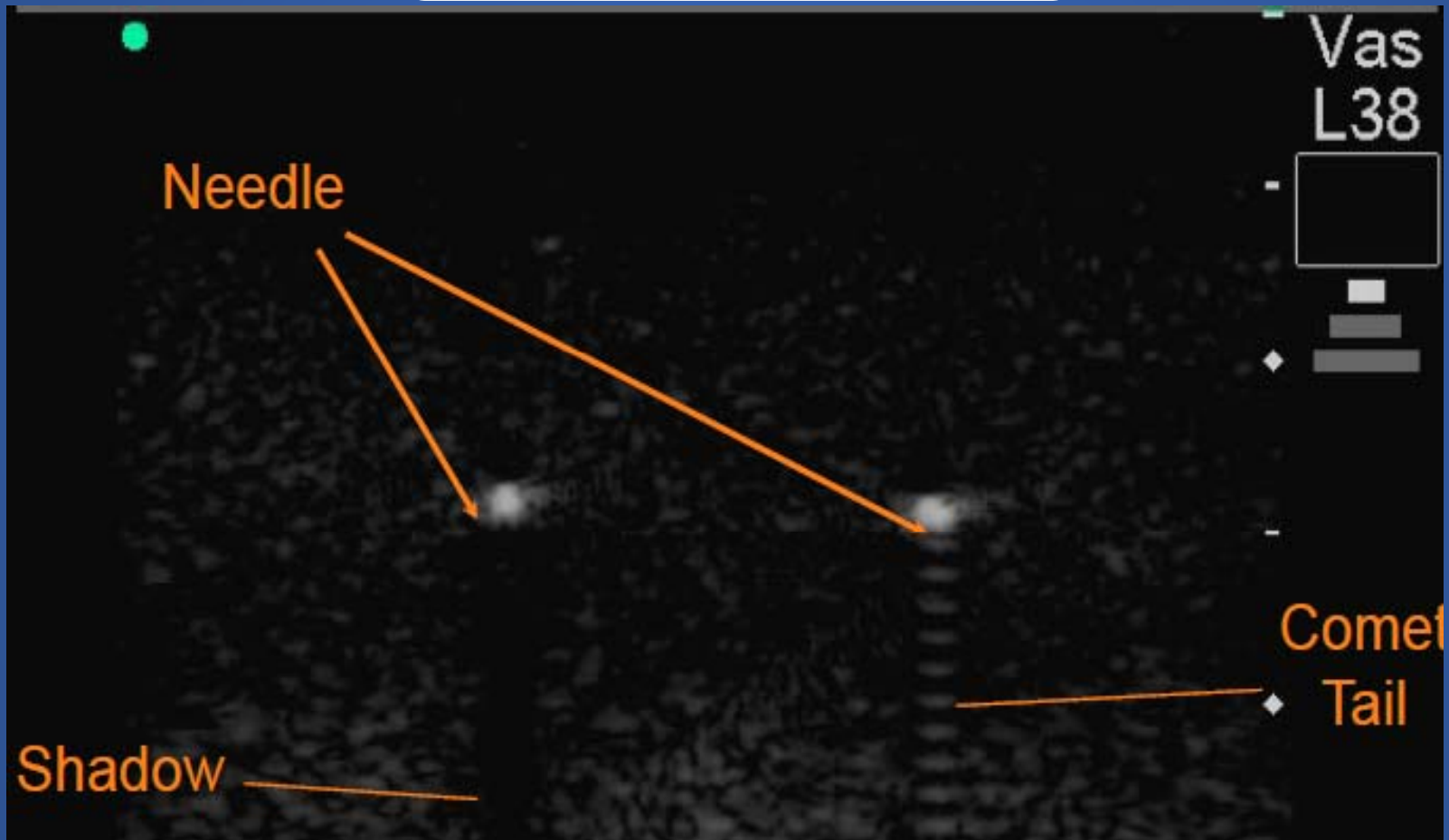


BLACK on U/S



Blood flowing
in vessel

WHITE on U/S



Ultrasound Machine: Technical Issues

Ultrasound Probe Types



Linear

- Elements arranged in a line
- Higher frequency (7.5-10 MHz)
- Higher resolution
- Lower penetration



Convex; curvilinear

- Elements arranged along a curve
- Lower frequency; lower resolution
- Higher penetration

3 Finger probe grasp

- Allows remaining fingers or wrist to rest on patient or anchor and stabilize
- Finer probe manipulations possible
- Sonographer can watch screen and not hand; prevents wandering probe
- Reduces patient discomfort and injury risk
- “Fine” grip preferred over “power grip”



Probe / screen orientation

- Probe notch = Screen green dot
- During imaging: notch goes to operator's left and green dot to screen's left



Probe / screen orientation

- Internal jugular CVC: operator at head of bed; looking inferiorly at patient and screen
 - Screen left = reality left
 - Anti-CT image orientation
- Femoral CVC operator at feet looking superiorly
 - Resultant image is consonant with CT orientation

Probe frequency

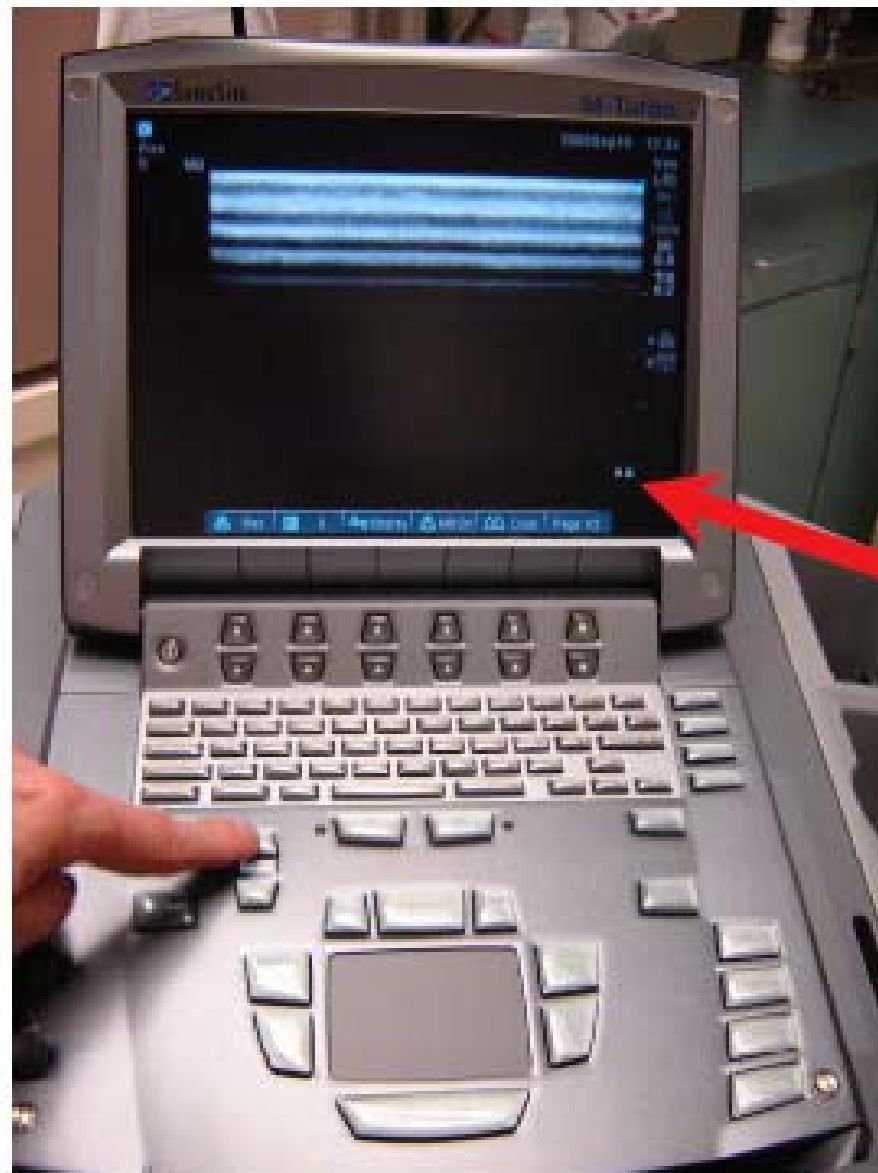
- High frequency: high resolution; low penetration
 - “Res” on Sonosite
- Moderate
 - “Gen” on Sonosite
- Low frequency: low resolution; high penetration
 - “Pen” on Sonosite

Probe
Frequency:
“Res, Gen, Pen”

(high) Resolution
General use
(high) Penetration



Screen Depth

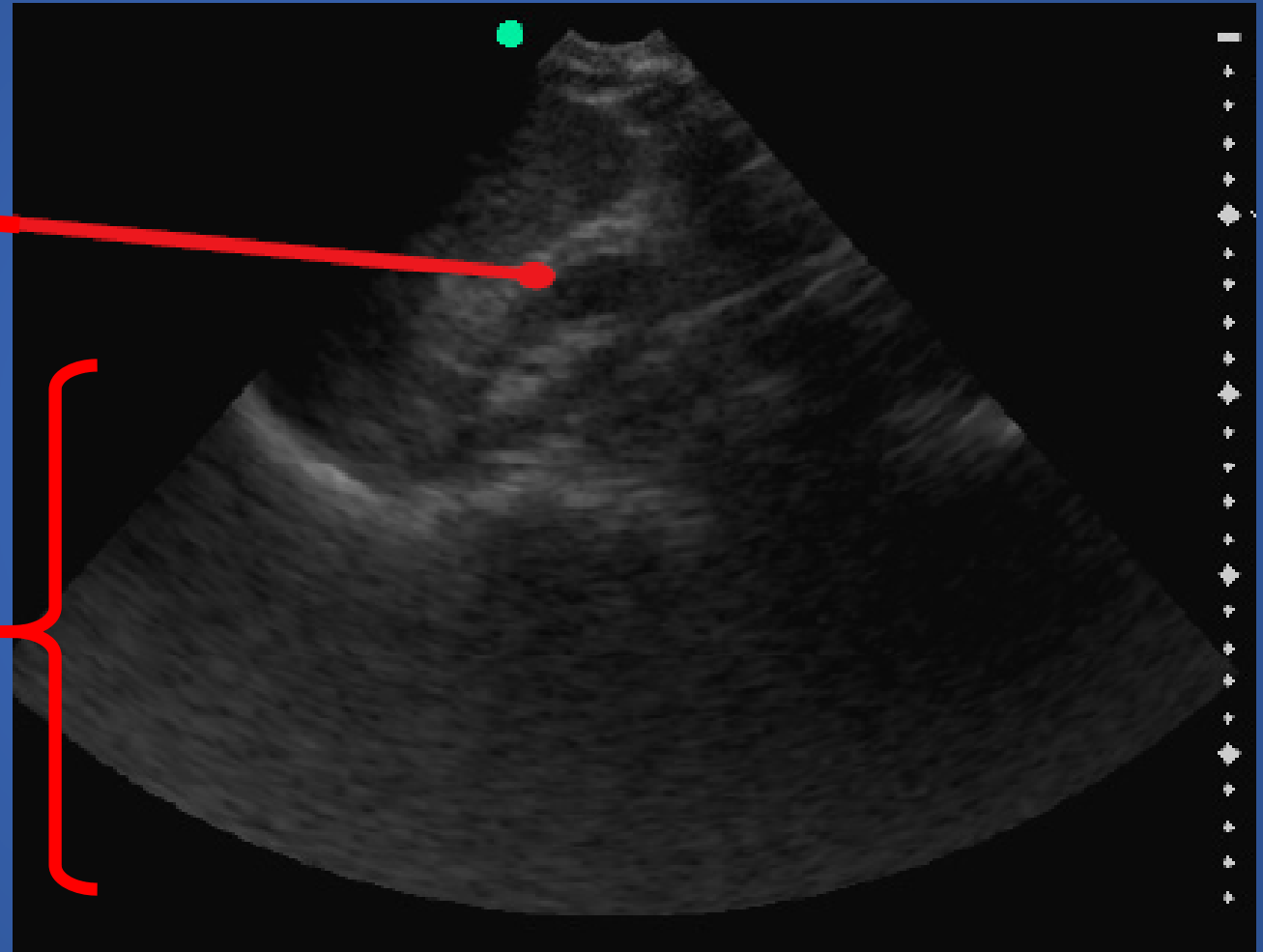


Screen Geography

- Allocate screen to area of interest (AOI)
- Locate AOI at mid depth; devote substantial screen
- Include identifying context anatomy
- Avoid quest for perfect still image

AOI

**Wasted
screen
space**



Cleaning the probe

- Treat transducer similar to stethoscope head
- “Clean” not sterilize
- Cannot heat sterilize
- List of approved and prohibited cleansing agents
- Caviwipes should be with machine

Ultrasound Guidance: Concepts and Technique

1st Step: U/S Guidance

- Locate and positively identify the target vein

Locating the vein

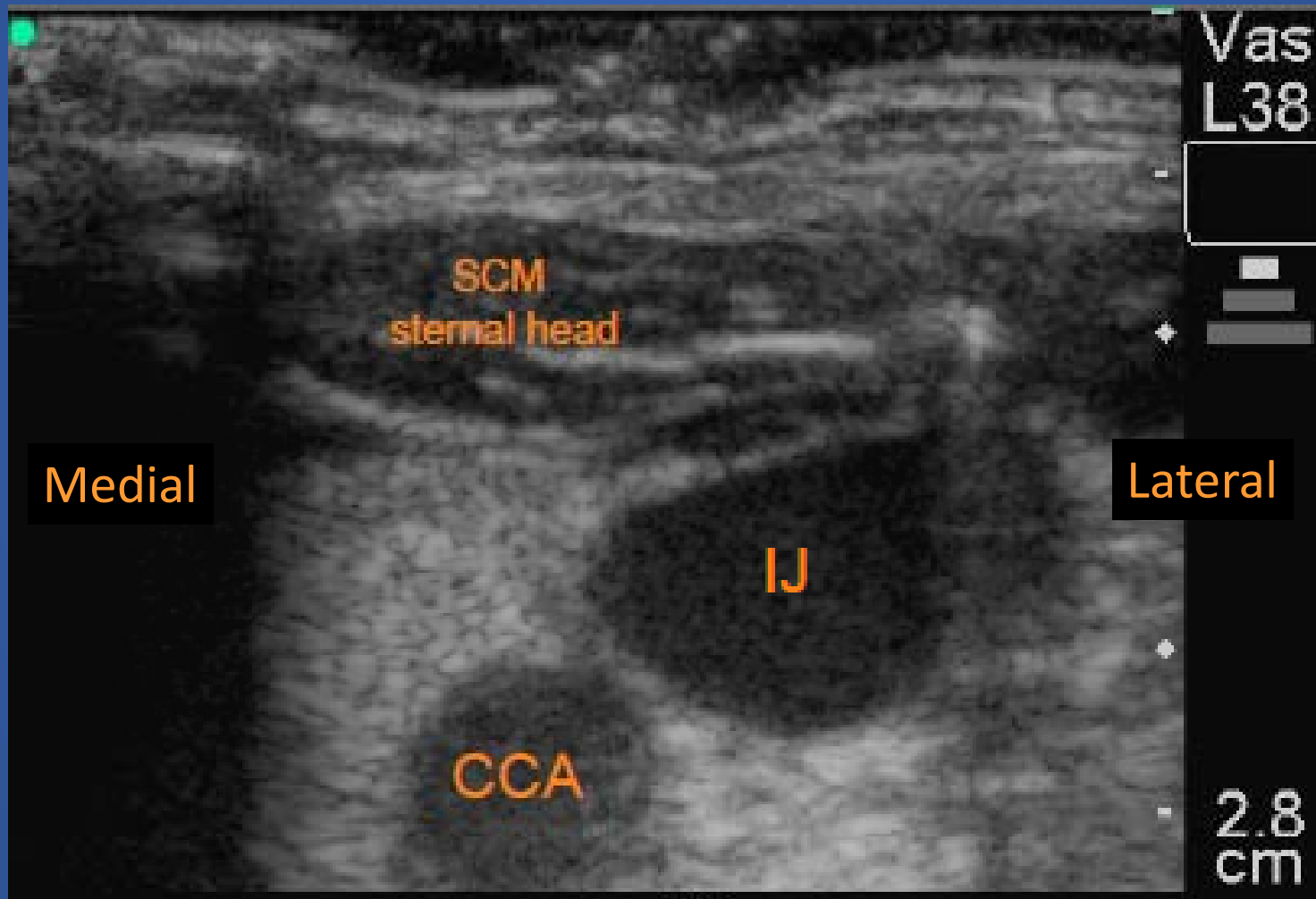
- Anatomy
- Size
- Compressibility
- Phasicity



Locating the vein: internal jugular

- Around the sternocleidomastoid (SCM) triangle
- Internal jugular vein (IJ) usually superficial and lateral to the common carotid artery (CCA)

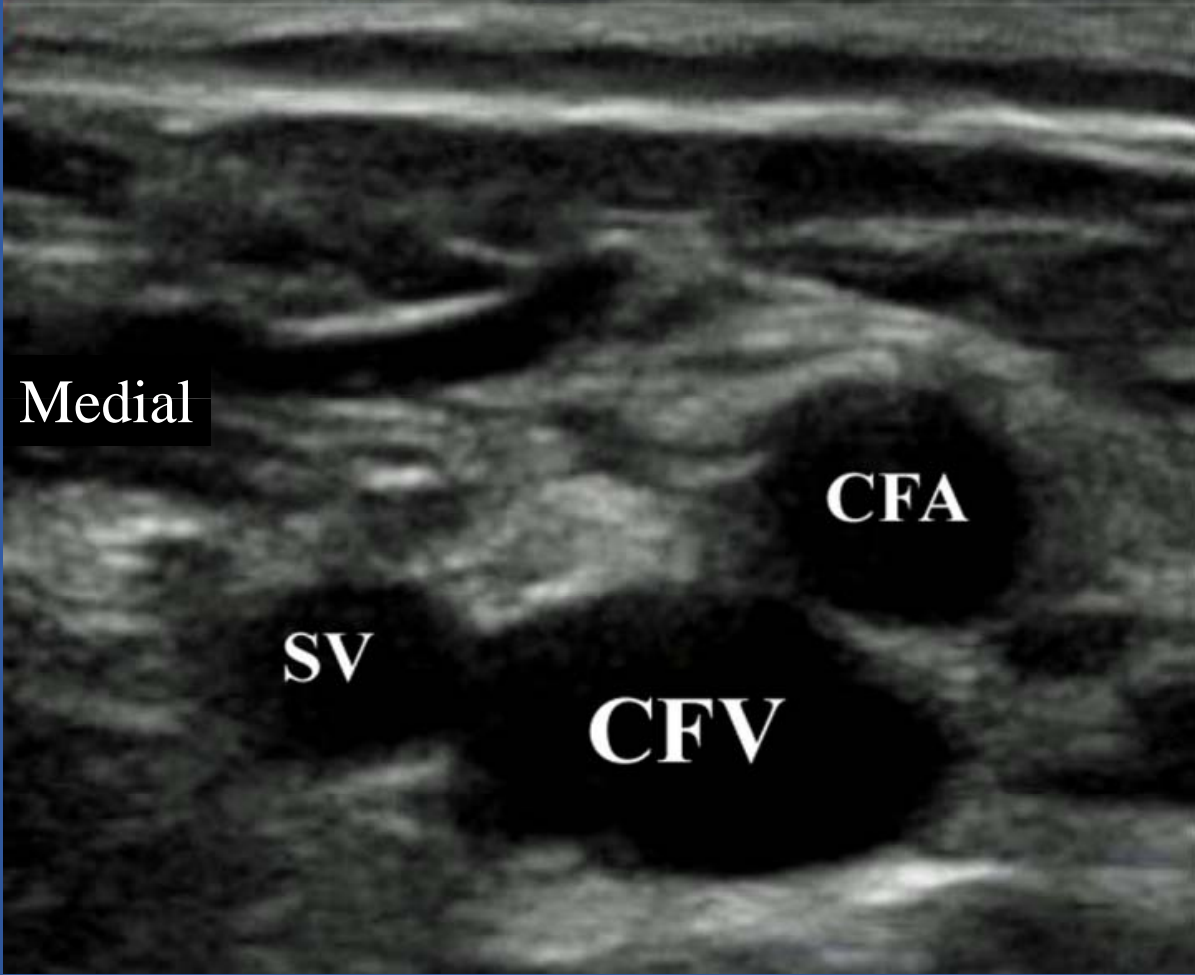
Right neck from HOB



Locating the vein: femoral

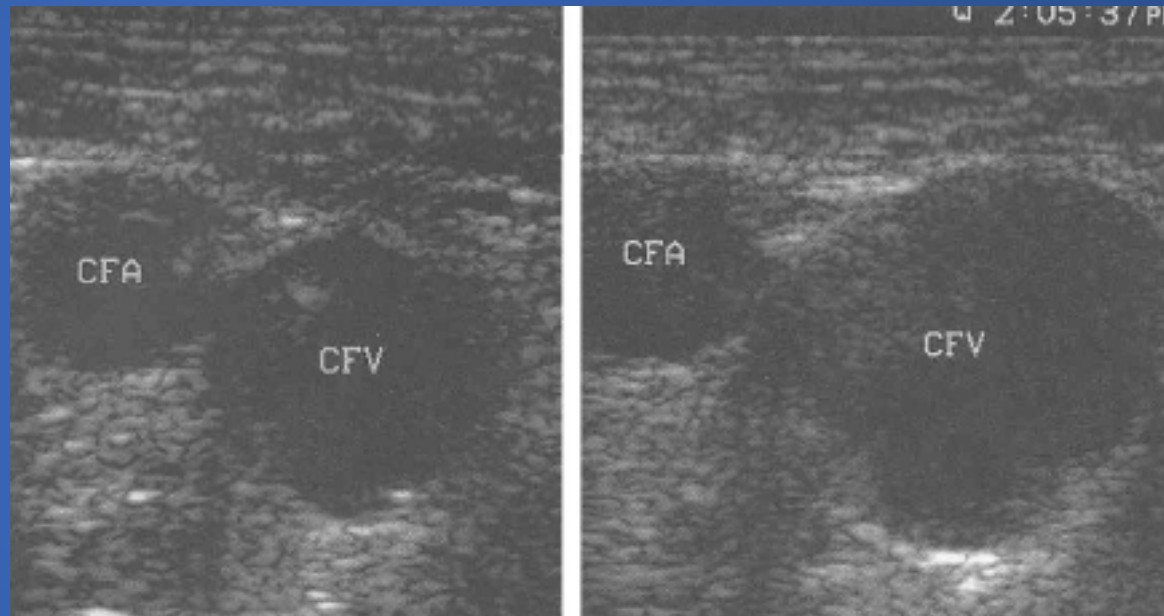
- Common femoral vein (CFV) is medial to the common femoral artery (CFA)
- In euvolemic, supine patient the CFV (and IJ) are larger than adjacent arteries

Left femoral: looking up



Phasicity / Competency

- Vein volume (size on U/S) can vary with respiratory cycle and abdominal or thoracic pressure

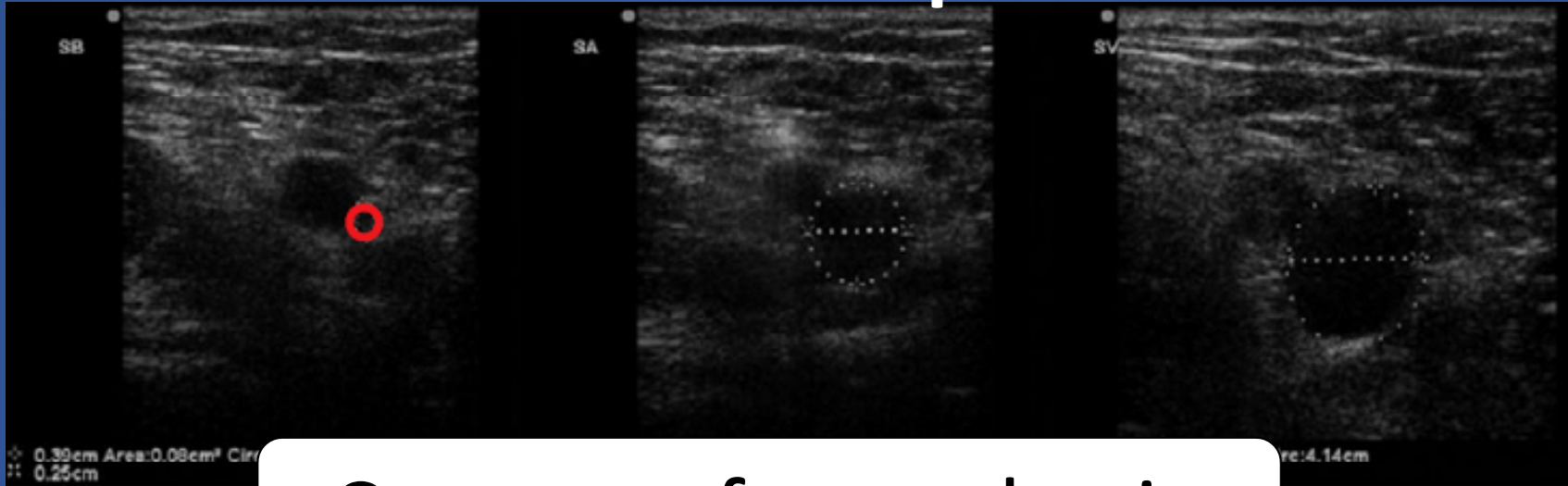


Baseline

Abd comp

Valsalva

Supine



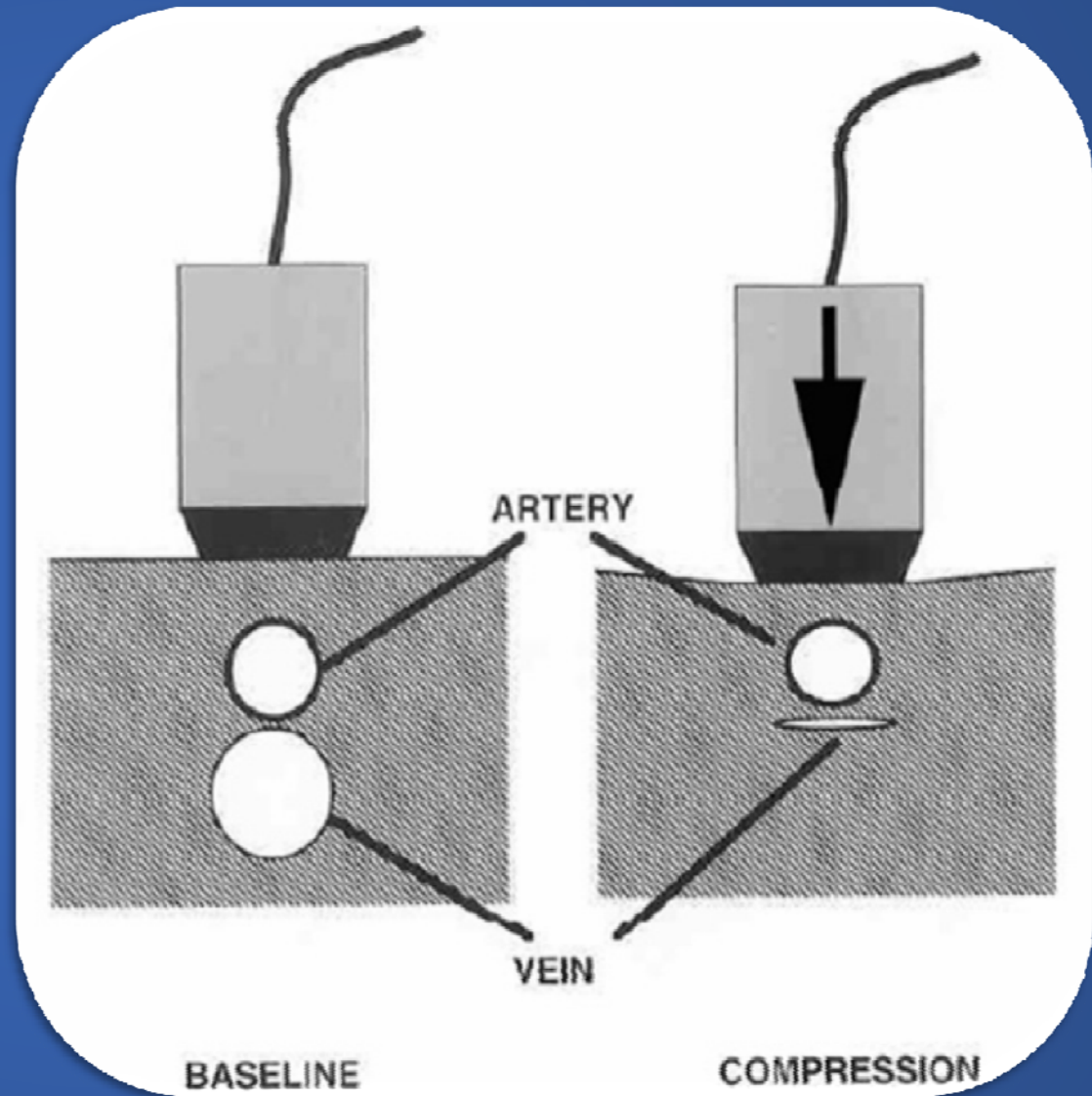
Common femoral vein

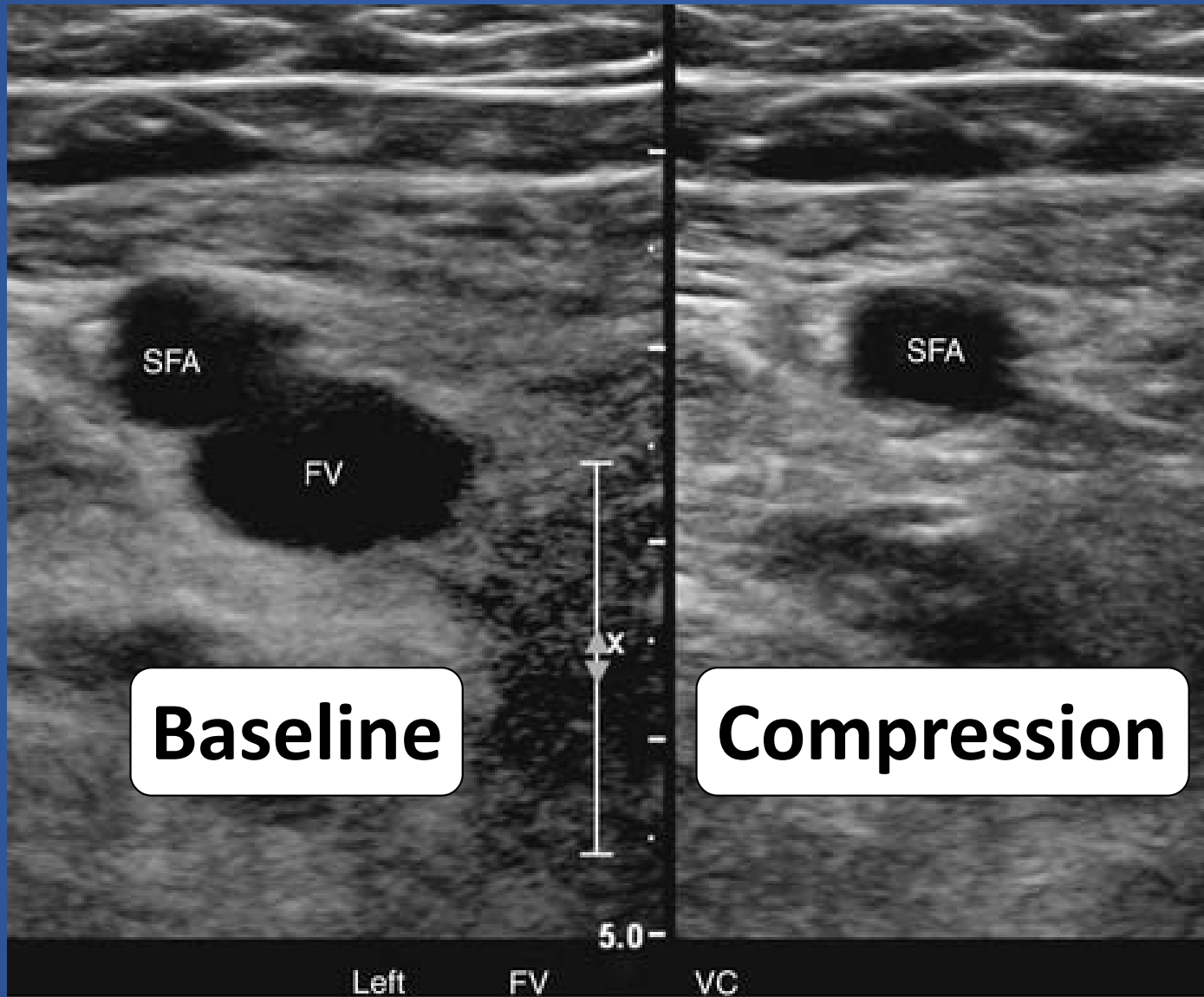
Rev T-burg

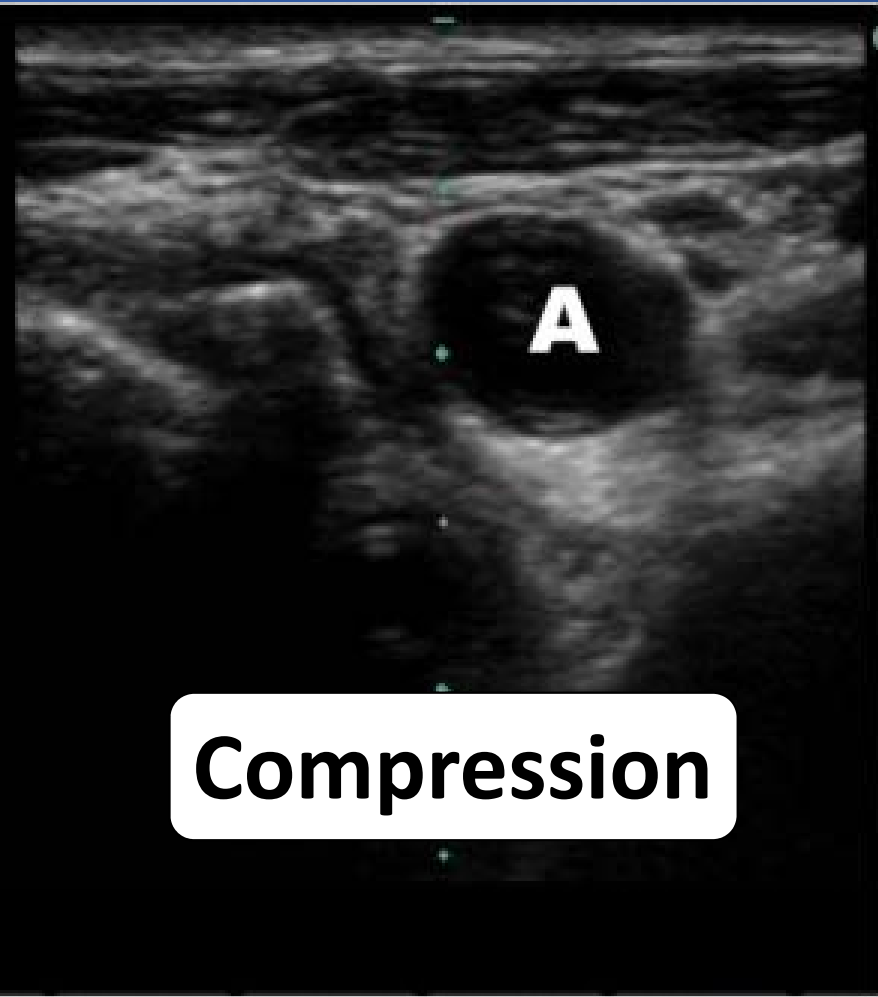
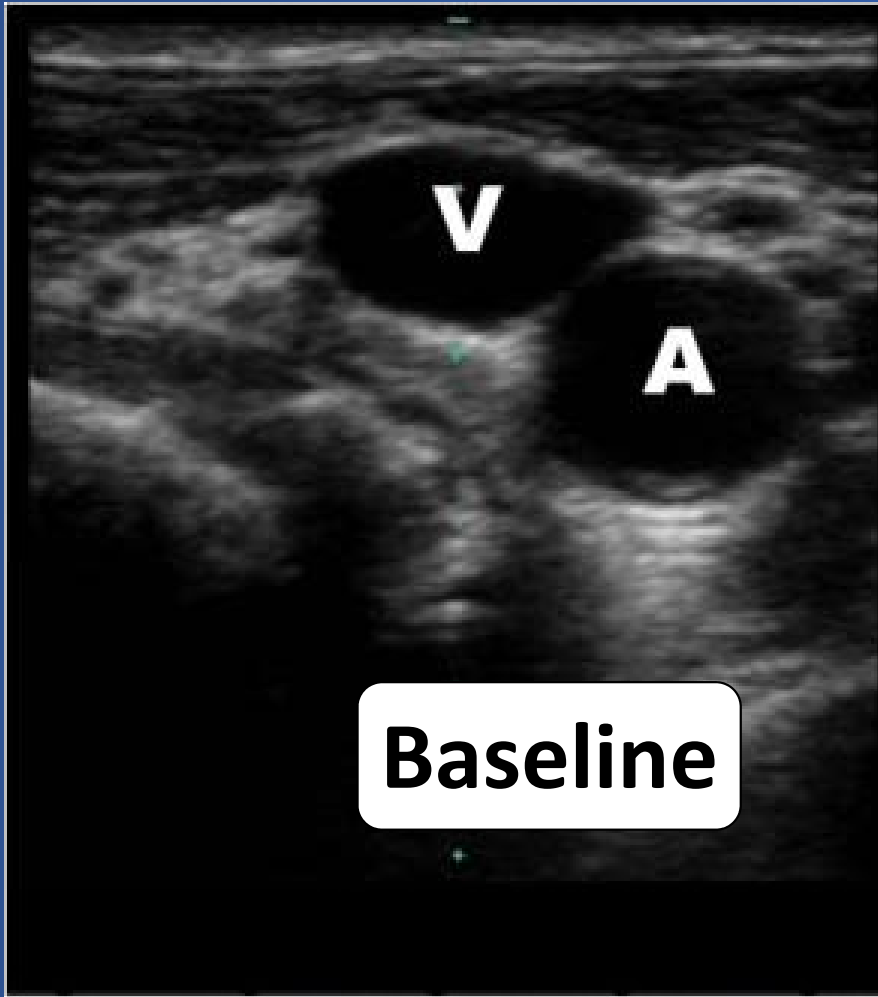


Compressibility

- Veins compress
- Arteries do not
- Easiest and primary differentiating factor

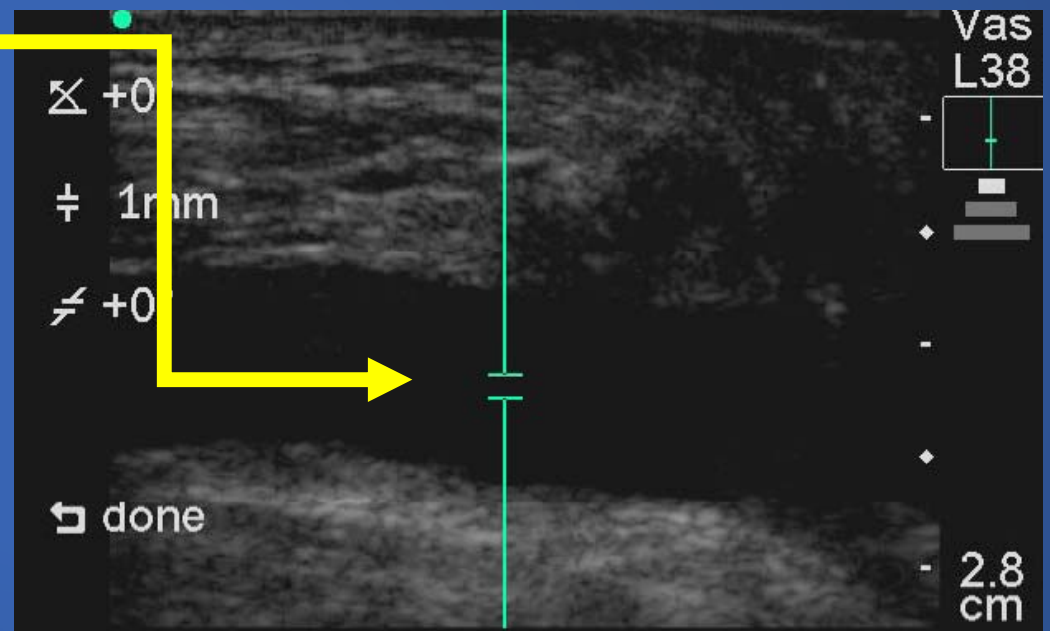


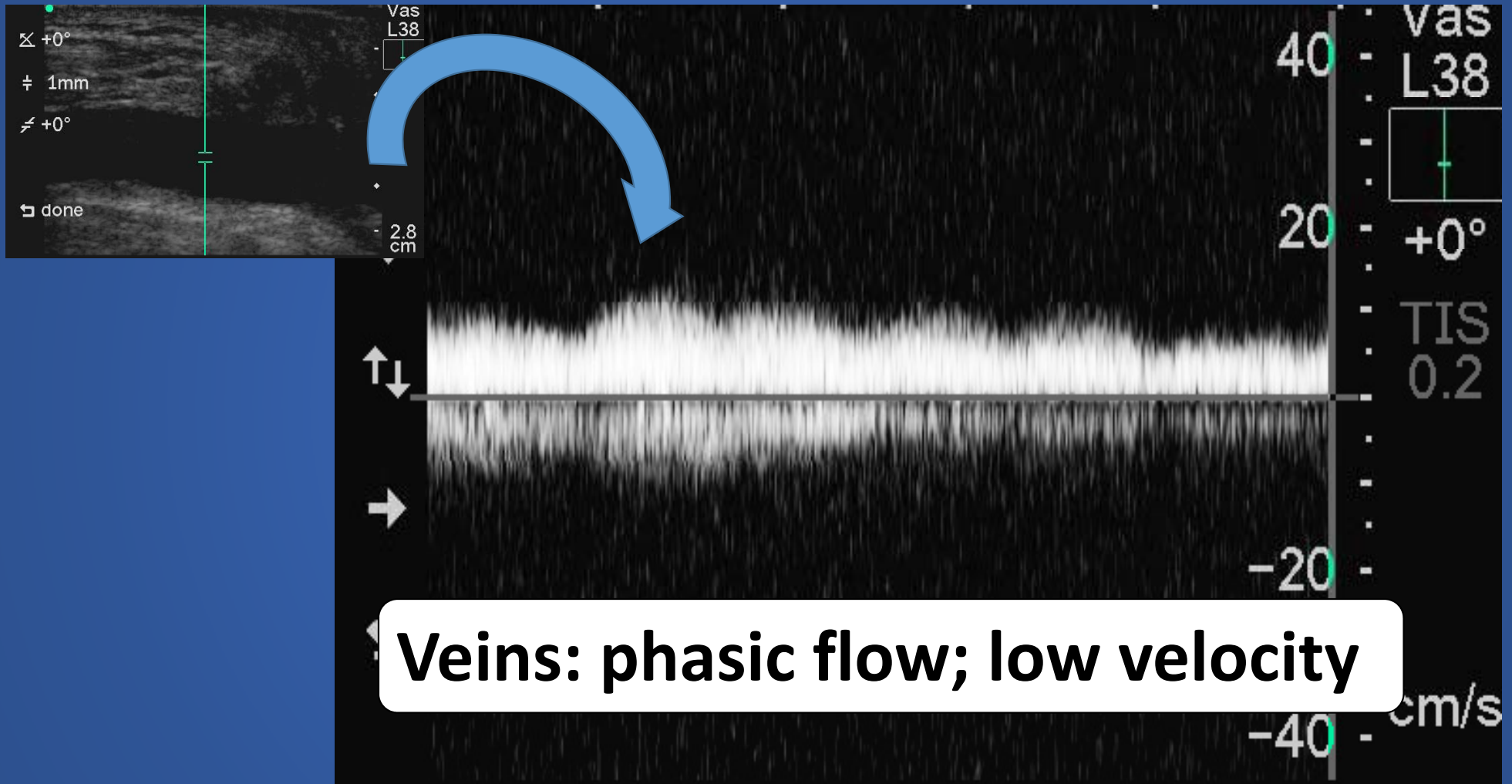


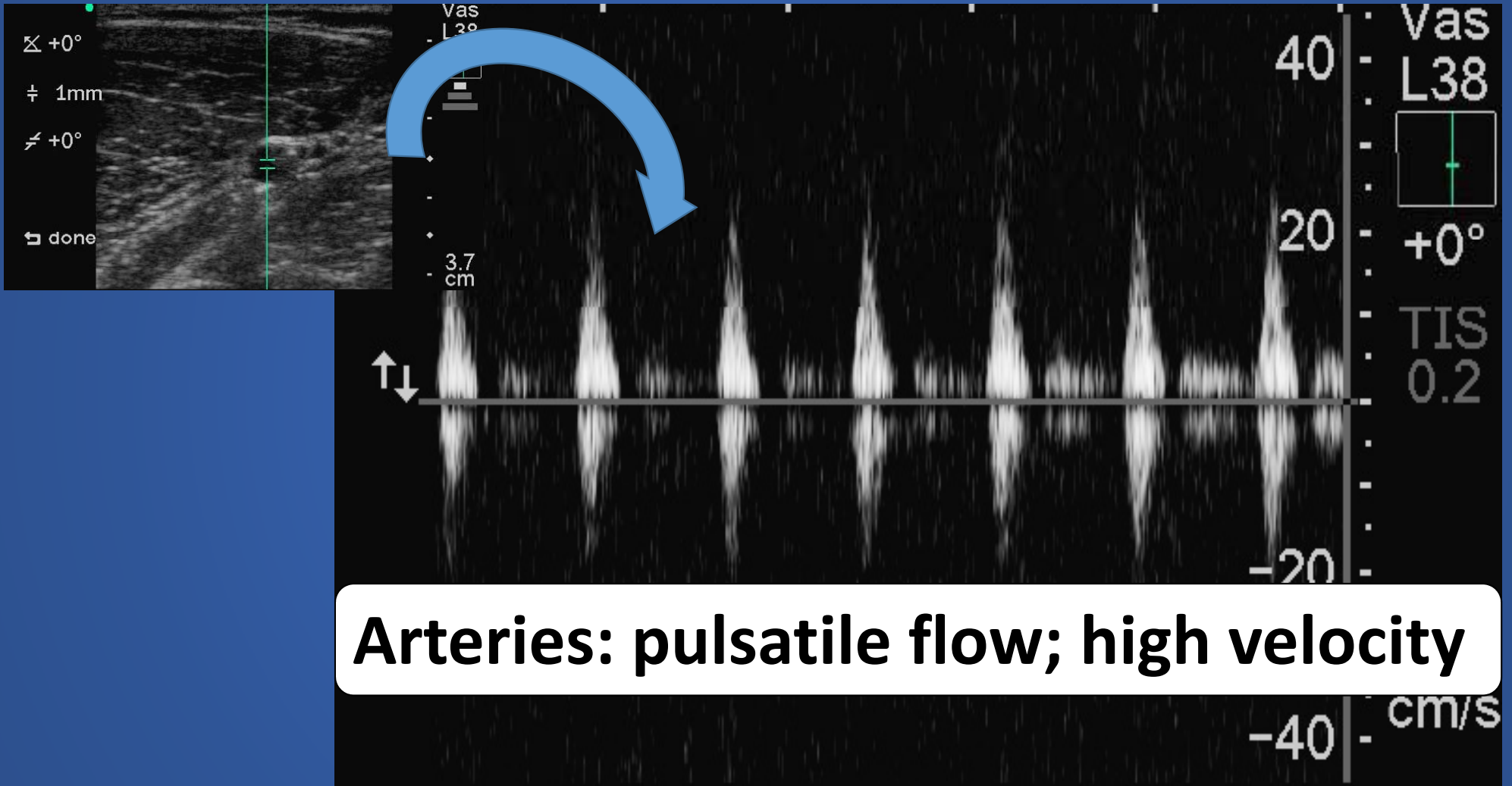


Doppler flow characteristics

- Electronic Doppler
- Wave form and velocity







Optimal target

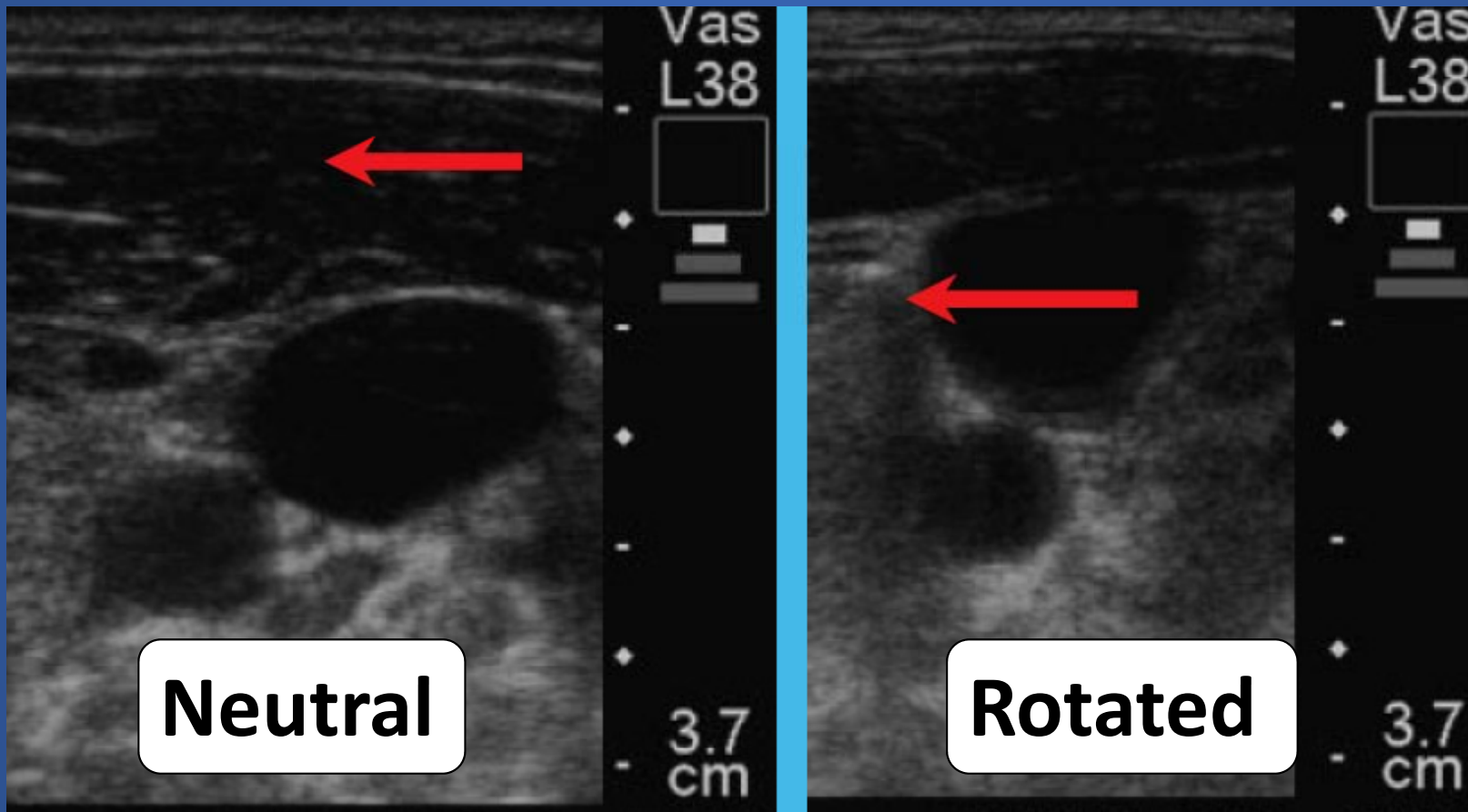
- Large caliber
- Superficial location
- Distant from non-target vital structures

- Usual venipuncture target is a compromise of these characteristics

Technique for IJ positioning

- Rotation of neck away from procedure side brings IJ over carotid; potentially increasing risk of carotid puncture
- Compromise: rotate head/chin out of operator's way; avoid extreme rotation
- Real time U/S visualization will decrease risk

Technique for IJ positioning



U/S Guidance Technique: 4 P's

- Pre-scan
- Preparation
- Poke
- Path

Pre-scan

- Before sterile prep; survey underlying vessels
- Confirm target vessel
- Optimize patient and machine positions and settings
- Set table height and tilt
- Lower room lights; adjust monitor gain (brightness)

Preparation

- Maximum barrier cart
- Prepare skin
- Transducer sterile sleeve and gel
- Drape covering entire patient; mayo stand cover for table
- Gown, gloves, hat, mask

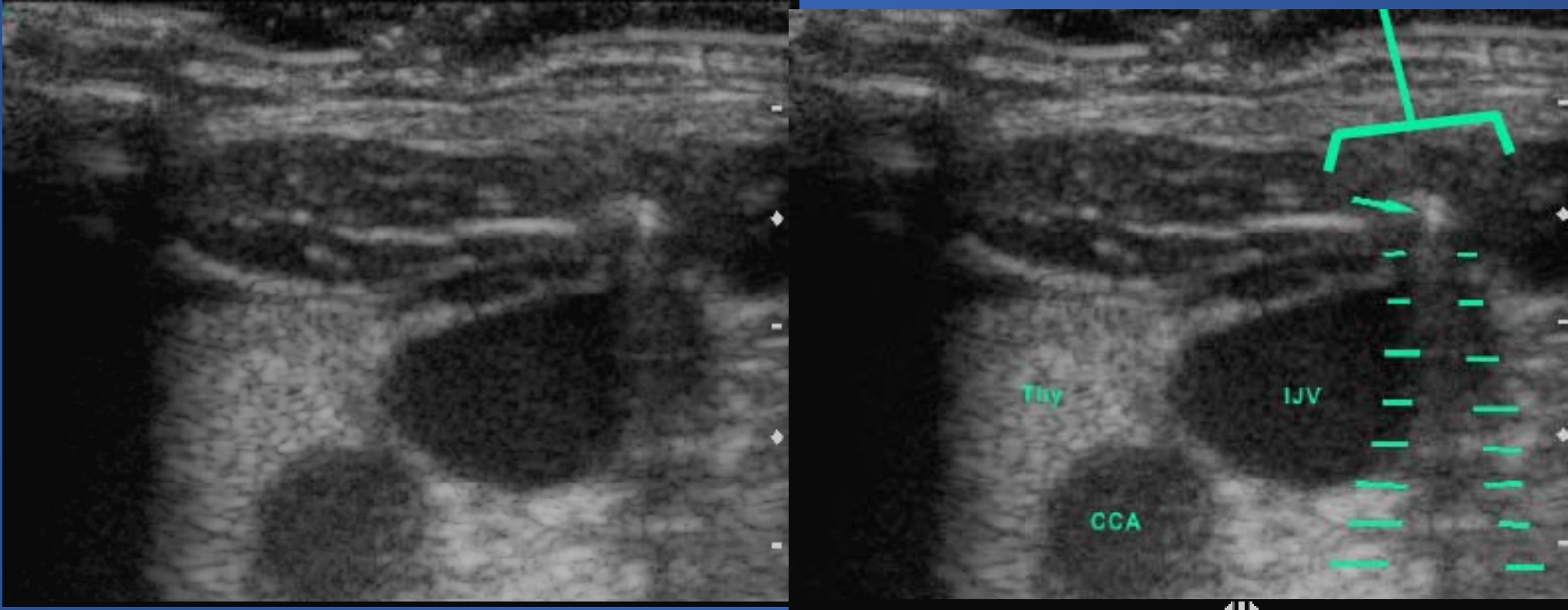
Poke

- Initial skin puncture
- Center the target vessel
- Near transducer, at midpoint; 45 degree angle
- Places needle in subcutaneous tissue
- Locate needle by ultrasound before advancement

Path

- Following the path of the needle and adjusting the course
- Tissue motion to localize needle
- Bright spot echo = needle
- Short axis: ring down artifact
- Long axis: reflection and shadowing or reverberation from shaft

Needle in cross-section



Shadow / comet tail from needle

Path

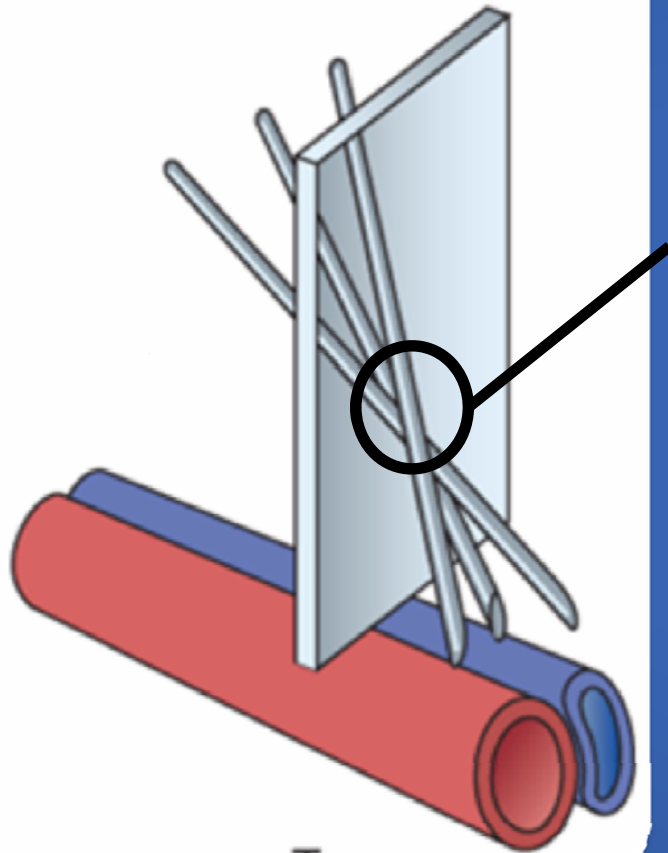
- Locate needle tip prior to advancement
- Accurately visualize the needle from skin to target vessel
- Requires sweeping motion of scan plane in short axis
- Potential error: mistaking shaft of needle for tip in transverse plane

Path

- Potential error: mistaking shaft of needle for tip in transverse plane
- Cross section of needle shaft does not represent true vector of needle

Needle

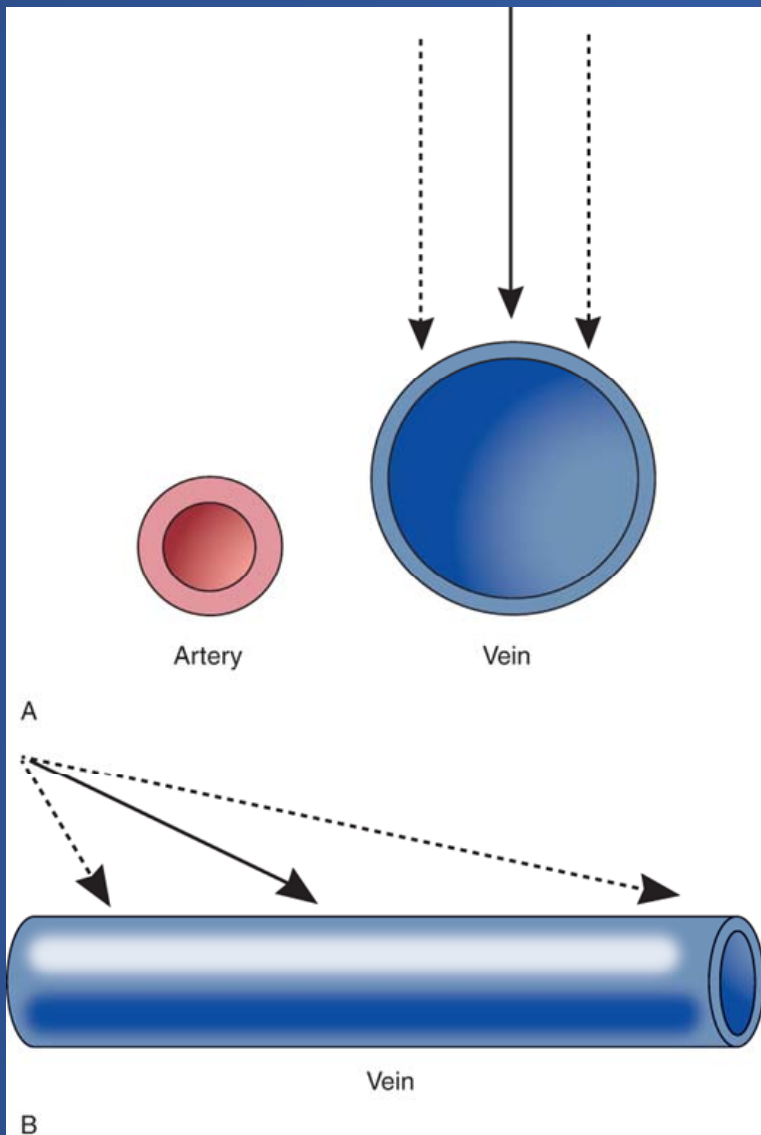
Out-of-Plane



**Needle shaft cross
section images
converge but
vectors are different**

Vein

Trans

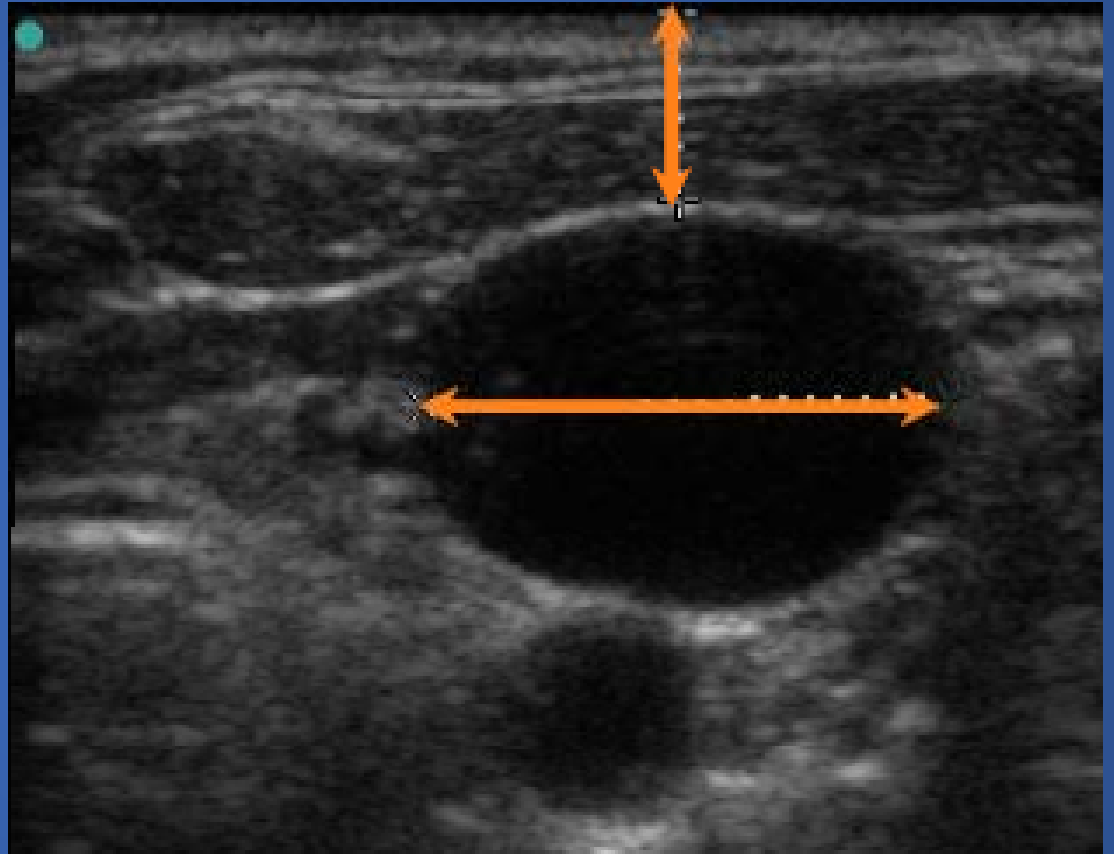


Transverse plane: better lateral/medial positioning

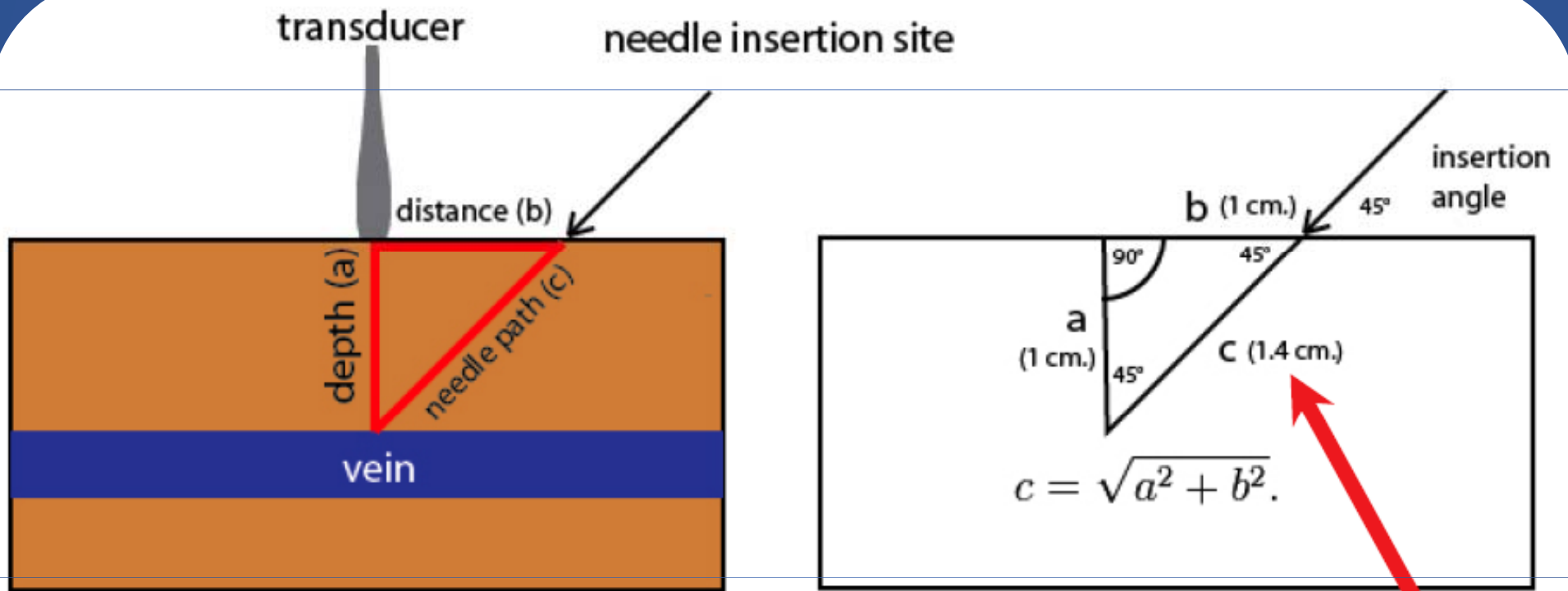
Longitudinal plane: better slope and depth positioning

During procedure know...

- size of target
- distance to target



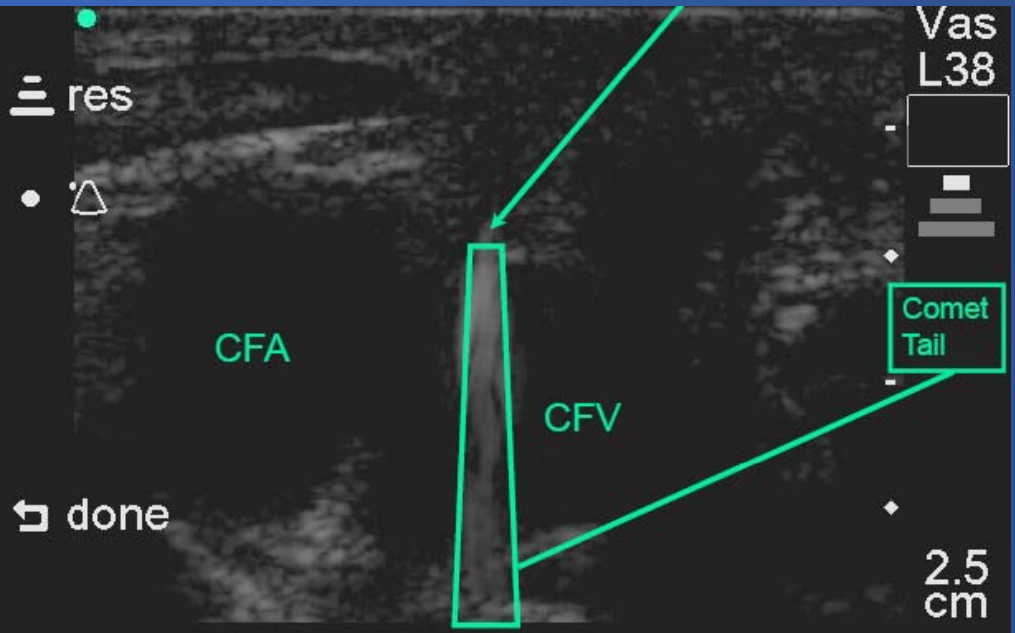
Estimating distance to target



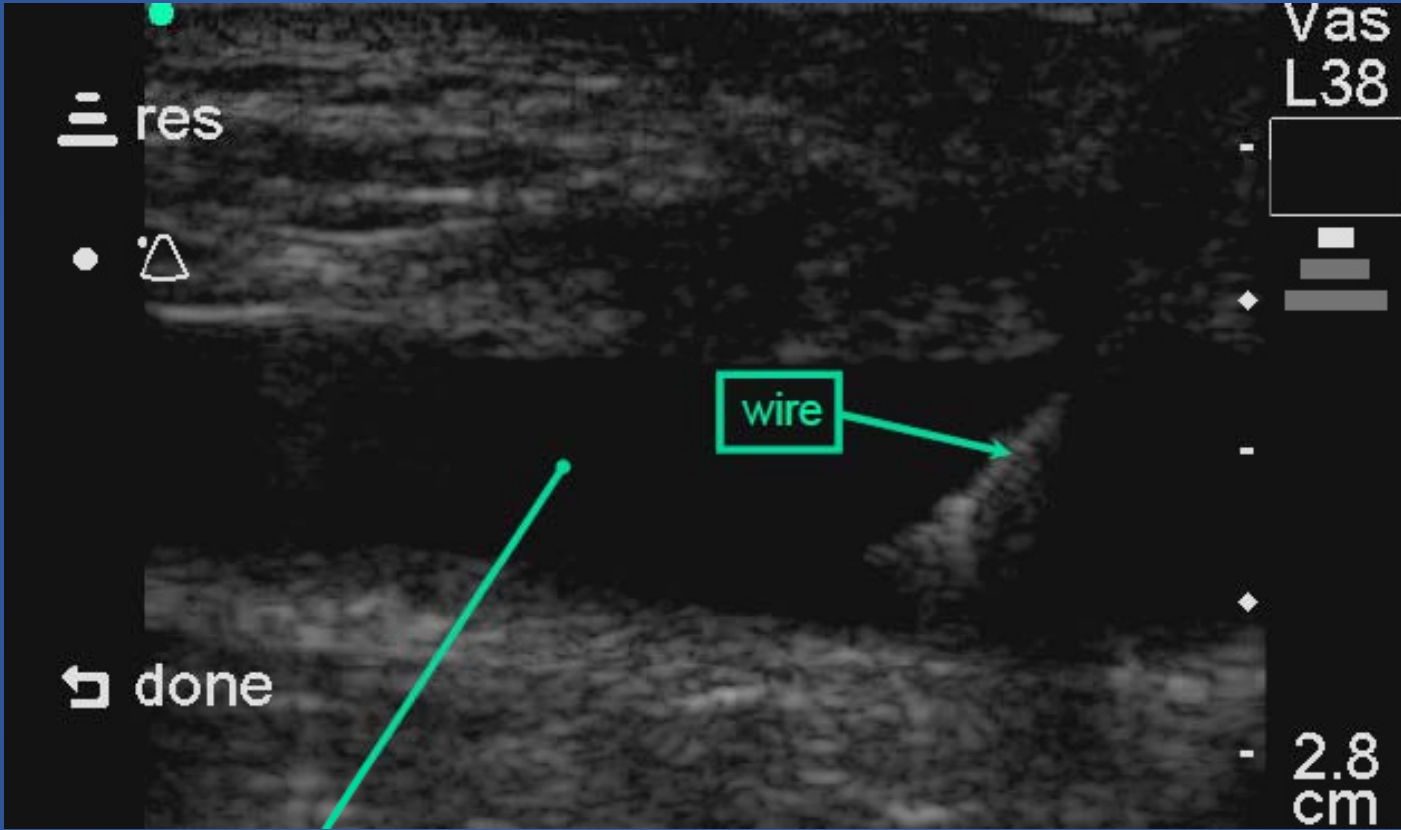
Vein puncture

- Vein deforms with pressure of advancing needle
 - Blood in needle
 - Set aside probe; stop U/S
 - Complete procedure
-
- 2 operator technique allows more imaging

Needle in cross section

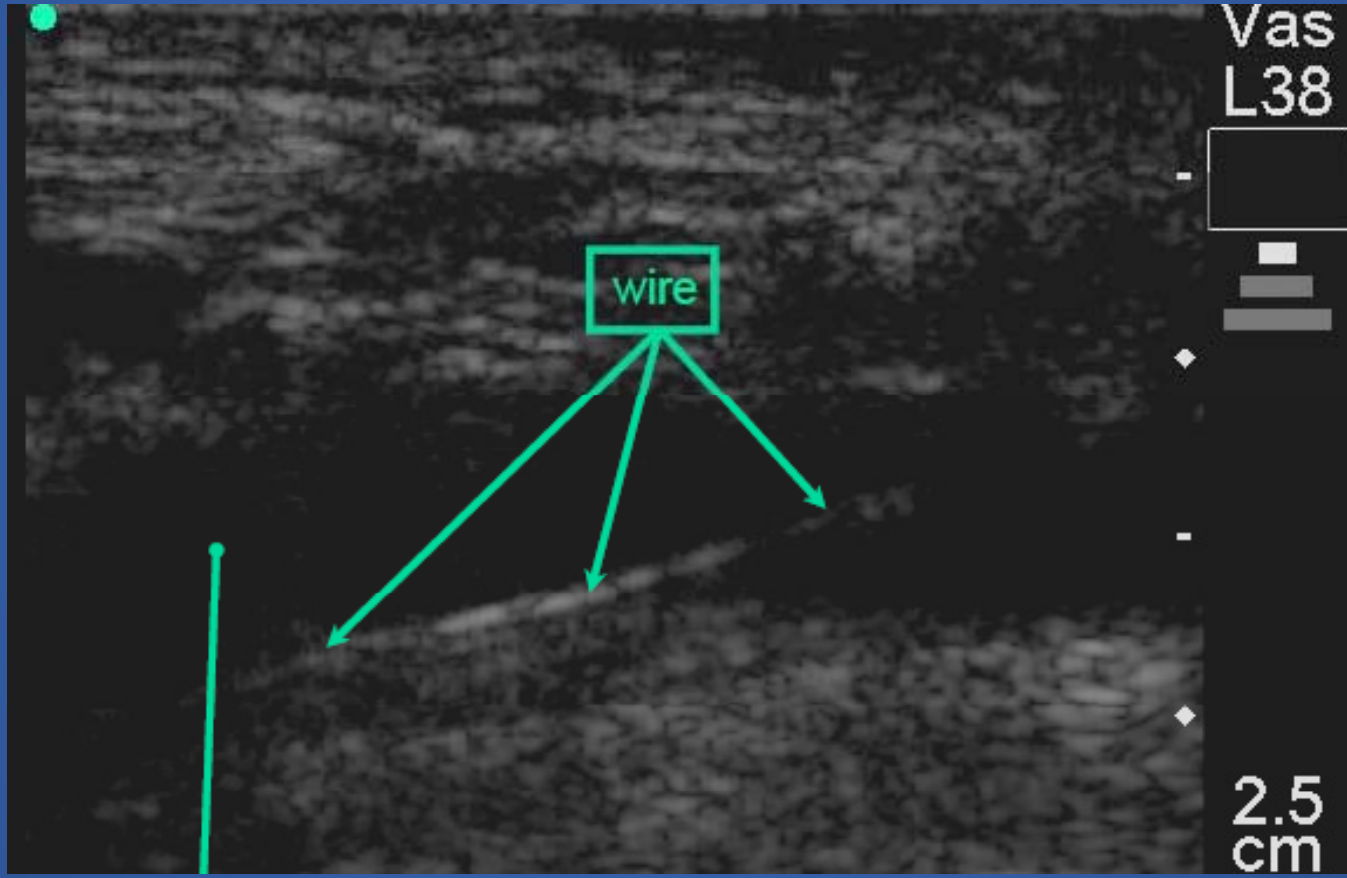


2 person: Seldinger wire entry



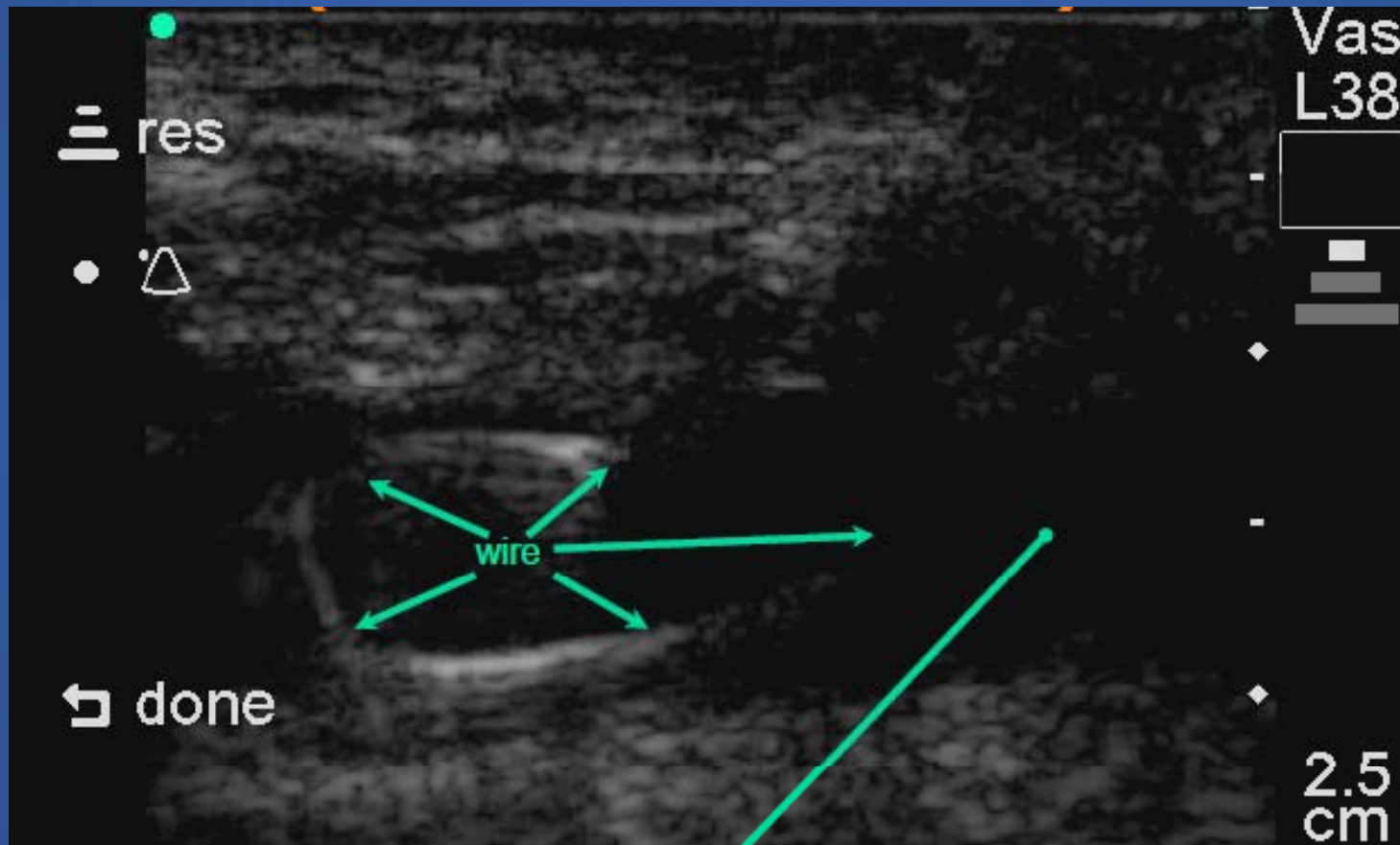
CFV long axis view

2 person: Advancing wire



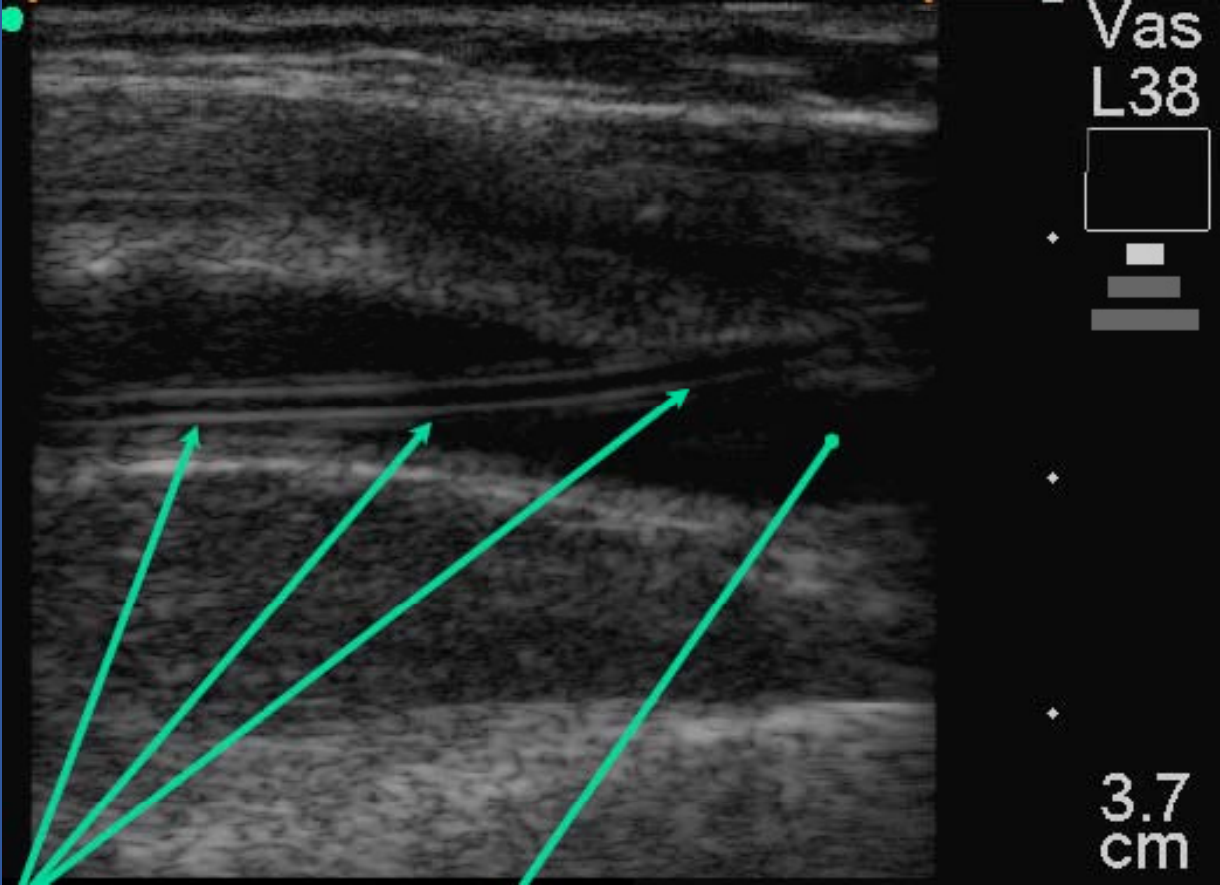
CFV long axis view

2 person: J tip wire



CFV long axis view

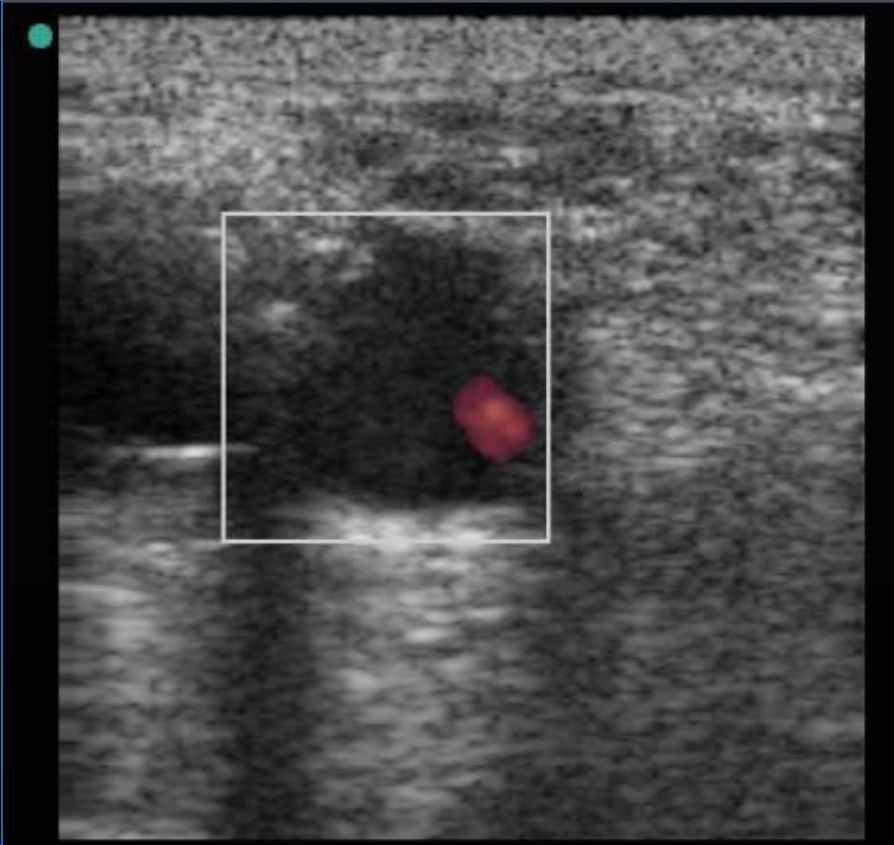
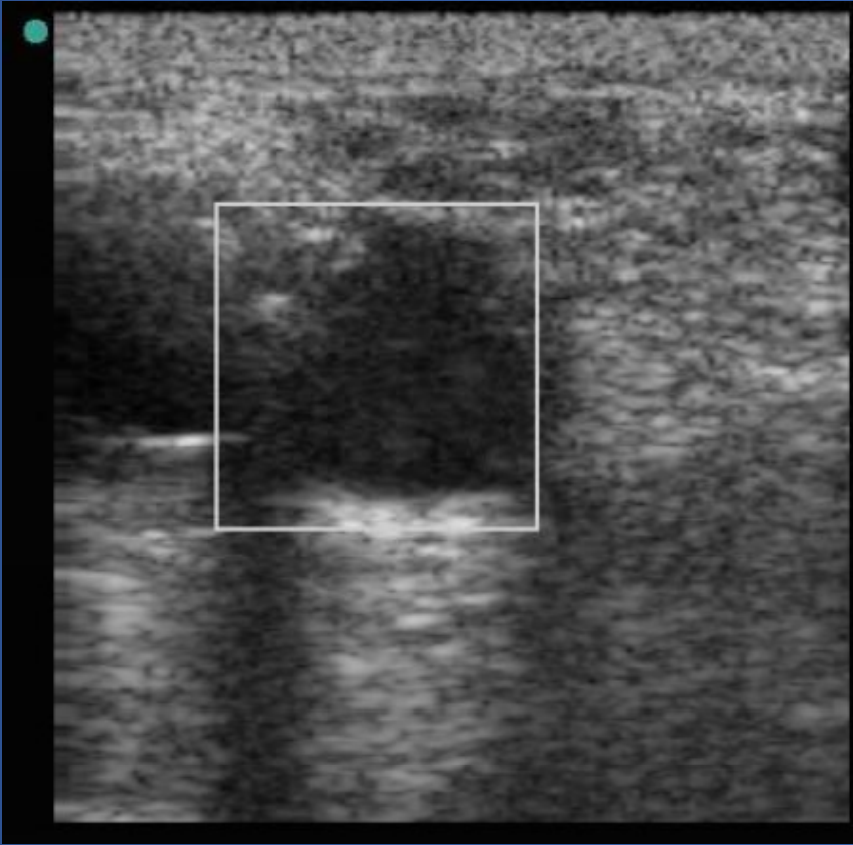
2 person: cannula



Cannula

CFV long axis view

Doppler flush of intraluminal cannula



Pitfalls to avoid

- Failure to identify needle in tissue
- Failure to distinguish between artery and vein
- Locating vessel prior to proper positioning
- Failure to angle transducer beam into needle puncture area

Maximum Barrier Precautions



Central Line Bundle

- Hand hygiene
- Maximal barrier precautions;
- Chlorhexidine skin antisepsis;
- Optimal catheter site selection, with avoidance of using the femoral vein for central venous access in adult patients
- Daily review of line necessity, with prompt removal of unnecessary lines.

Hand hygiene

- Washing hands or using an alcohol-based waterless hand cleaner helps prevent contamination of central line sites and resultant bloodstream infections
- All staff prior to starting procedure
- 15 sec hand wash with soap and water or waterless product rubbed until dry

Maximum Barrier Precautions

- Operator and assistants: strict compliance with hand hygiene and wearing a cap, mask, sterile gown, and sterile gloves
- Patient: covering from head to toe with a sterile drape, with a small opening for the site of insertion

Chlorhexidine skin antisepsis

- Friction scrub for at least 30 seconds
- Allow solution to dry completely (3 minutes)

Optimal catheter site selection

- Risk/benefit analysis as to which vein is most appropriate for patient

Daily review of central line necessity

- Risk of infection increases over time as the line remains in place
- Remove lines that are no longer clearly needed

References

Bair, A.E., Parikh, A.K., Rose, J.S. (2014). Vascular Access. In O.J. Ma, J.R. Mateer, R.F. Reardon, S.A. Joing (Eds.), *Ma & Mateer's Emergency Ultrasound* (3rd ed., Chapter 21). New York, NY: McGraw-Hill Education

ACKNOWLEDGEMENT OF EDUCATION COMPLETION

My signature here means that I have reviewed information regarding Central Venipuncture.

Tracker Code: CVP

Date:	
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Signature:	

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