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
Blood flowing in vessel
Needle

Shadow
Ultrasound Machine: Technical Issues
<table>
<thead>
<tr>
<th>Ultrasound Probe Types</th>
<th>Linear</th>
<th>Convex; curvilinear</th>
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<tbody>
<tr>
<td></td>
<td>Elements arranged in a line</td>
<td>Elements arranged along a curve</td>
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<tr>
<td></td>
<td>Higher frequency (7.5-10 MHz)</td>
<td>Lower frequency; lower resolution</td>
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<tr>
<td></td>
<td>Higher resolution</td>
<td>Higher penetration</td>
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<td>Lower penetration</td>
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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

SCM sternal head

Medial

IJ

CCA

Lateral

2.8 cm
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

Rev T-burg

Common femoral vein
Compressibility

• Veins compress
• Arteries do not
• Easiest and primary differentiating factor
Doppler flow characteristics

- Electronic Doppler
- Wave form and velocity
Veins: phasic flow; low velocity
Arteries: pulsatile flow; high 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 shaft cross section images converge but vectors are different.
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

c = \sqrt{a^2 + b^2}.
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

ACKNOWLEDGEMENT OF EDUCATION COMPLETION
My signature here means that I have reviewed information regarding Central Venipuncture.
Tracker Code: CVP

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