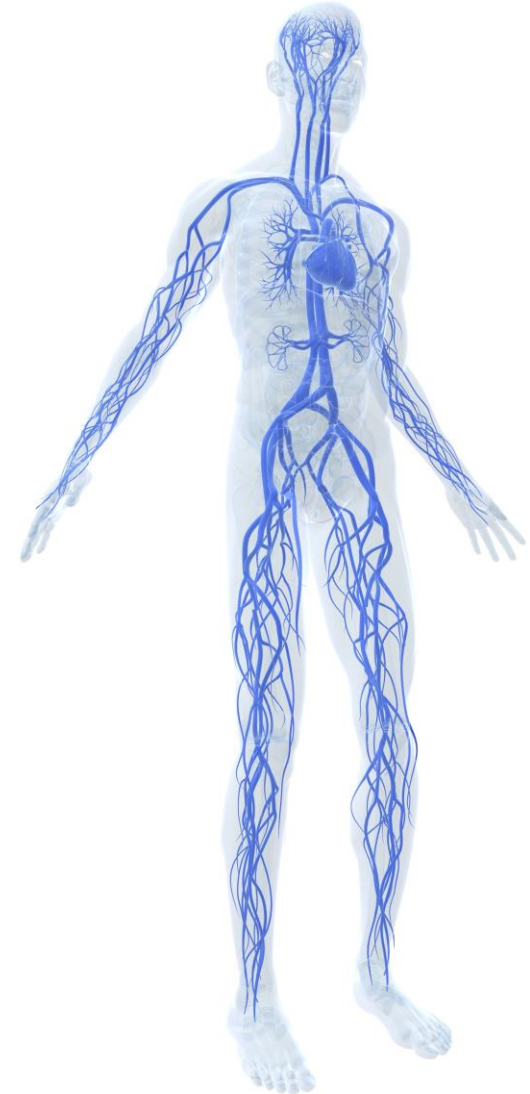


Ultrasound Guided Vascular Access

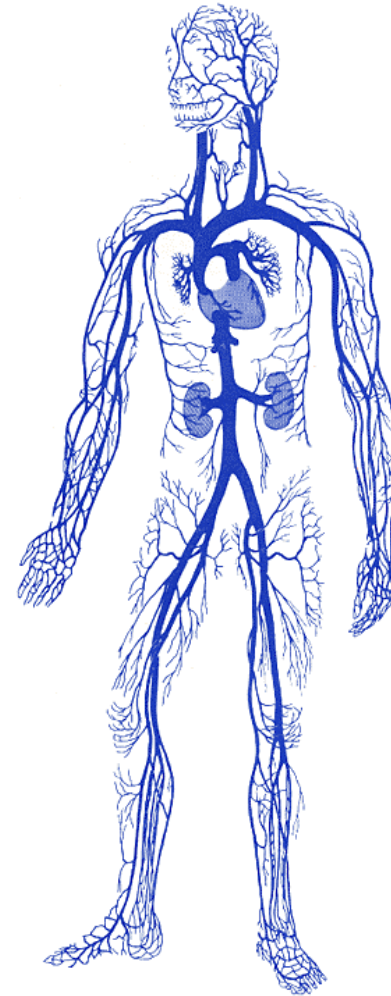


Objectives

- Indications for insertion of central and peripheral lines
- Complications associated with procedures
- Role of ultrasound in vascular access
- Recommended sites for vascular access
- Regional anatomy of neck and arms
- Ultrasound appearance of vascular structures
- Discuss proper needle visualization techniques

Vascular Access Insertion Sites

- Central Lines
 - Internal Jugular
 - Subclavian
 - Femoral
- Peripheral Lines
 - Basilic
 - Brachial
 - Cephalic



Where is it Performed?

- Intensive care units
- Emergency departments
- Operating rooms
- Pre- and post-anesthesia care units
- Hemodialysis units
- Cardiac catheterization units
- Oncology centers
 - outpatient chemotherapy



Who Performs Procedure?

- POCUS teams
- IV Nurses
- Anesthesiologists
- Oncologists
- Nephrologists, Dialysis teams
- Interventional Radiologists
- Surgeons
- Emergency Medicine Physicians
- Intensivists
- Physician Assistants

CVC vs Peripheral Indications

CVC

- Administration of drugs likely to induce phlebitis
- Hemodynamic monitoring
- Parental nutrition
- Temporary cardiac pacemaker
- When peripheral access difficult
- If multiple medications need to be infused
- Frequent blood draws
- Inserted by physicians

• PICC

- Alternative to subclavian lines, internal jugular lines or femoral lines which have higher rates of infection and complications
- Will remain in place no longer than 30 days
- More than 50% of central lines are PICC lines
- Inserted by nurses, physician assistants

Why use Ultrasound?

- Detect anatomic variations and exact vessel location
- Provides real-time guidance of needle insertion, guide wire and catheter
- Determine condition of vessels and insertion site
- Improves accuracy
- Shortens procedure time
- Improved patient satisfaction

Why use Ultrasound?

In 2001 Agency for Healthcare Research and Quality recommends use of ultrasound for placement of CVC lines as one of their 11 practices to improve patient care

In 2006 National Institute of Clinical Excellence fully support use of ultrasound for CVC placement

Ultrasound guidance now considered the gold standard for central line placement

Central Venous Catheters

- Unsuccessful insertion of CVCs may occur in up to 35% of cases
 - Associated complications result in the 9th most expensive healthcare problem in the U.S.
- The attributable cost per infection is an estimated \$34,508-\$56,000
- Annual cost of caring for patients with CVC-associated BSIs ranges from \$296 million to \$2.3 billion

Complications CVC Access

- Mechanical complications (21%)
 - Pneumothorax
 - Carotid or femoral arterial puncture
- Catheter related blood stream infections (CRBSI)
 - Higher rate of infection for CVC access than peripheral especially those placed in ICUs
 - Subclavian site preferred to IJV to minimize infection for non-tunneled

Getting to Zero Complications

Recommendations by IHI and CDC

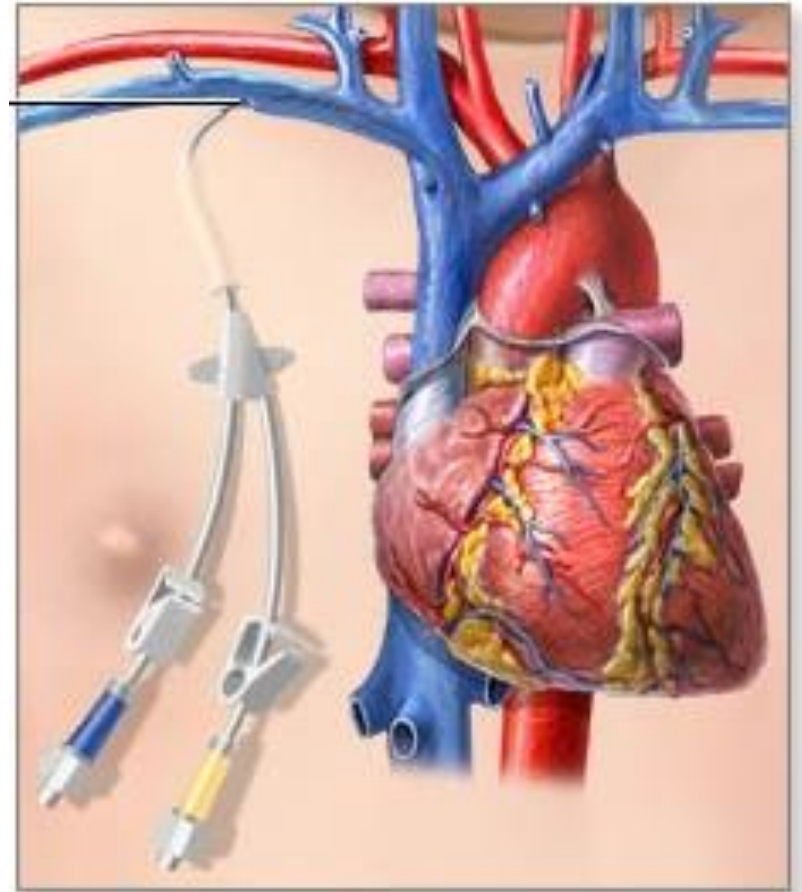
- 5 point central line bundle
- Many sites now adding Ultrasound as 6th Technical Aspect to bundle
- 6 Point Bundle
 - Hand hygiene
 - Maximal barrier precautions
 - Chlorhexidine skin antisepsis
 - Optimal catheter site selection
 - **Ultrasound guidance of line placement**
 - Daily review of line necessity with prompt removal of unnecessary lines



The use of the 5 point bundle for central line placement: *“Reduced CLABSI by 66% over the 18 month study period”* The Keystone Project

Central Venous Catheter

- Catheter placed into internal jugular vein, subclavian vein and femoral vein
- Tip sits in distal SVC or cavo-atrial junction



Central Venous Catheters

Indications

- Central venous pressure
- Pulmonary artery catheters
- IV therapeutic agents and nutrition
- Hemodialysis
- Placement of cardiac pacemakers
- Direct access to central circulation is needed

Central Venous Catheters

- Indications

- difficult peripheral intravenous (IV) access
 - IV Drug Abusers
 - Burn
 - Pediatrics
 - Obese patients

Comparison of CVC Insertion Sites

	Internal Jugular	Subclavian	Femoral
Potential for Pneumothorax	+	++	-
Thrombosis	++	+	+++
Infection	++	+	+++
Catheter tip malposition	+	++	-
Compressibility of vessels in bleeding	+++	+	+++
Ease of access during active resuscitation	+	++	+++
Ease of use with US guided techniques	+++	+	+++
Patient comfort and maintenance of dressing	++	+++	+

Ultrasound Decreases Complications

- Pneumothorax
- Carotid/femoral arterial puncture
- Needle stick attempts
 - can't make claim regarding ultrasound decreasing CRBSIs

Contraindications

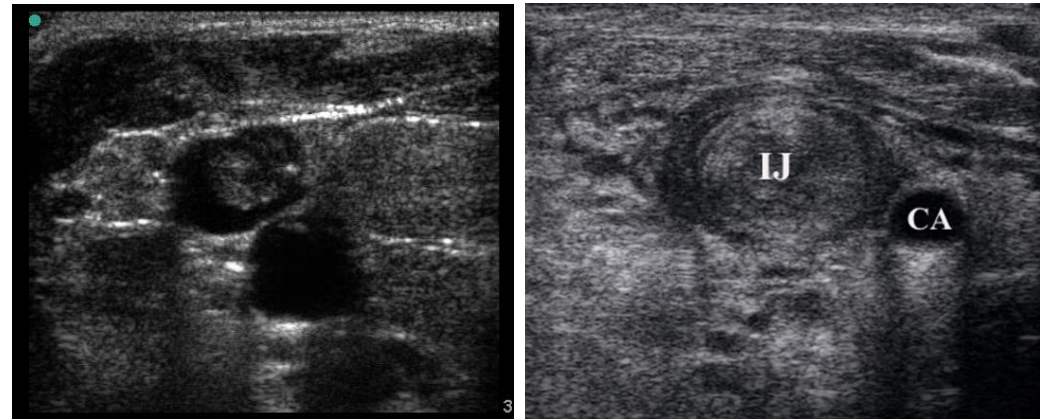
- Infection at placement site
- Pathology of IJV or SVC (occlusion, thrombosis)

Use contralateral IJV or Subclavian Vein, femoral vein is avoided because of higher infection rates.

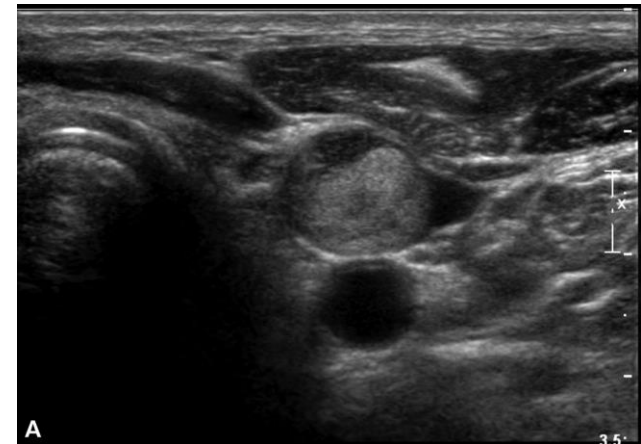
Caution Required

- Morbid obesity
- Neck deformity (burns, goiter)
- Neck rigidity
- Prior surgery at cannulation site
- Small IJV
- IJV thrombosis

Thrombus in IJV



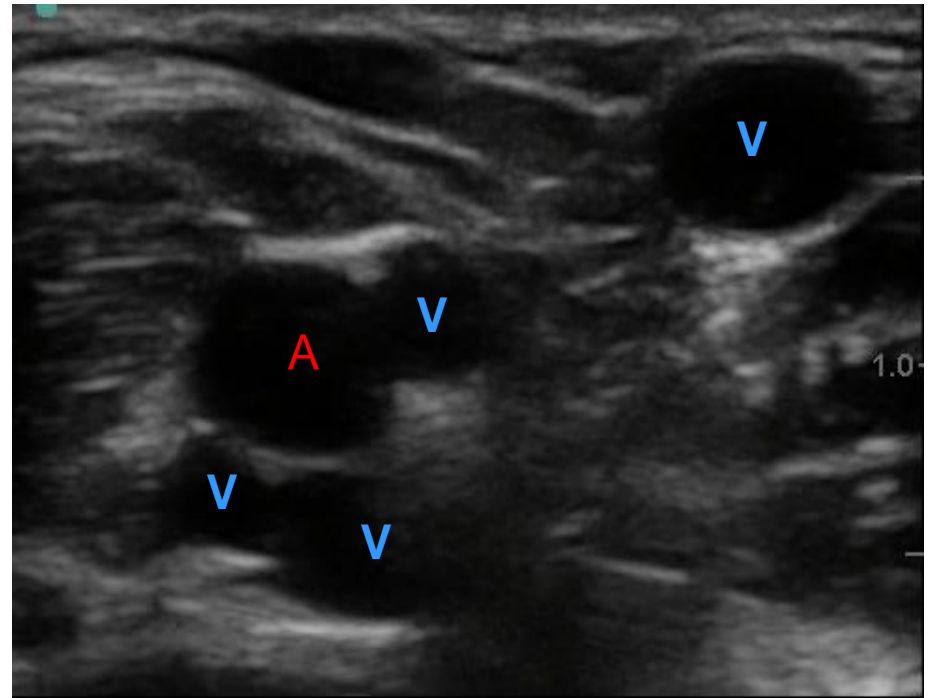
Intravascular metastasis IJV



Alternative site selection required

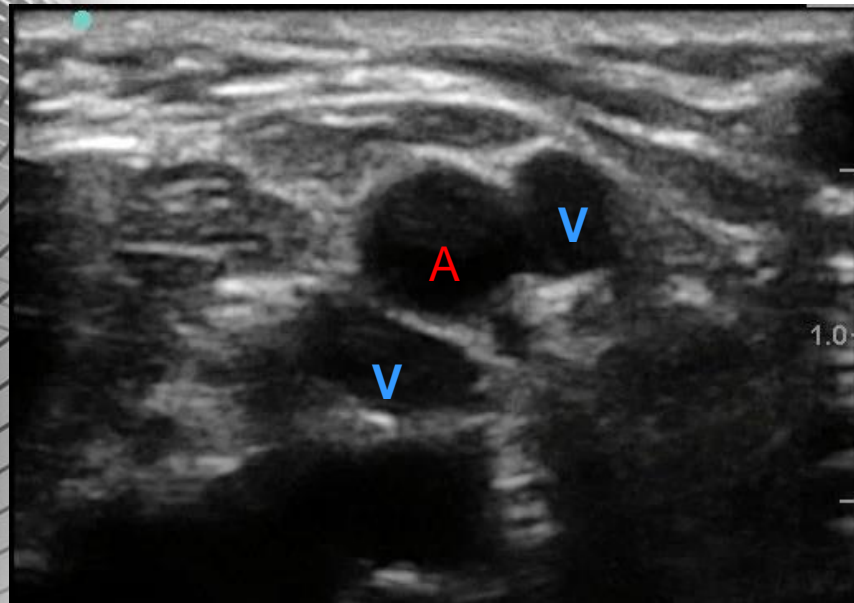
Ultrasound Appearance

- Artery
 - Round
 - Regular Shape
 - Pulsatile
- Vein
 - Oval
 - Irregular Shape
 - Compressible
 - Contain valves



Ultrasound Appearance

- Short Axis
 - Arteries round and veins oval



Ultrasound Appearance

Long Axis Veins

- tubular structure with valves at regular intervals, more valves at distal extremity.



Internal Jugular Vein Site

Ideal for

- Allows placement of pulmonary artery catheter
- Transvenous pacing wire
- Measurement of CVP

Not ideal for

- Patients who cannot lie flat
- Have respiratory distress
- Distorted anatomy
- Suspected cervical spine fracture

Central Venous Catheter

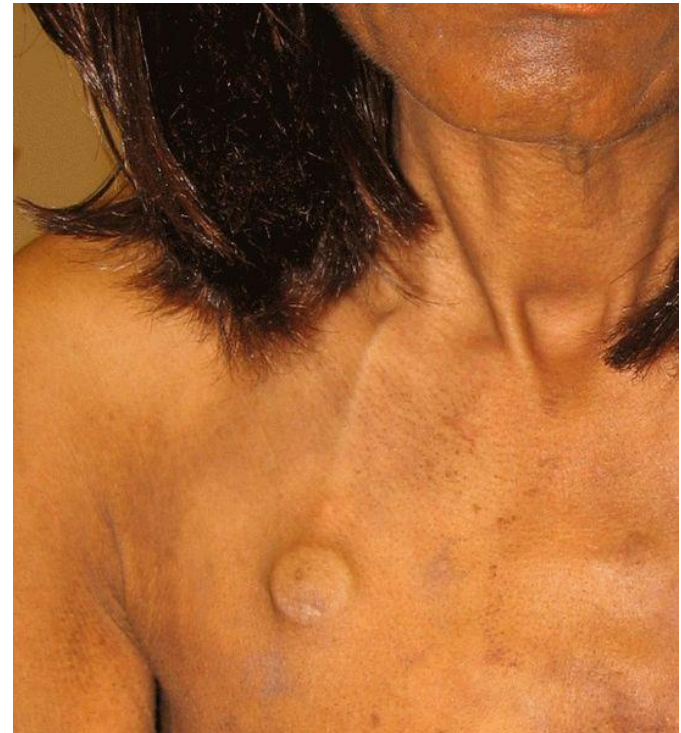


Non-tunneled
Placed in internal jugular vein

Central Venous Catheter



Tunneled under skin enters IJV but separate exit site



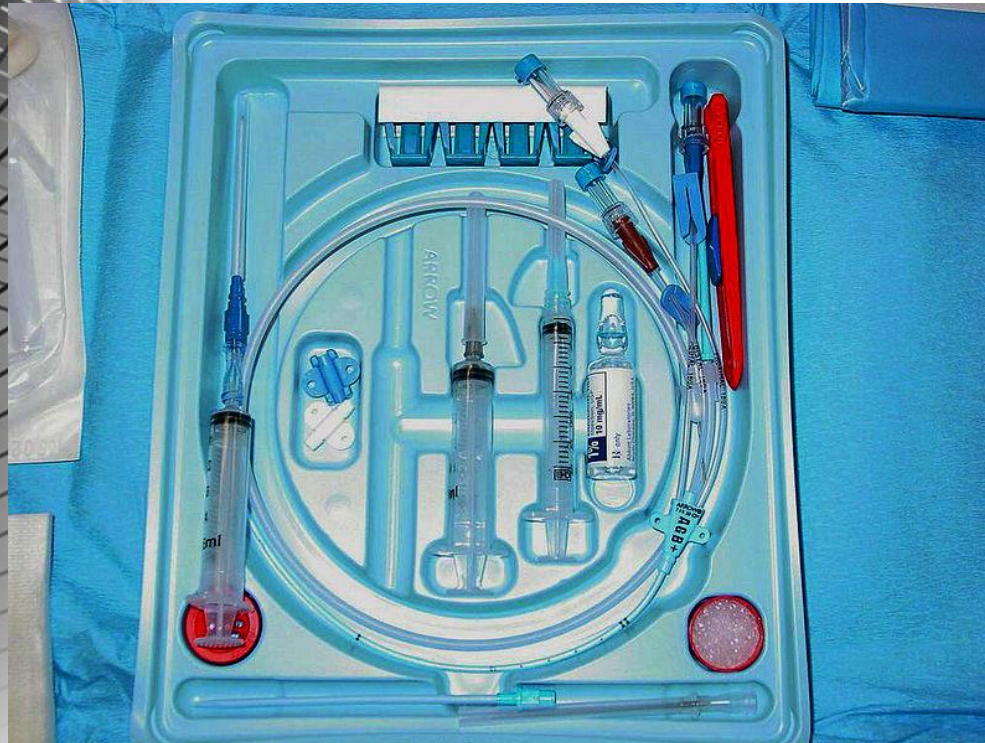
Tunneled Implanted port

Venous Catheters

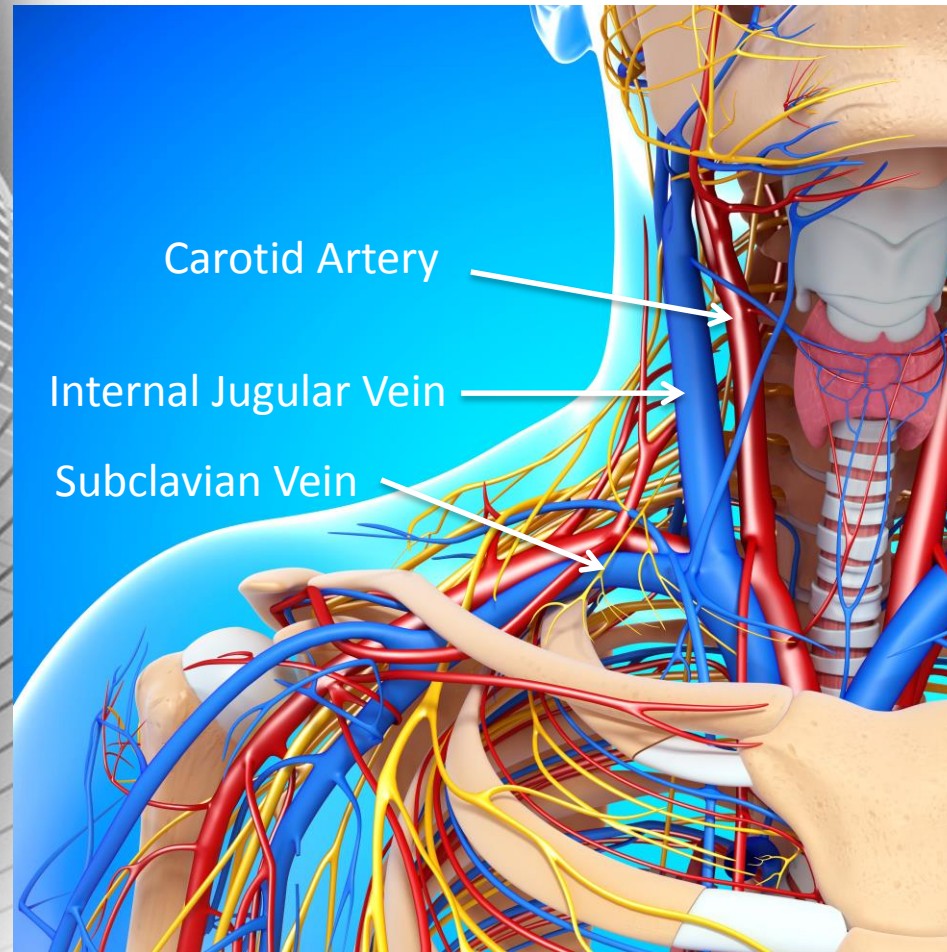
- Single, double or triple lumen catheters
- Allows different treatments to be given at the same time
- Can be used to give treatments such as chemotherapy, antibiotics and IV fluids and feeding
- Used for continuous treatment

Venous Catheters

- All centrally-placed catheters require an initial needle insertion into the vein, followed by a guidewire to permit passage of the catheter

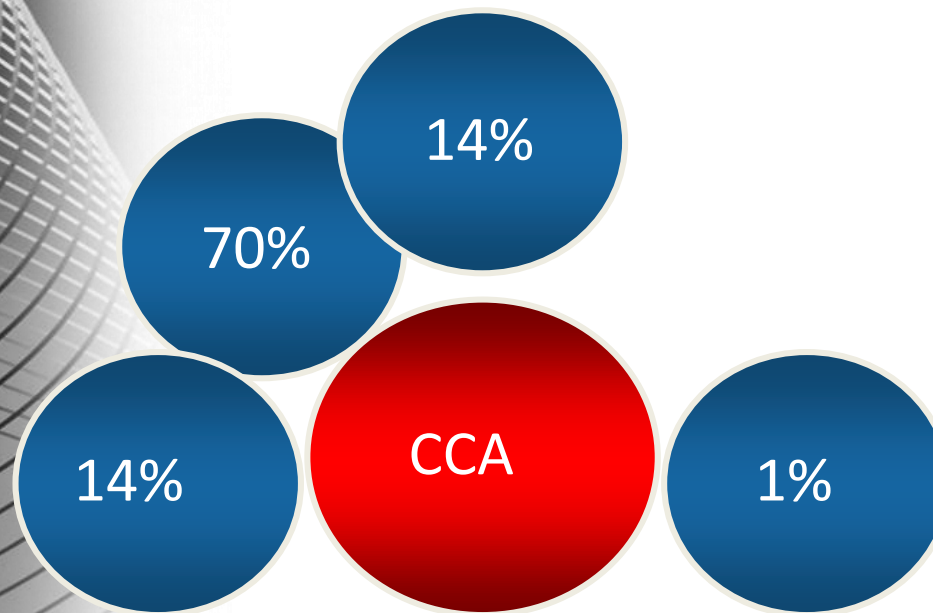


Vascular Anatomy



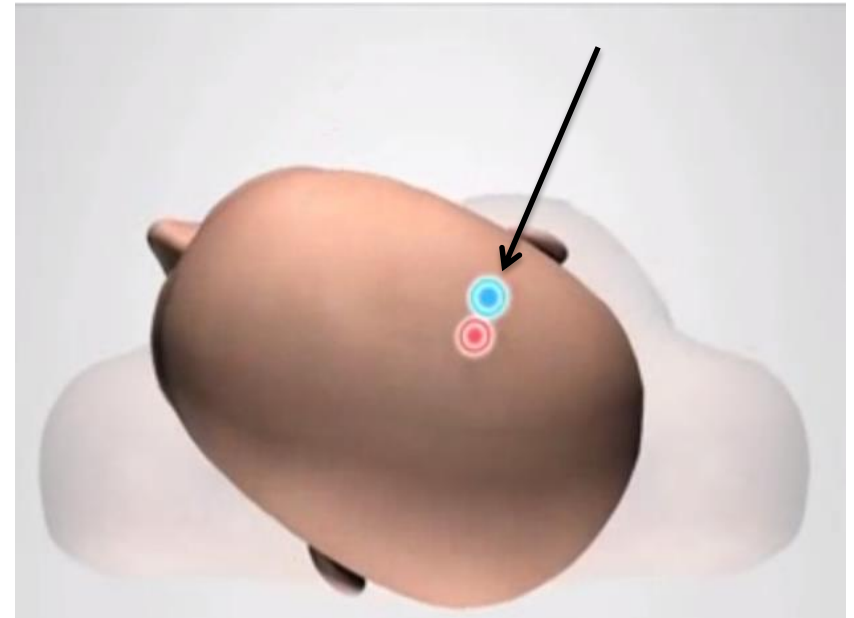
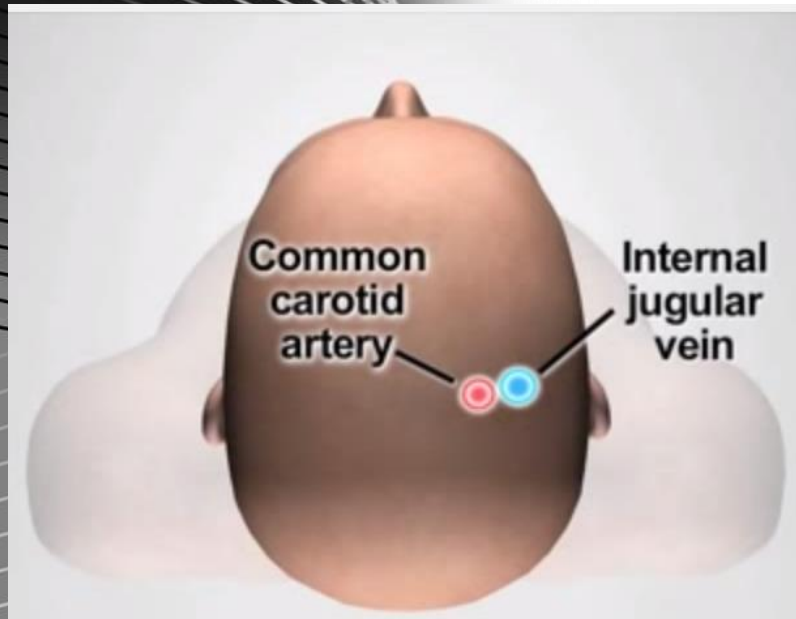
IJV Anatomical Variations

- Variation in Position of IJV relative to CCA



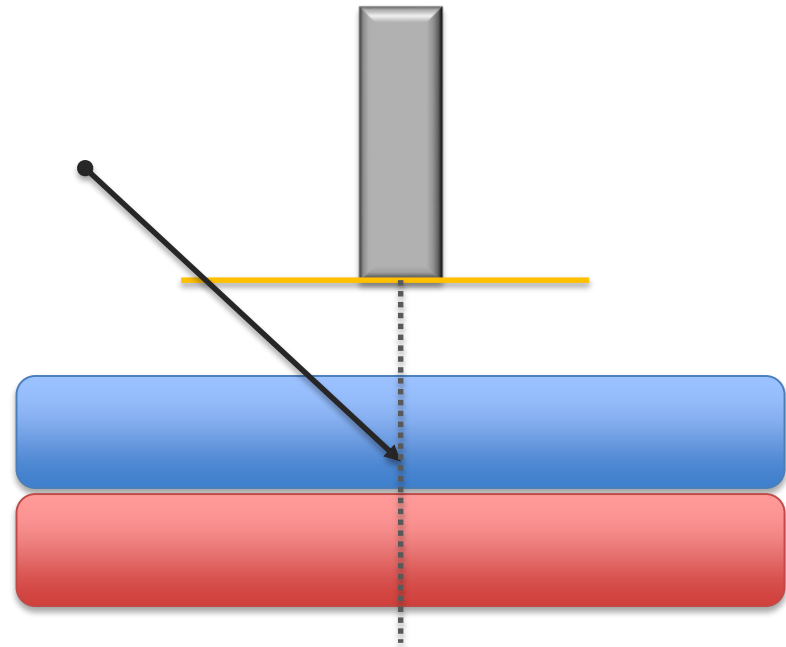
IJV Moves with Head Rotation

Increases chance of through and through of IJV and puncturing carotid artery



Insertion Technique

- Minimize chance of through and through by making sure needle is inserted at an angle and not perpendicular



Site Selection

RIJV preferred over LIJV

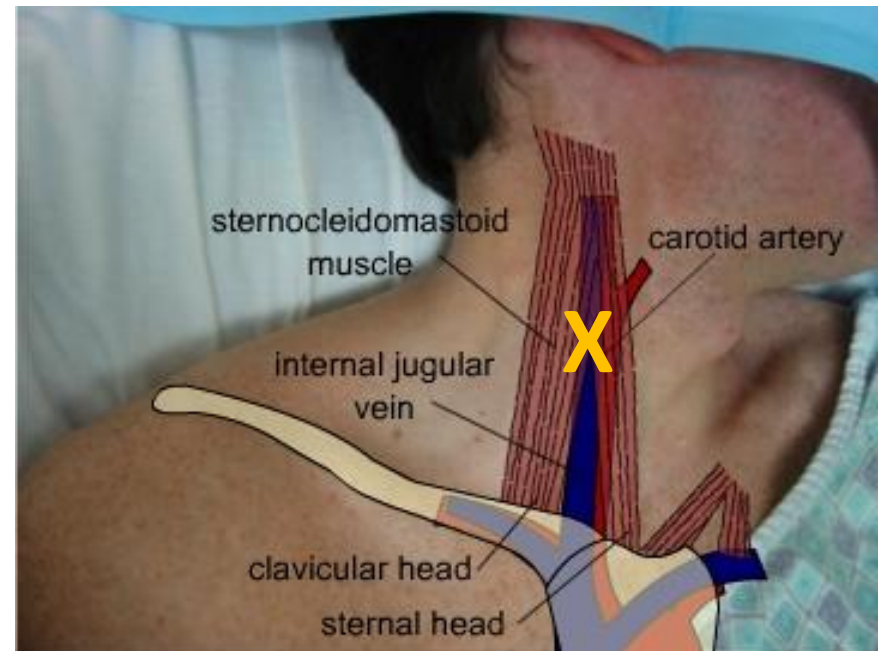
- Provides more direct access to the right atrium
- Avoids the thoracic duct (lymphatic)
- Reduces procedure time

Note: LIJV is more tortuous than RIJV which may make threading more difficult, the dome of left lung is higher than right which may increase risk of pneumothorax

Before CVC Access Procedure

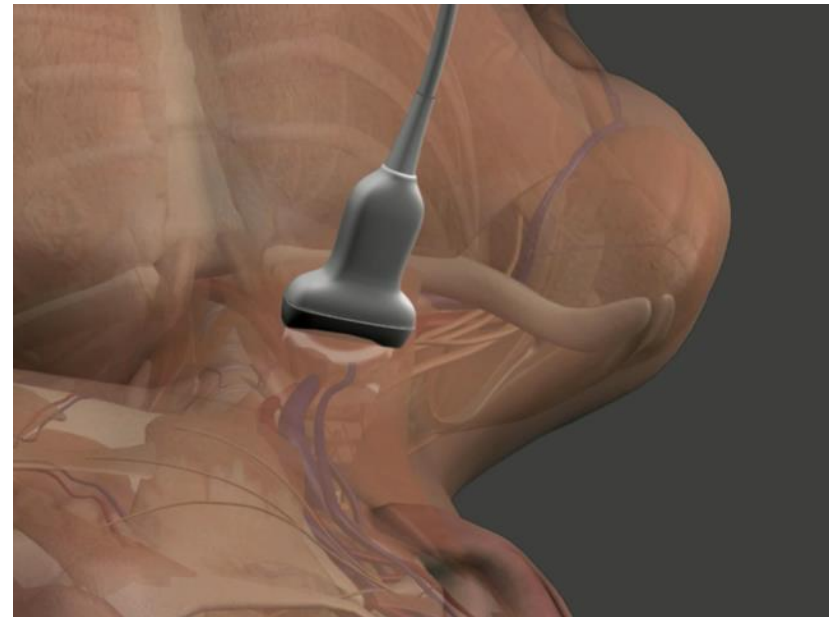
Site Selection

- Higher in SCM/Clavicle Triangle reduces risk of pneumothorax and allows for better compression if puncture of CCA occurs
- Needle is inserted between heads of SCM to prevent damage to muscle



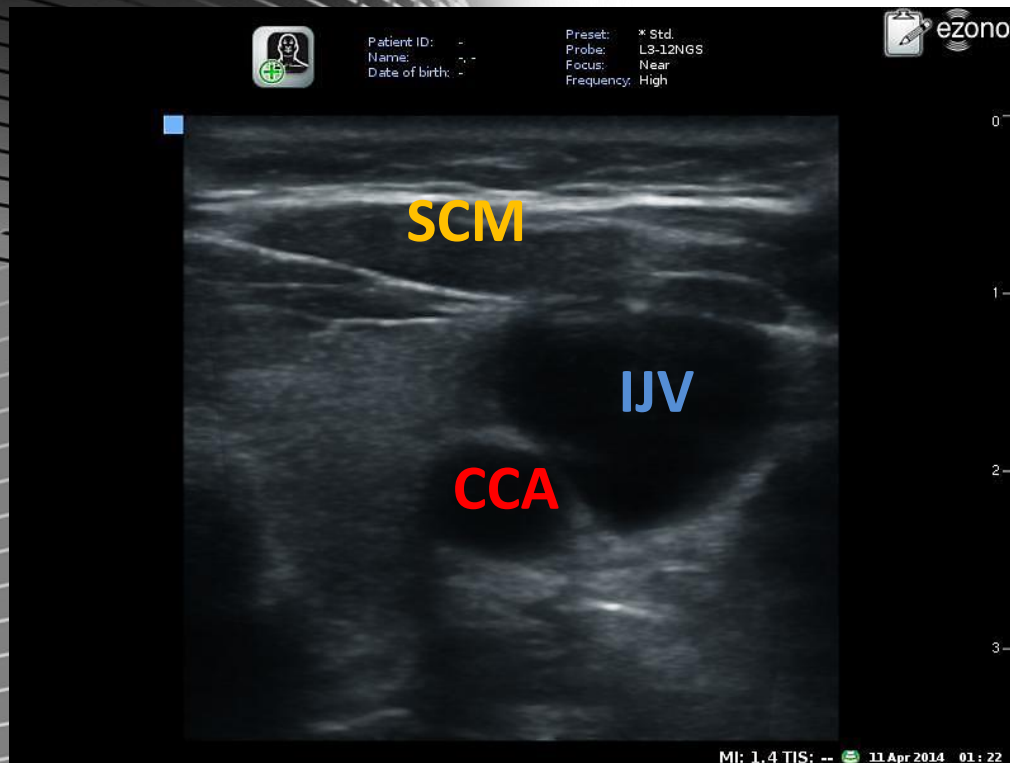
Site Selection

- Operator at patient's head
- Rotate patients head slightly to contralateral side
- Transducer transverse parallel to clavicle on sternocleidomastoid muscle



Site Selection

Survey to determine location and patency of IJV and evaluate neck anatomy



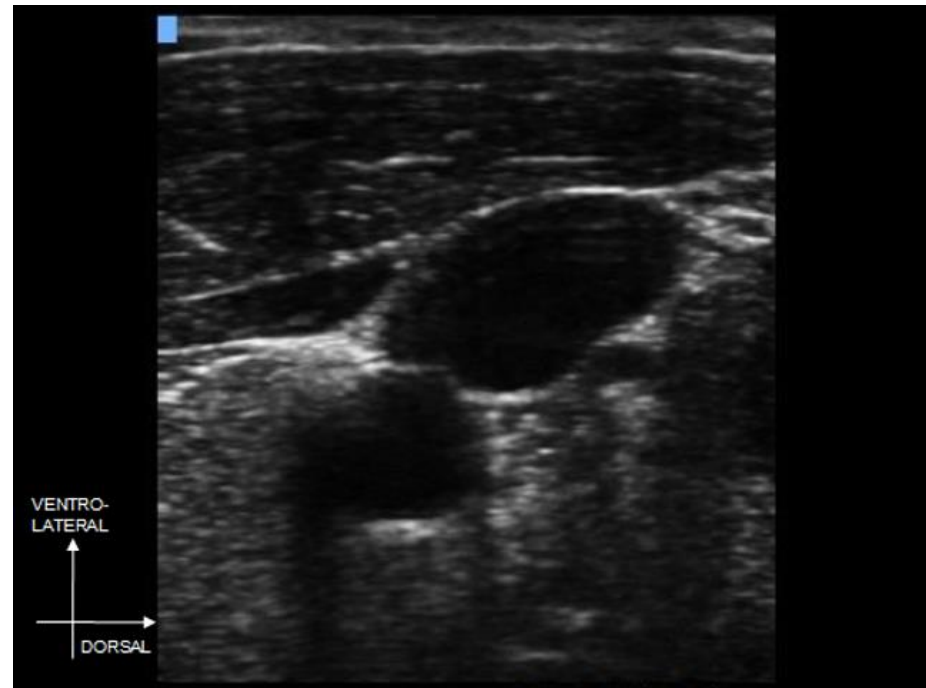
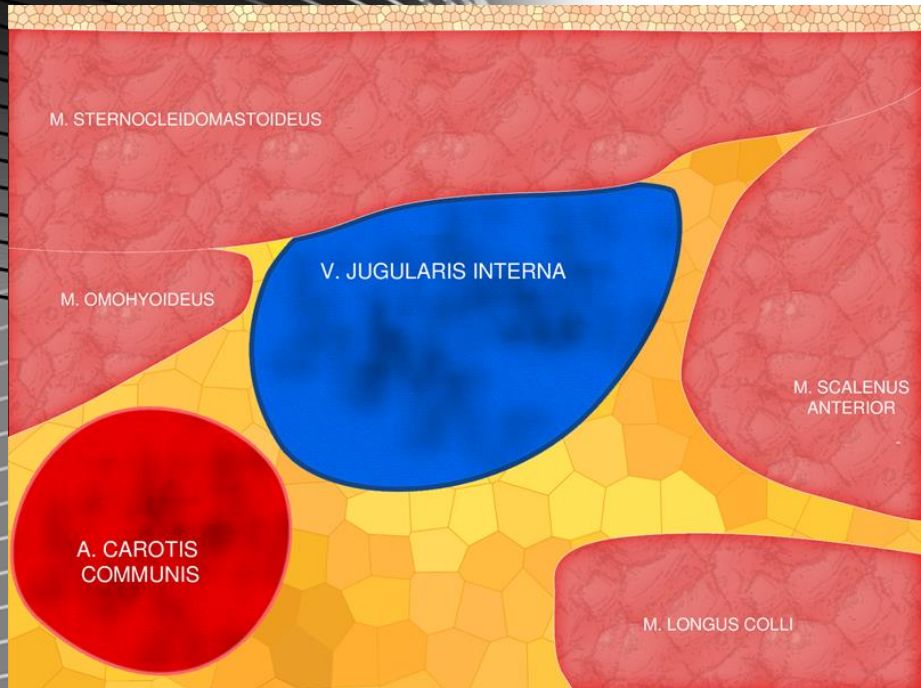
CCA

- round and pulsatile and hard to compress

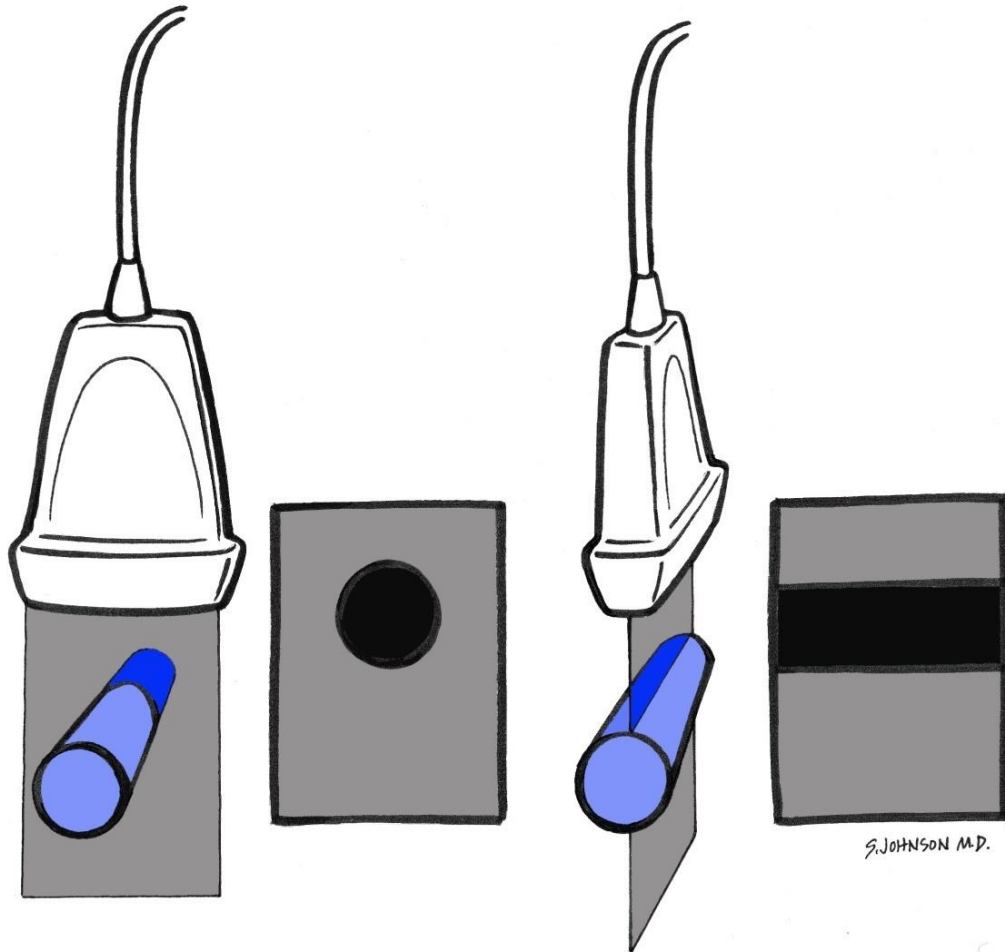
IJV

- larger and easily compressible
- Increases in size with Valsalva Maneuver

Ultrasound Landmarks



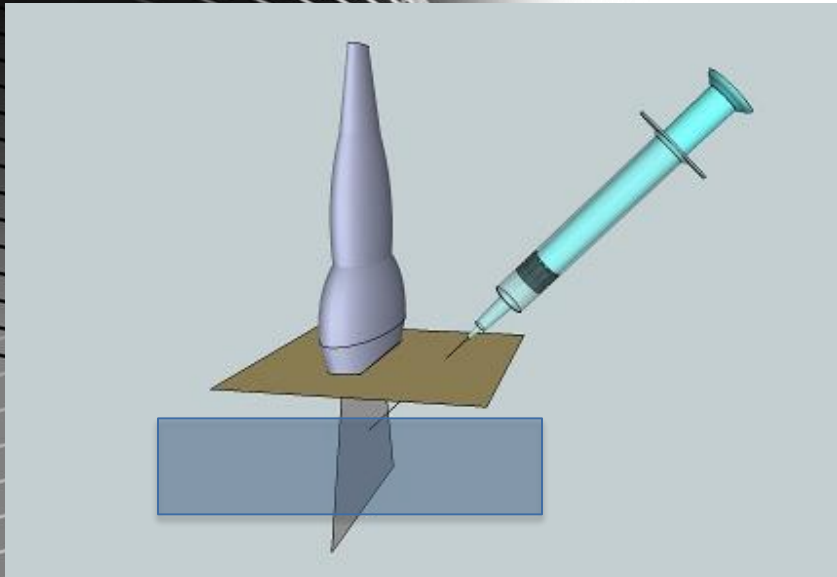
Approaches



Short Axis

Long Axis

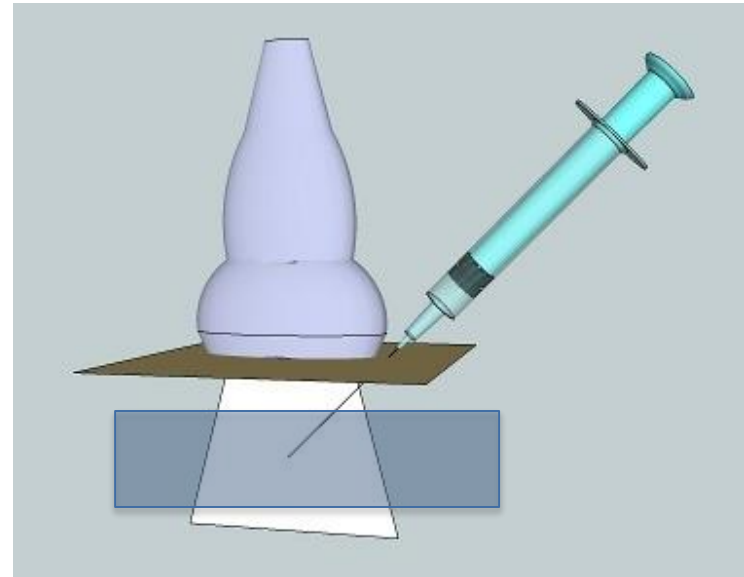
Approaches



Short Axis

See vessels in cross section

See needle tip as dot



Long Axis

See length of vessels a

See needle shaft

eZGuide

- Freehand navigation technology lets clinicians use approach of their choice for best clinical outcome
- Accurately visualizes the needle trajectory to target prior to skin puncture
- Identifies needle tip regardless of imaging plane
- Provides real-time color coded feedback on needle alignment and position of needle tip

During Procedure

CVC Procedure

- Time out and checklist
- ECG and pulse oximetry throughout
- Patient supine if CVP not elevated
Trendelenberg position (10-15 degrees)
 - This increases IJV filling and reduces incidence of air embolism
 - Can also put pillows under patient legs

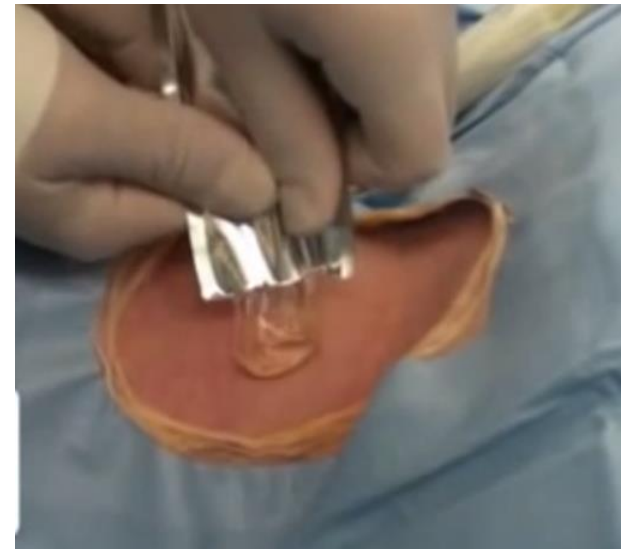
CVC Procedure US Guidance

1. Universal precautions (gown, gloves, surgical cap, mask, eye protection)
2. Full size sterile drape
3. Prep using chlorahexidine scrub
4. Local anesthesia (lidocaine)



CVC Procedure US Guidance

Prep transducer - Sterile sheath, non-sterile gel inside sheath, rubber bands to secure sheath, sterile gel for skin



CVC Guidance Procedure

• Determine access site



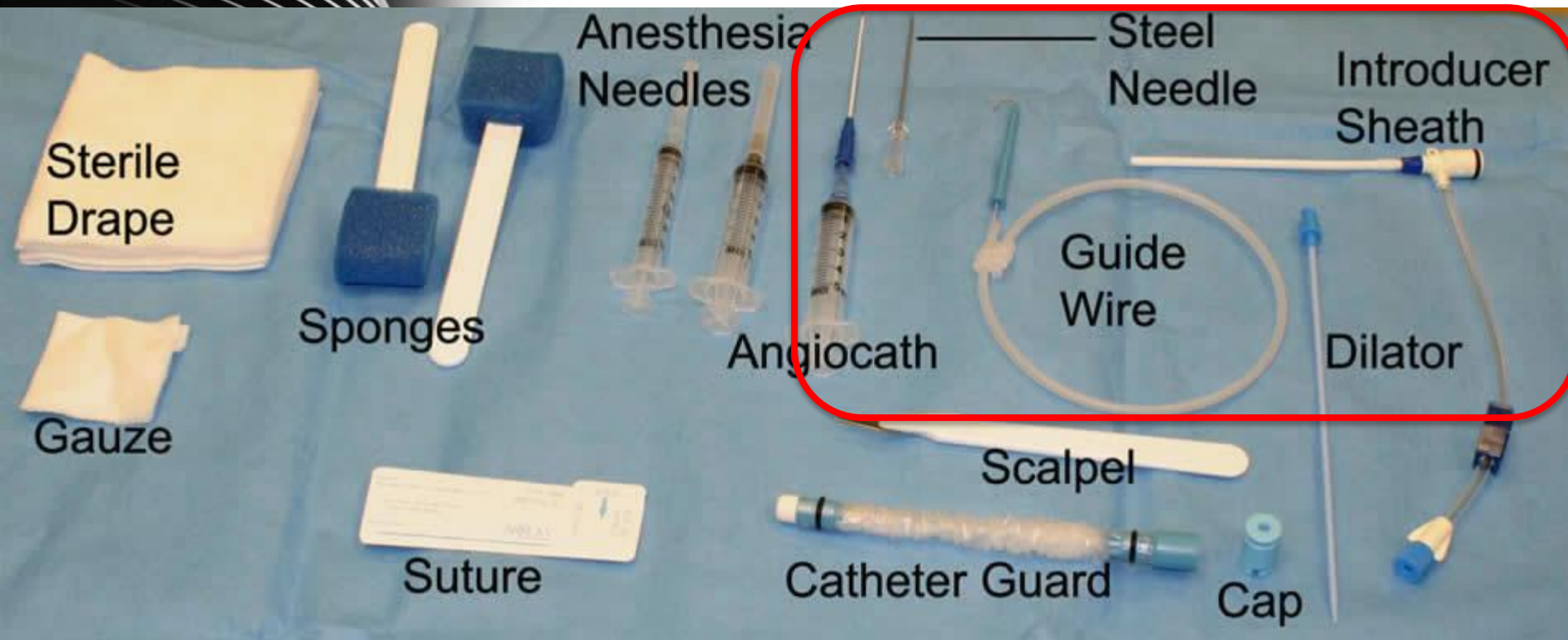
CVC Procedure US Guidance

- After site selection place sterile transducer on sterile cover for easy access



CVC Access Kit

Parts of kit visualized with ultrasound



CVC Procedure

- Finder needle used to help locate the vein
- Negative pressure on syringe for flash back when needle enters vein
- Confirm non-pulsatile and dark red blood

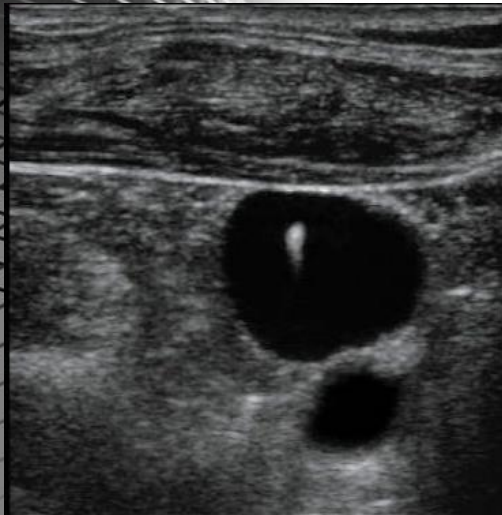


CVC Access Short Axis Approach



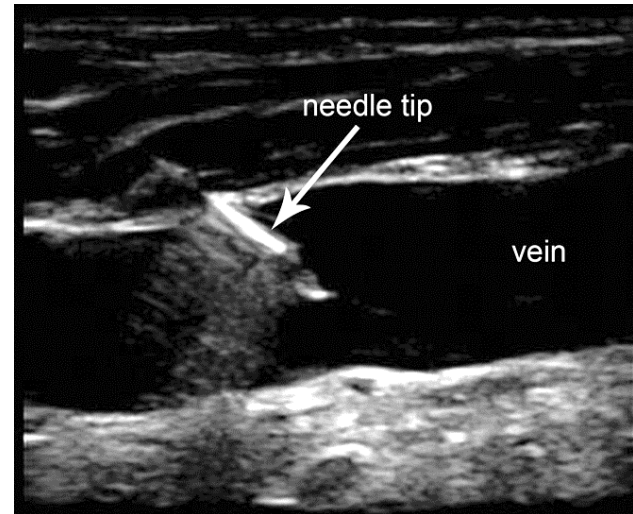
CVC Procedure US Guidance

US guidance for vein access site and location of introducer needle



Short Axis

See vessels in cross section
See needle tip as dot

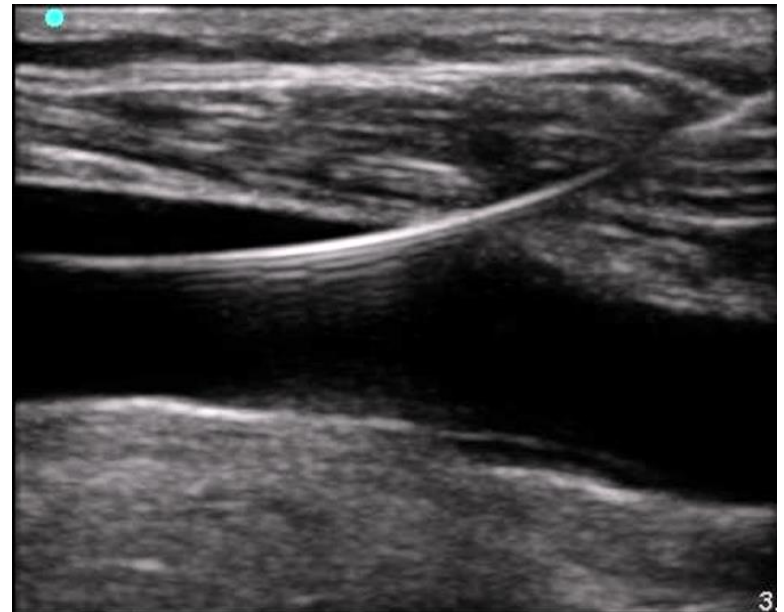
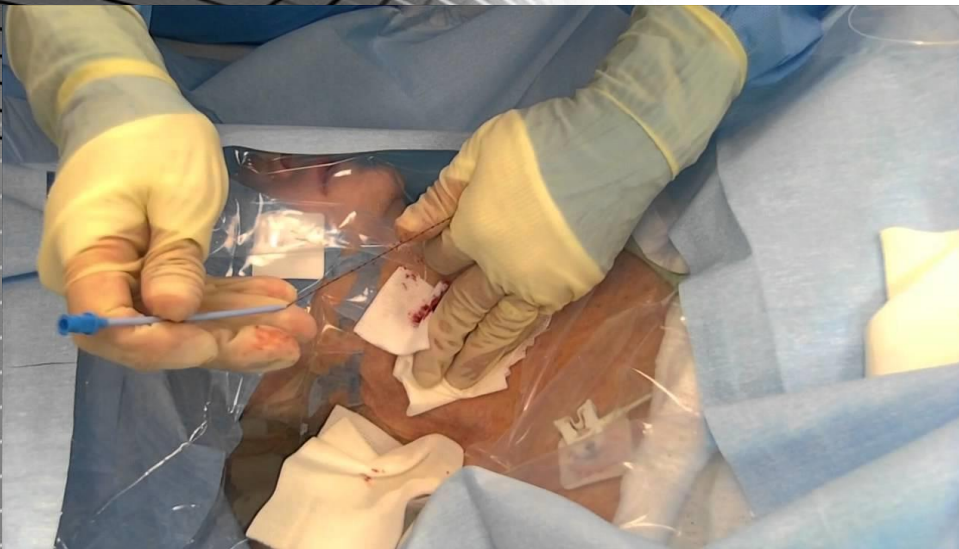


Long Axis

See length of vessels a
See needle shaft

Ultrasound Guidance

Guide wire is inserted through introducer needle
Guide wire is introduced to level of right atrium
Needle is removed while holding the guide wire

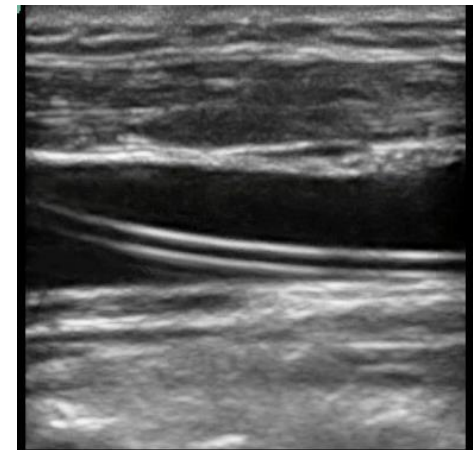
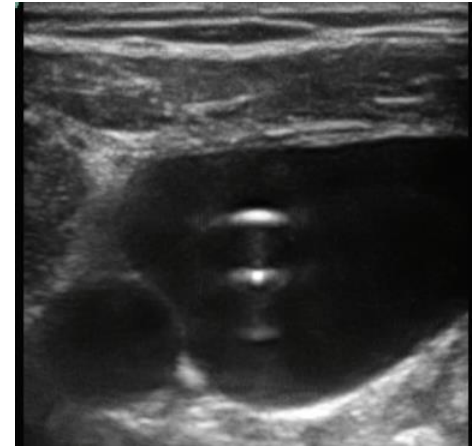


Guidewire

CVC Procedure

- Incision made with scalpel to enlarge space so dilator can advance over guide wire
- Dilator inserted into vessel and withdrawn
- Catheter advanced over guide wire
- US used to confirm placement of catheter
- Guide wire removed
- Catheter sutured into place

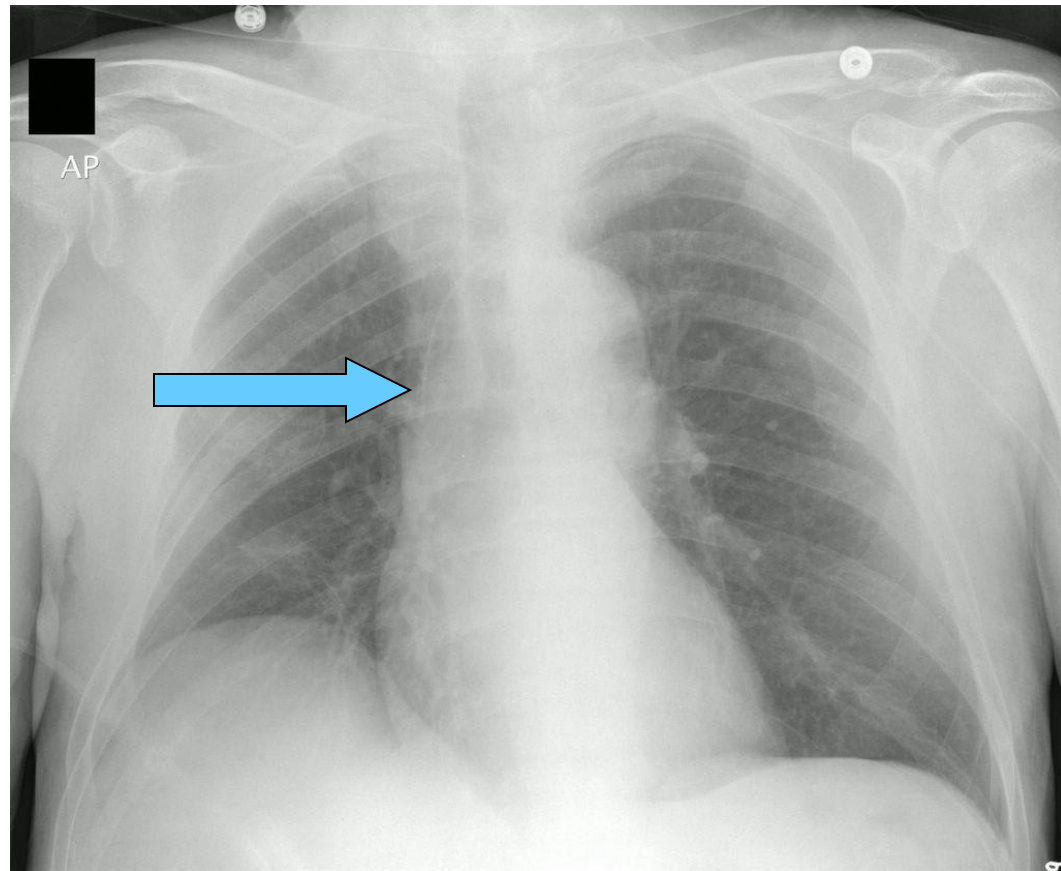
Short axis view



Long axis view used to confirm catheter within IJV

Catheter Tip Position

- Tip location in Right Atrium confirmed with chest film or fluoro
- Physiological feedback EKG (increase in P wave size)

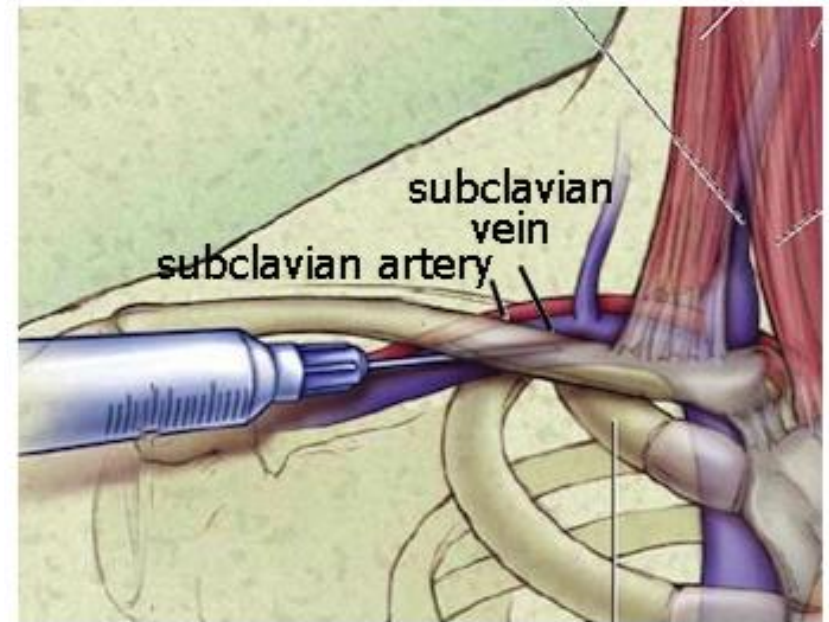


CVC Procedure

- Remember the 4 P's:
 - Pre-scan the to confirm location/compressibility
 - Prep: set up sterile field
 - Poke: access site with needle
 - Path: follow the path of the needle with ultrasound to assure proper placement.

Subclavian Vein

- ideal for CVC acces when ultrasound not available
- SV located under 1st rib

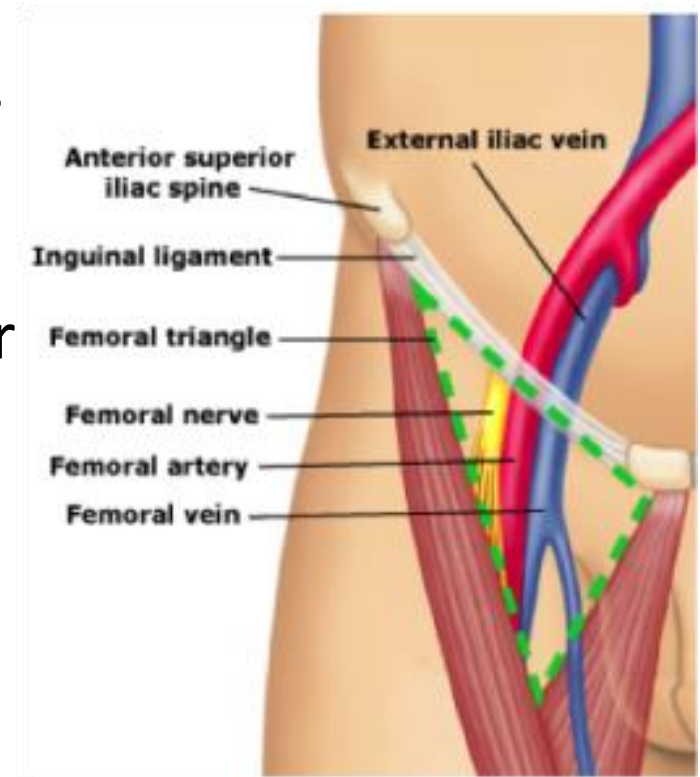


Femoral Vein

Useful for code/crash situation where neck is inaccessible due to active airway management or chest is occupied with ongoing CPR

- Used if patient cannot lay flat for IJV or subclavian line

Not ideal if distorted anatomy or trauma to region, suspected proximal vascular injury to IVC



Quick Quiz!

When visualized by ultrasound in the transverse plane, normal patent vessels appear as round or oval hyperechoic structures?

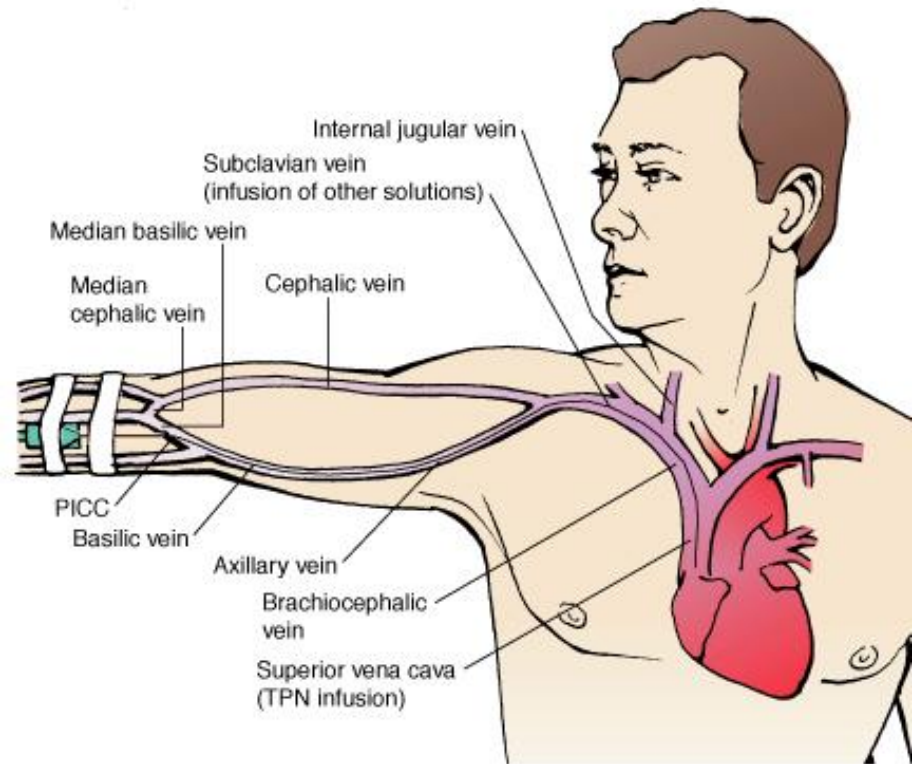
– True

– False

Peripherally Inserted Central Catheter (PICC)

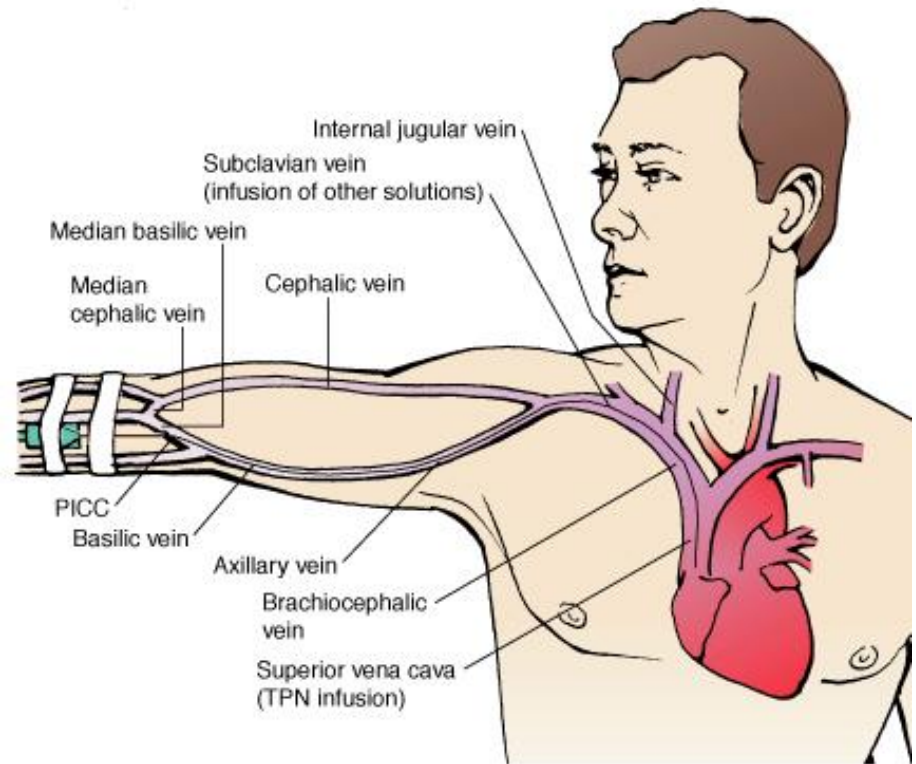
Peripherally Inserted Central Catheter

- In-patient or out-patient procedure
- Performed by registered nurses, nurse practitioner, physician assistant, physician



Peripherally Inserted Central Catheter

- Alternative to subclavian lines, internal jugular lines or femoral lines which have higher rates of infection
- Will remain in place no longer than 30 days
- Tip sits in distal 1/3 of SVC above right atrium and parallel to SVC wall



PICC Kits

Guidewires provided in different diameters, lengths and tip configuration for specific insertion techniques

Measure and cut catheter to patient size

Common Size

- 80 cm guidewire
- 130 cm guidewire



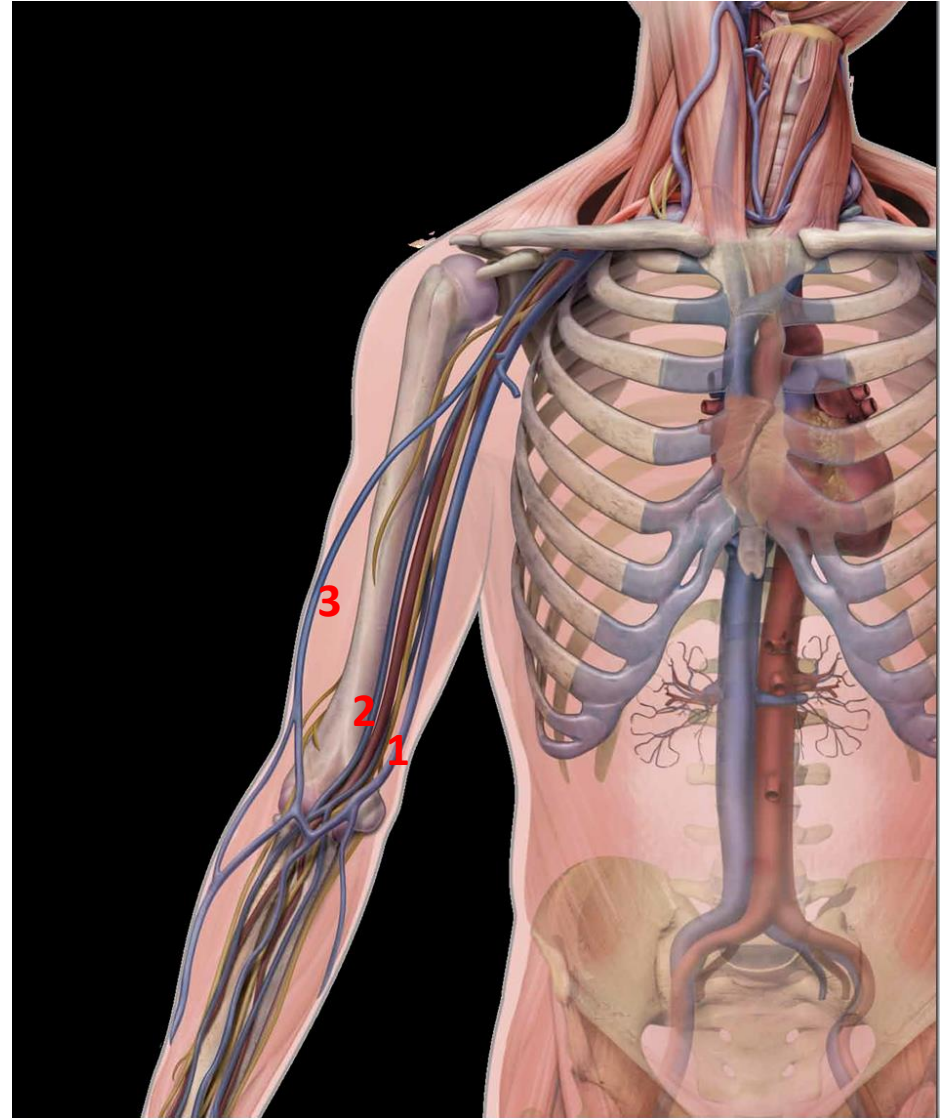
PICC Lines



Peripherally Inserted Central Catheter

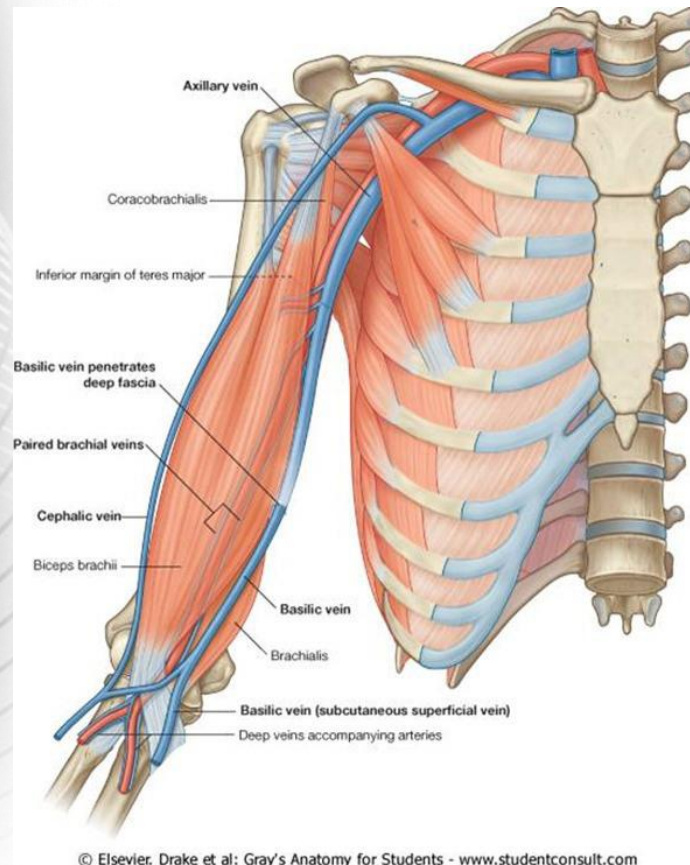
Insertion Sites

- Basilic
- Brachial
- Cephalic



Venous Anatomy

Brachial vein is deep to biceps muscle



Choosing a Peripheral Site

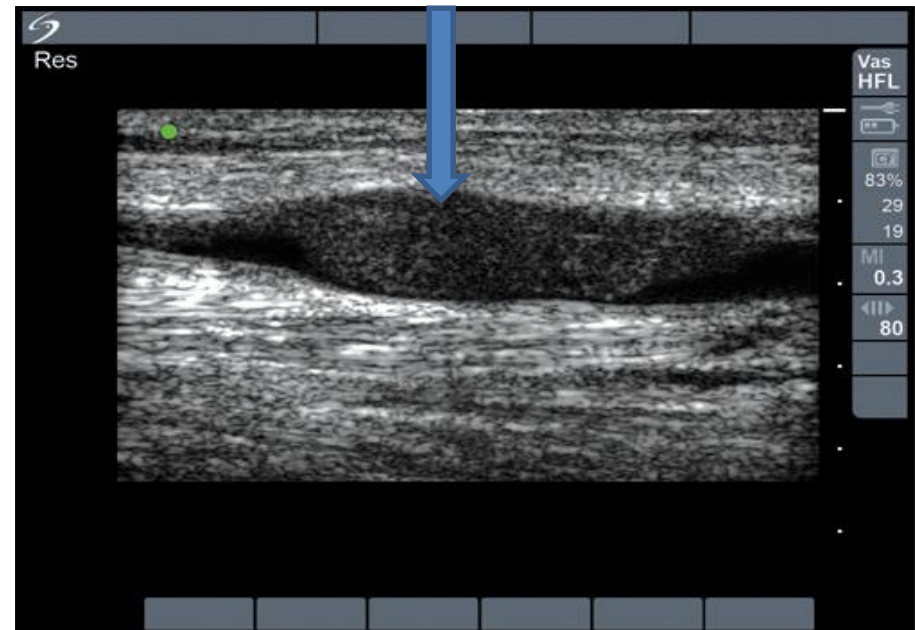
- Right arm preferred
 - Shorter path to SVC
 - Decrease risk thrombosis versus left side
- Avoid areas of flexion
- Choose size of vessel to allow good blood flow around the catheter

Access Challenges

Unable to establish peripheral IV access

- Small veins
- IV drug user
- Thrombosis
- Dehydration
- Obesity
- Prior surgery
- Burn Patient

Thrombus Basilic Vein



Choosing a Peripheral Site

Radial

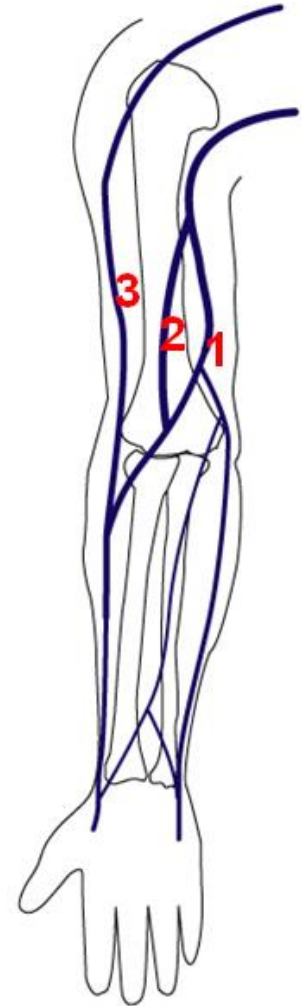
- Largest, straightest, 6-8mm diameter
- Enhanced by positioning arm at 90 degrees to body
- May be located too far medially or posteriorly making insertion and care difficult

- **Brachial - can be paired**

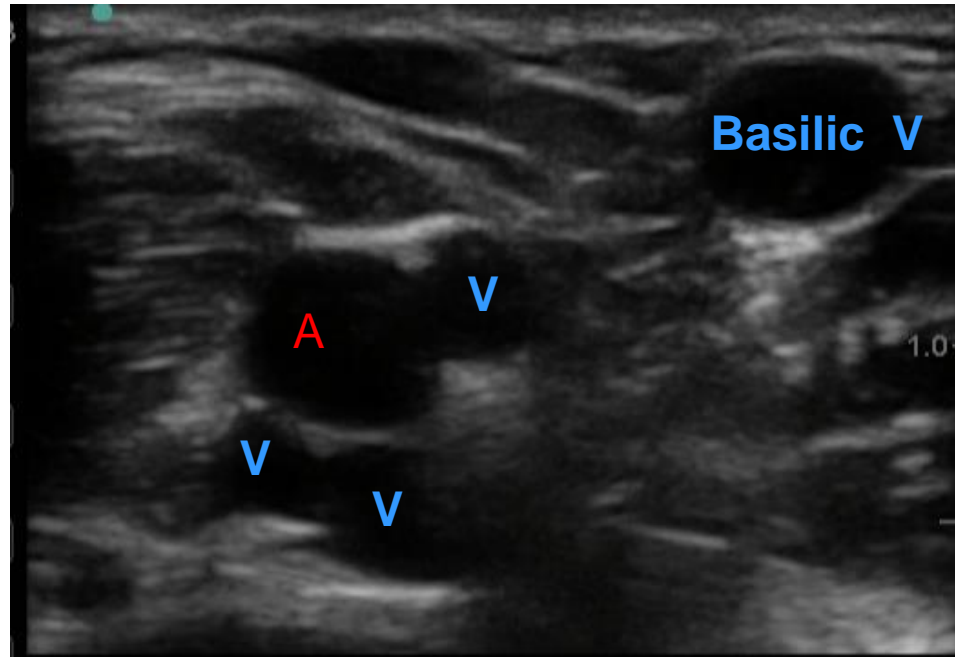
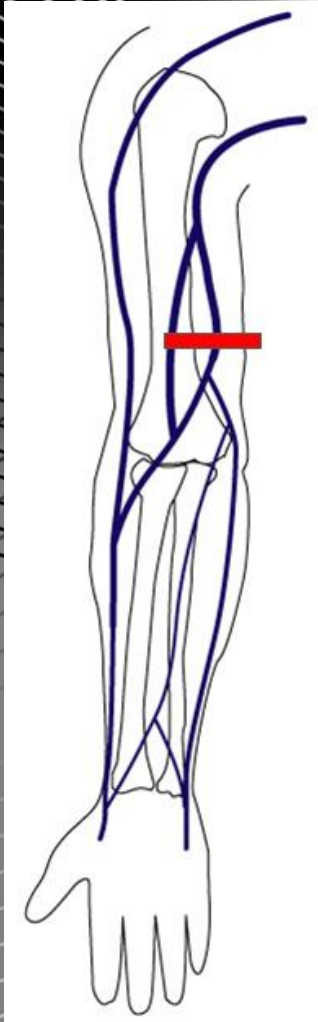
- Large vessel, usually undamaged
- Deep location, travels with nerve and artery
- Higher risk of injury to median nerve

- **Cephalic**

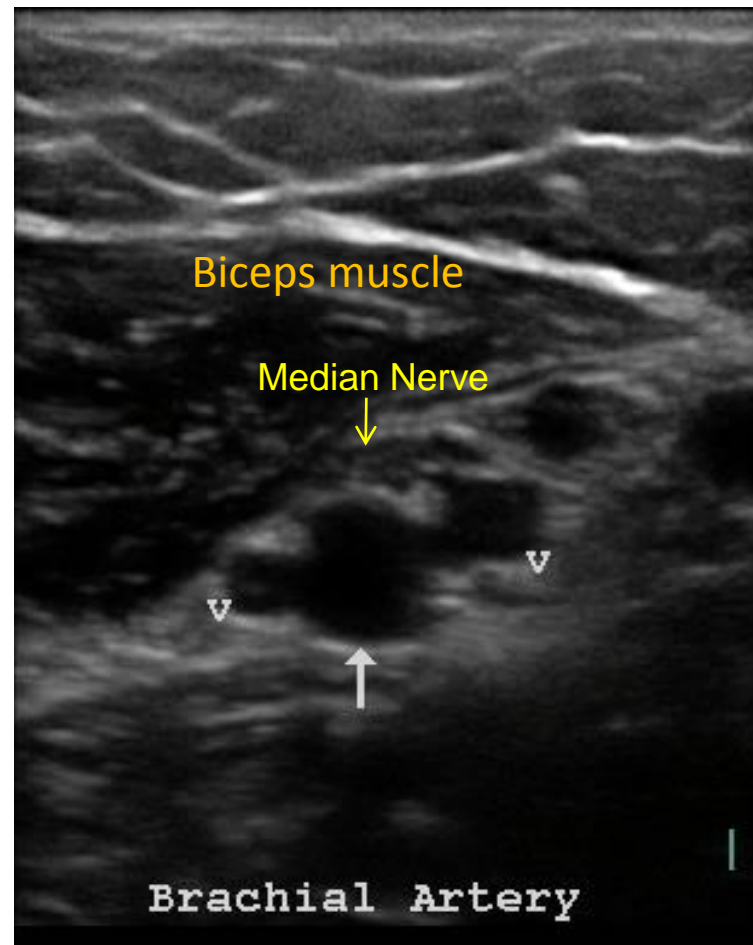
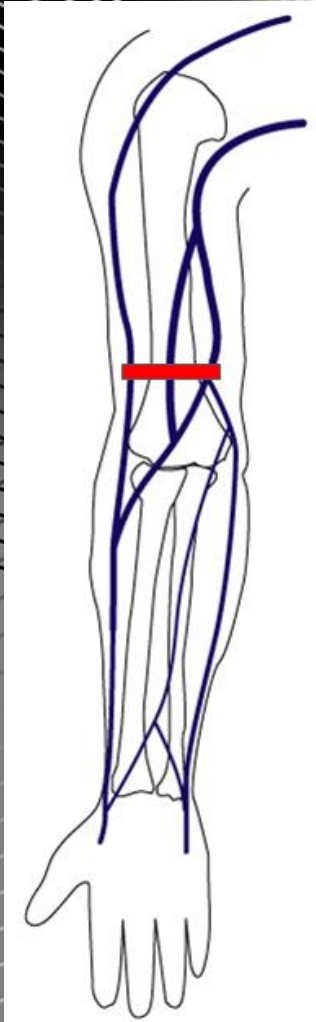
- Easy access for insertion and care
- Tortuous with many tributaries, increase risk of phlebitis
- Vessel narrows as it travels up the arm



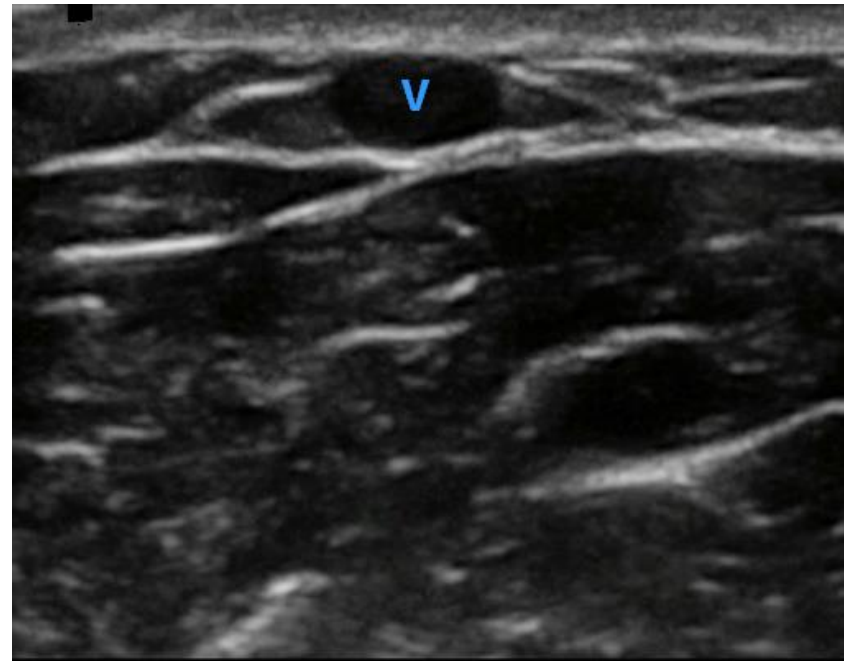
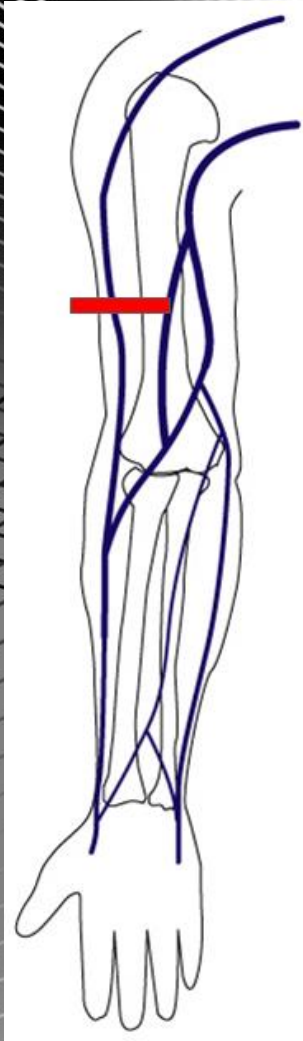
Basilic Vein



Deep Brachial Veins



Cephalic Vein



Ultrasound Assessment of Veins

- Presence, size and patency
- Distensibility and compressibility
- Presence of thrombus
- Position of vein relative to artery

Techniques Used for Insertion

- Peel Away Cannula
 - Rarely uses ultrasound, performed by feel only
- Modified Seldinger Technique



PICC Procedure

- Apply tourniquet above insertion site
- Identify appropriate vein for insertion with ultrasound
- Release tourniquet
- Extend arm 45 – 90 degree from body
- Measure distance from insertion site to distal SVC

PICC Procedure

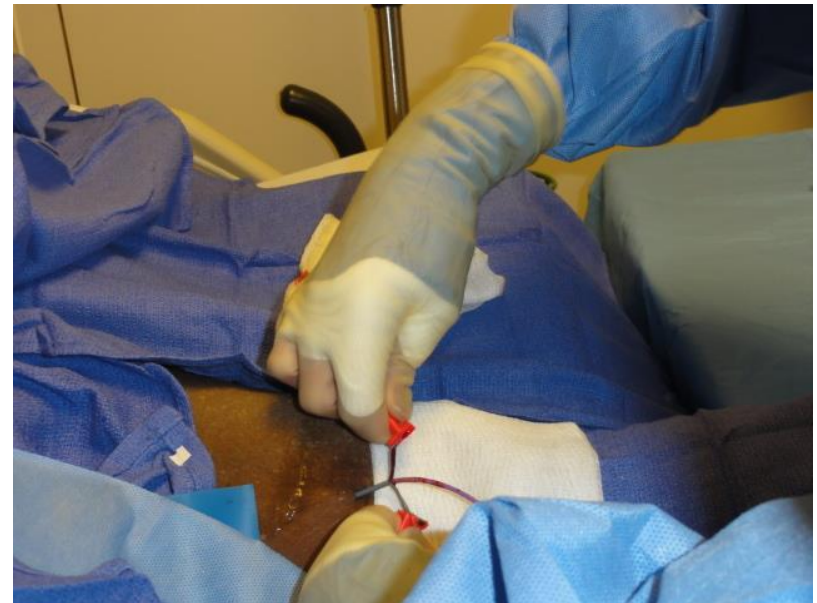
- A regular gauge hypodermic needle or an intravenous cannula is inserted into vein
- Guide wire is passed several centimeters into the needle/cannula
- The needle/cannula is removed leaving the guide wire in place. The guide wire is not advanced past the shoulder

PICC Procedure

- Introducer sheath with a dilator is introduced over the guide wire after a small incision is made on the skin near the wire.
- The guide wire and dilator are removed.
- Catheter is advanced through the introducer sheath
- Introducer is then pulled back and removed
- Position of the tip of the catheter is confirmed with fluoro or chest x-ray.

PICC Procedure

- Catheter is advanced through the introducer sheath
- Introducer is then pulled back and removed
- Position of the tip of the catheter is confirmed with fluoro or chest x-ray.



Summary

- Indications for insertion of central and peripheral lines
- Complications associated with procedures
- Role of ultrasound in vascular access
- Recommended sites for vascular access
- Regional anatomy of neck and arms
- Ultrasound appearance of vascular structures
- Discuss proper needle visualization techniques

Summary

Benefits, Ultrasound Guidance for Vascular Access

- Detect anatomic variations and exact vessel location
- Provides real-time guidance of needle insertion, guide wire and catheter
- Determine condition of vessels and insertion site
- Improves accuracy
- Shortens procedure time
- Improved patient satisfaction

Questions?

