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Intravenous venous Access

10/15/2024

OBJECTIVES

- Peripheral IV Access
- Central IV Access

Peripheral IV Access

Criteria	Peripheral Venous Access	Central Venous Access
Duration	Shorter periods	Longer periods
Clinical Circumstances	When direct access to central circulation is unnecessary	When direct access to central circulation is necessary
Catheter Size	Smaller gauge catheters suffice	Larger gauge catheters required
Safety	Generally safer, easier to obtain, and less painful	Higher risk, more complex procedure
Anticoagulant Use	Allows for direct compression of puncture sites, fewer hematoma-related complications	Higher risk of hematoma-related complications
Medication Type	Suitable for non-sclerosing medications	Preferred for sclerosing medications and vasopressors
Volume Depletion	Less effective in severe volume depletion	Preferred in severe volume depletion
Likelihood of Success	Higher success rate in general population	Preferred in patients with difficult peripheral access
Septic Shock	Recommended for initial vasopressor administration	Not recommended to delay vasopressor administration for central access
Extravasation Risk	Lower risk of tissue injury	Higher risk if extravasation occurs

- **Absolute Contraindication:**
  - When appropriate therapy can be provided by a less invasive route (e.g., orally).

- **Relative Contraindications:**
  - Use of a limb with a significant motor and/or sensory deficit, as:
    - Slightly increased risk of developing deep vein thrombosis in paralyzed or significantly weak limbs.
    - Potential delay in detecting fluid or medication infiltration in limbs with significant sensory deficits.

Equipment

Peripheral venous catheters of appropriate size

Connective tubing and intravenous (IV) fluid

Skin preparation materials (eg, chlorhexidine)

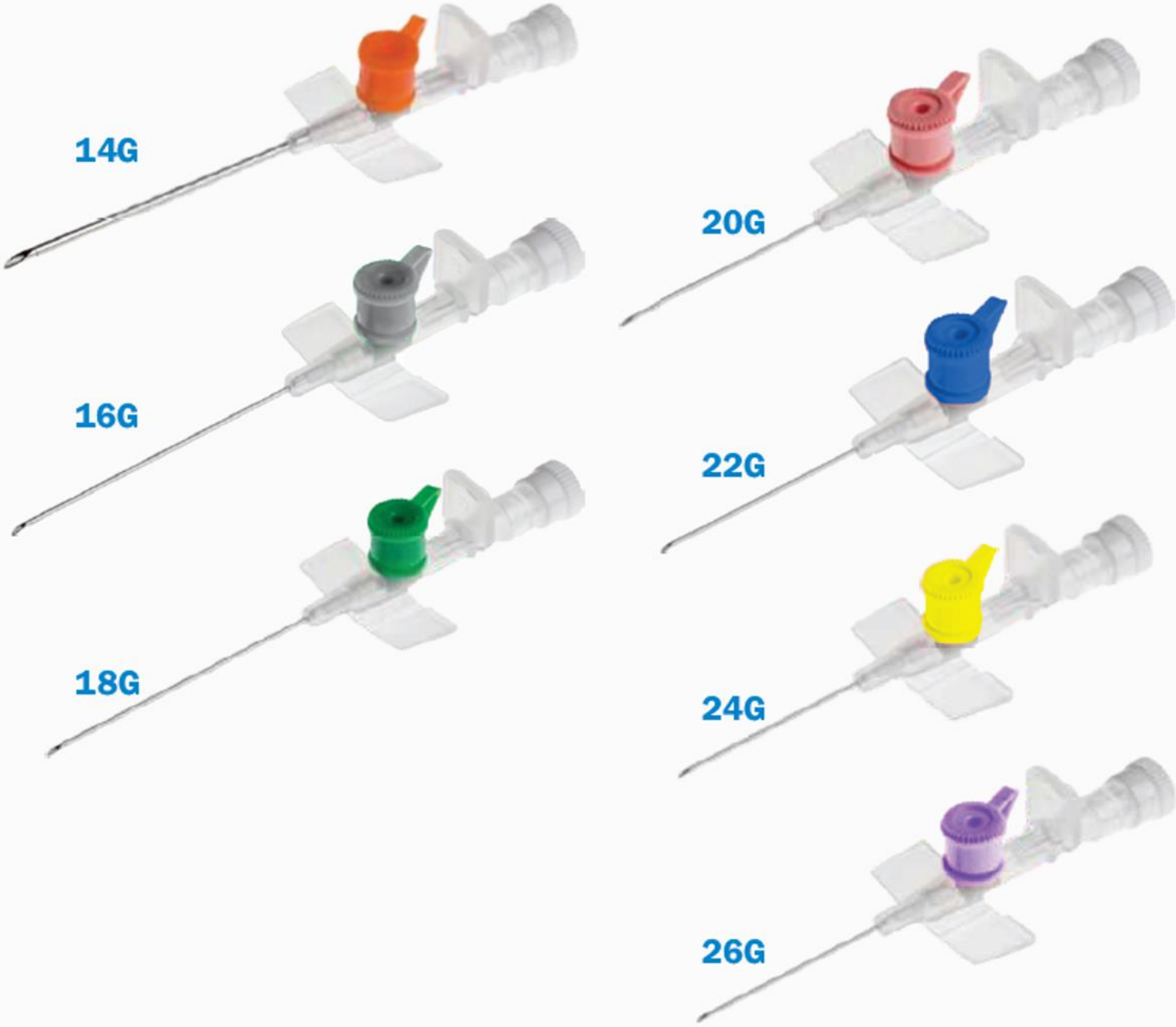
Tape or a commercial device to secure the catheter

Clean gloves and eye protection

Needle Size

- Use the smallest appropriate needle size to reduce trauma and phlebitis.
- They range from 24 gauge (smaller) to 14 gauge (larger).

- Common Gauges (22- to 20-gauge catheters) are typically used for medication administration or moderate fluid infusion.
- Larger catheters: Indicated for rapid infusion of large fluid volumes.


14G
16G
18G
20G
22G
24G
26G

IV Cannula	Size	Color	Uses
	14 Guage	Orange	Rapid Blood Transfusion, Trauma , Surgery
	16 Guage	Grey	Rapid Fluid Replacement- Transfusion, Surgery
	18 Guage	White	Rapid Blood Transfusion, Trauma , Surgery
	20 Guage	Pink	Rapid Blood Transfusion,Surgery
	22 Guage	Blue	Rapid Fluid Replacement- Transfusion, Surgery
	24 Guage	Yellow	Trauma, Routine Blood Transfusion
	26 Guage	Violet	Most Infusions,Rapid Fluid Replacement

DENEX INTERNATIONAL

Intravenous (IV) catheter flow rates

Catheter size (diameter, length)	Flow rate with gravity	Flow rate with pressure
22 gauge, 25 mm	35.7 mL/min	71.4 mL/min
20 gauge, 33 mm	64.4 mL/min	105 mL/min
18 gauge, 45 mm	98.1 mL/min	153 mL/min
16 gauge, 50 mm	155 mL/min	334 mL/min
14 gauge, 50 mm	236 mL/min	384 mL/min

Data from: Reddick AD, Ronald J, Morrison WG. Intravenous fluid resuscitation: Was Poiseuille right? Emerg Med J 2011; 28:201.

Site selection

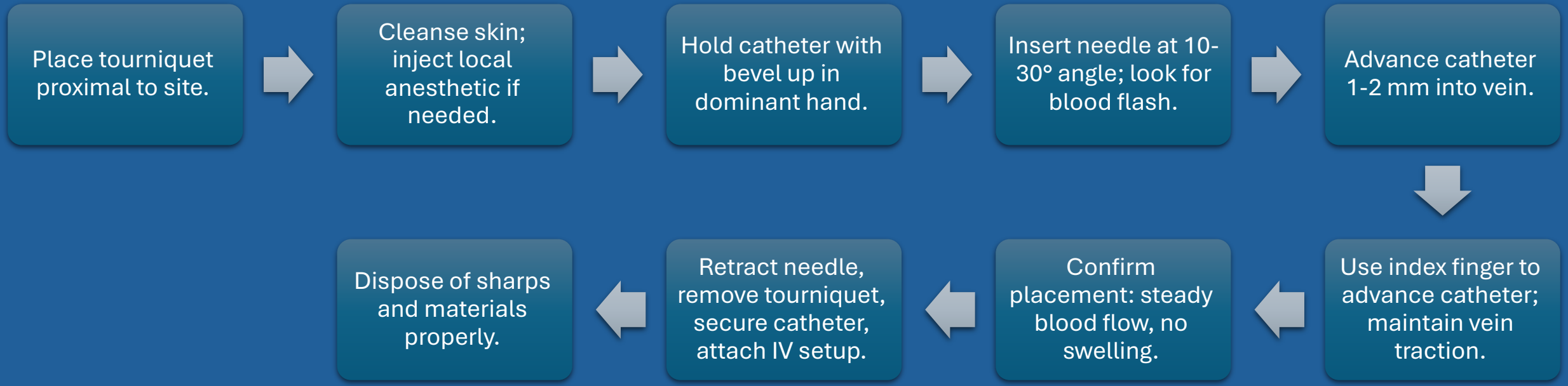
- *Ideally, in distal veins in the upper extremity.*
- *Do not place a peripheral IV in an extremity with an arteriovenous fistula, at a site that may interfere with an anticipated procedure, or through infected tissue.*

Venous dilation

Methods to enhance venous dilation and successful cannulation include:

- *Place the anticipated cannulation site below the level of the heart*
- *Apply a thin rubber tourniquet 5 to 10 cm proximal to the anticipated venipuncture site*
- *Lightly tap or gently stroke the vein along its length*
- *Have the patient alternately clench and relax their fist*
- *Elevate the skin temperature by applying a warm compress*

CATHETER INSERTION



Central Venous Access

Introduction

- Central venous catheterization, is a catheter that has it tip within
  - THE proximal third of the superior vena cava,
  - THE right atrium
  - THE inferior vena cava

Introduction

- Patient Safety in ICU is one of the “Hot” and area of focus for the New Millennium

- Multiple interventions in multiple areas are being proposed and adopted to help improve care/outcomes and prevent complications

Introduction

- Central Line Insertion is an area of focus and there are two main areas that can reduce complications and improve patient outcomes

    - Preventing Central Line Infections using a “Central Line Quality Bundle”
    - Ultrasound-guided Central Line Insertion

Indications

- Access for drugs & fluids
  - Difficult or poor peripheral access
  - Administration of long-term drugs
  - Infusion of irritant drugs, vasopressors, and inotropes
  - Total parenteral nutrition
- Access for extracorporeal blood circuits
  - Plasma exchange
  - Renal replacement therapy

- Haemodynamic monitoring
  - Central venous blood oxygen saturation
  - Repeated blood sampling
  - PAC
- Interventions
  - Temporary transvenous pacing
  - ASD closure

Contraindications

- Patient refusal
- Thrombocytopenia
- Ipsilateral indwelling central venous access device
- Contralateral hemothorax or pneumothorax
- Vein stenosis or thrombosis
- Localized infection at the insertion site

Consent

Complications

- The Immediate Complications
- The Delayed Complications

The Immediate Complications

- Cardiac
- Vascular
- Pulmonary
- Catheter placement complications

The Delayed Complications

- Infections
- Device dysfunction
- Catheter fracture
- Thrombosis

Internal jugular vein

Advantages

- Carotid artery directly compressible if punctured
- Decreased rate of catheter insertion failure
- Decreased incidence of catheter malposition
- Permits ambulation

Disadvantages

- Awkward for patient
- Risk of pneumothorax
- Brain tumors, cerebral hemorrhage and head injuries who are at risk of intracranial hypertension

Subclavian vein

Advantages

- Decreased risk of infection
- Comfortable for patient
- Permits ambulation

Disadvantages

- Difficult to apply direct pressure to the subclavian artery if punctured
- Increased rate of catheter insertion failure
- Increased incidence of catheter malposition
- Increased incidence of pneumothorax

Femoral vein

Advantages

- Femoral artery directly compressible if punctured
- More suitable in patients with coagulopathy as it is directly compressible.
- Pneumothorax is not a risk

Disadvantages

- Impairs patient mobility
- Increased incidence of symptomatic catheter-related deep venous thrombosis
- Increased risk of infection

Choice of anatomical site

- Depends on many factors including
  - The indication
  - Contraindications
  - Previous line insertion sites with associated stenosis or thrombosis
  - Intended duration of use
  - Anticipated future sites of insertion

Type of central venous catheter

- Type
- Length
- Lumens

Procedure

- **Preparation and Asepsis**
- **Patient’s Positioning**
- **Ultrasound**
- **Technique**
- **Depth, position, and confirmation of placement**

Procedure

- **Preparation and Asepsis**
- **Positioning**
- **Ultrasound**
- **Technique**
- **Depth, position and confirmation of placement**

Central Line Infections (CLI)

Why Should I care?

Central Line Infections (CLI):

- CLI's – Common!
  - 50% patients in ICU have Central Venous Catheter (CVC)
  - Infection rate is 2-5 /1000 catheter days
  - That equals up to 80,000 infections/yr U.S.A.

- CLI's – Costly!
  - 2.3 billion dollars/yr U.S.A.

- CLI's – Lethal!
  - 28,000 patients/yr die from infection

Central Line Infections

- Important Quality Health Care Topic!
  - In 2002 CDC made recommendations for insertion to help prevent infection
    - *O'Grady, MMWR 2002*
- Central Line Insertion Bundle Developed

The Central Line Bundle

- 5 Simple Steps that have been shown to decrease rates of CLI dramatically

  - Hand Hygiene –Wash your hands!
  - Full Barrier Precautions – Fully gown/drape
  - Clean Skin with Chlorhexidine
  - Avoid Femoral Line Site – Subclavian best
  - Remove Unnecessary Lines ASAP

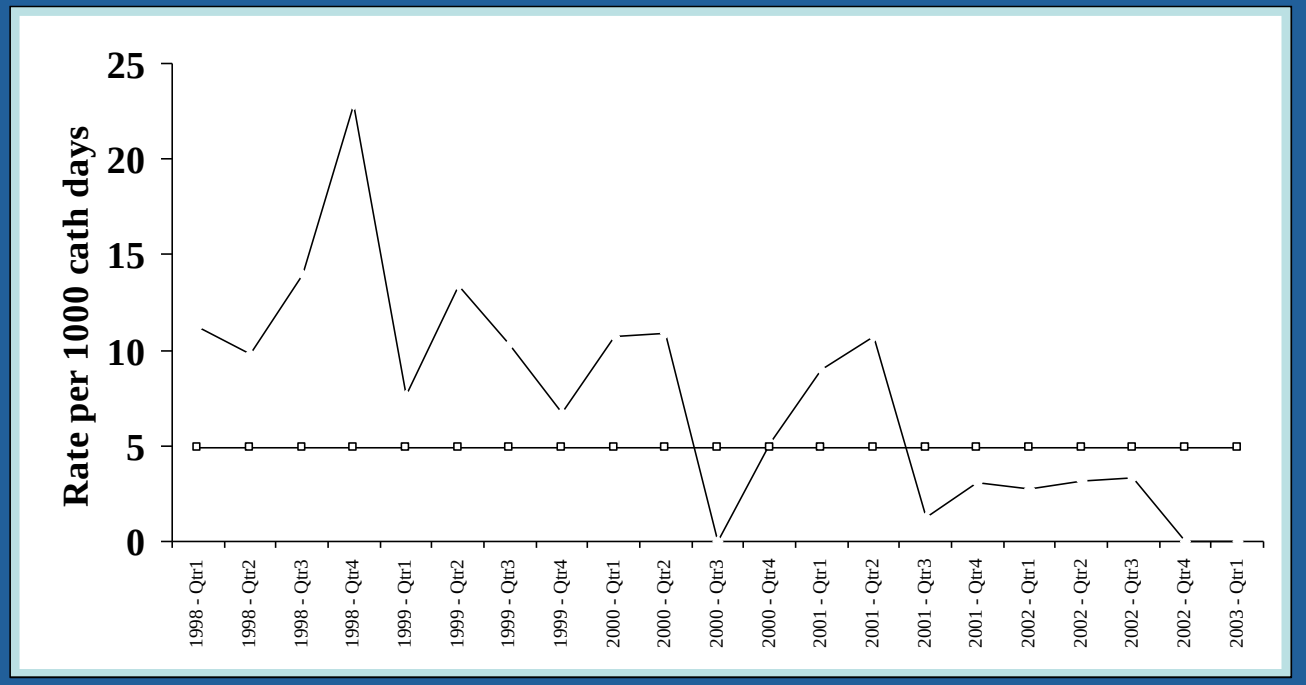
What are Maximal Barrier Precautions?

- For the Provider:
  - Hand hygiene
  - Non-sterile cap and mask
  - Sterile gown and gloves

- For the Patient:
  - Cover patient's head and body with a large sterile drape
  - "Head to Toe" coverage

Does All This Work?

ICUs that have implemented the central-line bundle have nearly eliminated CLI's !



Berenholtz et al. Critical Care Medicine. 2004; 32:2014-2020.

Preparation and Asepsis

- Non-sterile Hat and mask
- Sterile
- Gown and gloves, ultrasound probe cover and gel
- Ultrasound machine with linear array probe
- Skin preparation for sterilization, such as 2% chlorhexidine in 70% isopropyl alcohol
- Fenestrated drape
- Syringes
- Gauze
- Needles
- Lidocaine
- 0.9% normal saline
- Central venous catheter set, including needle, guidewire, scalpel, dilator and central venous catheter
- Three-way taps
- Sutures
- Dressing impregnated with an antimicrobial
- Sterile dressing

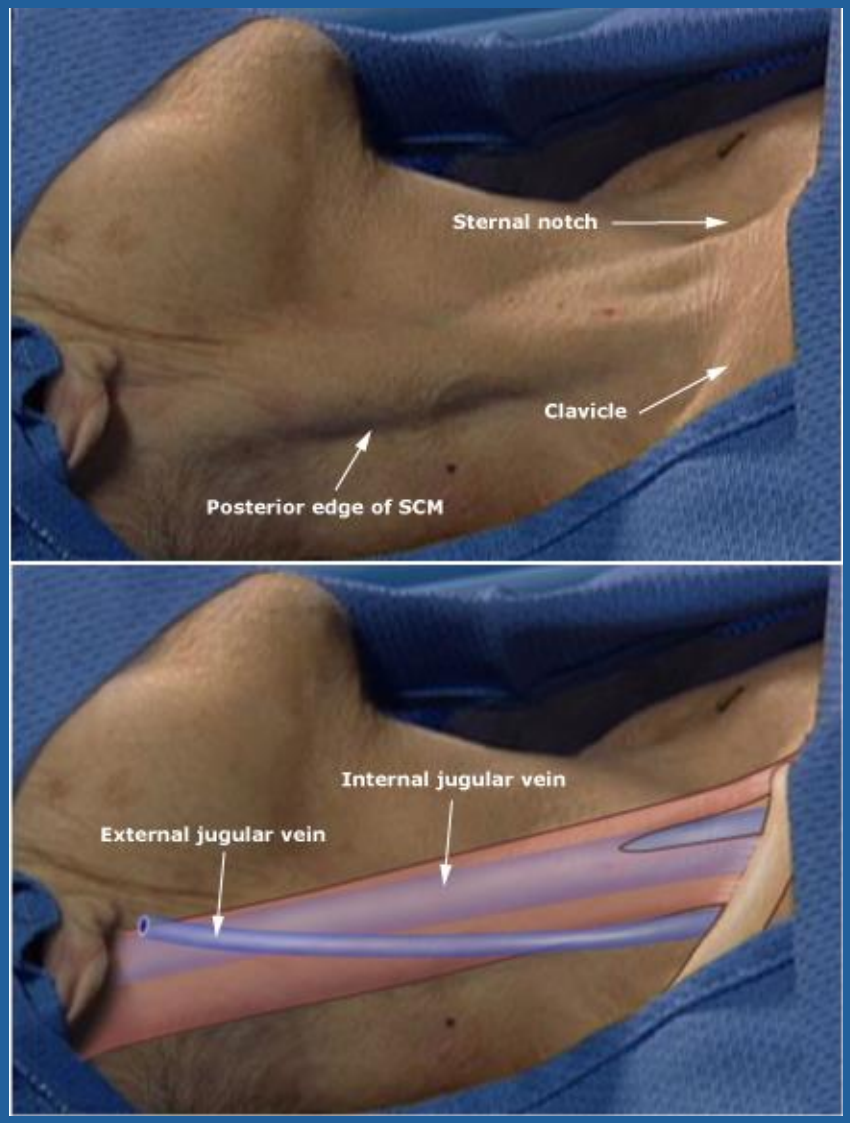
- An experienced assistant is required to help with monitoring, positioning and maintenance of a sterile field.

- Full monitoring, comprising pulse oximetry, three-lead electrocardiogram and non-invasive blood pressure, should be applied from the outset and should not interfere with the sterility of the procedure.

Procedure

- Preparation and Asepsis
- Positioning
- Ultrasound
- Technique
- Depth, position and confirmation of placement

Positioning



Procedure

- Preparation and Asepsis
- Positioning
- Ultrasound
- Technique
- Depth, position and confirmation of placement

Ultrasound Assisted Central Line Insertion

- In a meta-analysis by Brass et al (2015), the use of ultrasound compared to landmark techniques for central venous catheter insertion via the internal jugular was associated with an increase in the overall and the first attempt success rate and a decrease in the number of attempts and the time until successful catheterization, as well as a reduction in the total rate of complications.

- Ultrasound can thus provide an increased margin of quality and safety in central venous catheterization. In recognition of this, the National Institute for Health and Care Excellence (2002) recommends use of ultrasound guidance for insertion of a central venous catheter into the internal jugular vein.

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The Effectiveness of Real-Time Ultrasound-Guided Central Venous Catheterization: A Comparison with the Landmark Technique in Jordanian Patients

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Summary of Recent Meta-Analyses on US guided CVC Insertion

Table 2 Meta-analyses

Paper	N/Type	Group	Inter-vention	Outcome	Comments
Randolph *et al*[7] 1996	8 RCTs	Mixed hospital adult & paediatric inpatients undergoing CVC insertion	Doppler- and External-ultrasound guidance, versus Landmark	Reduced IJ & SC failure rate.	No emergency vs routine subgroup analysis.
	513 CVC placements in 493 patients.			Reduced complication rate.	No Doppler vs 2-D ultrasound analysis.
				Reduction in number of attempts.	Variable definitions of failure.
					No blinded studies
Keenan[8] 2002	17 RCTs & 1 Quasi-RCT	Mixed hospital adult & paediatric inpatients undergoing CVC insertion	Doppler ultrasound (898) and External 2-D ultrasound (1194)	Reduced failure rate.	No scoring system or dual assessment for inclusion.
	2092 patients			Reduction in number of attempts.	No emergency vs routine subgroup analysis.
				Reduced arterial puncture rate.	Variable definitions of failure.
				Increased first attempt success rate.	No blinded studies.
				Most improvement with 2-D ultrasound, IJ cannulation, less experienced clinicians.	
Hind *et al*[13] 2003	18 trials	Mixed hospital adult & paediatric inpatients undergoing CVC insertion	Doppler ultrasound (6 trials) and External 2-D ultrasound (11 trials) Both (1 trial)	Lower failure rate and higher first attempt success rate for SC, IJ and FV approaches.	Study quality was assessed by component approach
	1646 patients			Some evidence for Doppler ultrasound for IJ approach.	No emergency vs routine subgroup analysis
					No blinded studies

CVC, central venous cathetoriastion; FV, femoral vein; IJ, internal jugular vein; RCT, randomised controlled trial; SC, subclavian vein.

Why should you use Ultrasound?

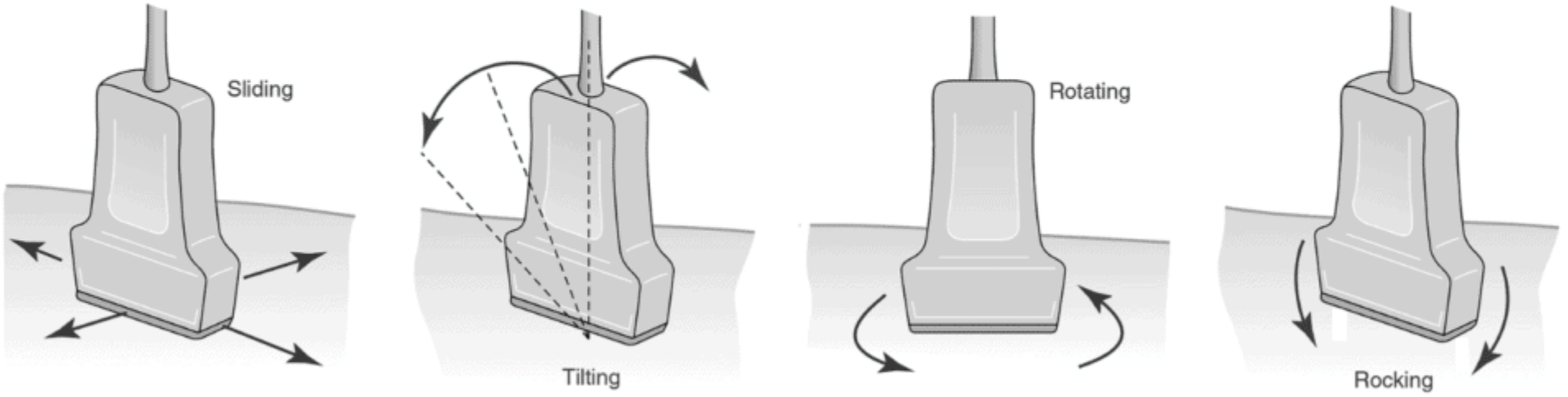
- Increased success rates
- Avoids complications
- Reduces time to cannulation
- Reduces the number of attempts
- And it’s FUN!

Procedure

- **Preparation and Asepsis**
- **Positioning**
- **Ultrasound**
- **Technique**
- **Depth, position and confirmation of placement**

Cardinal Transducer Manipulation/Movement

(Sliding, Tilting, Rotating, and Rocking)




1 Sliding (Up/Down)

2 Tilting (Fanning)

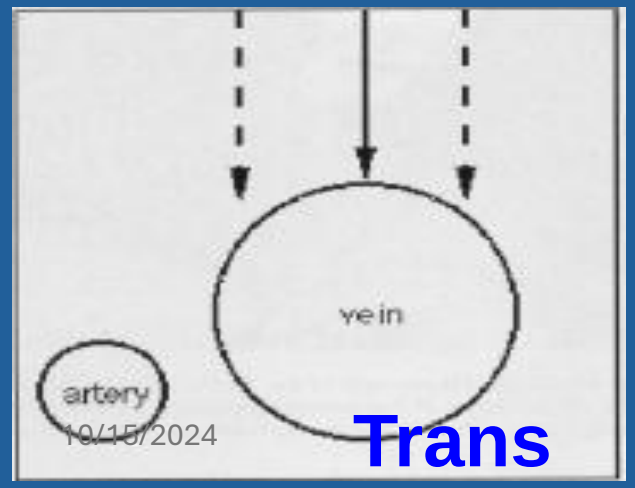

3 Rotating

4 Rocking

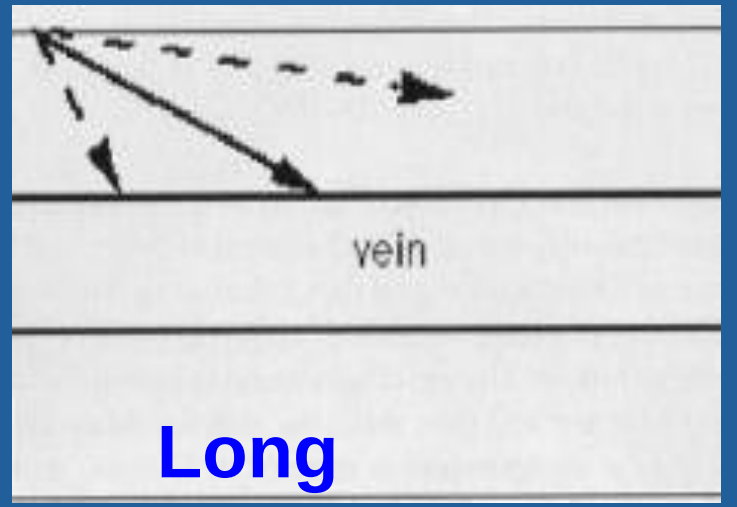
5 Compression

Orientation

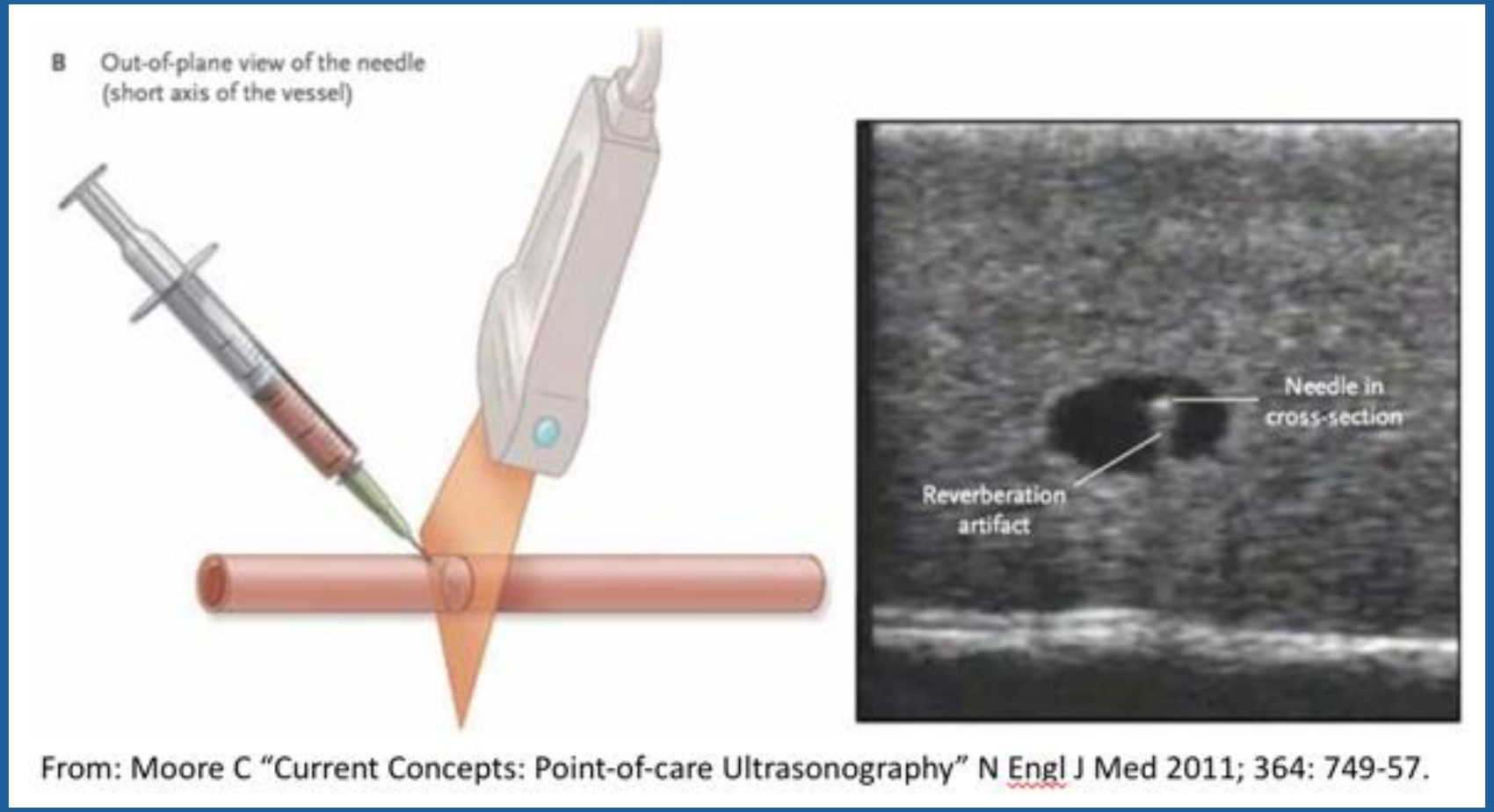
- Probe Position
  - Transverse(Outline) and longitudinal (Inline)
    - Transverse most useful – lateral orientation
    - Longitudinal – depth and slope
      - Can see back wall perforation



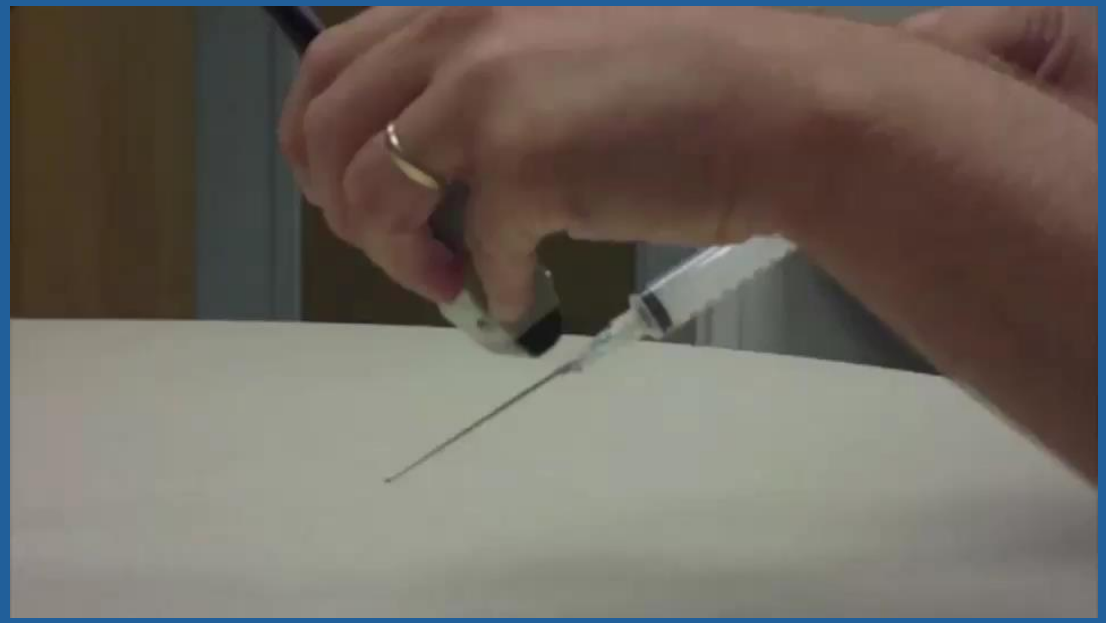
Trans

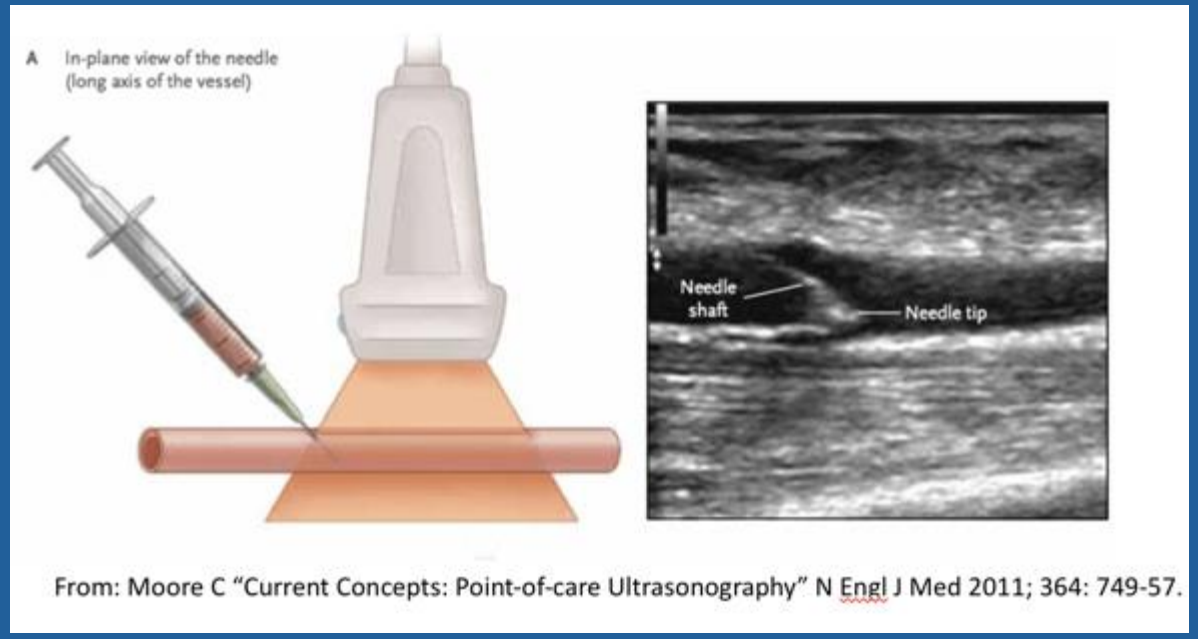


Long



From: Moore C "Current Concepts: Point-of-care Ultrasonography" N Engl J Med 2011; 364: 749-57.

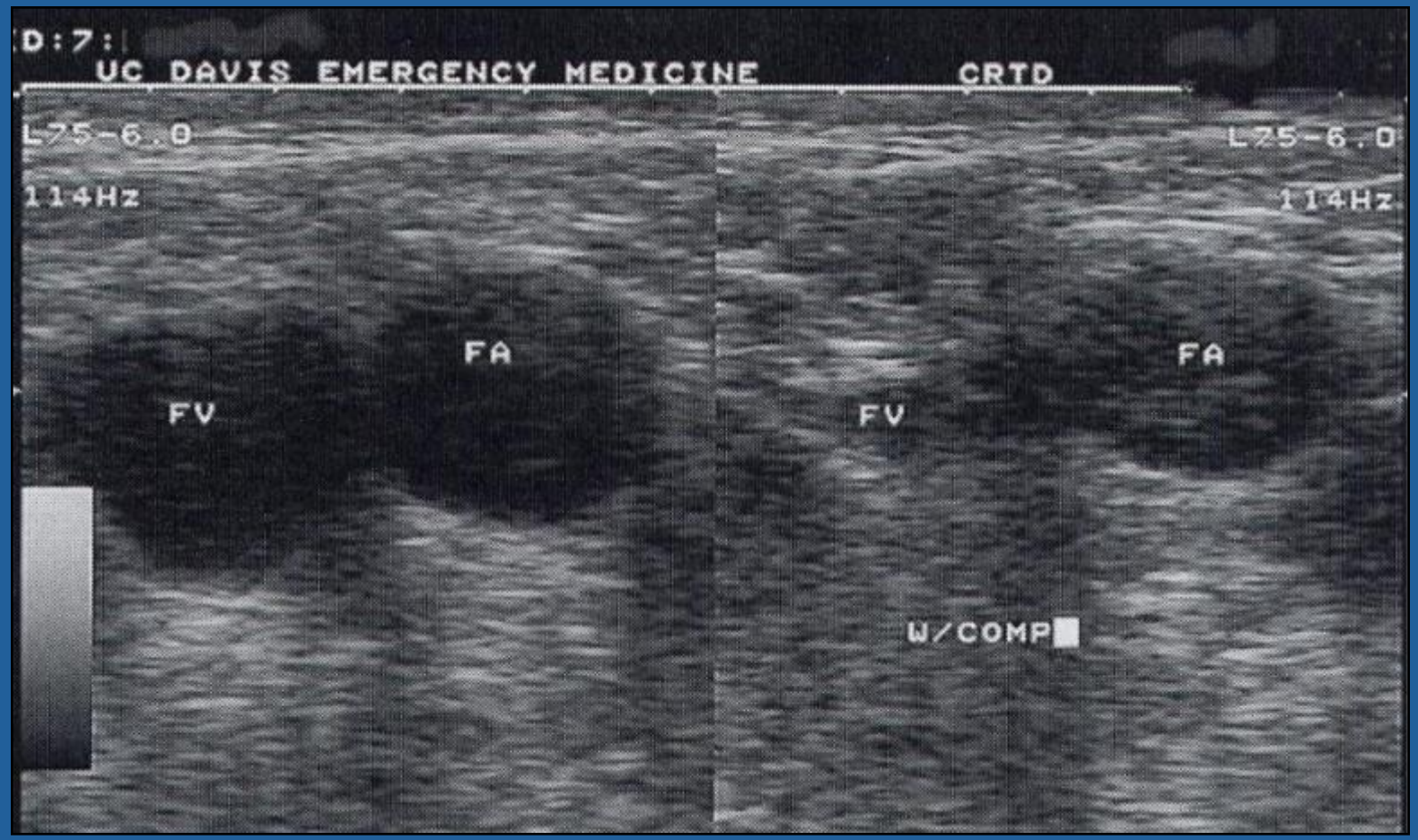




From: Moore C "Current Concepts: Point-of-care Ultrasonography" N Engl J Med 2011; 364: 749-57.

Image Interpretation

- Identifying Artery vs Vein on Ultrasound
  - Key to success!
  - VEINS ARE:
    - Compressible
    - Thin and irregular walled compared to artery
    - Not pulsatile Varies with respiration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UC DAVIS EMERGENCY MEDICINE
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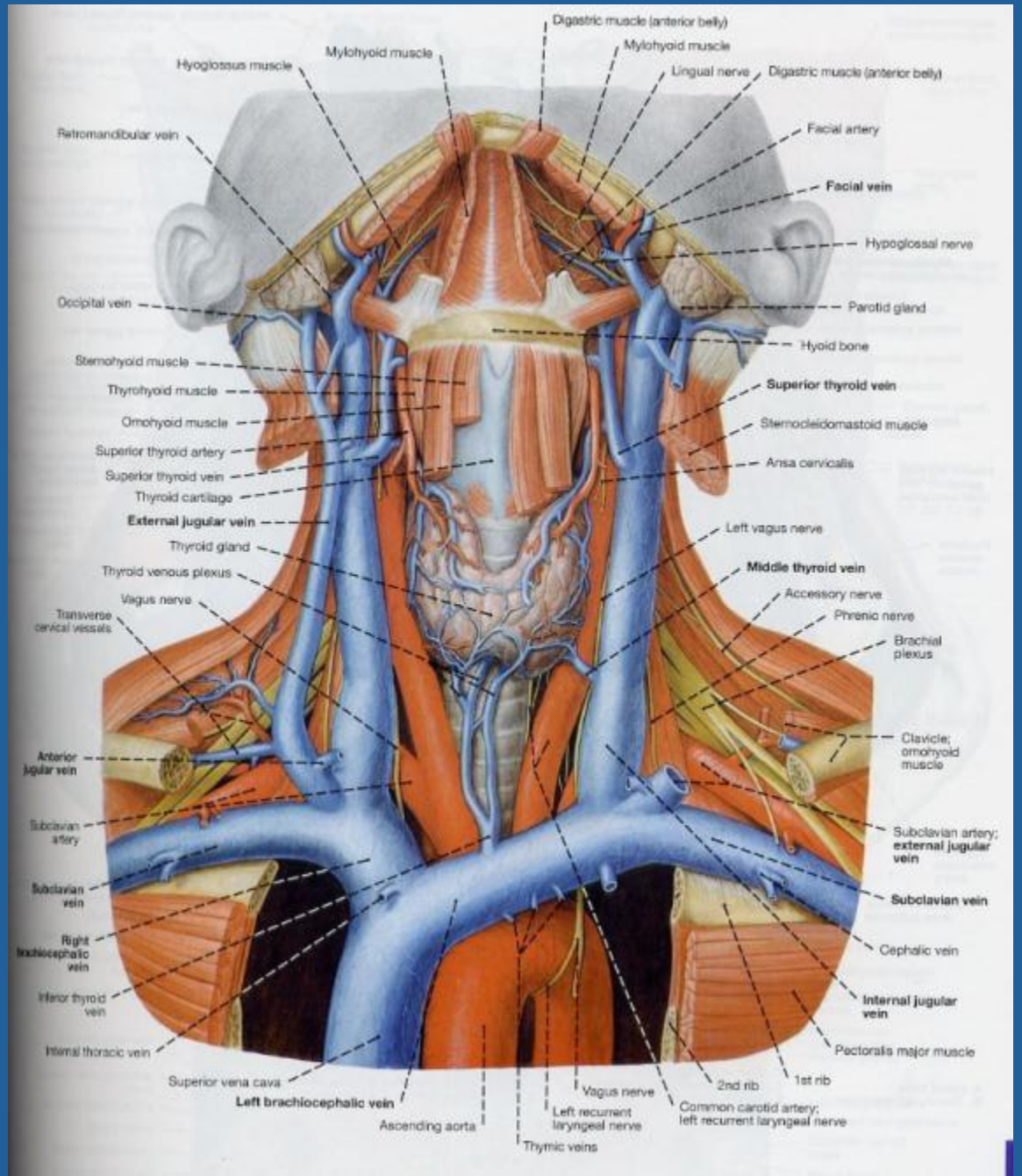
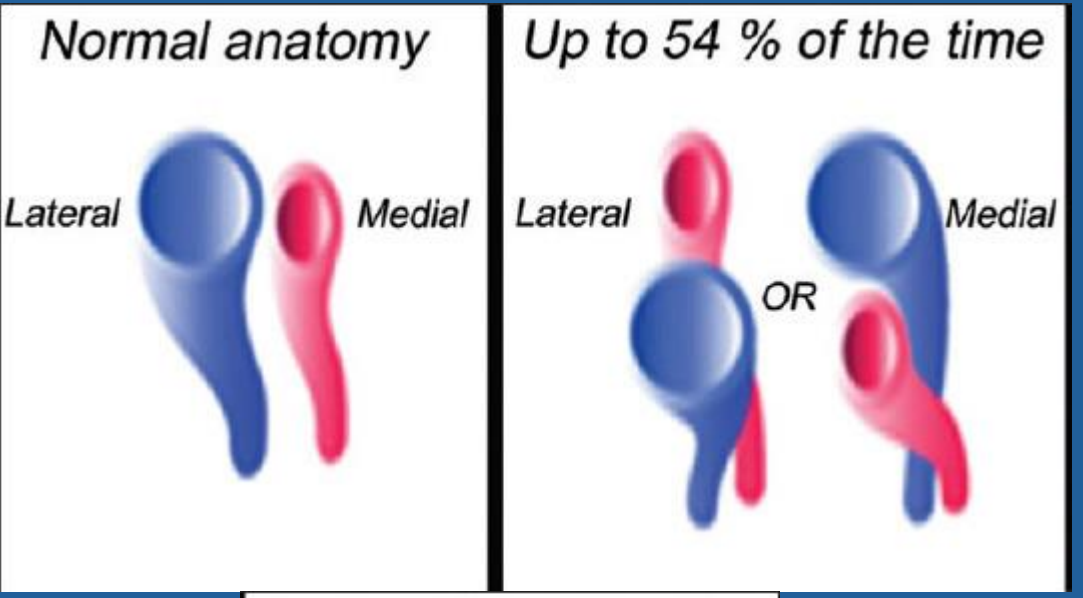
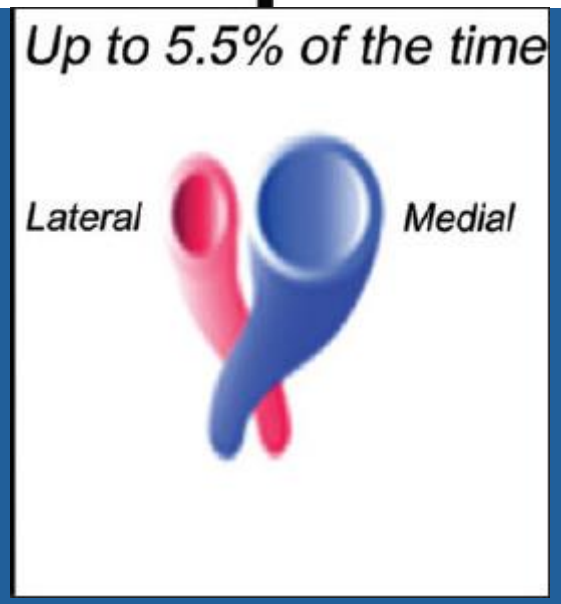
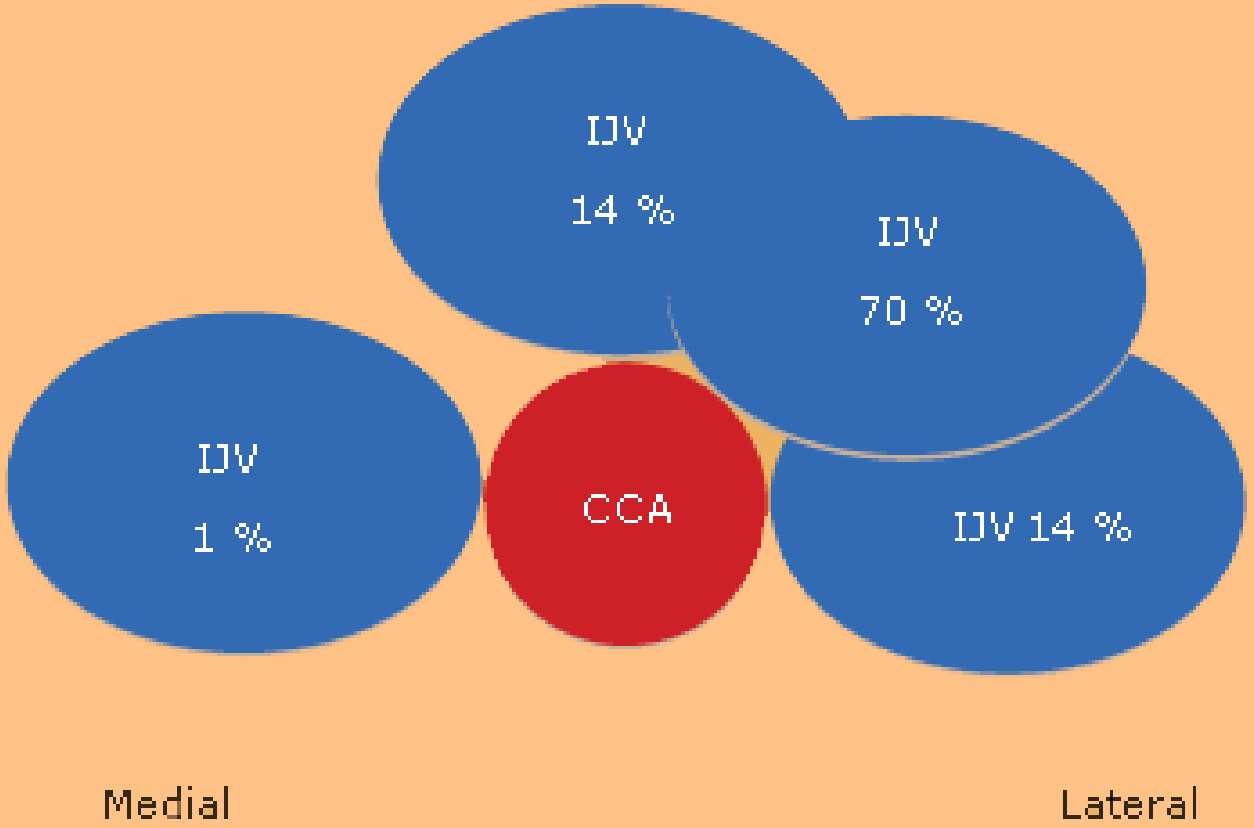
Internal Jugular Vein

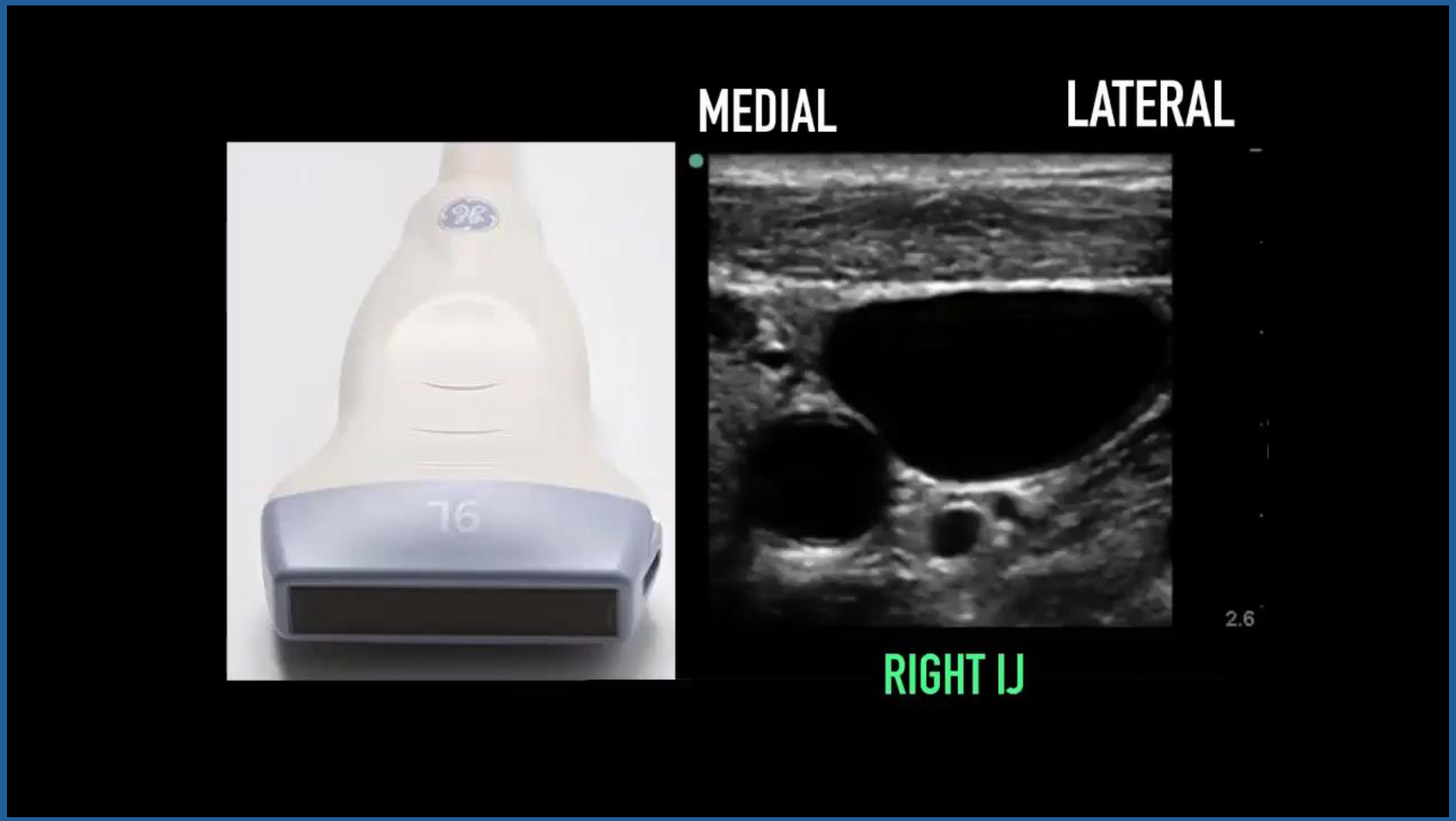



Normal anatomy
Lateral
Medial

Up to 54 % of the time
Lateral
OR
Medial


Up to 5.5% of the time
Lateral
Medial

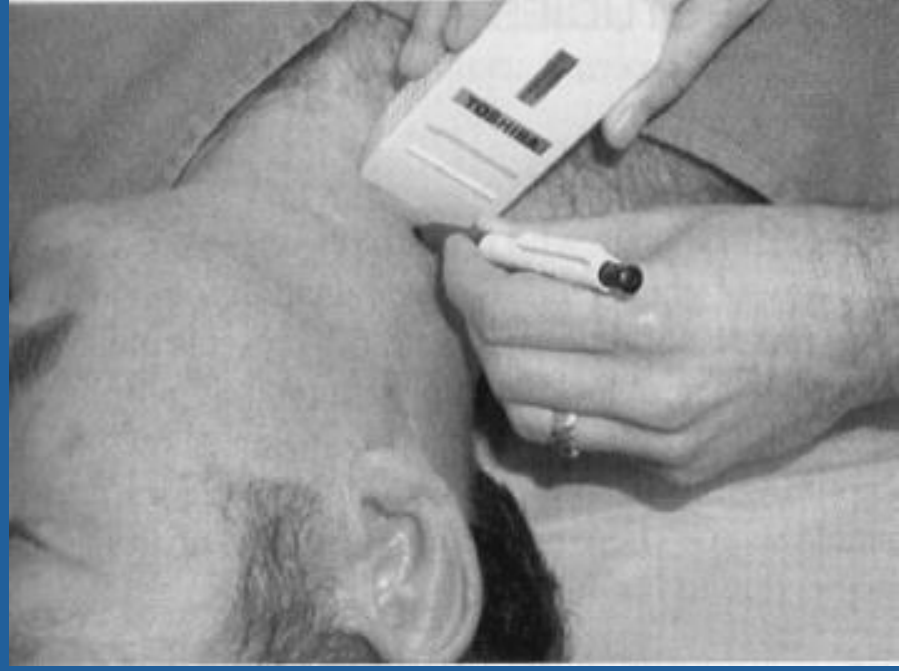

Right side
IJV
14 %
IJV
70 %
IJV
1 %
CCA
IJV 14 %
Medial
Lateral


MEDIAL
LATERAL
76
2.6
RIGHT IJ

Technique

- Two Main Approaches:
  - Static
  - Dynamic or Real Time

Technique



- Static Approach
  - Position patient
  - Use u/s to locate vessels and mark skin
  - Avoids complicated hand position/sterile issues

Technique

- Dynamic Approach
  - Real time cannulation under ultrasound visualization
  - Sterile sleeve placed on probe
  - Better technique

SELDINGER TECHNIQUE

- Vessel first cannulated
- Guide-wire advanced through the needle
- J-hook on wire to prevent vascular penetration
- Catheter-over–wire technique for dilatation and catheter insertion

Technique

- In General:
  - Position patient and get comfortable
  - Place probe on the neck in transverse
  - Sweep area and ID structures
  - Place vessel in the middle of SCREEN - Vessel should now be in middle of PROBE

Technique

- During “First Look” note the following:
  - Presence of vessel
  - Patency
  - Local anatomy
  - Size (<5 mm tricky)
  - Thrombus present?


PARKER
100

VISUALIZING IJ

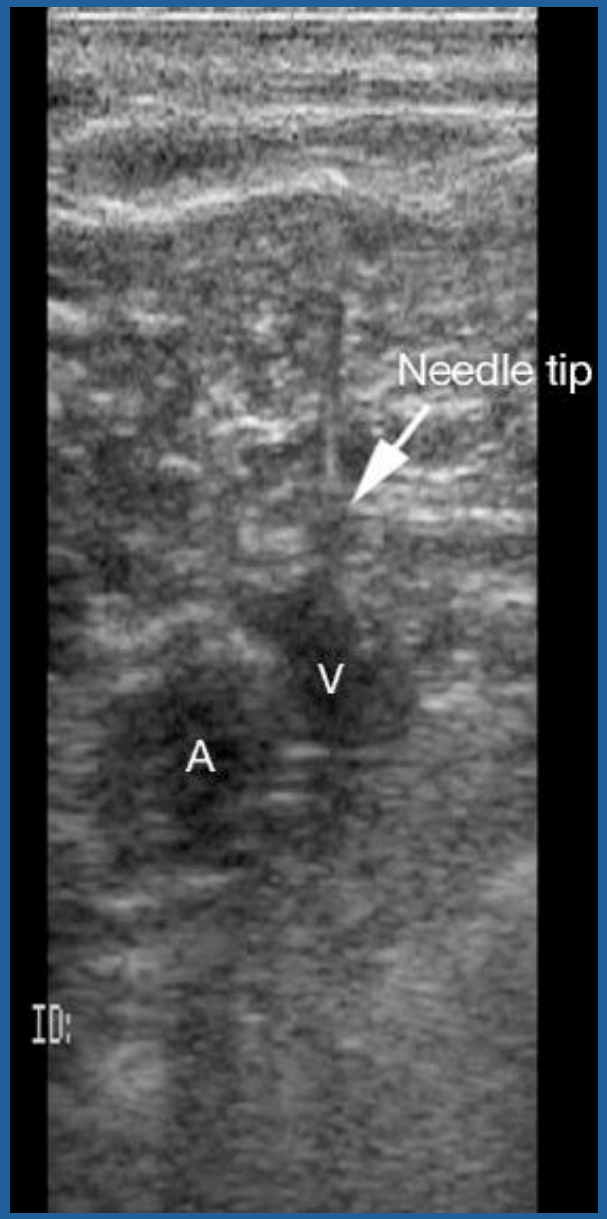
ENSURE CORRECT PROBE ORIENTATION

LOCAL ANESTHETIC INJECTION

Procedure

- Preparation and Asepsis
- Positioning
- Ultrasound
- Technique
- Depth, position and confirmation of placement

CONFIRMING WIRE PLACEMENT


Needle tip
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A
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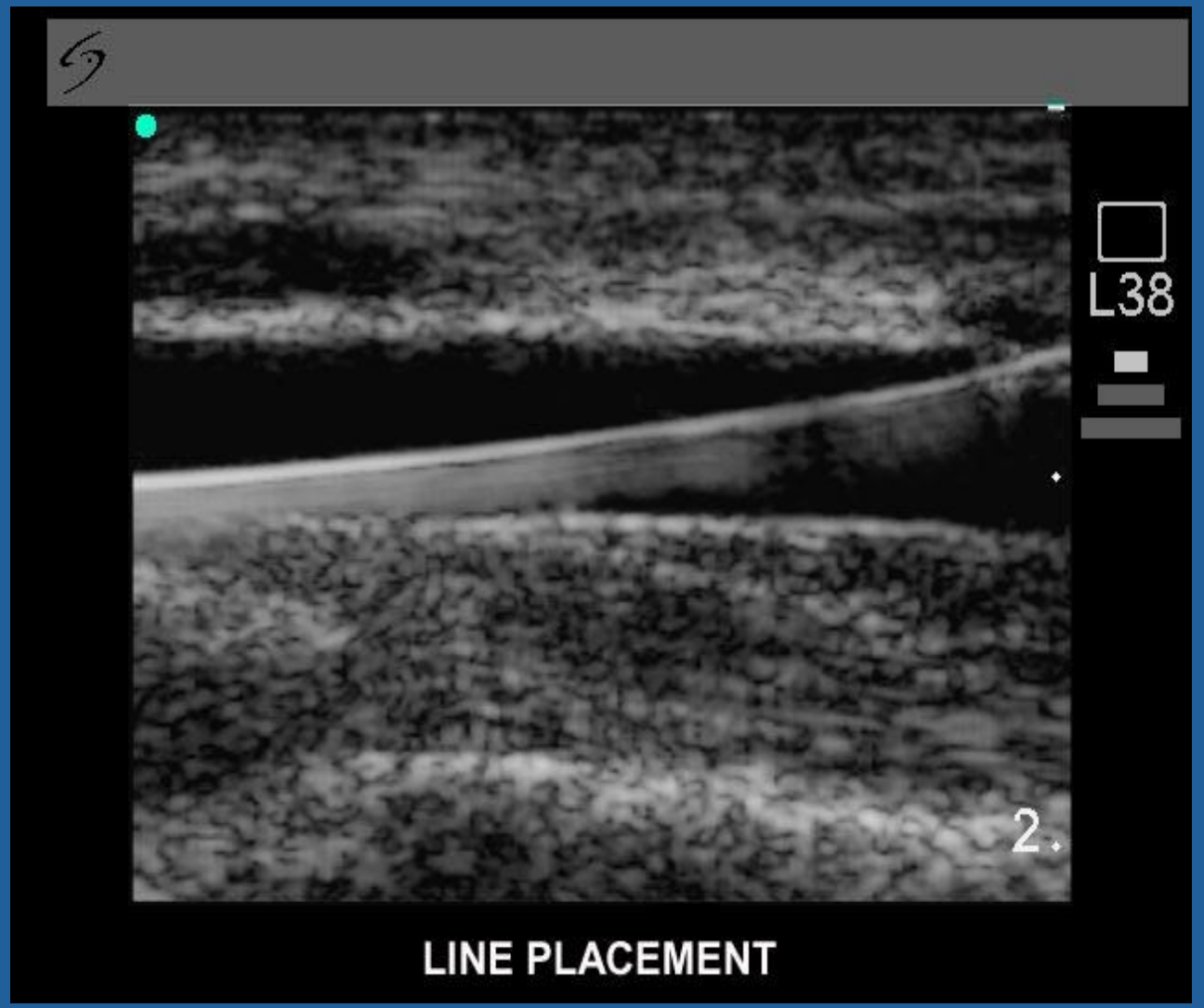
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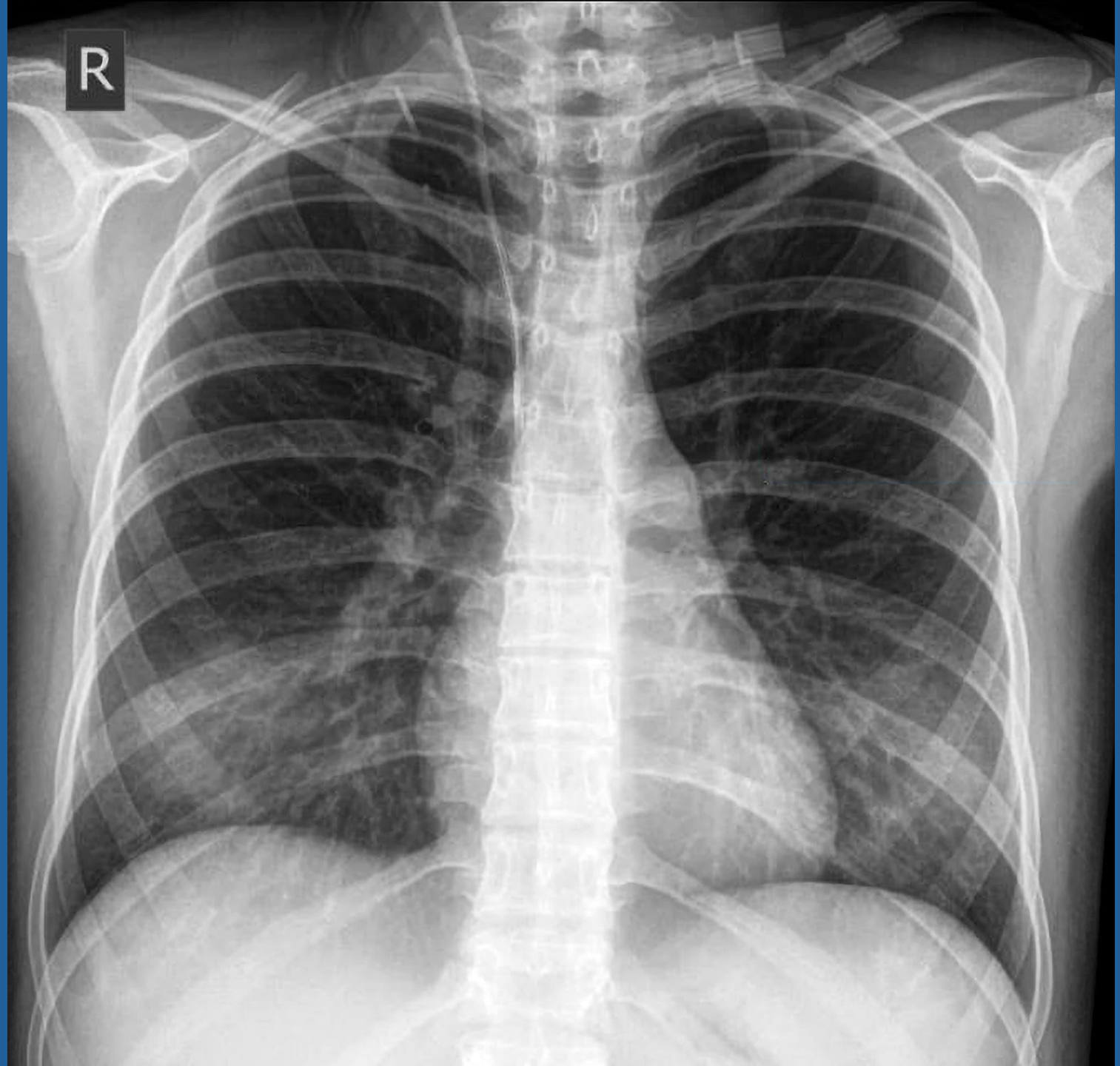
LINE PLACEMENT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Summery

- CVL is common in clinical practice with a wide range of indications.
- The Seldinger technique tends to be the primary mode of central venous catheterization.
- Veins compress - arteries do not
- Use of ultrasound for insertion of CVL has been associated with an increase in quality and safety.

Summary

- CLI are a significant risk to your patients
- Using the Central Line Bundle can reduce this risk to almost ZERO!
- Complications can occur with the insertion of central venous catheters, varying in frequency depending on the anatomical site.
- Changing practice is not always easy, but it is necessary to improve care!

THANK YOU for your attention

Go to the Ultrasound Lab.
Building 2