

# ANESTHESIA



435

## Vascular Access

{Color index: **Important**★ | **Notes** | Extra | [Editing File](#)}

### Objectives:

- Examine the construction of the commonly used venous catheters.
- Anatomical considerations regarding peripheral and central venous access.
- Choice of catheter size.
- Prepare and set-up an IV infusion set.
- The choice of sites for placement of IV catheters.
- What are the different sites suitable for central venous catheter and arterial catheter placement?
- Universal precautions.
- Indications and complications of central venous access.
- Indications and complications of arterial access.

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# Vascular Access:

## ★ Medical Asepsis:

Removal or destruction of disease-causing organisms or infected material through:

- Sterile technique (surgical asepsis).
- Clean technique.

## ★ Antiseptics and Disinfectants :

Chemical agents used to kill specific microorganisms

→ **Disinfectants:** Used on **non-living** objects, **Toxic to living tissue** (e.g.: Bleach “clorox”)

→ **Antiseptics:** Applied to **living** tissue, More **dilute** to prevent cell damage (e.g.: alcohol, iodine)



Sometimes they are using **both alcohol and iodine** at the same time in the OR, iodine is **bacteriostatic** (it decreases the bacterial count) after applying it wait 3-5 minutes it will decrease the bacterial count but still there are some remaining bacteria !, so after that apply alcohol which is **bactericidal** (it destroys the leftover of bacteria).



Some chemical agents have antiseptic and disinfectant properties .

## ★ Universal Precautions:

Universal standard precautions on every patient

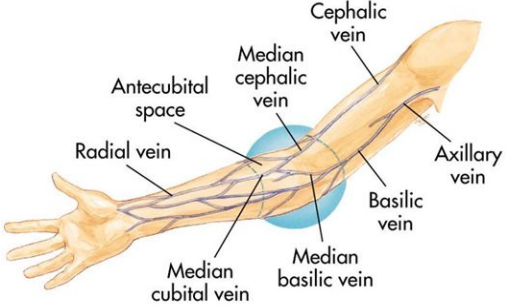
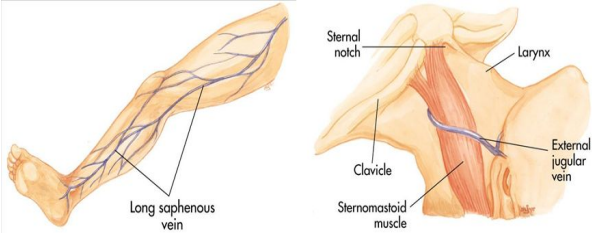
- Observe **hand washing** and gloving procedures. **In both clean and sterile procedures.**
- **Face shields** indicated during clean procedures. **Clean procedures like peripheral venous access.**
- **Sterile gowns** plus above all for sterile procedures. **Sterile procedures like CVP or epidural insertion.**



Types of IV Catheters :	Needles:
<ul style="list-style-type: none"> <li>● Hollow needles : Butterfly type. <b>Nowadays it's rarely used</b></li> <li>● Indwelling plastic catheter over hollow needle (<b>most commonly used</b>)               <ul style="list-style-type: none"> <li>- Intracath.</li> </ul> </li> </ul> 	<p>Vary in length and gauge <b>Larger gauge means a smaller needle.</b></p>  <p><b>18 gauge, 20 gauge, 22 gauge, 24 gauge</b>          18 and 20 for adults          22 and 24 for infants/pediatric</p>

# Peripheral IV:

## ★ Peripheral IV Insertion :

Common sites:	Alternate sites:
<p>1) <b>Hands and arms</b> 2) <b>Antecubital fossa (AC space)</b></p>  <p>Cephalic or antecubital vein is having a <u>fixed anatomy</u> (in case of difficult situations or obese pts) you can easily get access to it.</p>	<p>1) Long saphenous veins, <u>medial to the medial malleolus</u></p> <p>2) External jugular veins <u>Embolism and infection rates higher.</u></p> 

### → Avoid sites that have injury or disease:

- Trauma, - Dialysis fistula,
- History of mastectomy (for example pt has done right sided mastectomy that involve removal of the lymph nodes. So in case of infection due to the iv line it won't be treated easily, so it's better to avoid inserting the IV cannula in the right hand "it's not an absolute contraindications but better to avoid".

## ★ Peripheral IV Procedure :

1. Explain procedure
2. Assemble equipment
3. **Inspect fluid** for contamination, appearance, and expiration date
4. **Prepare infusion set** : Attach infusion set to bag of solution
5. **Clamp tubing** and squeeze reservoir on infusion set until it fills half way
6. **Open clamp** and **flush air from tubing**
7. **Close clamp**
8. **Maintain aseptic technique**
9. **Select catheter:**
  - **Large-bore catheter** used for fluid replacement : **14 to 16 gauge** .
  - **Smaller bore catheter** used for "keep open" lines : **18 to 20 gauge**
10. **Prepare other equipment**
11. **Put on gloves** to protect yourself from any pricking and getting infection. Double gloves decrease the dose of the injected product to 1/4.



12. **Select site**

13. **Apply tourniquet** above

antecubital space

14. Prepare site

15. **Cleanse area with alcohol or iodine wipes** (per protocol)

- Check for iodine allergy.

16. Stabilize vein.

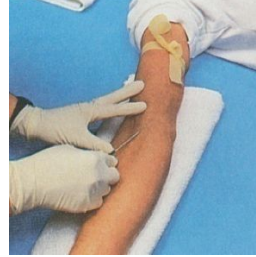
17. **Apply pressure** and tension to point of entry .

18. Bevel of the needle up in **adults**, May be down in **infants and children** .

19. **Pass needle through skin into vein from side or directly on top.**

20. **Advance needle** and catheter about **2 mm** past point where blood return is seen in hub of needle.

21. Slide catheter over needle and into vein .



22. **Withdraw needle** while stabilizing catheter.

23. Lock in protective sheath if present.

24. Apply pressure on proximal end of catheter to stop escaping blood.

25. Obtain blood samples if needed.

26. Release tourniquet

27. Attach IV tubing .

28. Open in at prescribed flow rate .

29. **Cover puncture site dressing:** Antibiotic ointment if indicated (by protocol).

30. Anchor tubing .

31. Secure catheter .

32. **Document procedure.**

(important step, document about which side did you insert the catheter and in which arm, vital signs, any complications like redness itching...etc)



33. **Monitor flow.**

→ **Local Complications :**

- Pain and irritation .
- **Infiltration and extravasation.**
- Phlebitis. **Late complication**
- Thrombosis and thrombophlebitis. **Late complication**
- **Hematoma formation.**
- Venous spasm , Vessel collapse, Cellulitis .
- Nerve, tendon, ligament, and limb damage.

➤ **Infiltration :**

● **Signs and symptoms :**

- Cool skin around IV site, - Swelling at IV site: with or without pain .
- Sluggish or absent flow,
- **Infusion flows when pressure is applied to vein above tip of cannula.**
- **No backflow of blood into IV tubing when clamp is fully opened and solution container is lowered below IV site**

- **Causes :**
  - Dislodgement of catheter or needle cannula during venipuncture .
  - Puncture of vein wall during venipuncture.
  - Leakage of solution into surrounding tissue from insertion site.

Extravasation (leakage of the solution into the surrounding tissue), is a very fatal and serious complication causing swelling and may lead to compression of the vessels “it’s like compartment syndrome” pt may lose his/her arm, and sometimes they may require fasciotomy.



- Poorly secured IV.
- Poor vein or site selection.
- Irritating solution inflames vein’s intima. (irritating solutions: are highly concentrated solutions like bicarbonate, potassium)
- Improper cannula size.
- High delivery rate or pressure.

- **Management :**
  - Lower fluid reservoir to check for presence of backflow of blood into the tubing.
    - Absence of backflow suggests infiltration.
  - Discontinue IV infusion.
  - Remove needle or catheter,
  - Apply a pressure dressing to the site.
  - Choose new site
  - Initiate IV therapy with new equipment,
  - **Document.**

## Central Venous Access :

- Requires special training ,
- Authorization from medical direction .
- **Not for rapid fluid replacement in prehospital setting. not for trauma cases (as trauma cases require rapid iv infusions)**
- Within scope of paramedic practice in some EMS systems.
- Prepare as for peripheral veins.
- **Sterile procedure.**

### ★ **Common Sites include:**

- **Femoral vein.** To get access to IVC
- **Internal jugular vein.** to get access to SVC
- **Subclavian vein.**

### ★ **Success depends on :**

- Patient's body position
- Knowledge of anatomy
- Familiarity with the procedure

### ★ **Indications :**

- Available when peripheral vessels collapse.
- Access to central pressure measurements > In-hospital procedure.
- Safer vasopressor administration.
- If you can't access peripheral veins like in obese pts or long term use of chemotherapy.
- Insertion of pacemaker.

## ★ Disadvantages:

- Excessive time for placement, - Sterile technique, - Special equipment,
- Skill deterioration
- High complication rate : **Pneumothorax, arterial injury, abnormal placement,**
- Chest x-ray should be obtained immediately
- Can't initiate during other patient care activities
- **Not generally considered to be a useful prehospital technique,**
- Lower flow rates than peripheral IV

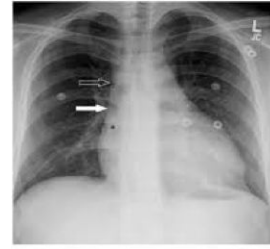


Fig. 5 - Frontal chest radiograph demonstrating the right lateral wall of the superior vena cava (open arrow) and the junction of the lower SVC with the superior vena cava (closed arrow). The right cardiac border (SVC-RAA junction) is also indicated by a closed arrow. The cavoatrial junction (\*) lies approximately 1.2 cm below the SVC-RAA junction in adults.

## ★ Complications:

### ↳ Systemic:

- Contamination and infection. **Long term complication**
- Hypersensitivity reactions.
- Sepsis
- Speed shock. **Administering drug through central circulation may cause rapid or exaggerated response of the drug unlike the peripheral vein which takes more time to do its action.**
- **Emboli** (blood clot, air, and catheter).

↳ **Femoral vein:** Local complications, Systemic complications

↳ **Internal jugular and subclavian veins:** Local complications, Systemic complications

**Complication of inserting left internal jugular vein catheter is Chylothorax MCQ**

### → Air Embolism:

- Uncommon but can be fatal,
- **Air enters bloodstream through catheter tubing**
- Risk **greatest** with catheter in central circulation > **Negative pressure may pull air in.**
- **Air can enter circulation:** **1.** During catheter insertion, **2.** If tubing is disconnected
- **If enough air enters the heart chamber:**
  - 1. Blood flow is impeded:** air will end up as bubbles > entering the pulmonary artery causing either partial or complete occlusion > the heart is unable to pump blood
  - 2. Shock develops**

### ● Signs and symptoms :

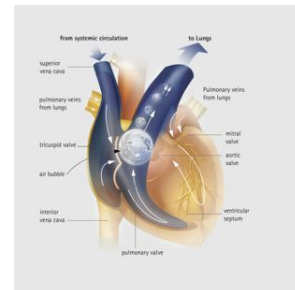
- Hypotension , - Cyanosis , - Weak and rapid pulse ,
- Loss of consciousness
  - **Sudden** arrhythmias
  - **Sudden** drop in saturation
  - **Sudden** drop in etCO<sub>2</sub>

### ● Management:

- Close the tubing
- **Turn patient on left side with head down**

It will shift the bubbles from pulmonary artery to the apex of the heart so the blood will start flowing.

- Check tubing for leaks
- Administer 100% Oxygen.
- **Notify medical direction**

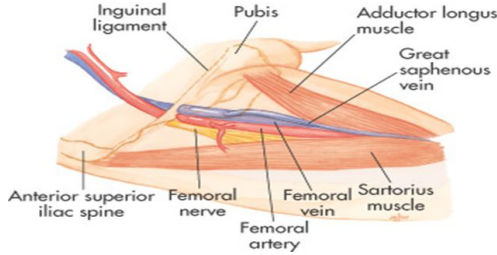


# Types of Central Venous Access :

## A. Femoral Vein:

- Anatomy :**

The femoral vein is a blood vessel that accompanies the femoral artery in the femoral sheath. It begins at the adductor canal (also known as Hunter's canal) and is a continuation of the popliteal vein .

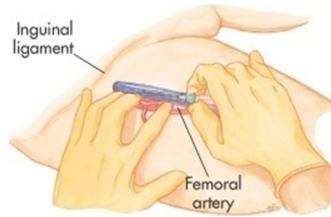


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Femoral vein is medial , femoral nerve is lateral.

Feel the pulse and go medial to it that's the femoral vein, lateral to the pulse is the femoral nerve.

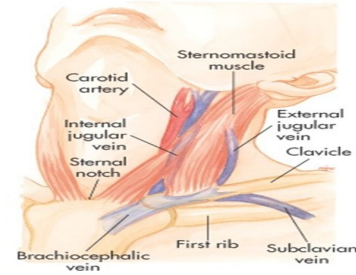
- Cannulation :**



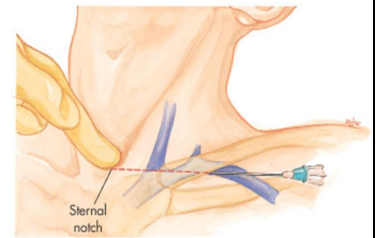
## B. Subclavian Vein:

- Anatomy:**

Each subclavian vein is a continuation of the axillary vein and runs from the outer border of the first rib to the medial border of anterior scalene muscle. From here it joins with the internal jugular vein to form the brachiocephalic vein



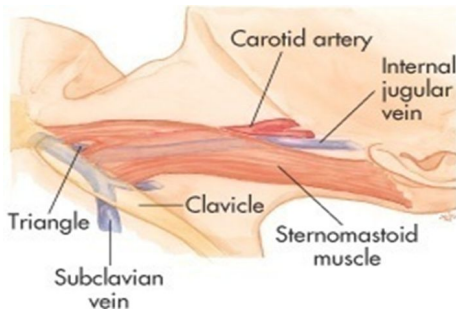
- Cannulation :**



## C. Internal Jugular Vein:

- Anatomy:**

It descends in the carotid sheath with the internal carotid artery. **usually between the heads of the sternocleidomastoid muscle.**



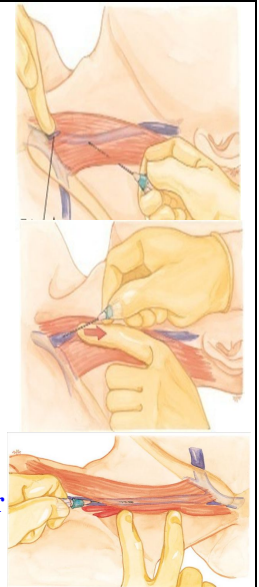
- Cannulation:**

- **Posterior approach**
- **Central approach**

There are chances of pneumothorax and air embolism which are fatal complications

- **Anterior approach**

its higher approach there are chances of carotid puncture or extravasation or if you go deep may lead to vertebral artery puncture.



After inserting central line Do chest X-ray:

- 1- To rule out pneumothorax
- 2- To check the tip of the catheter (the tip should be in the **lower margin of the 2nd rib** or **the upper margin of the 3rd rib**)

if the catheter goes down it will be in the right atrium causing arrhythmias "SA nodes is in the right atrium"



## Venous Access insertion:

- Ultrasound guided IV insertion
- Ultrasound guided CVC insertion



## Indwelling Vascular Devices:

- Heparin or saline lock ,
- Single-, dual-, and triple-lumen catheters.



## Arterial Line:

Indications:	Contraindications for arterial line placement	
<ul style="list-style-type: none"> <li>● Continuous arterial BP monitoring:               <ul style="list-style-type: none"> <li>- more accurate than NIBP</li> </ul> </li> <li>● Inability to use indirect BP monitoring (eg, in patients with severe burns or morbid obesity &gt; you may not find the appropriate cuff size)</li> <li>● Frequent blood sampling</li> <li>● Frequent arterial blood gas sampling mainly in ICU.</li> </ul> <p>★ mainly in major vascular surgeries (operating in the aorta, cardiac surgeries) or neurosurgery.</p>	Absolute:	Relative:
	<ul style="list-style-type: none"> <li>- Absent pulse</li> <li>- Thromboangiitis obliterans (Buerger disease) .</li> <li>- Full-thickness burns over the cannulation site</li> <li>- Inadequate circulation to the extremity</li> <li>- Raynaud syndrome</li> </ul> <p>Any <b>vasculopathy</b> is considered as an absolute contraindication.</p>	<ul style="list-style-type: none"> <li>● Anticoagulation</li> <li>● Atherosclerosis</li> <li>● Coagulopathy</li> <li>● Inadequate collateral flow</li> <li>● Infection at the cannulation site .</li> <li>● Partial-thickness burn at the cannulation site</li> <li>● Previous surgery in the area.</li> <li>● Synthetic vascular graft.</li> </ul>

## Complications:

### → Common:

- **Temporary radial artery occlusion (19.7%)**
- **Hematoma/bleeding (14.4%).**

### → Less common:

- Localized catheter site infection (0.72%): The risk increases with the length of time the catheter is in place
- Hemorrhage (0.53%)
- Sepsis (0.13%)
- Permanent ischemic damage (0.09%)
- Pseudoaneurysm formation (0.09%)

Most common site is the radial artery in the upper limb and femoral artery in the lower limb.



## Equipment :

- Sterile gloves • Sterile gauze
- Sterile towels
- Chlorhexidine or povidone-iodine skin preparation solution
- 1% Lidocaine needle
- 5-mL syringe
- Appropriate-sized cannula for artery
- Scalpel (No. 11 blade)
- Nonabsorbable suture (3-0 to 4-0)

- Sterile nonabsorbable dressing
- Three-way stopcock
- Pressure transducer kit
- Pressure tubing
- Arm board of appropriate size for the patient (eg, neonate, pediatric, adult)
- Needle holder
- Intravenous (IV) tubing T-connector



## Arterial Line Placement :



### ➤ Patient Preparation :



- **Unconscious patient:** anesthesia/ sedation is not required.
- **Conscious patient:** provided 1% lidocaine
- **Uncooperative patient:** sedation or general anesthesia may be required.

### ➤ Positioning :

- **The patient is placed in the supine position.**
- The arm is placed up on a flat surface in neutral position, with the palm up and the wrist adequately exposed.
- The wrist is dorsiflexed to 30-45° and supported in this position with a towel or gauze under its dorsal aspect



Radial artery Anatomic consideration	Femoral artery
<p><b>Anatomic consideration :</b></p> <ul style="list-style-type: none"> <li>- <b>Originates in the cubital fossa from the brachial artery.</b></li> <li>- <b>At the wrist, the radial artery sits proximal and medial to the radial styloid process and just lateral to the flexor carpi radialis tendon. MCQ</b></li> </ul> 	<p><b>Anatomic consideration :</b></p> <ul style="list-style-type: none"> <li>- Originates at the inguinal ligament from the external iliac artery</li> <li>- <b>Medial to the femoral nerve and lateral to the femoral vein</b> and lymphatics</li> </ul> 

Catheter over needle:	Catheter over wire : Used for central venous access and arterial line access
 <p><b>The most commonly used methods</b></p>	<p>including direct Seldinger and modified Seldinger techniques</p>  <p><b>Radial cannulation :</b> <b>Seldinger: Advancement of catheter over guidewire</b></p> <p>4 steps:</p> <ol style="list-style-type: none"> <li>1- get access to the artery with the needle</li> <li>2- Put the wire into the needle</li> <li>3- Remove the needle</li> <li>4- once the needle is removed put the catheter over the wire</li> </ol> <p>Sometimes we need an extra step: dilators before inserting a thick catheter</p>

➤ **Allen test :**


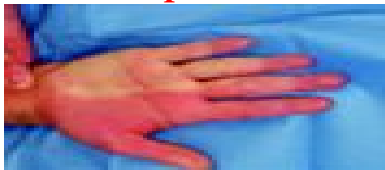
- The Allen test is a worldwide used test to determine **whether the patency of the radial or ulnar artery is normal.**
- It is performed prior to radial cannulation or catheterisation.
- The test is used to reduce the risk of ischemia to the hand.

➤ **Method:**

1. Instruct the patient to clench his or her fist OR hand tightly.
2. **Using your fingers, apply occlusive pressure to both the ulnar and radial arteries, to obstruct blood flow to the hand.**
3. While applying occlusive pressure to both arteries, have the patient relax his or her hand, and check whether the palm and fingers have blanched. If this is not the case, you have not completely occluded the arteries with your fingers



Results: Allen test- Release the occlusive pressure on the ulnar artery

Positive modified Allen test :	Negative modified Allen test
<p><b>hand flushes within 5-15 seconds</b> it indicates that the ulnar artery has good blood flow; this normal flushing of the hand is considered to be a positive test.</p> 	<p><b>If the hand does not flush within 5-15 seconds,</b> it indicates that ulnar circulation is inadequate or nonexistent; in this situation, the radial artery supplying arterial blood to <b>that hand should not be punctured.</b></p> 



Q1: What is the anatomic position of femoral vein?

- A) Medial to femoral nerve
- B) Lateral to femoral artery
- C) Medial to femoral artery
- D) Lateral to femoral nerve

Q2: While inserting central venous catheter. What will be the correct position of the tip of catheter on X-ray chest?

- A) Right atrium
- B) Lower border of 1st rib
- C) Upper border of 3rd rib
- D) Below the clavicle

Q3: Which of the following is an indication for central line insertion?

- A) Monitor O<sub>2</sub> saturation
- B) Parenteral nutrition
- C) Induction of anesthesia
- D) Monitor EtCO<sub>2</sub>

Q4: Which of the following is the expected complication when inserting left internal jugular vein catheter?

- A) Pneumothorax
- B) Vagus nerve injury
- C) Chylothorax
- D) Phrenic nerve injury

Answers:

- 1) C    2) C    3)    4) C