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Central Venous Catheter Insertion: Internal Jugular

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Overview

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Central venous access is necessary in a multitude of clinical situations, including vascular access, vasopressor and caustic medication delivery, central venous pressure monitoring, intravascular device delivery (pacing wires, Swann-Ganz catheters), volume resuscitation, total parental nutrition, hemodialysis, and frequent phlebotomy.

Safe reliable placement of a central venous catheter (CVC) in the internal jugular (IJ) vein using ultrasound guidance has become the standard of care. It is therefore imperative to understand the anatomy, the relationship between the IJ and the carotid artery, and their appearance on ultrasound. It is also necessary to have the psychomotor skills of vessel cannulation under ultrasound guidance.

Seldinger technique is an introduction of a device into the body over a guide wire, which is inserted through a thin-walled needle. In the case of CVC insertion, the device is an intravascular catheter and the target vessel is a central vein. First, the target vessel is cannulated with an 18 gauge thin-walled needle. A guide wire is then passed through the needle until it is appropriately positioned within the vessel. The needle is removed, and a dilator is passed over the wire to dilate the skin and soft tissue to the level of the vessel. The dilator is then removed, and the catheter is passed over the wire until it is appropriately positioned within the vessel. Lastly, the guide wire is removed.

Successful placement of a CVC using ultrasound consists of a working understanding of the target anatomy, facility with procedural ultrasound, and fluidity in Seldinger technique. An IJ CVC can be placed in either the right or the left IJ vein. In general, however, the right IJ vein is preferred because of its straight route to the superior vena cava (SVC), which makes malposition of the catheter less likely.

There are several types of CVC kits commonly available marketed by different manufacturers. CVCs may have a single lumen, a double lumen, or a triple lumen. For purposes of this discussion, we will place a triple-lumen CVC, as this is commonly needed when multiple different medications need to be delivered simultaneously. The procedure for placing any type of CVC is the same.

Procedure

1. Collect the supplies, including CVC kit, sterile gown, sterile gloves, sterile ultrasound probe cover, bonnet, mask, saline flushes, and any special dressings or antibiotic barriers required at your institution. Commonly marketed CVC kits generally contain the CVC (in this case a triple-lumen catheter), a j-tip guide wire, a dilator, a #11 scalpel, an introducer needle, 1% lidocaine, several 3 and 5 mL syringes, several smaller needles (usually 20, 22, and 23 gauge), single straight-suture needle with suture, CVC clamp, dressing, gauze, drape, and chlorhexidine. The contents of the kit are enclosed in a sterile tray wrapped with a sterile cover.

2. Positioning

1. Have the patient lie supine with the feet elevated (Trendelenburg position). This allows for maximal engorgement of the target vessel (usually the right IJ vein) and helps to prevent an introduction of an air embolus.
2. Have the patient's head rotated away from the target vessel.
3. Stand at the head of the patient's bed, facing the patient's feet.

3. Identification of the vascular structures of the neck using the ultrasound

1. The IJ runs through a triangle, the base of which is formed by the clavicle, and sides formed by the two heads of the sternocleidomastoid muscle. The carotid artery lies medial and deep to the IJ vein.
2. Apply acoustic gel on the linear transducer probe
3. With the indicator on the transducer oriented to the left, visualize the vascular structures in the neck.
4. To obtain transverse view, position the ultrasound probe parallel to the patient's clavicle. This orientation gives the operator a cross-sectional view of the deep neck vessels. On ultrasound, the appearance of fluid is dark (hypoechoic).
5. Apply slight pressure with the transducer in order to distinguish between the compressible IJ vein and pulsatile carotid artery.

4. Preparation

1. Clean skin with chlorhexidine solution, scrubbing vigorously for 60 seconds and allowing it to dry for 30 seconds.
2. Open the CVC kit
 1. Open the flaps of the sterile wrapping by grabbing the non-sterile side of the wrap and opening outward. In this manner the contents of the kit and the exposed surface (inside surface) of the wrapping will remain sterile.
 2. Carefully drop the sterile ultrasound probe cover and saline onto the open sterile kit.
 3. Open the sterile ultrasound probe cover packaging so that the sterile contents drop cleanly onto the sterile field you have just created.

4. When adding sterile saline to the sterile kit, remember that most of the packaging that the sterile saline comes in will not be sterile. Therefore, just the saline should be added to the kit (the tray of the CVC kit has several plastic molded wells in which sterile saline may be squirted).
3. Don mask, bonnet, sterile gown, and gloves
4. Drape the patient with the sterile drape
5. With the help of a non-sterile helper, cover the ultrasound probe with sterile cover.
 1. Hold the cover open for the assistant, who has already placed more acoustic gel on the probe. The sterile probe cover is essentially a bag. It is imperative that the outside surface of this cover remains sterile (the side that will be in contact with the sterile field and the patient), while the inside of the cover (not sterile) is where the ultrasound probe is placed. This is why the acoustic gel placed directly on the ultrasound probe does not need to be sterile. The operator holds the probe cover by the outside (the side that will remain sterile), while the assistant then gently drops the non-sterile probe into the opening of the cover.
 2. Hold the probe firmly within the sterile sheath while the assistant pulls the distal end of the cover, unfurling the length of the sheath over the cord. The typical sterile sheath will cover 4 feet of cord.
6. Prepare the kit: draw up lidocaine into a syringe, prepare the guide wire by retracting it slightly within the sheath (so that the J curve is straight and can easily feed into the needle), and remove the cap from the middle lumen (distal port) of the catheter.
7. Separate the contents of the kit for easy accessibility.

5. Seldinger procedure

1. Using ultrasound, again identify the target vessel and verify with external anatomy.
2. Inject lidocaine into skin at the insertion site, creating a wheal, and continue to anesthetize the soft tissues. Withdraw each time before injecting so that you can be certain you are not injecting into a vessel.
3. Insert the introducer needle
 1. Insert the introducer needle attached to an empty syringe at a 45° angle to the skin, and a 2 cm cephalad to the position of the ultrasound probe while gently retracting the plunger.
 2. Aim toward the ipsilateral nipple.
4. Fan the ultrasound probe in order to follow the tip of the needle towards the target vessel, redirecting as needed. It is easiest to follow the tip of the needle when the ultrasound probe is perpendicular to the needle itself, not perpendicular to the skin.
5. Observe the needle tip as it enters the vessel.
6. Confirm the needle location by drawing blood into the syringe. You should be able to draw blood freely when the needle is within the IJ vein.
7. Put down the ultrasound probe, and gently remove the syringe from the introducer needle without changing the depth at which the needle is positioned. The needle may be attached by Luer-lock (depending on kit used).
 1. Verify that the blood return from the needle is dark and non-pulsatile.
 2. To reduce needle migration be certain to brace the hand that holds the needle against the body of the patient.
 3. Reduce the angle of the needle to 30°, this will allow the needle to more easily stay in the vessel and will facilitate passage of the guide wire.
8. Feed the guide wire into the needle to a depth of 20 cm (noted by tick marks on the wire itself). A single black line indicates 10cm, two black lines indicate 20cm.
 1. If resistance is met, first be certain that the needle angle is not too steep (~30°). If still not passing easily, remove the wire and reattach the syringe to see if blood can still be drawn freely. If not, the needle is no longer in the vessel.
 2. If blood can be drawn freely but there is still difficulty advancing the guide wire, then verify its location within the vessel lumen by using the ultrasound in the longitudinal view (sagittal plane).
 3. You may be able to overcome difficulty in passing the wire by retracting the wire a few centimeters and rotating it 90°. This reorients the J tip and may allow for free passage. Never force the guide wire.
9. Make a nick with the scalpel in the skin around the wire insertion, and remove the needle from the guide wire.
10. Feed the dilator over the guide wire and gently dilate the skin and soft tissues with a gentle rotating motion.
11. Make sure the dilator is only inserted to a depth of 2-3cm.
12. Remove the dilator.
13. Feed the catheter over the guide wire. For a right IJ the depth of the catheter will be approximately 15 cm in most adults (20 cm for the left IJ). After catheter insertion, remove the guide wire.
14. With sterile saline in a syringe, attach it to the distal port of the CVC. Draw back to verify blood return, then flush the lumen. If the CVC has more than one lumen, repeat this step for the other lumens. Place the appropriate caps on the Luer-lock ports of each lumen.
15. Use a two-part clamp to hold the catheter in place. Place the soft rubber part over the catheter at the point at which the catheter enters the skin; then place the hard piece over it, securing the clamp in the chosen position.
16. Anesthetize the skin, and sew the clamp into place through the eyelets of the clamp.
17. Place a sterile dressing in accordance with your medical facility's practice with regard to reducing catheter-related bloodstream infections.

6. Post-procedure

1. Dispose of all sharps
2. Obtain a chest X-ray to determine proper placement and depth, as well as to rule out pneumothorax.

Summary

Central venous access is a frequently performed procedure in patients with critical illness. It is an invasive procedure and requires an informed consent that clearly discusses the procedure, the potential risks, the potential benefits, and alternatives.

The use of ultrasound has increased the frequency with which CVCs are placed in the IJ vein. This is because the safety profile has markedly increased with ultrasound visualization, while the infection rate is less than that associated with femoral placement and close to that of subclavian. Additionally, an accidental arterial puncture is readily compressible at this site, unlike the subclavian vein.

Similar to other sites for CVC access, IJ CVCs carry the risk of local and systemic infection, arterial puncture and bleeding, and thrombosis. There exists a risk of pneumothorax and tracheal puncture for IJ insertion as well. These risks are minimized with full barrier sterile precautions and ultrasound guidance.