Cannulation of the right internal jugular vein for central venous pressure—A review

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The authors review in a step-by-step illustrated manner a technique involved for placing a catheter to monitor central venous pressure in the internal jugular vein; they elaborate on both the advantages and disadvantages of the technique.

Central venous pressure (CVP) monitoring is a useful tool in the anesthetic management of the seriously ill patient for both emergency and elective procedures. A working knowledge of anatomy, various techniques, and the proper indication for CVP must be foremost in the anesthetist’s mind. There are a number of techniques used in the placement of the CVP catheter. The purpose of this article is to review these areas, with emphasis on placement in the internal jugular vein (IJV), elaborating on technique, advantages and disadvantages.

The indications for the insertion and monitoring of the central venous pressure (CVP) are as follows: (1) patients undergoing surgery in which a major volume shift may occur (such as in the Whipple procedure); (2) operations where the potential for hypovolemia exists (such as in a bowel resection); (3) patients in shock (such as in trauma); (4) operations performed with the patient in the sitting position with risk of air embolization; and (5) some selected patients with congestive heart failure. A Swan-Ganz catheter rather than a CVP catheter probably would be placed for assessment of left heart filling pressures in patients with severe left ventricular dysfunction.

Alternatives to the internal jugular vein for placement of the CVP catheter

Many techniques have been described for placing a catheter in the superior vena cava or right atrium. Frequently used routes include the femoral, basilic, cephalic, external jugular, subclavian and internal jugular veins.

These first four techniques have had a low incidence of successful central venous cannulation. The distance between the antecubital veins and the superior vena cava is the chief disadvantage in the use of the basilic and cephalic routes. In addition, these veins are relatively small and tolerate indwelling catheters for only short periods of time. The veins leading to the inferior vena cava have been virtually abandoned as sites for indwelling catheters because of the dangers associated with phlebitis and mechanical obstruction during abdominal surgery.

The external jugular vein is usually visible or easily palpable in the neck when the patient is supine. Central venous cannulation by this route is difficult, however, since the external jugular vein contains numerous valves and makes an acute angle where it joins the subclavian vein. The subclavian vein has the advantage of its large size and relatively high flow, rendering it suitable.
for indwelling catheters. However, numerous complications including pneumothorax, hemothorax, hematoma, mediastinal infiltration, subcutaneous emphysema and air embolism, brachial plexus injury, septicemia, and cellulitis have been reported.

In 1966, Hermosura and co-workers described a method of placing a polyethylene catheter in the internal jugular vein. In 1969, English and colleagues described two methods of internal jugular vein percutaneous cannulation, with no serious complications in 200 insertions. Anatomic location has been shown to be advantageous because of its straight course to the right atrium, easy accessibility (even in obese patients), and its definite external anatomic landmarks.

Use of the right internal jugular vein for CVP

The right internal jugular vein is preferred over the left internal jugular vein because: (1) the risk of laceration of thoracic duct is greater on the left than the right; (2) the carotid artery is consistently deep and medial to the IJV on the right; and (3) the right leads straight to the superior vena cava. Kaplan and Miller have described the technique we currently employ. We shall describe Kaplan's technique in a step by step illustrated manner.

Anatomical review

The internal jugular vein is located under the medial border of the clavicular head of the sternocleidomastoid muscle. The vein ending is behind the medial

![Figure 1: Line drawing showing the relationship of the right internal jugular vein to the carotid artery and sternocleidomastoid muscle. With the patient's head turned toward the left, the vein passes under the apex of a triangle forward by the sternum and clavicular heads of the SCM and lateral to the common carotid artery.](image)
end of the clavicle. The thoracic duct on
the left and the right lymphatic duct
enter the internal jugular and subclavian
veins at their confluence posteriorly.

The right side is preferred because
the internal jugular, innominate, and
superior vena cava are almost in a
straight line. The carotid artery is con-
sistently deep and medial to the internal
jugular vein and is deep under the ster-
nal head medial to the sternocleidoma-
stoid muscle and the clavicle. The triangle
formed by the two heads of this muscle
and the clavicle encompass the internal
jugular vein. (Figure 1.)

**Technique of cannulation**

*Step 1.* Place the patient in a 15°
Trendelenberg position with the neck ex-
tended and turned sharply to the left.
This distends the vein during cannula-
tion. The anatomy is demonstrated more
easily in the awake patient. The proce-
dure is no more uncomfortable than
starting a peripheral IV. If the patient
is to be anesthetized first, mark out the
anatomy and triangle when he is awake.
(Figure 2.)

*Step 2.* Using a surgical skin mark-
er, mark out the lateral border of the
sternal head and the medial border of
the clavicular head of the sternocleido-

described in a caudal direction
at a 30° angle to the skin, angled toward
the right nipple. Constant suction is
maintained on the syringe as the needle
is advanced toward the vein.

If the vein is difficult to find, a Val-
salva maneuver by the patient may mark-
edly distend the internal jugular and
ease identification (Figure 2). Aspira-
tion of dark venous blood signals entry
into the internal jugular vein. After lo-
cating the vein, infiltrate with Xylo-
caine® as the needle is withdrawn.

*Step 4.* The patient's skin located un-
der your left hand should not be per-
mitted to move, or the relationship of
the underlying anatomy will change. A
14-gauge, 8-inch Intracath is then in-

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**Figure 2.**
Steps 1 & 2: Anesthetist's eyview of the sternal (1) and clavicular (2) heads of the SCM
with “X” marking the location for IJV puncture.
serted at the same 30° angle toward the right nipple and the same depth into the vein. (Figure 4.) Two needle "pops" may be noted; these emanate from (1) the carotid sheath, and (2) the internal jugular vein, identified by a free return of dark venous blood through the catheter.

The full length of the catheter should thread easily into the superior vena cava. If threading is difficult, twist the catheter clockwise as it is inserted. This action will prevent the catheter from hitting the vein wall. To avoid laceration of the catheter, it should never be withdrawn through the needle.

Figure 3.
Step 3: Right internal jugular vein is identified with a #22-gauge needle.

Figure 4.
Step 4: IJV punctured with a #14-gauge thin wall needle and catheter advanced into the vein. Note the dark venous backflow into catheter.
If venipuncture is unsuccessful, both the needle and catheter should be withdrawn together.

**Step 5.** Once the catheter is placed, the needle is removed and the IV tubing is connected. (Figure 5.) Having the patient hold his breath while you attach the catheter to the IV will avoid air embolism. The plastic guard is attached at its proper place to avoid bending or disconnection of the catheter at bevel point.

Once established, a good check for proper insertion of the catheter is to place the IV bottle below the head of the patient to insure free flow of blood through the catheter. If free flow is not present, take the IV down and slowly withdraw the catheter until flow is obtained, assuring that the catheter is not curled and/or lodged against the vein wall. Another valuable check is to examine the postoperative chest x-ray for confirmation of catheter location. The skin is treated with tincture of benzoin, a sterile dressing is applied, and the catheter is taped along the anterior border of the ear with the IV tubing taped across the mid-forehead. (Figure 6.)

A flush solution for the CVP should contain 1-unit of heparin per ml of fluid and may be either normal saline, Ringer's lactate solution or Normosol R®. Cardiogreen or methylene blue can be added to the manometer to make it easier to read. Some anesthetists prefer to place a black silk suture through the skin and around the catheter in the similar fashion used by surgeons to secure drains.

**Catheter tip placement**

Vaughan and Weygandt described electrocardiogram changes that occurred during the placement of CVP catheters. They stressed the importance of EKG monitoring to detect arrhythmias as the catheter tip enters the right auricle or ventricle. Following insertion of the catheter, the P-wave is observed as the catheter is withdrawn into its proper place.

Placement should be just above the superior cavo-atrial junction in the superior vena cava. Changes in the QRS complex, ST segment, and T-wave sometimes occur but are less dramatic and more difficult to interpret than P-wave changes.
Baseline determination

The baseline zero point of the manometer is usually at the mid-atrial level. The external landmark is usually at the mid-axillary line. Remember, the Trendelenberg and Fowler’s positions, including respiration, will effect the levels in the manometer. Absolute pressure readings are not as important as the changes that occur.

Complications—Contraindications for IJV cannulation

The major contraindications to cannulation of the internal jugular vein are a recent history of anticoagulant medications and a history of prior neck surgery. The presence of an infectious process within the neck and the presence of tumors are further contraindications.

Several complications have occurred with the aforementioned technique for CVP insertion and monitoring. The most frequently encountered major complication is puncture of the carotid artery. Direct compression on the neck, however, readily controls bleeding and seems to prevent major sequelae. Air embolism, thrombophlebitis, septicemia, pleural puncture, catheter embolism, and pericardial tamponade secondary to heart puncture are other rare complications that have been reported in the literature; but, proper technique should avoid these.

Summary

There exists a wide margin of safety in the use of the right internal jugular vein as a route for CVP placement and monitoring. Here, we have described Kaplan’s acceptable technique which we have successfully employed for the past three years.

The central venous pressure alone does not assess blood volume, but rather reflects the relationship between blood volume, cardiac compensation (right ventricular capability) and venous tone.

Figure 6.
Demonstration of the proper positioning and taping for CVP.
The CVP is a function of four measurable and independent forces: (1) the volume of blood in the veins, (2) the distensibility and contractility of the right heart chambers, (3) venometer activity in the central veins, and (4) intrathoracic pressure. The CVP reflects principally the volume of blood returning to the heart and the ability of both the right and left ventricles to propel it. The normal central venous pressure is 6-16 cm of water or 5-12 mm of mercury.

Hypovolemia is characterized by a low CVP, low blood pressure, low cardiac output, and high peripheral resistance—all of which respond favorably to adequate and rapid volume replacement. In contrast, cardiac failure is characterized by low blood pressure with a high CVP and low cardiac output. Additional fluid load will not improve cardiac performance in this instance. However, cardiac stimulants, such as calcium, dopamine, and digitalis, will improve blood pressure and result in a return toward normal CVP.

As an index of right ventricular filling pressure, the CVP may be helpful to diagnose cardiac and volume-related changes responsible for alterations in cardiac output. It may also prevent volume overloading and subsequent pulmonary edema.

The usefulness of the central venous pressure has been clearly demonstrated as an adjunct to routine anesthetic management of our patients. We advocate using the CVP on those patients whose cardiac or fluid balance status require careful monitoring during anesthesia.

REFERENCES

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