CHEST Topics in Practice Management

Ultrasound-Guided Internal Jugular Access*

A Proposed Standardized Approach and Implications for Training and Practice

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In 2001, the Agency for Healthcare Research and Quality recommended the use of ultrasound for the placement of central venous catheters (CVCs) as one of their 11 practices to improve patient care. These recommendations were based on the results of several randomized clinical trials showing significantly improved overall success as well as reductions in complications. This article will describe the practical aspects of using ultrasound to guide placement of CVCs in the internal jugular vein in a "how I do it" approach, as well as review the practice management and training aspects related to incorporating ultrasound into daily practice.

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Abbreviations: CPT = current procedural terminology; CVC = central venous catheter; IJ = internal jugular

More than 5 million central venous catheters (CVC) are placed each year in the United States, with an associated complication rate of > 15%.[1,2] Mechanical complications such as arterial puncture and pneumothorax are seen in up to 21%, and up to 35% of insertion attempts are not successful.[3–5] The risk of complications depends on several factors, including (but not limited to) operator experience, urgency of placement, as well as patient factors such as obesity, prior difficult cannulation, and coagulopathy.[4,6,7] Although the above-mentioned studies were performed in the 1970s through the 1990s, there have been several more prospective/randomized trials,[8–16] as well as two metaanalyses[17,18] that suggest the use of ultrasound has been associated with a reduction in complication rate and an improved first-pass success when placing catheters in the internal jugular (IJ) vein. Although factors other than the use of ultrasound may be responsible for the improved outcomes, these data have led the Agency for Healthcare Research and Quality to recommend the use of ultrasound as one of their 11 practices to improve patient care in their landmark 2001 publication, "Making Health Care Safer: a Critical Analysis of Patient Safety Practices."[19,20] The National Institute of Clinical Excellence[21] in the United Kingdom has also fully supported the use of ultrasound guidance for CVC placement.

Unfortunately, the incorporation of these recommendations into clinical practice has been met with resistance. A survey of 250 anesthetists in the United Kingdom found that 41% disagreed or strongly disagreed with the recommendation that ultrasound imaging should be the preferred method for insertion of a CVC into the IJ vein.[22] Although 84% of respondents believed that those using ultrasound imaging should have appropriate training, 67% of respondents believed the level of training provided for ultrasound-guided CVC placement was inade-

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quate.[22] Likewise, a study[23] in the United States also found that < 15% of surgery, anesthesia, emergency medicine, internal medicine, and family medicine housestaff used ultrasound guidance for most CVC placements.

This article will discuss the practical aspects of performing ultrasound-guided CVC placement, and address recommendations for training in ultrasound-guided CVC placement. The reader is referred to the above-referenced studies for detailed discussions concerning the improvement in success and reduction in complications with the use of ultrasound for CVC placement. Additionally, as the data suggesting ultrasound guidance for other sites, including the subclavian, femoral, and axillary veins, are less robust, discussion will focus on the use of ultrasound for IJ CVCs.

Ultrasound-Guided IJ CVC Placement: How I Do It

Two types of ultrasound guidance are available: Doppler and B-mode (also referred to as *two-dimensional ultrasound*). Doppler ultrasound transforms the sound waves reflected from a moving object (RBC in this case) into an amplified audio signal. The respirophasic venous waveform is distinctly different from arterial pulsations, and Doppler ultrasound is frequently used to assess arterial patency in the lower extremities and aid in arterial catheters. The data behind Doppler ultrasound for vascular access, however, is associated with a longer learning curve than B-mode ultrasound, longer insertion times, and higher costs.[24–26]As such, IJ CVC catheter placement is performed with B-mode ultrasound; from here on, the generic reference to ultrasound will imply B-mode.

B-mode ultrasound converts the reflected sound waves into a real-time gray scale image. Fluid (*ie*, blood) is hypoechoic and appears dark on the screen, while tissue is more isoechoic and appears gray. The IJ vein is typically seen anterior and lateral to the artery; however, significant anatomic variation exists where the vein can overly the artery and even be medial to the artery.[27,28] The IJ vein and artery can be distinguished by the fact that the vein is compressible, nonpulsatile, and distensible by the Trendelenberg position or the Valsalva maneuver. The use of ultrasound is an excellent teaching tool to demonstrate the following: (1) excessive pressure during carotid palpation decreases IJ vein diameter (one cannot move the artery medially away from the vein as they lie in the same sheath); (2) extreme contralateral head rotation can decrease IJ vein diameter and increase overlap on the carotid artery; and (3) the Trendelenberg position and correct head positioning can significantly increase IJ vein diameter.[29–32]

I recommend that one perform an ultrasound assessment of the anticipated side prior to creating a sterile field in order to assess the degree of overlap of the carotid artery by the IJ vein, the compressibility of the vein, and the presence of internal echoes that may signify clot. If there is significant overlap of the carotid artery, the operator should try to reexamine the neck with the head in the neutral position, instead of with the head turned to the contralateral side.[31,32] If the vein is not compressible or a clot is visualized, the other IJ vein should be examined. Color power Doppler can also be used to visualize the distinct arterial and venous pulsations, although there have not been any studies ascribing specific benefit to its use.

Once the appropriate vein is selected, the site is sterilized and draped as per standard technique with full barrier precautions[33] and the ultrasound probe is placed in a sterile sheath. This step generally requires an assistant to hold the probe vertically and apply conducting gel to the uncovered probe. The sterile operator can also drop sterile conducting gel on the probe. The operator then inserts a hand into the sheath, holds the probe, and then inverts the sheath over the probe, making the probe and cable sterile. Additional gel is then placed on the outside of the sheath to ensure adequate coupling.

The two most commonly used methods for ultrasound guidance are the "one-handed" or the "three-handed" methods. In the one-handed method, the operator controls the ultrasound probe with the nondominant hand and the needle with the dominant hand. The three-handed method requires an assistant (with full sterile barrier precautions) to hold the probe while the operator controls the needle and performs the procedure under real-time guidance. The one-handed method is quite easy to learn, improves first-pass success and overall success when compared with the three-handed method,[34] and is the method we currently teach to our fellows. Using the ultrasound to mark the skin and proceed without real-time guidance is not recommended given the significant increase in success rates for dynamic guidance as compared with the "X marks the spot" technique.[34]

Regardless of the method used, the IJ vein and carotid artery are identified with ultrasound and centered on the screen. The lidocaine needle is then inserted through the skin directly anterior to the vessel (in the center of the probe), and the wheal of subcutaneous lidocaine is visualized with the ultrasound as an enlarging hypoechoic area. It is often helpful to "jiggle" the lidocaine needle to improve visualization of the hyperechoic needle. As the pro-