

Ultrasound in Emergency Medicine

THE OBLIQUE VIEW: AN ALTERNATIVE APPROACH FOR ULTRASOUND-GUIDED CENTRAL LINE PLACEMENT

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Abstract—Background: Numerous studies have shown significant benefits of using real-time ultrasonography for central line intravenous access. Traditionally, the ultrasound probe is placed along the short axis of the vein to visualize and direct needle placement. This view has some limitations, particularly being able to visualize the needle tip. Some practitioners place the ultrasound probe in the long axis of the vessel to direct needle placement, allowing better visualization of the needle entering the vein, but this does not allow visualization of relevant anatomic structures. **Objectives:** We describe an alternative means to obtain ultrasound-guided vascular access using an oblique axis rather than the traditional short-axis approach. **Discussion:** This view allows better visualization of the needle shaft and tip but also offers the safety of being able to visualize all relevant anatomically significant structures at the same time and in the same plane. This orientation is halfway between the short and long axis of the vessel, allowing visualization of the needle as it enters the vessel. This capitalizes on the strengths of the long axis while optimizing short-axis visualization of important structures during intravenous line placement. **Conclusion:** Ultrasound-guided vascular access can be obtained in a variety of ways. We describe a technique that is used by some experienced ultrasound users but that has never been fully described in the literature. This technique for obtaining ultrasound-guided vascular access offers another option for attempting ultrasound-guided vascular access that has the potential to improve success rates and minimize complications associated with intravenous access. © 2009 Elsevier Inc.

Keywords—ultrasound-guided vascular access; emergency medicine; axis; oblique; central line

INTRODUCTION

Obtaining vascular access is a vital component of patient care. When peripheral intravenous access is unable to be obtained, an intravenous catheter may be blindly placed percutaneously into the internal jugular vein using surface landmarks for guidance. Unfortunately, the performance of a landmark-guided procedure can be associated with significant complications, particularly in the obese, hypotensive, or anticoagulated patient, and in those with traumatic or congenital abnormalities.

Ultrasound-assisted vascular access can provide a safer and more efficient means of obtaining both peripheral and central venous access, reducing morbidity and the time required to place the catheter (1–4). Meta-analyses have reported that ultrasound guidance significantly increases the probability of successful cannulation while reducing both the number of attempts and the complication rate (5,6). The Agency for Healthcare Quality Research has recommended that ultrasound guidance be used for central line placement due to an improved margin of patient safety (7). Likewise, some authors suggest using ultrasound-guided vascular access in all central line attempts, and recommend that it should become the standard of practice for central line placement (8,9).

Several techniques for the performance of internal jugular vein central line placement have been described. These include the central, anterior, and posterior approaches (10). All are performed blindly, guided only by anatomic landmark of the sternocleidomastoid muscle where it overlies the internal jugular vein in the neck, and do not consider anatomic variation or abnormality.

Our purpose was to describe the use of an oblique view for direct visualization of the vein and artery during placement of ultrasound-guided venous catheter.

DISCUSSION

ULTRASOUND PROBE ORIENTATION

When using ultrasound to directly visualize placement of a venous catheter, there are two traditional ultrasonic views: short (transverse) and long (longitudinal) (11). The terminology “short” and “long” refer to the probe axis along the structures visualized on the ultrasound screen. Each view has its strengths and weaknesses. The short axis view allows a broad image of the lateral surrounding tissue and structures (especially the carotid artery during internal jugular line placement), making co-localization of the needle to vessel (artery vs. vein) much easier. However, it is difficult to keep the needle tip within the plane of the ultrasound beam, and frequent adjustments (fanning) of the probe are needed to maintain needle visibility.

Therefore, the practitioner, using careful coordination of needle, ultrasound probe, and hands, must advance both needle and probe in a continuous fashion to maintain visualization of the vein and needle tip within the beam of the ultrasound. In contrast, the long axis view shows orientation of the needle along its long axis and the long axis of the vessel, allowing direct visualization of the needle through the tissue and into the vein. However, this technique requires additional skill to maintain the needle directly in the midline axis for visualization and to keep all the necessary structures, especially the needle, within the very narrow width of the ultrasound beam. It is difficult to discern if the needle is overlying the artery or vein using the long axis technique alone and nearby structures cannot be visualized. Moreover, the long axis technique is anatomically limited to locations where the needle insertion angle is sufficiently shallow to accomplish this goal. Additionally, the long axis technique may be limited by anatomic considerations such as room on the neck with the probe in vertical orientation. Thus, the long axis view is used much less frequently to place central lines.

During central line placement with ultrasound guidance, direct visualization of key vascular structures is necessary to prevent arterial puncture, and most experienced ultrasonographers will use the short axis for cen-

tral vein cannulation (11). This preference may be due to a bias in training or the inability to visualize both the artery and vein with the more technically challenging long axis-guided procedure.

OBLIQUE VIEW

The oblique approach for ultrasound probe orientation may provide easier needle visualization during ultrasound-guided vascular access. Because the needle tip acts as a reflector dispersing the ultrasound beam, poor visualization of the tip in the short axis is one of the most common difficulties encountered during ultrasound-guided vascular access. Axis and approach angle affect needle visualization. When the needle is visualized in the short axis, only a small part acts as a reflector and it appears as only an echogenic dot. In contrast, positioned in the long axis, the whole needle acts as a reflector and it appears as a bright line. Angle of insertion determines appearance, where a steep angle provides a smaller reflector. A shallow angle of approach allows the best visualization, where there is more surface area for the ultrasound beam to reflect back to the probe. In this article, we describe the use of an oblique view for direct visualization of the vein and artery while visualizing the needle in the long axis during placement of ultrasound-guided venous access.

The oblique view is obtained by initially locating the vessel in the short axis, followed by rotation of the probe to almost midway between the short axis and long axis views. With this technique, both vessels are still visualized on the screen but in a slightly elongated view. The main advantage of this approach is that the needle will enter along the long axis of the probe, thus providing a long axis view of the needle as it enters the vessel, while providing the short axis advantage of simultaneously localizing both the internal jugular and carotid artery. This view both capitalizes on the strengths and minimizes the weaknesses of the short and long axis approaches to yield an optimized venous cannulation approach. Although we describe the oblique view using the internal jugular vein as a reference vessel, this technique can be applied to any vessel that allows an oblique approach.

INTERNAL JUGULAR VEIN ULTRASOUND-GUIDED ACCESS, POSTERIOR APPROACH USING OBLIQUE VIEW

The technique is as follows. Place and drape the patient in the usual sterile fashion using the head-down position to optimize distention of the vein. Locate a triangular region on the base of the neck, with the clavicle forming the inferior/base and the edges of the sternal and clavic-

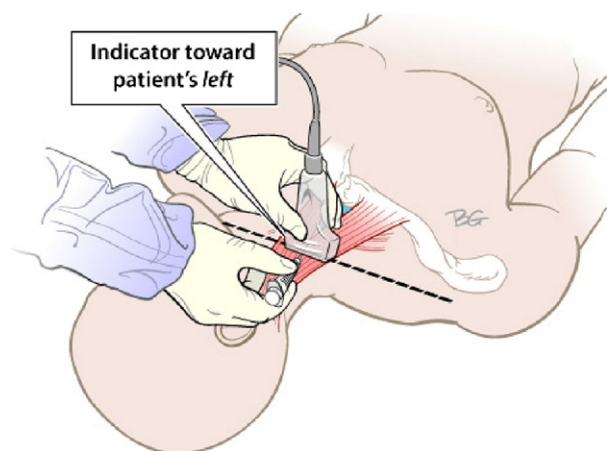


Figure 1. Proper placement of linear ultrasound probe for short axis (transverse) orientation over the right neck vessels. The ultrasound probe indicator is on the patient's left side.

ular heads of the sternocleidomastoid muscle (SCM) forming the sides of the triangle. Place sterile conductive medium, such as sterile lubricating gel available in commercial ultrasound cover kits, in the triangle, just cephalad to the clavicle. Cover the high-frequency linear probe and place it on the patient's neck between the two heads of the SCM oriented in the short axis of the vessels (transverse plane) (Figure 1), similar to the short axis or central approach. The ultrasound probe indicator is facing the patient's left side, regardless of whether one is attempting the right or left internal jugular central vein access, to preserve proper orientation of the ultrasound image. On the image, identify the vascular structures; the internal jugular vein is more superficial, usually larger, thin-walled, and easily compressible, compared to the deeper, thicker, and smaller carotid artery. To assure correct probe position, gently indent the skin along one side of the probe, watching the ultrasound screen for deformation of the image. Depression of the skin beneath the left side of the probe should yield deformity of the ultrasound image on the left side of the screen.

For right-sided internal jugular vein cannulation, rotate the ultrasound probe approximately 45° so that the medial end of the ultrasound probe (and the marker on the probe) aligns with the patient's contralateral nipple or shoulder (Figure 2). The probe should remain perpendicular to the surface of the skin. This position, the oblique view, now shows the same vascular structures but they are now seen as ovals (more elongated circles than when in the short axis) with black, hypoechoic centers (Figures 3, 4).

The SCM should be visualized overlying the vessels. For the anatomic landmark technique, the most lateral aspect of the SCM is the location of needle entry for the posterior approach. The needle should traverse the skin,

going beneath (or attempting to) or posterior to the SCM (hence the "posterior" anatomic or landmark approach). For the ultrasound-guided oblique approach, place the needle at the end of the long axis or lateral edge (the opposite end of where the marker is located for right-sided internal jugular vein cannulation) of the probe in approximately the same location used for the posterior anatomic approach. The key to the oblique view is to maximize the amount of skin the footprint (length) of the probe is in contact with and allow a generous amount of room for the needle to traverse the screen. This will require positioning the ultrasound probe so that the vessels are as far laterally on the screen as possible, and having as much contact with the patient's skin as reasonable before needle entry. Anesthetize the overlying subcutaneous skin at the most lateral aspect of the probe (very close to the posterior aspect of the SCM muscle) with lidocaine (Figure 2). Observe the changes to the subcutaneous tissue over the vessels.

Using the introducer needle and a syringe, puncture the patient's skin immediately beneath the cephalad/lateral edge (end) of the linear ultrasound probe, at the site of lidocaine injection (Figure 2). The closer the puncture site is to the probe, the easier it will be to visualize the needle just as it enters the skin and subcutaneous tissues. When the puncture is well-centered beneath the probe, the white/hyperechoic needle is visualized in a long axis format as a bright line. Advance the needle, keeping it centered beneath the ultrasound probe, allowing direct, continual visualization of the needle as it approaches the vein. Adjust the needle depth and angle of insertion according to the location of the needle tip during this process. This may require removing the needle and reinserting it if the angle is too

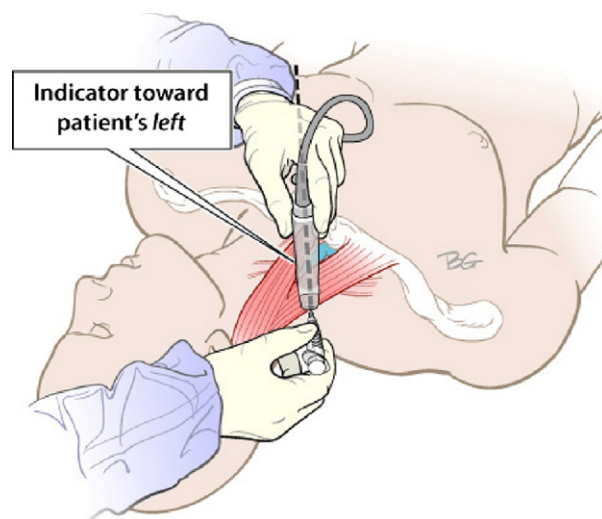


Figure 2. Proper placement of linear ultrasound probe for oblique orientation over right neck vessels. The ultrasound probe indicator is pointed toward the patient's left.

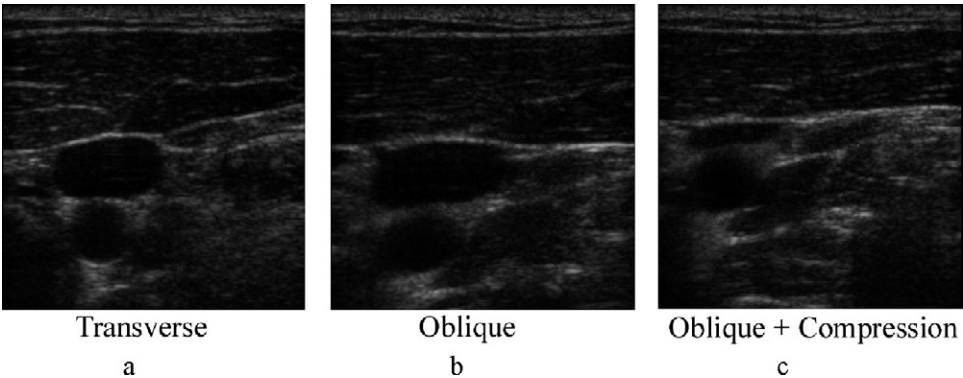


Figure 3. Ultrasound image of the right neck vessels shown transitioning from short axis orientation (a) to oblique orientation (b), causing vessels to appear more oval. There is anatomy distortion of vessels in oblique orientation when downward pressure is applied with the ultrasound probe (c).

steep. When the needle touches this anterior wall of the vessel, the vessel is momentarily indented (Figure 5). A final, small thrust allows the needle tip to enter the vein under continuous visualization and prevent puncturing of the posterior wall. Once the needle enters the vein, the wall returns to its previous distended position. Remove the ultrasound probe and place the central line according to standard Seldinger technique.

One of the most common visualization techniques when using ultrasound for vascular access is the standard short axis view: the vein, artery, and needle are visualized in their short axis. Figure 6 shows a single vessel vascular phantom with different approaches. For the short axis, the tip of the needle is visualized only as a small echoic dot when it crosses the narrow ultrasound beam (Figure 6a). As a result, the physician placing the needle estimates its location by watching for changes in the soft tissue or vessel during insertion. This technique is limited by its inability to visu-

alize and follow the needle. Although the long axis seems to be a better approach due to improved visualization of the needle itself (much more of the needle is available to act as a reflector), absence of landmarks to verify vessel identity (vein or artery) make the long technique less than optimal (Figure 6b).

CONCLUSIONS

The oblique view is a potentially superior technique because it optimizes the capabilities of dynamic ultrasound-guided vascular access. The oblique view uses the superiority of the short axis view by visualizing all of the important surrounding structures (artery and vein) in an oblong view while allowing continuous real-time visualization of the long axis of the needle, therefore providing a larger, more easily visible target with a brighter,



Figure 4. Ultrasound image of right neck vessels shown in oblique orientation. Notice the slight oval shape of the internal jugular vein.



Figure 5. Ultrasound image of the right internal jugular vein shown in oblique orientation with the needle in long axis, and needle tip indenting the internal jugular vein just before puncture.

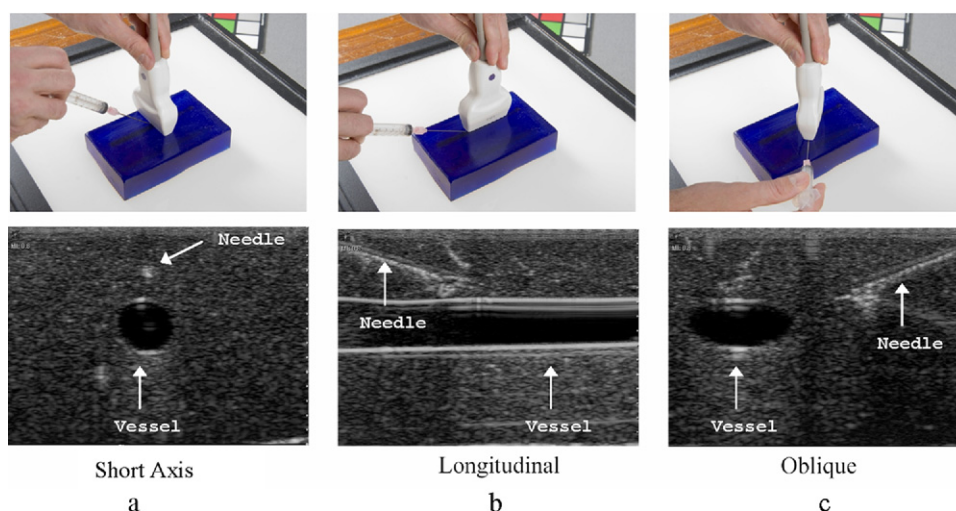


Figure 6. Photographs of ultrasound probe position with needle placement over a single-vessel phantom with corresponding ultrasound images. (a) Short axis orientation, needle in short axis is poorly visualized; (b) long axis orientation, cannot determine if vessel is artery or vein, but needle and vessel are viewed in the long axis; (c) oblique orientation vessel viewed in oblique orientation and needle visualized in long axis, allows excellent needle visualization and preserves vascular alignment.

more easily recognized needle (Figure 6c). This may be beneficial, especially for novice ultrasound users, as there is a steep learning curve to ultrasound-guided procedures. As a result, central venous cannulation success rates may be improved while decreasing complications and damage to adjacent structures. Further studies are needed to evaluate the efficacy of this variation of ultrasound-guided vascular access.

In practice, we continue to utilize this oblique approach during ultrasound-guided internal jugular central-line placement with excellent success. Our combined numbers at present are limited (about 25–30) and no significant complications have been reported. We teach this technique to residents and interested staff, who have reported it to be an easier method with superior needle visualization. Although not a replacement for current approaches to ultrasound-guided vascular access, the oblique view should give the physician an additional approach when needed. Moreover, this approach can be applied to any vessel (including the femoral vein); the technique was easiest to describe with the internal jugular vein. Evaluation of this technique compared to other ultrasound-guided approaches has yet to be conducted.

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ARTICLE SUMMARY

1. Why is this topic important?

Because emergency medicine physicians are increasingly using ultrasound to obtain vascular access; there are techniques that may improve visualization of the needle tip itself.

2. What does this study attempt to show?

The traditional way of teaching ultrasound-guided vascular access in the short access has some shortcomings, especially the ability to visualize the needle tip. We describe an alternative means of trying ultrasound-guided vascular access using an oblique axis, which is about halfway between the long and short axis.

3. What are the key findings?

This technique of using the oblique axis of the vessel, but long axis of the needle offers the advantage of the long axis visualization of the needle tip but continues to keep relevant anatomic structure within the view.

4. How is patient care impacted?

By being able to visualize the needle tip itself this could potentially increase comfort level of ultrasound users and possibly increase success rates and decrease complication rates.