

VIDEOS IN CLINICAL MEDICINE
SUMMARY POINTS

Ultrasound-Guided Insertion of a Radial Arterial Catheter

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The following text summarizes information provided in the video.

OVERVIEW

Insertion of a radial arterial catheter is a common procedure in critical care units. Ultrasonography may be used to ensure safe and successful insertion of an arterial catheter. The video demonstrates the use of ultrasound guidance for radial arterial catheterization in adults with the over-the-needle approach in the transverse and longitudinal planes.

INDICATIONS

Arterial catheterization allows for the continuous recording of arterial pressure measurements and can be used to adjust the doses of vasoactive drugs that are administered for hemodynamic support in critically ill patients. Arterial catheterization also provides easy and convenient access to arterial blood when sampling of arterial blood gases and other laboratory tests need to be performed.

The radial artery is the preferred site for catheterization. Because the radial artery is easily accessible, catheterization is associated with a low rate of complications.¹ The insertion of the catheter by means of a blind palpation technique, without ultrasound guidance, sometimes requires multiple attempts and thus contributes to patient discomfort and predisposes the patient to bleeding and arterial spasm. Successful arterial catheterization can be challenging in patients who are obese and in patients with edema, hypotension, or vascular anomalies, such as tortuous vessels.² Ultrasound guidance can be more effective than palpation for the insertion of a radial arterial catheter in such patients.

There is increasing recognition that the risks associated with performing blind bedside procedures are substantial.³ Point-of-care ultrasonography, defined as ultrasonography brought to the patient and performed by the provider in real time, can enhance diagnostic and procedural accuracy.⁴ Point-of-care ultrasonography can also decrease patient anxiety and discomfort and can reduce procedure-related complications.⁴⁻⁶

In general, the use of ultrasound guidance for the insertion of a radial arterial catheter takes less time than the palpation method and has a higher success rate. In addition, successful insertion is achieved after fewer attempts,⁷⁻⁹ which means that there are fewer sites of attempted insertion and less patient discomfort.

CONTRAINDICATIONS

There are no contraindications to the use of ultrasound guidance. However, radial arterial catheterization is contraindicated in patients with infection of the skin or soft tissue at the insertion site, severe peripheral vascular disease, impaired collateral circulation, or severe coagulopathy.¹⁰

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EQUIPMENT AND PREPARATION

After obtaining the patient's consent to perform the procedure, gather the necessary equipment. You will need two pairs of sterile gloves, a mask, a sterile gown, a skin-preparation solution such as chlorhexidine, sterile drapes, 1% lidocaine without epinephrine, a 5-cc syringe and a 25-gauge needle for delivery of the local anesthetic, and angiocatheters. Radial arterial catheterization can be performed with standard angiocatheters or with safety angiocatheters. Use the equipment that complies with the safety practices at your institution. You will need materials for dressing and securing the catheter, sterile gauze, and a sterile ultrasound probe cover with sterile gel. You will also need a pressure bag, a pressure transducer, and a monitor that is appropriate for arterial catheter transduction. In order to assess the vasculature, you will need a linear-array transducer ultrasound probe with a frequency range of 5 to 13 MHz.

Wash your hands before touching the patient, and put on the mask. Position the patient's wrist such that the forearm is flat. Put on a pair of sterile gloves, and use antiseptic solution to wash the skin of the patient's forearm from the wrist to the antecubital fossa. Discard the gloves, wash your hands again, and put on the gown and a new pair of sterile gloves. Drape the patient, exposing only the cleaned forearm from the wrist to the antecubital fossa.

STERILE TECHNIQUE WITH ULTRASONOGRAPHY

Have an assistant clean the ultrasound transducer with an antiseptic wipe. Apply sterile gel to the inside of the sterile sheath and cover the ultrasound probe without contaminating the sterile gloves or the sheath. Remove any air pockets from around the probe, which, if present, will cause poor-quality ultrasound images.

CHOOSING AN INSERTION SITE

Vascular assessment is typically performed with a linear array transducer operating at frequencies between 5 and 13 MHz. Make sure that the left side of the ultrasound probe corresponds to the left side of the screen. Starting at the patient's wrist, scan the lateral aspect of the forearm in the transverse orientation and identify the radial artery and the associated veins, which will be located between the styloid portion of the radius and the flexor carpi radialis tendon. If necessary, apply light pressure to help differentiate the artery from the veins; veins will collapse, whereas the artery will not (Fig. 1).

Once the radial artery has been identified, have the assistant adjust the gain to optimize the contrast between the black vessels and the surrounding structures. Next, adjust the depth so that the artery appears in the center of the ultrasound screen and is clearly visible. As you scan the artery from the wrist to the antecubital fossa, look for arterial tortuosity and calcification. Locate a section of the artery with a large diameter and minimal calcification.

To prevent the development of kinks in the catheter after it has been inserted, choose a site that is proximal to the wrist and distal to the elbow. Kinking can occur when the patient moves or is repositioned.

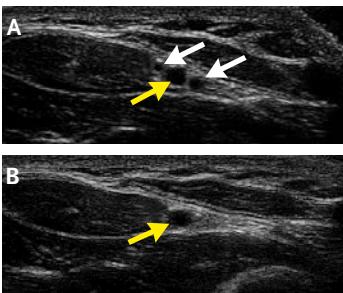


Figure 1. The Use of Compression to Differentiate Artery from Vein.

The radial artery (Panel A, yellow arrow) is shown in the transverse orientation along with associated veins (white arrows). The application of light pressure with the ultrasound probe results in the collapse of the veins but not the artery, which can still be visualized (Panel B, arrow).

CATHETER INSERTION IN THE TRANSVERSE ORIENTATION

After locating an appropriate site for catheterization, slide the probe so that the artery is centered on the screen. After anesthetizing the skin, insert the angiocatheter-covered needle at the middle of the probe at an angle of 45 to 60 degrees. Slide or tilt the probe toward the needle tip until you can visualize the tip on the monitor. Make small bouncing movements with the needle to locate the tip.

As you advance the needle toward the artery, tilt the probe in the direction of the needle's trajectory to ensure that you can see the needle tip at all times. Reposition the tip periodically to confirm that it is directly above the artery.

Insert the needle tip into the arterial lumen and examine the angiocatheter for flashback (Fig. 2), or blood return, in order to confirm its position. Flatten the angle of the angiocatheter, and then reexamine the area on the ultrasound monitor to make sure that the needle tip is still in the artery.

Slide the catheter over the needle into the arterial lumen. Apply pressure proximal to the catheter, remove the needle, and attach the catheter to the transducer.

CATHETER INSERTION IN THE LONGITUDINAL ORIENTATION

The catheter can also be inserted in the longitudinal orientation (Fig. 3). Begin the procedure with the ultrasound probe in the transverse orientation to locate the artery. Center the artery on the ultrasound screen and then rotate the probe 90 degrees. You should see the artery in the center of the screen, with a view along its long axis, at its maximum diameter.

Insert the angiocatheter at an angle of 15 to 30 degrees at the exact midline of the long axis of the probe. Advance the needle parallel to the long axis of the probe.

If you do not see the needle, it is probably medial or lateral to the vessel. Pull back on the needle without withdrawing it completely or letting it leave the skin, and readjust the angle so that you can see the needle tip on the ultrasound screen. Then advance the needle again, until it is within the lumen of the vessel, and look for flashback in the angiocatheter.

Slide the catheter over the needle and into the arterial lumen. Apply pressure proximal to the catheter, remove the needle, and attach the catheter to the transducer.

COMPLICATIONS

The main challenges when performing ultrasound-guided catheterization are visualization of the needle tip and differentiation of the needle tip from the needle shaft, since each will appear as a white dot on the screen (Fig. 4). Novice operators sometimes believe that they are visualizing the needle tip on the monitor when they are actually viewing the needle shaft. In such instances, the unseen needle tip has been inserted more deeply than the operator assumes and can cause injury to deeper structures. For this reason, continuous visualization of the needle tip is crucial during angiocatheter insertion.

Another challenge during arterial catheterization is arterial spasm, which may prevent the operator from advancing the catheter into the arterial lumen. If arterial spasm occurs, use ultrasound guidance to find a more proximal site for insertion or consider arterial catheterization of the radial artery in the other arm.

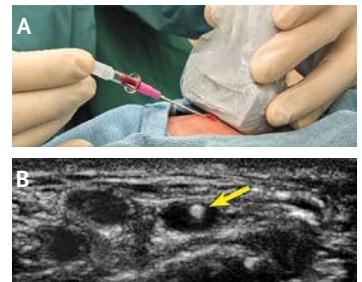


Figure 2. Ultrasound-Guided Catheterization in the Transverse Orientation.

The ultrasound probe is in the transverse orientation (Panel A) as the needle tip is inserted into the radial artery and visualized (Panel B, arrow).



Figure 3. Ultrasound-Guided Catheterization in the Longitudinal Orientation.

The ultrasound probe is in the longitudinal orientation (Panel A) as the needle tip is inserted into the radial artery and visualized (Panel B, arrow).

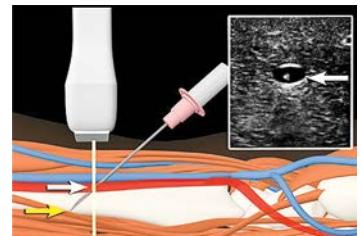


Figure 4. Identification of the Needle Tip and the Needle Shaft.

A white dot on the ultrasound screen represents either the needle tip or the needle shaft. In the illustration and the ultrasound image, the angiocatheter has traversed the radial artery and has been inserted more deeply than the operator assumes. The needle shaft (white arrows) rather than the needle tip (yellow arrow) is visualized on the ultrasound screen.

REFERENCES

1. Scheer B, Perel A, Pfeiffer UJ. Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine. *Crit Care* 2002;6:199-204.
2. Hofmann LJ, Reha JL, Hetz SP. Ultrasound-guided arterial line catheterization in the critically ill: technique and review. *J Vasc Access* 2010;11:106-11.
3. Kohn KT, Corrigan JM, Donaldson MS. *To err is human: building a safer health system*. Washington, DC: National Academy Press, 1999.
4. Moore CL, Copel JA. Point-of-care ultrasonography. *N Engl J Med* 2011;364:749-57.
5. McGee DC, Gould MK. Preventing complications of central venous catheterization. *N Engl J Med* 2003;348:1123-33.
6. Feller-Kopman D. Ultrasound-guided thoracentesis. *Chest* 2006;129:1709-14.
7. Shiver S, Blaivas M, Lyon M. A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters. *Acad Emerg Med* 2006;13:1275-9.
8. Levin PD, Sheinin O, Gozal Y. Use of ultrasound guidance in the insertion of radial artery catheters. *Crit Care Med* 2003;31:481-4.
9. Shiloh AL, Savel RH, Paulin LM, Eisen LA. Ultrasound-guided catheterization of the radial artery: a systematic review and meta-analysis of randomized controlled trials. *Chest* 2011;139:524-9.
10. Tegtmeyer K, Brady G, Lai S, Hodo R, Braner D. Videos in clinical medicine: placement of an arterial line. *N Engl J Med* 2006;354(15):e13.

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SUMMARY

It is easy to learn how to use ultrasound guidance when performing radial arterial catheterization in either the transverse or the longitudinal orientation. Clinicians who regularly insert arterial catheters should master this technique because it can increase the success rate and reduce the number of attempts required for successful catheterization as compared with the palpation technique.

No potential conflict of interest relevant to this article was reported.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.