

Ultrasound-Guided Radial Artery Access

A step-by-step guide to using US in the cath lab.

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The radial revolution is here. Radial artery access is rapidly becoming the dominant access site in many cath labs throughout the world. However, achieving radial access can be one of the most difficult parts of the procedure.¹ A femoralist who is used to palpating a 7- to 10-mm-diameter femoral artery may initially have difficulty cannulating a 2- to 3-mm-diameter radial artery. The human fingertip has a two-point discrimination limit of approximately 2 mm.²⁻⁴ Directing a needle by palpation into the radial artery may occasionally exceed one's ability of two-point discrimination, thereby leading to cannulation failure and frustration. Ultrasound-guided radial artery access (UGRAA) is a technique that essentially overcomes difficult radial access, allowing for rapid radial artery cannulation, usually on the first attempt.⁵ As experienced interventionists with no ultrasound (US)-guided vascular access experience, we found UGRAA easy to learn and highly predictable. In this article, we describe a step-by-step approach to UGRAA.

BECOMING COMFORTABLE WITH THE US MACHINE

It is essential to know your US machine well. For many interventional cardiologists, handling and directing an US probe has not been part of our cath lab experience. We suggest that the cath lab staff and physicians meet with an industry representative or experienced sonographer to fully understand the controls and all modalities of their US machine.

Establish the best ergonomic position of the US console for your lab. Some labs place the console on the left side of the patient, directly across from the operator. This prevents the neck strain experienced when the



Figure 1. Auxiliary US screen to facilitate UGRAA.

console is placed on the right side of the patient near the head, whereby you have to turn your head sharply to the left to see the screen. We have an auxiliary screen on an extension arm attached to the US stand (Figure 1), which we position directly over the patient's shoulder. This allows us to perfectly see the screen with no eye strain. We then only have to shift our eyes from the patient's wrist to the screen to perform UGRAA.

PREPARING THE PATIENT

The setup of the patient's arm and wrist is the same as for a routine radial procedure. A pulse oximetry Allen's (or Barbeau) test should be performed to assess ulnar artery patency. Proper sedation of the patient is important. We also instruct the nurse give the patient a 0.4-mg sublingual nitroglycerin tablet 1 or 2 minutes



Figure 2. The centerline of the transducer is marked with indelible ink.

before radial artery cannulation, which may dilate the radial artery, making the target slightly larger.⁵ Furthermore, having nitrates on board before cannulation may prevent radial spasm.

PREPARING THE US TRANSDUCER

Proper preparation of the US probe plays a vital role in efficiently performing UGRAA. If the transducer does not have a well-inscribed centerline mark, make one by carefully marking the exact center point with indelible ink (Figure 2). By doing this, one can see the center of the transducer easily even after covering it with gel and a sterile cover. A clearly visible centerline mark aids in aligning the center of the transducer exactly over the center of the radial artery. The raised center mark on many transducers, which is the same color as the rest of the transducer, is not good enough. We definitely suggest marking it with indelible ink.

After ensuring visibility of the centerline, cover the transducer with a sterile cover. We use a sterile CIV-Flex Transducer cover kit (Civco Medical Solutions, Kalona, IA), which includes a sterile rubber band and sterile gel. Place only a small amount of gel

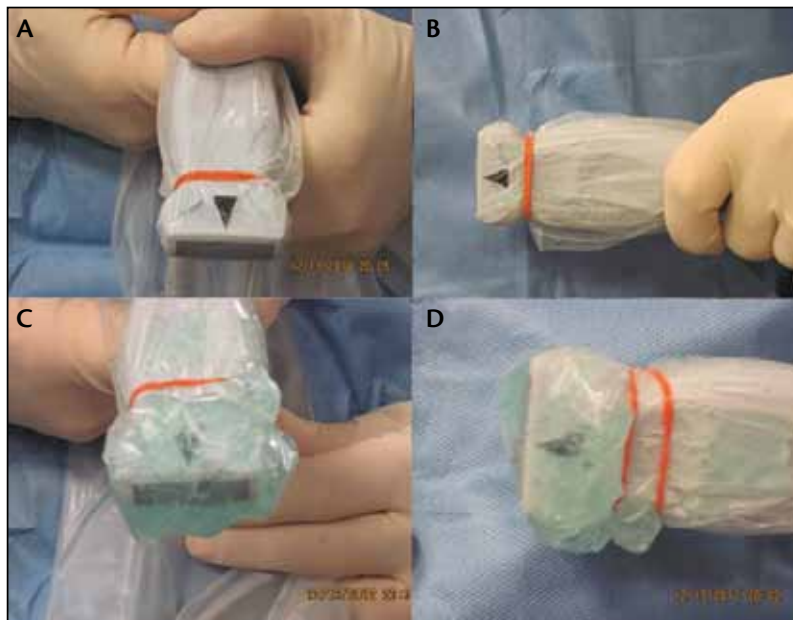


Figure 3. Correct probe preparation (A, B). Too much gel will obscure the center mark (C, D).

inside the sterile cover. Too much gel obscures the center mark of the transducer and may prevent proper needle advancement (Figure 3). Tightly wrap a sterile rubber band around the neck of the transducer, allowing only 1 to 2 mm of gel between the distal end of the transducer and the sterile covering sheath. Be certain that no air or seams of the sterile cover are over the tip of transducer, as they may obscure the image.

Loop the transducer cable and sterile cover in a 360° loop approximately 60 cm proximal to the transducer, and clip the loop to the patient drape at shoulder level or to an auxiliary screen, as shown in Figure 4. Doing so prevents the transducer cable from falling out of the field, causing unneeded tension on the transducer, which the operator must then fight against while trying to focus on holding the transducer still and achieving access.



Figure 4. Looping (red arrow) the transducer cable and securing it to the auxiliary screen will prevent the cable from falling out of the field.

POSITIONING AND ORIENTATION OF THE US TRANSDUCER

Apply a liberal amount of sterile US gel over the radial artery. Hold the transducer in your left hand and place it in the gel just proximal to the anticipated radial artery puncture site,

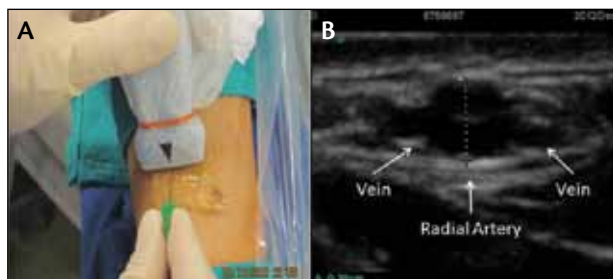


Figure 5. The probe is held perpendicular to the long axis of the radial artery to achieve a short axis view (A). Cross-section of a 3-mm radial artery and two veins on US, with the artery diameter measurement in the left lower corner (B).

approximately 2 to 3 cm proximal to the radial styloid. Firmly rest your left hand on the patient's wrist to keep the probe stable. Tilt the transducer slightly backward at an angle of approximately 75° to 80° to the horizontal. The probe should be perpendicular to the radial artery to achieve a transverse or short axis view (Figure 5). Be certain the probe is oriented such that structures to the left side of the radial artery appear on the left side of the US screen. The middle of the transducer is then centered exactly over the radial artery, positioning the radial artery exactly in the center of the US screen. Most US screens have a central mark that you can use to help center the artery on the screen.

ULTRASOUND SETTINGS AND MAKING MEASUREMENTS

Set the depth of field to provide the maximum magnification. The anterior wall of the typical radial artery is 3 mm under the skin, so a lot of depth is not necessary. We use a SonoSite M-Turbo portable US machine and a L25 X 13-6 MHz vascular transducer (SonoSite Inc., Bothell, WA). We use the least depth-of-field setting of 1.9 cm, which allows the maximum magnification of the depth settings. We then magnify the image by using the zoom mode, which further reduces the depth of field to 1 cm. This maximum magnification provides the best imaging for UGRAA.

With the radial artery imaged in the most magnified view, freeze the image on the screen, and measure the artery diameter (Figure 5B). Knowing the radial artery diameter has been very helpful. If the artery is < 2 mm in diameter, we use a 5-F sheath. If the diameter is ≥ 2 mm, we use a 6-F sheath. If the diameter is ≥ 2.4 mm, we know we can safely use a 7-F sheath for complex interventions, if needed. Knowing the diameter prevents inadvertently placing a sheath that is too large into a small radial artery and then having to deal with a sheath stuck in the artery. It also lessens the likeli-

hood of radial artery occlusion.⁶ If a radial artery is too small for the sheath size you need, slide the transducer over to the ulnar artery, and measure its diameter to see if the ulnar artery is larger than the radial artery. If a reverse pulse oximetry Allen's test (pulse oximeter on the 5th finger, compression of the ulnar artery) is adequate, use the ulnar artery for access.

ADMINISTERING LOCAL ANESTHESIA

We prefer to inject local anesthetic under US guidance, although this is optional. By infiltrating under US guidance, we can see the needle advancing into the soft tissue over the radial artery and can fine-tune the position of the transducer exactly over the center of the radial artery.

US-GUIDED RADIAL ARTERY ACCESS

There are two basic techniques of cannulating the radial artery, which we call the "stationary technique" and the "sliding technique."

The Stationary Technique

Inserting the percutaneous needle. With the US probe centered exactly over the radial artery, position the percutaneous entry needle 2 to 3 mm distal to the edge of the probe, keeping it exactly in line with the center marking. We use a 21-gauge, 2.5-cm Percutaneous Entry Thinwall needle (Cook Medical, Bloomington, IN). An IV Angiocath (Moore Medical, Farmington, CT) will work equally well. Insert the needle at an angle of approximately 45° to the wrist (Figure 6). Advance the needle while closely watching the US screen. Tissue movement secondary to deflection of soft tissue adjacent to the radial artery by the needle is often seen before the "bright white dot" of the needle tip is observed (Figure 7) above the radial artery.

The needle (bright white dot) should now be exactly over the center of the artery. If it is not (Figure 8), appropriately redirect the needle either medially or laterally while either advancing further or by withdrawing and then redirecting the needle. With experience, the operator will know which maneuver should be performed. Infrequently, the needle is not well visualized at all. With shallow up-and-down movements of the needle upon advancement, one can see tissue movement to properly direct the needle.

With the positioning of the transducer and needle, as previously described, the needle is usually seen on the US screen before it enters the artery, and one rarely visualizes the needle actually entering the artery (Figure 6). We find this method of "lining things up above the artery" to be the most successful technique for cannulating the

(Courtesy of Mr. James Young)

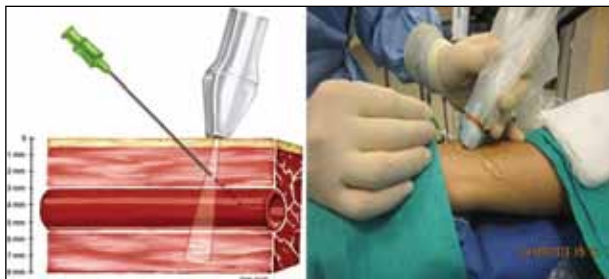


Figure 6. Note the position and angle of the probe. The needle tip is seen on US before it enters the artery.

artery on the first attempt (ie, making certain that the US transducer and needle are centered directly above the radial artery and then continuing to advance the needle while holding the transducer fixed). Frequently, a tactile pop can be felt when the needle pierces the anterior wall of the artery.

Brisk return of blood flow indicates that the needle is in the artery. Ideally, pulsatile blood flow return should be seen, but frequently is not with a micropuncture needle. If there is no return of blood on advancement of the needle, you may have inadvertently gone through the posterior radial artery wall (or purposefully if you are using the double-wall technique) or missed the artery altogether. Slowly withdraw the needle. If there is arterial flow on withdrawal, continue as subsequently described. If there is not, reposition the needle under careful UGRAA, usually without withdrawing it from the skin, and proceed as described in the previous two paragraphs.

Introducing the guidewire and sheath. When return of arterial flow is achieved through the needle, slowly move the transducer out of the way with your left hand. Now, exchange stabilization of the needle from your right hand to your left, with your left thumb and index finger holding the needle while resting your left hand on the patient's wrist; then advance a guidewire through the needle. We use the Cope Mandril 0.018-inch, 60-cm, stainless steel guidewire (Cook Medical). The percutaneous needle is then withdrawn over the wire, and a radial sheath is advanced over the guidewire.

The Sliding Technique

The sliding technique begins the same way as the stationary technique. Once the percutaneous needle tip is seen on the screen as a bright white dot in the soft tissue above the radial artery, slide the transducer backward toward the elbow following the needle tip as it is advanced. By following the needle tip under US as it is advanced, one can usually observe the anterior

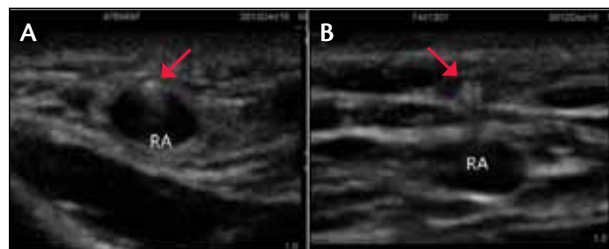


Figure 7. Bright white dot (red arrow, A) of the needle tip and longitudinal section of the needle (red arrow, B) observed above the radial artery on US.

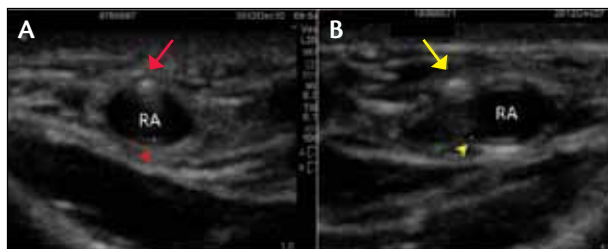


Figure 8. The importance of positioning the radial artery at the center of the US screen. The radial artery at the center marker (red arrowhead) of the US screen with the bright white dot of the needle tip (red arrow) positioned above the center of the radial artery (A). The radial artery not at the center marker (yellow arrowhead) of the US screen with the bright white dot of the needle tip (yellow arrow) positioned to one side of the radial artery (B). In both A and B images, the needle was in line with the center mark of the probe.

wall of the artery being compressed by the needle and then brisk return of blood as the needle enters the lumen of the radial artery. Occasionally, the needle will pass through both the anterior and posterior wall on advancement using the single anterior wall technique, which can often be seen and properly recognized. In the double-wall technique, the needle is purposefully passed through both walls, which is usually well visualized. Once the percutaneous needle or Angiocath is in the radial artery lumen upon withdrawal, the guidewire and sheath are inserted as previously described.

I prefer using a single anterior wall puncture and have achieved success rates of 80% on the first attempt, as well as first and second attempt cannulation rates of 92% using UGRAA.⁵ Both the stationary and sliding techniques of UGRAA work just as well with the single anterior wall technique or the double-wall puncture technique for all radials.

When we first began performing UGRAA, we used the sliding technique because of the ability to see the needle enter the artery. As more US experience and confidence was acquired, we abandoned the sliding technique because it is more complex and required

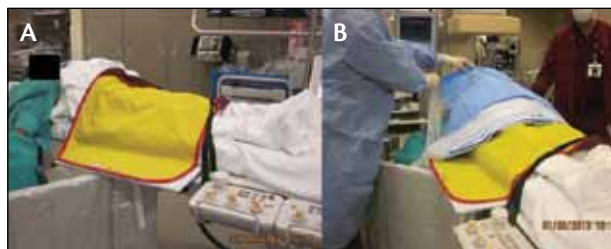


Figure 9. A lead apron placed over the patient's abdomen and pelvis (A) protects the operators from radiation. A sterile drape is placed over the lead apron (B).

moving both the right and left hands simultaneously. We now use the stationary technique and have found it to be easier and more efficient.

When we became “radial-first” operators several years ago, the cath lab staff would ask before every case if we “really wanted US” for the case. It added approximately 2 extra minutes of setup time. They don't ask anymore because UGRAA actually saves time, because the artery is almost always cannulated on the first attempt.

We no longer experience those infrequent but frustrating multiple attempt cases of radial cannulation as happened when using the palpation-guided method. Multiple attempts would occasionally cause radial artery spasm, and the vessel would become nonpalpable. In the past, while using the palpation-guided method, after three or more unsuccessful attempts, we would conclude that the radial artery must be rolling to the side as the needle was advanced. With use of UGRAA, one can see that the radial artery does not roll, it is just more difficult to achieve access using the palpation method.

I strongly recommend using UGRAA in every case. If used only after the palpation method has failed, it may be too late because the artery may already be in spasm. Such a frustrating situation may discourage a femoralist from adopting the radial approach. Crossover from radial to femoral access due to failure of radial artery cannulation is almost nonexistent when using UGRAA. Because of this, we no longer prepare the groins for all radial cases except in STEMI interventions. We drape a lead apron over the blanket covering the patient's abdomen and pelvis, extending it over a small radial board extension tucked under the patient's right hip (Figure 9). A normal sterile drape is then placed over the patient, also covering the lead apron. This placement of lead decreases scatter radiation to the operator and staff, allowing significantly decreased radiation exposure compared with a femoral approach.

Using UGRAA on every case allows for a better understanding of normal radial artery anatomy and an appre-

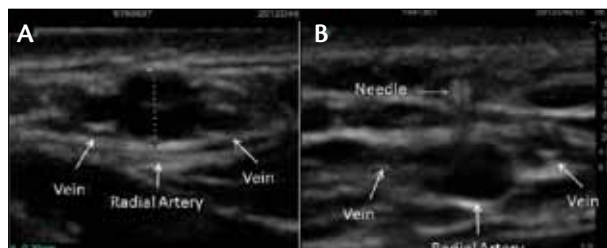


Figure 10. The radial artery and accompanying veins not compressed (A) and partially compressed (B) by the needle.

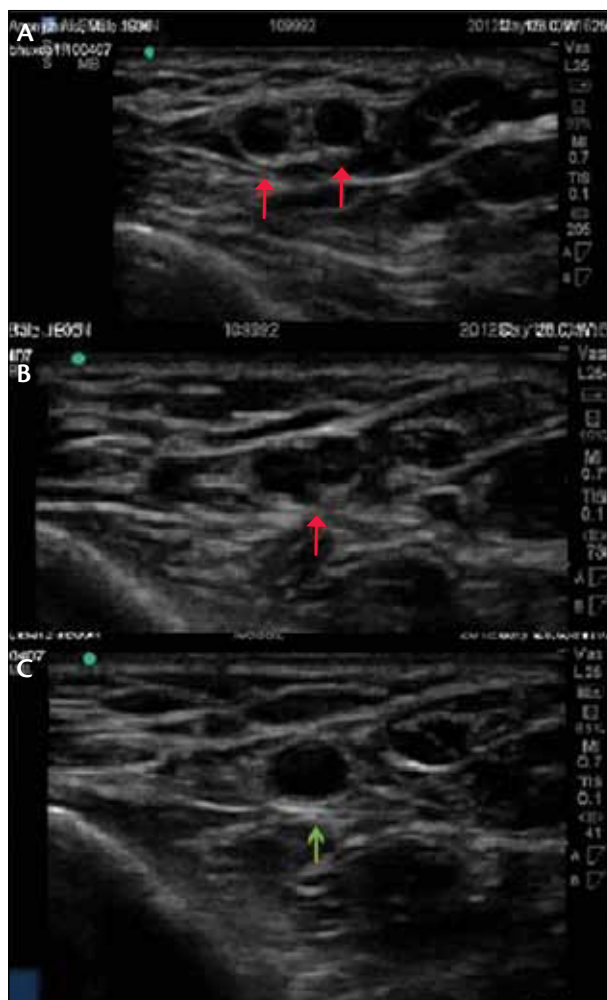


Figure 11. Dual radial arteries (red arrows). Two separate smaller-caliber arteries (A) merge (B) a few centimeters proximally into a larger single artery (green arrow, C).

ciation of variations of the normal anatomy. The normal radial artery can easily be seen pulsating by US in almost every case. Color flow is rarely, if ever, needed for radial artery identification. Frequently, there are one or two veins adjacent to the artery. The thin-walled veins are nonpulsatile and are easily compressible; they collapse

with mild pressure from the transducer (Figure 10). In approximately one in 75 cases, a dual radial artery is seen (Figure 11), which cannot be palpated. The two smaller dual radial arteries are typically only in the normal location of radial puncture. If the dual arteries are followed proximally for 2 to 3 cm, they become confluent into a single larger radial artery, which can then easily be cannulated under UGRAA.

CONCLUSION

UGRAA essentially eliminates difficult radial artery access. As with any technique, practice makes perfect, and UGRAA is no exception. The learning curve is short, and one should use a systematic approach as previously described. Using UGRAA in every case will allow you to quickly master this technique and predictably achieve rapid radial access on the first attempt a very high percentage of the time. Is UGRAA “better” than palpation-directed access? A prospective, multicenter, randomized controlled trial testing UGRAA versus palpation is nearing completion, which will shed light on this question. ■

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