10 Tips for Ultrasound-Guided Peripheral Venous Access

December 17, 2014 by Justin McNamee, DO, Jordan Jeong, DO, and Nilesh Patel, DO, FACOEP, FAAEM

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Intravenous access is a simple procedure of paramount importance for many emergency department patients. Although access is usually obtained with ease using the traditional blind technique, there are instances where this may prove to be exceedingly difficult. When this is the case, providers can use ultrasound to visualize and cannulate a peripheral vein. While there may be many barriers to completing this procedure, there are several ways to optimize your chances for success. Below are some tips and tricks for the EM provider that may help to improve the likelihood of success with this potentially difficult and sometimes frustrating procedure.

Literature Review

Placement of peripheral intravenous catheters is a common practice that occurs many times throughout the day in the ED. This is usually done with little to no difficulty. However, with the average BMI of patients on the rise as well as the number of visits to EDs continuing to increase, gaining access may become more difficult. Commonly cited reasons for difficult peripheral IV access include obesity, edema, and IV drug abuse, which unfortunately are prevalent throughout many emergency departments. Luckily, with the evolution of emergency medicine has come an increased use of ultrasound by EPs for bedside diagnostics and procedures. The use of ultrasound for gaining peripheral intravenous access in difficult cases is no exception. Many physicians and departments have looked into using ultrasound when hoping to gain peripheral IV access, but with what success? In 2005, Constantino et al studied 60 adult patients, with 39 in the ultrasound-guided group and 21 in the traditional control group. They found a 97 percent success rate in the ultrasound group versus a 33 percent success rate in the traditional group, with a statistically significant reduction in time to completion, as well as the number of percutaneous punctures in the ultrasound group.[1] In a 2009 Pediatric Emergency Care study by Doniger et al, the authors found similar results to Constantino et al, but this time in pediatric patients.[2] They studied 50 pediatric patients, with 25 patients in both the ultrasound and traditional access route groups. Again, results showed a trend toward improved overall success, less time to successful cannulation, and fewer attempts in the ultrasound group compared with the traditional group. In 2010, Gregg et al studied similar parameters in surgical ICU patients. The results again showed improved overall success, 99 percent for the ultrasound group, as well as improved first-attempt success (71 percent).[3] Further studies were performed in the following years as the trend toward using ultrasound guidance for gaining peripheral access increased in popularity. The majority of the studies supported the use of ultrasound, but others didn't seem to find a statistically significant improvement in overall success.[4] In 2013, Egan et al performed a meta-analysis of all ultrasound-guided peripheral intravenous access papers, which yielded 62 relevant publications but only seven quality papers to review. They found ultrasound guidance increased the likelihood of successful cannulation in difficult-access patients, just as the original studies had found (odds ratio 2.42; 95% confidence interval 1.26–4.68).[5] Ultrasound use for procedures within the ED is continuing to gain popularity. EM providers need to become

well-versed in the use of ultrasound guidance for placement of intravenous catheters to improve the likelihood of successfully gaining access.

DEPTH OF VEIN (CM)	ENTRY DISTANCE AWAY FROM PROBE (CM) FOR PROPER VISUALIZATION	TRUE DISTANCE TO VEIN (CM)	SUGGESTED CATHETER LENGTH (CM)
0.5	0.5	0.6	2.4
1.0	1.0	1.2	3.2
1.5	1.5	1.8	6.35
2.0	2.0	2.4	6.35

Table 1. Catheter Length Guidelines

Warnings and Complications

Although ultrasound-guided peripheral intravenous access is gaining popularity in emergency medicine, it is not the ideal choice for gaining access in critical patients who need emergent access. All studies conducted on this subject excluded critical patients due to the extended amount of time it takes to obtain ultrasound-guided access. If a critical patient requires emergent intravenous access, you should continue to approach these patients with the traditional peripheral IV approach first, and if you are unable to quickly establish access, then proceed quickly to central venous access or intraosseous (IO) lines.

Ultrasound-guided peripheral venous access has complication rates similar to those of the traditional approach. Several studies show a trend toward improving first-attempt success or decreased number of venipunctures which in theory should lead to less hematoma formation, infiltration, and phlebitis/cellulitis.[1-3] The Journal of Critical Care article by Gregg et al reported only five complications out of 148 patients, with phlebitis/cellulitis associated with 0.7 percent, and infiltration present in only 3.4 percent of total intravenous line insertions.[3] Even though the complication rate may closely resemble that of the traditional approach, the number of central venous access catheters being placed in the difficult-access patients will decrease, lessening major complications that occur with this procedure. Gregg et al reported that 34 central lines were avoided and 40 were removed as a result of ultrasound-guided peripheral intravenous access being obtained.[3] The downstream effect of avoiding long-term placement of central venous access or even avoiding an attempt at the placement of a central line may lead to fewer overall complications.

1 Be Prepared

Figure 1. Supplies for ultrasound-guided peripheral venous access.

This may sound simple, but like many other procedures in emergency medicine, preparation is vital to success. Providers should have all the necessary supplies at bedside, with extra or adjunct supplies within arm's length in case of a more difficult intravenous insertion, as shown in Figure 1. The choice of catheter gauge is up to the discretion of the provider, but prior studies have shown greater success with 18- and 20-gauge catheters. Catheter size should be individualized to the patient. Factors that may influence catheter gauge include vein depth, diameter, and the indication for placing the catheter (CTA, fluid resuscitation, antibiotics, etc.). Gregg et al found greater success rates for ultrasound-guided peripheral intravenous access using guidewire catheters to allow for easier advancement of the catheter once the vein was successfully cannulated.[3] Guidewire catheters are readily available in most emergency departments and may improve your chance of successfully gaining peripheral intravenous access.

2 Position the Patient and the Ultrasound

The key to a successful IV catheter insertion under ultrasound guidance is comfort. Both the patient and the provider need to be comfortable from start to finish. The position of the patient's arm will need to be adjusted depending upon the chosen IV site, but the arm should be held at a height where you do not have to arch your back. Using an adjustable table under the patient's arm with a sheet roll directly under the extended elbow is an optimal position (see Figure 2). The position of the ultrasound machine is also vital to success. The ultrasound should be placed on the opposite side of the arm being used for IV insertion. The screen should be angled to provide a continuous unobstructed view for real time insertion of the catheter (see Figures 2 and 3).

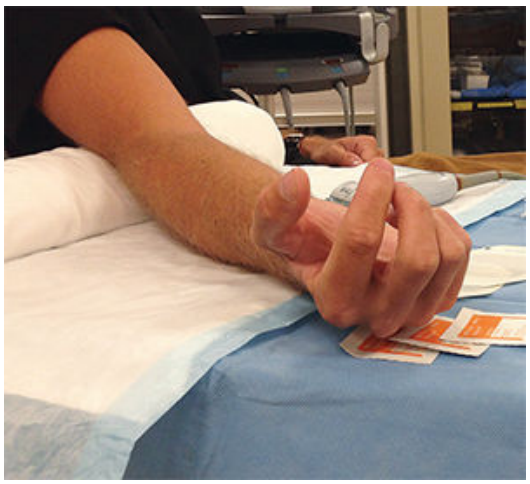

Figure 2. Place an adjustable table under the patient's arm and a sheet roll directly under the extended elbow.

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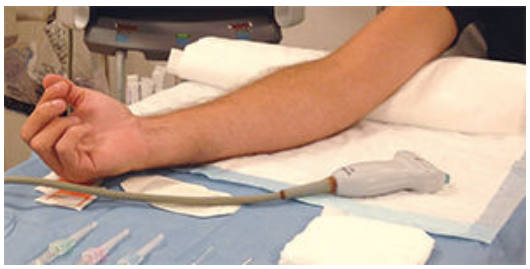

Figure 3. The ultrasound machine should be placed on the opposite side of the arm being used for IV insertion.

Use a Waterproof Transparent Dressing to Cover the Ultrasound Probe

Traditional probe covers may be bulky and cumbersome, and visualization may not be optimal depending on both the thickness of the cover and the amount of gel used underneath. By placing a waterproof transparent dressing directly over the probe, the need for the traditional probe cover is obviated. Make sure the transducer is clean and dry before applying, and after the procedure is completed, simply peel away the dressing (see Figure 4).

4 Place the Tourniquet High and Tight, or Possibly Place Two

Figure 4. Place a waterproof transparent dressing over the ultrasound probe.

To improve success with peripheral vein cannulation, providers typically use a tourniquet to obstruct the one-way flow of venous blood through valves, thus causing backflow with improved visualization of the target vein and decreased compressibility. Place the tourniquet as close to the axilla as possible when initially searching for an adequate vein. This will lead to better venodilation throughout the arm and will allow for improved visualization of potential cannulation sites. After a preferred site is found, consider placing the tourniquet closer to the desired location. One trick is to place a tourniquet below the target insertion point as well as above the targeted area to help create a closed loop. The two-tourniquet technique forces excess blood into the vein, creating a larger target with improved success rates of peripheral IV insertion. Using a blood pressure cuff inflated to 150 mmHg has also been shown to increase the size and decrease the compressibility of veins, which may also lead to higher rates of cannulation.[6]

5 Place the Ultrasound on Shallowest Depth for the Vascular Probe

The peripheral veins regularly targeted for ED catheter placement are often superficial. There will be times when the only available vein runs deeper. It is important to remember that the deeper the targeted vein, the lower your success rate for placing an intravenous catheter. A 2010 observational study in The Journal of Emergency Medicine found that success rates were significantly higher for veins of moderate depth between 0.3 cm and 1.5 cm.[7] In the same study, the authors found that depth was not the only measurement that predicted success rates of intravenous catheter insertion. Successful cannulation also vastly improved when the targeted vein diameter was greater than or equal to 0.4 cm2. Figure 5 shows a vessel within the parameters for optimal depth and width based on this study. Placing the ultrasound on the shallowest depth not only encompasses this range, it also narrows the field to those veins with higher success rates. The shallow depth with the vascular probe also allows for an expanded view of the targeted area, allowing for better visualization of the beveled edge of the catheter. When inserting the catheter through the patient's skin, be sure to keep the bevel tip facing up to allow the ultrasound beam to strike the beveled edge. When the ultrasound beam strikes the beveled edge, it creates artifact that allows for easier visualization of the tip as you cannulate the vein.

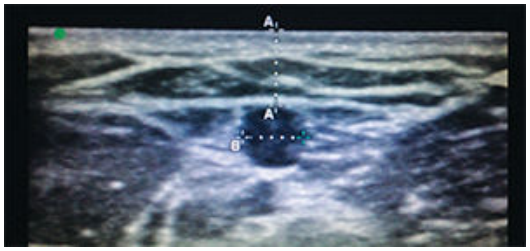

Figure 5. A vessel within the parameters for optimal depth and width for catheter placement.

6 Short Axis Versus Long Axis Approach

The ultrasound probe for intravenous catheter placement can be positioned on two axes, short or long. There are no studies to support greater success with one axis over another, but familiarity with both approaches may help to improve your visualization in real time. In short axis (see Figure 6), a trick to improve visualization of the catheter as you advance through the soft tissue toward the targeted vein is the "tilt to follow" method. Once the target vein is located, tilt the probe so the sonographic beams are angled toward the catheter at initial insertion. Then follow the catheter toward the vein, tilting the probe away from you toward the direction of the catheter as it passes beneath your initial position to a position distal to where the catheter will penetrate the venous wall. Using the "tilt to follow" method will limit the likelihood of advancing the catheter through the posterior venous wall, causing extravasation (see Figure 7). Another approach using the long axis gives you a longitudinal view of the entire length of the targeted vessel (see Figure 8). The sonographic beam is narrow, so you will need to place the catheter tip adjacent to the probe and advance the catheter in the same direction as the probe to be able to follow the beveled tip into the targeted vein.

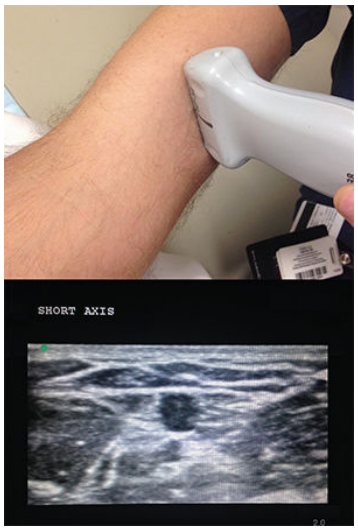

Figure 6. Short-axis positioning.

7 Do the Math

As previously mentioned, depth has been shown to play a role in the successful placement of ultrasound-guided catheters. However, simply recognizing the depth of a vessel is not enough to successfully cannulate a vein. There are several other factors that must be considered. The depth of the vein, the point of catheter insertion, and the angle of entry all play a role in deciding the necessary length of the catheter to be used. Table 1 shows several important values derived from trigonometric functions for catheter insertion at a 45º angle. A prospective study published in *The American Journal Of Emergency Medicine* showed that although it did take more time to place longer catheters, the rate of failure was only 14 percent versus 45 percent in the short catheter group.[8] This highlights the importance of choosing catheters of the correct length for each

Figure 7. The "tilt to follow" method is ideal for the short-axis positioning.

cannulation, especially when dealing with deeper veins. This may reduce the incidence of failure and extravasation, which are complications associated with ultrasound-guided peripheral lines.

8 Be Cognizant of Compression

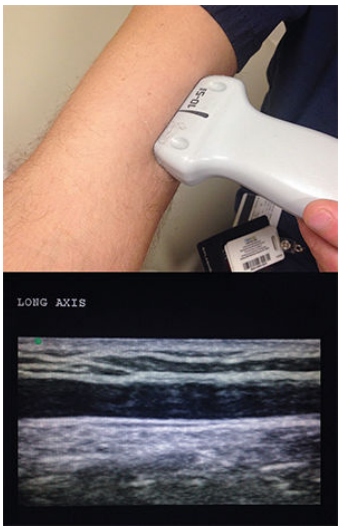

Figure 8. Long-axis positioning.

Veins, unlike arteries, lack muscular walls, which allows for easy compressibility. To verify the target vein, compression with the ultrasound probe is encouraged. However, when attempting to successfully place the catheter, be cognizant of the inherent compression that the probe itself may have on soft tissue. In areas with potentially excessive soft tissue, such as the medial bicep, it is important to use minimal compression as this gives a more accurate determination of depth. In the figures, there is not enough compression to collapse the vein but clearly enough to compress soft tissue. What looks like a superficial vessel may in fact be much deeper than initially thought when applying little to no pressure (see Figure 9). This may explain why some ultrasound-guided IVs are prone to extravasation and failure after seemingly successful placement. Understanding this concept and using the appropriate-length catheter may remedy any problems encountered. It is also important to note that excessive compression of the vein may also create a new challenge when attempting cannulation. Many times, the catheter will puncture the posterior wall, leading to extravasation.

9 Look Before You Leap

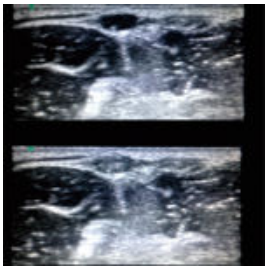

Figure 9. While there is not enough compression here to collapse the vein, there is enough to compress soft tissue.

After finding a vein you wish to cannulate, it is important to align the vessel in the middle of the screen while stabilizing the probe in that position. While some transducers have a marker in the center of the probe, others do not, and you must rely on your own judgment of where midline may be. To ensure your entry point is both midline and directly on top of the vessel, you can use the plastic catheter cover to compress the skin at the suspected midline. If the tissue directly above the vessel and the vessel itself compress, then you know you will enter in the appropriate midline location. If compression occurs lateral to the vessel, then you can adjust accordingly. Once you are comfortable with your chosen entry point, you may use the catheter to puncture the skin and cannulate the vein.

10 Verify Your Success

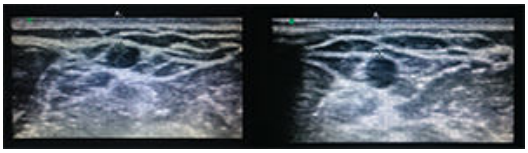

Figure 10. If catheter placement was successful, you will see turbulence inside of the vein when flushing with saline.

After you have placed an intravenous catheter, there are several ways to assess the integrity of your IV line. Little to no resistance when flushing the line with saline may be a good indicator that placement is correct. However, this may be unreliable. Good blood return may be a better sign that it is in place, but if there is any doubt, simply flush the line with saline under direct visualization with ultrasound. If catheter placement was successful, you will see turbulence inside of the vein when flushing with saline, as seen in Figure 10. You should not see the saline leaking into the surrounding tissues, creating edema. This is a sign of extravasation and line insertion failure.

Complete the CME activity.

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Dr. McNamee is chief resident of the emergency medicine residency at St. Joseph's Regional Medical Center in Paterson, New Jersey.

Dr. Jeong is an emergency medicine resident at St. Joseph's.

Dr. Patel is associate program director, emergency medicine, at St. Joseph's.

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