

# Ultrasonographically Guided Insertion of a 15-cm Catheter Into the Deep Brachial or Basilic Vein in Patients With Difficult Intravenous Access

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**Study objective:** Standard length (3 to 5 cm) intravenous catheters in the deep brachial or basilic vein tend to dislodge prematurely. We assess the safety and longevity of a 15-cm catheter inserted in these veins by a novel ultrasonographically guided technique.

**Methods:** This is a prospective cohort study conducted in an urban teaching emergency department (ED). Adult subjects were enrolled if 2 peripheral intravenous insertion attempts had failed. A 3.2-cm, 18-gauge catheter was first inserted into the deep brachial or basilic vein under ultrasonographic guidance. In a separate step, a wire was inserted through this catheter, and a 15-cm, 16-gauge catheter was placed over the wire and left in place for up to 3 days. Primary outcomes were time to securing access and rate of loss of access. Secondary outcomes included complication rates and subject satisfaction.

**Results:** Twenty-five subjects were enrolled; 23 catheters were successfully placed. Median time required for initial vein cannulation was 3 minutes (interquartile range [IQR] 2 to 7 minutes) and for securing the 15-cm catheter was an additional 4 minutes (IQR 3 to 5 minutes). Median duration of access was 26 hours (IQR 10 to 47 hours). The only complication was early infiltration in 1 subject. All subjects rated satisfaction as 4 or 5 on a 5-point Likert scale.

**Conclusion:** We present a promising alternative to central venous catheterization in patients with difficult intravenous access. This technique appears to be fast, safe, and well tolerated by adult patients. [Ann Emerg Med. 2007;50:68-72.]

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## INTRODUCTION

Emergency physicians are often required to obtain intravenous access in patients who have no readily available peripheral sites. Obesity, intravenous drug abuse, shock, and a variety of other conditions may make peripheral intravenous insertion difficult. Central line placement, which is relatively time-consuming and dangerous, is the standard alternative. Use of ultrasonographic guidance in central line placement is now widely recommended because it improves success and reduces complications.<sup>1,2</sup> Ultrasonography has also been used to cannulate deep peripheral veins.

Ultrasonographically guided cannulation of the deep brachial or basilic vein using a standard intravenous catheter was found to be a rapid and highly successful technique in 2 previous studies.<sup>3,4</sup> This technique is now used frequently in our ED. Its

principal drawback, however, is that intravenous catheters often dislodge and intravenous fluid infiltrates because standard length catheters may not extend far enough into the vein lumen. Keyes et al<sup>3</sup> reported a failure rate of 8% within the first hour after placement, which is consistent with our anecdotal experience and that of others.<sup>4</sup> Thus, it has been recommended that this technique generally be reserved for patients requiring only short-term intravenous access.

We developed a 2-phase technique involving ultrasonographic guidance for inserting a 15-cm, 16-gauge catheter over a wire into the deep brachial or basilic vein. We hypothesized that the long catheter would provide durable access for up to 3 days, with a low complication rate. Catheters of this approximate size are available in most EDs.

### Editor's Capsule Summary

#### *What is already known on this topic*

Standard intravenous catheters can be placed into deep arm veins under ultrasonographic guidance but tend to be easily dislodged.

#### *What question this study addressed*

Can clinicians safely and efficiently procure venous access with a 2-step procedure that uses ultrasonographically guided cannulation of deep arm veins and standard intravenous catheters, followed by guidewire-assisted exchange of initial catheters for 15-cm, 16-gauge catheters in patients with 2 failed peripheral intravenous cannulation attempts?

#### *What this study adds to our knowledge*

The procedure was successful in 23 of 25 patients, with a median procedure time of 8 minutes. Complications were rare and the procedure was well tolerated.

#### *How this might change clinical practice*

This technique may provide a useful alternative to central line placement in emergency department patients with difficult peripheral access.

## MATERIALS AND METHODS

### Study Design, Setting, and Selection of Participants

This was a prospective cohort study conducted at an urban academic ED between April and November 2005. A convenience sample of adult subjects was enrolled. Inclusion criteria were need for intravenous access, failure of 2 peripheral intravenous attempts, need for admission, ability to give informed consent, and age older than 18 years. Patients with upper-extremity cellulitis or suspected endocarditis, patients requiring central venous access, and pregnant patients were excluded. Institutional review board approval was obtained, and all subjects provided written consent. All procedures were performed by 1 of the 4 investigators (2 fourth-year emergency medicine residents, 1 emergency medicine ultrasonographic fellow, and 1 emergency medicine attending physician) or by an emergency medicine resident (second to fourth year) under direct supervision and assistance of an investigator. All the investigators had previously performed ultrasonographically guided peripheral vein cannulation at least 50 times; the emergency medicine residents who performed the procedure under direct supervision had previously performed the procedure approximately between 0 and 25 times.

### Interventions

In step 1 (the cannulation phase), the deep brachial or basilic vein was cannulated with a standard length catheter (32 mm, 18 gauge; ProtectIV; Ethicon Endo-Surgery, Inc., Cincinnati, OH) under ultrasonographic guidance using a 10-5-MHz linear

ultrasonograph transducer (SonoSite, Inc., Bothell, WA) and nonsterile ultrasonographic gel. Choice of deep brachial or basilic vein and choice of single- or 2-person technique were left to the investigator. Alcohol or chlorhexidine was used to prepare the skin, and the catheter was inserted using nonsterile gloves. Once the catheter was successfully placed, a Luer lock was placed on the catheter hub. Multiple attempts at initial cannulation were permitted. Up to 15 minutes was allowed between steps 1 and 2.

In step 2 (the rewiring phase), the catheter and surrounding area were sterilized with povidone-iodine 10% or chlorhexidine 2%, and a wire was threaded through the catheter into the vein, using sterile gloves and drape. The initial catheter was then removed, and a 15-cm single-lumen catheter (16 gauge; Cook, Inc., Bloomington, IN) was inserted over the wire and secured with tape and transparent dressing. Nicking the skin with a scalpel and use of a dilator were not necessary.

### Data Collection and Processing

Insertion and rewiring times were recorded by either a research assistant or a study investigator not involved in placement of the catheter. Patients were also evaluated for hematoma formation or paresthesias.

Immediately after the procedure was completed, subjects were asked to rate their overall satisfaction with the procedure with the question, How would you rate your overall satisfaction with the procedure on a scale of 1 to 5, with 1 representing "extremely dissatisfied" and 5 representing "extremely satisfied"?

The catheter was left in place until hospital day 3, unless the subject was discharged or a complication developed before the third day. Catheter dressings were labeled with instructions to page an investigator or research assistant for removal. When a catheter was removed by an investigator or research assistant, the subject was evaluated for pain, erythema, and edema, and the catheter tip was sent for culture. Catheter tip cultures were performed in a standard fashion.<sup>5</sup> In instances in which hospital staff inadvertently removed the catheter without contacting an investigator, nursing and physician notes were reviewed for any evidence of catheter-related complications.

### Outcome Measures

The primary outcome measures were the time required to perform the procedure and the rate of catheter dislodgment. Time to perform the cannulation phase was measured from when the ultrasonographic transducer was placed on the arm until successful insertion of the standard intravenous catheter. The rewiring phase was measured from sterile preparation until the 15-cm catheter was fully secured.

Secondary outcomes were incidence of mechanical, infectious, and thrombotic complications, as well as subject satisfaction. Mechanical complications were defined as arterial blood flow through the catheter, ultrasonographic evidence of arterial puncture, hematoma formation, or paresthesias. Infectious complications were defined as erythema, pain, or edema consistent with catheter-associated cellulitis or phlebitis,

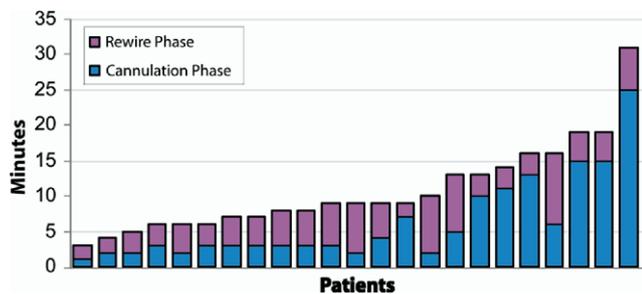


Figure. Time to securing access.

or a positive catheter tip culture. Thrombotic complications were defined as any clinical or sonographic evidence of upper-extremity venous thrombosis. Subject satisfaction was measured on a 1- to 5-point Likert scale, with 1 representing “extremely dissatisfied” and 5 “extremely satisfied.” Any visits to our ED by the study subjects within 90 days of enrollment were reviewed for evidence of delayed complication from the procedure.

**Primary Data Analysis**

Data were analyzed with descriptive statistics. Median and interquartile ranges (IQRs) were used to describe data ranges of recorded times; 95% confidence intervals (CIs) were calculated using the Wilson score interval for binomial proportions.

**RESULTS**

No patient who was offered enrollment refused to participate in the study. The most common cause of difficult intravenous access was injection drug use (46%), followed by chemotherapy, obesity, and hypotension. Mean age was 45.9 years. With regard to the primary hypothesis to evaluate effectiveness, of 25 enrolled subjects, 23 underwent successful catheterization with the 15-cm catheter, a 92% success rate overall (95% CI 75% to 98%). All 23 catheters remained in place until intravenous access was no longer required.

The deep brachial vein was cannulated in 12 subjects, the basilic vein in 7, and the site was not recorded in 4. Successful cannulation required 1 attempt in 61% of subjects, 2 attempts in 26%, and 3 attempts in 13%. Data on the time required to perform the procedure are presented in the Figure. Median time required for the cannulation phase was 3 minutes (IQR 2 to 7 minutes). Median time for the rewiring phase was 4 minutes (IQR 3 to 5 minutes). Median total procedure time was 8 minutes for investigators and noninvestigator emergency medicine residents (IQR 6 to 16 minutes and 5.5 to 16 minutes, respectively).

In 1 of 2 unsuccessful procedures, initial ultrasonographically guided vein cannulation could not be obtained after 10 minutes, despite multiple attempts by the attending investigator. In the other case, performed by the primary resident investigator, the 15-cm catheter was placed (cannulation phase 12 minutes; rewiring phase 6 minutes) but infiltrated after 15 minutes, requiring removal. No other

complications were observed; the short-term complication rate was therefore 4% (95% CI 1% to 20%) for the period when the catheter was in the vein. Time required in both cases was longer than the median for successful catheterizations. All 9 procedures by noninvestigator residents were successful, without complication.

Satisfaction level was rated as 5 (extremely satisfied) in 19 subjects (76%). Four subjects (16%) rated satisfaction as 4, including both subjects for whom the procedure failed. Satisfaction scores were not recorded for 2 subjects.

Catheters remained in place a median of 26 hours (IQR 10 to 47 hours). At catheter removal, no subjects had evidence of catheter-associated hematoma, infection, or thrombosis. Nine catheters were removed by nursing staff without the site being examined by an investigator; however, there was no documentation of erythema or swelling on medical record review in these cases. Three catheters were sent to the laboratory, but culture was not successfully performed. Of 11 catheter tips that were cultured, all were negative for bacterial colonization. Catheters that were cultured had been in the vein a median of 32 hours (IQR 24 to 47 hours). Although no formal evaluation of patients was performed for complications that developed after the catheter was removed, no subjects returned within 90 days with evidence of a delayed complication from the procedure.

**LIMITATIONS**

This small observational study is subject to a number of limitations. Although we found a 4% complication rate, the small sample size limits the validity of this finding. The 95% CI around the complication rate extends to 20%. We did not perform prospective long-term follow-up, which might have strengthened our findings about delayed development of thrombosis or infection. There was no control arm involving either standard length peripheral catheters or central lines; thus, no direct comparison can be made with these alternative intravenous access techniques.

The operators in this study (emergency medicine residents at our program and study investigators) were already relatively experienced at ultrasonographically guided deep brachial and basilic vein cannulation with a standard length catheter (the cannulation phase), which may limit the generalizability of our findings to less experienced operators. On the other hand, the skills required for the rewiring phase are essentially the same as those required for central line placement by Seldinger technique, a standard emergency medicine procedure. Also, 9 catheters were placed successfully by residents with various experience.

We may not have detected delayed complications that actually occurred. The fact that no subject returned to the ED for a complication from the procedure does not preclude the possibility that they could have presented to other EDs or a primary physician.

Incomplete data, including missing catheter tip cultures and subject satisfaction scores, limit the strength of our findings

about these secondary outcomes. Not recording the insertion site in 4 subjects prevented comparison of the success of deep brachial versus basilic vein cannulation.

## DISCUSSION

Standard 3- to 5-cm-length intravenous catheters in the deep brachial or basilic vein tend to dislodge prematurely. We studied a novel technique of ultrasonographically guided brachial or basilic vein cannulation with a 15-cm catheter and found it to be a rapid and safe alternative to central line placement in adult ED patients with difficult intravenous access who require admission.

Known mechanical complications of deep brachial vein cannulation include puncture of the brachial artery (observed in up to 2% of subjects in previous studies<sup>3,6</sup>) and needle contact with the median or medial cutaneous nerve, causing paresthesias. There were no such complications in our study, although the sample size was too small to detect a very low incidence of these events. An important advantage of accessing upper extremity veins instead of central or femoral veins is that it avoids the risk of numerous complications, including pneumothorax, hemothorax, carotid and subclavian artery puncture, and lower extremity deep vein thrombosis.

A previous study of ultrasonographically guided deep brachial and basilic vein cannulation using standard length intravenous catheters reported a failure (intravenous infiltration) rate of 8% in the first hour.<sup>3</sup> In our study, there was 1 case of early infiltration within 15 minutes (4%) and no cases of later infiltration. The apparently improved longevity of the 15-cm compared to shorter catheters suggests that this technique is well suited for patients requiring admission.

We used a semisterile technique for the cannulation phase, which provides a level of sterility equivalent to standard peripheral intravenous catheter insertion. This technique was chosen for its convenience and speed. It allowed operators to rapidly make multiple attempts at different sites, if necessary, and did not require sterile preparation of the ultrasonographic probe. The absence of catheter-associated infections or colonization of the catheter tips in this study suggests that it is safe to cannulate the vein in a nonsterile fashion, even before introduction of the 15-cm catheter over a wire. However, given the small sample size, a low but measurable incidence of infection and phlebitis remains possible, similar to the risk carried by any peripheral intravenous line.

Multiple studies have analyzed the rates of infection and upper extremity thrombosis associated with peripherally inserted central catheters, which differ from the catheters in this study in that they extend into the central circulation and may remain in the vein for months. Rates of infection<sup>7,8</sup> and thrombosis<sup>9,10</sup> at peripherally inserted central catheter sites have been reported to be low. It is therefore not surprising that in this study there were no cases of catheter-associated infection or thrombosis.

In conclusion, this novel technique of ultrasonographically guided deep brachial or basilic vein cannulation with a 15-cm catheter offers a potentially safe and rapid alternative to central

line placement in adult ED patients with difficult intravenous access who require admission, with a low rate of short-term complications.

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## REFERENCES

- Hind D, Calvert N, McWilliams R, et al. Ultrasonic locating devices for central venous cannulation: meta-analysis. *BMJ*. 2003;327:361-364.
- Miller AH, Roth BA, Mills TJ, et al. Ultrasound guidance versus the landmark technique for the placement of central venous catheters in the emergency department. *Acad Emerg Med*. 2002;9:800-805.
- Keyes LE, Frazee BW, Snoey ER, et al. Ultrasound-guided brachial and basilic vein cannulation in emergency department patients with difficult intravenous access. *Ann Emerg Med*. 1999;34:711-714.
- Costantino TG, Parikh AK, Satz WA, et al. Ultrasonography-guided peripheral intravenous access versus traditional approaches in patients with difficult intravenous access. *Ann Emerg Med*. 2005;46:456-461.
- Maki DG, Weise CE, Sarafin HW. A semiquantitative culture method identifying intravenous-catheter-related infection. *N Engl J Med*. 1977;296:1305-1309.
- Costantino TG, Fojtik JP. Success rate of peripheral IV catheter insertion by emergency physicians using ultrasound guidance [abstract]. *Acad Emerg Med*. 2003;10:487.
- Whigham CJ, Goodman CJ, Fisher RG, et al. Infectious complications of 393 peripherally implantable venous access devices in HIV-positive and HIV-negative patients. *J Vasc Interv Radiol*. 1999;10:71-77.

8. Loewenthal MR, Dobson PM, Starkey RE, et al. The peripherally inserted central catheter (PICC): a prospective study of its natural history after cubital fossa insertion. *Anaesth Intensive Care*. 2002;30:21-24.
9. Luciani A, Clement O, Halimi P, et al. Catheter-related upper extremity deep venous thrombosis in cancer patients: a prospective study based on Doppler US. *Radiology*. 2001;220:655-660.
10. Schimp VL, Munkarah AR, Morris RT, et al. Upper extremity deep vein thrombosis associated with indwelling peripheral venous catheters in gynecology oncology patients. *Gynecol Oncol*. 2003; 89:301-305.

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