A novel technique of axillary vein puncture involving peripherally inserted central venous catheters for a small basilic vein

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Abstract
Purpose: Peripherally inserted central venous catheters are some of the most useful devices for vascular access used globally. Peripherally inserted central venous catheters have a low rate of fatal mechanical complications when compared to non-tunnel central venous catheters. However, as peripherally inserted central venous catheter access requires a smaller vein, there is a high risk of thrombosis. The axillary vein (confluence of the basilic and brachial veins) can serve as an access for cannulation. Moreover, as this vein is larger than the basilic or brachial vein, it might be a superior option for preventing thrombosis. The risk of catheter-related bloodstream infection should be considered when the puncture site is at the axillary fossa. The aim of this study was to present our new protocol involving peripherally inserted central venous catheters (non-tunneled/tunneled) and a tunneling technique and assess its feasibility and safety for improving cannulation and preventing thrombosis and infection.

Methods: The study included 20 patients. The axillary vein in the upper arm was used for peripherally inserted central venous catheters in patients with a small-diameter basilic vein (<3 mm). When the puncture site was in the axillary fossa, a subcutaneous tunnel of about 3 cm was constructed easily using a peripheral venous catheter.

Results: The observed catheter duration was 645 days (median ± standard deviation, 26 ± 22.22 days). Catheterization was successful in all cases, however, two accidental dislodgements were identified. No fatal or serious complications were observed after catheterization.

Conclusion: Our new protocol for axillary peripherally inserted central venous catheters/tunneled axillary peripherally inserted central venous catheters use for a small-diameter basilic vein is safe and feasible.

Keywords
Peripherally inserted central venous catheter, axillary vein, small vein, tunneled

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Introduction
The use of peripherally inserted central venous catheters (PICCs) has become popular in intravenous therapy, especially when a long duration of infusion of peripherally or nonperipherally compatible infusates is required or when the patient has a difficult venous access or has undergone frequent phlebotomies. The rates of fatal mechanical complications, such as arterial puncture, hematoma, hemothorax, pneumothorax, and air embolism have been reported to be lower with PICCs than with non-tunneled central venous catheters. However, PICCs are associated with a high rate of PICC-related upper extremity deep vein thrombosis (UEDVT), because PICC access utilizes a small-diameter vein. Therefore, it is critical to use a larger vein as the puncture site and, thus, a more proximal vein needs to be...
identified. The axillary vein just after the confluence of the basilic and brachial veins might be large enough to prevent UEDVT. However, catheter-related bloodstream infection (CRBSI) and other complications may arise when the puncture site is located in the axillary fossa. We established a novel technique and protocol of ultrasound-guided non-tunneled/tunneled axillary peripherally inserted central catheter (A-PICC/TA-PICC) use to prevent UEDVT and CRBSI. The aim of this study was to present our new protocol and tunneling technique and assess its feasibility and safety for improving cannulation in difficult patients and preventing thrombosis and infection.

Methods

A-PICC or TA-PICC was used in 20 adults between January 2014 and July 2017 (Table 1). All patients gave written informed consent for all procedures in the study. Two physicians and one PICC nurse performed cannulation in all patients in the fluoroscopy room. The criterion for selecting A-PICC/TA-PICC was a basilic vein diameter less than 3 mm. The axillary vein was the puncture site for all patients. A 4-Fr polyurethane catheter provided in the Argyle™ PICC kit (single lumen catheter, 4 Fr × 45 cm Covidien, Japan) was used.

In the fluoroscopy room, patients were laid down in the supine position with the right arm positioned at up to 90° of horizontal abduction and slightly external rotation. Patients were assessed to ensure that they were comfortable and not restrained. Prescan was performed to measure the basilic vein diameter before the implementation of maximal sterile barrier precautions (MSBPs). When the basilic vein was less than 3 mm, the axillary vein was identified at the proximal region of the basilic-brachial confluence (Figure 1(a)). Then, patients underwent the indicated protocol (Figure 2), which can be considered safe and feasible.

The vessels were rescanned after setting up a cannulation catheter, MSBPs, ultrasound, catheter priming, and electrocardiography (ECG) monitoring. Ultrasound-guided axillary vein puncture was performed with an out-of-plane approach. A guidewire was placed in the superior vena cava using Seldinger technique. When the puncture site was out of the axillary fossa (so-called “Green Zone”), a PICC was placed as a regular PICC. However, when the puncture site was in the axillary fossa (so-called “Yellow Zone”), a subcutaneous tunnel was made so that the catheter site on the skin would be out of the axillary fossa (Figure 3(a)). Cutting the skin at the puncture site up to 1 or 2 mm before axillary vein puncture might help in tunneling and ensure safety not only for the patient but also for each device, including the guidewire. Under local anesthesia, a peripheral venous catheter (20G, 3.5 cm) from the PICC kit was introduced subcutaneously to establish a tunnel from a 3 cm distal site to the puncture site with a needle that was subsequently removed, while the small tube of the cannula remained in place. The end of the guidewire, which was already placed, was inserted through the tip of the 20G small tube to the distal site, and the 20G small tube was removed (Figure 3(b)). To avoid accidental removal, the guidewire should be held with forceps at the puncture site. The guidewire was then put through the subcutaneous tunnel. A dilator from the PICC kit was placed through the guidewire, which was passed through the subcutaneous tunnel to the axillary vein. The dilator of this kit does not require a skin incision. Finally, the PICC was cannulated and the inserted catheter was checked.

### Table 1. Results of A-PICC or TA-PICC use for a small-diameter basilic vein.

<table>
<thead>
<tr>
<th></th>
<th>A-PICC  (n = 13)</th>
<th>TA-PICC (n = 7)</th>
<th>Total (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex (M/F)</strong></td>
<td>6/7</td>
<td>4/3</td>
<td>10/10</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>79 ± 5.24</td>
<td>81 ± 7.63</td>
<td>80 ± 6.06</td>
</tr>
<tr>
<td><strong>BD (n)</strong></td>
<td>CTD</td>
<td>Ti</td>
<td>Malig.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>Malig.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Indication (n)</strong></td>
<td>TPN</td>
<td>Pallia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>AxV D (mm)</strong></td>
<td>4.5 ± 1.01</td>
<td>3.7 ± 0.91</td>
<td>4.4 ± 0.96</td>
</tr>
<tr>
<td><strong>VF(1/2)</strong></td>
<td>11/2</td>
<td>4/3</td>
<td>15/5</td>
</tr>
<tr>
<td><strong>CCD (cm)</strong></td>
<td>29 ± 4.42</td>
<td>26 ± 2.51</td>
<td>28 ± 4.31</td>
</tr>
<tr>
<td><strong>CD (day)</strong></td>
<td>20 ± 22.40</td>
<td>39 ± 27.52</td>
<td>26 ± 24.06</td>
</tr>
</tbody>
</table>

PICC: peripherally inserted central venous catheter; A-PICC: axillary peripherally inserted central venous catheter; TA-PICC: tunneled axillary peripherally inserted central catheter; **n**: number; BD: background; CTD: connective tissue disease; Ti: terminal ill; LC: liver cirrhosis; Malig.: malignancy; Dysph.: dysphagia; delir.: delirium; IC: ischemic colitis; TPN: total parenteral nutrition; Pallia: palliative; AxV D: axillary vein diameter; VF: venipuncture frequency; CCD: catheter cannulation distance; CD: catheter duration.
using ultrasound (Figures 1(b) and 3(c)). Fluoroscopy was also used to ensure the correct catheter tip position. SorbaView® SHIELD Small (Centurion Medical Product Corporation, MI, USA) was used for nonsuturing catheter fixation and stabilization and was replaced weekly. When the catheter became visible because of a large opening, the puncture site was sealed with 2-octyl cyanoacrylate (Dermabond Advanced® Topical Skin Adhesive, Ethicon Inc., Somerville, NJ, USA).

During cannulation, the catheter cannulation distance, punctured axillary vein diameter, venipuncture frequency, and mechanical complications for cannulation were assessed and recorded. After cannulation, the PICC team assessed the PICCs once a week until they were removed to identify and record catheter duration, CRBSI, UEDVT, phlebitis, occlusion, dislodgement, and other complications.

All data were evaluated with a retrospective chart review. The data regarding axillary vein diameter, catheter cannulation distance, and catheter duration are presented as median±standard deviation (SD) using Excel 2013 (Microsoft, USA).

**Results**

The results are presented in detail in Table 1. The male:female ratio was 10:10. Among the study patients, six had a medical history of connective tissue disease, four were terminally ill with advanced malignancy, three had liver cirrhosis, two had malignancy, two had dysphagia and delirium, two had ileus, and one had ischemic colitis. The indications of PICC use were total parenteral nutrition (TPN) in 11 patients and palliative treatment in 9 patients. A-PICCs and TA-PICCs were used in 13 and 7 patients, respectively. The observed catheter duration was 645 days (median±SD, 26±22.22 days). The median catheter cannulation distance (centimeter) from the catheter tip to the puncture site was 28±4.31, and the median diameter of the axillary vein at the puncture site was 4.4±0.96 mm. Fifteen cases required one venipuncture for catheterization, and five cases required two venipunctures. Catheterization was successful in all cases. During the observed catheter duration of 645 days, only two cases of accidental dislodgement occurred during episodes of dysphagia and delirium in an elderly patient. No other fatal or serious complications, including CRBSI, symptomatic UEDVT, phlebitis, and catheter occlusion, were observed.

**Discussions**

One of the reasons for the low rate of fatal complications with PICCs is that the access point is always in the upper arm. PICCs do not usually cause fatal mechanical complications, such as pneumothorax and choking after hematoma development. However, PICCs are associated with a high rate of UEDVT because of catheter cannulation in a small-diameter vein. The European Society for Clinical
Nutrition and Metabolism (ESPEN) guidelines recommend a catheter size that is one-third of the vein diameter. When scanning the basilic vein, an operator may not find an appropriately sized vein for puncture. The axillary vein, proximal to the basilic vein, can be located just after the confluence of the basilic and brachial veins in the upper extremity or axillary fossa. The size of the axillary vein is generally large enough for successful puncture and avoidance of thrombosis. However, a potential problem arises when the puncture site is within the axillary fossa because catheter-associated infection is possible owing to a large number of dermal bacteria in this warm and moist environment. However, subcutaneous tunneling for the catheter may help lower the infection incidence. As we did not encounter any CRBSI case, our new technique may help prevent CRBSI.

When the size of the basilic vein is less than 3 mm, cannulation and its management are challenging. This study set a protocol to determine when tunneling is required for the puncture site of a PICC.

In addition, only few studies have described tunneled PICCs. Unfortunately, the PICC kit used in this study is not commercially available outside of Japan. However, a 20G peripheral venous catheter and a 0.32-mm, 150-cm guidewire can easily substitute the components of the kit for performing the tunneling technique. The dilator is useful for this technique because it has enough strength to cut the skin without any surgical knife and enough flexibility not to damage the guidewire at body temperature; thus, it is safe enough not to damage vessel wall and has the same risk of damaging vessel wall as normal PICCs:

Between January 2014 and July 2017, our hospital had 618 cases of PICC use, and of these, 174 cases involved a PICC team and the rest involved uncountable operators. Only a small part of the clinical follow-up is available. Therefore, more cases and prospective studies are necessary to evaluate risks, such as thrombosis and infection, which are associated with this protocol and technique owing to the small sample size and the retrospective nature of this study.

**Conclusion**

The axillary vein in the upper arm or axillary fossa can be used as one of the accessible veins for PICCs. The A-PICC/TA-PICC protocol with a small basilic vein was found to be safe and feasible. Subcutaneous tunneling is an easy and simple solution to avoid infection in certain cases.
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References