Short-term complications of ultrasound-guided bedside peripherally inserted central catheter in the Intensive Care Unit: 1 year experiences

Se Heon Kim, Young Hoon Sul, Yook Kim, Joong Suck Kim, Moon Sang Ahn

Abstract

***Objectives*: Critically ill patients in the intensive care unit (ICU) need central catheter for various reasons, such as long-term intravenous access, nutrition, antibiotic usage, or chemotherapy. Generally, peripherally inserted central catheter (PICC) lines are the most commonly used type of intravenous access meant for long-term use. But, moving critically ill patients from the intensive care unit to the interventional radiology room (IRR), where PICC installation is usually performed, can disrupt ongoing critical care and may be in dangerous situation. Recently, several articles have reported the successful clinical implementation of bedside PICC installation under ultrasound (US) guidance. We aimed to evaluate and report the 1 year experiences of bedside PICC installation under US guidance in ICU by analysis short-term complications.**

***Methods*: We performed a retrospective cohort study of 123 PICCs placed in adult ICU at a tertiary care academic medical center between October 2017 and September 2018. The data were analyzed to identify short-term complications, such as malposition of catheter tip, infection, and occlusion.**

***Results*: Among 123 PICCs, 52 cases were performed in the IRR and 71 cases were performed in the ICU. The overall complications were in 18 cases (14.6%). Malposition of catheter tip was found in 12 cases (9.8%), infection was found in 4 cases (3.3%), occlusion was found in 2 cases (1.6%). Complication rate was higher in the ICU group (18.3%) than the IRR group (9.6%). Malposition was found in 11 cases in the ICU group and 1 case in the IRR group. Infection was found in 2 cases in both groups. Occlusion was found in 1 case in both groups.**

***Conclusions*: The incidence of malposition of catheter tip as short-term complication is higher in the case of performing bedside PICC installation under ultrasound in ICU than in IRR.**

Key words: Complication, peripherally inserted central catheter, ultrasound, interventional radiology, intensive care unit.

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Introduction

Critically ill patients receiving care in intensive care unit (ICU) often need long-dwelling central vein access for treatments of various shocks, parenteral nutrition, chemotherapy, and more. Peripherally inserted central catheter (PICC) is usually preferred for less risk of hemorrhage, pneumothorax, and infection, which can be fatal. (1,2) Traditionally, PICC insertions were performed in interventional radiology room (IRR), thus patients had to be moved from ICU to IRR. (3,4) However, critically ill patients are often intubated and ventilated, with large-bore central lines for continuous venovenous hemofiltration (CVVH) or extracorporeal membrane oxygenation (ECMO), or on various infusion pumps for administrations of inotropics, sedatives, analgesics, muscle relaxants, and more. Even if monitors and medical personnel are ac-

companied for the journey to IRR, intrahospital transfers are at risk of unexpected extubation, hypoxemia, removal and contamination of catheters, and power shortage of infusion pumps, jeopardizing patient safety. (5,6)
For this reason, there are reports of preferring bedside PICC insertions aided by ultrasonography and other imaging devices. (7,8) The authors, including surgeons requiring various management means for critically ill patients, also have recently started performing PICC insertions guided by ultrasonography in ICU. We aimed to compare early complications of patients who received PICC in IRR with bedside insertions in ICU.

Materials and methods

Patients

We included 123 ICU patients from October 2017 to September 2018, who required long-term intravenous drugs or nutrition, or long dwelling catheters due to poor peripheral veins, and thus needed PICC. Those without difficulties for intrahospital transfers included 52 patients who received PICC in IRR, while other 71 patients received PICC in ICU.

Procedures

Patients in the ICU group were in supine position with their arms abducted, where the veins were checked with ultrasonography. We used 2% chlorhexidine gluconate for antiseptics and 2% lidocaine for local analgesia. Aided by ultrasonography, a 20 G probe needle was inserted inside the vein, and using Seldinger technique, a guide wire was inserted and the probe needle was removed. The PICC catheter was inserted via dilatation of the connective tissue made by passing a tissue dilator with peelable sheath over the wire. When the PICC catheter was inserted at 20 cm, the patient's head was positioned toward the insertion arm in order to prevent the catheter migrating upward to the internal jugular vein. When the catheter was finally at wanted depth, the sheath was removed. The PICC catheter was sutured at skin and an X-ray was taken to check proper placement.

Early complications

If the catheter tip was at wrong place, we checked short-term infection sign within five days of insertion. Malposition was defined when the catheter tip was not in lower 1/3 of the superior vena cava (SVC) (**Figure 1**). Short-term infection was defined when blood-related infection was evident within five days of insertion. Malposition, infection within five days, and occlusion were verified retrospectively from medical records.

Statistical analysis

Statistical analysis was done using IBM SPSS Statistics ver. 21.0 (IBM Co., Armonk, NY, USA), and p value less than 0.05 was considered statistically significant.

Result

From October 2017 to September 2018, 123 patients received PICC insertions. Clinical characteristics of the patients are listed in **Table 1**. There were 68 males and 55 females, and their average age was 71.9 years (standard deviation 12.9). Seventy-one patients received PICC in ICU while the other 52 in IRR. PICC was placed on right basilic vein in 56 cases, right brachial vein in 58 cases, and left brachial vein in 9 cases.
Complications are listed in **Table 2**. There were complications in 18 cases (14.6%), including malposition in 12 cases (9.8%), short-term infection in 4 cases (3.3%), and occlusion in 2 cases (1.6%). The complication rate of the ICU group was higher than the IRR group (19.7% vs 7.7%), but without statistical significance (p=0.074).
The ICU group demonstrated higher malposition rate of 15.5% (11 cases) than that of IRR group (1.9%, 1 case) with statistical significance (p=0.013). Malposition included tip not in the low 1/3 of the SVC in 7 cases, tip at the right subclavian vein in 3 cases, and tip at the left subclavian vein in one case (**Figures 2** and **3**) The malposition case in the IRR group demonstrated the tip missing the low 1/3 point. Two cases of short-term infections and one case of occlusion were found in both groups.

Discussion

Traditionally, PICC insertion had been performed in IRR. However, transfer of ICU patient is not only dangerous, but is reported to induce pulmonary complications, hemodynamic instability, infection, and metabolic disorders, (9) thus unnecessary patient transfer should be minimized. Performing bedside PICC in ICU is one of the care plans for patient safety. (10) Bedside procedure has its disadvantages in difficult patient positioning, difficult insertion due to anatomic anomaly, and inability to check proper placement right away. (11) Furthermore, Glauser et al reported higher tip malposition rate without angiography guidance than with guidance. (12) Gao et al reported that if PICC tip is not in the low 1/3 of SVC, infection rate can be higher, (13) and other studies reported higher complication rate related with malposition

such as thrombus and vessel injury, (11,14,15) warranting proper placement. In order to reduce complications and overcome disadvantages, ultrasonography guidance has been reported to allow high success rate, (8) while dedicated team with experts also allowed high success rate. (10)

In this study, there were 12 cases (9.8%) of tip not in the low 1/3 of SVC, which indifferent from other studies such as 10% of Trerotola et al, (16) 8% of Li et al, (17) and 7.87% of Song et al. (18) This rate was much higher in ICU group than IRR group (15.5% vs 1.9%) with statistical significance ($p=0.013$). This is mostly due to the inability to check the placement right away in ICU, unlike IRR where the process of insertion can be viewed in real time. This result recently made us to call for portable X-ray during the procedure to check the tip placement as soon as possible and finish the procedure only when the tip is at wanted point.

Another complication was infection within 5 days of insertion, of which the rate was 3.3% (4 cases, 2 cases from each group), which is fairly indifferent from other reports such as 9.45% of Zhang et al, (19) and 0.5% of Nolan et al. (20) The most common pathogen was gram-positive, usually Staphylococcus aureus. (19)

Occlusion of PICC occurred in one case in each group (1.6%). Occlusion rate has been reported up to 12% by Smith et al, (21) which was affected by serum hemoglobin, PICC insertion site, and tip placement. Furthermore, since occlusion can be affected by various treatments, our short-term result cannot be assumed as better outcome than other studies.

There are some limitations in this study. First, one year and 123 patients are small number of samples. Second, the one year experience of procedure in ICU is not sufficient for proper verification. Third, the complications were surveyed within short period of time, thus long-term effectiveness cannot be assessed. Lastly, there was not detailed investigations for why it was difficult to move patients in the ICU to IRR, thus they were not classified into what high risks they were in.

Conclusion

Ultrasonography-guided PICC insertion in ICU may result in more malposition. In consideration of limitations, the effectiveness of ultrasonography-guided bedside PICC insertion in ICU should be further evaluated with more experience and long-term prospective design to compare short-term and long-term complications in various high risk patients.

Table 1. Clinical characteristics of patients

Variable	Value
Age (y)	71.9±12.9
Sex	
Male	68 (55.3%)
Female	55 (44.7%)
ICU (%)	
Medical ICU	74 (60.2%)
Trauma ICU	10 (8.1%)
Emergency ICU	39 (31.7%)
PICC position	
Right basilic vein	56 (45.5%)
Right brachial vein	58 (47.2%)
Left brachial vein	9 (7.3%)
Place of procedure	
IRR	52 (42.3%)
ICU	71 (57.7%)

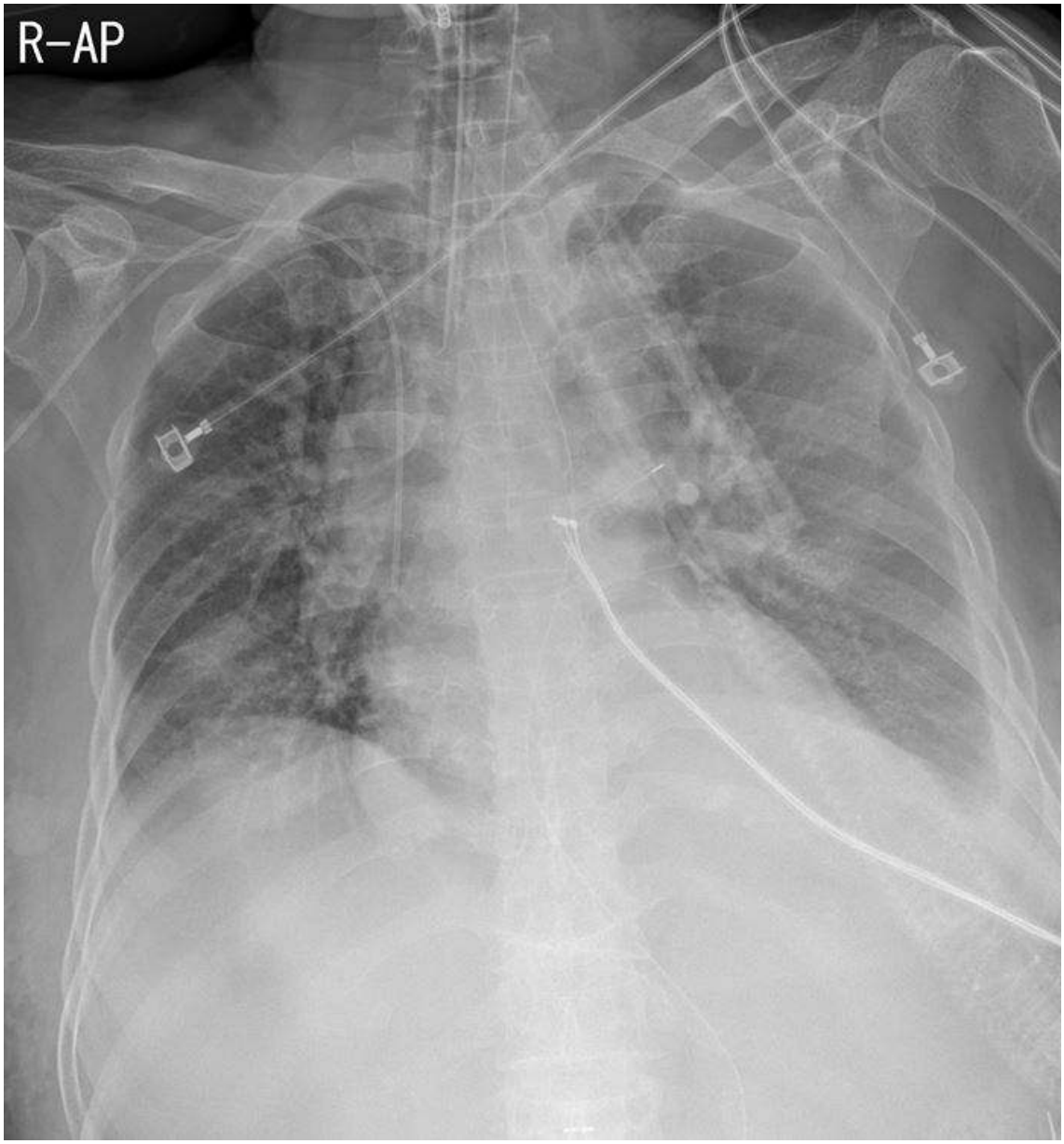
Legend: Values are presented as mean±standard deviation or number (%). ICU=intensive care unit; PICC=peripherally inserted central catheter; IRR=interventional radiology room.

Table 2. Complications of PICC

	ICU (n=72)	IRR (n=51)	Total (n=123)	p value
Complications	14 (19.7%)	4 (7.7%)	18 (14.6%)	0.074
Malposition	11 (15.5%)	1 (1.9%)	12 (9.8%)	0.013
Not in the lower third of SVC	7	1	8	
Right subclavian vein	3	0	3	
Left subclavian vein	1	0	1	
Infection	2 (2.8%)	2 (3.8%)	4 (3.3%)	
Occlusion	1 (1.4%)	1 (1.9%)	2 (1.6%)	

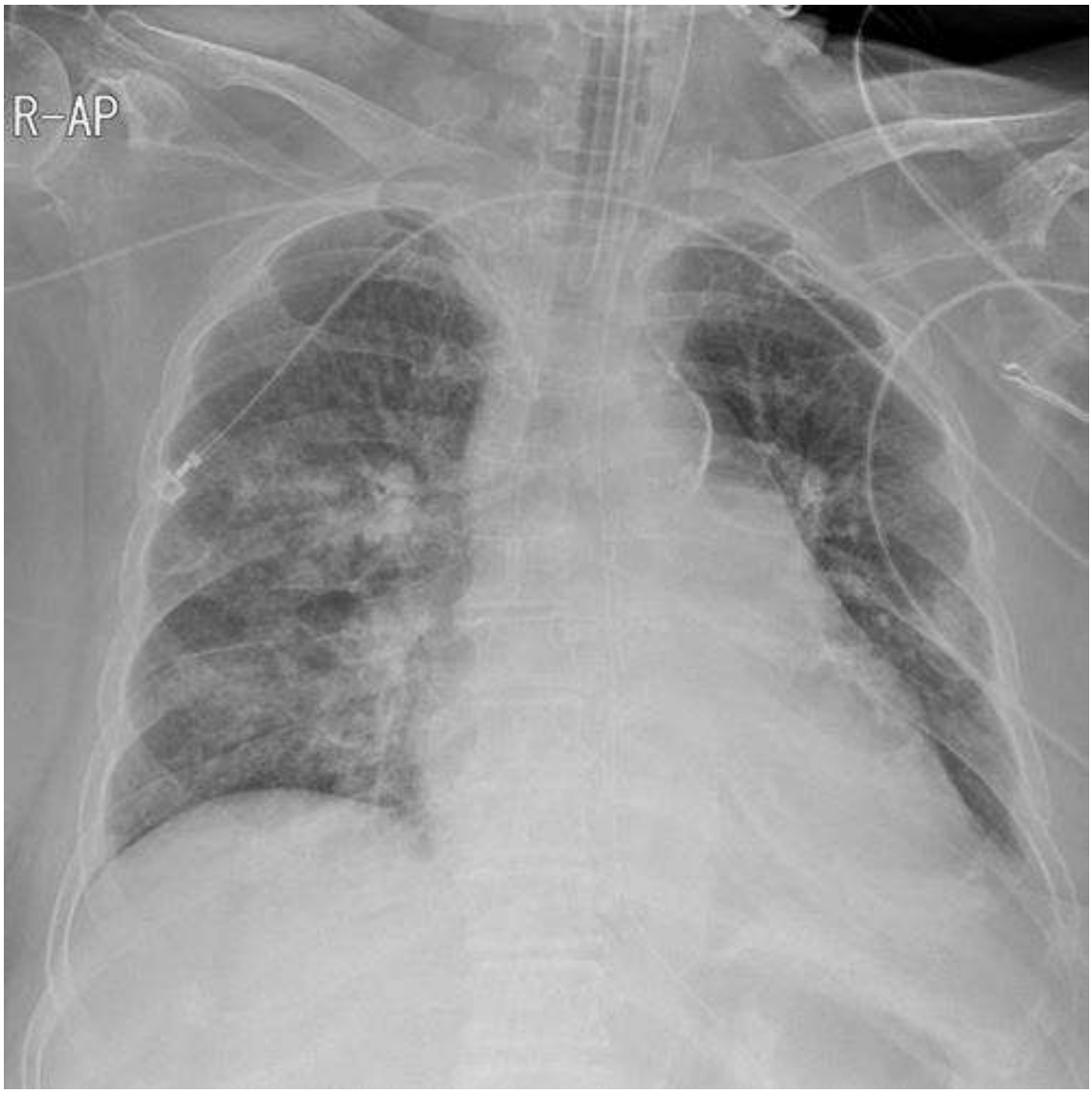
Legend: PICC=peripherally inserted central catheter; ICU=intensive care unit; IRR=interventional radiology room; SVC=superior vena cava.

Figure 1. Normal PICC tip located in lower 1/3 of SVC



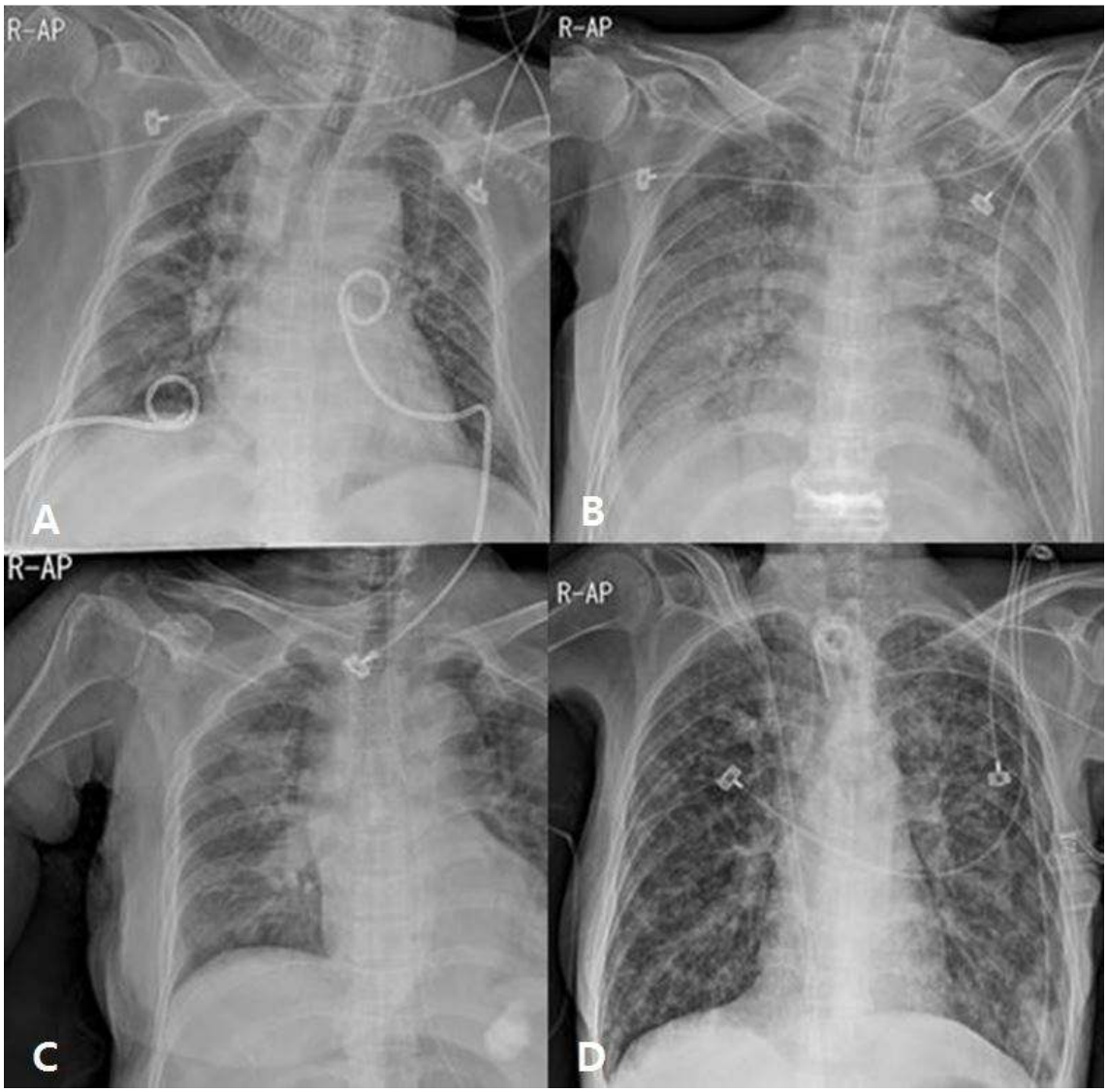
Legend: PICC=peripherally inserted central catheter; SVC=superior vena cava.

Figure 2. Malposition PICC tip located not in lower 1/3 of SVC



Legend: PICC=peripherally inserted central catheter; SVC=superior vena cava.

Figure 3. Malposition PICC tips



Legend: A=right subclavian vein; B=right subclavian vein; C=right subclavian vein; D=left subclavian vein. PICC=peripherally inserted central catheter.

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