

## RESEARCH COMMUNICATION

# Comparison of Complications of Peripherally Inserted Central Catheters with Ultrasound Guidance or Conventional Methods in Cancer Patients

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### Abstract

**Objective:** To compare the complications of peripherally inserted central catheters (PICC) by a modified Seldinger technique under ultrasound guidance or the conventional (peel-away cannula) technique. **Methods:** From February to December of 2010, cancer patients who received PICC at the Department of Chemotherapy in Jiangsu Cancer Hospital were recruited into this study, and designated UPICC if their PICC lines were inserted under ultrasound guidance, otherwise CPICC if were performed by peel-away cannula technique. The rates of successful placement, hemorrhage around the insertion area, phlebitis, comfort of the insertion arm, infection and thrombus related to catheterization were analyzed and compared on days 1, 5 and 6 after PICC and thereafter. **Results:** A total of 180 cancer patients were recruited, 90 in each group. The rates of successful catheter placement between two groups differed with statistical significance ( $P < 0.05$ ), favoring UPICC. More phlebitis and finger swelling were detected in the CPICC group ( $P < 0.05$ ). From day 6 to the date the catheter was removed and thereafter, more venous thrombosis and a higher rate of discomfort of insertion arms were also observed in the CPICC group. **Conclusion:** Compared with CPICC, UPICC could improve the rate of successful insertion, reduce catheter related complications and increase comfort of the involved arm, thus deserving to be further investigated in randomized clinical studies.

**Keywords:** Peripherally inserted central catheters - complications - cancer patients

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### Introduction

Peripherally inserted central venous catheter (PICC) was introduced into clinical use in the United States in 1980s. The main part of PICC is to insert an infusional catheter into human superior vein cava through arm elbow, basilica, median and cephalic vein (Fearonce et al., 2010). Although PICC could set up a safe and effective intravenous infusional system for cancer patients who are exposed to long-term venous medication, several adverse factors and complications, e.g. increase in economic burden, phlebitis and venous thrombosis still influence the quality of treatment (Fletcher et al., 2011; Sperry et al., 2012). Ultrasound-guided method combined with seldinger PICC was first proposed by Royer in 2000 (cited in Schweickert et al., 2009). Our hypothesis is that adverse effects, especially complications of conventional PICC could be avoided by ultrasound guided method. With this background, we carried out this study in 2010.

### Materials and Methods

#### Patient Eligibility

Patients were required to be pathologically diagnosed  
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with cancer and treated in the Department of Chemotherapy of Jiangsu Cancer Hospital from February to December of 2010; to sign the informed consent before PICC; to expose to long term chemotherapy or supportive care, hyperalimentation, repeated administration of blood or blood products or venous blood sampling; to have a score of karnofsky performance status  $\geq 70$ , and to be followed until the end of this study. Other eligibility criteria included: adequate hematological (white blood cell count  $> 3.0 \times 10^9$  and platelet count  $> 150 \times 10^9$ ), liver (bilirubin and transaminases  $< 1.5$  times the upper normal limit) and renal function (creatinine level  $< 1.5$  times the upper normal limit); patients were excluded from the study if they had active cardiac disease (LVEF  $< 50\%$ ), significant arrhythmia, any serious medical or psychiatric condition.

#### Methods

Ultrasound guided PICC catheterization (UPICC), which uses ultrasound guidance to visualize the vessels, and includes the following steps: A regular gauge hypodermic needle is inserted into a vein, then guide wire is passed several centimeters into the cannula, and cannula is removed leaving the guide wire in place. The guide wire is not advanced past the shoulder. An introducer

sheath with a dilator is introduced over the guide wire after a small incision is made on the skin near the wire; The guide wire and dilator are removed; The catheter is advanced through the introducer sheath; The introducer is then pulled back and removed. The position of the tip of the catheter is confirmed with a chest x-ray. Conventional PICC catheterization (CPICC), which is performed by feel only, steps are as follows: a cannula with a stylet is inserted into a vein near the elbow; after stylet is removed, PICC catheter is advanced through the cannula into the vein; then cannula is pulled back and peeled away from the catheter, and catheter is advanced further into the vein under ultrasound until it reaches the terminating point. The position of the tip is confirmed with a chest x-ray.

After PICC and during follow-up, information on PICC and related complications, eg., successful catheterization, abnormal tip location, bleeding, exudation, phlebitis, and discomfortability of insertion arms will be carefully recorded.

Phlebitis classification criterion is in line with U.S Institute of intravenous infusion care, the degree of phlebitis were 0 no symptoms;1 Erythema at access site with or without pain; 2 Pain at access site with erythema and/or edema; 3 Pain at access site with erythema and/or edema, Streak formation, Palpable venous cord;4 Pain at access site with erythema and/or edema, Streak formation, Palpable venous cord > 1 inch in length, Purulent drainage (Smeltzer et al., 2000; Fernandez et al., 2003).

All study data were analyzed through the STATA 8.0 software (Stata Corporation, 4905 Lakeway Drive College Station, Texas 77845 USA).  $P < 0.05$  was considered statistically significant.

## Results

The number of patients who fulfil the study eligibility was 180, and they were divided into UPICC or CPICC group. The number of UPICC group which adopted ultrasound-guided combined with improved Seldinger PICC catheterization was 90, including 54 male patients and 36 female patients, the age arranging from 22 to 79. The number of CPICC which adopted traditional PICC method was 90, including 58 male patients and 32 female patients, with age arranging from 26 to 74.

No statistically significant difference was detected

**Table 1. Characteristics of 180 Cancer Patients Who Received Ultrasound Guided Peripherally Inserted Central Venous Catheterization (UPICC) or Conventional PICC (CPICC)**

	UPICC	CPICC	p value
Age (range of age)	22~79	26~74	>0.05
Gender			>0.05
Male	(N) 54	58	
Female	(N) 36	32	
Cancer site			>0.05
Lung	(N) 25	23	
Gastrointestinal	(N) 45	50	
Breast	(N) 20	17	
Abnormal Clotting time	(N) 0	0	>0.05

N, number

**Table 2. Comparison between 180 Cancer Patients who received Ultrasound Guided Peripherally Inserted Central Venous Catheterization (UPICC) or Conventional PICC (CPICC)**

	UPICC N(%)	CPICC N(%)	P value
Successful PICC placement	89(98.9)	82(91.1)	0.04
Abnormal tip location of catheter	2(2.2)	9(10)	0.02

**Table 3. Complication Comparison Between Cancer Patients Who Received Ultrasound Guided Peripherally Inserted Central Venous Catheterization (UPICC) or Conventional PICC (CPICC)**

	UPICC N(%)	CPICC N(%)	P value
On second day of catheterization			
Hemorrhage	15(16.6)	18(20)	0.118
Pain	8(8.9)	10(11.1)	0.962
On fifth day of catheterization			
Hemorrhage	8(8.9)	12(13.3)	0.74
Phlebitis	1(1.1)	10(11.1)	0.001
Swelling	2(2.2)	9(10)	0.03
On six day to removal of catheter*			
Venous thrombosis	0(0)	6(7.5)	0.03
Catheter related infection	1(1.2)	3(3.8)	0.57
Discomfortability on insertion arms	2(2.4)	16(20)	0.001

\*According to follow-up analysis, five days after catheter removal, sample size was 85 in UPICC

between two group of patients in age, gender, cancer site, and clotting time (Table 1).

In Table 2, it suggested that rates of successful PICC placement and abnormal tip location of catheter were significantly different (both  $p < 0.05$ ) between two groups, that is 98.9% and 2.2% in UPICC, better than what observed in CPICC group. There were significant differences in phlebitis (1.1% in UPICC vs. 11.1% in CPICC) and finger swelling (2.2% in UPICC vs. 10% in CPICC) between two groups ( $P < 0.05$ ). During the sixth day to removal of catheter, statistically significant difference was revealed between two groups in terms of venous thrombosis and comfortability of insertion arms (Table 3). More thrombosis (7.5%) and discomfortability (20%) were recorded in CPICC than in UPICC group (0% and 2.4% , respectively).

## Discussion

PICC has been performed for more than 10 years in Jiangsu Cancer Hospital and Resarch Institute. Some information regarding research and clinical work of this hospital has been introduced elsewhere (Huang et al., 2004; Zhou et al., 2009; Jiang et al., 2010; Yan et al., 2010; Huang et al., 2011; Li et al., 2011; Li et al., 2011). Practitioners with good training and experience were arranged to conduct CPICC in Jiangsu Cancer Hospital and Resarch Institute. Before catheterization, they have to distinguish the location of a vein in the capital fosse or elbow by their naked eyes. This has been attributed to be a risk factor of imprecision and of unsuccessful venous puncture rate of CPICC that is reported around 65% to

91% (Yaghmai et al., 1998). Compared with CPICC, our study suggested that UPICC could clearly identify the vascular structure, therefore, increase the successful rate of venous puncture to 98.9%. Results of this study also revealed that the possibility of bleeding was reduced during UPICC. One reason is that needle of CPICC could impose more damage to vascular endothelium and induce more hemorrhage. This is different compared with UPICC, during which a tiny needle is employed to puncture the tissue and a blade to expand the operation field, thus reduced hemorrhage and exudation. The same reason could also explain our results that the occurrence of phlebitis during UPICC is less common than that observed during CPICC. Phlebitis was one of the most common complications in the PICC catheter, with the incidence reported around 2.6% to 9.7% (Zheng et al., 2004), and usually occurred within 5 days after catheterization (Du et al., 2005). For CPICC, catheter line is usually placed along the median or cephalic vein that is relatively superficial, and easy to be fixed. However these two veins, are thought to hold more venous valves and branches, making catheterization unsuccessful. In our study, rate of phlebitis in CPICC was 11.1%, that is in line with previous study, with another main risk considered to be repeat venous puncture (Nicholson et al., 2010). In addition to above reasons, other risk factors including weather condition in Nanjing that is hot and humid from June to October and makes patients sweat more, easy to be bacteria infected, also contributed to the high rate of phlebitis. On the other hand, during UPICC, practitioner could clearly view the structure of basilica vein that is usually straight, so that the length of catheter is shortened, thus reduce phlebitis (Wu et al., 2008). In our study, only one patient in UPICC group, with large body mass index and excessive sweating, was detected to suffer from phlebitis. In terms of venous thrombosis, which is the most dangerous complication caused by PICC, and generally occurs in 14 to 53 days after catheterization (Zhou et al., 2008), our results suggested that it was less common in UPICC than in CPICC group. We considered the reason could be in line with what observed in phlebitis.

In conclusion, considering low complications of UPICC when compared with CPICC, UPICC should be strongly recommended in clinical practice especially to cancer patients, who need long-term intravenous medications.

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