

Comparison of a Subclavian Vein Approach with a Peripheral Vein Approach in the Insertion of a Central Venous Catheter

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Summary. The purpose of this study was to evaluate the safety and usefulness of a peripheral vein approach when inserting a central venous catheter (CVC) as compared with a subclavian vein approach (infraclavicular approach).

During the period April-July, 1998, a total of 51 patients (41 male, 10 female) underwent the insertion of central venous catheters by a subclavian vein or peripheral vein approach at Department of Surgery I, Niigata University Medical Hospital. A total of 59 cases received central venous cannulation: 41 cases (38 patients; 29 male, 9 female) by a subclavian vein approach, and 18 cases (17 patients; 16 male, one female) by a peripheral vein approach. Four patients experienced both approaches.

Age, male-female ratio, body weight, underlying diseases, average number of days of catheterization, maximum calories administered, frequency of trials until successful insertion, frequency of complications, and rates of catheter related infection were compared between the two groups.

Although the peripherally approached group experienced a significantly higher frequency of trials until successful insertion than the subclavian approached group (1.3 ± 0.5 vs 1.1 ± 0.4 ; $p < 0.05$), there were no significant differences in other factors between two groups. Serious complications such as pneumothorax or arterial puncture were significantly frequent in the CVC group as compared with the peripherally inserted central venous catheter (PICC) group ($p < 0.05$).

In conclusion, a peripheral vein approach proved less dangerous at insertion compared with a subclavian vein approach.

Key words—central venous catheter, peripheral vein approach, subclavian vein approach.

INTRODUCTION

Since the introduction of total parenteral nutrition (TPN) in the 1960s¹⁾, the application of a central venous access to provide nutritional support has continued to increase, and has now become standard care in most hospitals.

There are several methods available for achieving a central venous access for TPN. In general, the subclavian vein approach, which sometimes causes severe complications such as pneumothorax or hemorrhage, is the most popular method for the insertion of a central venous catheter (CVC). However, recent procedures for a peripheral vein approach using a peripherally inserted central venous catheter (PICC) have also gained in favor²⁾. Since we introduced PICC at our department in April, 1998, we have performed both methods for the insertion of a central venous catheter.

The purpose of the present study was to evaluate the safety and usefulness of a peripheral vein approach when inserting a central venous catheter, comparing this with a subclavian vein approach (infraclavicular approach).

PATIENTS AND METHODS

A retrospective study was conducted on a total of 51 patients (41 male, 10 female) who had undergone the insertion of central venous catheters by a subclavian vein or peripheral vein approach in the Department

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of Surgery I, Niigata University Medical Hospital, during the period April-July, 1998. Patient information was obtained from hospital and office charts. A total of 59 trials were performed for the insertion of central venous catheters; these were divided into the two groups according to the approach: 41 trials in 38 patients who underwent a subclavian vein approach via an infraclavicular route, using 16 G sized Medicut central venous catheters (Sherwood Japan, Tokyo, Japan) (CVC group), and 18 trials in 17 patients who received a peripheral vein approach, using 4 Fr sized Groshong central venous catheters (Bard Access Systems, Salt Lake City, USA) (PICC group). Four patients experienced both approaches at different periods for receiving TPN.

Both CVC and PICC were inserted percutaneously at the bedside using strict sterile techniques, including gloves. CVC were inserted into the subclavian vein via an infraclavicular route, and PICC were inserted into suitable peripheral veins, usually at the antecubital fossas or forearms. Chest X-rays were performed after insertion to confirm the central positions of catheters. Both catheterotypes were inserted by young resident doctors of our department under the direction of well-trained senior doctors.

These two groups were compared in the following aspects: duration of catheter insertion, maximum calories administered, frequencies of puncture until successful insertion, complications during and after insertion, and frequency of catheter sepsis. Fever over 38°C without any evident focus of infection and

defevescence after removal of an implicated catheter were defined as catheter sepsis.

A total of 770 CVC and 441 PICC days was analyzed. There were 38 males and 10 females in the CVC group, and 16 males and 1 female in the PICC group. One female had experienced PICC insertion twice.

Statistical analysis was performed using standard descriptive statistics, the Mann-Whitney U-test, and chi-square analysis. Statistical significance was defined as $P < 0.05$.

RESULTS

There were no significant differences in background such as age, male-female ratio, or body weight between the two groups (Table 1). Also, there was no statistically significant difference in the distribution of underlying diseases between the two groups (Table 1).

No significant differences were observed in the duration of catheter placement (days), maximum calories administered, frequencies of complications, and rate of catheter related infections between the two groups. However, the PICC group clearly showed a higher frequency of trials until successful insertion than the CVC group ($p < 0.05$) (Table 2).

The catheter-related complications of both groups are summarized in Table 2. Although complications that occurred during insertion such as pneumothorax or arterial puncture were observed with higher fre-

Table 1. Background of catheter inserted patients

	CVC	PICC	
Age (years old)	58.6±16.4	56.7±15.6	N.S.
Male: Female	32 : 9	16 : 2	N.S.
Body weight (kg)	65.2±30.2	59.0±9.1	N.S.
Esophageal tumors	12	5	
Gastric tumors	6	1	
Colo-rectal tumors	6	6	
Hepato-biliary-pancreatic tumors	8	0	
Inflammatory bowel diseases	7	5	
Others	2	1	

CVC, central venous catheter; PICC, peripherally inserted central venous catheter.

Table 2. Comparison of CVC and PICC

	CVC	PICC	
Duration of catheter insertion (days)	18.7±13.5	24.5±17.4	N.S.
Maximum calories (kcal)	1116±528	1111±557	N.S.
Puncture for success (times)	1.1±0.4	1.3±0.5	$p < 0.05$
Complications (cases)	3	2	N.S.
Catheter sepsis (cases)	3	1	N.S.
Complications			
During insertion			
Pneumothorax	1	0	
Arterial puncture	2	0	
After the catheter placement			
Phlebitis	0	2	

(mean±standard deviation) N.S., not significant; CVC, central venous catheter; PICC, peripherally inserted central venous catheter.

quency in the CVC group, complications that occurred after the catheter placement were observed more often in the PICC group ($p < 0.05$).

DISCUSSION

Peripherally inserted central venous access catheters have been used since the 1940s. One of the complications of this approach is vein phlebitis³. In the late 1960s, a central venous access by direct cannulation of subclavian and jugular vein became popular. This subclavian vein approach for the insertion of central venous catheter confers some benefits upon patients: it is less restrictive of the patient's movement, and is easily kept clean at the insertion point. However, severe complications including pneumothorax and hemorrhage may sometimes accompany a subclavian vein approach. Since the report on the use of silastic PICC for parenteral hyperalimentation by Hoshal in 1975⁴, PICCs have become increasingly popular⁵⁻⁷.

A silastic Groshong central venous catheter has been used in Japan since 1995, and we have used this catheter at our hospital since April, 1998. The present study showed that factors including average durations of catheter placement, maximum calories administered, frequencies of complications, and rate of catheter related infections showed no significant difference between CVC and PICC groups. Serious and sometimes lethal complications such as pneumothorax or arterial puncture were observed with a higher frequency in the CVC group compared with the PICC group ($P < 0.05$). Among our cases, complications of PICC included phlebitis, identified in 2 cases (11.1%); this rate was within the degree of phlebitis reported in the past (2.2~23%)^{2,4,8-15}. When phlebitis occurred, we attempted to cover the skin at the inflammatory vessels with an anti-inflammatory compress. An improvement was seen in one case; however, the catheter might be removed in another such case because of progressed phlebitis. Phlebitis is an uncomfortable but less dangerous and lethal complication compared with pneumothorax or arterial puncture observed in CVC group. Although other complications such as thrombosis (0~8.5%), catheter occlusion (0~22%) and catheter breakage (0~9.6%)^{2,4,8-15} have been reported, none of these were recognized in our cases. These results suggest that PICC is safer during the insertion of a catheter, but produces more frequent phlebitis than CVC.

In the present study, the PICC group experienced a significantly higher frequency of trials until successful insertion than the CVC group (1.3 ± 0.5 vs 1.1 ± 0.4 $p < 0.05$). We experienced 6 cases with difficulty for

inserting PICC. In 4 of those cases, it was difficult to identify peripheral vessels, and some factors such as venous sclerosis originating from age or narrow vessels caused problems for inserting PICC. As for technical factors, skin swelling by subcutaneous injection of local anesthetic drugs, or putting on sterile globes seemed to make it difficult to identify peripheral vessels. In our cases, marking the lines on the skin close to the vessels before putting on globes was effective for identifying the vessels.

In the present study, catheter mislodgings not positioned within the superior vena cava, were seen in 6 cases. When a mislodging was recognized by chest x-ray, the position of the catheter was corrected. PICCs are placed under radiographic and/or ultrasonographic guidance at a certain institute¹⁶.

In summary, a peripheral vein approach was less dangerous in the insertion of catheter compared with a subclavian vein approach. Future study will be required to establish easy and reliable methods for insertion.

REFERENCES

- 1) Dudrick SJ, Wilmore DW, Vars HM, Rhoads JE: Long-term total parenteral nutrition with growth, development, and positive nitrogen balance. *Surgery* **64**: 134-142, 1968.
- 2) Loughran SC, Borzatta M: Peripherally inserted catheters: a report of 2560 catheter days. *JPEN* **19**: 133-136, 1995.
- 3) Walters MB, Stanger HA, Rotem CE: Complications with percutaneous central venous catheters. *JAMA* **220**: 1455-1457, 1972.
- 4) Hoshal VL: Total intravenous nutrition with peripherally inserted silicon elastomer central venous catheters. *Arch Surg* **110**: 644-646, 1975.
- 5) McDonald AS, Master SKP, Moffitt EA: A comparative study of peripherally inserted silicon catheters for parenteral nutrition. *Can Anaesth Soc J* **24**: 263-269, 1977.
- 6) Prian GW, Van Way CW: The long arm silastic catheter-acritical look at complications. *JPEN* **2**: 124-128, 1978.
- 7) Geiss AC, Fianagan SJ, Grossman A: Evaluation of 75 patients with the long arm silastic catheter. *JPEN* **3**: 462-464, 1979.
- 8) Bottino J, McCredie KB, Groschel DH, Lawson M: Long-term intravenous therapy with peripherally inserted silicone elastomer central venous catheters in patients with malignant diseases. *Cancer* **43**: 1937-1943, 1979.
- 9) Schuman E, Brady A, Gross G, Hayes J: Vascular

- access options for outpatient cancer therapy. *Am J Surg* **153**: 487-489, 1987.
- 10) Graham DR, Keldermans NN, Klemm LW, Semenza NJ, Shafer ML: Infectious complications among patients receiving home intravenous therapy with peripheral, central, or peripherally placed central venous catheters. *Am J Med* **91 (Suppl 3B)**: 95s-100s, 1991.
 - 11) Lam SR, Roessler D, Smith M: Peripherally inserted central catheters in an acute-care hospital. *Arch Intern Med* **154**: 1833-1837, 1994.
 - 12) Merrell SW, Peatross BG, Grossmann MD, Sullivan JJ, Harker WG: Peripherally inserted central venous catheters -low-risk alternatives for ongoing venous access. *West J Med* **160**: 125-130, 1994.
 - 13) Cardella JF, Cardella K, Bacci N, Fox PS, Post JH: Cumulative experience with 1273 peripherally inserted central venous catheters at a single institution. *J Vasc Intern Radiol* **7**: 5-13, 1996.
 - 14) Ng PK, Ault MJ, Ellrodt AG, Maldonado L: Peripherally inserted central catheters in general medicine. *Mayo Clin Proc* **72**: 225-233, 1997.
 - 15) Smith JR, Friedell ML, Cheatham ML, Martin SP, Cohen MJ, Horowitz JD: Peripherally inserted central catheters revised. *Am J Surg* **176**: 208-211, 1998.
 - 16) Chrisman HB, Omary RA, Nemcek AA, Ryu RK, Saker MB, Vogelzang RL: Peripherally inserted central catheters: guidance with use of US versus venography in 2,650 patients. *J Vasc Interv Radiol* **10**: 473-475, 1999.