Int J Clin Exp Med 2017;10(4):7173-7176
www.ijcem.com /ISSN:1940-5901/IJCEM0021540

Original Article

Improvement of insertion success rate of a modified peripherally inserted central catheter

Liren Wang, Miaojuan Gu

Huashan Hospital Affiliated to Fudan University, Shanghai 200040, P. R. China

Received December 9, 2015; Accepted July 8, 2016; Epub April 15, 2017; Published April 30, 2017

Abstract: Objective: To explore the application value of a modified peripherally inserted central catheter (PICC) technique. Methods: We compared modified PICC (observation group) and traditional PICC (control group) methods based on their insertion success rates, time requirements, patient comfort, and other aspects. Results: The first attempt success rate in 582 patients in the observation group was 100%, while the rate in 773 patients in the control group was 90.8% with a second attempt rate of 9.2% ($P<0.05$); the mean time required was 43.81±10.27 min in the observation group and 68.20±7.89 min in the control group ($P<0.05$). Thus, there were significant differences between the two groups. Conclusion: This modified PICC method can effectively decrease the incidence of catheter malposition, require less time, and is convenient for both the clinical medical worker and the patient. Therefore, this technique should be promoted in clinical practice.

Keywords: Peripherally inserted central catheter, insertion method, application value

Introduction

Currently, the peripherally inserted central catheter (PICC) infusion technique is widely used in clinical practice; however, catheter malposition (i.e., the catheter tip misses the superior vena cava), which occurs in blind insertion, is a common cause for first attempt failure. Between March and August, 2012, we adopted the modified PICC insertion method on 582 patients who underwent PICC placement. Among these, 582 cases had successful placement with an insertion success rate of 100%. Here, the method is summarized.

Materials and methods

Subjects

A total of 582 patients who underwent PICC placement between March and August 2012 were included in the observation group, while 773 patients who underwent PICC between February and September 2010 were enrolled in the control group. The general conditions of subjects are shown in **Table 1**. We used PICC catheters with a three-way valve (4-Fr PICC, Bard Access Systems Inc.) for all patients.

Inclusion criteria

1). The involved limb had no anatomic or structural abnormalities; 2). The basilic vein in the involved limb was the first choice (including patients with a failed first puncture, another puncture site was selected); 3). The involved limb could be abduced to form a 90° angle with the body; 4). The catheter tip was placed at the lower third of the superior vena cava after puncture was completed.

Selection of puncture site and external measurement method

The first choice was the right basilic vein [1-3] for most patients; the left basilic vein was chosen in patients with right breast disease because the right upper extremity was not suitable for puncturing. The puncture site selected for each enrolled patient is shown in **Table 2**. The external measurement procedure was performed according to the method of Du et al. [4]: the length from the puncture site to the right

Table 1. Comparisons of general conditions between groups

	Observation group	Control group
Cases (n)	582	773
Male (n, %)	301 (51.72)	376 (48.64)
Female (n, %)	281 (48.28)	397 (51.36)
Age (years)	46.31±19.77	50.49±20.25
Blood diseases (n, %)	119 (20.45)	126 (16.30)
Gastrointestinal tumors (n, %)	308 (52.92)	407 (52.65)
Breast diseases (n, %)	155 (26. 63)	240 (31. 05)

Table 2. The selection of punctured vein in the two groups (n, %)

Group	Cases	Puncture site (the first choice)	
		Left basilic vein	Right basilic vein
Observation group	582	155 (26.7)	427 (73.3)
Control group	773	240 (31.0)	533 (69.0)[a]

[a]*P*>0.05, there was no significant difference in the selection of basilic vein between the left and right extremities.

Table 3. Comparison of the success rate between the two insertion methods (n, %)

Group	Cases	First attempt success rate	Second attempt success rate	Total success rate
Observation group	582	582 (100)	0 (0)	582 (100)
Control group	773	702 (90.8)[a]	71 (9.2)[b]	773 (100)[c]

[a]*P*<0.05, the observation group was superior to the control group based on the first attempt success rate. [b]*P*>0.05, no significant difference was found in the second attempt success rate between the two groups. [c]*P*<0.05, the observation group was superior to the control group based on the total insertion success rate.

sternoclavicular joint and then downward to the second rib was measured.

Criteria for successful catheter insertion

First attempt success depended on the observation of blood after the first pricking or subcutaneous vascular detection was seen less than three times. Second attempt success was defined as selecting another puncture site, including less than three times of subcutaneous vascular detection [5].

Traditional insertion method

The patient was placed at the required position, and one operator measured the arm circumference and required length, performed the puncture after disinfection, and withdrew the stylet following confirmation of the point of entry of the introducer sheath into the blood vessel followed by slowly advancing the catheter along the introducer sheath. We asked each patient to turn his or her neck toward the puncture side, making the lower mandible touch to the shoulder to the greatest extent and advanced the catheter to the required graduation. Then, we pumped the returned blood and injected physiological saline in pulse to determine whether it was smooth and conducted positioning by radiography following the connection of heparin caps. We needed to adjust the position of the guide wire if X-ray film showed catheter malposition, until it was smooth, followed by positioning by radiography, which referenced PICC-related operating regulations of the Infusion Nursing Association [7]. During this process, the patient was placed at the required position (the involved limb formed a variety of angles with the body) [6].

Modified insertion method

The patient was placed at the supine position. We selected the puncture site, measured the arm circumference, the distance from the puncture site to the right sternoclavicular joint and then to the second rib, and made the punctured arm form a 90° angle with the body. We advanced the needle after skin disinfection, i.e. one operator advanced the catheter, while the other operator linked a 20 ml syringe to the tail-end of the catheter and slowly injected 0.9% sodium chloride solution, advancing the catheter when flushing the catheter in pulse until the catheter was advanced to the required graduation. Finally, we screened chest film to determine the position of the catheter tip without the firm attachment of the lower mandible to the shoulder of the patient.

Statistical analysis

All statistical analyses were performed using SPSS 19.0. The count data were analyzed using

Table 4. Comparison of time requirements between the two insertion methods (min)[a]

Group	Cases	Time required for first attempt success	Time required for second attempt success	Average time required
Observation group	582	43.81±10.27	-	43.81±10.27
Control group	773155	45.75±11.94[b]	84.21±6.77	68.20±7.89[c]

[a]Time required in this study was defined as the time from preparing used objects to positioning under radiography. [b]$P<0.05$, the time required for first attempt success in the observation group was slightly superior to that of the control group. [c]$P<0.01$ the average time required in the observation group was significantly superior to that of the control group.

the chi-squared test to compare the frequency of parameters. The measurement data were tested using the independent sample t-test to compare the mean and standard deviation. A level of $P<0.05$ was considered statistically significant.

Results

Comparison of insertion success rate between the two groups (**Table 3**).

Comparison of time requirements between the two groups (**Table 4**).

Conclusions

The modified insertion method can improve the insertion success rate and reduce complications

Catheter malposition is a common problem in PICC positioning with an incidence of 12.5-24.6% using traditional methods [8]. Disadvantages include obvious increases in the occurrence of other complications of PICC positioning, such as fluid leakage, limb swelling, pain, and so on; in addition, some special risks like the collection of fluid around the vertebra, atria fibrillation, and so forth are seen [9]. Foreign studies have shown [10-12] that only good preventive work during catheter insertion can effectively prevent catheter-related bloodstream infection (CR-BSI). Data have revealed that phlebitis occurring in the early stage of catheter insertion is usually related to repeated mechanical injury during puncturing [13]. Accordingly, first attempt success can reduce the occurrence of various adverse effects and complications. **Table 3** shows that the insertion success rate in the observation group was significantly greater than that in the control group (100% vs. 90.8%, respectively). Thus, the modified PICC technique effectively reduced the incidence of catheter malposition. There have been many studies using various methods to reposition malpositioned catheters. The method in which the assistant injects physiological saline from the connecter-connecting end of the catheter when advancing the catheter again provides a greater success rate [14, 15]. Therefore, this method was an effective method for successful catheter insertion.

The modified insertion method can reduce the time required for PICC placement

As shown in **Table 3**, the time required for PICC placement in the observation group was significantly less than that in the control group, which not only improved the operator efficiency but also saved patient's time based on first attempt success.

The modified insertion method is convenient for the patient

Xie et al. [16] confirmed that the traditional position (the patient is placed at the supine position with the involved limb forming a 90° angle with the body and the head is turned to the puncture side with the lower mandible firmly bent toward the shoulder) cannot reduce the occurrence of cathetermalposition. This modified insertion method did not require the patient to turn his or her head or change position during puncture, which decreased the occurrence of anxiety related to a failed puncture due to their ownactions as well as relieved psychological burden of the patient. At present, many researchers randomly monitor catheter insertion using a simulator; however, this expense greatly increases the economic burden on the patient. Considering the patient-centered principle, the modified insertion method is economical and convenient.

Summary

Abroad, intravenous therapy has been assessed in depth. The safety, efficacy, expense,

and indications of applied products have become the norm [17]. In China, various techniques of PICC placement are still rapidly developing. Under conditions without a simulator, this modified PICC insertion method can effectively reduce the incidence of catheter malposition, which makes it convenient for both clinicians and patients. However, this method needs good coordination between the operator and assistant. Therefore, only good coordination between PICC operators can make this method useful in the clinic.

Disclosure of conflict of interest

None.

Address correspondence to: Miaojuan Gu, Huashan Hospital Affiliated to Fudan University, Shanghai 200040, P. R. China. Tel: 86021-52888065; Fax: 86021-62486379; E-mail: gumiaojuan@hotmail.com

References

[1] Renan Uflacker, Shu Q, Zhang XF, trans. Renan Uflacker, Atlas of Vascular Anatomy: An Angiographic Approach. Shenyang: Liaoning Science and Technology Press; 1997. pp. 263.

[2] Lou XF, Gao JH, Zhu HH. Causes and prevention of malpositioning of peripherally inserted central catheter in neonates. Chin J Nurs 2004; 39: 621-622

[3] Tamburro RF, Conner DT, Proctor KE, Butler CL, Britton LR. The effect of amediastinal mean on the initial positioning of a peripherally inserted central venous catheter. Infus Nurs 2003; 26: 92-96.

[4] Du P, He PY, He MQ, et al. Comparison of Two Different External Measurement Methods of PICC. Journal of Nursing Science (Surgery) 2008; 23: 41-43.

[5] Dong WX, Qiao AZ, Li XH. Comparison of PICC intubation and subclavian vein catheter applied in hematologic disease patients. Chin J Nurs 2003; 38: 3-33.

[6] Wang LR, Wei Y, Sun XC. Application of peripherally inserted central venous catheter and central venous catheter in the surgical nutrition. Chin J Clin Nutrit 2011; 19: 417-421.

[7] Philpot P, Griffiths V. The peripherally inserted central catheter. Nurs Stand 2003; 7: 39-46.

[8] Xu XY. Reasons and prevention of PICC malpositioning. Chin J Pract Nerv Dis 2007; 10: 124-125.

[9] Mitsufuii N, Matsuo K, Kakita S, Ikuta H. Extravascular collection of fluid around the vertebra resulting from malpositioning of a peripherally inserted central venous catheter in extremely low birth weight infants. Perinat Med 2002; 30: 341-344.

[10] Alonso-Echanove J, Edwards JR, Richards MJ, Brennan P, Venezia RA, Keen J, Ashline V, Kirkland K, Chou E, Hupert M, Veeder AV, Speas J, Kaye J, Sharma K, Martin A, Moroz VD, Gaynes RP. Effect of nurse staffing and antimicrobial-impregnated central venous catheters on the risk for bloodstream infections in intensive care units. Infect Control Hosp Epidemiol 2003; 24: 916-925.

[11] Safdar N, Maki D. Risk of catheter-related bloodstream infection with peripherally inserted central venous catheters used in hospitalized patients. Chest 2005; 128: 489-495.

[12] Climo M, Diekema D, Warren DK, Herwaldt LA, Perl TM, Peterson L, Plaskett T, Price C, Sepkowitz K, Solomon S, Tokars J, Fraser VJ, Wong E. Prevalence of the use of central venous access devices within and outside of the intensive care unit: Results of a survey among hospitals in the prevention epicenter program of the Centers for Disease Control and Prevention. Infect Control Hosp Epidemiol 2003; 24: 942-945.

[13] Harter C, Ostendorf T, Bach A, Egerer G, Goldschmidt H, Ho AD. Peripherally inserted central venous catheters for autologous blood progenitor cell transplantation in patients with haematological malignancies. Support Care Cancer 2003; 11: 790-794.

[14] Zhao RW, Xie CQ, Cao SJ. Reason analysis and nursing care of 25 cases of PICC ectopia. Chin J Nurs 2009; 44: 526-528.

[15] Wang CL, Zhang MY, Zhang WP, et al. The improvement of reposition method of dislocated PICC catheter in the internal jugular vein. Chin J Nurs 2010; 45: 560-561.

[16] Xie J, Tang YF, Luo XY. Impact of body position on incidence of PICC malpositioning. Chinese Journal of Clinical Nutrition 2011; 19: 422-423.

[17] Kathryn EH, Lauren DB. Skilled IV therapy clinicians' product evaluation of open-ended versus closed-ended valve PICC lines a cost saving clinical report. J Intraven Nurs 1996; 19: 198-210.