

Peripherally inserted central catheters in palliative care patients: Our single-center experience

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ABSTRACT

Objectives: In this study, we present our experience in the insertion technique of peripherally inserted central catheters and catheter-related thrombosis.

Patients and methods: In this single-center, retrospective study, 19 PICCs inserted in 18 palliative care patients (7 males, 11 females; median age 59 years; range, 24 to 89 years) at Gülhane Training and Research Hospital between January 2017 and December 2019 were analyzed. The main indications for PICCs were parenteral supportive treatments. All procedures were performed under strict aseptic conditions using real-time ultrasound imaging with fluoroscopy guidance.

Results: The median dwell time of PICCs was 38 (range, 6 to 202) days. The PICC was left in situ for less than one month in five patients. Mortality and bloodstream infections were the most common causes of removing catheters which remained less than two months. Approximately two-thirds of our patients were on low-molecular-weight heparin, while their catheters were functioning.

Conclusion: Appropriate techniques such as determining the appropriate catheter for the vessel to be catheterized, real-time ultrasound during cannulation, and fluoroscopy should be used to minimize the complication risks.

Keywords: Catheterization, fluoroscopy, peripheral, thrombosis, ultrasonography.

The ability to obtain a secure and reliable venous access is crucial for hospitalized and critically ill patients.^[1] It is particularly vital for patients who often require recurrent blood sampling, parenteral nutrition, fluid replacement, and medications. Venous access can be obtained through conventional peripheral intravenous lines, peripherally inserted central catheters (PICCs) and central venous catheters (CVCs).

The majority of hospitalized patients receive a certain type of vesicant and irritant medications. If these medications are infused through peripheral intravenous lines, they lead to phlebitis. Therefore, CVCs can be safely used for the infusions of such drugs. However, CVC insertion is associated with the risk for life-threatening complications such as accidental arterial puncture, pneumothorax, arrhythmias, air embolism, hemothorax, and tamponade.^[1]

Recently, PICCs are considered as common devices which obtain central venous access in the different medical settings.^[2] This can be explained by various features of PICCs. For instance, CVCs can be inserted into the internal jugular and subclavian veins, but not into peripheral veins so that CVC-related procedural complications such as pneumothorax and hemothorax can be avoided. Moreover, CVCs are for short-term use and can only be used in the hospital. The PICCs may remain *in situ* for weeks or months and can avoid the pain of frequent needle sticks and reduce the risk for irritation to the smaller veins. Moreover, PICCs can be placed easily at the bedside, as well as used in the outpatient setting.^[1,3]

Although the use of PICCs provides numerous benefits, it is also associated with certain complications. Although PICCs may result in problems such as

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migration, displacement, occlusion, and infection, PICC-related deep vein thrombosis (DVT) has been recently reported, as DVT can lead to a wide range of problems from catheter removal and discontinuation of treatment to life-threatening pulmonary embolism.^[4]

In this study, we present our experience in the insertion technique of PICCs and catheter-related thrombosis in the light of current literature data.

PATIENTS AND METHODS

In this single-center, retrospective study, 19 PICCs inserted in 18 palliative care patients (7 males, 11 females; median age 59 years; range, 24 to 89 years) at Gülhane Training and Research Hospital between January 2017 and December 2019 were analyzed using patient files and follow-up forms. The main indications for PICC were parenteral supportive treatments in the palliative care setting. All procedures were performed by a single experienced anesthesiologist. The Groshong, double-lumen, 5-Fr (French) (Bard Access Systems, SLC, USA) catheters were used in all patients. Before the procedure, the patients underwent venous ultrasound of the arm for deep veins suitable for PICC insertion (Figure 1). The right basilic vein was the preferred access site, unless there was no medical contraindication. The PICC was not used in patients with a basilic vein diameter of less than 3 mm to minimize the risk for venous thrombosis; therefore, a catheter-to-vessel ratio of $\leq 33\%$ should be ensured. The PICC insertion was performed in the operating room under strict aseptic conditions with the support of local anesthesia under the guidance of ultrasound and fluoroscopy using a microintroducer and modified Seldinger technique. Prior to the insertion of PICC, the patients were informed about the risks and benefits of the procedure

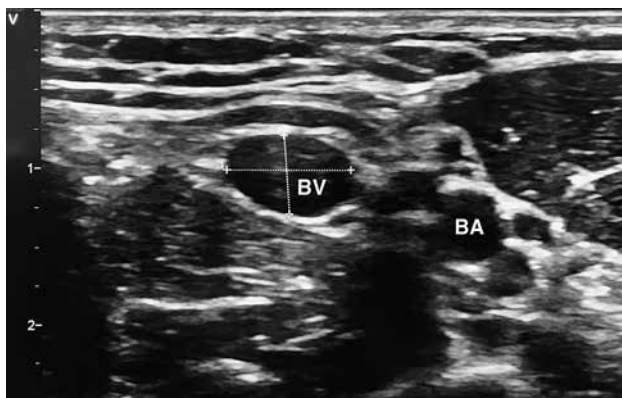


Figure 1. Pre-procedure ultrasound examination showing vascular structures. BV: Basilic vein, BA: Brachial artery.

in detail. A written informed consent was obtained from each patient. The study protocol was approved by the University of Health Sciences Ethics Committee (2020-96). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patient was placed in the supine position with their arms flexed at a 90° angle. A tourniquet was applied above the intended insertion site to distend the vessel. Following aseptic preparation of the skin with chlorhexidine, a high-frequency linear ultrasound probe was placed longitudinally, and the needle was inserted into the basilic vein using the in-plane technique (Figure 2). When the venous backflow was obtained, a guidewire was inserted through the needle. After the tourniquet was removed, an introducer sheath was advanced over the guidewire. Following the removal of guidewire and dilator, the catheter was inserted through the sheath and, then, slowly advanced under the guidance of fluoroscopy. When the catheter tip was advanced to the shoulder, the head of the patient was turned toward the insertion side to prevent possible insertion into the jugular vein. The catheter tip was placed at the superior vena cava-right atrial junction (Figure 3). Finally, the introducer sheath was withdrawn, and the catheter was fixed to the skin (StatLock Catheter Stabilization Device, Bard Access Systems) (Figure 4).



Figure 2. Linear ultrasound probe was placed longitudinally, and the needle was inserted into the basilic vein using the in-plane technique.

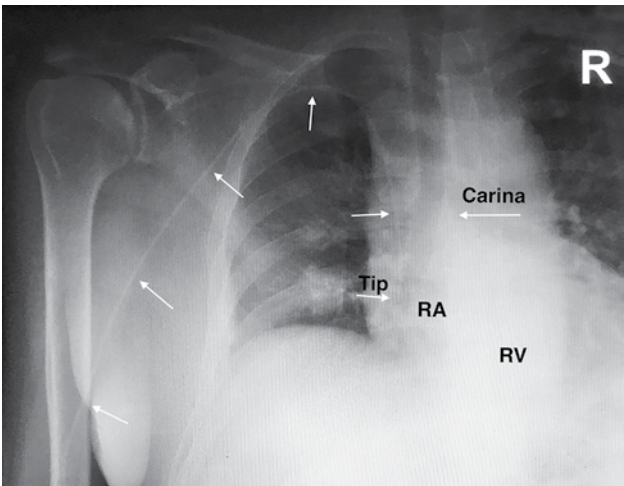


Figure 3. The catheter tip was placed at the superior vena cava-right atrial junction. The use of the carina as a radiologic reference allows the catheter tip to be left in the desired position.

The demographic characteristics, vessel diameters of the patients, the dwell time and purpose of PICCs, reason for removal and antiaggregant/anticoagulant use were recorded. The Michigan risk score (Table 1), which was developed by Chopra et al.,^[5] was also calculated to identify the risk for thrombus development.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 21.0 software (IBM Corp., Armonk, NY, USA). The normality of the data was tested using the Kolmogorov-Smirnov test. Descriptive data were expressed in median (min-max) or number and frequency.

RESULTS

Demographic characteristics of the patients and their indications for PICCs insertion are summarized in Table 2. The PICCs were mainly used for pharmaceutical support-blood sampling (n=13, 68.4%), pain management-parenteral nutrition (n=5 26.3%), and transfusion (n=1, 5.3%). The median dwell time



Figure 4. Final position of the catheter.

of PICC was 38 (range, 6 to 202) days. The dwelling times of PICCs and reasons of removal are shown in Table 3. One patient required a new PICC insertion due to the accidental removal of the catheter.

The PICC was left *in situ* for less than one month in five patients. However, the catheter removal reason of four (80%) of these patients was death due to cancer. Mortality and bloodstream infections were the most common causes of removing catheters which remained less than two months. On the other hand, only one patient who had the catheter remained longer than two months developed bloodstream infection (Table 4).

Approximately two-thirds of our patients were on low-molecular-weight heparin, while their catheters were functioning. Of the patients, two did not receive any antiaggregant/anticoagulant drug, while four were on aspirin and one who underwent mitral valve replacement was on warfarin.

Table 1. Michigan risk scores for PICC-related thrombosis ^[5]				
Presence of another CVC when index PICC placed	NO '0' point		YES '1' point	
WBC >12,000	NO '0' point		YES '1' point	
Number of PICC lumens	Single '0' point	Double '1' point	Triple '2' points	Quad '3' points
History of venous tromboembolism	Never '0' point	Yes, within 30 days '3' points		YES '2' points
Active cancer	NO '0' point			YES '1' point
PICC: Peripherally inserted central catheter; CVC: Central venous catheter; WBC: White blood cell; Class 1 (0 point); Class 2 (1 point); Class 3 (2-4 points); Class 4 (>4 points).				

Table 2. Demographic characteristics and indications for port catheter implantation of patients

Demographic characteristics of patients	n	%	Median	Range
Age (year)			59	24-89
Gender				
Male	7			
Female	11			
Solid tumor	7	36.8		
Leukemia/lymphoma	3	15.8		
Serebrovascular disease	3	15.8		
Other	6	31.6		

Table 3. PICCs indwelling times and removal reasons

	n	%
Dwell time		
Dwell time <1 month	5	31.6
Dwell time 1-2 month	9	42.1
Dwell time >2 months	5	26.3
PICC removal reasons		
Dead	7	36.9
Bloodstream infection	5	26.3
End of treatment	5	26.3
Accidental removal	2	10.5

PICC: Peripherally inserted central catheter.

Table 4. Distribution of removal reasons by indwelling time

Dwell time	n	%
Dwell time <1 month	5	
Dead	4	80
Accidental removal	1	20
Dwell time 1-2 month	9	
Dead	2	22.3
Bloodstream infection	4	44.4
End of treatment	3	33.3
Dwell time >2 months	5	
Dead	1	20
End of treatment	2	40
Accidental removal	1	20
Bloodstream infection	1	20

The median Michigan risk score of the patients was 4 (range, 1 to 5). One point was added to the scores of all patients, as a double-lumen PICC was inserted. In addition, two additional points were added due to the diagnosis of cerebrovascular disease caused by embolism in two patients. Eight of the patients had active malignancy and received an additional three points, while one of them received an additional one point due to a white blood count of >12,000. Although the majority of our patients were Class 3 (n=11) and 4 (n=1) according to the Michigan risk score, none of

the patients developed catheter-related DVT during follow-up.

DISCUSSION

In this study, the points to consider during the PICC insertion procedure and the measures to be taken for complications that may arise, particularly catheter-related thrombosis, are discussed in the light of the current literature. There are basically three steps for PICC insertion with the lowest complication rate and without any problem: choosing the appropriate vein and using the proper venous cannulation technique, leaving the catheter tip in the right place, and the maintenance process after the catheter has started to be used. Indeed, although all these steps are applied to all catheterization procedures, particularly the first step is more important for the PICC insertion procedure, as PICCs are placed in veins with a smaller diameter compared to CVCs and cause a decrease in the venous flow, leading to thrombosis development.^[6] This explains why the risk for DVT is 2.5 times higher in PICCs compared to CVCs.^[7] In the literature, the incidence of PICCs-related symptomatic DVT varies between 1 and 18%, while the incidence of asymptomatic DVT has been reported as 27 to 71%.^[8] In the light of these data, PICC-related DVT development appears to be affected by two factors: (i) vessel diameter (mm) and (ii) catheter size (Fr). In the Infusion Nurses Society (INS) Standartds published 2016, the catheter-to-vein ratio is recommended to be 45% or less of the vessel diameter.^[9] Based on this recommendation, Spencer and Mahoney^[10] created a table based on area instead of vessel and catheter diameter. Accordingly, a catheter-t-vein ratio of >45% is considered high risk for DVT development, while a catheter-to-vein ratio of <33% is considered low risk and shown as green area. The vessel choice for PICC insertion is another important parameter. The basilic vein is commonly used in the PICC insertion procedure. Then, the brachial vein and cephalic vein are preferred, respectively.^[11,12] The basilic vein is the first choice due to its characteristics such as being a large vein, progressing in a straight line and continuing as an axillary vein and containing fewer valves, compared to other veins.^[9] While evaluating our patients for eligibility before the procedure, we measured the right basilic vein diameter if there were no contraindications and we did not perform catheterization on the patients with a vessel diameter of ≤ 3 mm, considering a catheter-to-vein ratio of >33%, since we had 5-Fr catheters.

Furthermore, PICCs can be placed at the patient bedside using the blind technique^[13] as well as in the operating room setting^[14] under the guidance of ultrasound. The use of real-time ultrasound allows the cannulation of the desired vein, as well as appropriate vein selection with preprocedural evaluation and examination of the adjacent structures. In addition, ultrasound-guided placement of PICCs causes less thrombosis compared to the conventional blind technique.^[15] In the study by Stokowski et al.,^[16] the use of ultrasound was reported to reduce the thrombosis rate from 9.8 to 1.9%. As with all vascular catheters, the position of the catheter tip for PICCs also plays a decisive role in the development of complications. In addition to the conventional use of fluoroscopy for determining the catheter tip for PICCs, intracavitary electrocardiogram^[17] and real-time ultrasound^[11] can be used. The malposition rate for PICCs placed at the bedside is approximately 40%.^[11] In the meta-analysis of Balsorano et al.^[3] including approximately 6,000 PICCs, it was reported that techniques used to insert catheters might play a role in the development of catheter-related DVT. They concluded that choosing the correct catheter size and proper placement of the catheter tip would reduce the risk for DVT. Since the use of real-time fluoroscopy allows the correction of malposition that may develop during the procedure by immediately recognizing, we performed PICCs insertions in all patients under the guidance of fluoroscopy.

The pathogenesis of catheter-related thrombosis is explained by the Virchow's triad. Endothelial damage which occurs during the PICC insertion procedure initiates the process. A catheter, which narrows the vessel lumen, causes stasis by decreasing the blood flow. However, given that the majority of patients requiring catheters are cancer, the third component of the Virchow's triad is complemented.^[18] Although prophylactic routine anticoagulant use is not recommended for patients with inserted catheters, the studies have shown that the use of anticoagulant in patients with PICCs reduces the risk for DVT.^[19]

In conclusion, PICCs can provide a good and safe vascular access in patients scheduled to receive long-term treatment in the hospital setting. However, it should be kept in mind that life-threatening complications such as DVT may develop, although it is less invasive than CVCs. In order to minimize the risk for DVT development, appropriate techniques such as determining the appropriate catheter for the vessel to be catheterized, the use of real-time ultrasound

to reduce the number of interventions during the cannulation and the risk for traumatic cannulation, and the use of fluoroscopy to determine the correct placement of the catheter tip should be considered.

Declaration of conflicting interests

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REFERENCES

1. Timsit JF, Rupp M, Bouza E, Chopra V, Kärpänen T, Laupland K, et al. A state of the art review on optimal practices to prevent, recognize, and manage complications associated with intravascular devices in the critically ill. *Intensive Care Med* 2018;44:742-59.
2. Ullman AJ, Bulmer AC, Dargaville TR, Rickard CM, Chopra V. Antithrombogenic peripherally inserted central catheters: overview of efficacy and safety. *Expert Rev Med Devices* 2019;16:25-33.
3. Balsorano P, Virgili G, Villa G, Pittiruti M, Romagnoli S, De Gaudio AR, et al. Peripherally inserted central catheter-related thrombosis rate in modern vascular access era-when insertion technique matters: A systematic review and meta-analysis. *J Vasc Access* 2020;21:45-54.
4. Zochios V, Umar I, Simpson N, Jones N. Peripherally inserted central catheter (PICC)-related thrombosis in critically ill patients. *J Vasc Access* 2014;15:329-37.
5. Chopra V, Kaatz S, Conlon A, Paje D, Grant PJ, Rogers MAM, et al. The Michigan Risk Score to predict peripherally inserted central catheter-associated thrombosis. *J Thromb Haemost* 2017;15:1951-62.
6. Duwadi S, Zhao Q, Budal BS. Peripherally inserted central catheters in critically ill patients - complications and its prevention: A review. *Int J Nurs Sci* 2018;6:99-105.
7. Chopra V, Anand S, Hickner A, Buist M, Rogers MA, Saint S, et al. Risk of venous thromboembolism associated with peripherally inserted central catheters: a systematic review and meta-analysis. *Lancet* 2013;382:311-25.
8. Al-Asadi O, Almusarhed M, Eldeeb H. Predictive risk factors of venous thromboembolism (VTE) associated with peripherally inserted central catheters (PICC) in ambulant solid cancer patients: retrospective single Centre cohort study. *Thromb J* 2019;17:2.
9. Gorski LA. The 2016 Infusion Therapy Standards of Practice. *Home Healthc Now* 2017;35:10-8.
10. Spencer TR, Mahoney KJ. Reducing catheter-related thrombosis using a risk reduction tool centered on catheter to vessel ratio. *J Thromb Thrombolysis* 2017;44:427-34.
11. Nakamuta S, Nishizawa T, Matsushashi S, Shimizu A, Uraoka T, Yamamoto M. Real-time ultrasound-guided placement of peripherally inserted central venous catheter without fluoroscopy. *J Vasc Access* 2018;19:609-14.

12. Mielke D, Wittig A, Teichgräber U. Peripherally inserted central venous catheter (PICC) in outpatient and inpatient oncological treatment. *Support Care Cancer* 2020.
13. Sundriyal D, Shirsi N, Kapoor R, Jain S, Mittal G, Khivasara J, et al. "Peripherally inserted central catheters: our experience from a cancer research centre". *Indian J Surg Oncol* 2014;5:274-7.
14. Bertoglio S, Faccini B, Lalli L, Cafiero F, Bruzzi P. Peripherally inserted central catheters (PICCs) in cancer patients under chemotherapy: A prospective study on the incidence of complications and overall failures. *J Surg Oncol* 2016;113:708-14.
15. Kelly L. A practical guide to safe PICC placement. *Br J Nurs.* 2013;22:S13-4, S16, S18-9.
16. Stokowski G, Steele D, Wilson D. The use of ultrasound to improve practice and reduce complication rates in peripherally inserted central catheter insertions: final report of investigation. *J Infus Nurs* 2009;32:145-55.
17. Yang L, Bing X, Song L, Na C, Minghong D, Annuo L. Intracavitary electrocardiogram guidance for placement of peripherally inserted central catheters in premature infants. *Medicine (Baltimore)* 2019;98:e18368.
18. Kim HJ, Yun J, Kim HJ, Kim KH, Kim SH, Lee SC, et al. Safety and effectiveness of central venous catheterization in patients with cancer: prospective observational study. *J Korean Med Sci* 2010;25:1748-53.
19. Lv S, Liu Y, Wei G, Shi X, Chen S, Zhang X. The anticoagulants rivaroxaban and low molecular weight heparin prevent PICC-related upper extremity venous thrombosis in cancer patients. *Medicine (Baltimore)* 2019;98:e17894.