Clinics in Surgery

Research Article
Published: 09 Jun, 2022

Incidence and Risk Factors of Peripherally-Inserted Central Catheter–Related Venous Thromboembolism

Talal A Altuwaijri[1], Dalal I Alhuzaimi[2], Fatima S Sirajuddin[2], Sarah S AlMutawa[2], Hussam Anas[1] and Abdulmajeed Altoijry[1]*

[1]Department of Surgery, Division of Vascular Surgery, College of Medicine, King Saud University, Saudi Arabia

[2]College of Medicine, King Saud University, Saudi Arabia

Abstract

Objective: To estimate the incidence of Peripherally Inserted Central Catheter (PICC)-Related Venous Thromboembolism (VTE) and to evaluate the possible related risk factors.

Design: A retrospective cohort study.

Settings: King Khalid University Hospital, Riyadh, Saudi Arabia.

Subjects: All patients with PICC line inserted from 2015 until 2018.

Main outcomes: Incidence of VTE, mechanical, and clinical risk factors.

Results: Among 583 patients with PICC line, 72 of them (12.3%) found to have DVT. While pulmonary embolism incidence rate was 0%. Our results suggest that clinical risk factors associated with the development of PICC-related VTE are renal failure, hematological disease, cancer, receipt of chemotherapy, and a prior VTE. However, use of anticoagulants did not appear to decrease the risk of VTE.

Conclusion: Our findings have relevant implications for clinical practice. To avoid serious complications, awareness of the risks and benefits of different vascular access devices should be considered when determining their usage in patient care.

Keywords: Venous thromboembolism; Venous disease; Thrombosis; TPN; PICC

OPEN ACCESS

Correspondence:
Talal A Altuwaijri, Department of Surgery, Division of Vascular Surgery, College of Medicine, King Saud University, P.O. Box: 7805, Riyadh 11472, Saudi Arabia, Tel: +966118066417; E-mail: taltuwaijri@ksu.edu.sa

Received Date: *26 Apr 2022*
Accepted Date: *02 Jun 2022*
Published Date: *09 Jun 2022*

Citation:
Altuwaijri TA, Alhuzaimi DI, Sirajuddin FS, AlMutawa SS, Anas H, Altoijry A. Incidence and Risk Factors of Peripherally-Inserted Central Catheter–Related Venous Thromboembolism. Clin Surg. 2022; 7: 3530.

Introduction

During the past couple decades, Peripherally-Inserted Central Catheters (PICCs) have become widely used for temporary long-term central vascular access, especially in patients receiving chemotherapy, long-term antibiotics, or Total Parenteral Nutrition (TPN) [1-5]. They are a simple and cost-effective bedside method to facilitate the administration of multiple drugs and repeated removal of blood samples [4]. Despite these benefits, PICCs are associated with many complications, including catheter occlusion, breakage, and failure. More serious complications include catheter-associated bloodstream infections and catheter-related Venous Thromboembolism (VTE) [6-10], which can lead to Pulmonary Embolism (PE) and death [11]. Given the increased universal use of PICCs and the lack of studies conducted in our country estimating the frequency or possible risk factors of VTE related to PICC, objectives of this study were to estimate the incidence of PICC-related VTEs and to identify factors associated with an increased risk of this complication.

Materials and Methods

This retrospective cohort study was conducted at Vascular Surgery Department, King Saud University, Riyadh, Saudi Arabia. After obtaining patients consent and ethics approval (E-19-3863) from our institutional reviews board. We reviewed medical records of all 583 patients who underwent PICC insertion between August 9th, 2015, and September 18th, 2018 in the Angiography suite. VTE diagnosis was based on clinical suspicion of the primary team and subsequent confirmation by duplex scan. We manually reviewed patients' files and hospital's electronic medical record system to determine the incidence of Deep Venous Thrombosis (DVT) for both the upper and lower extremities, and the incidence of PE events. Subsequently, secondary data were obtained from electronic medical records to identify risk factors contributing to VTE. For each patient, we extracted information regarding demographics, clinical risk factors related to patient's comorbidities, indications for PICC insertion and mechanical risk factors related to PICC itself.

Statistical analysis

IBM SPSS Statistics for Windows, version 26, was used to analyze the data. Descriptive analysis was used to calculate frequencies and percentages. Chi-square test of independence was used as the main mode of analysis for risk factors. Independent variables were analyzed in three groups: demographic factors, patient clinical factors, and PICC mechanical factors. *P*-values <0.05 were considered statistically significant.

Results

Incidence of venous thromboembolism

Among 583 patients with PICC lines, VTE was observed in 72, for a cumulative VTE incidence rate of 12.3%. Upper limb DVT and lower limb DVT was found in 36 patients (6.2%) and 33 patients (5.7%) respectively. Three patients (0.5%) developed both upper and lower limb DVTs, one of whom had a DVT in all four extremities. No patient developed a PE.

Demographic risk factors

Of 583 patients in the study, 301 (51.6%) were male and 282 (48.4%) were female (Table 1). Incidence of VTE was similar in males (11.6%) and females (13.1%) (Table 1). Using chi-square test of independence, sex was not associated with the incidence of VTE ($\chi^2(1)=0.30$, $p=0.584$). The incidence of VTE was highest in elderly patients (18.9%) and individuals with a normal Body Mass Index (BMI) (17.7%). Age was significantly associated with VTE incidence ($\chi^2(3)=15.25$, $p=0.002$); although, the effect size was small (Cramer's $V=0.16$) (Figure 1). Similarly, a significant relationship was found between BMI and incidence of VTE ($\chi^2(4)=12.77$, $p=0.012$), with a medium effect size (Cramer's $V=0.15$).

Clinical risk factors

The highest rates of VTE were observed in patients with a prior VTE (50.6%), Chronic Obstructive Pulmonary Disease (COPD) (25%), renal failure (22%), and hypothyroidism (20.5%) (Table 2). The following risk factors were significantly associated with VTE incidence: renal failure ($\chi^2(1)=5.69$, $p=0.017$, $\varphi=0.10$), hematological disease ($\chi^2(1)=5.54$, $p=0.019$, $\varphi=0.10$), cancer ($\chi^2(1)=8.39$, $p=0.004$, $\varphi=0.12$), anticoagulant therapy ($\chi^2(1)=13.16$, $p<0.001$, $\varphi=0.15$), and chemotherapy ($\chi^2(1)=9.89$, $p=0.002$, $\varphi=0.13$) (Table 2). All of these φ values reflected a small effect size. Moreover, a prior VTE was also significantly associated with the incidence of VTE ($\chi^2(1)=120.22$, $p<0.001$, $\varphi=0.45$), with a medium effect size.

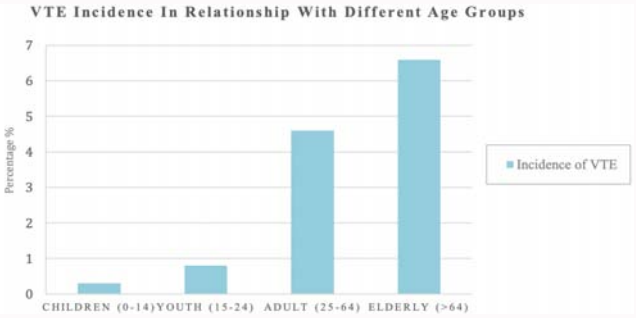

Figure 1: Age categories and Venous Thromboembolism (VTE) incidence.

The indications for PICC line insertion varied among the study population. Nearly half of the patients received multiple infusates (49.2%) (Table 3). None of the PICC indications were significantly associated with VTE incidence ($\chi^2(6)=4.22$, $p=0.646$) (Table 3).

Mechanical risk factors

In 511 patients (87.7%), PICC was inserted on the right side (Table 4). Basilic vein was the most common site of placement followed by the brachial vein, with a frequency of 54.7% and 35.2% respectively. VTE incidence was highest in patients with PICCs inserted on both sides, PICC malfunction, or more than one PICC site during their life, with rates of 27.3%, 26.9%, and 20.8% respectively (Table 4). The following factors were significantly associated with the incidence of VTE: Previous PICC insertion ($\chi^2(1)=5.69$, $p=0.017$, $\varphi=0.10$), size of lumen ($\chi^2(2)=10.54$, $p=0.005$, Cramer's $V=0.13$), and PICC malfunction ($\chi^2(1)=5.34$, $p=0.021$, $\varphi=0.10$). All φ and Cramer's values reflected a small effect size.

Table 1: Demographic factors.

Sex			
Group	**n (%)**	**Incidence of VTE, n (%)**	***p*-value***
Male	301 (51.6)	35 (11.6)	0.584
Female	282 (48.4)	37 (13.1)	
BMI categories			
Group	**n (%)**	**Incidence of VTE, n (%)**	***p*-value***
Underweight (<18.5)	125 (21.4)	8 (6.4)	0.012
Normal (18.5–24.9)	164 (28.1)	29 (17.7)	
Overweight (25.0–29.9)	139 (23.8)	22 (15.8)	
Obese (30.0–39.9)	101 (17.3)	7 (6.9)	
Extremely obese (>= 40)	54 (9.3)	6 (11.1)	
Age categories			
Group	**n (%)**	**Incidence of VTE, n (%)**	***p*-value***
Children (0–14 y)	90 (15.4)	2 (2.2)	0.002
Youth (15–24 y)	58 (9.9)	5 (8.6)	
Adult (25–64 y)	287 (49.2)	37 (12.9)	
Elderly (>64 y)	148 (25.4)	28 (18.9)	

*Chi-square test; BMI: Body Mass Index; VTE: Venous Thromboembolism

Table 2: Patient clinical factors.

Factor	n (%)	Incidence of VTE, n (%)	*p*-value*
Smoking	31 (5.3)	4 (12.9)	0.923
Diabetes mellitus	184 (31.6)	28 (15.2)	0.153
Hypertension	180 (30.9)	27 (15.0)	0.194
Coronary artery disease	53 (9.1)	5 (9.4)	0.499
Congestive heart failure	65 (11.1)	10 (15.4)	0.430
COPD	8 (1.4)	2 (25.0)	0.273
Renal failure	59 (10.1)	13 (22.0)	0.017
Hematological disease	104 (17.8)	20 (19.2)	0.019
Cancer	181 (31)	33 (18.2)	0.004
Hypothyroidism	39 (6.7)	8 (20.5)	0.109
Asthma	35 (6.0)	4 (11.4)	0.864
Inflammatory bowel disease	32 (5.5)	1 (3.1)	0.103
Dyslipidemia	35 (6.0)	5 (14.3)	0.720
Anticoagulant therapy	412 (70.7)	64 (15.5)	<0.001
Antiplatelet therapy	109 (18.7)	15 (13.8)	0.619
Chemotherapy	147 (25.2)	29 (19.7)	0.002
Operation	377 (64.7)	47 (12.5)	0.908
ICU admission	310 (53.2)	44 (14.2)	0.149
Trauma	49 (8.4)	3 (6.1)	0.166
Immobility	231 (39.6)	32 (13.9)	0.372
Prior VTE	77 (13.2)	39 (50.6)	<0.001

*Chi-square test; COPD: Chronic Obstructive Pulmonary Disease; ICU: Intensive Care Unit; PICC: Peripherally-Inserted Central Catheter; VTE: Venous Thromboembolism

Discussion

Incidence of PICC-related venous thromboembolism

VTE is a common complication of PICC insertion, and in this study, the cumulative incidence of VTE was 12.3%. As no PE was observed, this was also our DVT incidence rate. Our finding was consistent with those of two studies conducted in USA, which reported VTE incidence rates of 15% and 23.3% [12,13]. Although our rate is higher than those reported by six other studies from the USA (with incidence rates of 2% to 8.4% [2,6,14-17]), it is clearly lower than the rates noted in studies conducted in Australia (44.7%) and Malaysia (38.5%) [3,18]. Furthermore, six previous studies from China reported VTE incidence rates from 5.2% to 51.4% [4,7,10,19-21]. With regards to PE, our rate of PE was 0%. A previous systematic review reported that the rate was 0.5%, which represented 13.4% of all VTE events [1].

Risk factors for VTE

Clinical predictors: In our study, both age and BMI were significantly associated with VTE incidence. Interestingly, we found that patients with a normal BMI had the highest incidence of VTE (17.7%) of all BMI groups. This differs from results of most previous studies, which have identified overweight and obesity as risk factors for VTE [7,11]. The 18.9% incidence of VTE in the oldest patients in our study (aged >65 y) emphasizes the role of older age in the development of catheter-related VTE, as has been previously reported. Renal failure was previously identified as an important clinical risk factor for VTE [22], and it was also significantly associated with VTE in our study. Almost half of PICC-related VTEs occurred in cancer patients, which was consistent with results of previous studies [11,12,14,15].

Table 3: Peripherally-inserted central catheter indications/infusates.

Indication/infusate	n (%)	Incidence of VTE, n (%)	*p*-value*
Fluids	105 (18)	10 (9.5)	0.646
Antibiotics	74 (12.7)	8 (10.8)	
Chemotherapy	37 (6.3)	6 (16.2)	
TPN	55 (9.4)	5 (9.1)	
Analgesia	8 (1.4)	0 (0)	
Multiple infusates	287 (49.2)	40 (14)	
Others	17 (2.9)	3 (17.6)	

*Chi-square test; TPN: Total Parenteral Nutrition; VTE: Venous Thromboembolism

Table 4: Mechanical factors related to peripherally-inserted central catheter.

Factor	n (%)	Incidence of VTE, n (%)	*p*-value*
Previous PICC insertion	110 (18.9)	21 (19.1)	0.017
PICC side			
Right	511 (87.7)	58 (11.4)	0.060
Left	50 (8.6)	8 (16.0)	
Both sides	22 (3.8)	6 (27.3)	
PICC site			
Basilic	319 (54.7)	35 (11.0)	0.376
Cephalic	10 (1.7)	1 (10.0)	
Brachial	205 (35.2)	26 (12.7)	
Axillary	1 (0.2)	0 (0)	
Different sites	48 (8.1)	10 (20.8)	
PICC lumen size			
5-French (double-lumen)	499 (85.6)	70 (14.0)	0.005
3-French (single-lumen)	79 (13.6)	1 (1.3)	
4-French (double-lumen)	5 (0.9)	1 (20.0)	
PICC malfunction	26 (4.5)	7 (26.9)	0.021

*Chi-square test; PICC: Peripherally-Inserted Central Catheter; VTE: Venous Thromboembolism

This association can be attributed to the hypercoagulable status of patients with cancer, as well as their need for multiple PICC insertions for chemotherapy administration, triggering thrombus formation. Hematological disease and anticoagulant treatment were also significantly associated with PICC-related VTE incidence. Not surprisingly, half of those patients with a prior VTE developed a PICC-related VTE.

Mechanical predictors: Many mechanical risk factors have been reported to increase the likelihood of developing PICC-related VTE [2,6,11,16], including those related to the procedural technique, catheter, and infusate characteristics [3,7,9,14,15,22]. In our study, multiple PICC insertions were associated with a higher VTE incidence. Lumen size was also significantly related to VTE incidence, with an incidence rate of 14% in patients with a large diameter (5-French) PICC. This is consistent with results of a previous study reporting a higher risk of PICC-related VTE with 5-French or 6-French PICCs [7,9,15]. In addition, our VTE incidence rates with different lumen and diameter sizes were higher than previously published rates [16,23]. PICC malfunction, necessitating removal because of complete or partial occlusion, was also significantly associated with DVT incidence.

Limitations

This study has some limitations. As a retrospective study, there

may have been confounding factors that influenced the results. As a medical records review, the accuracy of our data depends on the accuracy of information in these records. Study design also does not allow us to make conclusions about causation. Although we included every patient who received a PICC over a more than 3-year period, the number of patients is relatively small. This prevented us from detecting any PE and may have reduced our ability to achieve statistical significance for some potential DVT risk factors. Additionally, this is a single-center study, which may limit its generalizability. However, it provides objective data about an important clinical issue that has not been previously reported in our country.

Conclusion

In conclusion, our findings have relevant implications for clinical practice. To avoid serious complications, awareness of the risks and benefits of different vascular access devices should be considered when determining their usage in patient care. Our results suggest that clinical risk factors associated with the development of PICC-related VTE are renal failure, hematological disease, cancer, receipt of chemotherapy, and a prior VTE. However, use of anticoagulants did not appear to decrease the risk of VTE. The side and site of PICC insertion were also not associated with VTE incidence. Patients with multiple PICC insertions during their lifetime also had a higher incidence of PICC-related VTE.

References

1. 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(9889):311-25.
2. Wilson TJ, Brown DL, Meurer WJ, Stetler WR, Wilkinson DA, Fletcher JJ. Risk factors associated with peripherally inserted central venous catheter-related large vein thrombosis in neurological intensive care patients. Intensive Care Med. 2012;38(2):272-8.
3. Abdullah BJ, Mohammad N, Sangkar JA, Abd Aziz YF, Gan GG, Goh KY, et al. Incidence of upper limb venous thrombosis associated with Peripherally Inserted Central Catheters (PICC). Br J Radiol. 2005;78(931):596-600.
4. Yi XL, Chen J, Li J, Feng L, Wang Y, Zhu JA, et al. Risk factors associated with PICC-related upper extremity venous thrombosis in cancer patients. J Clin Nurs. 2014;23(5-6):837-43.
5. Aw A, Carrier M, Koczerginski J, McDiarmid S, Tay J. Incidence and predictive factors of symptomatic thrombosis related to peripherally inserted central catheters in chemotherapy patients. Thromb Res. 2012;130(3):323-6.
6. Lobo BL, Vaidean G, Broyles J, Reaves AB, Shorr RI. Risk of venous thromboembolism in hospitalized patients with peripherally inserted central catheters. J Hosp Med. 2009;4(7):417-22.
7. Kang J, Chen W, Sun W, Ge R, Li H, Ma E, et al. Peripherally inserted central catheter-related complications in cancer patients: A prospective study of over 50,000 catheter days. J Vasc Access. 2017;18(2):153-7.
8. Menéndez JJ, Verdú C, Calderón B, Gómez-Zamora A, Schüffelmann C, De La Cruz JJ, et al. Incidence and risk factors of superficial and deep vein thrombosis associated with peripherally inserted central catheters in children. J Thromb Haemost. 2016;14(11):2158-68.
9. 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(6):708-14.
10. Liu Y, Gao Y, Wei L, Chen W, Ma X, Song L. Peripherally inserted central catheter thrombosis incidence and risk factors in cancer patients: A double-center prospective investigation. Ther Clin Risk Manag. 2015;11:153-60.
11. Leung A, Heal C, Perera M, Pretorius C. A systematic review of patient-related risk factors for catheter-related thrombosis. J Thromb Thrombolysis. 2015;40(3):363-73.
12. Ahn DH, Illum HB, Wang DH, Sharma A, Dowell JE. Upper extremity venous thrombosis in patients with cancer with peripherally inserted central venous catheters: A retrospective analysis of risk factors. J Oncol Pract. 2012;9:e8-12.
13. Allen AW, Megargell JL, Brown DB, Lynch FC, Singh H, Singh Y, et al. Venous thrombosis associated with the placement of peripherally inserted central catheters. J Vasc Interv Radiol. 2000;11(10):1309-14.
14. Greene MT, Flanders SA, Woller SC, Bernstein SJ, Chopra V. The association between PICC use and venous thromboembolism in upper and lower extremities. Am J Med. 2015;128(9):986-93.e1.
15. Chopra V, Ratz D, Kuhn L, Lopus T, Lee A, Krein S. Peripherally inserted central catheter-related deep vein thrombosis: Contemporary patterns and predictors. J Thromb Haemost. 2014;12(6):847-54.
16. Liem TK, Yanit KE, Moseley SE, Landry GJ, DeLoughery TG, Rumwell CA, et al. Peripherally inserted central catheter usage patterns and associated symptomatic upper extremity venous thrombosis. J Vasc Surg. 2012;55(3):761-7.
17. Fletcher JJ, Stetler W, Wilson TJ. The clinical significance of peripherally inserted central venous catheter-related deep vein thrombosis. Neurocrit Care. 2011;15(3):454-60.
18. Ye X, Wong SW, Zhang J, Moo IH, Lee CC. Catheter-related upper limb venous thrombosis in a tertiary hospital setting. ANZ J Surg. 2016;86:1033-7.
19. Zhao N, Zhang J, Jiang T, Chen X, Wang J, Ding C, et al. Risk factors of deep venous thrombosis associated with peripherally inserted central venous catheter in upper extremity in ICU. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue. 2017;29(2):167-71.
20. Kang JR, Long LH, Yan SW, Wei WW, Jun HZ, Chen W. Peripherally inserted central catheter-related vein thrombosis in patients with lung cancer. Clin Appl Thromb Hemost. 2017;23(2):181-6.
21. Luo L, Jing XM, Wang GR, Qin Y, Liang HX, Liu SS. Peripherally inserted central catheter–related upper extremity venous thrombosis in oncology patients: A prospective study based on Doppler sonography. J Ultrasound Med. 2016;35(8):1759-63.
22. Marnejon T, Angelo D, Abdou AA, Gemmel D. Risk factors for upper extremity venous thrombosis associated with peripherally inserted central venous catheters. J Vasc Access. 2012;13(2):231-8.
23. Zochios V, Umar I, Simpson N, Jones N. Peripherally Inserted Central Catheter (PICC)-related thrombosis in critically ill patients. J Vasc Access. 2014;15(5):329-37.