A Retrospective Analysis of Catheter-Related Upper Extremity Deep Vein Thrombosis in Peripherally Inserted Catheters With and Without a Dermatotomy

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Abstract

Background: *Successful placement of peripherally inserted central catheters (PICCs) has increased with the use of a modified Seldinger technique (MST). However, differences exist between MST kits related to the transition between the introducer and dilator. When blunt, a skin nick (dermatotomy) is necessary to allow the dilator/sheath combination to pass through the skin. However, this does not reduce the trauma on the vein. Upper extremity deep vein thrombosis (UEDVT) is a PICC-related complication. It is unclear what effect the MST kit has on this complication. Our previous study found a rate of 0.76% UEDVT ≤ 2 weeks postinsertion using a MST kit without dermatotomy.*

Methods: *We performed a retrospective analysis on a cohort of patients at The Ottawa Hospital undergoing a PICC insertion using a MST kit requiring a dermatotomy between November 1, 2016, and January 1, 2017. We obtained a complete dataset for 701 patients and determined the incidence of UEDVT ≤ 2 weeks postinsertion.*

Results: *Of 701 patients included in the study, 8 patients developed symptomatic UEDVT ≤ 2 weeks postinsertion, for a rate of 1.14%. The odds ratio comparing the group that received a dermatotomy to the previous group who did not was 1.50% (95% confidence interval 0.40-4.62).*

Conclusions: *The odds ratio of UEDVT ≤ 2 weeks post-PICC insertion with a dermatotomy compared with those without was not significantly different. We conclude that a MST kit requiring a dermatotomy does not increase the risk of early UEDVT.*

Keywords: *thrombosis, microintroducer, dermatotomy*

Background

Peripherally inserted central catheters (PICCs) are a cost-effective method used for long-term infusion therapies, including chemotherapy, antibiotics, and total parenteral nutrition.[1] The use of ultrasound guidance and a modified Seldinger technique (MST) has increased placement success.[2] One of the complications associated with PICC insertion is upper extremity deep vein thrombosis (UEDVT). This complication is well-established in the literature comparing thrombosis rates in PICC lines used for a variety of medical uses, including transfusions, dialysis, and antibiotics, for a baseline rate of 2.7%.[3] Although the specific cause of thrombosis is not known, various factors in the coagulation cascade contribute to thrombosis. According to Virchow's triad, endothelial injury is among the key mechanisms that may result in thrombosis.[4] When the endothelial lining gets injured, tissue factor is released, which complexes with factor VIIa to activate downstream factors, eventually leading to the formation of a thrombus.[5]

A review by Meissner et al[6] described trauma as a major factor influencing the rate of deep vein thrombosis (DVT). Increased trauma also may increase the risk of thromboembolism through a traumatic release of prothrombotic cytokines.[7] This raises the question as to whether procedures that cause vein trauma may result in an increased risk of thrombosis. The MST kit consists of an introducer needle, a guide wire and a 7-10 cm dilator/

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sheath combination. Inherent differences between MST kits are primarily related to the transition between the peel-away introducer and dilator. When the transition is tapered, the dilator/sheath combination can be introduced into the vein directly with a twisting motion. When the transition is blunt, a skin nick (dermatotomy) is necessary to facilitate the dilator/sheath combination to pass through the skin. However, the dermatotomy does not reduce the trauma on the vein.

A previous study by our vascular access team at The Ottawa Hospital identified the rate of thrombosis in patients undergoing PICC insertions using the Arrow International 5F PICC Seldinger Conversion Kit (Wayne, PA) that did not require a dermatotomy (skin nick) to be 1.52% (95% confidence interval 0.83%-2.78%).[8] Half of the UEDVTs from the study occurred within 2 weeks postinsertion, for a rate of 0.76%, and thus may truly represent a thrombosis related to the procedure itself. Due to a manufacturing interruption, this product was not available and the substitution MST product—Angiodynamics Mini-Stick II (Latham, NY)—required a dermatotomy to advance the dilator/sheath combination. Our standard practice for the last 9 years is to insert a PICC using the Arrow International 5F PICC Seldinger Conversion Kit without performing a dermatotomy. This particular MST kit has a smooth transition between the peel-away introducer and dilator, allowing the inserter to slowly turn the dilator/sheath combination and advance it through the skin and into the vein. The kit does not come with a scalpel that would be needed to perform the procedure. The substitute product has a blunt transition between the dilator and peel-away sheath and comes with a scalpel to perform the dermatotomy required to advance the device through the skin. We sought to determine whether an MST kit that requires a dermatotomy increased vein trauma, leading to an increased rate of early (≤2 weeks postinsertion) UEDVT.

Methods

This study is a retrospective analysis on a prospective cohort of patients at The Ottawa Hospital undergoing a PICC insertion between November 1, 2016, and January 1, 2017. The Ottawa Hospital is among North America's largest academic health centers and has a vascular access program overseen by an advanced practice nurse who oversees insertion, care, and maintenance of PICCs. A group of experienced registered nurses who insert 400-500 PICCs annually inserted all PICCs in this study.

This study adhered to the Safer Health Care Now central line insertion bundle, which consists of hand hygiene, barrier precautions, and chlorhexidine skin antisepsis.[9] Adequate vein diameter determines optimal catheter size (single or dual lumen). We developed care and maintenance protocols based on the Infusion Nurses Society Standards of Practice in conjuction with clinical nurse educators from The Ottawa Hospital and community providers.[10]

All catheters inserted were either a 4F single lumen or a 5F double lumen BioFlo PASV PICC (Angiodynamics) and trimmed to the desired length before insertion.[11] Catheters were trimmed to the desired length before insertion. A standard Tegaderm IV Advanced Securement Dressing (3M Company, St. Paul, MN) secured all inserted PICCs. No antimicrobial device was placed at the site at insertion or throughout the catheter dwell time. The study routinely flushed all catheters with Posiflush XS (Becton-Dickinson, Franklin Lakes, NJ) 10-mL prefilled 0.9% sodium chloride. We did not use any heparin products to flush or lock the PICC.

Ultrasound technology identified the vein for all catheter insertions, and chest radiography confirmed tip location.

Our research ethics board approved this study.

The primary outcome of this study was early catheter-related UEDVT, defined as a symptomatic occlusive or nonocclusive filling defect in the deep veins (brachial, axillary, and subclavian) proximal to the PICC insertion that occurred ≤ 2 weeks postinsertion. Ultrasound or venogram confirmed all UEDVTs and determined to be catheter-related if they presented on the ipsilateral side of the insertion.

Patients were eligible for the study if they had a PICC placed between November 1, 2016, and January 1, 2017. All patients during this time period underwent a PICC insertion requiring a dermatotomy. This provided a cohort that allowed for a valid comparison from patients in our previous study who underwent a PICC insertion that did not require a dermatotomy.[8] The study collected data on each patient prospectively as part of the clinical program. The only ultrasound reports obtained occurred 2 weeks postinsertion.

SPSS statistical software (IBM-SPSS Inc, Armonk, NY) calculated a descriptive summary of the baseline characteristics for this study population in addition to an odds ratio comparing the rate of thrombosis in the 2 different PICC insertion methods.

Results

A total of 656 patients had PICCs inserted that did not require a dermatotomy during a 2-year period from January 1, 2013, to December 31, 2015, and 701 patients had PICCs inserted by the vascular access team at The Ottawa Hospital during a 2-month period in 2016. Data were obtained for all patients, and 2-week postinsertion ultrasound or venogram reports were available for all patients with a potential UEDVT. The analysis included all patients, even those with a potential UEDVT. Baseline characteristics of the participants, ordering service, and reason for insertion are depicted in Table 1. Age, gender, or any catheter characteristic did not significantly differ in the populations of each sample. Populations differed slightly in the specific ordering service. The only significant difference came in the oncology referral population, perhaps due to the holiday season. In general, participants received referrals for a long-term requirement of antibiotics, chemotherapy, and parenteral nutrition. A description of the catheter characteristics can be found in Table 2.

A total of 8 out of 701 patients included in the study had an early catheter-related UEDVT confirmed by ultrasound within 2 weeks postinsertion, for a rate of 1.14% (Table 3). Two of 8 patients had hematologic malignancies, for a rate of 25%. Five additional patients had symptoms of UEDVT, but received a negative ultrasound report within the 2-week postinsertion period. The odds ratio comparing the group that received a dermatotomy to the group that did not was 1.50 (95% confidence interval 0.49-4.62).