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ORIGINAL ARTICLE

Equivalent success and complication rates of tunneled common femoral venous catheter placed in the interventional suite vs. at patient bedside

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Abstract

Background Femoral tunneled central line placement in the pediatric population offers an alternative means for intravenous (IV) access, but there is concern for higher complication and infection rates when placed at bedside.

Objective To describe the complications and infection outcomes of primary femoral tunneled central venous catheter placement in the interventional radiology suite compared to the portable bedside location at a single tertiary pediatric institution.

Materials and methods We conducted a retrospective review comparing interventional radiology suites vs. bedside primary tunneled common femoral vein central line placement (January 2014 to December 2015). We identified 244 primary femoral placements in pediatric patients, ages 1 day to 18 years, using our electronic medical record and collected into a Research Electronic Data Capture. We compared categorical variables using the Fisher exact test. We compared continuous variables using the Wilcoxon rank test.

Results In total, 2,375 pediatric patients received peripherally inserted and central lines; 244 of these were primary femoral tunneled central venous catheters (in 140 boys and 104 girls). In 140 children (mean age: 206 days), lines were inserted in the interventional radiology (IR) suite (technical success of 100%), with 14 (10.0%) complications including infection (n=7), malposition (n=2), bleeding (n=0), thrombosis (n=1) and line occlusion (n=4). The infection rate was 2.1 per 1,000 line days. In 104 children (mean age: 231 days), lines were placed at bedside (technical success 100%) with 14 (13.3%) complications including infection (n=3), malposition (n=5), bleeding (n=0), thrombosis (n=2) and line occlusion (n=4). The infection rate was 0.78 per 1,000 line days. The total line days were 7,109, of which 3,258 were in the IR suite and 3,851 in the bedside group. There was no statistical significance for complication rate (P=0.55) or infection rate (P=0.57) between bedside and interventional suite placements.

Conclusion In a cohort of children receiving primary femoral tunneled central venous catheters, the complication and infection rates in a bedside setting are not significantly increased compared to the lines placed in an IR suite. The perception of increased infection and complications from bedside-placed tunneled central venous catheters appears to be hyperbolized.

Keywords Children · Complications · Femoral catheter · Interventional radiology · Peripherally inserted central catheter · Tunneled central venous catheter

Introduction

Critically ill children requiring long-term venous access might be unstable for transport to the interventional radiology (IR) suite, necessitating bedside placement [1, 2]. Image-guided placement of lower-extremity tunneled vascular access has been found to be safe and feasible [3]. To date, we have found no data comparing outcomes of femoral tunneled central venous catheter (CVC) in the pediatric population inclusive of neonates and infants placed in an interventional radiology (IR) suite versus at bedside. In this study we evaluated experience at a single tertiary institution comparing bedside versus IR suite placement of femoral tunneled CVCs.

Materials and methods

We conducted a retrospective review to identify all primary pediatric common femoral tunneled CVC placements by interventional radiology between January 2014 and December 2015, following approval by the institutional review board.

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We identified complications by reviewing charts of all femoral tunneled CVCs placed by the IR department, looking specifically for any indications that may have contributed to line removal. We obtained patients' demographic information including age at catheter placement, weight, and gender via the electronic medical record database and summarized this in Table 1. The indications for catheter placement are shown in Table 2. The distribution of catheter types and placement location are summarized in Table 3.

The criteria for primary femoral tunneled CVC approach include congenital cardiac patients requiring preservation of upper extremity veins, infants younger than 6 months, or critically ill children unsuitable for transport to the IR suite. Common indications for bedside-placed primary femoral vein tunneled CVC include unstable transportation such as airway or cardiopulmonary compromise, extracorporeal membrane oxygenation, or oscillator ventilation. The bedside placement of tunneled femoral CVC primarily occurred in the intensive care unit and to lesser extent the emergency room. The respective primary team provided sedation for the bedside approach.

Our standard institutional line care protocol requires dressing change every 7 days or sooner if the dressing is soiled or loose. Changes are performed by the floor nurse, vascular access team or home health nurse. The vascular access team is required to change the dressing if the CVC is not sutured.

Technique

Informed consent was obtained from the parents or guardians before start of the procedure. Preoperative hematologic and coagulation lab assessment was obtained prior to start of the procedure with an overall goal of hemoglobin levels of 8 g/dL or greater, platelet levels ≥50,000/μL and an international normalized ratio of 1.5 or less. Pre-procedure prophylactic antibiotic was not required.

Table 1 Patient demographics for all catheter placements

	IR suite (140)	Bedside (104)
Gender		
Male	82	58
Female	58	46
Age (days)		
Mean	206	231
Median	94	70
Range	3 to 3,531	1 to 2,190
Weight (kg)		
Mean	5.6	5.3
Median	4.4	3.7
Range	0.9 to 50.2	0.5 to 23
Neonates	18	33

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Table 2 Indications for primary catheter placements

	IR suite (*n*)	Bedside (*n*)
Access (difficult access, long term, transfusion, drips)	69	64
Antibiotics	23	8
Cardiac	29	21
TPN	19	11
Total placements	140	104

IR interventional radiology, *TPN* total parenteral nutrition

Surgical sterile technique was followed in both placement locations. The groin to the knee was prepped and draped in the usual sterile fashion. Placement of the femoral tunneled CVC was performed with the single-stick tunneled technique, where a 7-cm, 21-gauge micropuncture needle (EchoTip; Cook, Bloomington, IN) gained skin entry under real-time ultrasound guidance (LOGIQ E L8 18-MHz high-frequency or 9 L–MHz linear transducers; GE Healthcare, Milwaukee, WI) from the medial thigh, just above the knee, and tunneled subcutaneously caudad to the cranial approach at a minimum of approximately 3 cm to the common femoral vein (Fig. 1). The access needle was then exchanged over the 0.018-in. wire for a peel-away sheath. The measuring wire was advanced approximately at or near (1- to 2-cm below) the inferior vena cava (IVC)–right atrium (RA) junction and confirmed with fluoroscopy in the IR suite or ultrasound via the liver as a window in the bedside setting (Fig. 1). For bedside femoral tunneled CVC, the catheter length measurement and placement were guided solely by ultrasound (Fig. 1). Afterward the catheter was sutured with non-absorbable material and a sterile dressing was applied [4]. The catheter lumen was then packed with heparinized saline with approximately 2 mL of 10 U/mL.

Four types of non-cuffed catheters were utilized: Bioflo PICC (Angiodynamics, Marlborough, MA); Vascu-PICC (Medcomp, Harleysville, PA); Deltec (Smiths Medical Brand, Minneapolis, MN) and TPN Cook Medical

Table 3 Distribution of catheter types and placements

	IR suite (*n*)	Bedside (*n*)
Bioflo 3-F SL	94 (67.1%)	41 (39.4%)
Bioflo 5-F DL	1 (0.7%)	0
Cook 4-F DL	0	1 (1.0%)
Deltec 1.9-F SL	0	1 (1.0%)
Medcomp 1.9-F SL	1 (0.7%)	0
Medcomp 2.6-F DL	25 (17.8%)	43 (41.3%)
Medcomp 4-F SL	1 (0.7%)	0
Medcomp 4-F DL	18 (12.9%)	18 (17.3%)
Total	140	104

DL double lumen, *F* French, *IR* interventional radiology, *SL* single lumen

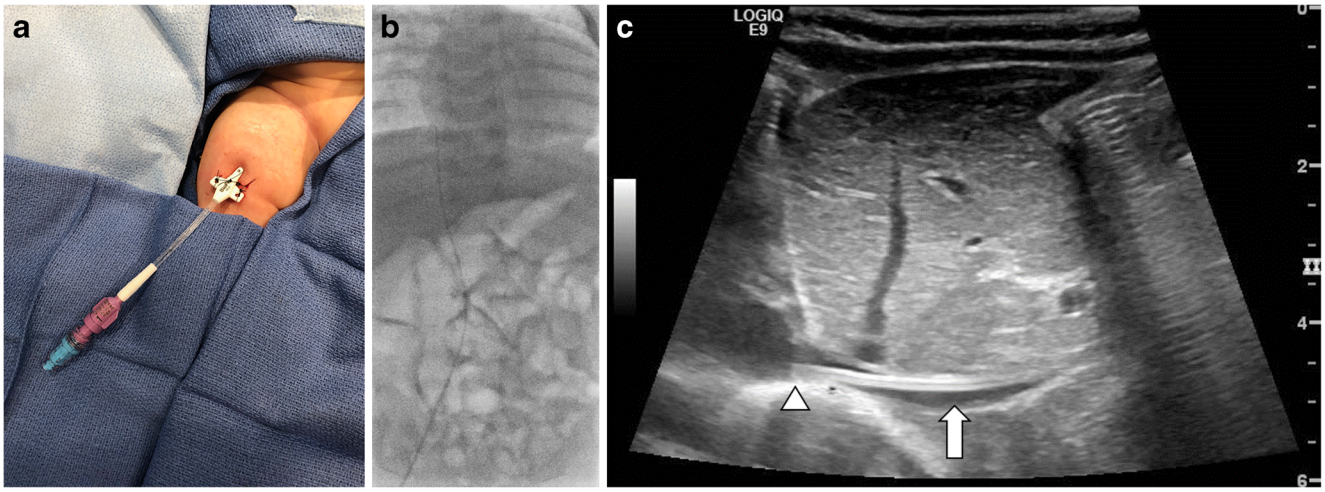

Fig. 1 Tunneled right femoral central line depicted in a 3-month-old boy. **a** Right lower extremity photograph shows the catheter entry site at the medial thigh, tunneled approximately 3 cm from the common femoral vein access entry point. **b** Fluoroscopic image with tip at the IVC–RA junction. **c** Corresponding ultrasound through the liver window in the mid-upper abdomen at the time of placement shows the catheter tip (*arrowhead*) within the IVC (*arrow*). *IVC* inferior vena cava, *RA* right atrium

(Bloomington, IN). Criteria for catheter size placement were generally determined by the lumen diameter of the catheter being ≤50% of the vessel size; however clinical need for specific vascular access superseded catheter-to-lumen diameter ratio in certain cases.

Definitions

Technical success was defined as appropriate placement with adequate function in a primary placed common femoral vein CVC insertion with tip at or near the IVC–RA junction along with functioning catheter [5]. The Society of Interventional Radiology (SIR) Reporting Standards for central venous access definition and complications was followed [5]. "Complication" was specific for infection, bleeding, malposition, symptomatic venous thrombosis and catheter occlusion. We defined central-line-associated bloodstream infection as meeting the laboratory confirmation of bloodstream infection, central venous catheter indwelling for 48 h before the bloodstream infection and without any other source of infection.

Statistical analysis

We analyzed the data with SAS software (version 9.3; SAS Institute Inc., Cary, NC). The statistical significance was set at $P \leq 0.05$. We compared the categorical variables using the Fisher exact test. We compared the continuous variables using the Wilcoxon rank test. The complication and infection rates per 1,000 line days was compared via the MidP exact test. We applied univariate logistic regression to study the risk factors of complication and infection. Finally, we applied multivariate logistic regression to study the complication and infection differences between bedside and IR suite, adjusting for line days and lumen number.

Results

A total of 244 primary common femoral vein catheter placements were performed (140 boys and 104 girls), of which 140 were placed in the IR suite and 104 at bedside. There was a mean age (days) of 206 in the IR suite and 231 in the bedside approach (Table 1). The mean weight (kg) in the IR suite compared to the bedside population was 5.6 kg and 5.3 kg, respectively. The most common indications for primary catheter placements for both groups were for access necessity, with a total placement of 140 in the IR suite and 104 at bedside (Table 2).

The distribution of catheter types and placement location is summarized in Table 3. The 3-French (F) single-lumen Bioflo catheters were most commonly utilized (n=94; 67.1%) in the IR suite group. The 2.6-F double-lumen Medcomp catheters were placed most often in the bedside group.

Total line days were 3,258 in the IR suite (median, 15; range, 0–166) and 3851 at bedside (median, 26; range, 0–263). The mean line days ± standard deviation for IR suite and bedside placement were 23.3±22.5 and 37.1±39.9, respectively.

In the IR group 96 single-lumen and 44 double-lumen catheters were placed. The bedside group had 42 single-lumen and 62 double-lumen catheters placed (Table 3).

IR suite placement lines had sedation provided by anesthesiology in 73% of the cases; the other 27% were performed with local anesthesia using buffered 1% lidocaine. The intensive care team provided 100% of the sedation for bedside-placed femoral tunneled CVC. The technical success rate of catheter placement with functioning catheter was 100% for both groups.

There were a total of 14 (10.0%) and 14 (13.5%) complications in IR suite and bedside-placed catheters, respectively. Specific complication types are listed in Table 4. The complications were adjusted for early (≤30 days) and late (>30 days) types, with 8 early and 6 late complications in the IR suite

Table 4 Catheter complications

	IR suite (*n*=140)	Bedside (*n*=104)
Total complications (% of *n*)	14 (10.0%)	14 (13.3%)
Infection	7 (5%)	3 (2.9%)
Bleeding	0	0
Malposition	2 (1.4%)	5 (4.8%)
Venous thrombosis	1 (0.7%)	2 (1.9%)
Catheter occlusion	4 (2.9%)	4 (3.8%)

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group. There were 3 early and 11 late complications in the bedside group (Table 5). The average line days in the IR suite vs. bedside placed tunneled CVC were statistically significant at 23.0±22.5 compared to 37.1±39.9, respectively (P=0.004). The IR suite-placed tunneled CVC was statistically significantly larger than the bedside CVC (P<0.01; Table 5). The complications per 1,000 line days were 4.3 for the IR suite and 3.6 for the bedside group. Of the 14 complications in IR suite, 7 (5% of total number in group) were infection-related. There were 3 (2.9% of total number in group) infections out of the 14 complications in the bedside group. Infection complications occurred in 2.1 and 0.78 per 1,000 line days in the IR suite and bedside group, respectively.

We applied univariate logistic regression to study the risk factors of complications. Line days has an odds ratio (OR) for complication of 1.01 (confidence interval [CI] = 1.003–1.02) with a P-value of 0.01. Lumen number of 2 versus 1 has an OR for complication of 2.8 (CI 1.2–6.2) with statistically significant P-value of 0.01 (Table 6). Age, weight, catheter size, lumen size/lumen number and bedside versus IR suite factors all had P>0.05.

Univariate logistic regression was determined for infection risk factors as shown in Table 7. All factors evaluated for infection had P-value of >0.05. We then applied multivariate logistic regression to study the difference between line days and lumen number at bedside versus the IR suite (Table 8). Bedside versus IR suite was not significant (P=0.6841) while holding line days and lumen number constant. Line days and lumen number were statistically significant, with P-values of 0.03.

Discussion

Placement of femoral tunneled CVC with image guidance in the IR suite is a common and routine procedure for patients, particularly in children and neonates in their medical care course. However, it is not uncommon for the primary team to request bedside placement for critically ill children who are unsafe for transport. For the interventional radiologist, there has always been concern not only about limited image guidance, staff support and supplies, but more important about the potential increased risk of infection and complications in bedside placements [3].

Tunneling a subcutaneous track from the medial thigh caudally to the common femoral vein, away from the diaper to the access site, has been shown to be feasible, with high technical success and without a statistically significant increase in infection or complication [3, 6–8]. Our study further investigated the complication rate and infection differences between common femoral tunneled CVC placements in the IR suite as compared to bedside placement.

We found no statistically significant differences in the total complication rate, early or late complications, or infection rate between the IR suites and bedside-placed lower extremity tunneled CVC, despite the bedside group having statistically significant longer mean line days (Table 5**)**. The bedside lines seem to be more technically challenging, as seen with the statistically significant lower mean weight, smaller mean catheter size and smaller catheter size-to-lumen number ratio.

Table 5 Complication statistics

	IR suite (*n*=140)	Bedside (*n*=104)	*P*-value
Complication (% of *n*)	14 (10.0%)	14 (13.5%)	0.55
Early complication (% of *n*)	8 (5.7%)	3 (2.9%)	0.44
Late complication (% of *n*)	6 (4.3%)	11 (10.6%)	0.07
Infection	7 (5.0%)	3 (2.9%)	0.57
	Mean ± SD		
Age in years	0.57±1.01	0.63±1.16	0.17
Weight (kg)	5.6±4.7	5.3±4.1	0.04
Catheter size (F)	3.1±0.8	3.0±0.5	0.01
Catheter size/lumen number	2.6±0.7	2.1±0.8	<0.0001
Line days	23.0±22.5	37.1±39.9	0.004
Complications per 1,000 line days (*n*)	4.3	3.6	0.53
Infections per 1,000 line days (*n*)	2.1	0.78	0.14

IR interventional radiology, *SD* standard deviation

Table 6 Univariate logistic regression for complications

	OR for complication (95% CI)	*P*-value
Age in years	1.1 (0.8–1.5)	0.69
Weight (kg)	1.0 (0.9–1.1)	0.83
Line days	1.01 (1.003–1.02)	0.01
Catheter size (F)	1.4 (0.9–2.2)	0.13
Lumen number 2 vs. 1	2.8 (1.2–6.2)	0.01
Lumen size/lumen number	0.67 (0.41–1.10)	0.12
Bedside vs. IR suite	1.3 (0.6–2.9)	0.49

CI confidence interval, *OR* odds ratio
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There was a statistically significant complication risk factor with increased duration of line days and utilization of multiple lumens. We further evaluated this with the multivariate regression analysis, adjusting specifically for line placement, line days and lumen number and demonstrating significant differences for line days and lumen numbers. Interestingly, these risk factors did not show any significance for infection. The present study did not demonstrate any significance for the factors evaluated (age, weight, catheter size, lumen size/lm number ratio, location) for the development of a complication, either.

The total complications per 1,000 line days for IR suite and bedside in this study (4.3 and 3.6, respectively) is within range of published literature for mechanical complications in all central venous access in the pediatric population 3.8–14 per 1,000 line days [9–11].

The most common complication with IR suite placement was infection, whereas the most common complication for the bedside approach was malposition of the catheter. The total number of complications in each group was relatively low, which is why a larger sample size would be helpful to increase the power of the study.

It would be insightful to further investigate the cost and charge analysis between these two groups. For the bedside placement group, we only bill an ultrasound and peripherally inserted central catheter (PICC) charge compared to the IR suite placement, where we include a fluoroscopic component. Furthermore, a charge and cost analysis for sedation between the primary team versus anesthesia might yield further justification for bedside placement of femoral CVC.

Although there were no significant median age or weight differences between the two groups, one limitation of this study is that it didn't account for variables such as different locations for the bedside group, multiple operators, retrospective nature of the study, various catheter types and sizes, lack of procedure time for the bedside group and myriad primary patient disease processes.

Table 7 Univariate logistic regression for infection

	OR for infection (95% CI)	*P*-value
Age in years	1.02 (0.58–1.79)	0.95
Weight (kg)	0.97 (0.80–1.16)	0.72
Line days	1.002 (0.99–1.02)	0.79
Catheter size	1.11 (0.50–2.46)	0.81
Lumen number 2 vs. 1	2.01 (0.55–7.29)	0.29
Lumen size/lumen number	0.75 (0.33–1.68)	0.48
Bedside vs. IR suite	0.57 (0.15–2.27)	0.43

CI confidence interval, *OR* odds ratio
IR interventional radiology

Table 8 Multivariate logistic regression

	OR for complication (95% CI)	*P*-value
Line days	1.011 (1.001–1.021)	0.03
Lumen number 2 vs. 1	2.6 (1.1–6.1)	0.03
Bedside vs. IR suite	0.8 (0.4–2.0)	0.68

CI confidence interval, *OR* odds ratio
IR interventional radiology

Conclusion

There was no increased risk of complications or infection for those with bedside-placed femoral tunneled CVC compared to those with CVCs placed in an IR suite. It would be informative to determine the differences in procedure time and cost in comparing the two groups, which might result in incorporating bedside procedures as routine.

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Compliance with ethical standards

Conflicts of interest None

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