Lower Extremity Vascular Access in Neonates and Infants: A Single Institutional Experience

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ABSTRACT

Purpose: To demonstrate feasibility and evaluate outcomes of direct-stick saphenous and single-incision tunneled femoral noncuffed central venous catheters (CVCs) placed in a large series of neonates and infants at a single institution.

Materials and Methods: A retrospective review was performed for all neonates and infants receiving a lower extremity CVC by interventional radiology between 2007 and 2012. Technical success, mechanical and infectious complications, and catheter outcomes were recorded.

Results: There were 271 primary insertions performed in 243 children by interventional radiologists in the interventional radiology suite or at the bedside. CVCs were placed via the femoral vein with single-incision technique (84.9%) or the saphenous vein via a direct-stick technique (15.1%), with a technical success rate of 100%. The total number of catheter-days was 7,917 days (median, 19 d; range, 0–220 d). The number of primary catheter-days was 5,333 days (median, 15 d; range, 0–123.0 d), and salvage procedures prolonged catheter life by 2,584 days (median, 15 d; range, 1.0–101.0 d). The mechanical and adjusted infectious complication rates were 1.67 and 0.44 per 100 catheter-days.

Conclusions: Image-guided placement of saphenous or tunneled femoral catheters using a single incision is a safe and feasible method for vascular access in neonates and infants.

ABBREVIATIONS

BSI = bloodstream infection, CFV = common femoral vein, CI = confidence interval, CVC = central venous catheter, IVC = inferior vena cava, RA = right atrial, TPN = total parenteral nutrition, VT = venous thrombosis

Placement of central venous catheters (CVCs) via the femoral vein raises concern for infection because of proximity of the femoral insertion site to the perineal skin (1). However, a single-incision technique can be used to tunnel the CVC subcutaneously from an insertion site at the distal medial thigh, avoiding the groin incision (1,2) and increasing the distance between the skin-catheter junction and venous insertion site (3). Subcutaneous tunneling has been shown to decrease the risk of catheter colonization and bloodstream infection (BSI) in adults (3) and the risk of catheter colonization of short-term CVCs in children (4).

At our institution, the single-incision technique is used to tunnel femoral CVCs from the distal thigh to the femoral vein (1), as was previously described in a small series of children (2), and saphenous vein access is obtained using a direct single needle stick (5,6). To date, few data have been published regarding outcomes of tunneled femoral and direct-stick saphenous noncuffed CVCs in neonates and infants. The aim of the present study was to evaluate a single institutional experience with a large series of lower extremity noncuffed CVCs in neonates and infants and describe technical success of the technique, catheter outcomes, and complications.

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MATERIALS AND METHODS

Following approval by the institutional review board, a retrospective review of the interventional radiology (IR) database was performed to identify all children who had a saphenous or tunneled femoral CVC insertion via single-incision technique between June 2007 and July 2012. We identified 243 children (130 boys and 113 girls) and reviewed electronic medical records for relevant clinical information. Patients included preterm, ex-preterm, and term neonates and infants. Ages were adjusted for ex-preterm neonates and infants. Patient demographics are summarized in Table 1. From June 2007 until January 2011, procedure times were collected from physician procedure notes. From January 2011 until July 2012, procedure times were collected from technologist documentation in the newly instituted electronic health record. The primary admitting diagnoses and indications for primary insertions are listed in Tables 2 and 3. Neonates and infants with institutional indications for lower extremity CVC placement include (*a*) neonates and infants requiring bedside CVC placement (ie, poor cardiopulmonary reserve, congenital diaphragmatic hernia, gastroschisis/omphalocele, oscillator ventilation/extracorporeal membrane oxygenation), (*b*) neonates and infants with hypoplastic left heart syndrome to avoid the risk of Glenn physiology thrombosis, (*c*) neonates and infants weighing < 3 kg or with upper extremity vein diameter < 2 mm, and (*d*) neonates and infants with known upper extremity vein thrombosis from prior access. For bedside placement of CVCs by IR, the saphenous or common femoral veins are the access sites of choice. Positioning of the catheter tip in the upper inferior vena cava (IVC)–right atrial (RA) junction is more feasible at the bedside than positioning in the superior vena cava–RA junction. This region is easily visualized with ultrasound (US) for determination of catheter tip location. In addition, in infants weighing < 3 kg, the common femoral vein (CFV) provides a larger access site with a more ideal catheter-to-vein diameter ratio.

Table 1. Patient Demographics for All Catheter Insertions

Patient Data	No. of Catheter Insertions
Premature at birth	
< 37 gestational wk at line placement	47
≥ 37 gestational wk at line placement	96
Term	128
Patient age	
Mean (d)	51.1
Median (d)	29.2
Range	24.0 gestational wk to 1 y
Weight (kg)	
Mean	3.6
Median	3.3
Range	0.6 to 9.2

Table 2. Primary Admitting Diagnoses

Diagnosis	No. of Occurrences
Congenital heart disease	78
Prematurity	61
Respiratory distress (secondary to pulmonary disease, respiratory infection, lymphatic malformation)	27
Congenital anomalies	18
Hyperinsulinism	13
Gastrointestinal disorder	20
Infection	11
Congenital diaphragmatic hernia	8
Metabolic abnormality	3
Renal failure	2
Neurologic	1
Other	5
Total admissions	247

Table 3. Indications for Primary Catheter Insertions

Indication	No. of Catheters
Cardiovascular/respiratory support	122
TPN	81
Access (eg, for antibiotics, TPN, medications, transfusions)	41
Long-term antibiotic therapy	27
Total catheter insertions	271

TPN = total parenteral nutrition.

Assessment before the Procedure

Informed consent was obtained from parents or guardians for all patients before the procedure. For tunneled catheters, hematologic requirements before the procedure were ideally platelet levels $\geq$ 50,000/μL and international normalized ratio ≤ 1.5 because of the potential for tract bleeding given creation of a tunnel and placement of a sheath that is larger than the access catheter. Prophylactic antibiotics were not routinely given.

Description of Catheters

Catheters for primary insertions were noncuffed peripherally inserted central catheters that included 1.9-F single-lumen (n = 12; 4.4%) and 2.6-F double-lumen (n = 68; 25.1%) peripherally inserted central catheters (Medcomp, Harleysville, Pennsylvania), 3-F single-lumen (n = 76; 28.0%) and 5-F double-lumen (n = 1; 0.4%) catheters (AngioDynamics Inc, Latham, New York), 4-F single-lumen (n = 10; 3.7%) catheters (AngioDynamics; Navilyst Medical, Glens Falls, New York), and 3.5-F double-lumen (n = 104; 38.3%)