Efficacy of Peripherally Inserted Central Venous Catheters Placed in Noncentral Veins

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Background: Peripherally inserted central venous catheters (PICCs) are commonly used intravenous access devices in children. Although PICCs are intended to be placed in central veins, many fail to reach this location. These noncentral PICCs are used for administration of medications and isotonic solutions.

Objectives: To examine the efficacy of noncentral PICCs for completion of therapy, the complications associated with their use, and the effectiveness of noncentral PICCs as compared with PICCs placed in a central vein.

Design: A prospective cohort study of children in whom PICCs were inserted, from January 1, 1994, to January 1, 1996.

Setting: A university-affiliated teaching institution.

Main Outcome Measurement: Completion of intravenous therapy.

Results: A total of 587 PICCs were studied. Thirty-nine percent of PICCs were placed in noncentral veins. Centrally placed PICCs had significantly longer catheter duration compared with those placed noncentrally (16.6 vs 11.4 days, respectively). However, central and noncentral PICCs had similar therapy completion rates (73% and 69%, respectively). Catheter failure because of occlusion and accidental dislodgment were similar for central and noncentral PICCs. Likewise, complications caused by exit-site infection, phlebitis, and catheter-associated sepsis were also similar for catheters in the 2 locations. Catheter survival curves were similar for central and noncentral PICCs.

Conclusions: Our study demonstrates that PICCs placed in noncentral veins provide reliable and safe intravenous access for administration of many medications and isotonic solutions for about 2 weeks' duration. The placement of PICCs in central veins may be restricted to those children who need central vascular access because of the type of intended therapy.


Editor's Note: The acronym PICC is very descriptive. Catherine D. DeAngelis, MD

PERIPHERALLY inserted central venous catheters (PICCs) are used frequently in children to provide prolonged access for intravenous (IV) therapy.1 When inserted, PICCs are generally intended to be placed in a central vein. However, many PICCs fail to reach this location because of anatomical variations in vein size or confluence and obstruction from valves in the venous system. The soft nature of the catheters can also make guiding them into a central vein difficult.2-3 Some PICCs may be intentionally placed in a noncentral vein. Because hyperosmolar solutions (eg, solutions with dextrose concentration of >12.5%) can be administered only through centrally placed PICCs, noncentrally placed PICCs are used for the administration of medications (eg, antibiotics) and isotonic solutions that are compatible with infusion through a peripheral vein.4,5

In a prior study,1 we found that 47% of PICCs used in our institution were placed in noncentral veins. Since a large portion of PICCs used in our institution were noncentral, we examined their efficacy for completion of therapy and complications associated with their use. We also compared their use with centrally placed PICCs to determine if noncentral placement is safe and effective in a population of children who need prolonged IV access, but not necessarily central vascular access.

RESULTS

Six hundred three PICCs were inserted in 519 patients. Complete information regarding distal tip location was available for 587 PICCs. All data on catheters that
METHODS

Information was prospectively collected on all PICCs inserted at Children’s Hospital and Medical Center, Seattle, Wash, from January 1, 1994, to January 1, 1996. The data from the first 441 PICCs were used in a prior study examining the use and complications of PICCs in children. For purposes of this study, the data collection was extended to include all PICCs inserted during a 24-month period. The PICC insertion technique and definitions regarding suspected catheter infection were described previously. A PICC completed therapy if it provided uninterrupted intravenous access for successful completion of a prescribed course of therapy without need for replacement.

All PICCs were inserted by the IV nursing team. Referrals to the IV team for catheter placement were made by the patient’s primary physician. All insertions were done in the hospital. Per-Q-Cath (Gesco Inc, San Antonio, Tex) or L-Cath (Luther Medical Products Inc, Tustin, Calif) catheters of sizes ranging from 2F to 5F (catheter sizes, 23 gauge-16 gauge) were used. The size and choice of catheter were determined by the IV team member inserting the catheter. The need for central PICC placement was determined by the attending physician and the IV team member.

After insertion, the location of the catheter tip was determined radiographically. When the tip was not easily visible by plain radiography, contrast material was injected through the catheter to delineate the tip. The PICC was centrally placed if the distal tip was located in the right atrium, the superior vena cava, the inferior vena cava, or the subclavian vein. Peripherally inserted central venous catheters with distal tips in other locations were defined as non-central. The IV team monitored the catheters closely for complications for the duration of catheter use and recorded any complication.

Total parental nutrition solutions with dextrose concentrations of more than 12.5% were administered only through central PICCs. Both central and noncentral PICCs were accessed continuously or intermittently. For PICCs used continuously, the use of heparin to maintain line patency was at the discretion of the primary physician. When PICCs were used intermittently, they were flushed with saline solution containing heparin after each use. For patients who were discharged home or to another institution with a catheter in situ, care was given by local nursing personnel, who maintained telephone contact with the IV team at Children’s Hospital and Medical Center. The reason for catheter removal was recorded.

For statistical analysis, PICCs were grouped as central or noncentral. Statistical procedures for univariate analysis included the independent Student t test for normally distributed continuous data, the Mann-Whitney U test for nonparametric continuous data, and the χ² test and χ² test for trend for categorical data. Multivariate survival analysis using the Cox proportional hazards model was done to estimate the hazard ratio and the 95% confidence interval (CI) for catheter failure for central and noncentral PICCs.

Simultaneous adjustments for the effects of patient age, catheter size, and other potential prognostic factors (continuous use, intermittent use, and heparin use) were made. To determine the effect of age on catheter use and failure, patients were grouped into 4 age variables: 0 to 30 days; 31 to 365 days; 366 days to 5 years; and older than 5 years. The age grouping was chosen to study differences in catheter use among neonates, infants, and young and older children. Age was also evaluated as a continuous variable and as a group linear variable. To determine the effect of catheter size on catheter use and failure, catheter size was compared individually as 5 separate size variables (2F, 2.7F, 3F, 4F, and 5F) and, finally, grouped as 2 variables: 2F and 2.7F catheters and 3F, 4F, and 5F catheters. The program SPSS for Windows (SPSS Inc, Chicago, Ill) was used for the calculations. Significance was defined as P ≤ .05.

Finally, we compared catheter survival for central and noncentral PICCs using the Cox proportional hazards model. For the whole group, rate of therapy completion was significantly influenced by catheter size and age of the patient (Table 4). The rate of therapy completion for 2F and 2.7F catheters was significantly lower when compared with 3F, 4F, and 5F catheters (64% vs 74%, respectively). The rate of therapy completion was significantly higher for the groups aged 0 to 30 days and greater than 5 years (73% and 77%, respectively) when compared with the groups aged 31 to 365 days and 366 days to 5 years (54% and 62%, respectively). Administration of continuous heparin, intermittent catheter use, and outpatient use did not significantly influence therapy completion. After adjusting for the influence of age and catheter size, the survival curves for PICCs placed in a central and noncentral location were not significantly different (Figure).

It is common practice in some pediatric institutions to use PICCs placed in a noncentral vein. Although central vascular access is required for administration of hy-
per osmolar solutions, inotropic agents, and chemotherapy, antibiotics and other isotonic solutions can be administered for prolonged periods through noncentrally placed PICCs. Many clinicians at our institution think that central PICCs are more likely to provide sustained intravascular access, resulting in more frequent completion of a prescribed IV regimen. This study demonstrates that noncentral PICC catheters can also provide reliable and prolonged IV access for administration of medications and solutions compatible with use through a peripheral vein. Furthermore, we did not demonstrate differences in the rate of occlusion, accidental dislodgment, phlebitis, or catheter-associated sepsis based on catheter tip location.

In a previous smaller study of 36 PICCs, Sheppard and Ong compared the use of and complications associated with central and noncentral PICCs. They reported that the average catheter duration was not significantly different for PICCs in central and noncentral veins. They also noted an increased risk of suspected catheter infection with central PICCs (2.2 and 0.3 episodes per 100 catheter days in central and noncentral catheters, respectively) and an increased incidence of exit-site infection with noncentral PICCs. Our results differ from this study. In a larger cohort of patients, we found that catheter duration was significantly less for noncentral PICCs than central PICCs. However, the absence of significant differences in therapy completion rate and cather-
eter survival for central and noncentral PICCs suggests that catheter duration for noncentral PICCs was limited by completion of therapy and not catheter failure. We also found that the incidence of catheter-associated sepsis was the same for central and noncentral PICCs (0.1 and 0.07 episodes per 100 catheter days, respectively). Furthermore, we did not find an increased incidence of exit-site infections in noncentral PICCs.

Although we have been able to examine a large cohort of children treated at a tertiary pediatric center, the limitations of our study should be considered. Our results represent the use of PICC catheters at a single pediatric institution and may be affected by nursing care of the catheters and severity of patient illness, as well as other unrecognized factors. Furthermore, comparison of central and noncentral PICC duration is affected by many important factors. Children with central and noncentral PICCs differed by age and catheter size. Likewise, patient diagnosis, severity of illness, and the chemical nature of solutions administered through the catheters may have differed between the 2 groups and could not be evaluated in the multivariate analysis. Nevertheless, our study is the first with sufficient sample size to examine the effects of multiple patient and catheter features and PICC location on catheter failure and complication rates.

Noncentral PICCs provide IV access for an average of 11 days, which is much longer than can be expected from conventional peripheral IV catheters (1.2-2.9 days).7,8 Furthermore, we found that the rates of phlebitis and catheter-associated infection are lower than that reported for conventional peripheral intravascular devices (phlebitis, 9.9%-34.5%; catheter-associated sepsis, 4.6%-9%).5,10 Hence, a noncentral PICC is a desirable intravascular device in children with difficult venous access, in those requiring prolonged antibiotic therapy at home or in the hospital, or in children who are highly sensitized to multiple needle punctures.

In conclusion, noncentral PICCs can be used to provide equally safe and reliable intravascular access for children needing IV therapy for approximately 2 weeks. The nonrandomized nature of this study does not allow definitive conclusions regarding the efficacy of longer catheter use, because the prescribed course of therapy in the noncentral PICC group may have been of shorter duration. However, 28% of noncentral PICCs in this study were used for more than 2 weeks. Of these noncentral PICCS, 77% of the patients completed therapy successfully. The placement of PICCs in central veins may be limited to those patients who need central venous access because of the type of intended therapy. The risk of serious complications associated with central venous access can be avoided in patients who need IV access for the administration of medications and isotonic solutions by using PICCs placed in noncentral veins.

Accepted for publication November 25, 1997.

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REFERENCES


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