Placement of Peripherally Inserted Central Catheters (PICC): The Upper Arm Approach

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Purpose: To evaluate a recently developed technique to place a medium-duration (weeks to months) central venous access.

Materials and Methods: Within three-year period, 635 patients were referred to interventional radiology suite for placement of peripherally inserted central catheter (PICC). Contrast medium was injected into the peripheral intravenous line and a puncture was made into the opacified vein near the junction of the middle and upper thirds of the upper arm, either the brachial or basilic vein under fluoroscopic guidance. A 5.5-French peel-away sheath was inserted into the vein and a 5-French silicone catheter was introduced with its distal tip to the junction of the right atrium and superior vena cava.

Results: Catheter placement was successful in all patients unless there was a central venous obstruction. Catheters were maintained from 2 days to 5 months with a mean of 3 weeks. Complications included infection requiring removal of the PICC in 16 patients (2.5%), acute thrombosis of the subclavian vein in 3 (0.5%). Occluded catheters in 4 patients were easily cleared with urokinase in place.

Conclusion: The PICC system is an excellent option for medium-duration central venous access. Patients were able to carry on normal activities with the catheters in place.

Index Words: Catheters and catheterization, technology
Veins, interventional procedure

Peripherally inserted central catheters (PICCs) have been in use initially in the pediatric and neonatal patients (1–3). These catheters locate to a central vein to permit infusion of hypertonic and sclerotic antineoplastic or antimicrobial agents. In larger children and adults, the need for long-term central venous access was achieved by large-bore central catheters placed in the jugular or subclavian veins, usually by surgeons. These large central catheters have a number of problems, including catheter occlusion (4, 5), venous thrombosis, infection, pneumothorax, hemotorax, inadvertent administration of agents into the pleural space, fracture and embolization into the heart and pulmonary circulation (6, 7), difficult exchange or replacement, expensive insertion, and difficult care. With proper attention to sterile technique and dressing changes, these long flexible catheters could be left in situ for longer periods than conventional peripheral IVs, and they did not damage the patient’s peripheral veins, since the drugs or alimentation fluids were delivered centrally in large veins in which dilution quickly lowered the high osmolarity. The problem with bedside insertions was the low success rate, with which the catheters could be threaded to the central circulation, particularly if the individuals who inserted the catheters were not adequately trained. It has become apparent that experts who were facile with catheters and worked in fluoroscopic assistance far outperformed bedside insertions in terms of venipuncture success rate, speed, and complication rate (8, 9). The purpose of this study is to evaluate a recently developed radiological technique to place a medium-duration PICC by upper arm approach.
PATIENTS and METHODS

Between April 1991 and February 1994, 635 consecutive patients were referred to the angiointerventional suite at the University of Michigan Medical Center for placement of PICC. This group included 337 men and 298 women, ranging 12–85 years old with a mean age of 51 years. The indications for PICC were antineoplastic chemotherapy (227 cases), long-term antibiotic infusion (312 cases), total parenteral nutrition (37 cases), blood products infusion (50 cases), and long-term IV administration of diuretics (9 cases).

Prior to the procedure, each patient permitted written, informed consent, as approved by the clinicians. The patient’s nondominant arm was used whenever possible. Patients were positioned with the arm abducted and externally rotated, and the axilla and upper arm were prepared and sterily draped.

PICC insertion technique uses a fluoroscopic-venographic approach. Initially, a small needle is inserted in a vein on the thumb, wrist, hand, or other peripheral location. Contrast medium (20–50 ml) is then injected until suitable veins at midhumeral level against an upper arm tourniquet are filled. The basilic vein is preferred because it is larger and follows a more direct course to the axillary and subclavian veins and superior vena cava, although the cephalic vein is suitable in most patients. Entry above the antecubital fossa is preferred because the veins are larger more proximally toward the heart and have generally been spared the ravages of repeated phlebotomy since they are deep at this location and rarely can be palpated. An additional advantage of this entry location is that the catheter is not subjected to repeated bending across the antecubital fossa with arm motion. After induction of local anesthesia with 2% lidocaine, the chosen entry vein is punctured under direct continuous vision with a 21 gauge needle by confirming blood aspiration. With a minipuncture system, a 0.018-inch wire is passed into the vein. Subsequently, a 5-F dilator wire is advanced over the wire to maintain venous access.

The PICC system was a single or dual lumen 5-F silicone catheter (Cook Inc., Bloomington, In) with a larger hub end and pinch clamp (Fig. 1) to let the patient and his safeguard to get easy handling. The required length of catheter was determined by advancing a guidewire through the dilator to the junction of the superior vena cava and the right atrium, and the catheter was cut to the length traversed by the wire. Next, a 0.035-inch guide wire was advanced under fluoroscopy into the distal inferior vena cava. A 5.5-F peel-away sheath (Cook Inc., Bloomington, In) was advanced into the vein, and a 5-F silicone catheter was subsequently advanced over the wire with its tip in the superior vena cava/right atrial junction in such a way that the tip kicks with each cardiac cycle (Fig. 2). After the catheter was placed into the position, the sheath was removed, and the wings at the catheter hub sutured in place with two 4–0 prolene stitches.

Following radiographic imaging of the catheter, all channels of the PICC were irrigated with heparinized saline and finally flushed with a heparin lock solution containing 100 U/mL of heparin. Infusion caps were placed on each port hub and pressure was held on the puncture site until hemostasis was obtained. The PICC was secured the skin by means of an occlusive dressing which was changed every 5 to 7 days. Care was taken to flush the catheter with heparin solution after each use.

RESULTS

A total of 635 PICC devices was used in the 635 PICC
patients. Successful initial insertions were achieved in 635 of 635 (100%) consecutive patients excluding 17 patients with central venous obstruction on digital subtraction venogram.

Catheters were indwelling from 2 days to 5 months, with a mean duration of 3 weeks. The catheters were used for antineoplastic drug infusion, administration of antibiotics, total parenteral nutrition, administration of diuretics, and transfusion of blood products.

Overall complications after the procedures occurred in 23 patients (3.6%). Complications requiring removal of the catheter occurred in 19 patients (3%). Sixteen catheters (2.5%) were removed because of infection. In fourteen cases, frank infection was present around the insertion site, and in the other two, blood cultures contained gram-positive Staphylococcus epidermidis of the skin flora, and the catheter was thought to be the source through the insertion site (10). Symptomatic acute subclavian vein thrombosis occurred in three patients. Arm swelling responded to removal of the catheters and systemic anticoagulation with an administration of 2500 Units of Heparin. In four patients, the catheters became occluded after blood drawing, but were easily cleared with 5000 Units of Urokinase.

**DISCUSSION**

With the introduction of PICC devices primarily in pediatric literature (1-3), relatively little is written about these devices in radiological literature (8, 9). Although the PICCs were initially inserted at bedside, it rapidly became that such insertions were only successful with large adequate peripheral veins. Patients, who need temporary or long term central venous access, often do not have visible peripheral veins, and this fact limits the easy placement of PICC device at bedside. It has become apparent that experts who were facile with catheters and worked in fluoroscopic assistance far outperformed bedside insertions in terms of venipuncture success rate, speed, and complication rate (4-9).

Advantages in interventional radiology technologies are to locate and target undamaged veins and advance the catheter into the central circulation with safety. The basilic vein is preferred because it is larger and follows a more direct course to the axillary and subclavian veins and superior vena cava, although the cephalic vein is suitable in most patients. When the initial attempt to cannulate the adequate vein is unsuccessful such as inadvertent entry into the brachial artery or extravasation of contrast medium at fluoroscopy, the venipuncture system can result in minimal damage and prevent the serious complication with final success, but this has not occurred in this study. The fluoroscopic-venographic guidance of the PICC through the collateral veins and into central circulation is another advantage when major veins are segmentally occluded about the elbow, shoulder, or subclavian area that is impossible at bedside or by surgeons (8). Advantage of entry above the antecubital fossa is that the catheter is not subjected to repeated trauma across the antecubital fossa with arm motion (9).

The PICCs are intended for and well tolerated by the patients who require venous access for up to 3-5 months, and their dwell time is optimal to complete therapy with a single device. Service interval of the PICCs can be maximized by careful attention to site care, heparin flushing after each use, and restricting blood sampling through small lumen. In patients requiring blood draws, the largest channel is used and meticulous flushing of the channel after the draw is critical for the longer service interval. Blood sampling was avoided as possible because PICCs through which blood was drawn had not longer service interval than those through which blood drawing was not achieved (8).

The catheter occlusion after the blood drawing has occurred in four patients in our series, and cleared with 5000 units of urokinase successfully. When the PICCs fail because of dislodgement, breakage, leakage, or occlusion, they can be easily be exchanged over a guide wire or through a peel-away sheath. Exchangeability into the same vein is a fascinating advantage of the PICCs over other devices such as Hickman, Broviac right atrial catheter, and subcutaneous infusion ports (8, 9, 11). Fortunately, failures other than occlusion have not occurred in our series.

The overall complication rate of the PICCs (23 of 635 (3.6%)) in our series compares favorably with that of other devices (3.5-8.9%) (8, 9) and, surgical or bedside approaches. PICC complications of infection (n=16) and venous thrombosis (n=3) in our series are minor when compared with those of surgical approach such as pneumothorax, hemothorax, breakage with embolization of fragments to pulmonary circulation, and injection port occlusion (4-18). The PICCs are less expensive than other devices, with lowered morbidity, mortality, and fee of the surgery.

In conclusion, the PICC system by radiological insertion is an excellent option for medium-duration central venous access. Patients were able to carry on normal activities with the catheters in place without difficulty.

**REFERENCES**

실태
지난 몇 년 동안 충분한 연구가 이루어지지 않아, 상완부위의 말초정맥을 통한 중심정맥도관 삽입의 성공률이 낮고, 이로 인한 합병증 발생률이 높다는 보고가 있었다. 11

목적: 이 연구는 신선도의 재맥경색증의 위험성, 그리고 삽입과 관리에 따른 합병증의 위험성을 평가하기 위한 것이다.

대상 및 방법: 3년 동안 635명의 환자에 대해 이 시술을 시행하였다. 조영제를 사용하여 상완부위 정맥을 가시화하고, 투시 하여 전공을 시행하였다. 정맥에 5.5 프렌치 탈피초를 삽입한 후, 5 프렌치 도관을 끝부분이 상대정맥과 우심방이 만나는 부 위에 위치시켰다.

결과: 모든 환자에서 성공적으로 삽입되었고, 기간은 2일에서 5개월로 평균 기간은 3주일이었다. 도관 삽입 후 도관제거가 필요한 경우는 16예의 감염(2.5%), 16예의 합병증 중 3예(0.5%)였다. 도관 폐쇄는 유로키나제 직접 투여로 재개통되었다.

결론: 상완부위 말초정맥을 통한 중심 도관 삽입술은 수술, 투약, 정맥의 급성 혈전증 예방 등의 방법이 있다. 말초정맥을 통한 중심 도관 삽입은 정상 생활을 영위할 수 있었다.