Single-Lumen Subcutaneous Ports Inserted by Interventional Radiologists in Patients Undergoing Chemotherapy

Incidence of Infection and Outcome of Attempted Catheter Salvage

Delia Kuizon, MD; Steven M. Gordon, MD; Bart L. Dolmatch, MD

Background: Subcutaneous ports are commonly used for vascular access in patients with cancer undergoing chemotherapy.

Objectives: To determine the incidence of catheter-related infection and to assess the efficacy of catheter salvage in subcutaneous ports.

Methods: We retrospectively reviewed 300 subcutaneous single-lumen chest ports inserted by interventional radiologists in 294 patients between December 1, 1995, and November 15, 1997, at the Cleveland Clinic Foundation, Cleveland, Ohio. The number of days that the catheter remained in situ, infection rate, treatment, and outcome of infection were determined.

Results: Two hundred ninety-four patients had a total of 79,748 catheter-days. Vascular access for chemotherapy was the indication for 95% of the subcutaneous ports placed. Seventeen catheters (5.7%) developed 20 episodes of noninfectious complications resulting in the removal of 6 ports. Seventeen patients (5.7%) developed catheter-related infections (2.1/10,000 catheter-days) including 10 episodes of catheter-related bacteremia (1.2/10,000 catheter-days). The most common organism isolated was *Staphylococcus aureus*. A total of 15 of the 17 infected catheters were removed. Salvage was attempted in 6 patients in whom 4 catheters were eventually removed due to recurrent bacteremia (2 patients) and persistent local infection (2 patients). One of the 10 patients with catheter-related bacteremia developed septic arthritis. There were no complications associated with attempted catheter salvage.

Conclusions: Subcutaneous single-lumen ports inserted by interventional radiologists in patients undergoing chemotherapy have low complication rates but infections remain the leading cause of catheter loss. Antibiotic therapy without catheter removal is unlikely to eradicate catheter-related bacteremia.

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LONG-TERM indwelling venous access devices are a critical issue in the management of many patients with cancer, facilitating the administration of chemotherapy and supportive care such as blood transfusion, intravenous antibiotics, intravenous fluids, and total parenteral nutrition. Since the introduction of totally implantable central venous catheters as an alternative to external catheters in the early 1980s, subcutaneous ports have been widely used in patients with cancer undergoing chemotherapy. Aside from easier maintenance and less physical limitations in daily activities, studies have shown lower rates of catheter-related infections and mechanical complications with subcutaneous ports compared with external catheters. Recently, these ports are also increasingly being placed by interventional radiologists with comparable long-term results or even lower complication rates than traditional surgical placement. Infection remains the leading cause of morbidity and catheter loss in patients with subcutaneous ports. The appropriate management of catheter-related infections, however, has not been clearly defined. A prospective study of patients undergoing hemodialysis with tunneled, dual-lumen catheters showed failure of antibiotic therapy without catheter removal (catheter salvage) to eradicate catheter-related bacteremia. Although a few studies have suggested that port infections, including bacteremic episodes, can be treated successfully without catheter removal, the safety and efficacy of catheter salvage in subcutaneous ports has not been determined.

To determine the incidence of subcutaneous port infection and to assess the outcome of various methods of managing these infections, especially attempted...
PATIENTS AND METHODS

DATA COLLECTION

We reviewed the medical records of all patients with subcutaneous single-lumen chest wall ports (CR Bard Inc, Murray Hill, NJ, and Meditech, Westwood, Mass) placed by the interventional radiology department at the Cleveland Clinic Foundation, Cleveland, Ohio, between December 1, 1995, and November 15, 1997. Demographic data, underlying diagnosis, indication for port placement, date of placement, site of venous access, procedural complications, and outcome of the port on subsequent follow-up were collected by reviewing the radiology database and computer records. The medical records of patients with suspected or confirmed catheter-related infections were reviewed. Clinical presentation, microbiological data, treatment (catheter removal or attempted catheter salvage), response to treatment, and complications (ie, infective endocarditis, osteomyelitis, septic arthritis, and death) were recorded. Patients were followed up through July 1, 1998, or until death or catheter removal.

CASE DEFINITIONS

We defined suspected catheter-related bacteremia as fever (body temperature $>$38°C) or nonspecific systemic symptoms in a patient with a subcutaneous port for whom no other source of infection was apparent after a complete medical history was taken and a physical examination was performed. We defined confirmed catheter-related bacteremia as growth of the same organism in blood cultures obtained from 2 peripheral locations, or from the catheter and a peripheral site, or growth of the same organism in 1 blood culture and in a drainage or catheter tip culture.

Local catheter-related infection was defined if there was an organism isolated in a drainage culture or a positive catheter tip culture and induration, tenderness, or erythema at the catheter site. Local infection was further classified into cutaneous site infection (ie, inflammation limited to tissue overlying the port) and port pocket infection (ie, subcutaneous abscess in a port pocket).

Patients with catheter-related bacteremia and/or local infection whose catheters were still in place 3 days after the initial recognition of infection were considered to have had attempted catheter salvage. Salvage was considered successful if the same catheter was still in place at the end of 3 months or if the catheter had been removed for reasons other than persistent or recurrent bacteremia caused by the same organism, or persistent signs of local infection. Catheters removed because of persistent or recurrent bacteremia or persistent local infection were considered to have had salvage failure.

PROCEDURE FOR PORT PLACEMENT BY INTERVENTIONAL RADIOLOGISTS

A total of 3 staff radiologists (B.L.D. and others) performed almost all (>95%) of the procedures during the study period. Almost all (96%) venous procedure were done via the internal jugular vein approach. All venous punctures were done under direct ultrasound guidance with adherence to aseptic technique during insertion with the use of maximal barrier precautions (ie, sterile gloves, large sterile drape, and sterile gown, cap, and mask) in a dedicated procedure room with more than 20 air exchanges per hour.

All patients were given 1 dose of prophylactic intravenous antibiotic agents, either cefazolin sodium (1 g) or vancomycin hydrochloride (1 g) if penicillin-allergic, 30 minutes prior to the procedure. Patients with platelet counts lower than 30 x 10^9/L or those with known dysfunctional platelets were given platelet transfusion during the procedure.

All patients receiving subcutaneous port-a-catheters (a totally implanted vascular system) got home-going instructions about care of the site, and were instructed to watch for swelling, redness, fever, or hematoma. All patients were scheduled for a return visit at 3 to 5 days after insertion for a dressing change in the department of interventional radiology. A second visit was scheduled at 10 to 14 days after insertion. At that time, the patient is seen by a physician, and the site is inspected. If things were fine, then the patient was instructed to return on an as-needed basis.

DATA ANALYSIS

Data analysis was performed using the Epi Info software (USD Inc, Stone Mountain, Ga).

RESULTS

During the 2-year study period, 300 subcutaneous ports were placed in 294 patients for a total of 79 748 catheter-days. Six patients had a second catheter placed after the first was removed because of complications. Eighty-seven percent of the patients were white, 59% were female, and the patients’ mean age was 55 years. Almost all patients (97%) had an underlying malignancy (Table 1) and almost all (95%) of the catheters were placed for administration of chemotherapy.

At the time of last follow-up the mean duration of the subcutaneous ports was 266 catheter-days (range, 1-896 catheter-days). A total of 114 catheters (38%) were in patients who had died secondary to their malignant neoplasms with a functioning catheter in situ, 91 catheters (30%) were still in place and functioning in surviving patients, 73 catheters (24%) had been removed electively, and 21 catheters (7%) had been removed because of complications. The status of 1 catheter was lost to follow-up. Therefore, the overall catheter failure rate was 2.6 per 10 000 catheter-days.

NONINFECTIOUS COMPLICATIONS

There were no intraprocedural complications during port-a-catheter insertion. Three patients had oozing and 1 patient developed a hematoma during the first
24 hours of placement; none required additional interventions.

Seventeen catheters (5.7%) developed 20 episodes of noninfectious complications beyond the first 24 hours resulting in removal of 6 ports. The overall noninfectious complication rate was 2.5 episodes per 10,000 catheter-days. There were 13 episodes of catheter occlusion: 9 catheters had resolution of occlusion after flushing with plasminogen activator while 4 catheters with persistent flow problems were found to have a dense fibrin sheath. Three catheters required removal and 1 catheter was salvaged by fibrin stripping. There were 2 cases of venous thrombosis: one was symptomatic and required removal after anticoagulation therapy while the other was diagnosed after a failed salvage attempt for bacteremia. One patient had 2 episodes of skin erosion involving 2 catheters. Both catheters were removed. There was 1 episode of malposition that resolved spontaneously, 1 case of catheter migration requiring repositioning, and 1 case of subcutaneous hematoma after the port was accessed.

**INFECTIOUS COMPLICATIONS**

Seventeen patients (5.7%) developed catheter-related infections for a catheter infection rate of 2.1 episodes per 10,000 catheter-days. Ten patients had catheter-related bacteremia (1.2 episodes/10,000 catheter-days). Four of these patients had concurrent local catheter infections. Six patients had a pure local infection that was classified into 4 cutaneous site infections and 2 port pocket infections. One catheter was removed in a local hospital for infection and detailed information could not be obtained.

Infection was documented after a median of 64 days (range, 6-530 days) from catheter placement. Five (30%) of the 17 catheter-related infections developed within the first 30 days of placement.

Five of the 17 infected catheters had a preceding noninfectious complication: 4 catheters had 1 episode of catheter occlusion that resolved with flushing of plasminogen activator and 1 catheter had a subcutaneous hematoma.

**MICROBIOLOGY**

Eleven microorganisms were identified in the 10 episodes of bacteremia (1 patient had 2 organisms isolated). The most common organism was Gram-positive cocci that was isolated in 8 episodes (73%). Gram-negative rods were isolated in 3 episodes (27%) (Table 2). For pure local infections, Gram-positive cocci were isolated in 8 cases (67%), Gram-negative rods in 3 cases (25%), and mixed anaerobic flora was documented in 1 case (Table 3).

Staphylococcus aureus and coagulase-negative staphylococci were the most common organisms isolated for...
both catheter-related bacteremia and local infection (Table 2 and Table 3). No catheter-associated fungal infection was identified.

TREATMENT AND CLINICAL OUTCOME

Fifteen (88%) of the 17 infected catheters were removed. Eleven catheters were removed immediately while 4 catheters were removed after a failed salvage attempt.

Catheter salvage was attempted in 3 of the 4 catheters with cutaneous site infection. Two catheters were eventually removed because of persistent symptoms. The first patient had persistent discharge despite treatment with oral ciprofloxacin hydrochloride and drainage culture later grew methicillin-sensitive \textit{S. aureus}. The second patient had persistent tenderness and induration despite treatment with oral dicloxacillin sodium; catheter tip culture done after removal yielded \textit{Pseudomonas aeruginosa}. The 2 patients with port pocket infection were both treated with immediate catheter removal, oral antibiotics, and local wound care.

Catheter salvage was attempted in 3 of the 10 patients with bacteremia. Salvage attempt failed in 2 patients. The first patient had recurrent \textit{Klebsiella pneumoniae} bacteremia while receiving intravenous ciprofloxacin therapy. This patient had a right internal jugular vein port and a concomitant left internal jugular hemodialysis catheter. Further investigation also revealed a nonocclusive right internal jugular vein thrombus. Both catheters were removed. Repeated blood cultures yielded no organisms after catheter removal. The second patient had \textit{S. aureus} isolated from both central and peripheral blood cultures but also had an abscess surrounding a subcutaneous morphine pump yielding the same organism. The morphine pump was removed and the patient was treated with 4 weeks of intravenous cefazolin through the port with resolution of the abscess. Ten days after completion of antibiotic treatment, the patient developed fever and chills. Blood cultures again yielded \textit{S. aureus} and the port was then removed. Salvage attempt was successful in 1 patient with coagulase-negative staphylococci bacteremia and the catheter was still functional on last follow-up.

Patients who had attempted catheter salvage did not have complications. There was 1 patient with catheter-related \textit{S. aureus} bacteremia who had a septic prosthetic joint. His port was immediately removed. There were no cases of osteomyelitis, endocarditis, or deaths due to catheter-related bacteremia.

Our study shows that catheter-related complications (infectious or noninfectious) occur infrequently in patients with cancer who have subcutaneous ports (tunneled, central venous catheters) inserted by interventional radiologists for the administration of chemotherapy. The overall catheter failure rate was low (2.6/10,000 catheter-days). The incidence of noninfectious complications (2.5/10,000 catheter-days) was the incidence of infectious complications (2.1/10,000 catheter-days).

The infections associated with subcutaneous port catheters were almost evenly distributed between bacteremias (1.2/10,000 catheter-days) and local (tunnel) infections. Most infectious complications occurred after 30 days of insertion and the pathogens most frequently associated with infections were skin flora (\textit{S. aureus} and coagulase-negative staphylococci). This probably reflects adherence to aseptic technique during insertion with the use of maximal barrier precautions in a dedicated procedure room, the routine use of antibiotic prophylaxis, and the use of skilled personnel to inset and maintain these catheters.

A total of 4 of the 17 patients with catheter-associated infections had an episode of catheter occlusion prior to onset of infection requiring flushing with plasminogen activator, but there were 5 other cases of catheter occlusion that were salvaged by flushing with plasminogen activator (without subsequent infections) and 4 other patients with catheters with persistent flow problems despite plasminogen activator and who were found subsequently to have dense fibrin sheaths requiring removal or salvage by stripping but no infectious complications. There was no clustering by date of receipt of plasminogen activator or practitioner performing the placement or salvage for the 5 patients with catheter-related infections who had prior noninfectious complications (including the 4 with catheter occlusions) to suggest a common-source outbreak (eg, contaminated plasminogen activator).

Almost all of the patients (88%) with catheter-associated infections required catheter removal with or without attempts at salvage. There was 1 patient with catheter-associated bacteremia with a metastatic complication. Our findings are consistent with recently reported low success rates of salvage in patients with bacteremia and tunneled cuff hemodialysis catheters.\textsuperscript{14}

We were unable to compare the infectious complications of single-lumen subcutaneous ports used for chemotherapy inserted by surgeons vs interventional radiologists. However, the incidence of catheter-related bloodstream infections among 360 patients receiving home parenteral nutrition at our institution between 1976 and 1994 was 6 bloodstream infections per 10,000 catheter-days (vs 1.2/10,000 in the current study). The tunneled catheters used for home parenteral nutrition are usually Hickman catheters and were inserted in the operating room by general surgeons.

These results are important for clinicians who care for patients receiving chemotherapy. We have shown the use of an interventional radiologist to insert subcutaneous ports to provide vascular access for chemotherapy was safe and effective with low rates of complications.
REFERENCES


Correction

Mislabeled Headings in Table. In the Original Investigation by Loria et al titled “Serum Folate and Cardiovascular Disease Mortality Among US Men and Women,” published in the November 27, 2000, issue of the *ARCHIVES* (2000; 160:3258-3262), in Table 2 on page 3261, under the column heading “Serum Folate Tertile,” the column subheadings “Low” and “High” should have been transposed.