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Complications and management of long-term central venous access catheters and ports

B. YILDIZELİ, T. LAÇİN, H.F. BATIREL, M. YÜKSEL

Department of Thoracic Surgery, Faculty of Medicine, Marmara University Hospital, Acıbadem, Istanbul - Turkey

Abstract: *Purpose:* **Although prolonged venous access devices (PVADs) are used in case prolonged intravenous therapy is required, implantation and use of these devices is associated with complications. The purpose of this study was to evaluate perioperative and long-term complications associated with PVADs and the management of these complications.**

Methods: **A retrospective review was undertaken of 225 PVADs implanted in 217 patients from February 1993 to June 2004. This included 144 single-lumen port infusion systems, 49 single-lumen Hickman® catheters and 32 double-lumen Groshong® catheters. The PVADs were inserted using either the percutaneous Seldinger method (n=183) or cutdown access to the subclavian vein (n=42). Indications for placement were as follows: chemotherapy in 66.2% of patients, drug-infusion treatment in 31.6% of patients and total parenteral nutrition in 2.2% of patients.**

Results: **Perioperative complications occurred in 13 patients (5.7%): catheter malposition in seven patients (3.1%), pneumothorax in three patients (1.3%), hemorrhage in two patients (0.9%) and catheter embolization in one patient (0.4%). Long-term complications appeared in 15 patients (6.6%): infection in five patients (2.2%), thrombosis in three patients (1.3%), extravasation in three patients (1.3%), and catheter fracture in four patients (1.8%). The fractured fragments were removed by the Amplatz® snare device. In 10 patients (4.4%) only were PVADs removed prior to completion of the intended therapy. Indications for removal were catheter infection in five patients (2.2%) and catheter fracture in five patients (2.2%).**

Conclusions: **PVAD implantation is associated with some risk of serious perioperative and long-term complications. Care of the catheter and the patient should be maintained with the proper and immediate evaluation of the perioperative and long-term complications. (The Journal of Vascular Access 2004; 5: 174-8)**

Key words: *Venous access devices, Complications, Management*

INTRODUCTION

Various prolonged vascular access devices (PVADs) are widely used in the management of patients with malignancy (1-5), fluid and electrolyte imbalances (6), malnutrition (7) and renal failure (8). Since repeated venous puncture is a painful and anxious experience, the use of vascular access (VA) devices provides a better solution for the problem of VA (5). Although PVAD use appears to be safe, complications during implantation or during long-term therapy can arise. In this study, we attempted to determine the immediate and long-term complications of PVADs and their management.

METHODS

Between February 1993 and June 2004, 225 PVADs were placed in 217 patients. Patients had difficult venous access and frequent need of venipuncture for the administration of chemotherapy, fluids, or blood products. The records of the patients were analyzed retrospectively with regard to implantation complications and complications in the course of PVAD use and the management of the complications. The type of devices used, and the indication for placement and the side of implantation were recorded. Patients requiring PVAD removal and the reason for removal were identified.

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Procedure for subclavian catheterization

The patient was placed in a supine position. The physician decided the side of skin puncture, primarily the right side. The ipsilateral anterior superior region of the chest was shaved and sterilized with povidine-iodine. The patient was sedated or local anesthesia with 1% lignocaine was injected at the infraclavicular puncture side. The subclavian vein was punctured with a proper gauge needle, 2-3 cm medial to the midpoint of the clavicle. A guidewire was passed through the needle into the vein and the needle was removed. A vein-dilator was passed over the guidewire. The guidewire was then removed and the catheter passed over the wire under fluoroscope guidance. The distal tip of the catheter was passed through the subcutaneous tissue with the help of a tunneler approximately 3-4 cm caudal to the puncture site. The correct catheter position was maintained by the fluoroscope when the catheter tip was seen in the superior vena cava (SVC) and by the free flow of blood through the catheter into the syringe. If the PVAD was a port infusion system, the distal tip was connected to the infusion system, which was also placed subcutaneously. After the procedure, a chest X-ray was performed to determine the position of the PVAD catheter tip and to exclude pneumothorax.

PVAD-related complications were categorized as perioperative complications (catheter tip malposition, pneumothorax, hemorrhage associated with PVAD implantation or removal and catheter embolization) and long-term complications (infection, thrombosis, extravasation, catheter tip migration, pain at the PVAD reservoir, and port inaccessibility).

Patients were followed either until their PVAD was removed or until their death. This ranged from 1 month to >4 yrs.

RESULTS

Of the 225 implantations, 113 were females (50.2%), 112 males (49.8%). Mean age was 50 yrs (range 5-88, SD 15.5). The PVADs included 144 single-lumen port infusion systems, 49 single-lumen Hickman® catheters and 32 double-lumen Groshong® catheters. The PVADs were inserted using either the percutaneous Seldinger method (n=183) or cutdown access to the subclavian vein (n=42).

Table I shows the patient characteristics and indications for PVAD implantation and removal. The average duration over which a PVAD remained in place was 260 days (range 7-1550 days). Indications for placement were as follows: chemotherapy in 149 patients (66.2%), drug-infusion treatment in 71 patients (31.6%) and total parenteral nutrition in five patients (2.2%).

Post-operative complications occurred in 28 patients (12.4%) (Tab. II); of these, 13 were perioperative and 15 were long-term complications.

TABLE I - PATIENT CHARACTERISTICS AND INDICATIONS OF PVAD IMPLANTATION AND REMOVAL

Number of patients	217	
M/F ratio	0.99	
Mean age in yrs (range)	50 (5-80)	
Number of implanted PVADs	225	
Side of venipuncture (right/left)	194/31	
Type of implantation		
Open surgery	42	
Seldinger method	183	
Indication for implantation (%)		
Chemotherapy	66.2	(n=149)
TPN/fluid i.v.	2.2	(n=5)
Drug infusion	31.6	(n=71)
Indications for removal (%)		
Completion of therapy	70.2	(n=158)
Complications	4.4	(n=10)
Catheter infection	2.2	(n=5)
Fracture of the catheter	2.2	(n=5)

TABLE II - COMPLICATIONS ASSOCIATED WITH THE IMPLANTATION AND USE OF PVADs

Perioperative complications (%)		
Malposition of catheter	3.1	(n=7)
Pneumothorax	1.3	(n=3)
Hemorrhage	0.9	(n=2)
Catheter embolization	0.4	(n=1)
Long-term complications (%)		
Infection	2.2	(n=5)
Exit-site infection	1.8	(n=4)
Pocket infection	0.4	(n=1)
Extravasation	1.3	(n=3)
Catheter thrombosis	1.3	(n=3)
Fracture (tip migration)	1.8	(n=4)

Catheter tip malposition was the most common perioperative complication (3.1%). Five out of seven malpositioned tips were located in the right ventricle, one in the axillary vein and one in the contralateral subclavian vein. The tips located in the ventricle were slightly withdrawn to place the catheter in the SVC. The axillary and contralateral subclavian placements were corrected by repeating the whole procedure. Iatrogenic pneumothorax was observed in three patients (1.3%), two of whom required tube thoracostomy. Hemorrhage related with PVAD implantation was observed in two patients (0.9%), one due to heparization overdose and the other due to a capillary leak whilst preparing the pocket. In one patient (0.4%), the catheter sheath detached from the subcutaneous port and embolization to the right upper lobe pulmonary artery occurred.

Regarding the long-term complications, catheter-related infections were seen in five patients (2.2%); of these five, four (1.8%) were exit-site infection and one (0.4%) was an isolated pocket infection. Catheter-related sepsis was not seen in any of the infected patients. The causative microorganism was Staphylococcal species in four out of five infections. All the infected PVADs were removed.

In three patients (1.3%), catheter thrombosis occurred and was successfully treated by heparin and oral anticoagulant drugs and catheter function restoration was achieved.

Extravasation occurred in three patients (1.3%) and comprised subcutaneous leakage of the cytostatics at the port site. Local symptoms included erythema and edema, without ulceration or necrosis. All were treated conservatively and infusion was restarted successfully.

Catheter fracture occurred in four patients (1.8%). Catheter fractures were suspected by the failure to aspire blood and detection on a chest X-ray. Three of the four fractured catheters did not migrate and the tips were located in the SVC after 126, 140 and 154 days of implantation. The remaining fourth broken catheter segment migrated to the left upper lobe pulmonary artery 175 days after implantation. All of the patients were asymptomatic. In all cases, the fragments were removed with the Amplatz snare device by catheterization under local anesthesia via the femoral vein.

There were 10 PVADs (4.4%) removed prior to therapy completion. Indications for removal were catheter infection in five patients (2.2%) and catheter fracture in five patients (2.2%).

DISCUSSION

VA problems ceased dramatically after the introduction and development of long-term VA devices (5, 9-15). When the patient receives long-term chemotherapy regimens, progressive venous sclerosis makes drug infusion a heavy burden. For oncology patients and for those who need VA, central venous catheters (CVCs) appear to be a reliable treatment of choice.

Dudrick et al first described CVCs (12). The introduction of externalized tunneled venous catheters by Broviac et al (13) and Hickman et al (14) was followed by the invention of subcutaneous implantable ports in 1982 (15). PVADs have become a safe, reliable and a potentially better solution to the problem of VA, associated with low complication rates (1-6). Although the advantages of PVAD use outweigh the disadvantages (1), PVAD-related complications can be very serious (3). In this study, the overall incidence of PVAD-related complications was 12.4% and two types of complications were distinguished: immediate perioperative (5.8%) and long-term complications (6.6%). Immediate adverse events consisting of pneumothorax, hemorrhage, catheter malposition and catheter embolization range between 1.7 and 20.5% (16, 17), and the rates of late complications consisting of infections, thrombosis, extravasation and catheter fracture have been described as 0.0-55.5% in the literature (16).

Pneumothorax, hemorrhage, catheter malposition and embolization were observed in 1.3, 0.9, 3.1 and 0.4% of patients, respectively. The occurrence of immediate complications was similar to that reported by Lefrant et al (17) (immediate complications 20.5%, catheter tip misplacement 4.2% and pneumothorax 3.1%). More than one venipuncture was predictive of immediate complications (17). In our pneumothorax cases, patients had more than one venipuncture and they were all slim. As the risk of immediate complications increases after the failure of the second venipuncture attempt (17), Mansfield et al showed that a new operator could successfully catheterize the subclavian vein in 73.6% of cases (18). Although this can be attempted in these cases, Doppler guidance is helpful in successful venipuncture (17).

The ability to monitor each step of the procedure fluoroscopically avoids catheter tip malpositioning. Fluoroscopic assistance and appropriate guidewire usage prevent this difficulty. When anatomical landmarks are used instead of fluoroscopic guidance failure rates range from 2.5-8% (19). In our group, the catheter malposition rate was 3.1%. The tips lo-

cated in the ventricle (5/7) were slightly withdrawn to place the catheter in the SVC. The catheter tips located at axillary (1/7) and contralateral subclavian veins (1/7) were corrected with repositioning the catheters by repeating the whole procedure.

In our study, three patients (1.3%) had catheter thrombosis and this is comparable with results in the literature, which vary from 0-16% (4, 5, 16). All three catheter tips were located too proximally in the SVC. Heparin infusion and oral anticoagulant drugs restored catheter function.

Five cases of PVAD-related infectious complications (2.2%) were documented; four (1.8%) were exit-site infections and one (0.4%) was an isolated pocket infection. No catheter-related sepsis was documented. In four of the five cases, the infective organism was Staphylococcal species. In the literature, PVAD-associated infection rates range from 0.6-27% (3, 5, 9, 16). PVAD-associated infection should not always lead to catheter removal and can be treated with antibiotics specific to the causative organism and local care (9). In our study, because of progressive infection despite antibiotic treatment, the infected PVADs were removed.

The extravasation rate of 1.3% found in our study is comparable with that in the literature (0.9-6.5%) (5, 16). Probably, a clot at the catheter tip caused an infused drug backflow. In our group, local symptoms were mild and managed by conservative treatment.

Catheter migration or fragmentation, and moreover, embolization is a problem that can be treated by catheter removal with snares. Catheter fragmentation at the time of the placement used to be a problem, as the plastic catheter was inserted directly through the metal needle. This prevalence decreased after the introduction of the change from a needle to a sheath and guidewire usage (4). Delayed fragmentation with or without embolization can be caused by too medial positioning, which causes friction in the catheter between the clavicle and the first rib ("pinch off sign") (10, 16, 20). Catheter fracture is often discovered when an attempt to use the device has failed. In our study, delayed catheter fracture occurred in four patients (1.8%). Catheter fractures were suspected by the failure to aspire blood and detection on a chest X-ray. Three of the four fractured catheters did not migrate and the tips were located in the SVC after 126, 140 and 154 days of implantation. The fourth broken catheter segment migrated to the left upper lobe pulmonary artery 175 days after implantation. In all cases, the fragments were removed with the Amplatz snare device by catheterization under local anesthesia via the femoral vein. The embolized catheter sheath during the procedure was removed by the same method using the snare through the femoral vein (20).

In conclusion, the implantation and use of PVADs is a reliable and valuable method for long-term intravenous therapy, with a complication rate of 12.4% in our study. Immediate complications are uncommon with one venipuncture. Image-guided PVAD placement is useful for proper catheter placement. Sufficient information prior to implantation should be given and with appropriate follow-up after implantation for patient satisfaction and the early recognition of complications.

Address for correspondence:
Mustafa Yüksel, MD
Chief of Thoracic Surgery
Marmara University Hospital
Department of Thoracic Surgery
PK 97
34718 Acıbadem
Istanbul, Turkey
myuksel@marmara.edu.tr

REFERENCES

1. Hartkamp A, van Boxtel AJH, Zonnenberg BA, Witteven PO. Totally implantable venous access devices: evaluation of complications and a prospective comparative study of two different port systems. Neth J Med 2000; 57: 215-23.
2. Poorter RL, Lauw FN, Bemelman WA, Bakker PJM, Taat CW, Veenhof CHN. Complications of an implantable venous access device (Port-a-Cath®) during intermittent continuous infusion of chemotherapy. Eur J Cancer 1996; 32A: 2262-6.
3. Sariego J, Bootorabi B, Matsumoto T, et al. Major long-term complications in 1422 permanent venous access devices. Am J Surg 1993; 165: 249-51.
4. Denny DF. Placement and management of long-term central venous access catheters and ports. AJR Am J Roentgenol 1993; 161: 385-93.
5. Barrios CH, Zuke JE, Blaes B, Hirsch JD, Lyss AP. Evaluation of an implantable venous access system in a general oncology population. Oncology 1992; 49: 474-8.
6. Brothers TE, VonMoll LK, Niederhuber JE, Roberts JA, Walker-Andrews S, Ensminger WD. Experience

with subcutaneous infusion ports in three hundred patients. Surg Gynecol Obstet 1988; 166: 295-301.
7. Fletcher JP, Little JM. Subclavian vein catheterisation for parenteral nutrition. Ann R Coll Surg Engl 1988; 70: 150-2.
8. Kinnaert P, Hooghe L, DePauw L, Dhaene M, Dratwa M, Vanherweghem SL. Use of the Hickman catheter as permanent vascular access for hemodialysis. ASAIO Trans 1990; 36: 104-6.
9. Keung Y, Watkins K, Chen S, et al. Comparative study of infectious complications of different types of chronic central venous access devices. Cancer 1994; 73: 2832-7.
10. Klotz HP, Schopke W, Kohler A, Pestalozzi B, Largiader F. Catheter fracture: a rare complication of totally implantable subclavian venous access devices. J Surg Oncol 1996; 62: 222-5.
11. Nazarian GK, Myers TV, Bjarnason H, Stackhouse DJ, Dietz CA, Hunter DW. Applications of the Amplatz snare device during interventional radiologic procedures. AJR Am J Roentgenol 1995; 165: 673-8.
12. Dudrick SJ, Wilmore DW, Vars HM, Rhoads JE. Long-term parenteral nutrition with growth, development and positive nitrogen balance. Surgery 1968; 64: 134.
13. Broviac JW, Cole JJ, Scribner BH. A silicone atrial catheter for prolonged parenteral alimentation. Surg Gynecol Obstet 1973; 136: 602-6.
14. Hickman RO, Buchner CD, Clift RA, Sanders JE, Stewart P, Thomas ED. A modified right atrial catheter for access to the venous system in marrow transplant recipients. Surg Gynecol Obstet 1979; 148: 871-5.
15. Niederhuber JE, Ensminger W, Gyres JW, Liepman M, Doan K, Cozzi E. Totally implanted venous and arterial access systems to replace external catheters in cancer treatment. Surgery 1982; 92: 706.
16. Lemmers NWM, Gels ME, Sleijfer DT, et al. Complications of venous access ports in 132 patients with disseminated testicular cancer treated with polychemotherapy. J Clin Oncol 1996; 14: 2916-22.
17. Lefrant JY, Muller L, Coussaye JE, et al. Risk factors of failure and immediate complication of subclavian vein catheterization in critically ill patients. Intensive Care Med 2002; 28: 1036-41.
18. Mansfield PF, Hohn DC, Fornage B, Gregurich MA, Ota DM. Complications and failures of subclavian vein catherization. N Engl J Med 1994; 331: 1735-8.
19. Kincaid EH, Davis PW, Cahng MC, Fenstermaker JM, Pennel TC. "Blind" placement of long-term central venous access devices. Report of 589 consecutive procedures. Am Surg 1999; 65: 520.
20. Yıldızeli B, Laçin T, Baltacıoğlu F, Batırel HF, Yüksel M. Approach to ruptured central venous catheters. Vascular 2005 (in press).