Int Surg 2015;**100**:827–835
DOI: 10.9738/INTSURG-D-14-00214.1

Performance of Venous Port Catheter Insertion by a General Surgeon: A Prospective Study

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As part of the vascular access procedures, venous ports, commonly referred to as catheters, are placed under the skin to enable safe and easy vascular access for administration of repeated drug treatments. 122 patients who had received a venous port catheter insertion procedure in the general surgery department between January 1012 and January 2014 were involved in this study. Patients were divided into two groups: those who had undergone a fluoroscopy (group 1) and those who had not undergone a fluoroscopy (group 2). Complications that emerged during and after the port catheter insertion procedure and successful insertion rates were recorded in the database. Data of these patients were presented in a prospective manner. There were 92 to 30 patients in groups 1 and 2, respectively. In group 1, the mean age was approximately 56.8, total catheter stay time was 20,631 days, and mean time of port use was 224.2 days. In group 2, the mean age was approximately 61.2, total catheter stay time was 13,575 days, and mean time of port use was 452.5 days. Successful insertion rate was 100% and 90% in groups 1 and 2, respectively ($P < 0.05$). The proper insertion of the port catheter accompanied by monitoring methods can decrease procedure-related complications. Statistical comparisons between the two groups in terms of malposition and successful insertion rates also support this view ($P < 0.05$). The findings support the view that in cancer patients, a venous port catheter insertion accompanied by a fluoroscopy can be safely performed by general surgeons.

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Key words: Cancer – Infusion treatment – Port catheter

Central venous access is used in long-term intravenous chemotherapy, antibiotics infusion, parenteral nutrition, and transfusion of blood products.[1] Subcutaneous-inserted venous port catheters (VPC) are preferred over peripheral catheters in that they are more comfortable for the patient and have reduced wound infection rates, especially in patients that receive intermittent and long-term infusion treatment.[2] Since it was first defined by Morris *et al*[3] in 1992, the use of venous port implantation has been increasingly widespread. Its advantages include ease of insertion under local anesthesia, minimal discomfort to the patient, low rates of complication, and the ability to continue treatment at home after patient has been discharged.[4] The most common port complications are infection, malposition, catheter occlusion, catheter breakage, and failure of blood return from the catheter.[5,6] In the literature,[7,8] VPC insertion procedures are performed by oncologists, radiologists, and surgeons. The performance of a fluoroscopy and an ultrasonography is recommended for the prevention of dislocation, subclavian arterial thrombosis, and pneumothorax.[9,10] In this study, we aimed to identify the importance of the use of a fluoroscopy in the VPC insertion procedure and to demonstrate that general surgeons can perform this procedure as successfully as radiologists.

Materials and Methods

Study population and measurements

Patients who had received a venous port catheter insertion procedure in general surgery clinics between January 2012 and January 2014 were involved in this study. The study was conducted in a prospective manner by reviewing the hospital database, patient files, and surgery notes. The Ethical Committee of our center approved the study protocol (ANEH. EK.2013 /87).

A total of 125 venous ports were inserted in 122 patients, 55 (45%) of whom were women and 67 (55%) men. The age range of the patients was 29 –96 years and their mean age was 57.9 years. Total catheter stay time was 34,206 (3 to 702 days), and mean time of catheter use was 280.3 days. Patients were divided into 2 groups: those who had had a C-arm fluoroscopy used on them and those who had not. An ultrasonography was performed during port catheter insertion when required. The fluoroscopy group included 92 (75.4%) patients, and the other group included 30 (24.6%) patients. The randomization was not possible because of complication rates began to increase in fluoroscopy (–) group. The port catheter insertion procedure was performed by 2 general surgeons who were experienced in the procedure. All VPCs were inserted through subclavian venous access. In 3 patients whose catheters were placed in malposition, catheters were removed from the right and inserted through the left subclavian access. Indication of venous port catheter insertion was identified by the oncology clinics. Patients' demographic characteristics, primary diagnoses, port insertion indications, port stay times, and port types and diameters were recorded. Furthermore, the data on successful insertion rates, benefits of procedure under fluoroscopy, localizations of intervention, problems related to intervention, techniques used, port-related complications that emerged during or after intervention, and reasons for removal were recorded. Distribution of patients according to their diagnosis is given in Table 1.

Inclusion and exclusion criteria

In this study, patients included were selected according to the following criteria:

1. International normalizing ratio (INR) less than 1.5.
2. Prothrombin time (PT) must be less than 15 s.
3. Partial thromboplastin (PTT) time should be near normal.
4. Platelet count should be greater than 50,000 per mm^3 to limit the risk of bleeding.
5. There must be no infection at the time of port placement.
6. There should be oncology patients (malignancy disease).
7. Pediatric patients were excluded.
8. Patients with septic condition who do not comply and do not consent were excluded.

The selected patients who had been approved (or their guardians had approved them) to participate in our study gave an informed consent; their images will be included.

Surgical procedures and port care

Prior to the procedure, patients underwent an evaluation to examine their anamnesis, physical

Table 1 Distribution of groups

Diagnosis (malignancy)	Total number of (n)	Patients (%)	Fluoroscopy (+) group	Fluoroscopy (−) group
GIS	104	85.2	76	28
Breast	4	3.2	3	1
Lung	4	3.2	4	0
Pancreas	3	2.4	3	0
Laryngeal	3	2.4	3	0
Nasopharyngeal	1	0.8	1	0
Renal cell	1	0.8	1	0
Biliary tract	1	0.8	1	0
Malignancy of melanoma	1	0.8	0	1
Total	122	100	92	30

condition, bleeding time, and coagulation time. The intervention site was analyzed in terms of infection, swelling, mass and previously received radiotherapy. All patients were informed about the intervention to be performed and potential associated risk factors; their verbal and written consents for surgery were taken. The procedure was performed on all patients under local anesthesia or sedoanalgesia. In patients whose blood platelet count was lower than 70.000/mm^3 and whose international randomized ratio (INR) was over 1.5, the procedure was performed after correcting the problem in their coagulation parameters. For the patients with antibiotics prophylaxis, 1 gram of cefazolin sodium (Sefazol, Mustafa Nevzat Ilaç Sanayi AŞ, Istanbul, Turkey) was administered via intravenous access 30 minutes before the procedure.

Peripheral oxygen saturation (SpO2), electrocardiography (EKG), and blood pressure monitoring were performed at the surgery setting. The VPC implantation site was cleaned with a solution containing 10% povidone iodine and then covered with sterile surgical drapes. Puncture site and port pocket of patients were anesthetized with 1% lidocaine (jetokain simplex amp, Adeka, Istanbul, Turkey) infiltration. Before the procedure, port pocket and cable were combined and locked and then flushed with a solution of heparin 1 mL/100 Units.

We selected the subclavian venous as the port catheter insertion location, as we often use it in our central catheter procedures at our clinic. The puncture was made on the left subclavian vein of the patients who had received a mastectomy, had an edema or infection at the site of insertion, or were unable to be administered a puncture through the right subclavian vein. The puncture was made after orienting the patient's head to the opposite direction; then, a guide wire was advanced through the subclavian vein (Fig. 1A). Once it was confirmed with the C-arm fluoroscopy that guide wire was inside the vena cava superior or cavoatrial junction, a 0.5-cm incision was made parallel to the clavicle so that guide wire was in the middle, and a vein dilator sheath was advanced over the guide wire. After removing the vein dilator, catheter sheath was advanced over the guide wire (Fig. 1B). Three to 4 cm below the guide wire, port pocket was opened by making an approximately 2-cm incision. A subcutaneous pocket suitable for reservoir size was then formed toward caudal by blunt dissection. Electrocautery was used on patients to control bleeding. The catheter was tunnelized from puncture site through port pocket, and guide wire was removed once the location of port sheath was confirmed with the C-arm fluoroscopy. After making adjustments to attain the suitable length of the catheter for the patient, port was advanced through the sheath. Once it was confirmed with the C-arm fluoroscopy that catheter tip was in the vena cava superior or cavoatrial junction, the sheath was split into two, withdrawn to left and right, and removed (Fig. 1C). Blood was taken from the catheter using the port needle prepared with heparinized solution, and solution control was performed.

The port reservoir was sutured at the base of port pocket with 3/0 circle monofilament propylene, and the skin incision was closed with 3/0 taper monofilament propylene. A P-A chest X-ray was performed for the control of port catheter location and hemopneumothorax determination (Fig. 1D). Patients were called for a follow-up 1 week after the procedure. Port care was performed by flushing, using 1 mL heparin and 9 mL 0.9% NaCl solution, and sutures of the patient were removed.

Two different port catheters were placed in the patients; namely, 2 types of the Lexel titanium-ports (Buenos Aires, Capital Federal – Argentina) in 112 patients and the Vaxcel port (Boston Scientific, Watertown, MA) in the other 10 patients (Table 2).

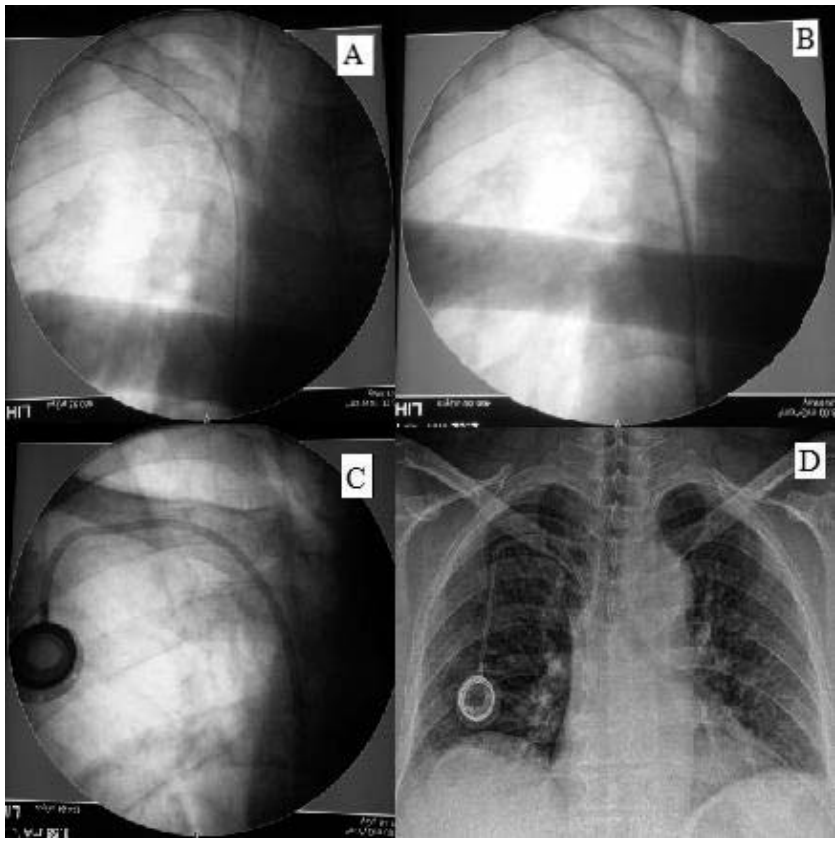

Fig. 1 Insertion of port catheter with C-arm fluoroscopy. Guide wire in subclavian vein (A), vein dilator catheter over the guide wire (B), port catheter is placed through the vein dilator (C), control X-Ray (D).

Statistical analysis

Data received in this study were analyzed using the SPSS 20 package. Chi-square analysis was used for the dependency between variants, and Mann-Whitney *U* test was used for comparisons between 2 groups. Categoric variables were compared using a chi-square test or Fisher's exact test, as applicable. A *P*-value of less than 0.05 was considered to be statistically significant.

Results

Access was made through right subclavian vein in 118 patients and left subclavian vein in 4 patients. A total of 125 port implantations were successful. Procedure-related mortality was not seen. There were 92 patients in the fluoroscopy group, and 30 patients in the group that had not undergone a fluoroscopy. Exitus related to malignancies occurred in 12 patients in both groups. Six patients discontinued their follow-up. One hundred and four patients have remained alive and their venous port catheters are operative. Major complications related to the procedure and early follow-up (the first week following the procedure) were not seen in either group. Single-lumen port catheters were placed in all patients, and the ports of all patients were inserted in the frontal chest area.

In the fluoroscopy group, the female/male ratio was 0.57 (36/56); mean age, 56.8 years (29–84); body mass index (BMI) 22.2 (19–25) kg/m^2; catheter stay time, 20,631 days (3–674 days); mean time of use, 224.2 days; and successful insertion rate, 100%. The

Table 2 Characters of port catheter

Port catheters	Type	Size (Fr)	Length (cm)	Inside/outside diameter (mm)	Weight (gr)	Diameter of septum	Patients (n)
Lexel titanium port (adult; Buenos Aires, Argentina)	Silicon	9	60	1.6/3	6.5	12 mm	88
Lexel titanium port (pediatric; Buenos Aires, Argentina)	Silicon	7	60	1/2.4	5.4	12 mm	24
Vaxcel port (Boston Scientific, Watertown, MA, ABD)	Silicon	8	70	1/2.3	7.3	10 mm	10

Table 3 Variables between groups and statistical analysis

Variables	Fluoroscopy (+) group	Fluoroscopy (−) group	P*
Patients	92	30	
Female/male	36/56	19/11	0.04
Mean age (year)	56.8 (29–84)	61.2 (40–96)	0.12
Body mass index (kg/m^2)	22.2 (19–25)	21.3 (18–24)	0.63
Total catheter days	20,631 (3–674)	13.575 (22–702)	
Mean time of use (days)	224.2	452.5	
Removal after complications	0	3	0.014
Successful placement	92/92 (100%)	27/30 (90%)	0.014
Removal after treatment	1	0	0.99
Malignancy-related death	10	2	0.72

*P values analyzed by Mann-Whitney U test ($P < 0.05$).

port of 1 patient was removed as a result of completion of treatment (Table 2).

In the group whose patients had not undergone a fluoroscopy, the female/male ratio was 1.72 (19/11); mean age, 61.2 years (40–96); BMI, 21.3 (18–24) kg/m^2; catheter stay time, 13,575 (22–702 days); mean time of use, 452.5 days; and successful insertion rate, 90%. Venous port catheters were removed in 3 patients from this group (2.4%) as a result of port pocket infection (Table 3).

In the fluoroscopy group, pneumothorax, sepsis, malposition, and thrombosis were not observed, but catheter dysfunction developed in 3 patients (2.4%) and port pocket infection developed in 1 (0.8%) during the follow-up period. No wound infections were observed in any patients in the early period. In both groups, however, port pocket infections occurred in the long-term follow-ups (Table 4). Port catheters of these patients were removed due to infection in their port pockets. No reproduction was seen in the culture taken from the catheter tip. The remaining treatment of these patients was performed peripherally.

In the group whose patients had not undergone a fluoroscopy, localized pneumothorax was observed in the postprocedure chest X-rays of 2 patients (1.6%). Malposition (catheter tip in the internal jugular vein) was observed in the chest X-rays of 3 patients (2.4%). The port catheters of these 3 patients were removed and reinserted through the left subclavian vein. A statistically significant difference was determined in the comparison of the 2 groups in terms of malposition ($P = 0.014$). Catheter dysfunction developed in 3 patients (2.4%) in the fluoroscopy group and in 5 patients (4%) in the no fluoroscopy group during the long-term follow-up period. Catheters were flushed using the prepared heparinized solution (1 mL/100 unit heparin). In group 1, 3 patients had catheter dysfunction and in group 2, 5 patients had catheter dysfunction. A significant difference was found in the comparison of the 2 groups in terms of catheter dysfunction ($P = 0.02$). Patients were advised to flush the catheter 2–3 times a week regardless of whether or not they received treatment. Hemothorax, thrombosis, catheter breakage ("pinch-off" syndrome), arterial damage, port pocket hematoma, and severe pneumothorax were not observed in either group (Table 4).

Discussion

The use of port catheters has increased substantially in recent years due to development of long-term cancer treatment, the need for frequent venous access, the use of hyperosmolar agents, and the administration of a large amount of fluids. Low infection rates, long life cycles, and lack of restriction in patients' daily activities, increased comfort, long-term use capability, and reliability are the greatest advantages of port catheters as compared to other central catheters.[1,2,4]

Performed in operating rooms with the accompaniment of monitoring devices, port implantation has been carried out in the surgery clinics of many health centers within the last 10 years.[3,4] The techniques used by interventional radiologists and

Table 4 Complications

Complications	Fluoroscopy (+) group	Fluoroscopy (−) group	P*
Infection of port pocket	1	3	0.046
Pneumothorax	0	2	0.059
Malposition	0	3	0.014
Catheter dysfunction	3	5	0.02
Skin necrosis	1	0	0.98

*P values analyzed by Chi-square test ($P < 0.05$).

Table 5 Summary of venous access device studies

Author	Year	No. of devices	Inserted by	Infection[a]	Thrombosis[a]	Pneumothorax[a]	Device malfunction[a]	Removal for complication[a]	Mean catheter life (months)	Successful insertion[a]
Kock *et al*[13]	1998	1500	Surgery	3.2	2.5	0.3	2.8	11.9	9	N/A
Lorch *et al*[10]	2001	125	Radiology	2.4	0	1.6	2.4	4.8	3	N/A
Vardy[21]	2004	111	Radiology	4	2	2	1	7	7	99
Charvat *et al*[20]	2006	200	Radiology	1	0	0	N/A	6.3	13.5	N/A
Cil *et al*[16]	2006	476	Radiology	1.8	0	0	6	3.1	12.5	99
Plumhans *et al*[22]	2011	138	Radiology	0	3	0	1	N/A	N/A	86
Ahn *et al*[23]	2012	1254	Radiology	1.9	0.6	1.8	1.3	2.7	350 (days)	99
Arıbas *et al*[24]	2012	347	Radiology	2	7	N/A	4	4.4	N/A	96
Seok *et al*[25]	2014	156	Surgery	19	2	0.5	N/A	17	307 (days)	97
Aziret *et al*	2014	122	Surgery	3.2	0	2[c]	6	3.2[c]	9	97.5[b]

[a]Percentage, N/A: Not available.

[b]The average of both groups.

[c]Fluoroscopy (–) group.

surgeons are similar in port insertion procedures. Interventional radiologists often use fluoroscopy and ultrasonography during procedures. Port insertion accompanied by monitoring can reduce procedure-related complications, such as pneumothorax, hemothorax, arterial damage, and catheter malposition.[4,5] When compared to our case series, it was seen that similar infection and general complication rates are present in port insertion procedures performed by interventional radiologists.[6–10] According to the criteria listed in the Society of Interventional Radiology[11] guide, only minor complications were found our study, in contrast to major complications was not determined in our case series (Table 5). Port-related infection was reported as 0.5 to 9% in different case series performed by Ahn and Krupski.[2] Infection is generally accompanied with pyrexia of unknown origin and irregular blood glucose. It is recommended that the catheter be removed in these patients.[2,10] As infections related to the catheter or port pocket might develop. In a study by Kurul *et al*,[12] port pocket infection related to long-term treatment was reported as 0.3 to 4.4%. In patients with port infection, it is recommended that the port responsible for causing the infection be removed. Additionally, a treatment of oral antibiotics and surgical site care is performed.[12] In our study, port pocket infection developed in 4 patients (3.2%) who, after the discovery of infection was made, had their catheters removed and began antibiotic treatment and surgical site care. No problems were encountered in the follow-up of patients. A statistically significant difference was found in the comparison of both groups in terms of port pocket infection ($P < 0.05$).

The movement of the needle at a wrong angle during the insertion of port catheter could lead to the development of pneumothorax or hemothorax. In the literature,[13] the risk of a pneumothorax increases in the event of the collapse of the subclavian vein, affecting the pulmonary parenchyma lying directly to the posterior. Kock[13] and Plumhans[22] reported the occurrence of pneumothorax in 0 to 3.2% in different studies. The subclavian vein was preferred for port catheter, as it is used as the central venous access in our clinic. In our case series, a pneumothorax developed at a ratio of 1.6% (2/122) in only the group that had not undergone a fluoroscopy. Although no statistically significant difference was found, the absence of a pneumothorax in the fluoroscopy group might lend support to the need to conduct a fluoroscopy in the procedure. The patients who had a pneumothorax were monitored, and their arterial blood pressure, pulse, and oxygen saturation were regularly checked; no problems were observed in their vital functions and chest surgery consultations were conducted and

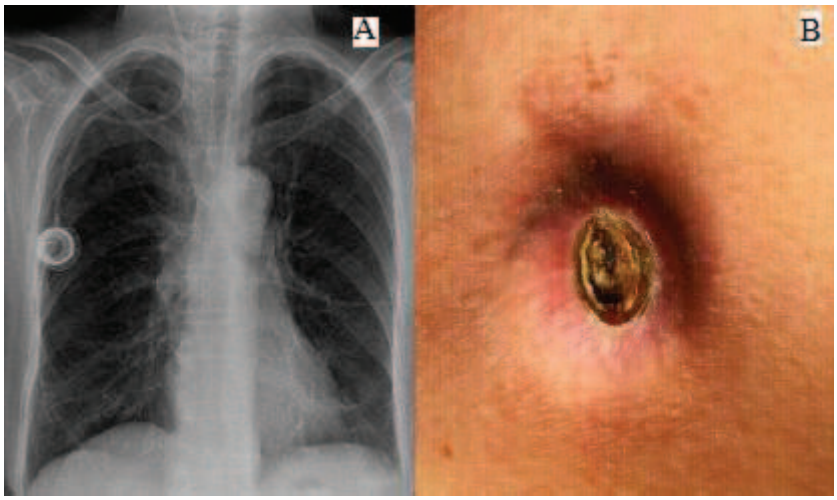

Fig. 2 Malposition of catheter (A) and skin necrosis (B).

respiratory exercises were initiated. The chest X-rays of these patients were normal in their follow-ups.

During the placement of the central venous catheter, it is recommended that the catheter tip be placed in the inferior 1/3 of vena cava superior or junction of vena cava superior and atrium with the help of a fluoroscopy, as suitable to the patient's anatomy.[14] Failure to place the port catheter tip at this location is referred to as catheter malposition. The placement of the catheter tip into smaller veins, such as jugular or subclavian vein could increase the risk of venous thrombosis. Further, the placement of the catheter tip in the right atrium or ventricle could lead to the development of a cardiac arrhythmia,[1] thrombosis,[2] and in rare cases cardiac tamponade.[15] Lorch *et al*[10] reported a malposition ratio of 1% in their study. In our study, malposition rates were 2.4% (3/122) in the group that underwent no fluoroscopy and 0% in the fluoroscopy group (Fig. 2A). As the catheter tip was in the internal jugular vein in these patients, the port catheters were removed and reinserted through left subclavian vein through the aid of fluoroscopy. A statistically significant difference was observed in comparison of groups in terms of malposition ($P < 0.014$). This result shows that the performance of a fluoroscopy in port catheter placement might reduce the development of complications.

Due to cachexia and malnutrition in oncology patients, abnormal skin texture or large port selection in these patients could lead to erosion in the skin above the port. In a study by Cil *et al*,[16] skin erosion and associated skin necrosis were reported as 1%. The close location of port pocket to the skin might be caused by insufficient technical experience. Additionally, port might be located below pectoral fascia or muscle in order to protect the skin above the port from erosion in thin patients with little subcutaneous texture. Suturing the port pocket to pectoral fascia with a nonabsorbable suture could also prevent port erosion.[16,21–23] Skin necrosis was seen in 1 patient (0.8%) in our study (Fig. 2B). The necrotized skin was excised in the operating room, a skin flap was formed and then closed primarily.

Known as catheter breakage, "pinch-off" syndrome was reported below 1% in different case series.[17,18] This is often seen in port catheters that are placed through subclavian vein access. The syndrome occurs when these catheters are compressed between the clavicle and first rib, worn off, and broken. In the literature review of Chang *et al*,[18] 27 cases of catheter breakage were reported. Break location was reported as between clavicle and first rib in 82% of these cases. Other rare causes of catheter breakage include application of high pressure and formation of direct catheter damage with wire or needles. In order to decrease catheter breakage, it is recommended that the catheter be placed close to one-third distal of clavicle.[19] "Pinch-off" syndrome was not seen in either group in our study.

Catheter dysfunction is the decrease in blood aspiration and fluid infusion capacity from catheter and is generally associated with long-term use. For the most part, in catheters that are placed without the aid of a fluoroscopy or that are not controlled, catheter dysfunction occurs due to the kinking of catheter, fibrin sleeve or deposition, precipitation of administered hyperosmolar drugs and fluids, the lean of catheter tip towards the vessel wall or

disconnection of catheter.[4] In various studies[4,20] the prevalence of catheter disconnection was reported as 0.8 to 6%. Catheter dysfunction is usually clinically manifested by the catheter's failure to aspirate blood rather than by any difficulty in infusion. The reason for this failure is generally believed to be the fibrin sheath, which functions as a single-way flap valve at the catheter tip.[12] In our case series, the prevalence rate was 6% in both groups. The anamnesis showed that adequate care was not performed on the port following the treatment or during the period with no treatment. The port of these patients was opened after undergoing a few flushes with heparinized solution. No statistically significant difference was determined between the 2 groups in terms of catheter dysfunction. We believe, however, that the development of catheter dysfunction could be reduced with the use of fluoroscopy and accurate technical placement.

Severe arrhythmia,[1] embolism,[2] venous thrombosis, extravasation of fluids,[4] cardiac perforation,[10] arteriovenous fistula,[13] left thoracic ductus lesion,[21,22] phrenic or brachial plexus lesion,[23] and hematoma[24,25] in port pocket have been rarely reported in venous port catheter implantations. Life-threatening major complications were not seen in our case series containing 122 cases.

Conclusion

Results in our study comply with previous studies[4,10] (Table 5). Venous port catheter placement under fluoroscopy can be performed safely by general surgeons treating cancer patients.

Acknowledgments

This study was not supported by any institution and company.

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