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Subcutaneous venous port implantation in adult patients: a single center experience

Barbaros Erhan Çil, Murat Canyiğit, Bora Peynircioğlu, Tuncay Hazırolan, Selin Çarkacı, Saruhan Çekirge, Ferhun Balkancı

PURPOSE
To present the midterm follow-up results of subcutaneous venous chest ports in adult patients.

MATERIALS AND METHODS
Between January 2001 and November 2005, 476 subcutaneous venous chest ports were placed in 472 adult patients. Five patients underwent port implantation twice. All the ports had single lumen catheters. The procedures were performed under intravenous sedation as well as local anesthesia. All ports were placed on the anterior chest wall, except one, which was placed on the trapezius muscle.

RESULTS
The technical success rate was 99.8%. The procedure-related minor complication rate was 0.63% (total: 3 cases; 1 hematoma during local anesthesia application, and 2 early hematomas) and there were no major complications. Mean duration of catheter usage was 376 days (total: 178,997 catheter days; range: 2 to 1522 catheter days). Late complications occurred at a rate of 10.7% (51 cases). Among those 51 cases, 36 (7.6%) developed minor complications in which port removal was not needed; however, 15 ports (3.15%) had to be removed due to major complications. Seven ports (1.47%) were explanted due to treatment-resistant bacteremia and sepsis, in addition to 2 other ports (0.42%) because of port pocket infections. An additional 6 ports (1.26%) required explantation for the following reasons: skin necrosis (0.21%); incision dehiscence (0.21%); broken or torn catheter (0.42%); jugular vein thrombosis (0.21%); thrombosis of superior caval vein (0.21%).

CONCLUSION
Radiological implantation of subcutaneous venous ports can be performed with similar or lower complication rates as compared to the surgical literature, due to the obvious advantage of imaging guidance. Hence, we think that port implantation with imaging guidance will become the preferred implantation method in the future.

Key words: • *port* • *adult* • *interventional radiology*

From the Department of Radiology (M.C. ✉ *mcanyigit@yahoo.com*), Hacettepe University School of Medicine, Ankara, Turkey.

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Subcutaneous venous ports are preferred to external catheters, particularly in patients who have received intermittent long-term infusion therapies, due to low infection rates and high patient comfort (1). Traditionally, port implantation is performed by surgery departments under general anesthesia, with venous cut-down in the operation room. Since the first port implantation performed in an angiography unit using interventional radiology techniques was reported by Morris et al. in 1992, radiological venous port placement has become very common (2). In this study, we present our experience and results in patients who underwent subcutaneous venous port implantations in our vascular interventional radiology unit.

Materials and methods

This study included 472 patients from our database who were treated between January 2001 and November 2005. In total, 476 venous ports were placed in 221 (46.9%) women and 250 (53.1%) men aged between 16 and 80 years (mean: 50.5 years). All port implantation procedures were performed by 3 experienced radiology fellows and 1 radiology chief resident. In 1 patient, port placement failed due to the development of a pectoral hematoma. Five patients underwent port placement twice. One of the ports initially implanted at a different hospital was explanted in our unit because of infection. The indications for port implantation were as follows: systemic chemotherapy; long-term antibiotic treatment; protocols for bone marrow transplantation. The distribution of the patients according to their primary disease is shown in Table 1. Single lumen ports were used in all patients. Except for one port placed on the trapezius muscle, all were placed on the anterior chest wall. Ports produced by 5 different manufacturers were implanted in the following quantities: 281 Deltec (SIMS Deltec, St. Paul, MN, USA); 142 Vaxcel (Boston Scientific, Watertown, MA, USA); 24 Braun (B. Braun, Melsungen, Germany); 18 Arrow (Arrow international, Bernville Road Reading, PA, USA); 11 Polysite (Perouse Laboratoires, Ivry-Le-Temple, France) (Table 2). Thirty-six port chambers were originally manufactured for pediatric patients and 440 ports had low profile chambers.

Description of radiological port implantation technique

All of the procedures were performed in the interventional radiology unit under intravenous (IV) sedation with local anesthesia. Anesthesiologists administered all IV sedations using fentanyl and midazolam. General anesthesia was not used. Antibiotic prophylaxis was only given to high risk patients and patients with absolute neutropenia (white blood cell count < 500/mm^3); prophylactic 1 gr IV cefazolin sodium (Sefazol®, Mustafa Nevzat İlaç Sanayi AŞ, İstanbul, Turkey) was given 30 minutes before the procedure. Patients with an INR (international normalized

ratio) higher than normal and platelet count < 70,000 mm^3 received blood products before the procedure to correct the deficiencies. Ultrasound (US) examination of the internal jugular veins was performed prior to skin site preparation in sterile fashion. Right internal jugular vein access (IJV) was initially preferred in all patients. If the right IJV was occluded, then the left IJV was accessed. In cases of bilateral occlusion, subclavian veins were used. In patients who had undergone mastectomy, the contralateral IJV was preferred. Skin at the insertion site was widely prepared from the mandible to the nipple, cranio-caudally, and laterally from the sternum to the mid-axillary line. During each procedure, the interventional radiologist and the assistant nurse wore a cap and a mask and meticulously followed a sterile protocol, which included a full surgical scrub prior to performing the procedure. Venous access was performed under US (Tosbee, Toshiba, Japan and; Sonolite Elegra, Siemens, Germany) guidance with a 7.5-MHz linear array probe. Sterile US gel and a sterile probe cover were used to cover the US probe and its cable. In most patients, venous puncture was performed using an 18 G venous needle included in the port packages. With patients in whom a fine needle was thought to be needed (extremely narrow IJV), a 21 G needle and 0.018-inch mandrill wire (Micro puncture kit, Cook, Inc., Bloomington, IN, USA) were used. After puncturing with the 18 G venous needle, a 0.035-inch guide wire was pushed forward the inferior caval vein. After the peel-away sheath was placed, holding the tip of the guide wire at the level of the atrio-caval junction or high atrium, the guide wire outside of the peel away sheath was bent to measure the length of the port catheter. Next, the guide wire was removed and the sheath was capped to prevent bleeding or air embolization.

After that, subcutaneous pocket dissection, the second step of the procedure, began. Following pectoral region skin and subcutaneous tissue infiltration with 2% xylocaine local anesthesia, a 2–3-cm incision was made approximately 3 cm caudal to the clavicle with a no. 15 scalpel. A subcutaneous pocket, large enough for the port reservoir, was created using blunt dissection towards the caudal direction from the incision. A disposable surgical pencil cautery or suturing was used, whenever necessary, to control persistent bleeding. Extreme care was taken to avoid an excessively large port pocket size, so that the port barely fit into the pocket. Once the pocket was created, the catheter was tunneled to the vein access site using the trochar that came with the port kit. The port was then connected to the catheter and flushed, followed by placement to the port pocket. Stay sutures for the port base were not routinely used; only in patients with a large port pocket and in high risk patients for the port rotation, two resorbable 3-0 vicryl stay sutures were placed, running through the holes at the base of the port and the chest wall. The port catheter was trimmed to length, using the previously bent guide wire, and than advanced through the peel away sheath. After insertion, the catheter tip position and catheter curve at the venous puncture site were evaluated using fluoroscopy. Using a Huber needle, the port was accessed and its function was confirmed with aspiration of blood and the reservoir was flushed with 100 U/ml of heparin solution while carefully observing for any leakage at the connection site. The incision was closed in layers with resorbable 4-0 vicryl interrupted inverted mattress sutures, subcutaneously, and the skin was closed with a running subcuticular stitch. The venous puncture site incision was closed in the same manner. Steristrips were applied to keep the edges of the incision together. Outpa-

Table 1. Distribution of patients according to their primary diseases.

Diagnosis	Patient number	%
Gastrointestinal system malignancies	191	40.6
Breast cancer	67	14.3
Hematopoietic malignancies	111	23.2
Genitourinary system malignancies	24	5.1
Others	78	16.5
No intervention due to hematoma	1	0.2
Total	472	100

Table 2. Port types and specifications.

Port	Catheter size and material	OD/ID of the catheter (mm)	Number of patients
Port-A-Cath II Low-profile (SIMS Deltec, St Paul, MN, USA)	7.8F, polyurethane	2.6/1.6	253
PAS Port Elite (SIMS Deltec, St Paul, MN, USA)	5.8F, polyurethane	1.9/1.0	2
PAS Port T2 (SIMS Deltec, St Paul, MN, USA)	5.8F, polyurethane	1.9/1.0	26
B. Braun Celsite ST 305 (Melsungen, Germany)	6.5F, silicone	2.2/1.0	8
B. Braun Celsite ST 301 (Melsungen, Germany)	8.5F, silicone	2.8/1.1	13
Vaxcel mini port (Boston Scientific, Watertown, MA, USA)	8F, silicone	2.6/1.5	142
Polysite 4008 ISP (Perouse Laboratoires, Ivry-Le-Temple, France)	8F, silicone	2.4/1.2	11
Arrow Low-profile (Bernville Road Reading, PA, USA)	7.8F, polyurethane	2.6/1.6	18
B.Braun Celsite ST301V (Melsungen, Germany)	7.5F, silicone	2.5/1.5	3

OD: outer diameter; ID: inner diameter

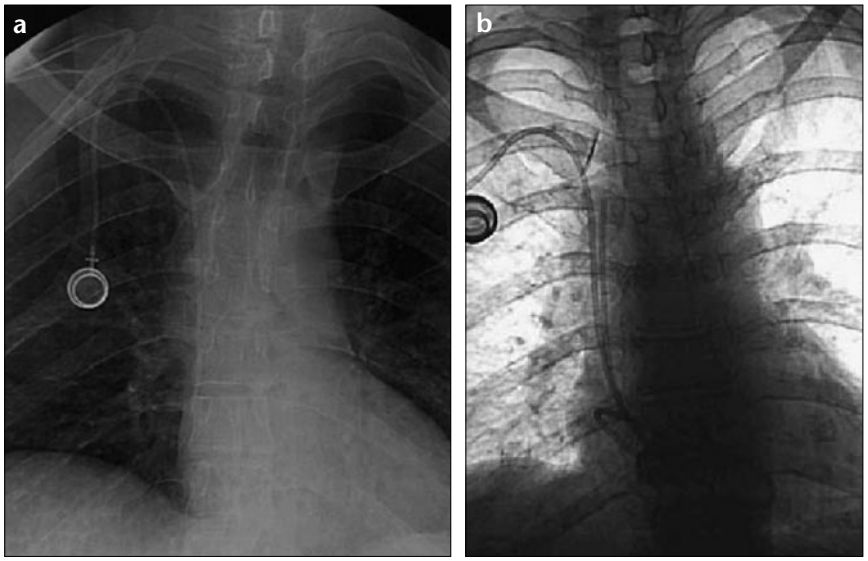

Figure 1. a, b. Standard port placed on the chest wall via the right internal jugular vein **(a)**, port malposition originally implanted at a different institution **(b).**

tient cases were discharged home after 2 h of observation and all the patients were called back for a 1-week routine follow-up. At 1-week follow-up, redness, swelling, increased local temperature, hematoma, and suture dehiscence were checked at the site of port placement. Information on port details, indications, early and late complications, duration of the stay, and the reason for removal was obtained by retrospective review of patient records.

Table 4. Early complications related to port implantation.

	Number of patients	%
Hematoma during the procedure	1	0.21
Hemothorax	-	
Pneumothorax	-	
Arterial puncture	-	
Early hematoma	2	0.42
Early revision	-	
Total	3	0.63

Table 3. Results of 476 port implantations in 471 patients.

Duration of catheter stay	For all patients		178.997 catheter-days
	For a single patient	Mean	376 catheter-days
		Range	2-1522 catheter-days
Follow up	Still in use		347 patients
	Exitus		75 patients
	Removal before the end of therapy		15 patients
	Removal after the end of therapy		21 patients
	Follow-up terminated		13 patients

Results

Right IJV access was used in 435 patients, the left IJV was accessed in 40 patients, and the subclavian vein was used in 1 patient with bilateral IJV occlusion. In total, 476 port implantations were successfully performed (Table 3). There were no procedure-related or early major complications seen. In 3 patients (0.63%), procedure-related minor complications occurred (Table 4). In 1 patient with multiple myeloma-related thrombocytopenia (< 60.000/mm3), a hematoma developed at the pectoral region during local anesthetic infiltration that resulted in procedure failure (technical success rate: 99.8%). Port pocket hematomas developed immediately after the procedure in 2 patients and use of the ports was delayed until hematoma resorption. No arterial puncture complication or pneumothorax was noted. The catheter tip was placed in the junction of the right atrium and superior caval vein or in the proximal right atrium in all patients (Figure 1). Total implantation time for the ports was between 2 and 1522 catheter-days, with mean catheter time of 376 days and a total of 178,997 catheter-days for all ports. All the ports had single lumen catheters. With the exception of 1, all ports were placed on the anterior chest wall. In a patient with bilateral mastectomy, the port was implanted on the trapezius muscle. Ports were removed from 36 patients. Twenty-one of the 36 ports were removed due to end of treatment, whereas in the remaining 15 (3.15%) patients, complications developed that necessitated port removal. Among the 15 patients who underwent early port removal due to complications, 5 had a second port placement. Seventy-five patients died due to progression of their primary malign diseases during the follow-up, and 13 patients were lost to follow-up. At the time of this writing, 347 patients were still living with functioning ports.

There were no procedure-related early (first week after the procedure) infections observed. All the infections noted were diagnosed during long-term follow-up (Table 5). As a result of antibiotic resistant bacteremia and sepsis, 7 ports (1.47%) were explanted. Of those patients, 1 had Candida albicans,

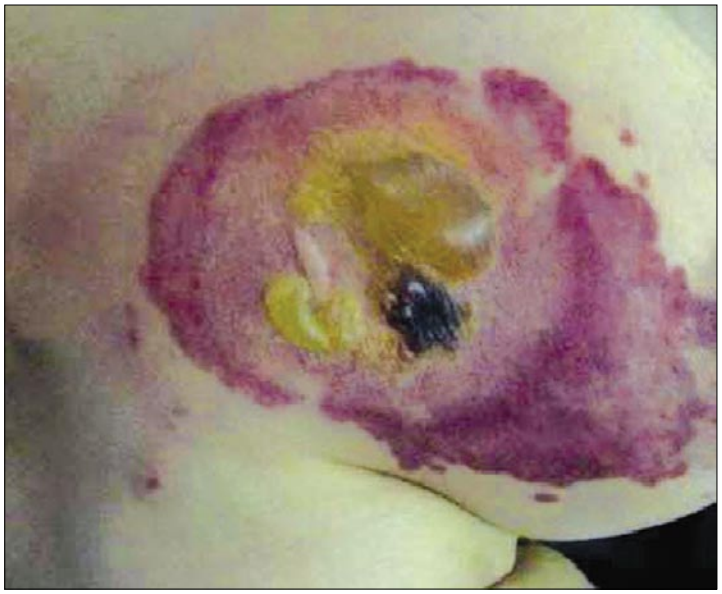

Figure 2. Port pocket infection characterized by widespread erythema, blisters, and skin necrosis at the right pectoral region in a relapse leukemia patient with neutropenia.

3 had Staphylococcus epidermidis, and 1 had Staphylococcus aureus. Cultures were negative in the 2 remaining patients. Two of those patients underwent a second port placement, 4 patients did not have a second port placement due to the short length of time until the end of treatment, and 1 patient died. Port pocket infection occurred only in 2 (0.42%) patients (Figure 2). Both of the patients had port removal in our unit and were followed with daily care for secondary wound healing. One of those patients underwent a second port placement on the contra lateral chest wall and the other patient was in the relapse period of the primary disease and was thrombocytopenic and neutropenic; therefore, a second port was not implanted. Instead, a temporary central venous catheter was placed, but the patient died during follow-up. One patient, who had a bilateral radical mastectomy and radiotherapy, underwent a port placement just below the left clavicle at a different hospital and developed tissue loss above the port with port pocket infection during the follow-up. This port was removed in our unit and the patient was admitted to the plastic surgery clinic because of severe tissue loss. One patient presented with dehiscence of the port pocket incision one month after the placement, and then underwent removal of the existing port and placement of a new one on the other chest wall. A forceful infusion of saline solution was attempted on the floor on 2 malfunctioning ports in which one patient developed swelling and pain at the neck area. Contrast injection then revealed a fracture of the port catheter at the venous entry site and contrast extravasation, which resulted in port removal (Figure 3). In the other patient, the port catheter detached from the chamber and migrated to the venous system. Approaching from the right femoral vein, a 20 mm snare was used to retrieve the port catheter from the superior caval vein (Figure 4). The port reservoir was not removed in this particular chamber due to thrombocytopenia. Another patient developed skin necrosis secondary to superficial port placement. This patient underwent removal of the existing port and placement of a new one on the other chest wall, as well. One of our patients underwent port removal secondary to superior vena cava syndrome, but an additional port was not required since he was close to the completion of therapy. Another patient underwent port removal due to symptomatic right IJV thrombosis.

Table 5. Late complications that occurred during port usage.

		# patients	%
Explantation needed	Sepsis	1	0.21
	Bacteremia	6	1.26
	Port pocket infection	2	0.42
	Skin necrosis	1	0.21
	Incision dehiscence	1	0.21
	Catheter fracture or detachment	2	0.42
	Symptomatic jugular vein thrombosis	1	0.21
	Symptomatic superior vena cava thrombosis	1	0.21
Explantation not needed	Catheter dysfunction	29	6.09
	Symptomatic jugular vein thrombosis	4	0.84
	Asymptomatic superior vena cava thrombosis	1	0.21
	Inverted port	1	0.21
	Catheter malposition	1	0.21
	Total	51	10.7

During follow-up, 36 (7.6%) patients developed minor complications in which port removal was not needed. Port dysfunction presenting with difficult aspiration occurred in 29 (6.09%) patients. In one of the patients with difficult aspiration, fluoroscopic examination revealed that the tip of the catheter was against the other sidewall of the superior caval vein and port revision was not considered at that point. In the remaining patients, after excluding catheter malposition by fluoroscopic examination, contrast injection was performed showing that fibrin sheath

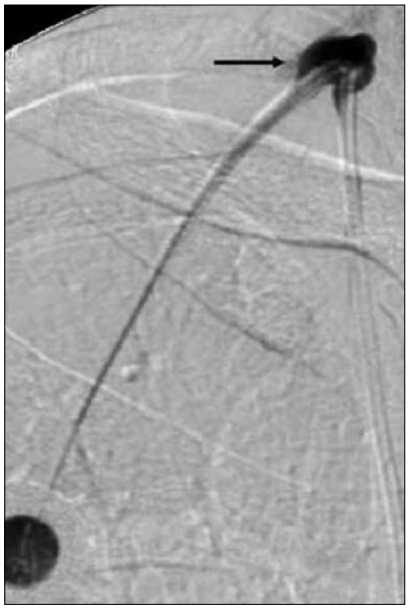

Figure 3. Contrast injection into the port reveals catheter fracture and contrast extravasation *(arrow)* at the jugular venous entry site in a patient who had a pain on the right neck region immediately after a forceful saline injection.

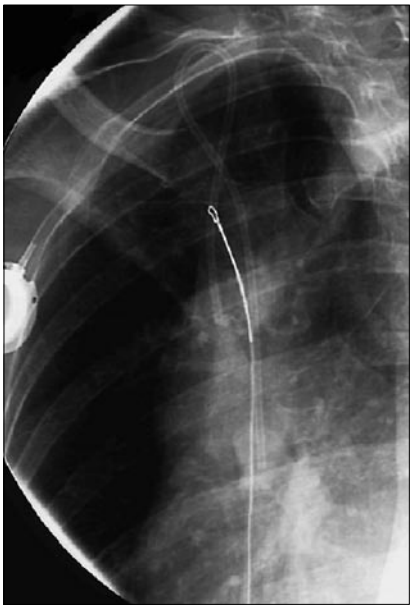

Figure 4. Angiographic image representing the retrieval of the detached port catheter with a 20 mm snare, which migrated to the venous system after a forceful saline injection that caused detachment of the port catheter from the port reservoir.

formation or partial thrombus within the catheter was the reason for difficult aspiration. All were relieved with 2 mg recombinant tissue plasminogen activator (rt-TPA) dwell. In addition, 4 patients developed symptomatic right IJV thrombosis within the first month following the procedure and presented with pain at the right neck area. These 4 patients were treated with oral pain medications and low molecular weight heparin, which resulted in complete relief. A superior caval vein thrombosis was incidentally diagnosed during a thoracic CT scan that was performed for follow-up of the primary disease. Since the patient was completely asymptomatic and the port was needed, it was not removed. Revision was performed in a patient in whom port rotated reversely.

Discussion

Subcutaneous venous port devices are of major importance in the care of oncology patients by providing reliable vascular access. They have great advantages over tunneled catheters, such as low infection rates, long life, and patient comfort (1-3). Traditionally, ports have been inserted by surgical departments, but during the last decade, they have begun to be placed in angiography suits using imaging guidance. Surgical and radiological techniques are similar for port implantation. The major difference between the techniques is radiology's use of fluoroscopy and ultrasonography. An image-guided port placement technique virtually eliminates the procedure-related complications reported in the surgical series, such as pneumothorax, hemothorax, arterial injury, and catheter malpositioning (4). Numerous studies have demonstrated that the results of ports placed by vascular interventional radiologists have compared favorably with reported surgical series, in both infection and late complication rates (5-10). We had 3 minor complications in our study group, based on the Society of Interventional Radiology (SIR) guidelines (11), and no major complications were noted (11). The port infection rate in the related literature ranges from 2.6% to 9% (5, 6, 12). There were no procedure-related early (within the first week) infections in our study group. Nine patients (1.89%) developed port-related infection during follow-up, in which 2 had port pocket infections, 1 had sepsis, and 6 had bacteremia. Infection can be local or systemic (bloodstream infection) in clinical settings. Local infections can be classified as needle access site infections and port pocket infections. Needle access site infections occur at the skin through the needle to the port. It presents with local tenderness, pain, erythema, and edema. The most common pathogen for needle access site infections is Staphylococcus epidermidis (13). Although there is no standard treatment protocol for needle access site infections, from our standpoint, port removal is indicated in patients who do not respond to local wound care and oral antibiotic treatment, and have persistent fever and recurrent positive cultures.

Port pocket infection is reported to occur at a rate of 0.3% to 4.4% (12). The port, as the source of the infection, should be removed immediately and local wound care along with oral antibiotic treatment should be administered as soon as possible. In determining the most appropriate place for port placement, the site of mastectomy should be avoided in patients with radical mastectomy, especially if that region has been radiated. In 1 patient with bilateral radical mastectomy, the port was implanted on the right trapezius muscle and in 1 patient with bilateral simple mastectomy, the port was implanted on the right parasternal region. Both patients have been doing well, with no problems as of this writing.

Creation of a superficial port pocket and choice of a large profile port chamber in thin patients can cause skin erosion over the port chamber. Skin erosion has been reported in 0% to 1% of cases in the literature (5). Although creation of a superficial port pocket is most likely related to the experience of the operator, one may have to place the port under the pectoral fascia or muscle to avoid skin erosion.

We preferred the right IJV for venous access. There is a straight course from the right IJV to the superior caval vein that minimizes the contact of the catheter with the vessel wall, and thus leads to a lower risk of thrombosis (14). Additionally, procedure time for venous puncture is shorter and there is no risk of pneumothorax. The left IJV was used when a patient had an occluded right IJV or right mastectomy. One should be careful while positioning the tip of the port catheter from the left side, especially in obese female patients, due to acute angulations between the left brachiocephalic vein and superior caval vein. In those patients, if the tip of the

catheter is positioned at the level of the atrio-caval junction while the patient lies supine, the catheter can be retracted when the patient stands up and subcutaneous fat tissue moves down. For that reason, the tip of the catheter should be trimmed longer in order to position the tip within the right atrium, especially in these patients (4,15). In one our obese female patients with acute angulation and a port on the left side, fluoroscopic examination for difficult aspiration revealed that the tip of the catheter was against the other sidewall of the superior caval vein and had retracted. Since she was on her chemotherapy regimen, port revision was not considered at that time.

A 'pinch off' syndrome may occur in ports placed through the subclavian vein secondary to the pinching of the port catheter between the clavicle and the first rib, leading to catheter fracture (5). Additionally, in cases of a collapsed subclavian vein, the risk of pneumothorax is reported to be around 0.1% to 3.2%, due to underlying lung parenchyma (16-18). It has been shown in studies of long-term catheters for chemotherapy and hemodialysis that the risk of venous stenosis and thrombosis is higher in subclavian vein accesses compared to IJV accesses (19, 20). Moreover, we visualized the IJV better then the subclavian vein with US. For those reasons, with the exception of 1 patient, we did not use the subclavian vein as an access.

Fluoroscopic evaluation before using the port and the catheter is recommended in patients who develop pain and swelling during infusion therapy.

Subcutaneous extravasation of the chemotherapeutic agent to the subcutaneous tissue, secondary to a catheter fracture or a broken catheter, can cause soft tissue necrosis or non-healing wounds (13).

According to our experience, if the port pocket is tight enough (the port barely fits), it is not necessary to use stay sutures to attach the port to the subcutaneous tissue. In cases with a large port pocket or a patient with excessive and loose subcutaneous fat tissue, it may be necessary to secure the port to the subcutaneous tissue. Port revision was performed for an inverted port due to loose and excessive subcutaneous fat tissue in 1 of our patients; the port was repositioned and sutured to the subcutaneous tissue.

Our results correlate with the results of Lorch, Funaki, and Yip, and show that the radiological implantation of venous ports is safe and effective (5, 6, 10).

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