ORIGINAL ARTICLE

Subcutaneous venous port catheter insertion through subclavian vein on 770 patients: do the catheter type and the placement technique matter?

Inserción de catéter venoso subcutáneo a través de la vena subclavia en 770 pacientes: ¿importan el tipo de catéter y la técnica de colocación?

Uğur Temel and Onur Derdiyok*

Department of Thoracic Surgery, Şişli Hamidiye Etfal Training and Research Hospital, İstanbul, Turkey

Abstract

Objective: *The aim of this study was to present our clinical experience in patients undergoing subcutaneous venous port catheter (SVPC) placement through subclavian vein for chemotherapy.* **Methods:** *We retrospectively investigated 770 patients undergoing SVPC placement. Two different catheters were used (polyurethane [n = 100, 13%] and silicone [n = 670, 87%]). Port reservoir (PR) was placed by removing subcutaneous fatty tissue equivalent to the resevoir size (n = 220, 29%), or buried directly under fatty tissue (n = 550, 71%). Results and complications according to catheter types and placement techniques were investigated.* **Results:** *There were 59 complications (7.7%). Port-site infection and wound dehiscence were higher when the reservoir was placed after removing subcutaneous fatty tissue (p < 0.05). Port-site infection, wound dehiscence, subclavian vein thrombosis, and catheter occlusion were common in polyurethane catheters (p < 0.05). Of 192 patients who were followed-up (mean 18 months), SVPC was removed in 25% due to the death of the patients (n = 100), completion of treatment (n = 87), and development of complication (n = 5).* **Conclusion:** *During SVPC insertion, the placement of PR under the adipose tissue and preferring silicone catheters may reduce the complication rates.*

Keywords: *Central venous access device. Chemotherapy port. Complications. Outcomes.*

Resumen

Objetivo: *Presentar nuestra experiencia clínica en pacientes sometidos a colocación de catéter venoso subcutáneo (CVS) a través de la vena subclavia para quimioterapia.* **Métodos:** *Investigamos retrospectivamente a 770 pacientes a los que se colocó un CVS. Se utilizaron dos catéteres diferentes: de poliuretano (n = 100; 13%) y de silicona (n = 670; 87%). El reservorio se colocó eliminando tejido graso subcutáneo equivalente al tamaño del reservorio (n = 220; 29%) o enterrado directamente debajo del tejido graso (n = 550; 71%). Se investigaron los resultados y las complicaciones según el tipo de catéter y la técnica de colocación.* **Resultados:** *Hubo 59 complicaciones (7.7%). Ocurrieron más infecciones del catéter y dehiscencias de la herida cuando el reservorio se colocó tras retirar tejido graso subcutáneo (p < 0.05). La infección del catéter, la dehiscencia de la herida, la trombosis de la vena subclavia y la oclusión del catéter fueron más comunes con los catéteres de poliuretano (p < 0.05). De los 192 pacientes con seguimiento (media: 18 meses), en el 25% se retiró el CVS por muerte del paciente (n = 100), finalización del tratamiento (n = 87) o desarrollo de complicaciones (n = 5).* **Conclusiones:** *Durante la inserción de un CVS, la colocación del reservorio debajo del tejido adiposo y la preferencia por catéteres de silicona pueden reducir las tasas de complicaciones.*

Palabras clave: *Dispositivo de acceso venoso central. Puerto de quimioterapia. Complicaciones. Resultados.*

***Correspondence:**
Uğur Temel
E-mail: drugurtemel@hotmail.com

Date of reception: 16-09-2024
Date of acceptance: 22-12-2024
DOI: 10.24875/CIRU.24000498

Cir Cir. 2025;93(4):378-384
Contents available at PubMed
www.cirugiaycirujanos.com

Introduction

Short- or long-term central venous catheter is the standard of practice for various central venous therapies, including chemotherapy, fluid administration, antibiotic therapy, and parenteral nutrition. Its first insertion on a human was reported in a self-experimentation attempt in 1929. Later, Seldinger technique was described facilitating catheter placement into vascular system over a guide-wire in 1953. In the 1970s, the first long-term central venous catheters were designed[1].

Subcutaneous venous port catheter (SVPC) or simply called "port" is a small reservoir connected to a venous catheter positioned in the subcutaneous tissue, and its first usage was reported in 1982[2]. It remains an integral part of chemotherapy in oncologic patients reducing patient discomfort. Lower risk of infection and thrombosis are among its advantages in patients necessitating a continuous intravenous line compared to peripheral vein access[1,3]. Yet, this technique has various complications including pneumothorax, hemothorax, hematoma, catheter-related infection, venous thrombosis, catheter occlusion or rupture, pain, and skin disorders[1,4,5]. This study aimed to present our clinical experience in patients undergoing SVPC placement.

Methods

This retrospective study consisted of 770 patients (427 males, and 343 females; mean age 54 ± 13 years; range 11-82 years) undergoing SVPC placement for adjuvant or neoadjuvant chemotherapy from January 2012 to December 2022. Patients' demographic/clinical features, surgical results, duration of catheter stay, reasons for catheter removal, and complications were investigated. The study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Local Ethical Committee (date: October 10, 2023, No: 4121) and written consent was obtained individually.

Before implantation, bleeding and coagulation times, and basic biochemical parameters of each patient were controlled. The intervention site was examined in terms of infection, swelling, mass, and previously received radiotherapy. The same thoracic surgeon implanted all the catheters under operating room settings. Right subclavian vein was mostly preferred (n = 747, 97%) due to its anatomical convenience. Left subclavian vein was used in patients with prior mastectomy, radiotherapy/head-neck surgery, or structural anomaly. Laryngeal mask airway and general anesthesia were used in the first 50 patients so that the principal surgeon should gain experience. Then, the next 50 patients received combination sedoanalgesia with propofol and dormicum. However, since it was remarked that patients felt pain and were unable to remain still during the procedure, sedoanalgesia using dormicum and fentanyl was preferred for the remaining 670 patients. Propofol was added just before the placement of port reservoir (PR). All patients were provided with continuous monitoring using pulse oximetry, electrocardiography, and a non-invasive blood pressure.

For the first 220 patients, polyurethane catheters (n = 100) and silicone catheters (n = 120) were used. Since it was observed that the rates of complications including port-site infection, skin dehiscence, and venous thrombosis were higher in patients with polyurethane catheters, only silicone catheters were preferred for the remaining 550 patients. Overall, silicone catheters were used in 670 patients (87%), and polyurethane catheters in 100 patients (13%).

Implantation was performed using Seldinger method, as previously described[3]. No superficial Doppler ultrasound was used. Needle was inserted 1 cm under the clavicular angle at the midclavicular area. A pocket of 3 cm was created 3-4 cm under the needle aspiration point for the port insertion. While creating a pocket, a piece of subcutaneous fatty tissue equivalent to the size of the PR was removed and the PR was placed in this pouch for the first 220 patients (29%). However, since we detected that skin dehiscence and port-site infection rates were higher, we did not remove any fatty tissue for the last 550 patients (71%), and buried the PR directly under the adipose tissue. No additional port suture was used in any patient.

No fluoroscopy was used to control the place of the catheter. Peroperative chest X-ray was taken for the first 100 patients. After gaining experience, the catheter was inserted over the guidewire according to the calculated length on the patient before the procedure. The length was 15-17 cm for thin patients, 17-19 cm for normal body type patients, and 19-22 cm for obese patients. Then, after 100 patients, we stopped having peroperative chest X-ray. During the procedure, the catheter was checked for proper working and probable leakages with preventing thrombus formations by aspiration blood through and giving saline solution

containing 100U/mL heparin inside. The skin incision was closed with 3/0 taper monofilament propylene. Skin sutures were put in a way not to overlay the punctured area over the PR.

Post-operative chest X-ray was routinely taken. Patients were discharged after 4-6 h of follow-up in the ward. First-generation cephalosporin and analgesics were administered orally for 5 days. The oncologists of the patients were advised to wait about 4-5 days to ensure the proper wound healing before beginning the chemotherapy.

Patients were called to follow-up visit 1 week after the procedure. Skin sutures were removed 10 days after implantation. Catheters were flushed monthly if patients were given monthly chemotherapy or had catheter left *in situ*. Complications and their management were noted. Complications were defined as early and late when they occurred within 7 days of implantation and 7 days after the procedure, as previously described[5]. Complications were analyzed according to the procedure of PR insertion (whether a piece of the adipose tissue removed to place the PR or it was buried under the adipose tissue) and the type of catheters (polyurethane versus silicone).

Descriptive statistics were used in number and percentage, including mean ± standard deviation, median and range, frequencies, and proportions. Continuous variables were compared using student t-test. Categoric variables were compared using a X^2 test or Fisher's exact test, as applicable. $p < 0.05$ was considered to be statistically significant.

Table 1. Indications for SVPC placement (n = 770)

Type of malignancy	n	Percentage
Colorectal cancer	420	54.6
Gastric cancer	80	10.4
Lung cancer	74	9.6
Bladder cancer	70	9.1
Breast cancer	32	4.2
Esophageal cancer	27	3.5
Pancreatic cancer	25	3.2
Head and neck cancer	21	2.7
Others*	21	2.7

*Including ovarian cancer, prostatic cancer, plasmocytoma, osteosarcoma, and retinoblastoma.
SVPC: subcutaneous venous port catheter.

Table 2. Complications of SVPC placement

Complication	n	Percentage
Port-site infection	22	2.9
Wound dehiscence	13	1.7
Pneumothorax	8	1.0
Catheter occlusion	8	1.0
Subclavian vein thrombosis	5	0.7
Port-catheter breaking off	3	0.4
Total	59	7.7

SVPC: subcutaneous venous port catheter.

Results

Table 1 outlines the indications for SVPC placement. Gastrointestinal system tumors predominated (n = 527, 68.5%) followed by lung cancer (n = 74, 9.6%). Most patients (n = 440, 57%) had metastatic tumors. Among them, 39 patients had received previous chemotherapy through standard venous access, and offered SVPC placement due to several reasons by their oncologists. The remaining 401 patients were not given chemotherapy before. Three hundred-and thirty patients (43%) necessitated SVPC placement for adjuvant (n = 247) and neoadjuvant (n = 83) chemotherapy.

Table 2 demonstrates the complications after the implantation. Fifty-nine complications developed (7.7%). Twenty-one complications (36%) including wound dehiscence and pneumothorax were early complications, while the remaining 38 (64%) including port-site infection, catheter occlusion, subclavian vein thrombosis, and port-catheter breaking off were late complications.

Port-site infection was the commonest complication (22 patients, 2.9%), managed by administering empirical antibiotics for 2 days. Fifteen patients unresponsive to treatment necessitated wound debridement and replacement of the PR 3-4 cm laterally. Wound dehiscence developed in 13 patients (1.7%). Simple suturing was enough for five patients, but the remaining eight patients necessitated wound debridement and replacement of the PR. Pneumothorax occurred in 8 patients (1.0%). Tube thoracostomy was performed for 2 patients, while the other six patients were given short-term oxygen support therapy. Catheter occlusion was detected in 8 patients (1.0%) which resolved by the catheter flushing using the

heparinized solution (1 mL/100 unit heparin). Five patients presented with neck pain, and arm pain and swelling. Ultrasound imaging demonstrated thrombotic obstruction of the subclavian vein (0.7%). These patients received low-molecular-weight heparin (enoxaparin sodium 1 mg/kg) for treatment. However, despite the therapy, port catheter had to be removed in two patients.

Complete transection and embolization of the catheter occurred in 3 patients (0.4%). A 39-year-old female patient with breast cancer developed sudden chest pain in the post-operative 6th month. Computed tomography of the chest showed the broken catheter fragment at the left pulmonary artery lying down from truncus. An 11-year-old male patient with retinoblastoma admitted a year after the SVPC placement and planned for catheter removal since his treatment ended. During the removal, a piece of the catheter transected and remained in the right ventricle. Another female patient (37 years old) with breast cancer developed sudden chest pain after vigorous physical effort (traditional dancing with hands and arms shaking for a long time). She had SVPC placement 3 months ago. Chest X-ray demonstrated the broken catheter in the left pulmonary artery. PR was taken out in these three patients, and interventional radiology team removed the broken parts of the catheter through Snare technique using the right femoral vein.

When complications were analyzed according to the technique of the PR insertion (whether a piece of fatty tissue was removed to place the PR or it was buried under the adipose tissue), we found that the rates of port-site infection (18 vs. 4 patients, 8.2% vs. 0.7%, respectively, $p < 0.05$) and wound dehiscence (10 vs. 3 patients, 4.5% vs. 1.4%, respectively, $p = 0.0004$) were higher in cases in the former technique. We also detected that the usage of polyurethane catheters increased significantly the rates of port-site infection (13 vs. nine patients, 13.0% vs. 1.3%, respectively, $p < 0.05$), wound dehiscence (six vs. seven patients, 6.0% vs. 1.0%, respectively, $p = 0.003$), subclavian vein thrombosis (four vs. one patient, 4.0% vs. 0.1%, respectively, $p = 0.001$), and catheter occlusion (four vs. four patients, 4.0% vs. 0.6%, respectively, $p = 0.01$).

The follow-up data of 413 patients (54%) were missing since they were coming from different cities of the country and went back home after the SVPC placement procedure. The remaining 357 patients (46%) were followed-up with a mean duration of 18 months (range 6-41 months). Of them, port catheters were removed in 192 patients (25%) due to the death of the patients during treatment (n = 100), the completion of treatment (n = 87), and development of complication (n = 5).

Discussion

This study reflects the results of SVPC placement of a tertiary referral center. We have been performing SVPC placement since 2012. In the first 5 years, we had 20-50 patients/year. However, in the recent 5 years, we had nearly 100 patients/year. Yanik et al.[3] reported the highest number of cases (n = 3000) in Turkey, and there are several national reports up to 225 patients[6-8]. Our study is the second national study with higher number of cases (n = 770).

Most patients undergoing SVPC placement had gastrointestinal system tumors (colorectal, gastric, and esophageal) and breast tumors (26-56% and 20-47%, respectively)[3,9-12]. Patients with gastrointestinal system tumors predominated in our study (n = 527, 68.5%). The mean age and gender of the patients vary according to the type of cancer; the mean ages were between 53 and 61 years, and 16-61% of the patients were male[3,5,12,13]. The mean age of the patients in our study was 54 ± 13 years, and 55% of them were male. SVPC can be placed in subclavian vein, and external or internal jugular vein. The laterality (left or right) is chosen according to surgeon's preference and patient's physical and medical history characteristics[14]. We commonly used right subclavian vein (97%), and preferred left subclavian vein in patients with prior mastectomy, radiotherapy/head-neck surgery, or structural anomaly.

The use of ultrasound is advised to secure the venous puncture[10-14]. We did not use ultrasound since the puncture could also be done without[3,6]. Besides, it was mentioned that the insertion of a catheter by a physician who had performed more than 50 catheterizations results lower rates of mechanical complication compared to by a physician who had performed < 50 catheterizations[15]. As mentioned above, all catheters were implanted by the same thoracic surgeon who had performed enough subclavian venous catheterization before beginning SVPC placement.

Fluoroscopy may be used to check the catheter position[10-13]. We did not use fluoroscopy, since the catheter could be positioned by calculating the length on the patient before the procedure, as described[3,14,16]. We obtained a post-operative chest X-ray to confirm the correct positioning of the port catheter and

documentation of pneumothorax and hemothorax, as suggested[3,11,14].

More than 15 million patients/year undergo central venous access in the United States with a complication rate of 5-19%[17]. The complication rate varies between 3 and 21%[3,4,12,18,19]. In our study, complications developed in 59 patients (7.7%). Mechanical complications including arterial puncture, nerve injury, hematoma, wound dehiscence, hemothorax, and pneumothorax occur during and directly after the placement and are called early complications. Late complications are infection, thrombosis, catheter occlusion, and break-off[20]. Although Fazli et al.[3] reported a high incidence for early complications (53%), late complications predominate with a rate between 54 and 92%[7,12,18]. Similar to the literature, we observed late complications more frequently in our study.

SVPC-related infections include localized (port-site) and systemic (bacteremia) infections. Shim et al.[13] reported the rate of infectious complications as 2.3% in 1747 patients. In general, the rate of infection varies between 1.3% and 9%[3-5,7,10,12]. Port-site infection was the commonest complication in our study (n = 22, 2.9%). None of our patients had systemic infection. Second common complication in our series was wound dehiscence (n = 13, 1.7%). The rate of this complication has been reported between 0.4% and 5%[3-5,12], so our result is consistent with the literature.

The movement of the needle at the wrong angle during the placement of SVPC might cause pneumothorax, which occur in 0.5-2%[3,4,7]. Eight patients (1%) in our study developed pneumothorax. If the physician prefers landmark-guided subclavian vein puncture (without ultrasound), the anatomic landmarks of the midpoint of the clavicle, the junction between the middle and medial border of the clavicle should be used, and the angle between the needle and clavicle must be < 30°. This reduces the rate of pneumothorax.

The catheter was occluded in our 8 patients (1%), which is a complication occurring in 0.1-2% of the patients[3-5,12]. To reduce the occlusion rate, we performed port washings with 1000U of heparin after each chemotherapy session, or every 4 weeks if no chemotherapy was given, or advised to the patient's caretaker to do so, as previously recommended[21]. Subclavian vein thrombosis rate was 0.7% in our study (n = 5). The incidence of venous thrombosis varied from 0.3 to 3.5%[3-5,10,14]. Piran et al.[9] reported a higher rate (8.5%), but their cases included also patients with deep venous thrombosis.

Port fracture and catheter embolization are rare complications resulting when the catheter within the subclavian vein is pinched within the thoracic outlet between the clavicle and the first rib, so-called pinch off syndrome. It occurs in 0.06-0.5% of the patients[3,14,22]. Port should be removed and fragmented part should be extracted by endovascular approach[22]. We observed this complication in 3 patients (0.04%), and the fragmented parts were extracted through Snare technique. To prevent this complication, the catheter entry point to the subclavian vein should not be more medially[22]. We recommend to make a puncture 1 cm laterally and inferiorly to the clavicula arch.

When the management of the complications fails, the port catheter must be removed. The removal rate varies between 1.6% and 17%[4,5,7,12]. SVPC-related infection is the most common complication necessitating the removal[12,19], but it may be required due to catheter occlusion, venous thrombosis, wound dehiscence, and catheter fracture and embolization[3,9,22]. In cases where there was no response to initial treatment, we replaced the PR 3-4 cm laterally instead of removing the port and continued broad spectrum antibiotics. In our study, 5 patients (0.6%) necessitated port removal due to catheter fracture in 3, venous thrombosis in 2. Our rate of port removal is less than the literature.

In our study, the PR was placed either by removing a piece of adipose tissue similar in size of PR and placing it there, or by burying it directly under adipose tissue. We detected significantly higher rates of port-site infection and wound dehiscence in the former technique ($p < 0.05$). The reason may be that patients undergoing chemotherapy are immunosuppressed and are prone to lose weight due to side effects of the treatment. Thus, skin erosion leading to infection is more common in these patients[10].

The usage of polyurethane catheters resulted in significantly higher rates of port-site infection, wound dehiscence, subclavian vein thrombosis, and catheter occlusion in our study ($p < 0.05$). Kartsouni et al.[12] reported that the catheter material did not affect the development of thrombosis or infection. However, Gallieni et al.[23] reported a higher incidence of thrombosis in polyurethane catheters. Polyurethane catheters were more susceptible to catheter-related infections and showed a higher thrombogenicity[11]. More thrombotic catheter occlusions in silicone catheters, and more venous thromboses in polyurethane catheters were reported[24]. Besides, the risk of catheter fracture is higher in silicon catheters[25].

There are controversies about when to administer chemotherapy after SVPC placement. Narducci et al.[19] reported that early use of the port within 7 days increased the risk of complications. However, it was demonstrated that immediate administration of chemotherapy within the 1st or 2nd days after the placement may not increase the complications[5,8]. We did not have comparative results in our study, but as a clinical opinion, we advise to wait 4-5 days to begin chemotherapy.

The main limitation of this study was the lower rate of follow-up. More than half (54%) of the patients in our study had missing follow-up data. The reason of this lower rate can be explained by the fact that our clinic is a part of a tertiary referral center. Most patients admitted from different cities, and returned back after the SVPC placement to continue their treatment. Although we tried to collect follow-up data either by their physicians or by the patients/relatives through e-mail or phone calls, this was not possible all the time. The second limitation was that this study mainly described our clinical experience and results in brief. We did not evaluate in details about the risk factors of each complication in details (such as gender, age, body mass index, tumor type, and previous chemotherapy). We only investigated the effects of two different PR placement procedure and two different types of catheter and obtained statistically significant results.

Conclusion

SVPC placement is a safe choice for long-term intravenous access. The complication rates are acceptable. To prevent or reduce the risk of complications, SVPC placement should be performed by surgeons with adequate experience and in qualified well-equipped centers. Furthermore, the placement of PR under the adipose tissue and the usage of silicone catheters may reduce the complication rates.

Funding

The authors declare that they have not received funding.

Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from patients, and received approval from the Ethics Committee. The authors have obtained approval from the Ethics Committee for the analysis of routinely obtained and anonymized clinical data, so informed consent was not necessary.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

References

1. Kehagias E, Galanakis N, Tsetis D. Central venous catheters: which, when and how. Br J Radiol. 2023;96:20220894.
2. Niederhuber JE, Ensminger W, Gyves JW, Liepman M, Doan K, Cozzi E. Totally implanted venous and arterial access system to replace external catheters in cancer treatment. Surgery. 1982;92:706-12.
3. Yanik F, Karamustafaoğlu YA, Karataş A, Yörük Y. Experience in totally implantable venous port catheter: analysis of 3,000 patients in 12 years. Turk Gogus Kalp Dama Cerrahisi Derg. 2018;26:422-8.
4. Seok JP, Kim YJ, Cho HM, Ryu HY, Hwang WJ, Sung TY. A retrospective clinical study: complications of totally implanted central venous access ports. Korean J Thorac Cardiovasc Surg. 2014;47:26-31.
5. Lee J, Hur SM, Kim Z, Lim CW. Safety of immediate use of totally implantable venous access ports in adult patients with cancer: a retrospective single-center study. Korean J Clin Oncol. 2021;17:104-10.
6. Aziret M, İrkörücü O, Gökler C, Reyhan E, Çetinkünar S, Çil T, et al. Performance of venous port catheter insertion by a general surgeon: a prospective study. Int Surg. 2015;100:827-35.
7. Yıldızeli B, Laçin T, Batırel HF, Yüksel M. Complications and management of long-term central venous access catheters and ports. J Vasc Access. 2004;5:174-8.
8. Özdemir NY, Abalı H, Öksüzoğlu B, Budakoğlu B, Akmangit I, Zengin N. It appears to be safe to start chemotherapy on the day of implantation through subcutaneous venous port catheters in inpatient setting. Support Care Cancer. 2009;17:399-403.
9. Piran S, Ngo V, McDiarmid S, Le Gal G, Petrcich W, Carrier M. Incidence and risk factors of symptomatic venous thromboembolism related to implanted ports in cancer patients. Thromb Res. 2014;133: 30-3.
10. Kim DH, Ryu DY, Jung HJ, Lee SS. Evaluation of complications of totally implantable central venous port system insertion. Exp Ther Med. 2019;17:2013-8.
11. Hsu JF, Chang HL, Tsai MJ, Tsai YM, Lee YL, Chen PH, et al. Port type is a possible risk factor for implantable venous access port-related bloodstream infections and no sign of local infection predicts the growth of gram-negative bacilli. World J Surg Oncol. 2015;13:288.
12. Kartsouni V, Moschouris H, Bersimis F, Gkeneralis G, Gkeli M, Dodoura S, et al. Complications of totally implantable central venous catheters (ports) inserted via the internal jugular vein under ultrasound and fluoroscopy guidance in adult oncology patients: a single-center experience. Cureus. 2022;14:e27485.
13. Shim J, Seo TS, Song MG, Cha IH, Kim JS, Choi CW, et al. Incidence and risk factors of infectious complications related to implantable venous-access ports. Korean J Radiol. 2014;15:494-500.
14. Zhou J, Qian S, He W, Han G, Li H, Luo R. Implanting totally implantable venous access port via the internal jugular vein guided by ultrasonography is feasible and safe in patients with breast cancer. World J Surg Oncol. 2014;12:378.
15. Bernard RW, Stahl WM. Subclavian vein catheterizations: a prospective study. I. Non-infectious complications. Ann Surg. 1971;173: 184-90.

16. Salimi F, Imani MR, Ghasemi N, Keshavarzian A, Jazi AH. The mid-sternal length, a practical anatomical landmark for optimal positioning of long-term central venous catheters. J Res Med Sci. 2013;18: 383-6.
17. Behesti MV. A concise history of central venous access. Tech Vasc Interv Radiol. 2011;14:184-5.
18. Ignatov A, Hoffman O, Smith B, Fahlke J, Peters B, Bischoff J, et al. An 11-year retrospective study of totally implanted central venous access ports: complications and patient satisfaction. Eur J Surg Oncol. 2009;35:241-6.
19. Narducci F, Jean-Laurent M, Boulanger L, El Bedoui S, Mallet Y, Houpeau JL, et al. Totally implantable venous access port systems and risk factors for complications: a one-year prospective study in a cancer centre. Eur J Surg Oncol. 2011;37:913-8.
20. Yaacob Y, Nguyen DV, Mohamed Z, Ralib AR, Zakaria R, Muda S. Imageguided chemoport insertion by interventional radiologists: a single-center experience on periprocedural complications. Indian J Radiol Imaging. 2013;23:1215.
21. Kefeli U, Dane F, Yumuk PF, Karamanoğlu A, İyikesici S, Başaran G, et al. Prolonged interval in prophylactic heparin flushing for maintenance of subcutaneous implanted port care in patients with cancer. Eur J Cancer Care (Engl). 2009;18:191-4.
22. Lakshmi HN, Sharma M, Jain A, Puj K, Jayaprakash D, Pandya S. Chemoport fracture due to catheter pinch off syndrome: a rare complication of subclavian vein approach revisited. Indian J Surg Oncol. 2022;13:343-7.
23. Gallieni M, Pittiruti M, Biffi R. Vascular access in oncology patients. CA Cancer J Clin. 2008;58:323-46.
24. Busch JD, Vens M, Mahler C, Herrmann J, Adam G, Ittrich H. Complication rates observed in silicone and polyurethane catheters of totally implanted central venous access devices implanted in the upper arm. J Vasc Interv Radiol. 2017;28:1177-83.
25. Kojima S, Hiraki T, Gobara H, Iguchi T, Fujiwara S, Matsui Y, et al. Fracture of totally implanted central venous access devices: a propensity-score-matched comparison of risks for groshong silicone versus polyurethane catheters. J Vasc Access. 2016;17:535-41.