Original Article

Damar Cerrahi Dergisi 2017;26(2):39-44

DOI: 10.5606/tjvs.2017.30
www.turkishjournalofvascularsurgery.org

Analysis of totally implantable venous access with modified fast track technique

Modifiye hızlandırılmış teknik ile tamamen implante edilebilir venöz erişim analizi

Serkan Burç Deşer, Mustafa Kemal Demirağ

Department of Cardiovascular Surgery, School of Medicine, Ondokuz Mayıs University, Samsun, Turkey

ABSTRACT

Objectives: In this study, we present our experience with fast track technique modifying the cut-down model for totally implantable venous access.

Patients and methods: Between June 2013 and December 2016, a total of 70 patients (33 males, 37 females; mean age 67.7±9.8 years, range 21 to 86 years) in whom a venous port was implanted were retrospectively analyzed. All patients were evaluated in terms of surgery time, early and late complications, and primary success rate and classified on the basis of totally implantable venous access port (TIVAP) technique.

Results: The primary success rate of fast-track TIVAP implantation was 91% (64/70) for the cephalic cut-down technique and 100% (6/6) for the Seldinger technique. No major intraoperative complications related to the procedures were seen. The mean duration of the surgical procedure for the cephalic cut-down technique was 14 min (range, 10 to 22 min) and 32 min (range, 25 to 50 min) for the percutaneous Seldinger technique.

Conclusion: Our study results show that percutaneous Seldinger technique extends the time of TIVAP implantation and, therefore, TIVAP implantation with fast cephalic cut-down technique reduces both the duration of the procedure and serious complication rates such as pneumothorax.

Keywords: Cephalic vein; complication; cut-down; totally implantable venous access port.

ÖZ

Amaç: Bu çalışmada tamamen implante edilebilir venöz erişim için cut-down modelini modifiye ederek hızlandırılmış tekniğe ilişkin deneyimlerimiz sunuldu.

Hastalar ve Yöntemler: Haziran 2013 - Aralık 2016 tarihleri arasında venöz port yerleştirilen toplam 70 hasta (33 erkek, 37 kadın; ort. yaş 67.7±9.8 yıl; dağılım, 21-86 yaş) retrospektif olarak incelendi. Hastalar tamamen implante edilebilir venöz erişim portu (TIVAP) tekniğine göre değerlendirildi ve sınıflandırıldı. Hastaların tümü ameliyat süresi, erken ve geç komplikasyonlar ve primer başarı oranı açısından değerlendirildi ve tamamen TIVAP tekniğine göre sınıflandırıldı.

Bulgular: TIVAP implantasyonunun birincil başarı oranı, hızlı sefalik cut-down tekniği için %91 (64/70) ve Seldinger tekniği için %100 (6/6) idi. İşlemlere ilişkin işlem sırası majör bir komplikasyon görülmedi. Cerrahi işlemin sefalik cut-down tekniği için ortalama süresi 14 dk. (dağılım, 10-22 dk.), perkütan Seldinger tekniği için 32 dk. (dağılım, 25-50 dk.) idi.

Sonuç: Çalışma sonuçlarımız perkütan Seldinger tekniğinin TIVAP implantasyon süresini uzattığını ve bu nedenle hızlı sefalik cut-down tekniği ile yapılan TIVAP implantasyonunun işlem süresini kısalttığını ve pnömotoraks gibi ciddi komplikasyon oranlarını azalttığını göstermektedir.

Anahtar sözcükler: Sefalik ven; komplikasyon; cut-down; tamamen implante edilebilir venöz erişim portu.

Received: December 07, 2017 ***Accepted:*** December 10, 2017

Correspondence: Serkan Burç Deşer, MD. Ondokuz Mayıs Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 55139 Atakum, Samsun, Turkey.
e-mail: sbd983@yahoo.com

Citation:
Deşer SB, Demirağ MK. Analysis of totally implantable venous access of 70 cases with modified fast track technique. Damar Cer Derg 2017;26(2):39-44.

After many years, using of the Broviac and Hickman type central venous catheters, venous port implantation was first reported in 1982 by Niederhuber et al.[1] Totally implantable venous access ports (TIVAP) are of great convenience for repeating intravenous (IV) therapy, long-term parenteral nutrition, blood transfusion, blood sampling, bone marrow transplantation, and patients with fragile vessels. It also provides readily available safe and easy, long-life, central venous access which is placed under the skin; therefore, using TIVAP has been increasing year by year.[2] Cephalic vein, subclavian vein, and jugular vein can be preferred for the implantation. The overall complication rate ranges between 16 and 28%.[3] The most common complications of TIVAP include pneumothorax, great vessel injury, infection, malposition, catheter obstruction, catheter rupture, extravasation, venous thrombosis, bleeding, atrial fibrillation, pulmonary embolism, and the pinch-off syndrome.[1-5] Upper extremity deep vein thromboses (UEDVT) are seen in 2 to 6% of patients with TIVAP.[6] *Staphylococcus aureus* and *coagulase-negative Staphylococcus* are the most common causes of infection.[7] However, yeast infections are often associated with parenteral nutrition.[8,9]

In this study, we aimed to present our experience with fast track technique modifying the cut-down model for TIVAP.

PATIENTS AND METHODS

This retrospective study included a total of 70 patients (33 males, 37 females; mean age 67.7±9.8 years; range, 21 to 86 years) who were referred to our Cardiovascular Surgery clinic for the insertion of TIVAP (Groshong catheter, BARD X-Port isp™; CR Bard Inc., Murray Hill, NJ, USA) between June 2014 and December 2016. The study protocol was approved by the Institutional Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

During the study period, a total of 70 TIVAP procedures were performed in our hospital. Data included in demographic characteristics, early and late complication rates including pneumothorax, great vessel injury, malposition, sepsis, local infection (pocket, tunnel), catheter obstruction, catheter rupture, pulmonary embolism, occurrence of pinch-off syndrome, etiology, skin necrosis, catheter/port dislocation, extravasation, hematoma, venous thrombosis incidence, time of surgery, and general health status of the patients were recorded (Table 1). The mean body mass index was 22 (range, 15 to 35) kg/m^2. All patients underwent TIVAP implantation with the guidance of fluoroscopy under local anesthesia with intravenous sedation, if needed, in the operating room. Continuous monitoring of the heart rate, arterial oxygen saturation, and non-invasive arterial blood pressure was performed in all patients. Then, the TIVAP was placed via a modified surgical cut-down access through the cephalic vein at the deltoid-pectoralis groove in 64 patients (91%) due to its ease of implantation or placed through a percutaneous landmark access through the subclavian vein in six patients (9%), when the cut-down technique failed. All implantation procedures were performed

Table 1. Demographic variables of patients (n=70)

Characteristics	n	%	Mean±SD	Range	Median	Min-Max
Age (year)			67.7±9.8	21-86		
Gender						
Male	33					
Female	37					
Body Mass Index (kg/m^2)					22	15-35
White blood cells (/mm^3)					6500	4000-18500
Hemoglobin (g/dL)					12.3	3.9-18.7
Platelet count (×10^3/mm^3)					201	140-547
Hypertension	12	17				
Diabetes mellitus	10	14				
Cardiovascular disease		57				
Anticoagulative drugs	0	0				
History of venous thrombosis	0	0				
Gastrointestinal tumors	26	37				
Breast tumors	25	35				
Lung tumor	11	15				

SD: Standard deviation.

successfully (catheter tip was placed correctly, confirmed by C-arm fluoroscopy [Spinel 2G, Gemss Medical, Korea] and the port was functioning as tested by aspiration and injection). Chest X-ray was taken after port implantation to confirm the tip of the port catheter. After port implantation, oral antimicrobial agents were given for seven days to prevent infection. The primary objective of this study was the primary success rate and secondary objectives were overall success rate, procedure time, and perioperative complication rates during follow-up. The diagnosis of pneumothorax and catheter/port dislocation was confirmed by chest X-ray or computed tomography. Infection was defined as local infection signs or positive blood cultures requiring removal of the device.

Fast track venous 'cut-down' technique

Totally implantable catheters with 8 or 9 Fr silicone catheters and titanium or silicone ports were implanted in the operating room in a sterile fashion under local anesthesia with appropriate sedation, when needed. A single dose of antibiotic prophylaxis was administered before process and oral antibiotics were given after the procedure. After a 3 to 5 cm single skin incision along the deltoid-pectoral groove was made, the cephalic vein was exposed. The distal end of the vein was ligated and the proximal side was suspended. The catheter was shortened to 15 cm for females and 20 cm for males, and the port reservoir and catheter were connected. A transverse venotomy was carried out and the catheter was inserted. Subsequently, the catheter tip was positioned in the superior vena cava under fluoroscopy. The port reservoir was fixed beneath the pectoral fascia. The chemotherapy port catheter was washed with saline and the reservoir filled with diluted heparin (2500 unit standard heparin in 10 mL saline). Chest X-ray was taken to evaluate hemothorax or pneumothorax (Figure 1). After wound healing was completed, chemotherapy was initiated.

Statistical analysis

Statistical analysis was performed using the PASW for Windows version 18.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed in mean + standard deviation (SD), while categorical variables were expressed in frequency and percentage. The chi-square test was used to compare categorical variables and the Student's t-test was used to compare the mean differences between the independent groups. A p value of <0.05 was considered statistically significant.

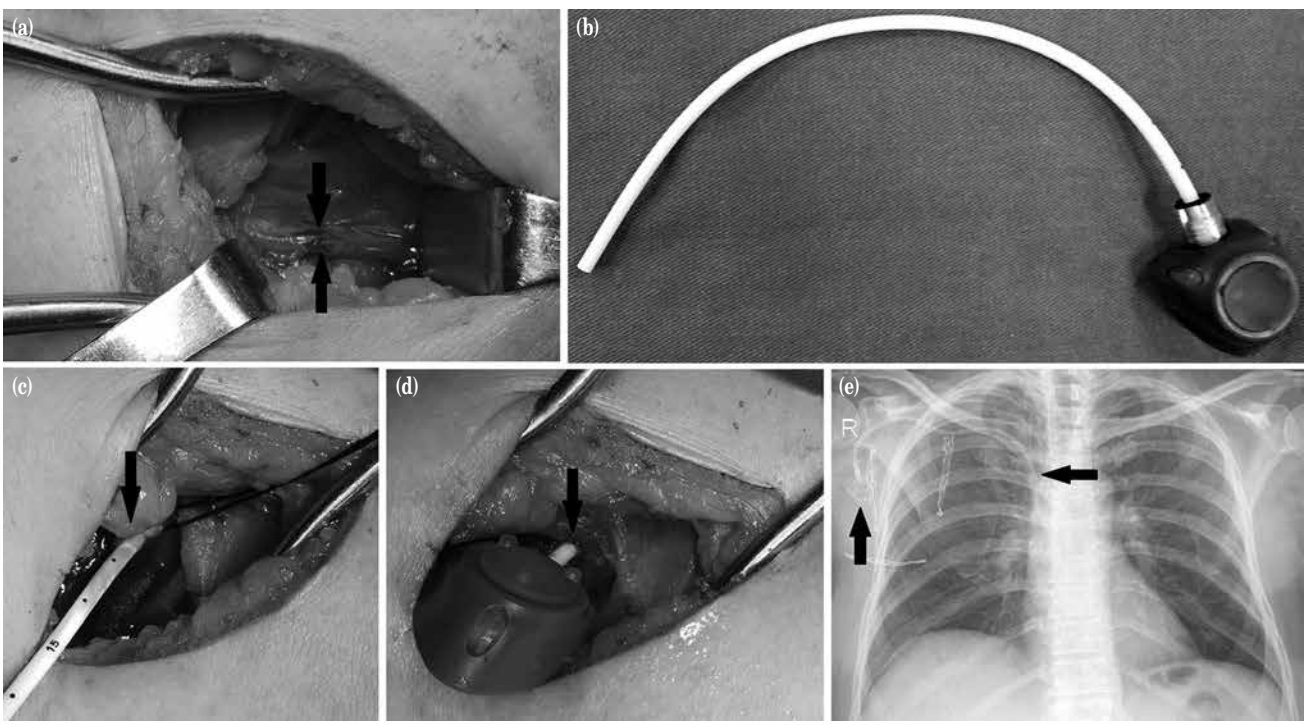

Figure 1. An external view of the right cephalic vein **(a)**, connection of the port reservoir and the catheter **(b)**, insertion of the totally implantable venous access port (TIVAP) through the right cephalic vein **(c, d)**, black arrows showing the tip of the catheter and the port reservoir on chest X-ray image **(e)**.

Table 2. Early and late complications following insertion of totally implantable venous access ports and perioperative overall condition of the patients

	n	%	Median	Min-Max
Subclavian vein access	6	9		
Cephalic vein access	64	91		
Arterial puncture	2	2.8		
Hematoma	1	1.4		
Operating time (min)			14	10-50
Pneumothorax	2	2.8		
Catheter injury	0	0		
Catheter/port malposition	0	0		
Catheter obstruction	0	0		
Skin necrosis	0	0		
Implantation side (right)	67	95		
Primary malposition	0	0		
Port-related bacteremia and/or pocket infection	2	2.8		
Port removal	2	2.8		
Infiltration/extravasation	0	0		
Venous thrombosis	0	0		

Min: Minimum; Max: Maximum.

RESULTS

The primary success rate of TIVAP implantation was 91% (64/70) for the cephalic cut-down technique and 100% (6/6) for the percutaneous Seldinger technique. No major intraoperative complications related to the procedures were seen. The TIVAP implantation was shifted to the left arm in three patients (4%). The mean duration of the surgical procedure for the cephalic cut-down technique was 14 min (range, 10 to 22 min) and 32 min (range, 25 to 50 min) for the percutaneous Seldinger technique ($p<0.05$).

Among the pathologies, TIVAP was implanted due to gastrointestinal tumors (n=26; 37%), breast tumors (n=25; 35%), and lung tumors (n=11; 15%). The percutaneous Seldinger technique was used due to several reasons (i.e., absence or small diameter of cephalic vein, the difficulty of catheter advancement). The median follow-up was 242 days (range, 7 to 922 days). No major complication during the procedure was observed and no transfusion of any blood products was needed. Postoperative early complications occurred in three patients (4.2%). Two patients (2.8%) developed pneumothorax in the right hemithorax using the Seldinger technique. These patients were followed with a chest tube and local hematoma was detected in only one patient (1.4%). Postoperative late complications occurred in three patients (4.2%). Catheter thrombosis was found in one patient (1.4%) and local infection developed in two patients (2.8%). However, no venous thrombosis was observed in the long-term. Catheters were removed in two patients (2.8%) due to the infection and in 20 patients (28%) due to the termination of the treatment. None of the patients had port extravasation/reversal, catheter malposition/dysfunction, bleeding, catheter pinch-off syndrome, nerve damage, or venous thrombosis. All patients were followed for hemorrhage, hematoma, and infection in the early postoperative period. Early and late complications and perioperative overall condition of patients are shown in Table 2.

DISCUSSION

Venous ports provide less pain, less infection rate, less needle penetration, less cosmetic problems, and increase patient's comfort.[9,10] We reviewed the literature according to the choice of the cephalic cut-down or subcutaneous Seldinger technique, subclavian or jugular vein, right or left side, utilization of Doppler ultrasound and/or fluoroscopy. In addition, pneumothorax, hemothorax, overall complication rate, infection, catheter rupture, malposition, bleeding, primary success rate, catheter and venous thrombosis, extravasation and atrial fibrillation rates were evaluated in the related studies.

Malposition, arrhythmia, venous thrombosis hematoma, skin necrosis, catheter rupture and embolism, wound infection, catheter occlusion and extravasation of fluids are common complications of TIVAP implantation (not only cephalic cut-down technique, but also percutaneous Seldinger technique).[11] In our

study, no differences were found between the cephalic cut-down technique and the percutaneous Seldinger technique in terms of late complication rate ($p>0.05$). However, early complication rates were lower for the cephalic cut-down technique ($p<0.05$).

Catheter-related infections are defined as bloodstream, pocket, exit-site, and tunnel based infections. *Gram-positive cocci* are the most frequent factors seen in catheter-related infections.[7] The reported rate of catheter-related infections for TIVAP, Hickman catheters, and Groshong catheters were reported as 0-22%, 11 to 45%, and 7 to 32%, respectively.[12] However, infections related to TIVAP vary between 2.6% and 9% in different series in the literature.[13] Our results are consistent with the results of Biffi et al.[14] and lower than Kock et al.[4] that the catheter infection rate was 2.8%. Although surgically implanted long-term central venous port catheters are associated with fewer infections, no correlation was found between the infection and the catheterization sites. We, therefore, suggest that TIVAP should be promptly removed with wound debridement and systemic antibiotics should be initiated, when infected.

A review and meta-analysis of a non-randomized study published in 2002 reported that jugular access was associated with fewer malposition rather than subclavian access.[15] Kock et al.[4] also found that catheter malposition rate was 2.4%. In our study, we observed no malposition.

The most undesirable complications of the percutaneous Seldinger technique include pneumothorax, major vascular injury, and hemothorax. Bayrak et al.[16] reported no pneumothorax in their study cohort. Our results are also similar to the literature and pneumothorax was seen 2.8% of the patients. In addition, pneumothorax frequency is less common in the jugular vein,[17] ranging between 0.2 and 6% in the literature.[18]

On the other hand, our results were more successful than the literature reports[14] using the cephalic cut-down technique. We believe that this depends on the gaining experience of the surgeon and the fast-track method which we used. The absence of the cephalic vein or the unexpected thinness are the main causes of failure of the cut-down technique.[19]

Subclavian vein puncture is the most popular route; however, perioperative complications occur in up to 12% of patients and Sarveswaran et al.[20] reported that implantation via subclavian vein under Duplex ultrasound guidance might reduce the rate of hematoma, hemothorax, and pneumothorax. The number of entry is another important factor for the complication rate. The complication rate of single, double, and triple needle entry were found 1.6%, 10.2%, and 43.2%, respectively.[21] Our results showed that overall complication rate was 8.5%. Early and late complication rates were lower than Chang et al.[18] in the cephalic cut-down technique with 4.2% and 4.2%, respectively.

Barbetakis et al.[22] and Nocito et al.[23] reported that the percutaneous method is easier and faster than the cephalic cut-down technique. However, the surgical exposure of the cephalic vein at deltoid-pectoralis groove is free of serious intra and early complications. Wolosker et al.[24] reported that the cephalic cut-down technique is a safe, effective, reliable, and low-cost procedure which should be regarded as the method of choice for the TIVAP placement. Lower rates of pneumothorax, hemothorax, and major vascular injury are the most important advantages of this technique. The incidence of extravasation of drugs ranges from 0.1 to 6.5%[25] which may damage the soft tissue around veins and lead to edema, pain, ulceration, cellulitis, phlebitis and tissue necrosis.[14] However, we found lower rates in our study compared to the literature.

Nonetheless, this study has some limitations. First, this study is a non-randomized, retrospective study. Second, the relatively small sample size potentially may lead to inaccuracy. Therefore, further large-scale, prospective, randomized studies are needed to establish a conclusion.

In conclusion, the distance between the vena cava and the right atrium is shorter and no tunneling is needed for the cephalic cut-down technique. Therefore, it does not require a second incision. Both percutaneous Seldinger and cephalic cut-down techniques require surgical exploration for the port reservoir; hence, the percutaneous Seldinger technique is not a less invasive method. In addition, the percutaneous Seldinger technique may extend the time of TIVAP implantation. We believe that fast-track cephalic cut-down technique which we used is an easy technique for the TIVAP implantation in terms of low early complication rates and should be the approach of choice for TIVAP implantation with promising results.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. 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.
2. Sakamoto N, Arai Y, Takeuchi Y, Takahashi M, Tsurusaki M, Sugimuta K. Ultrasound-Guided Radiological Placement of Central Venous Port via the Subclavian Vein: A Retrospective Analysis of 500 Cases at a Single Institute. Cardiovasc Intervent Radiol 2010;33:989-94.
3. Kurul S, Saip P, Aydin T. Totally implantable venous-access ports: local problems and extravasation injury. Lancet Oncol 2002;3:684-92.
4. Kock HJ, Pietsch M, Krause U, Wilke H, Eigler FW. Implantable vascular access systems: experience in 1500 patients with totally implanted central venous port systems. World J Surg 1998;22:12-6.
5. Lin YC, Chu CH, Ou KW, Chan DC, Hsieh CB, Chen TW, et al. Use of a totally implantable access port through the external jugular vein when the cephalic vein approach is not feasible. Ann Vasc Surg 2011;25:217-21.
6. Grant JD, Stevens SM, Woller SC, Lee EW, Kee ST, Liu DM, et al. Diagnosis and management of upper extremity deep-vein thrombosis in adults. Thromb Haemost 2012;108:1097-108.
7. Hung MC, Chen CJ, Wu KG, Hung GY, Lin YJ, Tang RB. Subcutaneously implanted central venous access device infection in pediatric patients with cancer. J Microbiol Immunol Infect 2009;42:166-71.
8. Cotogni P, Pittiruti M, Barbero C, Monge T, Palmo A, Boggio Bertinet D. Catheter-related complications in cancer patients on home parenteral nutrition: a prospective study of over 51,000 catheter days. JPEN J Parenter Enteral Nutr 2013;37:375-83.
9. Krupski G, Fröschle GW, Weh FJ, Schlosser GA. Central venous access devices in treatment of patients with malignant tumors: venous port, central venous catheter and Hickman catheter. Cost-benefit analysis based on a critical review of the literature, personal experiences with 135 port implantations and patient attitude. Chirurg 1995;66:202-7. [Abstract]
10. Groeger JS, Lucas AB, Thaler HT, Friedlander-Klar H, Brown AE, Kiehn TE, et al. Infectious morbidity associated with long-term use of venous access devices in patients with cancer. Ann Intern Med 1993;119:1168-74.
11. Groeger JS, Lucas AB, Thaler HT, Friedlander-Klar H, Brown AE, Kiehn TE, et al. Infectious morbidity associated with long-term use of venous access devices in patients with cancer. Ann Intern Med 1993;119:1168-74.
12. Beşirli K, Demirkaya A, Demirbaş MY, Kılıç Z. "Pinch-off syndrome": an unusual complication following central venous port implantation. Turkish J Thorac Cardiovasc Surg 2010;18:229-31.
13. Lorch H, Zwaan M, Kagel C, Weiss HD. Lorch H, Zwaan M, Kagel C, Weiss HD. Cardiovasc Intervent Radiol 2001;24:180-4.
14. Biffi R, Orsi F, Pozzi S, Pace U, Bonomo G, Monfardini L, et al. Best choice of central venous insertion site for the prevention of catheter-related complications in adult patients who need cancer therapy: a randomized trial. Oncol 2009;20:935-40.
15. Ruesch S, Walder B, Tramèr MR. Complications of central venous catheters: internal jugular versus subclavian access--a systematic review. Crit Care Med 2002;30:454-60.
16. Bayrak S, Güneş T, Özcem B, Gökalp O, Yürekli İ, Yazman S, et al. Port catheter implantation under scopy in hybrid operation rooms. Turkish J Thorac Cardiovasc Surg 2012;20:275-80.
17. Çelik A, Sayan M, Teber İ, Tülüce K, Demiröz ŞM, Kurul İC. Central venous port implantation with cephalic vein cut-down method. Turkish J Thorac Cardiovasc Surg 2013;21:845-8.
18. Chang HM, Hsieh CB, Hsieh HF, Chen TW, Chen CJ, Chan DC, et al. An alternative technique for totally implantable central venous access devices. Eur J Surg Oncol 2006;32:90-3.
19. Di Carlo I, Cordio S, La Greca G, Privitera G, Russello D, Puleo S, et al. Totally implantable venous access devices implanted surgically: a retrospective study on early and late complications. Arch Surg 2001;136:1050-3.
20. Sarveswaran J, Burke D, Bodenham A. Cephalic vein cut-down verses percutaneous access: a retrospective study of complications of implantable venous access devices. Am J Surg 2007;194:699.
21. 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.
22. Barbetakis N, Asteriou C, Kleontas A, Tsilikas C. Totally implantable central venous access ports. Analysis of 700 cases. J Surg Oncol 2011;104:654-6.
23. Nocito A, Wildi S, Rufibach K, Clavien PA, Weber M. Randomized clinical trial comparing venous cutdown with the Seldinger technique for placement of implantable venous access ports. Br J Surg 2009;96:1129-34.
24. Wolosker N, Yazbek G, Nishinari K, Malavolta LC, Munia MA, Langer M, et al. Totally implantable venous catheters for chemotherapy: experience in 500 patients. Sao Paulo Med J 2004;122:147-51.
25. Aksoy A, Mavioğlu L. Our experiences with chemotherapy port catheter. Turkish J Thorac Cardiovasc Surg 2012;20:69-71.