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Four-Year Study on Subcutaneous Port Catheters in Oncology Patients: Patency, Complications, and Outcomes

Onkoloji Hastalarında Subkutan Port Kateterler Üzerine Dört Yıllık Çalışma: Açıklık, Komplikasyonlar ve Sonuçlar

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ABSTRACT

Aim: Our primary focus was port patency, postoperative complications, mortality rates, and demographic factors.
Methods: In this extensive four-year study, we examined subcutaneous port catheter placement in 172 oncology patients (111 men, 61 women) between March 2018 and December 2021. We excluded one 10-month-old infant who received a pediatric port catheter.
Results: Patients predominantly underwent jugular intervention via the right internal jugular vein (97%) and occasionally via the left internal jugular vein (3%). On average, the port patency lasted for 375 days, with an overall duration of 432 days. Males had a mean patency of 13.58 months, while females averaged 11.97 months. Notably, bladder cancer patients had the longest port patency (44 months), followed by uterine cancer (35 months) and breast cancer (22.5 months). Among the 171 patients, nine had mild to moderate infections, six had mild ecchymosis-hematoma, and two required early catheter removal due to severe infections. Only one patient had mild pneumothorax that did not necessitate surgery. No major complications, such as hemothorax, nerve injury, neck compression, massive hematoma, blood transfusion, substantial bleeding, port detachment, rupture, or fragment embolism were recorded.
Conclusion: Subcutaneous port catheter placement proved to be safe and effective for patients undergoing chemotherapy, particularly with skilled surgical teams. Procedures via the right internal jugular vein consistently yielded favorable outcomes, with low infection rates, minimal occlusion, stenosis, thrombosis, and complication rates, while maintaining extended port patency. This study underscores the substantial improvement in oncology patients' quality of life by eliminating the challenges associated with frequent peripheral vessel access.

Keywords: Port catheter, Complications, Intravenous Chemotherapy, Malignancy, Internal Jugular Vein

ÖZ

Amaç: Öncelikli odak noktamız port açıklığı, postoperatif komplikasyonlar, mortalite oranları ve demografik faktörlerdi.
Yöntem: Bu dört yıllık kapsamlı çalışmada, Mart 2018 ve Aralık 2021 tarihleri arasında 172 onkoloji hastasında (111 erkek, 61 kadın) subkutan port kateter yerleştirilmesini inceledik. Pediatrik port kateteri takılan 10 aylık bir bebek hariç tutulmuştur.
Bulgular: Hastalara ağırlıklı olarak sağ internal juguler venden (%97) ve nadiren soldan (%3) juguler girişim uygulandı. Ortalama olarak, port açıklığı 375 gün sürmüş ve toplam süre 432 gün olmuştur. Erkeklerde ortalama açık kalma süresi 13,58 ay iken, kadınlarda ortalama 11,97 aydır. Özellikle, mesane kanseri hastaları en uzun port açıklığına (44 ay) sahipken, bunu rahim kanseri (35 ay) ve meme kanseri (22,5 ay) takip etmiştir. 171 hastanın dokuzunda hafif ila orta derecede enfeksiyon, altısında hafif ekimoz-hematom ve ikisinde ciddi enfeksiyon nedeniyle kateterin erken çıkarılması gerekmiştir. Sadece bir hastada ameliyat gerektirmeyen hafif bir pnömotoraks görülmüştür. Hemotoraks, sinir yaralanması, boyun sıkışması, masif hematom, kan transfüzyonu, ciddi kanama, port ayrılması, rüptür veya fragman embolisi gibi majör komplikasyonlar kaydedilmedi.
Sonuç: Subkütan port kateter yerleştirme işleminin kemoterapi hastaları için, özellikle de deneyimli cerrahi ekiplerle, güvenli ve etkili olduğu kanıtlanmıştır. Sağ internal juguler ven yoluyla yapılan prosedürler, düşük enfeksiyon oranları, minimal oklüzyon, stenoz, tromboz ve komplikasyon oranları ile sürekli olarak olumlu sonuçlar verirken, uzun süreli port açıklığını da korumuştur. Bu araştırma, sık periferik damar erişimiyle ilişkili zorlukları ortadan kaldırarak onkoloji hastalarının yaşam kalitesindeki önemli iyileşmenin altını çizmektedir.

Anahtar Kelimeler: Port Katater, Komplikasyonlar, İntravenöz Kemoterapi, Malignite, Internal Juguler Ven

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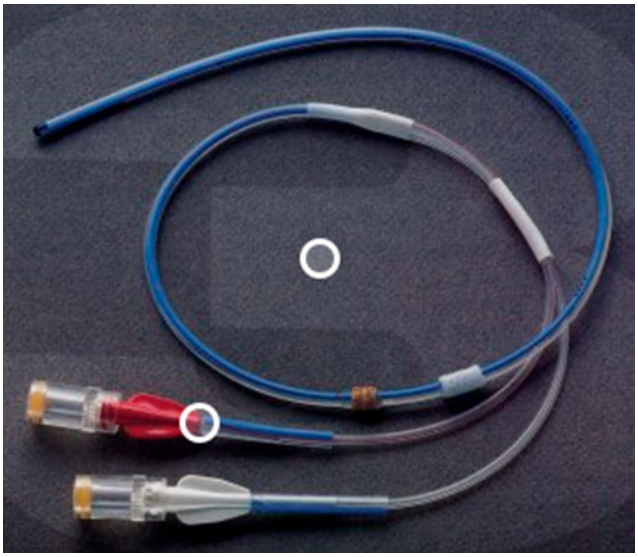
Introduction

A port catheter is a highly favored vascular access method in oncology. This preference stems from the challenges associated with establishing new vascular access points for repeated intravenous chemotherapy, blood transfusions, fluid replacement, parenteral nutrition, and routine follow-up examinations [1]. Relying solely on the peripheral vascular access during routine clinical use can lead to severe complications. These complications may include chronic intravascular damage, extravasation, thrombophlebitis, phlebitis, cellulitis, and in advanced cases, the risk of skin and subcutaneous tissue necrosis.

Until 1982, Broviac and Hickman-type multilumen central venous access catheters, featuring a traditional felt component protruding into the subcutaneous tissue (Picture 1), were the standard choice. However, in 1982, Niederhuber introduced a series of conical chamber port catheters connected to a silicone catheter that could be entirely implanted under the skin. This innovation was applied to 30 patients with cancer who required both arterial and venous vascular access [2].



Picture 1. Broviac and Hickman type 2-lumen venous catheter

Subsequently, with the publication of the findings of Schwarz et al., who documented an average patency of 1,191 days in a series of 680 patients between 1987 and 1989, the use of port catheters gained widespread acceptance in the global medical community [3].

Furthermore, a cost-effectiveness analysis conducted on 1,050 patients in 2021 revealed that venous catheters were more cost-effective during the initial 3-9 months of use. However, during the 9-12 month follow-up period, port catheters demonstrated superior cost-effectiveness compared to venous catheters [4]. In the context of long-term use, port catheters have emerged as a cost-effective and comfortable option.

Port catheters have evolved in design, incorporating materials such as plastic, titanium, polyurethane, and silicone, accompanied by structural modifications. However, their fundamental composition typically includes a 1-1.5 cm elliptical or round reservoir chamber and a silicone-polyurethane catheter system connected to an apparatus, all implanted under the skin (Picture 2).

Picture 2. Subcutaneous venous port catheter

This study presents our clinical experience and outcomes in patients who underwent subcutaneous venous port implantation within the operating room of the cardiovascular surgery clinic.

Patients and Method

This study enrolled 171 patients (110 male and 61 female) who were referred from our hospital's Oncology Clinic for port catheter insertion between March 2018 and December 2021. A comprehensive assessment, including general systemic and local neck examinations, was conducted prior to the procedure. Detailed

inquiries were made regarding anticoagulant and antiplatelet medications, and any drugs potentially causing bleeding diathesis were discontinued 4-7 days prior. Additionally, recent hemograms and routine blood tests, along with coagulation tests within the last 10 days, were carefully reviewed.

During the pandemic, patients admitted to the Cardiovascular Surgery Clinic underwent routine operating room procedures and were required to present negative PCR test results from the previous 2 days. Before surgery, patients and their families received detailed information about the operation, associated risks, potential complications, the specific anatomical region where the port catheter would be inserted, and the essential aspects of the surgical procedure. Informed consent for surgical intervention was obtained.

Upon admission to the hospital, the patients were brought to the Cardiovascular Surgery operating room after establishing peripheral vascular access. The animals were closely monitored and maintained under sterile conditions. For patients who underwent mastectomy and tracheostomy, a surgical chamber sac was created in the skin area away from the wound site between the pectoral muscles to house the catheter reservoir. In cases in which patients had neck fullness or a palpable mass prior to jugular puncture, we investigated the possibility of thrombosed vascular beds using a B-mode Doppler ultrasonography device, although routine punctures did not routinely employ Doppler. The reservoir chamber, situated in a subcutaneous pouch, was connected to the silicone catheter line and securely anchored to the pectoral muscles using bilateral fixation sutures (Picture 3).

Retrograde flow was monitored using a set needle, and the reservoir and line were filled with heparinized washing liquid and 10 mL saline. The subcutaneous bleeding was controlled, and surgical sutures were applied. Following skin closure, the patients were transferred to their rooms with pressure bandages to monitor for potential hematoma and ecchymosis. Patients in good general condition, without bleeding, hematoma, ecchymosis, neck, or surgical field swelling, underwent an allergy history evaluation and were prescribed Cephalosporin or Ciprofloxacin group antibiotics. The patients were discharged on the same day after receiving their prescriptions. Ten days later, all patients returned for routine follow-up, and the stitches were removed between days 12th and 18th day.

Picture 3. Port catheter reservoir placed in the pouch opened between the pectoral muscle

A comprehensive review of all catheter patients treated at our clinic over a four-year period was conducted using the hospital database. This retrospective analysis was performed with written approval from both the hospital and the university Ethics Committee, covering data such as demographic information, age, sex, cancer type, intervention date, active use of the port catheter, patency duration, and comorbidities, including hypertension, diabetes, and vascular diseases.

Statistical Analysis

Statistical analyses were performed using SPSS version 20 (IBM SPSS Statistics, ed. 20, 2014) for data analysis. Continuous variables are presented as mean ± standard deviation (SD). For a more complex and multivariate data analysis, we utilized the high-level professional statistical program GRETL: Gnu Regression, Econometrics, and Time-series Library GRETL 2020 B MS WINDOWS (X86).

Results

Among 171 patients, 110 were men (64%) and 61 were women (36%). The patients' ages ranged from 21 to 84 years, with an average age of 61.32 (SD+/- 4) for females and 61.98 (SD+/- 3.5) for males. A detailed examination revealed that 28% of the 48 patients had additional conditions such as hypertension, diabetes mellitus, or at least one vascular disease (Table 1).

Table 1. Patients' Characteristics

Patient Characteristics	Total (n=171)	Men (n=110)	Women (n=61)
Age (years)			
- Range	21-84	21-84	21-84
- Mean (SD)	-	61.98 (±3.5)	61.32 (±4)
Gender, n (%)		110 (64%)	61 (36%)
Comorbidities (Hypertension, DM, or Vascular Disease)			
- Patients with comorbidities, n (%)	48 (28%)		

The most prevalent cancer types were colon (48 patients), stomach (47 patients), rectum (21 patients), and pancreas (16 patients), with gastrointestinal malignancies accounting for 77% of the entire group.

Studies involving 115 and 99 patient series have highlighted a higher risk of thrombosis and occlusion in the subclavian veins compared to the jugular vein [5, 6]. Moreover, it has been reported that the right jugular vein carries a lower risk of thrombus formation than the left jugular vein [7]. Additionally, in an extensive study encompassing 831 catheter patients, infection rates in the jugular vein were found to be significantly lower than those in the femoral and subclavian areas [8].

In our clinic, we exclusively used jugular catheters, with right jugular punctures and procedures performed in 166 of 171 patients (97%) and left jugular punctures in the remaining 5 patients (3%). Performing the procedure on the left side involves two angulations when advancing the catheter, potentially affecting the endothelial integrity of the guidewire and the silicone catheter that slides over it. Moreover, the risk of thrombosis escalates when local chemotrauma induced by chemotherapeutic drugs is added to the endothelial damage [7]. These risks are minimized when using the right internal jugular vein route, which is characterized by a straight anatomical extension and provides angle-free access to the superior vena cava and atrio-caval junction.

Our cumulative port monitoring time spanned 64,410 days, equivalent to 2,147 months, with an average duration of 375 days or 12.5 months of active port use. The mean active port usage time for male and female patients was 13.58 and 11.97 months, respectively (Figure 1), and this difference was not statistically significant (p: 0.45).

No statistically significant correlation was observed between the duration of active port use and patient age (Figure 2).

According to the GRETL Statistics program, the variables most closely related to active port catheter time in the initial modeling were age and cancer type. In the process of progressively refining the model by automatically excluding less relevant variables, additional diseases were excluded owing to low correlation in the second model, followed by the presence of diabetes in the third model. Gender was the least significant variable in the fourth statistical model. The strongest statistically significant correlations were found between port patency time and cancer type (p = 0.0016) in the fifth model (Figure 3), with weaker correlations observed between the presence of hypertension and age (p: 0.08 and p = 0.05).

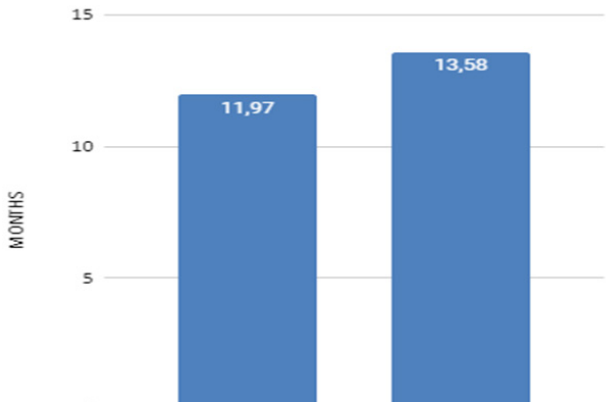


Figure 1 : Active port usage time by gender (in months)

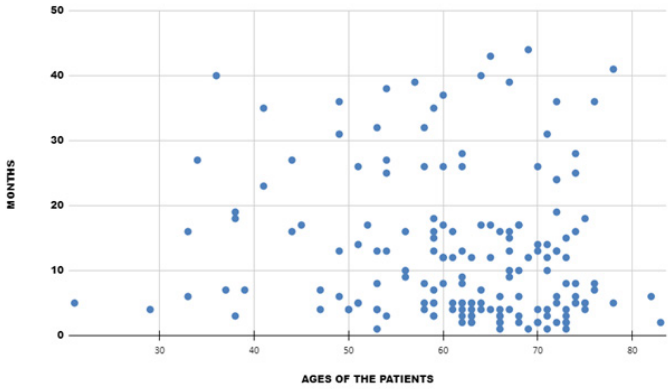


Figure 2: Active port usage time distribution graph by age groups (in months)

Analysis of the relationship between cancer type and port patency revealed that the highest patency time was 44 months in the bladder cancer group, followed by 35 months in the uterine cancer group. However, it is important to note that these groups represent a relatively small proportion of cancer types compared to the overall patient population, which limits their statistical significance owing to the low number of patients. Breast cancer exhibited the third-highest average active port usage time at 22.5 months, whereas rectal cancer, with an average of 17.04 months, provided more quantitatively significant data in terms of patient numbers.

Conversely, the group with ovarian and brain spinal cord malignancies displayed the lowest active port opening time. While some hematological cancers are associated with an increased risk of deep venous thrombosis and catheter embolism, there are no definitive data on port open time for specific cancer types, and clear information on this topic remains absent in the literature.

Over the 4-year follow-up period, 25% of the total patient cohort (43 patients) sadly passed away. Among these, 29 (26%) of 109 male patients and 14 (22%) of 62 female patients died during the study period. The mean duration of port use for these patients was 6.88 months, which was notably lower than the 14.4-month average observed in the patient group followed throughout the study. When transitioning from modeling port patency time to mortality risk analysis, we found significant correlations between mortality and the presence of vascular disease ($p = 0.03$), with hypertension displaying weaker significance ($p = 0.08$). Our study did not reveal any statistically significant associations between mortality and other factors such as cancer type, age, and sex. Among patients who died during the 4-year period, laryngeal malignancies exhibited the highest mortality rate (60%), followed by lung cancer (50%). Esophageal and pharyngeal cancers had the third highest mortality rate, averaging 33%. Notably, no mortality occurred in seven cancer types, including brain, bladder, and ovarian cancer.

Complications observed in port patients during the early period included pneumothorax due to lung tissue injury, hemothorax, ecchymosis, hematoma in the port pocket, catheter malposition, dysfunction due to vascular access issues, arrhythmias, cardiac injury, arteriovenous fistula formation, and phrenic nerve injury. Late complications include cutaneous subcutaneous tissue necrosis, catheter rupture, detachment, leakage and embolism, infection, sepsis, catheter occlusion, and inadequate retrograde flow during blood aspiration.

Discussion

In our study, we observed that mild-to-moderate infectious conditions improved with antibiotic therapy in 9 out of 171 patients (5%). Additionally, mild ecchymosis and hematoma in the port pocket were present in 6 patients (3%), but they did not affect port functionality. In two patients (1%), the port catheter had to be removed within one month due to severe infection. In one patient with a history of coronary bypass surgery, mild pneumothorax and subcutaneous emphysema developed, which was likely attributable to prior vascular interventions. Fortunately, the pneumothorax resolved during follow-up, without requiring a thoracic tube.

Two patients had their catheters removed 2-5 months later because of thrombosis, while one patient experienced leakage at the catheter site. Another patient developed a foreign body reaction in the late 5th month, leading to catheter removal. Importantly, we did not report any cases of hemothorax, nerve injury, significant hematoma compressing the neck, massive bleeding at the surgical site, port detachment, rupture, fragment

embolism, or sepsis. Notably, a study involving 550 patients over an 11-year period reported a thrombosis rate of 7.5%, with left-sided ports demonstrating the highest complication rate [9].

In a 2017 study involving 100 ports, the early infection rate was 4%, the late infection rate was 4%, and septic infections were recorded at 2% [10]. A comprehensive study conducted in 2022 comprising 4,480 patients reported symptomatic catheter thrombosis at a rate of 2.1%, with early and late temporary complications occurring at a rate of 20% [11].

In our study, we observed a serious infection rate of 1% in the early period. Port removal was necessary for 2 of 171 patients due to severe reactions and infections. In the late period, our thrombosis rate was 1%, affecting 2 patients. Among these, six patients (3%) required port catheter removal for various reasons, including infection, thrombosis, leakage, and foreign body reaction. Notably, one thrombosed patient and one infected patient underwent port catheter reinsertion 6-8 weeks later. The rate of catheter revision in our study was 1% among the three patients.

The psychological well-being of port patients is a crucial consideration, especially in surgical procedures performed under local anesthesia, where patients are fully conscious. Unlike surgeries in major surgical branches, where patients are often under general anesthesia with continuous vital sign monitoring, minor surgical procedures conducted under local anesthesia require careful attention to the patient's psychological comfort.

Recent research from 2021 demonstrated that patients who listened to their preferred relaxing music in the operating room experienced lower and more stable vital parameters, including reduced anxiety and stress levels, salivary cortisol measurements, blood pressure, and heart rate [12]. A similar study conducted in our country involving 100 port catheter patients confirmed the pain- and anxiety-reducing effects of music [13].

In our practice, we prioritize creating a calming atmosphere in the operating room. We informed patients about each step of the procedure, such as administering a narcotic injection or initiating the port chamber placement process. This approach has proven to be highly effective in preventing panic attacks and ensuring that patients remain calm and cooperative throughout the procedure, ultimately contributing to its successful completion.

While there have been reports of cases lasting up to four weeks and sometimes even up to four months with symptoms of flushing, redness, and heat sensations on the face and neck following port catheter placement, which can be uncomfortable for patients [14], we encountered a patient who experienced facial flushing for approximately two weeks. In this case, clinical signs, such as jugular fullness, redness, and edema, were not evident. Two weeks after the sutures were removed, the patient reported that the sensation had subsided, and upon reexamination, there were no signs of jugular fullness, edema, infection, or hematoma.

A recent publication from 2022 detailed an exceptionally rare case involving a 3-year-old pediatric patient in which the catheter had completely separated and fell into the right ventricle, with the other end extending into the pulmonary artery. Fortunately, the catheter was successfully removed via open-heart surgery [15]. Similar studies have discussed the complications related to catheter separation. It is noteworthy that in our patient cohort, we did not encounter any catastrophic complications such as embolism or catheter separation.

Percutaneous venous port catheters offer a significant advantage in addressing challenges associated with frequent and repetitive peripheral vascular access. They enhance the convenience of long-term drug infusion, parenteral nutrition, and blood test administration in patients undergoing extended chemotherapy and infusion therapy. Furthermore, they contribute to increased patient comfort and are preferred over external catheters because of their exceptionally low infection rates [16].

A recent cost-effectiveness analysis involving a substantial patient cohort revealed that venous catheters are more cost-effective during the initial 3-9 months of use. However, it is worth noting that port catheters have emerged as more cost-effective options during the 9-12 month period [4]. This underscores the importance of considering

the duration of treatment when selecting between the two options.

Our low rate of port thrombosis revisions can be attributed to our specific approach of exclusively using the internal jugular vein for surgical vascular interventions, with the right internal jugular vein being the preferred choice in 97% of the cases. Existing studies have consistently shown that subclavian veins carry a higher risk of thrombosis and occlusion compared to jugular veins [5, 6]. Therefore, in our patient cohort, we opted for port implantation solely through the internal jugular vein.

While femoral IPs have been found to be a safe option for breast cancer patients, their use in gastrointestinal cancers requires careful consideration [17]. Moreover, research has shown that the jugular vein has significantly lower infection rates compared to the femoral and subclavian sites [8]. Larger, prospective studies are necessary to validate the findings of the current study.

We believe that the low rates of infection and sepsis in our patients are consistent with these findings. This can be attributed to rigorous sterilization practices, standardization of sterilization protocols, meticulous surgical sepsis measures such as surgical antiseptic application, sterile covering, complete sterile surgical scrubbing by both nurses and surgeons, and thorough cleaning intervals of 30-45 minutes between each patient. Furthermore, we recommend that patients shower the night before the procedure, ensure the cleanliness of the chest and neck area, provide professional surgical nursing care following wound dressing, conduct daily wound care, and encourage early polyclinic follow-up. Prophylactic antibiotics were prescribed to every patient as an additional preventive measure.

Conclusions : The implantation of chemotherapy port catheters is a procedure that can be safely performed in cardiovascular surgery clinics with the requisite surgical expertise to minimize complications and effectively address potential major issues. Although there are inherent risks associated with the implantation process, it remains a highly secure surgical method that can be favored for patients scheduled for chemotherapy because of its long-term treatment benefits and enhanced patient convenience.

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Ethics Committee Approval: Balıkesir University Clinical Researh Ethics Committee approved this study (decision number: 2022/39, approval date: 09.03.2022)

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