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Risk factors for complications in cancer patients with totally implantable access ports: A retrospective study and review of the literature

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Abstract

Objectives: To analyze the risk factors for complications associated with the use of totally implantable access ports (TIAPs) in cancer patients.

Methods: Data for 2,713 cancer patients who received a TIAP between January 2010 and September 2016 at a single center were analyzed retrospectively.

Results: The average age of the patients was 54.2 ± 9.92 years, and 1,247 (47.5%) were women. The right subclavian vein was the preferred insertion site. Seventy-seven patients developed early complications and 50 developed late complications. The incidence of complications increased as the number of punctures increased. Percutaneous intervention increased the risk of complications during port insertion, but age, sex, body mass index, and the use of physiological saline solution instead of heparin for washing after port insertion did not increase the risk. The use of ultrasonography during insertion reduced the risk of complications.

Conclusions: Various factors may affect the function of TIAPs in cancer patients both during insertion and follow-up. Age, sex, body mass index, and the use of physiological saline solution for washing did not affect the incidence of complications, but the use of ultrasonography during insertion did affect the complication rate.

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Introduction

Cancer continues to be a significant health problem in Turkey and throughout the world, with approximately 200,000 people diagnosed with cancer in Turkey in 2013.[1] Recent additions of new chemotherapeutic agents have led to a corresponding increase in the use of intravenous medications and totally implantable access ports (TIAPs).[2,3] However, patients with cancer already undergo difficult processes that challenge the immune system, and port insertion is associated with additional problems both during and after insertion. These complications can be classified as either early complications (hemothorax, pneumothorax, arterial puncture, and hematoma) or late complications (infection, obstruction, and catheter fracture).[4,5]

This study aimed to analyze the complications associated with TIAP and the risk factors affecting these complications, and to compare the results of our experience in a single tertiary cancer center with data from the literature.

Patients and methods

Patients

We retrospectively evaluated data for 2713 patients who had TIAPs inserted at the Institute of Oncology, Surgical Oncology Unit, Istanbul University, between January 2010 and September 2017. Eighty-five patients with insufficient data were excluded from the study. The team performing the procedure consisted of general surgery specialists, and only ports inserted by surgeons with experience of at least 20 procedures and who had inserted at least 20 ports in the presence of an experienced surgeon were included in the study. Ports not inserted in our unit were excluded, even if the patient was followed up by our unit. All patients were followed up for at least 1 year.

This study was approved by the ethics committee of Istanbul University (form number: 423). All patients provided written informed consent for participation in the study.

Port insertion

In routine practice, we initially attempted catheter insertion via the subclavian vein (SCV) in all patients, followed by the use of other veins (jugularis externa, jugularis interna, brachial) only if SCV insertion was unsuccessful or if complications developed. Accordingly, complications in relation to the insertion site were not compared in our study.

Ultrasound-guided port insertion was the preferred technique, but anatomical landmarks could also be used to guide insertion. The anatomical landmarks were located and local anesthetic was applied to the puncture and pocket sites. After venous puncture with an 18G needle, a 0.088 mm J-tipped flexible wire was passed through the needle and the needle was then removed. An 8-F dilator was passed over the wire and the wire was then removed, and a 7.5-F catheter was then guided

through the dilator to the SCV and then to the cavoatrial junction. The catheter size was calculated by measuring the height of the patient and the size of the external surface of the thorax (range: 14–19 cm). The ports were placed in a tight subcutaneous pocket over the right pectoralis fascia, 2 cm under the clavicle, with holding sutures. The incision length was 2–4 cm. The proximal tip and the chamber of the catheter were connected by subcutaneous tunneling, and blood aspiration and saline injection were easily visible. After coagulation, surgical wounds were closed with 3/0 absorbable sutures, and the port was flushed with 10 mL of 0.9% sodium chloride at the end of the procedure. The location of the catheter tip was confirmed by an arrhythmia on electrocardiography and by the anatomical landmarks.

Real-time ultrasound guidance was performed using a 7.5-MHz superficial US probe (Toshiba Corp., Shimoishigami, Otawara-Shi, Tochigi-Ken, Japan). The surgical site was then sterilized with povidone–iodine solution, and the ultrasound probe was covered with a sterile cover and placed parallel to the infraclavicular site. The vein was distinguished from the artery by its lack of pulsation and compression-related diameter changes. The catheter and port were placed as described above, following local anesthesia and venipuncture.[6]

Complications

Pneumothorax, hemothorax, arterial puncture, hematoma, catheter malposition, and arrhythmia were regarded as early complications of TIAP insertion; i.e., complications that occurred during port insertion. Obstruction, deep vein thrombosis, local infection (redness, swelling, and purulent discharge at the port-insertion site), erosion (thinning of the skin over the port), opening of the incision for port insertion, and port rotation were regarded as late complications. Risks of individual complications were not analyzed in the current study.

Statistical analysis

Data were presented as the average and standard deviation, frequency, and percentage as appropriate, and the distribution of the variables was checked using the Kolmogorov–Smirnov test. Quantitative and qualitative data were analyzed using the independent samples *t*-test and Mann–Whitney U test, and χ^2 test, respectively. Pearson's or Spearman's correlation analysis was used, depending on the data distribution. Risk distribution was assessed by logistic regression analysis. Data analysis was carried out using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp., Armonk, NY, USA). A value of $P < 0.05$ was considered significant.

Results

The demographic data for all the patients is shown in Table 1. The 2,628 patients enrolled in the study included 1,247 women (47.5%) and 1,381 men (52.5%). The average age of the group was 54.2 ± 9.92 years (range 14 to 86 years). The average body mass index (BMI) was 26.01 ± 4.82 (range 12.65 to 57.3). Higher BMI was not associated with an increased incidence of complications ($P > 0.05$).

A total of 976 patients had colon cancer, 681 had upper gastrointestinal cancer, 292 had breast cancer, 448 had rectal cancer, and 231 patients had other cancers. Overall, 47 patients had comorbidities including hypertension, diabetes, asthma, chronic artery disease, arrhythmia, chronic obstructive pulmonary disease, and hypothyroidism. All patients were followed up for at least 1 year, and no patients died during the study.

Seventy-seven patients developed early complications and 50 developed late

Table 1. Risk factors in patients with and without complications.

	Complications		No Complications		
	n	%	n	%	*P*
Sex					
Female	66	5.3	1181	94.7	0.317
Male	61	4.4	1320	95.6	
Insertion method					
Anatomic landmark	65	5.9	1042	94.1	0.042
Ultrasound guidance	62	4.1	1459	95.9	
Number of punctures					
1	36	2.6	1342	97.4	<0.001
2	34	4.8	668	95.2	
3	20	6.1	310	93.9	
>3	37	17	181	83.0	
Port-washing method					
Heparin	89	5.2	1626	94.8	0.253
Physiological saline	38	4.2	875	95.8	

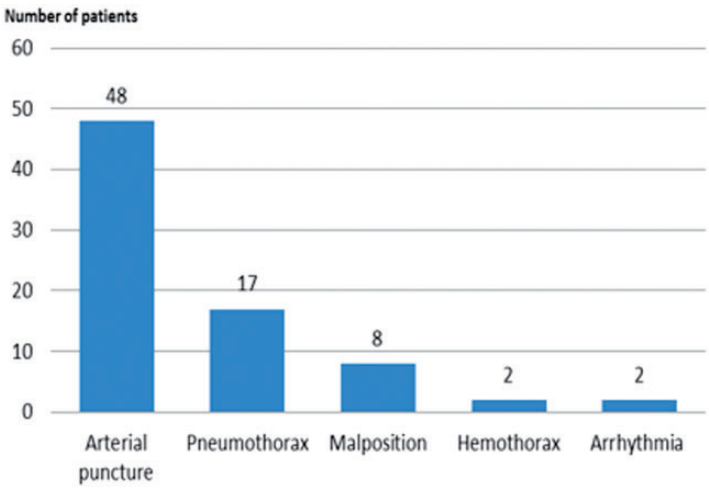

Figure 1. Early complications of totally implantable access ports in cancer patients.

complications. The most frequently observed early complication was arterial puncture (Figures 1 and 2). There was no significant relationship between the development of complications and age, sex, or port-washing method. The incidence of complications increased significantly as the number of punctures increased ($P < 0.001$). The use of anatomic landmarks rather than ultrasound during port insertion also increased the risk of complications ($P = 0.042$), but washing the port system

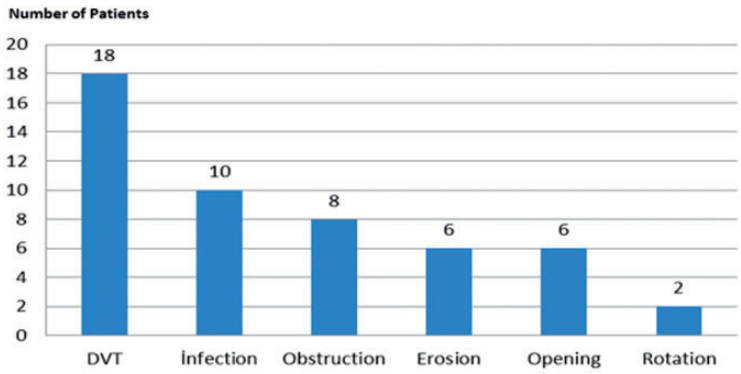

Figure 2. Late complications of totally implantable access ports in cancer patients. DVT, deep vein thrombosis.

Table 2. Patients who developed complications.

	Early complications		Late complications	
	n	%	N	%
Sex				
Female	33	42.9	33	66
Male	44	57.1	17	34
Insertion method				
Anatomic landmark	47	61	18	36
Ultrasound guidance	30	39	32	64
Number of punctures				
1	10	13	26	52
2	21	27.3	13	26
3	17	22.1	3	6
>3	29	37.7	8	16
Port-washing method				
Heparin	53	68.8	36	72
Physiological saline	24	31.2	14	28

with physiological saline instead of heparin did not lead to an increase in the risk of complications.

Among the patients who developed complications, male sex was a risk factor for developing early complications and female sex was a risk factor for developing late complications. In addition, having colon cancer and washing with heparin or physiological saline after port insertion did not represent risk factors for early or late complications, while port insertion using anatomic landmarks ($P = 0.007$) and increased number of punctures for insertion ($P < 0.001$) were risk factors for both early and late complications (Table 2).

Using veins other than the SCV for intervention also increased the risk of complications. Multivariate analysis in the logistic regression model showed that an increased

Table 3. Risk factors for complications: multivariate analysis - logistic regression model.

				95% Confidence interval	
		P	Hazard ratio	Lower	Upper
Compared with 1 puncture	2	0.003	2.170	1.306	3.606
	3	<0.001	3.364	1.818	6.226
	≥4	<0.001	9.631	5.388	17.213
Compared with ultrasound use	Percutaneous	0.035	1.468	1.027	2.098

number of punctures increased the risk of complications, while the use of ultrasonography decreased the risk (Table 3).

Discussion

Many studies have investigated the development of complications during or after TIAP insertion in patients with cancer; however, conflicting results have been obtained. For instance, some studies concluded that the rate of infections increased in older patients,[7,8] while others found no such correlation between infection rate and patient age.[9,10] Accordingly, the current study showed no significant correlation between patient age and complication rate.

Ting et al. showed that TIAPs were associated with more infectious complications in patients with hematologic malignancies compared with patients with solid tumors. They also demonstrated that using TIAPs for additional treatments, such as parenteral nutrition, increased the risk of complications.[11] In the current study, the inserted ports were only used to deliver chemotherapy and for drawing blood, and were not used to provide nutrition; however palliative care has recently gained importance in Turkey, and TIAPs are thus likely to be used for parenteral nutrition in the future. This may explain why the rate of infection-related complications in the present study was relatively low. Although some studies considered that higher BMI was a risk factor for complications,[12] other studies, including the current study, found no association between high BMI and an increased risk of complications.[13]

The risk of venous thromboembolism is four times greater in patients with cancer than in healthy people, and this discrepancy is increased up to six times in patients receiving chemotherapy.[14] Venous thromboembolism development rates also increased up to 60%. Catheter type, insertion site, catheter usage duration, cancer type, chemotherapy treatment frequency, and port usage for nutrition and drawing blood have all been analyzed as potential risk factors for complication.[15–17] The current results indicated that inserting the port in the SCV increased the risk of developing complications, while using physiological saline for washing instead of heparin did not increase the complication risk. This finding was consistent with previous data.[17]

Previous studies reported TIAP complication rates of 1.8% to 30.2%, which were consistent with the rate of 4.8% detected in the current study.[9–19] Although some studies indicated that insertion via the SCV was less risky,[20] many other studies conversely found that this route was more risky.[21] We did not analyze the effect of insertion route because we initially attempted entry via the SCV and only shifted to other veins if necessary. However, in routine

practice, we observed fewer complications with points of entry other than the SCV.

TIAP insertion under ultrasound guidance reduced the risk of complications.[13] In addition, we found that significantly fewer complications developed in patients whose TIAP insertions were performed under ultrasound guidance and with fewer punctures. The complication rates for ports inserted by radiologists ranged from 6.6% to 14%;[22–25] however, because these insertions were performed under ultrasound guidance, the pneumothorax rate was zero. One previous study reported that the complication rate decreased with increasing experience of the surgeon.[25] We did not analyze the effect of differences in experience in the present study, because only ports inserted by individuals with a certain level of experience were included. Although surgeons have recently started to insert ports under ultrasound guidance, we believe that a certain level of training and experience is required for this procedure.

The current study had some limitations. It was not designed as a randomized, controlled study, and it did not investigate the effects of some factors that might affect port complications, such as the chemotherapy regimen used, whether the port was used for taking blood samples, and the use of additional treatment products. However, the study aimed to shed light on recent discussions in the field by using a large number of patients and prospective data collected from a single center.

In conclusion, TIAPs continue to be a significant tool for the treatment of patients with cancer, but functionality during insertion and follow-up is affected by many factors. The current study concluded that the risk of developing complications was not affected by patient age, sex, BMI, or the use of physiological saline for washing, but ultrasound guidance during insertion did affect the risk of complications.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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