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Totally implantable venous access devices: A fifteen-year single-center experience

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ABSTRACT

Objectives: Totally implantable venous access devices (TIVADs) are frequently used in cancer patients, offering significant comfort and advantages. This study aims to evaluate the outcomes of patients who underwent port catheter placement.

Methods: Data from 3,774 patients who underwent venous port catheter placement between 2007 and 2022 were reviewed. Demographic information, primary diagnoses, port placement locations, number of punctures, complications, and reasons for removal were recorded.

Results: The median age of the patients was 54 years (range: 18-86 years). Catheters were placed on the right side in 3,667 patients (97.2%). The most commonly used vessel was the right subclavian vein, accessed in 2,494 patients (66.1%). Complication rates were observed as follows: femoral vein (40%), brachial vein (20%), subclavian vein (12.1%), internal jugular vein (9.9%), and external jugular vein (6.5%). The complication rate following a single puncture was 7.4%, compared to 16.1% for multiple punctures, showing a significant increase with the number of punctures (P=0.03). The most common early complication in 142 (3.8%) patients was arterial puncture with bleeding or hematoma, while the most common late complication was catheter infection of 1.4% (n=54).

Conclusions: Venous port catheter placement is generally safe, with the right subclavian vein being the most commonly used site. Ultrasound-guided placement reduces complications, which are more frequent with multiple punctures and left-side placements. Early complications like arterial puncture were more common, while late complications were primarily catheter infection.

Keywords: Totally implantable venous access devices, port catheter, subclavian vein

Cancer continues to be increasingly prevalent worldwide and in our country, and according to 2018 data, the cancer incidence in Turkey is 48.6 per hundred thousand [1]. These patients require a suitable intravenous route for many procedures such as getting rid of the irritating effect of the cytotoxic agents used in treating peripheral vessels, blood transfusion, and infection treatment. This pathway should be easily accessible and safe at the same time. Totally implantable venous access devices (TIVAD), or ports, have been used in the treatment of oncological patients since 1982 [2] when they were first used. These devices are preferred because they are long-lasting, easy to maintain, provide high patient comfort, and are

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cost-effective in the long term [3]. It offers significant advantages in managing chemotherapy, blood transfusion, fluid therapy, and other intravenous applications by providing vascular access safely and effectively [4]. However, as with any medical intervention, the use of a venous port catheter (VPC) carries potential risks, and it is important to understand and manage these risks properly.

This study is crucial for evaluating the effectiveness of VPC in cancer patients and understanding the possible risks and complications during the placement and use processes. Our aim is to retrospectively examine the prospectively collected data of patients who had port catheters inserted by a team experienced in cancer treatment and to share the long-term results in light of the literature.

METHODS

The data of 4,739 patients who received treatment for cancer and underwent VPC between 2007 and 2022 in Istanbul University Institute of Oncology, Oncological Surgery Unit were retrospectively analyzed through the file and electronic database. A total of 3,774 patients were included in the study after excluding 12 patients under the age of 18, 212 patients with missing data, 328 patients who died in less than a year, 226 patients who could not communicate, and 187 patients who had a port inserted using the open method.

Demographic information, diagnoses, anatomical location of the port catheter, total number of venous access, arterial puncture, and early and late complications were recorded. The successful procedure was defined as the catheter being in the appropriate anatomical position in the radiological evaluation, blood coming out with aspiration, and the infusion is performed without any problems. Successful venous puncture was defined as the venous blood coming out easily when the vein was entered percutaneously with a syringe. The total number of punctures was recorded.

Complications during catheter insertion were determined as events (allergy, methemoglobinemia) against the local anesthetic drug, arterial puncture and associated hematoma, bleeding, persistent cardiac arrhythmia, and pneumo-hemothorax detected in post-procedure control imaging. Early complications were wound infection, wound dehiscence, pneumothorax (Px), malposition, catheter dysfunction, arrhythmia, methemoglobinemia due to local anesthesia, and late complications were catheter infection, deep vein thrombosis (DVT), catheter occlusion, migration, skin necrosis, and malfunction. Complications seen within 30 days after port catheter placement were evaluated as early complications and complications seen afterward were evaluated as late complications. All results were evaluated by comparing them with the literature data.

Patient Preparation

Patients applied with a letter requesting the insertion of a venous port catheter, issued by the oncologist who performed their medical follow-up. All patients were evaluated before the procedure by a full-time anesthesiologist in our unit. Posterior-anterior (PA) chest X-ray, complete blood count, blood electrolytes, acute phase reactants, and coagulation factors were examined before and after the application. Attention was paid to ensuring that the platelet count was 50.000/mm3 and above, the hemoglobin level was preferably 9 g/dL and above, the coagulation factors were within normal limits, and there was no examination finding or laboratory value suggestive of acute infection. Patients with detected problems in their values were treated after the appropriate treatment given by their own physicians. Before the procedure, all patients were informed, and written informed consent was obtained. The ethics committee approval for the study was obtained from the Istanbul Faculty of Medicine Ethics Committee Unit on 03.09.2024 with number 2834775.

All procedures were performed in the operating room. A fasting period of at least 6 hours was requested before the procedure to provide general anesthesia against possible acute problems and when necessary. Patients were monitored by the anesthesia team, blood pressure and oxygen saturation were monitored, and peripheral vascular access was established. The electrocautery device plate was placed on the patient so that it was on the same side as the surgical site. Patients with cardiac pacemakers were identified before the procedure, and bipolar cautery was used throughout the procedure.

When necessary, skin shaving of the patients was performed using a machine in the operating room. The patients were positioned in the Trendelenburg position

at a 10-15-degree angle. In cases where visualization of the venous vessel by ultrasonography was difficult due to dehydration, a better image was achieved by administering a 1,000 cc saline infusion. The ultrasound device was positioned on the side where the procedure was not performed, ensuring that the physician could easily view it. When the catheter was planned to be inserted through the jugular vein, pillows were placed under the lower part of the neck and/or the interscapular area to achieve a 45-degree extension of the patient's neck. Since 2012, all procedures have been routinely performed under ultrasound guidance.

The area where the port catheter would be inserted was cleaned with povidone-iodine and then closed with a sterile drape. The ultrasound probe was covered with a sterile sheath. Since the application was relatively easier and more comfortable for the patient, the right subclavian vein was preferred primarily. In case of failure, the following vessels were preferred: left subclavian, right-left external or internal jugular vein, and right-left femoral vein. Especially in patients who underwent mastectomy due to breast cancer and whose treatment was ongoing, the contralateral subclavian vein was preferred, and in patients with bilateral mastectomy and especially if radiotherapy was to be given during treatment, the right-left jugular or femoral vein was preferred. Polysite (Perouse Laboratories, France), Celsite ST301 (Braun, FB Medical, France), and Bard (Bard Access Systems Inc., Salt Lake City, USA) brand products were used at various times as port catheters.

Placement of Port Catheter

A total of 15-20 cc of 2% prilocaine hydrochloride (Citanest, AstraZeneca, Istanbul, Turkey) was applied to the area where the catheter would be inserted and the reservoir would be placed, providing local anesthesia. Port placement under the guidance of anatomical signs without the use of ultrasound was defined as a "Conventional pathway". After visualizing the relevant vein using a 7.5 MHz superficial ultrasound probe (Toshiba Corp., Shimoishigami, Otawara-Shi, Tochigi-Ken, Japan), the vein was entered by aspirating the syringe with an 18G needle. The guidewire was passed through the needle and advanced through the superior vena cava into the right atrium. During this process, the arrhythmia detected on the monitor was observed, and the catheter was retracted and left close to the junction of the vena cava and right atrium (Cava-atrial junction). The resolution of the arrhythmia indicated that the catheter tip was in the correct position (if no arrhythmia, abnormal position is suspected, or repositioning of the catheter is considered, the patient was taken to the Radiation Oncology unit's operating room, and the catheter was checked to be in the anatomically appropriate place by fluoroscopy). Then, an 8/9F dilator was placed over the guidewire, and under its guidance, a 7.5/8F port catheter was positioned. Two incisions were made, one for the catheter insertion site (small incision) and the other (larger incision) for the reservoir pocket. The catheter was tunneled subcutaneously from the smaller to the larger incision. The catheter was fixed at the cava-atrial junction at approximately 17-20 cm, depending on the patient's height and entry site.

The reservoir was placed in a prepared pocket in the upper part of the pectoralis major muscle, 2 cm distally to the puncture site, with a 2-4 cm skin incision. It was then connected and secured to the catheter. The presence of blood flow from the reservoir was checked, and it was flushed with 10 cc of saline. Until 2015, heparinized saline was used as the flushing solution, but since then, only saline has been used based on our study [5]. To prevent the reservoir from rotating, fixation stitches were placed on both sides using 3/0 Prolene. The subcutaneous tissue, skin, and puncture site were closed with 3/0 Monocryl sutures.

Post-procedure, a PA and lateral chest X-ray were performed for control purposes. Patients with catheter misplacement were transferred to another room with fluoroscopy, where the malposition was corrected. During the procedure, 1 gram of cefazolin sodium was used for prophylaxis, and based on our study from 2011, prophylaxis was not routinely performed afterward [6]. In high-risk patients such as those with neutropenia, prophylaxis was continued. Port catheters were placed by general surgeons (HK, SB, BK, BI), anesthesia specialists (IY), and plastic surgery specialists (SK), each of whom performed at least 50 port catheter placements per year.

Statistical Analysis

Normally distributed variables were given as mean and standard deviation, frequency and percentage, and the distribution of variables was checked

using the Kolmogorov-Smirnov test. Variables that did not show normal distribution were presented as median (min-max). Risk distribution was evaluated by logistic regression analysis. The chi-square test was used to compare independent groups with categorical variables. Data analysis was performed using the IBM SPSS Statistics for Windows, Version 19.0 (IBM-Corp., Armonk, NY, USA). A P-value ≤0.05 was accepted as statistically significant.

RESULTS

Patient Characteristics

The median age of the patients was 54 years (range: 18-86 years). Of the patients, 2,030 (53.8%) were male, and 1,744 (46.2%) were female. The mean body mass index (BMI) was 25.1±5.1 kg/m2. Higher BMI was not associated with an increased complication rate (P=0.43). Based on anesthesia evaluations, the majority of patients had an ASA II score of 54.4% (n=2,053). There was no significant difference between complications and ASA scores (P=0.38).

Of the patients, 1,298 (34.4%) were diagnosed with colorectal cancer, 1,023 (27.1%) with lung cancer, 419 (11.1%) with cancers of the upper gastrointestinal tract, 279 (7.4%) with cancers of the hepatopancreatobiliary system, and 245 (6.5%) with breast cancer. Patients' demographic findings are shown in Table 1.

Port Placement Locations

All but seven (0.19%) of the port catheters were placed for malignancy and chemotherapy treatment. A total of 132 (3.5%) procedures were performed under intravenous (IV) sedation combined with local anesthesia due to patient requests or medical conditions that were not suitable for local anesthesia alone, while the remaining procedures were performed under local anesthesia only. While the catheter was placed on the right in 3,667 (97.2%) patients, it was placed on the left side in 107 (2.8%) patients, which was statistically significant in terms of complications (P=0.001). The most preferred vein was the right subclavian vein in 2,494 (66.1%) patients. Right jugular interna was preferred in 961 (25.5%), right jugular externa in 196 (5.2%), right femoral in 11 (0.29%), and right brachial vein in five (0.13%) patients. Using anatomical markers, port catheters were placed in 45.4% (n=1,714) of the patients conventionally and in 54.6% (n=2,060) of the patients with ultrasound guidance. Antibiotic prophylaxis was administered to 2,061 (54.6%) patients, while it was not administered to 1,713 (45.4%) patients. Port flushing was predominantly performed with a normal saline (NS) + Heparin (100 U/mL) solution in 60.5% (n=2,283) patients, while it was performed with only NS in 39.5% (n=1,491) of patients (Table 1). During the follow-up, all patients were advised to come to our unit to have the port flushed with 10 cc NS after each use (medication, parenteral nutrition, blood collection, etc.) or every two months when not in use.

Complications

While 11.3% (n=427) of the patients had complications, 88.7% (n=3,347) in the whole patient group had no complications, The highest complication rates were seen after application from the femoral, brachial, subclavian and jugularis internal veins, respectively (40%, 20%, 12.1%, 9.9%). The least complication was observed after the procedures performed from the jugularis external vein with 14/215 (6.5%).

The number of successful procedures was 2,079 (55.1%) in a single puncture and 1,695 (44.9%) with more than one puncture. Additionally, the complication rate after a single puncture was 7.4%, while the rate was 16.2% in multiple punctures, and the frequency of complications increased significantly with the increase in the number of punctures (P=0.03).

While the complication rate was 12.4% when prophylactic antibiotics were not used during the procedure, it was 10.1% when used, but there was no statistical difference between antibiotic use and complication development (P=0.64).

When ultrasound was used during port insertion, the complication rate was 5.6%, while the complication rate after conventional insertion using anatomical markers was 18.1% and was statistically significant (P=0.024). In other words, the use of conventional route was one of the factors that increased the frequency of complications. However, flushing the port system with physiological serum instead of heparin solution after the procedure did not increase the risk of complications (P=0.82) (Table 1).

The early complication rate was 6.7% (n=252), while the late complication rate was 4.6% (n=175).

Table 1. Demographic information and port catheter procedure characteristics

n (%)	Overall 3.774 (100)	Complication (-) 3.347 (88.7)	Complication (+) 427 (11.3)	P value
Male, n (%)	2.030 (53.8)	1.785 (47.3)	245 (6.5)	0.37
Female, n (%)	1.744 (46.2)	1.562 (41.4)	182 (4.8)	
Age (years) (median, range)	54 (18- 86)	54 (18-83)	53 (20-86)	0.56
BMI (kg/m^2) (mean±SD)	25.1 (±5.1)	25.7 (±5.2)	24.3 (±5.4)	0.43
ASA I, n (%)	864 (22.9)	712 (18.8)	152 (4.1)	0.38
ASA II, n (%)	2.053 (54.4)	1.904 (50.5)	149 (3.9)	
ASA III, n (%)	857 (22.7)	731 (19.4)	126 (3.3)	
Colorectal Ca, n (%)	1.298 (34.4)	1.129 (30)	169 (4.4)	0.23
Lung Ca, n (%)	1.023 (27.1)	948 (25)	75 (2.1)	
Upper GIS Ca, n (%)	419 (11.1)	382 (10.1)	37 (1)	
Hepatopancreatobiliary Ca, n (%)	279 (7.4)	248 (6.6)	31 (0.8)	
Breast Ca, n (%)	245 (6.5)	210 (5.6)	35 (0.9)	
Hematological Ca, n (%)	230 (6.1)	198 (5.3)	32 (0.8)	
Gynecological Ca, n (%)	174 (4.6)	148 (3.9)	26 (0.7)	
Others, n (%)	106 (2.8)	84 (2.2)	22 (0.6)	
Right side, n (%)	3.667 (97.2)	3.281 (87)	386 (10.2)	**0.001**
Left side, n (%)	107 (2.8)	66 (1.7)	41 (1.1)	
Subclavian, n (%)	2.543 (67.4)	2.236 (59.3)	307 (8.1)	
Right	2.494 (66.1)	2.191 (58.1)	303 (8)	0.38
Left	49 (1.3)	45 (1.2)	4 (0.11)	
Internal Jugular, n (%)	996 (26.4)	897 (23.8)	99 (2.8)	
Right	961 (25.5)	868 (23)	93 (2.5)	**0.017**
Left	35 (0.93)	29 (0.77)	6 (0.16)	
External Jugular, n (%)	215 (5.7)	201 (5.3)	14 (0.4)	
Right	196 (5.2)	187 (4.9)	9 (0.23)	0.42
Left	19 (0.53)	14 (0.4)	5 (0.13)	
Femoral, n (%)	15 (0.39)	9 (0.23)	6 (0.16)	
Right	11 (0.29)	7 (0.18)	4 (0.11)	0.76
Left	4 (0.1)	2 (0.05)	2 (0.05)	
Brachial, n (%)	5 (0.13)	4 (0.11)	1 (0.02)	0.78
Number of Punctures, n (%)				
1	2.079 (55.1)	1.925 (51)	154 (4.1) *7,4	**0.03**
≥ 2	1.695 (44.9)	1.422 (37.7)	273 (7.2) *16,2	
Prophylactic Ab, none, n (%)	2.061 (54.6)	1.806 (47.9)	255 (6.7) *12,4	0.64
Prophylactic Ab, yes, n (%)	1.713 (45.4)	1.541 (40.8)	172 (4.6) *10,1	
Convantional method, n (%)	1.714 (45.4)	1.403 (37.2)	311 (8.2) *18.1	**0.024**
Ultrasound-Guided, n (%)	2.060 (54.6)	1.944 (51.5)	116 (3.1) *5,6	
Heparin + NS, n (%)	2.283 (60.5)	2.081 (55.2)	202 (5.3) *8,8	0.82
NS, n (%)	1.491 (39.5)	1.266 (33.5)	225 (6) *15.1	

SD=Standard Deviation, Ab=Antibiotic, BMI=Body mass index, USG=Ultrasonography, NS=Normal saline, Ca=Cancer, ASA=American society of anesthesiologists, *Complication rate within the group

Table 2. Early and late complications

n= 427 (11.3%)	Early Complications n= 252 (6.7%)		P value	Late Complications n= 175 (4.6%)		P value
	n	%		n	%	
Gender						
Male	144	57.1	0.12	90	51.6	0.38
Female	108	42.9		85	48.4	
Venous Access Method						
Conventional	155	61.5	**0.004**	78	44.7	0.16
Ultrasound-Guided	97	38.5		97	55.3	
Number of Punctures						
1	101	40.1	**0.012**	77	43.8	0.08
≥2	151	59.9		98	56.2	
Port Flushing Method						
Heparin +	110	43.5	0.07	82	47.1	0.18
Normal Saline	142	56.5		93	52.9	

Both early (57.1%) and late complications (51.6%) were higher in the male gender but were not statistically significant (P=0.38). In the procedures performed with the conventional method, early complications were observed at a higher rate than those performed with ultrasound guidance and were statistically significant (P=0.004), while there was no significant difference in terms of late complications (P=0.16). When evaluated according to the number of punctures, it was statistically significant that both early (P=0.012) and late complications (P=0.08) were seen as the number of punctures increased. There was no statistical difference between early (P=0.07) and late (P=0.18) complications in terms of port flushing method (Table 2).

The most common early complication, occurring in n=142 (3.8%), was arterial puncture with possible bleeding or hematoma due to the procedure. The common characteristic of these patients was that most were on anticoagulant therapy. Although no patient required surgery due to bleeding, port removal was performed in eight patients due to infection secondary to bleeding. The second most frequent early complication, seen in n=46 (1.2%) patients, was malposition, and revision was performed on the same day for all patients in whom this condition was detected. The least common early complication was methemoglobinemia with a rate of 0.08% (n=3). While one patient with this condition recovered with conservative follow-up, two patients were hospitalized for one day due to nausea and vomiting and a decrease in oxygen saturation in room air (<80 mmHg) and discharged with recovery. Pneumo and/or hemothorax were seen in 0.7% (n=28) of the patients. Since two of these patients had less than 5% pneumothorax, the mask was conservatively followed up with oxygen and bronchodilator treatment and discharged without any problems, while 26 patients were hospitalized with closed thoracic tube drainage. No complications developed during hospitalization and all patients were discharged without any problems. Permanent cardiac arrhythmia requiring procedural intervention developed in n=12 (0.3%) patients. Patients recovered without any problems with anti-arrhythmic treatment by the anesthesiologist without the need for catheter removal. Only one patient's arrhythmia could not be controlled with the treatment applied in the operating room and was admitted to the Cardiology Arrhythmia Intensive Care Unit and was followed up and discharged two days later without any problems.

The most common late complication was catheter infection of 1.4% (n=54). These patients were con-

Table 3. Causes and outcomes of complications

Complications	n	%	% Overall	Outcomes
Early Complications	252	100	6.7	
Arterial puncture +/- Hematoma	142	56.3	3.8	Eight patients' ports were **removed***
Malposition	46	17.7	1.2	Revision was done on the same day
Pneumothorax +/- Hemothorax	28	11.1	0.7	Two patients were monitored 26 patients had chest tubes inserted
Arrhythmia (requiring intervention)	12	4.7	0.3	One patient was monitored in the intensive care unit for arrhytmia
Methemoglobinemia	3	1.3	0.08	One patient stayed in the hospital for one day
Other (Persistent pain, patient request, wound dehiscence	21	8.3	0.6	Five ports were **removed**
Number of removed ports	13	5.6	0.34	
Late Complications	175	100	4.6	
Catheter infection	54	30.9	1.4	44 patients' port were **removed**
Deep vein thrombosis	48	27.4	1.3	All patients' ports were removed after antithrombotic treatment
Reservoir malrotation	29	16.5	0.8	21 patients had their port corrected surgically Eight patients had their port corrected manually
Malfunction	20	11.4	0.5	15 patients had their port **removed.**
Skin necrosis	14	8.1	0.4	Nine patients underwent wound debridement Five patients had their port **removed****
Other*** (Seroma, wound dehiscence, migration)	10	5.7	0.3	Three patients had their port **removed** Seven patients' ports were revised
Number of removed ports	115	6.6	3.04	

*Due to infection secondary to bleeding

**Due to chemical burn and necrosis caused by chemotherapeutic drug extravasation

***Requiring intervention

sulted with infectious diseases. Catheters were removed in 44 patients who had pathogenic microorganism growth in blood cultures taken from the catheter and peripheral vein and who did not respond to treatment. In ten patients with no bacterial growth, who responded well to treatment or had no growth in two consecutive blood cultures after treatment, the catheter was not removed. DVT, a serious complication, was the second most common (n=48, 1.3%). The level of thrombosis was determined by Doppler ultrasonography and anti-thrombotic treatment was organized by the Cardiovascular Surgery Unit. After the treatment, the catheters of all patients were removed. The third most common complication was reservoir malrotation (n=29, 0.8%). In 21 of these patients, a second procedure was performed to reposition the reservoir and it was observed that the reservoir was not fixed with sutures. The catheters of eight patients were manually corrected in the outpatient clinic. The least common complication was seroma, wound dehiscence, and catheter tip migration, which required intervention and were seen at a rate of 0.3%. Fourteen (0.4%) patients developed partial skin necrosis due to drug extravasation, and improvement was achieved with debridement

and dressings. However, catheter was removed in five patients due to secondary infection that did not respond to treatment (Table 3).

DISCUSSION

Complications occurred in 11.3% (n=427) of 3,774 patients who underwent permanent central venous port catheterization with a minimum follow-up period of one year. We found that age, gender, ASA score, body mass index, prophylactic antibiotic use, and use of physiological saline for port flushing did not increase the risk of complications, while using conventional methods instead of ultrasound during the procedure (P=0.024), performing procedures on the left side (P=0.017), and performing more than one puncture (P=0.03) were factors that increased complication rates.

Permanent central venous port catheters are widely used, especially in cancer patients who experience difficulty finding vascular access or require long-term intravenous treatment [7]. Although the use of these catheters offers several advantages, the implantation process and the post-implantation period can lead to some undesired situations. The use of ultrasound guidance during port insertion is likely to be beneficial in reducing complication rates [8].

The most common early complication in our study was arterial puncture and/or hematoma (n=142, 3.8%). This rate was consistent with the studies in the literature [9, 10]. Eight patients who developed a secondary infection due to hematoma, which did not respond to treatment, required port removal.

When deciding on the veins for port catheter placement, several factors must be considered. Different veins such as the subclavian, jugular, and cephalic veins each have distinct advantages and disadvantages. The selection of each vein type depends on the patient's general health status, surgical history, vascular anatomy, and intended use of the catheter [11]. The preference for the subclavian vein is typically due to its short distance to the vena cava and right atrium; however, potential complications such as the risk of pneumothorax must be considered. The jugular vein, on the other hand, follows a relatively straight path, which can make catheter placement easier. The risk of pneumothorax is not as high as that of the subclavian vein. During surgical intervention, if the neck region is involved, the segment of the catheter passing through the subcutaneous tunnel may bulge over time and become visible with neck movements, potentially impacting the patient's quality of life. Although the risk of hemothorax and/or pneumothorax is reported in the literature to range from 1.5% to 4.7% [12-14] it is closely associated with the surgeon's level of experience. In our study, the pneumothorax rate (0.7%) was relatively lower than the literature, as the port catheter was placed by specialist physicians who performed at least 50 or more successful procedures per year. Another factor contributing to its low occurrence rate is that procedures have been performed with ultrasound guidance since 2012. In a recently published meta-analysis [15] evaluating 130 studies, it was reported that ultrasound-guided port placement reduced both arterial puncture (risk ratio [RR], 0.20; 95% credible interval [CrI], 0.09-0.44; 13.5 events vs. 68.8 events/1000 catheters) and pneumothorax (RR, 0.25; 95% CrI, 0.08-0.80; 2.4 events vs. 9.9 events/1000 catheters). The right subclavian vein was used as the primary vein choice due to patient comfort. If success was not achieved after several punctures, the right jugular vein was preferred instead of insisting. Three of the 28 patients who developed pneumothorax were followed conservatively because they had less than 5% Px, while 26 patients were hospitalized with closed thoracic tube drainage and were discharged without any problems after hospitalization.

In our study, the port was localized toward the cava-atrial junction, which was confirmed by observing cardiac arrhythmia on the monitor. The catheter tip was retracted and fixed at the cava-atrial junction. Twelve patients with persistent arrhythmia (sinus tachycardia, ventricular extrasystole) were treated with lidocaine, beta blocker, or calcium channel blockers by the anesthesia team. Only one patient was taken to the Cardiology Arrhythmia Intensive Care Unit and monitored because the arrhythmia continued. If no arrhythmia was present, but there was uncertainty about the correct placement of the port, the issue was resolved by transferring the patient to the operating room with a fluoroscopy. The rate of arrhythmia was 0.3% and it was consistent with the studies in the literature [16].

The least common early complication was methemoglobinemia, observed in three patients (0.08%). Local anesthetic reactions occurred in one patient

(0.04%), characterized by reduced oxygen saturation (room air sO_2=82-90 mmHg), while another patient (0.04%) experienced nausea, vomiting, and cyanosis (room air sO_2=78-86 mmHg). In both patients, the maximum methemoglobin levels in blood gas analysis were measured as 10% and 12%. One patient was hospitalized and monitored with oxygen therapy; by the following day, the methemoglobin level had decreased to <2% and the patient was discharged. The other patient was discharged on the same day after an uneventful follow-up with oxygen therapy via mask. None of the patients required antidotes such as methylene blue.

Among the late complications, DVT was seen in 48 (1.3%) patients. Most of these patients had a history of extravasation during the administration of chemotherapy or failure to regularly flush the port after use. In addition, none of them had anti-coagulant agents in their routine treatment. Only four patients were using anti-aggregates. The port catheter was removed in all patients at the end of antithrombotic treatment. The rate of thrombosis was consistent with the literature [17-19]. In a group of 1,586 patients with breast cancer, catheter-related thrombosis was reported in 96 patients (6.1%). The authors indicated that the location of catheter placement (P=0.004), catheter size (P<0.001), and catheter dwell time (P < 0.001) were significant factors associated with thrombotic occlusion [20].

In a study of 799 cancer patients, the rate of catheter-related infection was 2.1% [21]. In a recent study, the infection rate was reported to be 5.1%, with the rate of port catheter removal due to infection at 0.85% [22]. In our study, the infection rate was 1.4% (n=54) across the entire group. Among patients with bacterial growth in blood cultures, the catheter was removed in 44 cases based on the recommendation of infectious disease specialists. In contrast, catheter removal was not required in 10 patients without bacterial growth.

Reservoir malrotation was observed in 29 (0.8%) patients. The reasons for catheter complications, particularly in obese patients, were the wide opening of the reservoir pocket, the loss of subcutaneous fat in weight loss patients causing an enlargement of the pocket, and the failure of fixation stitches.

A less common complication, skin necrosis (0.4%), was primarily caused by extravasation of the chemotherapeutic drug during administration. Additionally, in patients with a small distance between the reservoir and the skin, the port needle eroded the skin during reservoir access. These patients were treated with debridement and dressing, although the port had to be removed in five patients (0.1%).

Among the 427 patients who developed complications after PCVC insertion, 30.1% (n=128) required port removal. When considering the entire patient group, the rate of port removal was 3.4% (n=128/3,774), which aligns with findings in the literature.

Limitations

The limitations of our study include its retrospective design, single-center nature, and the absence of a control group.

CONCLUSION

A large sample size reduces the margin of error and increases the accuracy of estimates, thereby enhancing the reliability of the study findings. Furthermore, a study with sufficient power is crucial for generalizability, as it ensures that the results represent the target population. In this context, our study is one of the largest reported to date, focusing exclusively on cancer patients. The findings demonstrated that positioning the port on the left side, performing multiple punctures, and using conventional methods instead of ultrasound guidance significantly increased the risk of complications. Furthermore, when performed by experienced practitioners and followed by appropriate post-procedural care, venous port catheter placement under ultrasound guidance is a highly comfortable and safe procedure for cancer patients.

Ethics Statement

The ethics committee approval for the study was obtained from the Istanbul Faculty of Medicine Ethics Committee Unit on 03.09.2024 with number 2834775.

Authors' Contribution

Study Conception: BK; Study Design: BK; Supervision: BK; Funding: BI; Materials: BK; Data Collection and/or Processing: BK; Statistical Analysis and/or

Data Interpretation: BI; Literature Review: BI; Manuscript Preparation: BK and Critical Review: HK.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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