

Evaluation of the removal reasons of totally implantable venous devices in children: a retrospective study

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Received: 1 March 2016, Accepted: 31 May 2016

SUMMARY: Kılıç S, Soyer T, Karnak İ, Çiftçi AÖ, Tanyel FC, Şenocak ME. Evaluation of the removal reasons of totally implantable venous devices in children: a retrospective study. Turk J Pediatr 2016; 58: 187-194.

Totally implantable venous access devices (TIVADs) increase the quality of life in children with hematologic and oncologic diseases or organ failures. The aim of this study is to determine the reasons for port removal. The port catheters, implanted and removed in patients between January 2000 and June 2013 were evaluated retrospectively. The patients were divided into two groups, whose port catheters were removed due to completed therapy (completed therapy group, CTG) and whose port catheters were removed because of a port catheter-related complications (complication group, CG). In the CG, the patients whose port catheters are removed for infectious reasons are investigated for whether there is a relationship with age, gender, body mass index (BMI), height and weight at the time of port implantation and removal. In total, 242 patients who underwent port implantation and removal were included in the study. The male to female ratio was 1.32/1 and the mean age of the patients was 9.4 ± 4.9 years (0-24 year). Patients were enrolled in CTG (n=170, 70.2%), and CG (n=72, 29%). There is a positive correlation between BMI and infections ($p < 0.05$). In the CG, patients under steroid treatment had higher incidence of non-infectious causes than infectious causes ($p < 0.05$). Oppositely, non infectious complications were higher in steroid free patients ($p < 0.05$). There was no catheter related mortality in the entire study group.

The hematological malignancies and solid tumors are the most common underlying primary disease in patients with port removal because of complications. Infectious complications are most common cause of port removal in children and despite other microorganism, fungi should be considered as a cause of catheter related infections.

Key words: totally implantable venous catheter, children, cancer, infection, port.

Totally implantable venous access devices (TIVADs) improve the quality of life and healthcare services provided to patients with cancer because they allow long term intravenous (IV) access for chemotherapy, antibiotherapy, blood transfusion and so on. In addition, they have an advantage for venous blood sampling without having to puncture the vein repetitively. Their usage has been accepted widely, especially since 1980s, and they are preferred over central venous catheters in oncologic patients receiving chemotherapy.

Due to easy access for IV line, port catheters improve the quality of treatment and patient adaptation in oncologic patients¹⁻³. However, like the other central venous routes, port catheters have some early and late term complications. Some of these complications may sometimes become more severe than the primary disease itself. The complications related to procedure are pneumothorax, hemothorax, air embolism, arterial puncture, arrhythmia, pericardial tamponade and brachial plexus injury⁴⁻⁶. The short term complications after the procedure include hemoptysis, hematoma

in the port implantation site, dehiscence of the incision^{7,8}; whereas late complications include catheter related infections, thrombosis of the catheter, tear and transection of the catheter, 'pinch-off' syndrome, relocation of the catheter tip, embolization due to catheter, extravasations of the given medications, slipping of the catheter, erosion and/or perforation of superior vena cava⁹⁻¹⁴. However, these short and late complications may be observed in both terms.

The aim of this study is to determine the reasons for port removal and to compare the characteristics of patients whose ports were removed due to completed therapy and whose ports were removed due to port catheter related complications. Therefore, a retrospective study was performed to evaluate the causes of port removal in children.

Material and Methods

The patients who underwent port implantation and removal at the Department of Pediatric Surgery between January 2000 and June 2013 were evaluated retrospectively. The patients were evaluated for age, gender, primary diagnosis, height, weight and body mass index (BMI) of the patient at the time of implantation and removal of port catheter, the access vein of the port, port size, complications during implantation and follow-up, usage of steroids, reasons for port removal, port infections and their characteristics (catheter culture and antibiogram results) and survival rates. The data of the patients are obtained from the patient files and from the online hospital documentation systems.

The insertion criteria for port catheters in our Children's Hospital include long term

intravenous access for chemotherapy and blood infusions. According to chemotherapy protocols, pediatric oncology and hematology patients offered port insertion and port catheters were inserted surgically after obtaining consent of the parents. Cuffed-tunnel catheters were used for short term intravenous nutrition and hemodialysis. The patients, whose port catheters were implanted by the interventional radiology unit or other institutes, were not included in the study.

Surgical intervention for port insertion and removal: Under general anesthesia, port catheters were inserted with cut down for external jugular veins and purse-string technique for internal jugular veins. Ports were inserted subcutaneously with small incisions on chest wall and catheters were implanted to ports via guided subcutaneous tunnel. For port removal, ports and catheters were freed from surrounding pseudo-capsule and removed from previous incision.

Definition of port infections and port thrombosis: The wound of the port site and dressing of ports are evaluated daily in oncology and hematology patients. Care and dressing of port catheters were managed by the Guidelines for prevention of intravascular catheter-related infections¹⁵. Wound infection of patients was assessed according to criteria for Guideline for Prevention of Surgical Site Infection adopted by Center for Disease Control Prevention (CDC)¹⁶. Definition of port site infections were monitored during each dressing and tenderness in the port site, fever without obvious source and other manifestations suggesting local and/or blood stream infections are considered for port infection¹⁵. Wound swabs and blood stream cultures were obtained for definite

Table I. Demographic Characteristics of the Patients and Their Distribution Across the Groups

		CTG	CG	p
Age (years)		10.2 ± 4.9	7.7 ± 4.4	>0.05
Gender (M/F)		1.32/1	1.15/1	>0.05
Weight (kg)	During implantation	17.9±1.2	14.1±9.4	>0.05
	During removal	27±1.6	16±9.3	>0.05
Height (cm)	During implantation	100.8±29.3	92±24	>0.05
	During removal	110±29	96±23	>0.05
Steroid usage		58 (34.1%)	35 (49.3%)	>0.05

M: male; F: female; CTG: completed therapy group; CG: complication group

diagnosis. Wound infections are treated with appropriate antimicrobials, debridement and abscess drainage. Dehiscence of port catheters due to wound infection and systemic infection findings according to catheter infections were considered for port removal.

Occluded ports were evaluated for thrombosis by Doppler USG and anticoagulant treatment was used for these patients. Patients with occluded catheters due to massive thrombosis and unresponsive to anticoagulant treatment were considered for port removal.

The patients were divided into two groups, whose port catheters were removed due to completed therapy (completed therapy group, CTG) and whose port catheters were removed because of a port catheter related complications (complication group, CG).

The study protocol was approved by the Institutional Non-interventional Clinical Studies Ethical Committee (Date: 12.07.13, Registration No: 16999557-775).

Statistical Analysis

The data of the patients were compared with SPSS 16.0 and descriptive studies were obtained. The data of patients regarding CTG and CG were compared by using Chi-square test. The p values less than 0.05 were considered as significant.

Results

A total of 242 patients who underwent port implantation and removal between January 2000 and June 2013 were included in the study. Among 242 patients 132 (54.5%) of children were male, and 110 (45.5%) were female. The

male to female ratio was 1.32/1. The mean age of the patients was 9.4±4.9 years (0-24 year). Patients were enrolled in CTG (n=170, 70.2%), and CG (n=72, 29.8%).

The demographic characteristics and steroid use are summarized in Table I; demographic features showed no significant difference in both groups (p>0.05).

Ninety-three patients (38.6%) received steroid treatment during follow-up. The rest of the patients 148 (61.4%) did not receive steroid during follow-up. The incidence of steroid treatment was similar in groups (p>0.05) (Table I).

The patients are divided into four groups according to their primary disease including: hematological malignancy (n=77, 31.8%), solid tumors (n=94, 38.8%), other malignancies (n=57, 23.6%), and non-tumoral indications (n=14, 5.8%) for port implantation. The distribution of patients were similar in four primary diseases (p>0.05).

Among hematological malignancies, acute lymphoblastic leukemia (ALL) was the most common primary disease for port implantation (n=41, 16.9%). There was no significance between groups for the distribution of hematological malignancy subtypes (p>0.05).

Neuroblastoma (n=40, 16.5%), Wilms' tumor (n=20, 8.3%), retinoblastoma (n=22, 9.1%) and primitive neuroectodermal tumor (PNET) (n=8, 3.3%) were the most common solid tumors in groups with similar incidences in CTG and CG (p>0.05).

Non-tumoral indications for port catheter implantation include, chronic diarrhea/

Table II. The Distribution of Access Vein

Site of access	CTG		CG		Total		P
	n	%	n	(%)	n	(%)	
R EJ	117	69.2%	50	69.4%	167	69.3%	>0.05
R IJ	41	24.3%	17	23.6%	58	24.1%	>0.05
L EJ	7	4.1%	4	5.6%	11	4.6%	>0.05
L IJ	3	1.8%	0		3	1.2%	>0.05
Great saphenous vein	0		1	1.4%	1	1.4%	>0.05
Femoral vein	1	0.6%	0		1	0.4%	>0.05
Total	169		72		241		>0.05

R: right; L: left; EJ: external jugular; IJ: internal jugular; CTG: completed therapy group; CG: complication group

Table III. The Causes of Port Removal in the Complication Group

	N	%
Infection	37	51.4
Dehiscence of incision site	13	18.1
Extravasation	7	9.7
Mechanical problems	7	9.7
Thrombosis	6	8.3
Exchange of the catheter with dialysis catheters	2	2.8

malnutrition (n=5, 21%), short gut syndrome (n=2, 0.8%), prematurity (n=1, 0.4%), immune deficiencies (n=1, 0.4%), Beckwith-Wiedemann syndrome (n=1, 0.4%), hemophagocytic syndrome (n=1, 0.4%), Joubert syndrome (n=1, 0.4%), hemolytic uremic syndrome (HUS) (n=1, 0.4%). This group of patients had TIVADs after several other complicated catheter insertions. Also, there was no significant difference between groups for distribution of non-tumoral indications ($p>0.05$).

The diameters of port catheter lumens were 4.5 Fr, 5 Fr, 6 Fr, 6.5 Fr and more than 7 Fr (up to 9 Fr) catheters were used in adolescent patients. One hundred and twenty-four of cases (51.2%) received 6.5 Fr catheter, 86 (35%) of cases received 4.5 Fr, 12 of (5%) cases received 7.6 Fr, and 8 (3%) of them received 8.5 Fr sized port catheters. There is no significance between groups for distribution of port catheter lumen diameters ($p>0.05$).

When we analyzed the access vein for port catheters; external jugular, internal jugular, great saphenous and the femoral veins were the sites for port catheter access. While the great saphenous vein and femoral vein are used in one case each, jugular veins were the most common sites for vascular access. In 14 of cases

(5.8%), left side of the neck is preferred due to thrombus, mass or infection in the right side. Left external jugular vein was chosen in 11 of such cases, while 3 of them were performed from left internal jugular vein.

When site of port accesses were analyzed CTG and CG did not show significant difference (Table II).

There were no complications in 97.5% of the cases (n=236) during the port implantation procedure. The displacement of catheter into right ventricle (n=3, 1.2%), hematoma (n=2, 0.8%) and disconnection of port reservoir and port catheter (n=1, 0.3%) were the intra-operative complications. These early complications during the procedure are managed with hemostasis, debridement and catheter revision.

The causes for port removal in the CG are shown in Table III. Infectious reasons were the most common complications (51.4%).

When we investigated the amount of time with port catheters, the mean duration of a port catheter was 864 ± 556 days (7-3,696 days). In CTG, the mean duration of port catheter was 1,043 days (24-2,917 days), while it was 443 days (7-3,696 days) in CG. The mean duration

Table IV. The Interventions During Follow-Up of Port Catheters

	Completed therapy group (n)	Complication group (n)
No intervention	164	56
Anticoagulation	3	4
Debridment	0	6*
Drainage for abscess	1	5*
Pulling up of port catheter	1	1
Hemostasis	1	0

*Despite the successful intervention, the port catheter needed to be removed.

Table V. Infectious Agents Reproduced in the Catheter Blood Culture

	Completed therapy group (n)	Complication group (n)	Total
No organism	166	33	199
<i>Staphylococcus aureus</i>	0	11	11
Candida	1	13	14
<i>Staphylococcus epidermidis</i>	1	6	7
Candida + <i>Staphylococcus</i>	0	2	2
MRSA (Methicillin-resistant <i>Staphylococcus aureus</i>)	2	1	3
Klebsiella	0	3	3
Pseudomonas	0	2	2
<i>Acinetobacter baumani</i>	0	1	1

Table VI. The Correlation Between Causes of Port Removal and Primary Disease

	Infection		Non-infectious reasons		p
	n	(%)	n	(%)	
Hematological malignancies	14	37.8	11	31.4	>0.05
Solid tumors	14	37.8	12	34.3	>0.05
Other malignancies	4	10.8	9	25.7	>0.05
Non-tumoral indications	5	13.5	3	8.6	>0.05

of port catheter was 431 days (63-1449 days) because of infectious complications and 455 days (7-3,696 days) for other complications. The time duration of port usage was similar between patients whose ports were removed for infectious complications and other ($p > 0.05$).

During the follow-up, 9.1% of patients faced complications. These complications were managed with different treatment interventions (Table IV). In 199 (82.2%) of patients, blood cultures obtained from catheters were negative for organisms. Fungi were the most common microorganism and followed by *S. aureus* and *S. epidermidis* in blood cultures. The antimicrobial characteristics of catheter-related complications were listed in Table V.

When the causes for port removal and primary diseases were correlated in the CG, patients with hematological malignancies and solid tumors had higher incidence of infectious causes ($p > 0.05$; Table VI). But there was no significance between patients with hematological malignancies and solid tumors of infectious causes. In the CG, the patients whose port catheters were removed for infectious reasons were investigated for

whether there is a relationship with age, gender, BMI, height and weight at the time of port implantation and removal. There is a positive correlation between BMI and infections ($p < 0.05$) Children with higher BMI had higher incidence of infectious complications. In the CG, patients under steroid treatment had higher incidence of non-infectious causes ($n = 21$, 60%) than infectious causes ($n = 14$, 40%) ($p < 0.05$) Oppositely, non infectious complications were higher in steroid free patients ($n = 22$, 62.8%, $p < 0.05$).

Discussion

Difficulties in venous blood sampling or venous line access decrease the compatibility of the patient to treatment in pediatric age group. Port catheters improve the quality of life and healthcare services provided to patients with cancer, since they allow long term IV access for chemotherapy, antibiotherapy and blood transfusion¹⁷. In addition, they have an advantage for venous blood sampling without having to puncture the vein. In recent years, usage of port catheters in oncologic patients has been widely accepted, and it

is preferred to other central venous access routes¹⁸. In our institution, almost all patients who need long term chemotherapy undergo port catheter implantation. Apart from patients with cancer, children who require fluid therapy or blood products for chronic diarrhea, short gut syndrome, hemophagocytic syndrome, and hemolytic uremic syndrome may also undergo port catheter implantation.

There are a number of studies related to port catheter complications. However, there is no study regarding the characteristic of patients who have undergone port catheter removal or there is no such study which deals with the reasons for port removal in the complicated patients. Therefore this retrospective study is the first to analyze the causes of port removal in children.

In our study, we found that 29.8% of patients underwent port removal because of port catheter related complications. Hollyoak et al.¹⁸ reported that 75% of port catheters is removed due to completed therapy in adults¹⁹. The incidence of port removal for infectious complications accounts for 31.4% of all port removals in children²⁰. These results were compatible with our findings and we suggest that in about 1 of 3 cases, port catheters are removed before completing the therapy due to port related complications in children.

In another study, patients who underwent port removal were below 2 years of age (41.3%)²¹. Since we only include patients with removed ports, patients in our study were older (>9 year of age) than other patients reported in previous studies, however, demographic features of patients did not show significant difference in CTG and CG. These findings are similar to that of previous studies^{22,23}.

In our patient population, solid tumors (38.8%) and hematological malignancies (31.8%) were the most common primary disease in children with port removal. Yazıcı et al.²⁰ reported that Non-Hodgkin lymphoma is the most common primary malignancy in patients with infectious complications²¹. We found that ALL is the most common malignancy in children and infectious complications were more common in hematologic malignancies and solid tumors.

The intraoperative complication rate was limited to 2.5% of all procedures in our

patients and can be easily overcome during the implantation. Right jugular vein is preferable in all patients but left jugular veins may be used for port access. Also external veins were more preferred sites because of fewer complications. Tretola et al.²³ suggest that jugular veins showed less complications (thrombosis and infections) when compared to subclavian veins. The lumen size of catheter and duration of catheters were not found as a cause of complications in hemodialysis catheters²⁴. Also, we could not find any correlation between port size, duration of port access and complications.

When we investigate the patients who underwent port removal because of complications, the most common factor for port removal was infections (51.4%). We found that patients with hematological malignancies or solid tumors were more prone to develop port infections. On the other hand, other underlying diseases showed non-infections complications. Since, patients with hematologic disease show altered immunity and develop severe neutropenia, infectious complications are more likely to be detected. In a previous study, the incidence of port infection was 14% and infection rate was reported to be 1.92/1000 catheter days²¹. Port infections can be classified as sepsis, port reservoir site infection and catheter tunnel infections. Although port reservoir site infections were less than sepsis, incidence of 26.3% was reported by Yazıcı et al.²⁰. However, only 5% of our patients developed reservoir site infections and no catheter tunnel infection was detected in our patients.

In previous studies, the most common infectious agent is reported as *S. epidermidis* in port catheter related infections^{15,25}. Also, coagulase negative staphylococci (*S. epidermidis*, *S. hominis*, *S. saprophyticus*) were reported as the most common microbial organisms²². In our study, different from other, we found that fungi were the most common and were followed by *S. aureus* and *S. epidermidis*. The reasons for higher incidence of fungi are thought to be the long duration of catheters inside the body and increased usage of total parenteral nutrition through port catheters^{15,26}. Especially in immune-compromised patients and patients under extensive antibiotherapy regimens, the frequency of *Candida* (*C. albicans*, *C. parapsilosis*) and other fungi (*Fusarium*,

Malassezia furfur, *Rhodotorula*, *Trichosporon*) significantly increases²⁶⁻²⁷. We suggest that longer duration of port catheters with an underlying hematological diseases are the possible causes of higher fungi infection in port cultures.

In this study, we could not find any correlation with infectious complications and age, gender, height and weight at the time of port implantation and removal in the CG. However, there is a positive relation between infections and higher BMI.

Although higher incidence of infectious complications were expected in patients under long term steroid treatment because of altered immune system and neutropenia, we found that patients with steroid treatment were more prone to develop non-infectious complications. Therefore, we suggest that the reasons of the higher incidence of non-infectious causes in patients under steroid therapy might be conservation of port catheter and reservoir under a thinner skin and subcutaneous adipose tissue and the negative effects of steroids on wound healing.

The catheter related mortality has been reported between 2.8%-3.5%²⁸. It has been suggested that recurrent disease and neutropenia may contribute to catheter-related mortality²¹. In our study, there was no catheter-related mortality. In the follow-up, 16% of the patients did not receive another port catheter and their treatment continued with another central venous route. However, 74% of the patients underwent new port catheter implantation.

In conclusion, one third of the port catheters in the pediatric population are removed before completing the treatment due to various complications. The hematological malignancies and solid tumors are the most common underlying primary disease in patients with port removal because of complications. Infectious complications are the most common cause of port removal in children and despite form, other microorganism fungi should be considered as a cause of catheter-related infections. It should be kept in mind that patients with higher BMI are more prone to infectious complications.

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