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A Retrospective Clinical Study: Complications of Totally Implanted Central Venous Access Ports

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Background: When managing patients who require repeated venous access, gaining a viable intravenous route has been problematic. To improve the situation, various studies on techniques for venous access have been conducted. The aim of this study is to evaluate the clinical results of complications following totally implanted central venous access port (TICVAP) insertion. ***Methods:*** A retrospective analysis was conducted on 163 patients, from December 2008 to March 2013. The occurrence of complications was studied in three separate periods of catheter use: the intraoperative period, postoperative period, and period during the treatment. ***Results:*** A total of 165 cases of TICVAP insertions involving 156 patients were included in the final analysis. There were 35 complications (21%) overall. Among these, 31 cases of complications (19%) occurred during the treatment period and the other 4 cases were intraoperative and postoperative complications (2%). There were no statistically significant differences in age and gender of the patients between the two groups to be risk factors (p=0.147, p=0.08). Past history of chemotherapy, initial laboratory findings, and the locations of TICVAP insertion also showed no statistical significance as risk factors ($p > 0.05$). ***Conclusion:*** Because the majority of complications occurred after port placement and during treatment, meticulous care and management and appropriate education are necessary when using TICVAPs.

Key words: 1. Central venous access device
2. Chemotherapy, adjuvant
3. Intraoperative complications
4. Postoperative complications

INTRODUCTION

When managing patients who require repeated venous access, particularly cancer patients, establishing a patent intravenous line has always been problematic, because repeated venous punctures may lead to the rupturing of veins, thrombophlebitis, and physical and psychological stress to patients [1]. To address these problems, various studies have been conducted on the access techniques of the totally implanted central venous access port (TICVAP) and the Hickman catheter, that is, the tunneled, cuffed silastic catheters that were first described by Broviac et al. [2] and subsequently modified by Hickman and associates.

However, although TICVAPs are currently accepted as relatively safe and appropriate for use in cancer patients, we have experienced several cases of complications, in both the

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early and late phases of treatment. In this study, we report and review the complications of TICVAPs.

METHODS

1) Study population and measurements

This study was approved by the institutional review board at Konyang University Hospital. A retrospective analysis was conducted on 163 cancer patients, who had any type of TICVAPs inserted between December 2008 and March 2013 for infusional chemotherapy in the Department of Thoracic and Cardiovascular Surgery, Konyang University Hospital.

One hundred and sixty-three patients underwent the insertion of TICVAPs, and 6 of them were excluded due to a lack of laboratory data. One additional patient was excluded from analysis because the patient's TICVAP implantation had failed due to venous anomalies. Thus, 156 patients were included in the final analysis.

The patient's age, gender, site of primary tumor, catheter type, history of previous chemotherapy, and laboratory results were recorded and classified as patient-related risk factors. The laboratory results, including white blood cell (WBC) counts, platelets, hemoglobin, partial thromboplastin time (PTT), and activated PTT were obtained within 14 days of the operation date. In addition, the date of catheter removal, as well as complications related to the catheters, reimplantation, reimplanted catheter removal, and death, were recorded.

The occurrence of complications was studied in three separate periods: intraoperative period, postoperative period, and period during the treatment involving the use of the catheter. Postoperative complications following the catheter implantation were apparent even before the treatment began. A total of 165 TICVAPs were placed in 156 patients. Nine patients each received 2 ports. All of their TICVAPs had been removed after their first chemotherapy administration but reinserted due to the recurrence or metastasis of cancer during this period. The follow-up period for this study for each patient lasted from the date of TICVAP insertion to the date of device removal, death, or last recorded date.

2) Surgical procedures

The TICVAP implantation procedures were conducted under sterile conditions in the operating room by experienced general thoracic and cardiovascular surgeons and residents in training, with a portable fluoroscopic device (X-ray image intensifier, C-arm). For internal jugular vein approaches, portable ultrasonography was used.

The patient was placed in a supine position with a 10-cm-high rolled auxiliary bed so that the patient's chest faced the ceiling. The operator determined the side of procedure, usually the patient's right side. The ipsilateral chest wall was also shaved and sterilized with povidine-iodine. Under local anesthesia with 2% lidocaine, the subclavian or internal jugular vein was punctured with a suitable gauge needle. A guidewire was passed through the needle and into the vein, and the needle was removed. After confirming that the tip of the guidewire was located well into the right atrium under fluoroscope guidance, the guidewire was fixed temporarily around the operation field. The port pocket was made on the upper anterior aspect of the chest wall. The TICVAP combined with the intravenous catheter was implanted subcutaneously, primarily on the pectoralis major fascia. With the help of a tunneler, the distal tip of the catheter was passed through the subcutaneous tissue, to exit directly through the puncture site. The peel-away sheath, combined with the vein dilator, was passed through the guidewire guided by the fluoroscope. The guidewire was then removed and the distal tip of the catheter was passed through the peel-away sheath. The distal tip of the catheter could be inserted into the central vein by splitting and pulling out the peel-away sheath. The correct catheter position was established when the catheter tip was seen by the fluoroscope in the superior vena cava (SVC) and the free flow of blood through the catheter into the syringe was witnessed. After the procedure, a chest X-ray was taken to exclude complications such as pneumothorax and to determine the positions of the TICVAP and the catheter tip.

3) Catheter care

TICVAPs were cared for by experienced nurses, including cleaning the insertion site with chloorhexidine and covering

Table 1. Population and port characteristics

Characteristic	Value
No. of patients	156
Age (yr)	55±13.2
Gender	
Male	63 (40)
Female	93 (60)
Cancer location	
Colorectal	59 (38)
Breast	38 (24)
Lung	14 (9)
Stomach	12 (8)
Biliary tract	12 (8)
Lymphoma	5 (3)
Esophagus	5 (3)
Miscellaneous	11 (7)
No. of ports	165
Port duration	307±296
Range (day)	7–1,532

Values are presented as mean±standard deviation or number (%).

Table 2. TIAP complications and indications of removal

Total ports removed	68 (41)
Complication	28 (17)
Completion of treatment or at patient request	40 (24)
Intraoperative complications	2 (1)
Pneumothorax	1 (0.5)
Hemothorax	1 (0.5)
Postoperative complications	2 (1)
Kinking	1 (0.5)
Hematoma	1 (0.5)
Complications during treatment	31 (19)
Fungemia	10 (6)
Bacteremia	5 (3)
Cut down of catheter	3 (2)
Leakage due to wrong needling	3 (2)
Wound dehiscence	3 (2)
Thrombus	3 (2)
Spontaneous turned over	2 (1)
Spontaneous kinking	1 (0.5)
Spontaneous disunion of port and catheter	1 (0.5)

Values are presented as number (%).

the insertion site dressing twice a week or more often if indicated. The TIAP was flushed with 9 mL of 0.9% saline solution and 1 mL of heparin after administration of medication or blood products. If the TIAP was not used for a long time, the port was flushed every 5 to 6 weeks.

4) Statistical analysis

The data were analyzed using the PASW SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were compared using the 2-tailed Student t-test or Mann-Whitney U-test and described as mean±standard deviation or median (range). Categorical variables were compared using a chi-square test or Fisher's exact test, as applicable. A p-value of less than 0.05 was considered to be statistically significant.

RESULTS

Demographic data are shown in Table 1. Of 156 patients, 93 were females and 63 were males; among them, 9 patients (8 females and 1 male) received two ports each. The mean age of the patients was 55 years (range, 17 to 82 years; ±13.2 years). The average time during which a TICVAP remained in place was 307 days (range, 7 to 1,532 days; ±296 days).

The TICVAP complications and indications for removal are listed in Table 2. In the case of 30 patients (18%), with 32 ports in total, death occurred; therefore, the TICVAPs were not removed. Thirty-five cases of complications occurred (21%) with 4 intraoperative and postoperative complication cases (2%). Two patients had intraoperative complications; pneumothorax (1 case, 0.5%) and hemothorax (1 case, 0.5%). These were treated with closed thoracostomy and had no further complications. Postoperatively, one patient had the TICVAP removed with uncorrectable kinking (0.5%), and the other patient had a hematoma (0.5%) at the operation site, which was treated immediately.

Most complications occurred during the treatment period (31 cases, 19%); and of these, almost one-third were fungal infections (10 cases, 6%). The main causes of fungal infections were *Candida parapsilosis* (4 cases, 2%), *Candida tropicalis* (4 cases, 2%), *Candida albicans* (1 case, 0.5%), and *Rhodotorula minuta* (1 case, 0.5%). Causes for the bacterial infection were *Staphylococcus aureus* (2 cases, 1%), *Staphylococcus sanguis* (1 case, 0.5%), *Pseudomonas aureginosa* (1 case, 0.5%), and *Serratia marcescens* (1 case, 0.5%). Most of the infected TICVAPs (13 cases, 8%) were

Table 3. Analysis of factors affecting complications

Factors	Complications		p-value
	No (cases=130)	Yes (cases=35)	
Age (yr)	55.8±13.2	52.1±13.1	0.147
Gender			
Male	55 (42.3)	9 (25.7)	0.082
Female	75 (57.7)	26 (74.3)	
Laboratory			
White blood cell count	5.9±2.9	6.2±2.2	0.582
Hemoglobin	11.1±1.6	11.6±1.6	0.133
Partial thromboplastin time	13.6±0.8	13.5±0.9	0.353
Activated partial thromboplastin time	35.5±3.9	34.8±4.2	0.378
Platelet count	230.6±80.7	256.3±104.8	0.186
History of chemotherapy			
Yes	67 (51.5)	13 (37.1)	0.182
No	63 (48.5)	22 (62.9)	
TICVAP site			
Subclavian	113 (86.9)	26 (74.3)	0.113
Jugular	17 (13.1)	9 (25.7)	

Values are presented as mean±standard deviation or number (%).
TICVAP, totally implanted central venous access.

removed, but 2 patients (1%) died before catheter removal. In addition, there were 3 cases of unexpected complications that resulted in the removal of TICVAPs during the treatment period: spontaneous kinking of the catheter (0.5%), catheter turnover (0.5%), and disunion of the catheter from the port (0.5%). Another case of catheter turnover was corrected easily by manual reduction. Complications due to mishandling or unfamiliarity with TICVAPs occurred in 6 cases (4%). In 3 out of these 6 cases, catheters were cut down and were migrated into the right ventricle by needling on the wrong site, that is, not on the port, but on the catheter. Catheters were then removed under fluoroscopic guidance, with femoral vein puncture after the removal of TICVAPs. In the other 3 cases, extravasations were found, caused by inappropriate needling. In 2 of these 3 cases, the TICVAPs were removed because of the dehiscence of the operation site, while in the third case, spontaneous resolution occurred. In the 3 thrombus cases (2%), the complications were treated with 10% heparinized saline injection through the TICVAPs.

Risk factors that could affect the occurrence of complications were collected and analyzed (Table 3). There were no statistically significant differences between the two groups in terms of the age and the gender of the patients (p=0.147 and p=0.08). Nor were there any statistically significant differences in past history of chemotherapy, initial laboratory findings, or the locations of TICVAP access ($p > 0.05$).

DISCUSSION

The TICVAP, also called a port or a chemoport, is a small reservoir connected to a venous catheter and is positioned in the subcutaneous tissue. The use of TICVAPs started in the early 1980s in oncologic patients [3] and remains an integral part of their daily clinical routine [4].

As compared to external venous access, TICVAPs have many advantages for the patient who requires a continuous intravenous line, such as greater cost-effectiveness, a lower risk of infection, and thrombosis [5-7]. However, TICVAPs may be associated with several complications, most of which can be effectively prevented [8].

In a retrospective study of the risk factors of TICVAP involving 561 implantation cases by Ignatov et al. [9], complications occurred in 104 cases (19%), and most of these were late complications (96 cases, 17%). They reported that a body mass index (BMI) of more than 28.75 had a significant influence on the rate of complications and stated that the age, the type of cancer, and the presence of metastasis were not patient-related risk factors for complications. However, another study has shown BMI not to be a patient-related risk factor. In a prospective study of 815 cases by Narducci et al. [10], the overall morbidity rate was 16.1%, with infection as the main cause of complications. In this study, baseline BMI, type of cancer, and history of chemotherapy showed little correlation with complications. Further, they concluded that early first use of an implanted device within 7 days from placement and a jugular vein approach were factors significantly related to complications (p=0.003 and p=0.005, respectively).

In addition to the factors mentioned above, the location of the catheter tip and the choice of vein for intravenous access were highly significant independent prognostic factors. Complication rates and the rates of port removal because of

malfunction were significantly higher when the port was located in the peripheral part of the upper venous system or inserted through the subclavian vein [9]. Araujo et al. [11] showed access via the internal jugular vein rather than the subclavian vein to be associated with lower rates of immediate complications, catheter malpositioning, long-term morbidity (including venous thrombosis), and catheter malfunction. However, Narducci et al. [10] stated that external jugular vein catheterization resulted in higher rates of inflammation (20/405 patients vs. 3/339 patients; p=0.003) and port expulsion. Further, Deshpande et al. [12] identified no significant correlation between the insertion site and the incidence of infection and bacterial colonization. In our study, complications occurred in 35 cases (21%) of 165 implantations, with 31 cases of these (19%) occurring during treatment periods using TICVAPs. Laboratory findings, gender, and history of chemotherapy had no statistically significant relationship with the rates of complications. The access site of TICVAP had no statistically significant (p=0.113) association with the occurrence of late complications in our study; this may have resulted from the difference between the number of TICVAPs made through the subclavian vein access and that made via the jugular vein access. The majority of implantations were made via subclavian vein access (139 cases, 84%), and only 26 cases of implantation (16%) were made via jugular vein access. If we had more cases of jugular vein access, we could have obtained more significant results.

As for WBC counts as a patient-related factor, Gutierrez and Gollin [13] noted that the exclusion of neutropenic children ($<0.5\times10^9$/L) from TICVAPs significantly lowers the rate of complications. In our study, however, there were no neutropenic patients and the WBC count was not a risk factor (p=0.582).

The position of the catheter tip of the TICVAP is also important for long-term maintenance. Many studies have reported that catheter tips should be placed at the SVC-right atrial junction [14,15]. The United States Food and Drug Administration guidelines suggest that the catheter tip should not be positioned in the right atrium [16]. When the catheter is positioned in the right atrium, it may cause cardiac-related complications. To determine the appropriate length of the catheter, we used portable fluoroscopy in every case of TICVAP insertion. The optimal catheter length was determined under fluoroscopic guidance by measuring the distance from the pocket for the TICVAP to the angle of the right main bronchus and trachea. Variable studies about the SVC-right atrium junction level on the chest radiograph [17,18] have been reported, but in our study, there were no late complications related to the catheter length.

Table 4. Distribution of complications

Variable	Value
Total TICVAPs	165
Total complications	35 (21)
Intraoperative complications	2 (1)
Postoperative complications	2 (1)
Complications during treatment	31 (19)
Infections	15 (9)
Mishandling	6 (4)
Wound dehiscence	3 (2)
Thrombus	3 (2)
Miscellaneous	4 (3)

Values are presented as number (%).
TICVAP, totally implanted central venous access.

In our study, patient characteristics such as the age, gender, site of primary tumor, catheter type, history of previous chemotherapy, and laboratory results did not influence the overall incidence of complications. In common with other studies [9,10], the main complication observed in our study was infection (Table 4), occurring in 15 cases of implantation (9%).

In conclusion, a majority of complications of TICVAPs occurred after port placement and during treatment. To prevent complications of TICVAPs, it is essential to provide meticulous care and management and give appropriate education about TICVAPs, particularly during treatment.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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