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Original Article

Totally Implantable Subpectoral vs. Subcutaneous Port Systems in Children with Malignant Diseases

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Background: For many years, subcutaneous therapeutic port system was known as a major route to access central veins. However, significant complications have been reported through recent years. One of the most important complications of subcutaneous port implantation is skin necrosis. In order to decrease this complication, we would like to introduce subpectoral fascia port implantation through this study.

Methods: Five hundred and twenty four patients with a variety of neoplastic diseases underwent port implantation, from March 2003 to March 2008 (60 months). All suitable size catheters were put in the superior vena cava through the internal jugular vein under general anesthesia. The ports were placed in the subcutaneous pocket (SCP group) in 342 patients and in the subpectoral fascia pocket (SPFP group) in 182 patients. Data were analyzed using Chi-square test and survival analysis for time (Kaplan-Meier).

Results: A total of 538 devices were placed for 524 patients in two groups (14 patients received a second device after removal of the first one, due to failure of the first implantation). Mean follow-up period was 508 days (8 – 2025 days).

Common complications observed in the SPFP group were as follows: wound infection (7 cases, 3.8%), catheter obstruction (7 cases, 3.8%), catheter displacement (6 cases, 3.2%), port related infection (5 cases, 2.7%), and pocket hematoma (2 cases, 1.1%).

Common complications observed in the SCP group were as follows: catheter displacement (12 cases, 3.5%), skin necrosis (11 cases, 3.21%), port exposure (9 cases, 2.6%), port related infection (8 cases, 2.3%), catheter obstruction (8 cases, 2.3%), and port rotation (3 cases, 0.9%).

Conclusion: The results showed that port implantation in the subpectoral fascia pocket had a lower rate of skin complications than the subcutaneous pocket implantation. According to this study, this procedure was not complicated by skin necrosis over the port, port exposure or port rotation.

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Introduction

Reliable central venous access is necessary for a variety of purposes such as the treatment of children who require chemotherapy, prolonged antibiotic administration, frequent blood sampling, parenteral nutrition, and transfusion of blood or blood products.[1,2]

Repeated access to the bloodstream or a specific body site in order to administer therapeutic agents or blood sampling can be achieved with greater ease and less discomfort, with a port in

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place.[3,4] The unique feature of an implantable port is that it is placed completely under the skin. This placement allows the patient to conduct a normal life style and to move around freely.[5] In addition, the implanted port requires minimal care.[1,6]

Application and maintenance of long term vascular access devices may cause some problems. The most common complications include catheter occlusion, vein thrombosis, port pocket infection, catheter related sepsis, device rotation or dislodgement, catheter migration, skin necrosis, pocket hematoma and the port exposed.[7–9] The rare complications that are reported include catheter rupture,[10] cardiac tamponade,[11] catheter disconnection and difficulty in catheter removal.[12]

Subcutaneous pocket (SCP) and subpectoral fascia pocket (SPFP) procedures were compared for complications with a special emphasis on skin necrosis.

Materials and Methods

From March 2003 to March 2008, 538 ports were placed for 524 children (320 boys, 204 girls) with various neoplastic diseases at Mofid Children's Hospital during a 60 month period for chemotherapy. This is the largest study on children with totally implantable access ports in Iran.

Fourteen patients received a second device after removal of the first one, due to failure of the first implantation.

From March 2003 to March 2006, the ports were placed in SCP in 342 patients and from March 2006 to March 2008, the ports were placed in SPFP in 182 patients.

After medical preparation, 538 suitable size devices were implanted through an open surgical technique. All catheters were placed in the SVC above the right atrium (level of Louis angle of the sternum) through the internal jugular vein under general anesthesia and all port reservoirs were placed in the anterior chest wall, 3 – 5 cm below the clavicles and above the breast by a 2 – 3 cm incision. The pocket was created caudally from the incision site.

If there was a possible anatomic pitfall in the preoperative evaluation (e.g., huge cervical lymph adenopathy, cephalovenous or cephaloperitoneal shunt, previous cervical vascular surgery), the catheter was placed in the subclavian or femoral vein and was not included in the study.

All patients were followed up for port complications with a special emphasis on skin complications until the termination of treatment or patient's death.

All information including demographic data, type of malignancy, preoperative CBC, device related complications, and cause of port removal was analyzed by SPSS version 16.5 using Chi-square test and survival analysis for time (Kaplan-Meier).

Results

Ports were successfully placed in all 524 children (320 boys, 204 girls), with a mean age of 5.5 years (2 months – 14 years), with an underlying malignancy who comprised the study population. 182 patients were implanted in the SPFP and 342 patients were implanted in the SCP. Patients were followed up for an average of 508 days (8-2025 days) or until port removal or the patient's death.

The main malignancy types were as follows (Table 1): acute lymphoblastic leukemia (ALL) (49.8%), Wilm's tumor (7.4%), non-Hodgkin lymphoma (6.7%), acute myeloblastic leukemia (AML) (6.5%), neuroblastoma (5.9%), Hodgkin lymphoma (4.2%), rhabdomyosarcoma (3.1%), histiocytosis (2.7%), Ewing sarcoma (2.5%), and other types (11.2%).

The variables with no importance in the occurrence of port related complications were sex, age, preoperative antibiotic therapy, type of malignancy, surgeon, length of operation, entry vein ligation, intraoperative complications, immediate use of port, and type of port devices.

Port catheters stayed functional in place for an average of 370 days (8 – 2025 days) after implantation. Median Time of catheter function was 329.5 days (8 – 2028 days). Cumulative survival and standard error in the SCP and the SPFP group was 0.8936 and 0.0182, and 0.8115 and 0.0365, respectively.

Ports were removed in 14 cases due to complications (4 cases in the SPFP group and 10 cases in the SCP group) and in 157 cases due to ending of treatment (10 cases in the SPFP group and 147 cases in the SCP group). Eighty two patients died before the study was ended. One minus survival in SPFP and SCP based on functional time of catheter shown in Figure 1. Survival analysis for time of catheter function is

Table 1. Tumor types in the patient population of this study.

Malignancy type	Count	%	Malignancy type	Count	%
ALL	261	49.8%	Brain tumor	2	0.4%
Wilm's tumor	39	7.4%	Pancreatoblastoma	2	0.4%
NHL	35	6.7%	Chondrosarcoma	1	0.2%
AML	34	6.5%	Pancytopenia	1	0.2%
Neuroblastoma	31	5.9%	Eye tumor	1	0.2%
Hodgkin lymphoma	22	4.2%	Fibrosarcoma	1	0.2%
Rhabdomyosarcoma	16	3.1%	Giant cell tumor	1	0.2%
Histiocytosis	14	2.7%	Bladder inflammatory pseudo-tumor	1	0.2%
Ewing sarcoma	13	2.5%	Leiomyosarcoma	1	0.2%
Germ cell tumor	9	1.7%	Meduloblastoma	1	0.2%
PNET	8	1.5%	Nephroblastoma	1	0.2%
Burkitt lymphoma	5	1.0%	Renal rhabdoid tumor	1	0.2%
Hepatoblastoma	5	1.0%	Sacrococigeal teratoma	1	0.2%
Osteosarcoma	4	0.8%	Small round cell tumor	1	0.2%
Clear cell sarcoma	3	0.6%	Sinus tumor	1	0.2%
Ganglioneuroblastoma	3	0.6%	Engelman syndrome	1	0.2%
Retinoblastoma	3	0.6%	Spindle cell sarcoma	1	0.2%

ALL=acute lymphoblastic leukemia; NHL=non-Hodjkin lymphoma; AML= acute myolocytic leukemia; PNET=primary neuroectodermal tumor.

shown in Table 2.

Fourteen patients in both groups received a second device after removal of the first one, due to failure of the first implantation (1 case due to wound bleeding, 2 cases due to skin necrosis, 6 cases due to catheter related infection, 3 cases for wound & pocket infection, 2 cases for catheter obstruction). Major complications observed in the two groups in this period of time are shown in Table 3. In the SCP group, skin necrosis over the port in 11 cases (3.2%), port exposure in 9 cases (2.6%) and port rotation in 3 cases (0.9%) were observed but none of such complications were seen in the SPFP group. Pocket hematoma was found in the SPFP group more than the SCP group (2 vs. 0).

The patients with skin necrosis over the port and port exposure were either managed by port removal (2 cases) or were surgically helped in the remaining cases using rotational flaps.

Mean platelet count at the time of port implantation was $2.07\times10^5/mm^3$ ($2.20\times10^5/mm^3$ in the SPFP group & $2.00\times10^5/mm^3$ in the SCP group) while it was $1.68\times10^5/mm^3$ in patients with wound bleeding or pocket hematoma. Mean Absolute Neutrophil Count (ANC) in patients with wound and pocket infection was $3973/mm^3$ ($2433/mm^3$ in the SPFP and $4413/mm^3$ in the SCP group).

The incidence of catheter associated venous thrombosis was 1.3% (3 cases in the SCP and 4

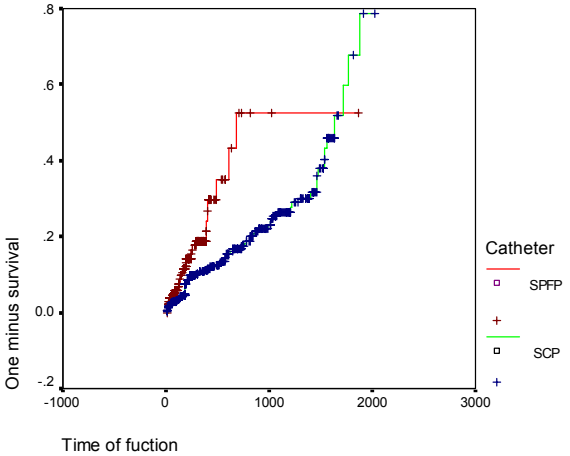

Figure 1. One minus survival in SPFP and SCP based on functional time of catheter.

Table 2. Survival Analysis for Time of Catheter Function.

Implantation	Total	Number events	Number censored	Percentage censored
SCP	342	70	272	79.53
SPFP	182	31	151	82.97
Overall	524	101	423	80.73

SCP=subcutaneous port implantation group, SPFP=subpectoral fascia port implantation group.

cases in the SPFP group) who were treated with intravenous continuous heparin infusion via the port.

Pocket infection, mainly caused by saprophyte skin cocci, occurred in 3 cases in the SCP and in 2 cases in the SPFP group which resulted in 2 port removals.

Thirteen patients (8 cases in the SCP and 5 cases in the SPFP group) showed port-related infection leading to 5 port removals (3 cases in the SCP and 2 cases in the SPFP group). There was a relationship between the duration of having the catheter and catheter-related infection (6 cases in the SCP vs. 3 cases in the SPFP group over three months). In our series, we had difficulty in the removal of the intravascular portion in two cases (0.5%) that led to neck exploration in one case and limited thoracotomy in the other case.

Analysis of other complications showed no significant difference between two groups (P= 0.343). Test statistics for the equality of catheter survival distributions showed that log rank was 11.29. (P=0.0008)

Discussion

Children have limited venous accessibility and cannulation of suitable peripheral veins may be a very painful and terrifying experience to them. Therefore, central venous access is a better option for long-time therapy.[13,14]

Venous access devices are valuable instruments for children who require intravenous medication, chemotherapy, blood sampling, nutrition and blood products transfusion.[1,10]

Totally implantable access ports improve quality of life and have the advantages of not requiring an external dressing, allowing more patient activity, and are associated with fewer infectious complications compared to tunneled catheters.[5,6]

Venus access devices placed into the subclavian vein may have some disadvantages including pneumothorax, catheter fracture by neighboring bony structure compression, and the catheter fragment embolization into pulmonary arteries, and swelling and pain in arms due to upper extremity deep vein thrombosis.[15–17]

Femoral vein catheter placement may also result in deep venous thrombosis which is difficult to manage.[18]

Overall, these devices have a reported complication rate of 11 – 25% according to some authors.[1,3] Overall complication rate in our study

Table 3. Major complications of the implanted ports during the study.

Complication	SCP (342 cases)	SPFP (182 cases)
Catheter obstruction	8 (2.3%)	7 (3.8%)
Wound infection	4 (1.2%)	7 (3.8%)
Catheter displacement	12 (3.5%)	6 (3.3%)
Catheter related infection	8 (2.3%)	5 (2.7%)
Wound bleeding	8 (2.3%)	4 (2.2%)
Vein thrombosis	3 (0.9%)	4 (2.2%)
Port rotation	3 (0.9%)	0
Port dysfunction	4 (1.2%)	2 (1.1%)
Pocket infection	3 (0.9%)	2 (1.1%)
Pocket hematoma	0	2 (1.1%)
Skin necrosis over the port	11 (3.2%)	0
Port Exposure	9 (2.6%)	0
Venous calcification around the catheter	3 (0.9%)	0
Drug leak	3 (0.9%)	0
Phrenic nerve injury	2 (0.6%)	0

SCP=subcutaneous port implantation group, SPFP=subpectoral fascia port implantation group.

was 19.3%. Catheter-related infection is the most common complication of intravenous access catheters (0.3 – 4.4%) and the leading cause of their removal (11 – 45%).[19,20]

Catheter tip occlusion and thrombosis are common problems seen with implantable ports (28%).[3] Ameliorating these difficulties may simply require catheter manipulation and flushing and occasionally device removal.[9] In this study, the most common complication was catheter displacement (18 cases).

Araujo et al. supported the preferential use of internal jugular vein for the insertion of port devices.[2] Port pocket infection was reported to occur at a rate of 0.3 – 4.4 %,[3] but in our patients, the rate was 1.0%. There was no correlation between platelet count and hematoma or bleeding (P=0.221), and also between absolute neutrophil count and device-related infection (P=0.295). The port implanted in the subcutaneous pocket may rotate in the long term due to its more mobility. On the other hand, port rotation was never seen in the SPFP group due to its limited space and well fixation. In children with malignancy, due to their impaired wound healing, thinning of skin layers, poor skin vasculature over the port and frequent needle punctures, the skin may gradually erode and the port may become exposed. However, skin with its underlying fascia has a better blood perfusion and less chance for skin erosion, necrosis and subsequent port exposure. Management of this complication is very difficult and sometimes requires removal of the port system (20 cases).

At the end of the treatment, the port and the catheter could be removed easily under local or light general anesthesia, but sometimes it may be a difficult procedure due to venous calcification around the catheter which in this study, occurred in two cases that required neck exploration in one case and limited thoracotomy in the other one.

In compression to subcutaneous pocket port implantation, skin necrosis as well as port rotation and some other significant complications were not seen in this method. According to the results of this research, it is recommended to implant port systems in subpectoral fascia pocket.

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