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Long-term totally implantable venous access port systems — one centre's experience

Jerzy Paleczny

Intensive Care Unit, Beskid Oncology Centre — Municipal Hospital in Bielsko-Biała, Poland

Abstract

Background. Implantable venous access ports are essential for patients requiring chronic venous access. The aim of this study was to determine securities, risks of complications and patients' satisfaction with using a port system.

Methods. Between April 2008 and May 2013, 220 consecutive patients (mean age: 53 ± 12 years; 155 female) were enrolled into this observational, single-centre study. 65 patients who received a port system were asked to complete a questionnaire with the aim of evaluating the patient's satisfaction and quality of life.

Results. First vena subclavia and later internal jugular were the most frequently used for venous access. Among serious complications, three cases (1.5%) of pneumothorax were observed. Technical difficulties of cannulation were observed in 12 cases (5.6%). In the late period, functional complications, defined as 'easy injection, impossible aspiration' at port access, affected more than 25% of the patients.

Conclusions. Implantation of vascular ports is a safe procedure, and serious complications are rare. In the evaluated group, complications connected with the complete functioning of ports were observed. Among responders, more than 90% of patients reported high overall satisfaction.

Key words: venous access, vascular port; vascular port, implantation; vascular port, complications; vascular port, management

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Long-term vascular access is essential for modern, complex therapy of cancers. Implantable port systems are a convenient solution and have been used in medicine for over 30 years. Their popularity in Poland has been increasing, and in many centres they are used as standard tools for the management of cancer.

An absolute indication for vascular port implantation is the infeasibility of peripheral venous cannulation or considerable difficulties in peripheral cannulation as well as repeated cycles of chemotherapy with agents inducing vascular reactions. In children, vascular ports should be used from the very beginning of treatment due to the potential stress associated with repeated vascular punctures. Apart from cancer therapy, implantation of vascular ports is also used for treatment of some chronic diseases, such as cystic fibrosis, asthma or chronic obstructive pulmonary disease (COPD). Moreover, vascular ports enable a quick infusion of clotting factors in patients with haemophilia [1]. Suitably selected vascular ports are useful for radiologic examinations with high-pressure contrast [2], magnetic resonance imaging and cycles of radiation therapy in the area of implantation. Vascular ports can also be used for blood sampling. When properly managed, the entire system can be used for several years [1].

Typically, vascular ports are inserted in the operating theatre by anaesthesiologists and other specialists, primarily surgeons. In some centres, anaesthesiologists are involved only in vessel cannulation, which is usually the most difficult part of the procedure and requires experience in central line placement. Preparation of the port pocket under the skin and stabilisation of the vascular port chamber in the planned region are technically easier. The entire procedure can be performed by one physician, who also carries out intraoperative radiologic evaluation.

Vascular ports are most commonly inserted through the subclavian or internal jugular vein (bilaterally, prefera-

bly on the right side). The subcutaneous pocket in which the port chamber is placed is created on the pectoralis major muscle in the subclavicular region. This location of the vascular port enables good stabilisation of the port as well as palpability under the skin and is well tolerated by patients. When the subclavicular region is unavailable for various reasons (e.g., lesions, planned procedures), the vascular port can be placed in the forearm [3]. In special cases, the vascular port has to be inserted in the femoral vein with the port chamber on the abdominal wall, lower thoracic or anterior femoral surface directly on the quadriceps [4]. The appropriate selection of patients and optimal time and technique of implantation are crucial for procedure success. The selection of patients is important because the state of their immune system, expressed as white blood cell count (optimally > 3 G L^{-1}), particularly neutrophil count (> 1 G L^{-1}), should be considered when placing a vascular port. Blood clotting capacity should also be considered, although the criteria and principles of anticoagulant therapy are not significantly different from the norms and management algorithms generally accepted in surgery [1].

The aim of the study was to present our experience regarding vascular ports used in adult patients treated in the municipal oncologic hospital. The course of vascular port implantations, port use and the satisfaction and comfort of patients who underwent implantation procedures were assessed.

METHODS

Participants in this study consisted of all consecutive patients with long-term venous access ports implanted for various reasons between April 2008 and April 2012. Selection of patients was carried out by physicians from conservative and surgical departments (oncology, pneumology, radiotherapy, general surgery, oncologic surgery, internal diseases), and all vascular ports were implanted by anaesthesiologists. Several days prior to implantations, patients were provided with detailed information about the planned procedure. Vascular ports were implanted following the patients giving written informed consent. In each case, the date of implantation was set with the attending physician to optimise the patient condition, often between the successive cycles of chemotherapy. The single-chamberPort-A-CathPolysulfone/ /Titanium Venous Access System (Smiths Medical ASD, USA) or Ambix Intraport C (Fresenius Kabi AG, Germany) was implanted. In slim or debilitated patients, "Low Profile" port systems (Smiths Medical ASD, USA) were inserted.

All procedures were carried out in the operating theatre; aseptic surgical standards were followed, and radiologic control (intraoperative imaging) was available. Monitoring during the procedure included ECG tracings, haemoglobin oxygen saturation in the arterial blood, and non-invasive measurements of arterial pressure. During the procedure, each patient received oxygen at the flow of 4–6 L per minute throughVenturi mask; sedation was induced with fractionated doses of midazolam (0.5–1 mg). The level of sedation did not exceed on the Ramsay Sedation Scale (a 1–6 scale where 1 is not sedated and 6 is heavily sedated) — patients remained able to respond verbally when spoken to. Under local anaesthesia with 1% lidocaine, the subclavian or internal jugular vein was cannulated. When the subclavian vein was chosen, the preferred site of needle insertion was approximately 1 cm below the centre of the inferior border of the clavicle or 1–2 cm laterally. The internal jugular vein was cannulated by inserting the needle medially, between the two heads of the sternocleidomastoid muscle. After placing the catheter in the vessel, the pocket was created on the pectoralis major muscle after infiltration of 1% lidocaine with epinephrine, 1:100 000. The catheter was tunnelled under the skin from the puncture site and led outside through the pocket. The catheter tip was fixed centrally, just above the point where the superior vena cava opens into the right atrium. The radiologic reference point for the catheter tip was the carina. The catheter excess was cut off and the catheter was connected to the port chamber. The port chamber was stabilised with single linen sutures stitching it to the superficial lamina of the pectoral fascia. In obese patients, sutures were placed within the subcutaneous tissue to provide good palpability of the port chamber through the skin. Once blood was aspirated from the port, which confirms placement of the lumen in the vessel, the port was flushed with normal saline and the system was filled with normal saline and heparin at a dilution of 100 U mL^{-1}. The system was closed under the skin with single layer sutures. The individual stages of the procedure were monitored radiologically in real time. After the completion of the procedure and before leaving the operating theatre, all patients underwent X-ray examinations covering the entire system (the vascular port with the catheter) against a background of the pulmonary hilum to confirm the procedure correctness. X-ray pictures were also meticulously analysed in search for perioperative complications. Additionally, 24 hours after implantation, all patients underwent thoracic X-ray examinations while sitting upright. Moreover, the 24–48 hour prophylactic perioperative antibiotic treatment was administered to all patients according to the local recommendations of the Committee for Hospital Infection Control. Initially, perioperative prophylactics involved amoxicillin with clavulanic acid 1.2 g every 8 h i.v., and since January 2013 — cefazolin 1 g every 8 h i.v.

Vascular ports were operated according to the standard devised by the authorsby the trained personnel of the departments that admitted the patients. The standard included dressing changes after the procedure, suture removal after

Table 1. Characteristics of patients

Characteristic		Number of patients	%
All procedures		220	100
	Vascular port implantation	212	96.4
	Vascular port removal	8	3.6
Gender			
	Males	65	29.5
	Females	155	70.5
Diagnosis			
	Cancer	214	97.3
	Others (COPD, asthma)	6	2.7

COPD — chronic obstructive pulmonary disease

10 days, transfusion of fluids, chemotherapeutics and the administration other drugs as well as blood sampling. Needles designed for vascular ports (Huber needles) were used in all cases. Ports were routinely flushed with 5–10 mL of 0.9% NaCl after each infusion. In patients whose treatment schedule involved longer treatment intervals or in those who completed the therapy, the port systems were periodically flushed with the solution of 0.9% NaCl, 5–10 mL and 0.9% NaCl with heparin (100 U mL^{-1}), 5–10 mL, at a minimum of every 1–2 months (according to the manufacturer's instructions). In cases of difficult port access, control of system patency and tightness, infectious or thrombotic complications, decisions about further management were made together with the physicians performing procedures.

The operative report prepared by physicians carrying out vascular port implantations and medical records of patients were used to determine all complications and technical difficulties related to implantations and system operation. The complications that developed between the procedure onset and suture removal were defined as early complications; those diagnosed later were considered late complications.

Following patients' written consent, satisfaction of patients and late implantation–related complications were assessed using a questionnaire. The questionnaire was prepared by the authors based on the Iowa Satisfaction with Anesthesia Scale (ISAS) and included a variety of detailed questions regarding the course of implantation and the use of vascular ports throughout the treatment (see the appendix). Patients were surveyed at various times after vascular port insertion (4 weeks — 26 months) during stationary or ambulatory treatment in the Oncology Department.

RESULTS

During the 5-year study period, specialists in anaesthesiology and intensive therapy performed 220 procedures related to vascular ports. The majority of procedures were vascular port implantations (96.4%), including two replacements (0.9%) due to port occlusion. The demographic data and main indications for implantation are presented in Table 1. Ten procedures were conducted as day surgery (patients from other centres) and 210 during hospitalisation in our hospital.

Right subclavian vein access was most commonly used; during the last 6 months of our study, the right internal jugular vein was more common.

The most common early complications were procedure-related technical difficulties, which were associated with vessel cannulation. The most severe complication was pneumothorax, which developed in 3 patients (1.5%). In one case, pneumothorax was diagnosed during the procedure. In the second case, pneumothorax was diagnosed 24 h after the procedure on routine follow up X-ray (no clinical sequels); the third case of pneumothorax was exclusively associated with port management during the further stage of treatment. In one extremely slim patient with a typically implanted low-profile vascular port, the port chamber rotated, which was most likely caused by poor stabilisation or loosening of fixing sutures. The rotation was unrecognised by the personnel during multiple attempts to access the port and resulted in continuous sliding of the needle along the posterior chamber wall (in this case laterally and anteriorly), unintended pleural punctures and, consequently, pneumothorax. In all cases, the anaesthesiologist typically treated the pneumothorax and the vascular port did not have to be removed. Spontaneous dislocation of the vascular port associated with changes in body position was found in 2 patients with the catheters placed in the subclavian vein (Fig. 1).

Late complications were observed at various times after suture removal; in none of the cases, the time was shorter than 1 month. The late complication detected the earliest was complete occlusion of the system, which resulted from improperly managed infusions through the vascular port (35 days after suture removal). The most common late complications were "valve" occlusions (inability to aspirate blood at effective supply maintained), which occurred in over 25%

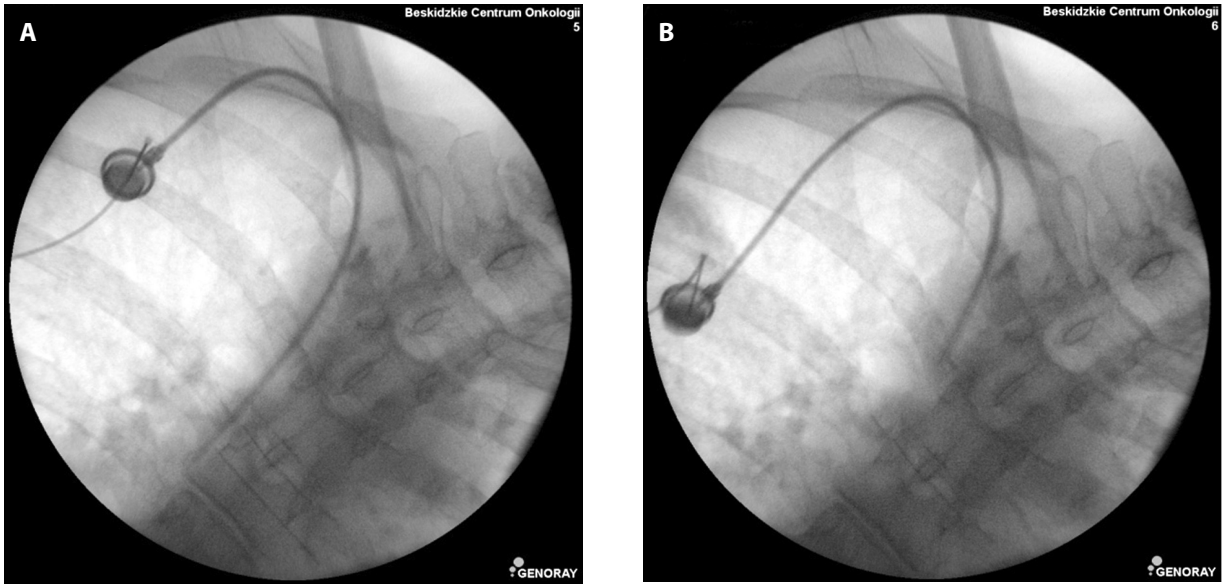

Figure 1. Spontaneous dislocation of the port chamber and catheter tip related to body position; A — in the recumbent position, B — in the erect position

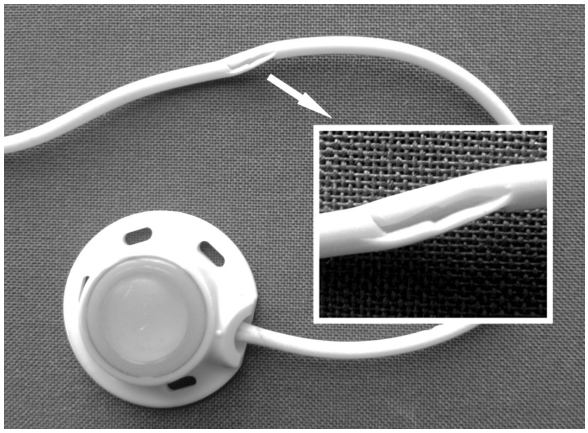

Figure 2. Pinch-off syndrome. Long-term compression between the clavicle and the first rib during movements within the region of the right shoulder caused substantial catheter damage

of patients. This complication developed predominantly in patients who used ports for longer periods. In one of the replacement procedures, due to device malfunction (pain during the supply to the post chamber and radiologically confirmed leak of contrast from the catheter under the clavicle), permanent damage to the vascular catheter was detected in the subclavicular region. The complication was considered a consequence of long-term pinch off syndrome, i.e., mechanical compression of the catheter between bony structures (in the case in question, between the first rib and clavicle). This complication was the latest to be detected, at more than 2 months after vascular port use (Fig. 2). Infectious complications occurred in 3 patients and all of them were detected at the later stage of vascular port use. Targeted antibiotic therapy supplemented with the use of antibiotic filling (filling of the system with high-concentration antibiotic solution) was effective in 2 cases. In only one casewas it decided to remove the system due to recurrent symptoms of generalised inflammatory reactions with bacteraemia and high probability of catheter-related infection. All of the complications detected in our patients are listed in Table 2.

The questionnaire was completed by 65 patients (30% of those with implanted vascular ports). All respondents were satisfied with their vascular ports used during therapy. Over 90% of respondents stated that this therapy was superior to the insertion of peripheral cannulae each time they were needed. Before the procedure, patients were provided with detailed information about the type of procedure and only in few cases they were anxious about the procedure (7.7% of respondents). The anaesthetic care for vascular port implantation was sufficient and the patients would decide to repeat the procedure, if necessary. The use of vascular ports was not associated with pain experienced during the insertion and use of peripheral accesses. Over half of patients (63.5%) believed that the procedure should have been performed during the earlier stage of treatment. Four patients (6.1%) were not satisfied with the cosmetic effect (the catheter visible under the skin); all of these patients had their access inserted through the right internal jugular vein (Fig. 3). None of the respondents complained of everyday life limitations resulting from the presence of vascular ports or necessary periodic flushing of the system.

DISCUSSION

A vascular port is a convenient and quick vascular access for both patients and medical personnel. Physicians planning the treatment and anticipating its long-term

Table 2. Catheter location and complications in patients with implanted vascular ports

Feature		Number of patients	%
Number of vascular port implantations		212	100
Catheter location			
	Right subclavian vein	165	77.8
	Left subclavian vein	14	6.6
	Right internal jugular vein	32	15.1
	Left internal jugular vein	1	0.5
Early complications			
	Technical problems during procedures	12	5.7
	Artery cannulation	1	0.5
	Pneumothorax requiring decompression	2	1
	Correction of catheter length required	3	1.5
	Port dislocation related to body position	2	1
Late complications			
	Port rotation (with pneumothorax)	1	0.5
	Catheter damage — pinch-off syndrome	1	0.5
	Bacteraemia	3	1.5
	Complete system occlusion	2	1
	Functional valve occlusion	56	26.4

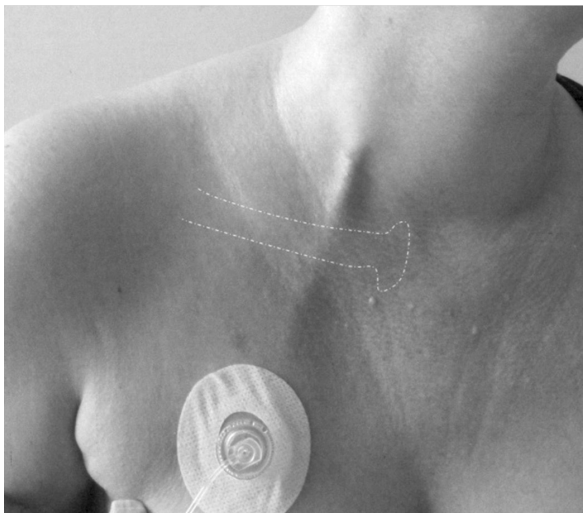

Figure 3. Unfavourable cosmetic effect after vascular port placement from right internal jugular vein access. The vascular catheter placed under the skin is clearly visible. The effect intensifies with head rotation towards the side opposite to insertion. The clavicle was outlined in white

nature should consider indications and contraindications for the use of vascular ports. Attending physicians planning vascular port implantations and those performing the procedures should have appropriate knowledge to detect and treat potential complications. Once the guidelines for safe implantation and use of vascular ports are followed, the port can be fully used during treatment, is safe for patients and contributes to improvement of their quality of life [5, 6].

On the suggestion of the national consultant in clinical oncology, on January 20, 2006, a consensus meeting of physicians experienced in vascular port implantation from various Polish centres was held in Warsaw. The working group enhanced the document (guidelines) containing crucial issues related to such procedures, i.e., selection of patients, indications and contraindications, implantation-related safety standards, post-procedure care, treatment of thrombotic and embolic complications [1]. The guidelines are extremely helpful in implementation of vascular port implantation procedures.

Our data indicated that the number of severe complications was low. We believe that the radiographic detection of pneumothorax 24 hours after the procedure indicates that despite routine radiologic monitoring of the procedure in real time, standard imaging 2 hours after the puncture is definitely necessary. During vascular port implantations, as on insertion of any type of central access, the risk of severe complications, e.g., pneumothorax or haemothorax, can be additionally reduced using routine ultrasound assessment at the stage of vessel identification [7]. Central vessel cannulation skills are essential for successful procedures. The surgical stage is simple and there were no complications related to it. However, each patient should be managed individually; his/her body structure, nutritional status, tissue compactness and skin relaxation resulting from body weight loss should be considered. Spontaneous dislocation of the port and the catheter associated with body position (recumbent/erect) is likely to be substantial. The ana-

tomic structures used to measure insertion site may not be a reliable method for insertion. Catheters located too deep can induce cardiac arrhythmias, which, considering the long-term nature of vascular access, require immediate shortening of the catheter. In contrast, catheters that are too short are associated with the risk of slipping from the vessel. In one case of port dislocation, the catheter was found to dislocate by almost two intercostal spaces (4–6 cm) depending on the patient position. Firm stabilisation of the vascular port to the pectoral facia with sutures prevents such complications. In obese patients, however, deep placement of the port under the skin results in its difficult palpability and thus markedly hindered or infeasible management. In such cases, the authors advise shallower stabilisation of the port within the subcutaneous tissue near the clavicle following assessment of tissue mobility.

The catheter placement in the subclavian vein is associated with the risk of pinch-off syndrome, i.e., various extents of damage to the port-catheter system, resulting from the mechanical compression between the bony structures (clavicle-first rib) [1]. The catheter wall breakage detected in our material required the replacement of the system and provision of another central access. The consequences of pinch-off syndrome described by other authors are more serious, ranging from disconnection of the system to catheter fragmentation resulting in pieces of the catheter travelling to the ventricle [8]. Considering the above risks, the change from subclavicular access to jugular access introduced during the last 6 months of observation is well-grounded. Fluid infusions through the vascular port using the internal jugular vein seem easier and to date no occlusions of the system have been observed. It is important to note that some of the vascular ports available on our market, often high-quality ones, are not designed to be inserted through the subclavian vein, most likely due to possible development of pinch-off syndrome (e.g., AngioDynamics, Inc. USA). The jugular access is presented favourably in the literature [9]. In our study, in some patients with such accesses, the catheter was visible under the skin. Nagel and colleagues [6] demonstrated that unfavourable cosmetic effects might be correlated with lower satisfaction of patients.

Except for a few cases, the first infusions through vascular ports in our patients were performed after suture removal, i.e., after approximately 1 week. No early infections were observed and wounds healed normally. According to French authors, the risk of various complications was two times lower if infusions were initiated between post-procedure day 4 and 7 compared to day 0–3 [10]. The early use of the port as a risk factor for complications was supported by other French authors. They found that some chemotherapeutics (e.g., bevacizumab) were particularly predisposing to wound dehiscence and secondary infections after their early infusion [11].

Infectious complications related to port use can vary in severity and nature [1, 12]. We believe that a low number of such complications in our study results from personnel experienced in port operation, particularly the oncologic ward staff, and following the hospital standards for vascular port management. According to some authors, the additional risk factors of infection include the type of cancer, treatment protocol, fitness of patients, frequency of infusions and parenteral nutrition [13]. Moreover, taurolidine, which is used for filling the port chamber and catheter, may be helpful in preventing and treating catheter-related infections, either directly after use or during periodic flushing.

Patency maintenance-related complications (¼ of patients) were predominantly "valve occlusion" in nature (inability to aspirate blood from the vascular port with efficient supply). Due to such occlusions, additional peripheral punctures of veins for blood sampling are necessary. In several cases, flushing of the system with normal saline plus heparin at slightly increased pressure performed at several-hour intervals restored full patency of the system. An interesting solution in cases of occlusion was put forward by researchers from Lyon, who flushed the port chamber with the solution of urokinase using the system of two needles (inflow/outflow). According to the authors of this method, the management was effective in all cases of occlusions inside the vascular port [14]. Flushing of the system after infusions and in the periods when the port is not used is crucial for maintaining its efficiency. Nevertheless, the quality of procedure rather than the agent used is essential, which is confirmed by both retrospective and prospective studies [15, 16]. There have been no differences in maintaining patency between the heparinized solution of NaCl and 0.9% NaCl alone. Additionally, the orientation of the Huber point needle bevelis likely to be important. Fluid injection through the port chamber opposite of the outlet increases the efficiency of flushing [17]. Detailed analysis of our complete occlusion complications revealed that they resulted from negligence and not adhering to the protocol. Considering the available literature reports and our experience and observations, the use of 10–15 mL of 0.9% NaCl for this purpose seems justified [15, 16]. The use of ampoule syringes is particularly recommended and is associated with improved patency of the system and reduced incidence of infectious complications [18]. The frequency of vascular port flushing seems less relevant. Ignatov and co-workers [19] demonstrated that intervals extended to 4 months had no effect on the system patency.

Our patients confirmed high satisfaction with the vascular port placement. Nagel and colleagues [7] showed that the predictors of patient well-being include good cosmetic effects and lack of pain in the port region. Therefore, no efforts should be spared to perform implantation procedures using a low invasive technique. A substantial proportion of respondents believe that port implantation should be performed at some earlier stage of oncologic treatment, which could save them unnecessary suffering attributable to increasingly difficult placements of peripheral access, usually after several failed attempts. This is also supported from the medical point of view, as early port implantation in patients with less advanced cancers has been shown to be correlated with lower incidence of port-related complications [20].

CONCLUSIONS

1. Vascular port implantation is a safe procedure associated with low incidence of severe complications.
2. The most port-related complication in our population was functional valve occlusion.
3. Treatment with the use vascular ports is highly appraised by patients.

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Corresponding author:
Jerzy Paleczny, MD, PhD
Intensive Care Unit, Beskid Oncology Centre
Municipal Hospital in Bielsko-Biała
ul. Wyzwolenia 18, 43–300 Bielsko-Biała, Poland
tel.: +48 33 498 40 33
fax: +48 33 816 44 01
e-mail: j_pal@wp.pl

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Assessment of satisfaction with vascular port implantation
Questionnaire for patients

Name and Surname:						Date:		
Date of port insertion:						Pat. No.		
Port location:								
qualification	1.	I am satisfied with port implantation	-2	-1	0	+1	+2	
	2.	Repeated intravenous injections are bothersome	-2	-1	0	+1	+2	
	3.	IV line injection is painful	-2	-1	0	+1	+2	
	4.	I will agree for another procedure, if need be	-2	-1	0	+1	+2	
	5.	I believe that the port should have been inserted at the earlier stage of disease	-2	-1	0	+1	+2	
	6.	I was sufficiently informed about the procedure type	-2	-1	0	+1	+2	
procedure	7.	I was scared before surgery	-2	-1	0	+1	+2	
	8.	I was anxious during surgery	-2	-1	0	+1	+2	
	9.	I felt pain during the procedure	-2	-1	0	+1	+2	
	10.	I was achy after surgery	-2	-1	0	+1	+2	
	11.	There were problems with wound healing	-2	-1	0	+1	+2	
Use after the procedure	12.	I felt safe during surgery	-2	-1	0	+1	+2	
	13.	I am satisfied with anaesthetic care	-2	-1	0	+1	+2	
	14.	I am satisfied with management provided by the physician performing the procedure	-2	-1	0	+1	+2	
	15.	I feel pain at the site of port insertion	-2	-1	0	+1	+2	
	16.	Injection of the needle to the port is painful	-2	-1	0	+1	+2	
	17.	Port flushing is troublesome	-2	-1	0	+1	+2	
	18.	The presence of the port makes me feel uncomfortable	-2	-1	0	+1	+2	
	19.	The presence of port causes limitations in everyday life	-2	-1	0	+1	+2	
	20.	Mobility of the hand on the port side is limited	-2	-1	0	+1	+2	
	21.	I would want to have my port removed as quickly as possible	-2	-1	0	+1	+2	

Key:
-2 I disagree very much
-1 I disagree to some extent
0 I do not know – difficult to say
+1 I agree very much
+2 I agree to some extent

Physician's signature

Comments:

Additional information: