IJBC 2013;3: 107-114

How to Care for Implanted Ports

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Submitted: 11-01-2013 , Accepted: 15-04-2013

Abstract

Implantable ports are used for intravenous infusion therapy and play an important role in management of oncology patients with malignant diseases. These ports are best suited for patients requiring long-term therapy (>4 weeks). Implanted ports provide reliable venous access; protect peripheral access; increase patients' comfort through reducing repeated and difficult vein punctures; allow for safe and comfortable administration of concentrated solutions, vesicants or irritants with minimal risk of extravasations and chemical phlebitis; help patients avoid anxiety related to repeated vein puncture and provide a better quality of life. Implanted port systems and their needles are from a variety of types and materials. They are inserted with a surgical technique through an incision into subcutaneous tissue commonly in the upper chest wall. Implanted ports need some care including: flushing, locking, dressing, change of needle and minimizing the risk of contamination by scrubbing the access port with an appropriate antiseptic. The aim of this review is to provide evidence on managing port systems in order to improve practice, boost patient outcomes and reduce complications and health care costs.

Keyword: Implanted port, care, chemotherapy.

Introduction

Over the last few decades, many management changes have occurred in oncology settings, particularly with respect to new chemotherapy combinations. Implantable port systems which resolve the problem of vascular access [1] have become an essential prerequisite for many chemotherapy protocols for solid tumors and hematological malignancies and are extensively used world-wide [2]. Implantable ports which were first introduced in 1982 by Niederhuber are currently implanted with a high success rate and are routinely used in oncology, facilitating long-term chemotherapy and other procedures [3]. They have definitely changed the quality of life among cancer patients [4]. These ports are used for safe administration of chemotherapy, antibiotics, parenteral nutrition, frequent draw of blood for laboratory tests, transfusion of blood and blood products and contrast media injection [5; 6, 7; 8; 9; 10].

These ports can be placed in chest, forearm or upper arm [5]. Implantable port systems have some merits and disadvantages. Merits of using these kind of ports are being a more acceptable cosmetic option; allowing better bathing, swimming and playing [8]; no need for external dressing; possibility of patient mobility and probably being less prone to infectious complications and minimizing the occlusion rate of the catheter compared to non-totally implantable catheters [4]. They may appeal to patients concerned about the presence of the visible external part of non-implanted catheters, but they are more expensive to purchase; difficult to insert and remove; and also leave larger scars [11]. Patients selection is an important criterion for placing a port. Malnourished patients are best to be avoided since the tissue will not hold the port and the skin over the port may get necrotic. Patients who have an infection or are suspected to have infection should be appropriately treated with antibiotics before placing the port. Ideally the blood lab test results should be near normal at the time of placing the port. For this reason it is

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recommended that the port should be inserted at the onset of chemotherapy treatment rather than after the first period of treatment by peripheral vein punctures [8]. Despite the fact that these ports have been shown to have the lowest reported rates of catheter-related bloodstream infections compared with other central venues catheters (CVC), patients should receive clear and comprehensive verbal and written information explaining the risks, benefits and the method of catheter care. Signed consent should also be obtained prior to catheter insertion [10].

Materials and Methods

This article reviews the current literature on implanted ports based on published research articles in the past ten years. International journals on Medline database, guidelines, recommendations, Centers for Disease Control and Prevention (CDC) guidelines, national guidelines, Evidence Based Practice in Infection Control and oncology society recommendations were searched using the keywords "implanted ports", "oncology" and "chemotherapy".

Implanting the port

Insertion of an implantable port should be performed under strict sterile conditions using sterile gloves, gowns, caps and masks in the operating rooms [11, 12, 13, 14] and under local anesthesia, with or without sedation (general anesthesia is required for most pediatric patients). Insertion should be done by experienced and competent professionals [15]. The nurse and patient wear mask during procedure to reduce the possibility of airborne contamination [16]. Insertion of implantable ports is very similar to the insertion of tunneled central venous catheters; they do not exit the skin, but terminate with a device buried in the subcutaneous tissues [17]. Implantable ports are placed via the subclavian or jugular vein [18]. Subclavian venous puncture catheterization is recommended as the standard implantable central venous access port, because of its easy and quick manipulation [19]. In general, devices for central-venous access are inserted through percutaneous to access the right or left internal jugular or subclavian vein by applying Seldinger technique, over a guide-wire with split-sheath technology. Some surgeons prefer surgical cut-down of the internal jugular or subclavian vein for the insertion of the catheter. The right subclavian vein is generally preferred to the left, because the left is the innominate vein and forms a more acute angle with the vena cava and on the other hand the ductus thoracicus lies on the left side. Therefore, when the surgeon pushes the catheter, it may strike against the external wall of the vena cava at the level of this angle. Resistance can occur when the catheter is pushed downwards, and the catheter guide-wire could injure the endothelium [18, 20]. The anterior upper chest wall is the most commonly used site, but antecubital area of the forearm or upper arm or the abdomen and groin may also be used if there is disease involvement of the chest wall [21]. The catheter enters the venous system, commonly through the subclavian vein. As in other central venous access devices, the catheter tip resides in the superior vena cava and its end sits above the right atrium [6, 9, 22].

Patients with head and neck cancer may have undergone radiation in the neck and upper thorax adjacent to the insertion site of the implanted port but it is suggested that both subclavian and arm implanted ports are feasible in patients with head and neck cancers [23]. Typically the catheter tip position is verified radiologically. Postoperative chest radiography is performed routinely to detect inadvertent pneumothorax and to confirm correct catheter tip placement [24]. This is important because accurate position is necessary for proper functioning of the port. The desired location of the catheter tip is at the junction between the right atrium and superior vena cava [15] but the ideal position is between the lower third of the superior cava vein and the upper third of the right atrium; that should preferably be checked during the procedure [25]. The functionality of the catheter is immediately checked after insertion, e.g. assessing the presence of blood return and ability to flush the device easily [26]. The port can then be anchored to the deeper tissues using sutures and the subcutaneous incision can be sutured and dressed [9]. The practitioner should ensure that the port is placed below the intended suture line in order to prevent port cannulation through scar tissue. Catheter malposition may occur during insertion or days to months after insertion. Possible causes include vigorous use of upper extremity; forceful flushing of the catheter; changes in intrathoracic pressure associated with coughing, sneezing, vomiting or

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constipation; and congestive cardiac failure or catheter foreshortening [9].

The ports can be used on the first day of implantation or immediately after [8], but approximately one week interval between the implantation and the first use of implantable port for administration of chemotherapy may reduce the likelihood of complications and the need for premature device removal [27, 28].

There is no need for routine administration of systemic antimicrobial prophylaxis before the insertion or during the use of an intravascular catheter to prevent catheter colonization or catheter-related bloodstream infections (CRBSI) [11, 12, 13, 29].

Removal of the port

Removal of the implantable port is indicated when therapy via the device is no longer needed, or if complications, such as catheter migration and infection develops [15, 20]. According to a review by Vescia1 et al. [1], routine device removal cannot be recommended for every patient with central venous port related infection. Port systems must be removed in case of persistent sepsis/bacteremia or relapse of infection after antibiotic treatment, appearance of signs of port infection, unstable patients, systemic complications (e.g. septic thrombosis/embolism, osteomyelitis, abscess formation or endocarditis), or detection of certain microorganisms such as Staphylococcus aureus or Candida species, as these are often associated with systemic complications and low success rates with catheter salvage [1].

Removal of implantable port is a surgical procedure which should be carried out using strict aseptic techniques. An incision should be made into the fibrous tissue which forms around the port, the anchoring sutures should then be cut and the port can be removed, ensuring that the entire catheter length is pulled from the venous system [15, 20]. The tip of the withdrawn catheter should always be inspected to make sure that it is intact, the subcutaneous incision can then be sutured and dressings applied [30]. Although removal of a port is usually a simple procedure, if a catheter has been in place for a very long period, it may adhere firmly to the vessel wall. In these cases some unexpected difficulties can be encountered [31].

The structure of ports

Most ports are single lumen [10] made of stainless steel/titanium or plastic that contains a compressed latex septum. The portal chambers are connected via a small tube to a polyurethane or silicone catheter that is inserted into the blood vessel. There are a variety of ports: vascular system (intravenous or intra-arterial), intra peritoneal and epidural. Ports are available in both adult and pediatric sizes [26]. Most catheters are made from silicone or polyurethane. Catheters made from silicone that is a soft biocompatible material, provide benefits for the patient as the material reduces the adherence of fibrin to the catheter and offers increased biocompatibility, thus the risk of complications such as thrombosis or occlusion are reduced. Polyurethane is a stronger, firmer material, which allows the walls of the catheter to be thinner while still providing the same lumen diameter. This material softens following insertion in response to body temperature and offers increased biocompatibility and less adherence of fibrin when compared to other materials. It is a safe, well tolerated device that can remain in place for many years [26, 32]. The lifetime of catheters is depending on insertion techniques and sterility, catheter care, infection, thrombosis and mechanical wear with repeated use. Port membranes deteriorate as a result of repetitive punctures (manufacturers state 1000 ± 2000 punctures depending on needle gauge used). Such devices have the best survival rates of all long-term access devices [1, 11, 20]. There is not enough information about implanted port maintenance for an extended period of time after completion of therapy [13]. Ports made of titanium or plastic are magnetic resonance imaging (MRI) compatible. Plastic ports cause only minimal if only imaging artifacts, where as titanium ports cause minimal artifact on CT and only local artifact on MRI [32].

Power injectable ports

Many clinicians and physicians wonder if central lines could be power injected. Many central lines are not approved for power-injection use and have a maximum capability of 25 psi Catheters must be tested and approved to stand the pressure of 300 psi or greater to be used for power injected contrast media. To be used for power injection, the power-

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injectable port must also be accessed with a non-coring Huber needle that has the manufacturer approval for power injection with 300 psi for 19 and 20 gauge needles [33, 34]. Power injectable port needles are labeled and some are color coded. Instead of only stocking power injectable port needles, many institutions keep both power and non-power injectable port needles. Placing a power injectable port needle into a non-power injectable port could be considered mislabeling of the port. Maximum flow rates for 19-gauge, and 22-gauge power injectable needles are 5ml/second and 2ml/second [35]. Implanted ports may be used for power injection if the manufacturer provides documentation of psi capability. Based on the FDA recommendations three points should be considered when power injecting: 1. Check the labeling of each vascular access device for its maximum pressure and flow rate. 2. Know the pressure-limit setting for the power injector and how to adjust it. 3. Ensure that the pressure limit set for the power injector does not exceed the maximum labeled pressure for the vascular access devices [33]. If power injectors are used with implanted ports that are not designed to withstand pressures generated by the injectors, catheter ruptures may occur. Catheter rupture can lead to extravasation of vesicant contrast dye, catheter fragment emboli in the right atrium or pulmonary artery, and the need for port removal and replacement [35].

How to care for ports

Hand hygiene remains a key measure in reducing nosocomial infections in health care setting. Health care workers' hands are frequently contaminated by organisms acquired from colonized patients and their immediate environment, and these may be readily become transmitted to other patients in the absence of adequate hand hygiene [14]. Hand hygiene should be performed before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter. Hands shall be washed with an antimicrobial soap [13, 16].

Skin cleansing and antisepsis preparation of the insertion site is one of the most important measures for preventing catheter related infections. Clinical management of vascular access devices requires sterile technique because their correct maintenance increases the benefits to the patient and decreases the risk of serious complications. Infections can be minimized by careful hand washing and catheter site care [36]. It has been shown that wearing sterile gloves and disinfecting the skin with 2% chlorhexidine based preparations reduce the catheter-related infections most effectively [11]. Chlorhexidine has been shown to have a residual effect for up to six hours after drying. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor or 70% alcohol can be used as alternatives [13]. Skin asepsis can be performed by applying 2% chlorhexidine gluconate in 70% isopropyl alcohol in a circular motion beginning in the center of the proposed site and moving outward to approximately 3 inch. This procedure is repeated two times, for at least 30 seconds. This step should be repeated by using a new swab for each application. Allow air dry completely prior to inserting the catheter [16] .

Needles

The needles used to access a port are specially designed to prevent damage to the port septum. They have a flattened or off set bevel and are called non-coring or Huber needles. They are available in gauge size from 19 to 22 G and lengths ranging from 15 to 25 mm. Needle length depends on how superficially or deeply the septum lies (may need a longer needle; if port is very deep). When using an implanted port for continuous infusions, there is insufficient evidence to support the optimal time for replacement of the non-coring needle. But more resources recommend that non-coring needles must be changed every seven days unless there is an indication to change them sooner [11, 12, 26, 37]. In this regard, Pittiruti et al. [25] emphasized that non-coring needles should not be left in place for more than a week [25]. While Karamanoglu et al. stated that Huber needles can be left in place up to several weeks without any unwanted effect as long as proper aseptic technique is used [38]. They expressed that this procedure helps patients avoid stress and anxiety related to needle insertion. Portal septum life could be extended by fewer access exposures, and infrequent changing of the Huber needles may be the best option for countries that have limited healthcare resources [38]. Vescia1 et al. state that the needle can be kept in place for 72 hours, but should be replaced after 24 hours when used for administering blood products

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or lipid emulsions [1]. The CDC has published no recommendation regarding the frequency of replacing needles to access implantable ports [13].

Flushing of the implanted ports

To prevent CRBSI, a wide variety of antibiotics and antiseptic solutions are used to flush or lock catheter lumens [13]. Two purposes for routine flushing of implanted ports are maintaining catheter patency and preventing the mixing of incompatible medications or solutions and /or cleansing the catheter lumen of blood or fibrin buildup. Catheter lock is a technique by which a solution is used to fill a catheter lumen and then allowed to dwell for a period of time while the catheter is idle and prevents blood from backing up into the catheter lumen. Flushing procedures before, between and after administrating the medications should be established to reduce the risk of occlusion [39, 40]. Flushing with the correct solution and technique is essential to maintain catheter patency [41]. Administered volume of the flush solution should be equal to at least twice the volume of the catheter [39, 40]. Garland et al. suggest that antibiotic lock solutions may well be effective for prevention of catheter related bacteremia associated with long-term central devices, such as subcutaneous central ports [42]. Antibiotics of various concentrations which are used either alone or in combination to prophylactically flush or lock central venous catheters include vancomycin, gentamicin, ciprofloxacin, amikacin, cefazolin, cefotaxime and ceftazidime; while antiseptics include ethanol, taurolidine, trisodium citrate (Taurolidine and trisodium citrate are not approved for this use in the United States). These agents are usually combined with a compound acting as an anticoagulant, such as heparin or EDTA. Altogether there are no FDA approved formulations approved for marketing, and most formulations have been prepared in hospital pharmacies [13]. There was insufficient evidence to support the routine use of an antibiotic flushing solution, because of the risk of resistance [43].

Anticoagulant flush solutions are used widely to prevent catheter thrombosis. Because thrombi and fibrin deposit on catheters might serve as a nidus for microbial colonization of intravascular catheters, the use of anticoagulants might have a role in the prevention of CRBSI [44]. There is a close association between thrombosis of central venous catheters and infection therefore, anticoagulants are used to prevent catheter thrombosis and presumably reduce the risk of infection [13]. Routine flushing of implanted ports with heparin remains controversial [10], there is a lack of randomized controlled trials supporting the benefits of heparin flushes [43]. In most instances the concentration of heparin is determined according to manufacturers' recommendations and clinicians' experience.

In vitro results gained from a study by Shanks et al. indicates that heparin actually stimulates the growth of biofilm, the polysaccharide matrix known to be the most important factor in the pathogenesis of catheter infection [44]. Exposure to heparin should be minimized to prevent the development of heparin-induced thrombocytopenia (HITS) and to avoid development of bleeding complications because of inadvertent heparinization secondary to multiple heparin flushes [10].

Little is known about proper interval periods between the flushing of implantable ports after completion of chemotherapy but some sources recommend that before the removal of an access needle from an implanted port and/or for periodic access and flushing, the device should be locked with heparin lock solution 100 units/ml every 4 weeks [11, 26, 45].

Positive pressure has long been suspected to play a role in the reduction of distal catheter reflux; its application during needle withdrawal from implanted port is now recommended in clinical practice [46, 47].

Complications

Implanted ports provide safe and reliable vascular access for patients on chemotherapy in general but are not without complications [2]. Although insertion and placement problems are rare with modern access and imaging techniques, catheter related infections, thrombosis and loss of function continue to be present. The complications of implanted ports can be classified into 2 main categories: (A) early (intra operative and post implantation period to first use) and (B) late complications. Early complications which are related to central venipuncture for catheter insertion are by definition, those arising between 24 hours and 4 weeks after implantation, while late complications are those arising more than 4 weeks

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after implantation [34].

Early complications are: air embolism, pneumothorax, hemothorax, accidental arterial puncture, cardiac arrhythmia, pericardial tamponade, and brachial plexus injury. Air embolism is usually self-limiting and the symptoms resolve within minutes, although outcomes of large gas emboli are associated with bradycardia, high morbidity, and mortality [48].

Late complications are: catheter-related bloodstream infection, superior vena cava erosion and perforation, pinch-off syndrome, pocket infection, difficult access of the port (port inversion), extravasation, thrombosis, catheter dysfunction, catheter rupture, catheter migration, and catheter embolization [15, 49].

Infection remains a major problem in cancer patients who have implanted ports. According to the guidelines from the CDC, the density of skin flora at the catheter insertion site is a major risk factor for catheter-related bloodstream infections [12]. Infectious complications with implanted ports in the range of 4.8-8.8% have been reported in the literature [2]. Erosion or damage to the skin above the port occurs frequently, and is usually secondary to: (a) error during placement (choice of a too big port or positioning of the port in an area of the body where there is an inadequate layer of subcutaneous fat) or (b) inappropriate nursing (e.g., a Huber needle left in place for more than a week) [25].

Pinch-off syndrome which refers to entrapment of subclavian catheters between the clavicle and first rib may occur in as many as 1% of all long-term central venous catheterizations via the subclavian vein. The compression may lead to malfunction, obstruction, damage and even fracture of the catheter, with embolization of part of it into the pulmonary. The condition needs to be recognized, and there are characteristic X-ray appearances showing scalloping of the catheter on plain chest X-ray [20, 25].

Incomplete needle placement occurs when non-coring needles do not penetrate the septum of the port and their tips reside in the tissue overlying the portal body. Non-coring needles also can be misplaced on the metal or plastic that surrounds the port septum. These needles are ''on'' the port, and are not properly placed in the septum of the port. In both of these instances a blood return is not obtainable and fluids or medications will infiltrate into the tissue when they are administered. If vesicant chemotherapy is administered, an extravasation will occur [49].

Conclusion

The implanted port requires minimal care and allows the patients completed freedom of activity and have a high acceptance among patients as well as doctors. Health care professionals should be trained in order to improve patient outcomes and must recognize the complications by their signs and symptoms and take necessary actions. Educating about infection prevention and how to increase port systems' life span is essential.

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