

1000 Port-A-Cath[®] Placements by Subclavian Vein Approach: Single Surgeon Experience

S. Mudan · A. Giakoustidis · D. Morrison ·
S. Iosifidou · R. Raobaikady · K. Neofytou ·
J. Stebbing

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Abstract

Introduction Totally implantable venous access ports are widely used for the administration of chemotherapy in patients with cancer. Although there are several approaches to implantation, here we describe Port-A-Cath[®] (PAC) placement by percutaneous puncture of the subclavian vein with ultrasonographic guidance.

Patients and methods Data on our vascular access service were collected prospectively from June 2004. This service included port-a-caths and Hickman lines. Once 1000 consecutive port-a-caths[®] had been reached the study was closed and data analysed for the port-a-caths[®] alone. The left subclavian vein was the preferred site for venous access, with the right subclavian and jugular veins being the alternative choices if the initial approach failed. Patients were followed up in the short-term, and all the procedures were carried out by a single surgeon at each one of two institutions.

Results Venous access by PAC was established in 100 % of the 1,000 cases. Of the 952 patients where the left subclavian vein was chosen for the first attempt of puncture, the success rate of PAC placement was 95 % ($n = 904$). Pneumothorax occurred in 12 patients (1.2 %), and a wound haematoma occurred in 4 (0.4 %) out of the total 1,000 patients. No infections were recorded during the immediate post-operative period but only in the long-term post-operative use with 8 patients requiring removal of the PAC due to infection following administration of chemotherapy.

Conclusion This is a very large series of PAC placement with an ultrasound-guided approach for left subclavian vein and X-ray confirmation, performed by a single surgeon, demonstrating both the safety and effectiveness of the procedure.

Introduction

TIVAPs provide long-term central venous access, which are instrumental to adult and paediatric cancer patients who

during treatment require intravenous chemotherapy, multiple phlebotomies, contrast for scanning, and in some cases parenteral nutrition [1]. Compared to external catheters, TIVAPs permit a wider range of patients activity and are less prone to device-related complications such as the infection and catheter-related bacteraemia or thrombosis [2, 3].

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S. Mudan · K. Neofytou
Department of Academic Surgery, The Royal Marsden NHS
Trust, Fulham Road, London SW3 6JJ, UK

S. Mudan
Department of Surgery and Cancer, Faculty of Medicine,
Imperial College, London W2 1PG, UK

S. Mudan · A. Giakoustidis (✉) · D. Morrison · S. Iosifidou
Department of Surgery, The London Clinic, 116 Harley Street,
London W1G 7JL, UK
e-mail: alexgiakoustidis@gmail.com

Venous access devices can be introduced through a number of vessels including the jugular, subclavian, and upper extremity veins [1, 2]. The two methods for TIVAP placement are the direct percutaneous puncture of a central vein and insertion of a catheter by the Seldinger technique and open insertion by cut down onto the distal cephalic or external jugular vein and sometimes the internal jugular vein. Although haematoma, catheter misplacement, and wound infection are common to both methods, pneumothorax and haemothorax are reportedly more frequent following implantation by the Seldinger technique [4–8]. At present, the radiologically assisted percutaneous approach is preferred to the traditional surgical approach, due to its technical success rate, and safety and reduced morbidity [9, 10]. Some investigators have reported that PAC devices can be placed safely without the aid of catheter-localizing devices or intraoperative imaging in order to reduce cost and surgical time [11, 12]; however, UK guidelines for the placement of central venous catheters (CVCs) recommend that an ultrasound-guided technique should be adopted as it is associated with a reduced incidence of complications [13, 14].

This study describes the single surgeon experience of 1,000 consecutive TIVAP placement procedures with ultrasonographic guidance and X-ray confirmation in oncology patients.

Materials and methods

Using the prospectively collected database of all surgical procedures performed between June 2004 and January 2014, we identified all the vascular access procedures. The patients data were collected and reviewed for incidence of procedural and early post-operative complications. The short-term follow-up was done by the surgical team and the long-term follow-up by the oncology team in the two institutions. The immediate follow-up care includes clinical assessment by the surgical team to ensure the functioning of the port and the wound healing. The long-term follow-up ensures the optimal functioning of the port with no complications arising. If there were suspicion of complication, X-ray would be performed to confirm the position of the catheter, and in some cases if necessary an U/S would be required to exclude thrombosis of the vein. In

A. Giakoustidis
Barts Cancer Institute, Queen Mary School of Medicine and
Dentistry, London EC1M 6BQ, UK

R. Raobaikady · J. Stebbing
Department of Oncology, Imperial College Healthcare National
Health Service Trust, Charing Cross Hospital, Fulham Palace
Rd, London W6 8RF, UK

case of suspected infection of the port which could not be managed conservatively with antibiotics, the port was removed as the possible cause of sepsis and the tip of the catheter was sent for culture and sensitivity.

All patients were treated and monitored in a day-case setting. Preoperative evaluation consisted a standard process of a thorough assessment of the patient's clinical history with a physical examination to detect any possible anatomic pitfalls (e.g., clavicle fracture, cervical or mediastinal masses, chest wall lesions, body habitus, the presence of rotation flaps, etc., as part of head and neck or breast reconstructive surgery) as well as any significant vascular access history, including any prior incidence of central vein thrombosis, infection, or pneumothorax. All the patients were advised to have port placement on the left side through a subclavian vein access except those with left breast surgery, left chest wall tumour, left axillary dissection, known left subclavian or left internal jugular vein thrombosis, and if there was a specific patient preference for the right side, for example a professional violinist. Informed consent was obtained from all patients, as well as a full blood count and coagulation test.

Port devices from two manufacturers were used Bard and PFM Medical, and in all cases, a port with separately attachable catheter was deployed.

Operative technique

The procedure is performed under general anaesthesia except where the anaesthetic hazard was thought to be high and in which cases the procedures were performed under sedation with propofol. A single prophylactic dose of 1.2 g Augmentin or an alternative antibiotic in cases of penicillin allergy was administered at the time of anaesthetic induction. The patient is placed on the operating table in the supine position and then Trendelenburg. A radiolucent support is used between the scapulae and a head ring used to support and maintain stability of the neck. The chest, shoulders, and neck to the level of the mandible are prepared on both sides of the patient and draped to allow visual access to both subclavian and internal jugular veins. Ultrasound is used for image of the subclavian vessels and to locate the vein, lying more superficially and slightly caudal to the artery (Figs. 1, 2). The first rib can be seen with the vein passing across. For the duration of the data collection period, the left subclavian vein was the preferred site of access (except for patients with preference for the right side or previous surgery for left-sided breast cancer). In the period from 2004 to 2010, vein puncture was attempted in the middle portion of the subclavian vein as is common practice. Thereafter, a puncture in the lateral third part of the subclavian vein was preferred. Once accessed by

needle puncture, the guide wire is passed into the right atrium, and the location is confirmed by X-ray. The vein dilator is then passed over the wire into the subclavian vein. Next the port pocket is fashioned with the incision situated at the level of the second intercostal space and the pocket created caudal to the incision such that the port will come to lie with its centre 2 cm below the skin incision and deepened to the level of the deep fascia in slim individuals or more superficial in patients with a great deal of subcutaneous fat. For women with pendulous breasts, the incision is correspondingly cephalad to compensate for the descent of the port when the patient is in the sitting position. The catheter is tunneled from the port pocket using the guide rod, and the dilator stylus and guide wire are removed to allow exchange of the catheter through the dilator sheath. The tip is adjusted to lie in the mid atrial position under X-ray screening. The catheter is then tested for good antegrade and retrograde flow and then trimmed and attached to the port with the securing cuff. The port is then placed and secured with sutures to the deep fascia with 2/0 prolene sutures, and the final position is checked again with X-ray and function by flushing with heparinised saline. The port pocket is then closed with interrupted 2/0 vicryl sutures to the subcuticular layer and subcutaneous vicryl 3/0 suture to the skin, with Op-site® spray applied and Steri-strips® placed. If the chemotherapy infusion is scheduled to commence within 4 days after the insertion of the port, an access needle is placed and the port is flushed with heparin saline. Gauze dressings are applied and covered with waterproof dressing to make it convenient for the patient to shower but they are instructed not to disturb the dressings but leave this for the nurses at the treatment centre. A chest X-ray is obtained 1–2 h following port placement, to reconfirm the position of the catheter and



Fig. 1 Preparation of the kit used for the vein catheterisation and port-a-cath® placement



Fig. 2 Puncture of the subclavian vein with U/S guidance

position of the tip, and to rule out complications, such as pneumothorax (Fig. 3a, b). All patients were reviewed by the surgical team prior to discharge.

Results

A total of 1,000 patients underwent PAC placement (mean age: 59 years, range: 19–86 years, 524 women and 476 men). There was a 100 % success rate of port-a-cath insertions as all 1,000 patients were discharged with a functioning port placed. Left subclavian vein puncture was attempted in 952/1,000 (95.2 %) cases. However, in 46/1,000 (4.6 %) patients, the right subclavian vein was the first choice for puncture for the patients having a preference for the right side, a history of cancer in the left breast, prior evidence of left subclavian vein thrombosis, and the presence of a pace maker wire on the left side. The right jugular vein was the first site of puncture in 2/1,000 (0.2 %) patients. (Table 1)

Up to 2010, the middle third of the subclavian vein served as the access point, as is typically described for this technique. From 2010, the access point was changed to the lateral third of the vein. This was considered to be a better approach as the needle would be less likely to cause pneumothorax as the access point lies lateral to the first rib.

Successful access to the left subclavian vein was obtained in all cases where this was attempted first ($n = 952$). However, in 48 cases, the wire could not be threaded despite puncture giving a catheterisation success rate of 95 %. In cases where it was not possible to pass the guide wire, access was obtained at alternate sites—either right subclavian or internal jugular vein.

Pneumothorax occurred in 12 patients (1.2 %), and patients were treated according to well-established UK guidelines (Table 2). The median BMI for the patients with

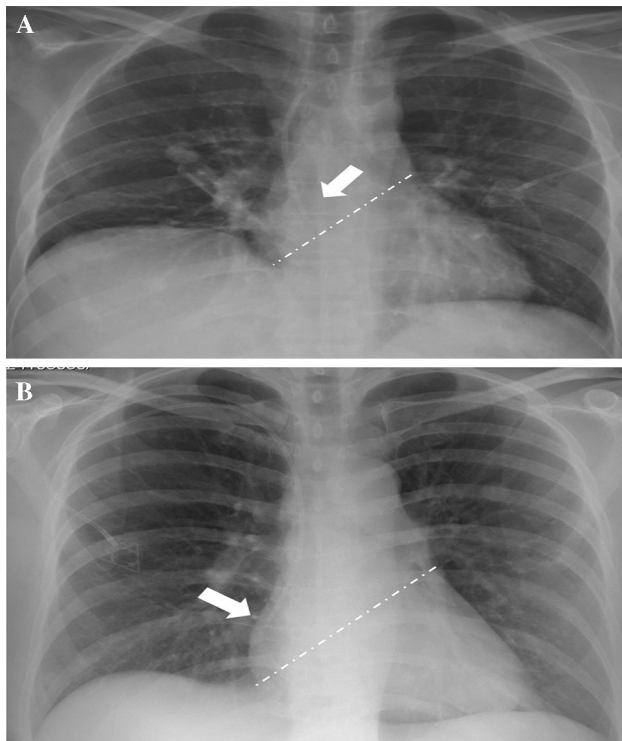


Fig. 3 **a** Chest X-ray confirming the position of the port-a-cath[®] and exclusion of the pneumothorax. A port-a-cath[®] placed via the left subclavian vein, and there is a difference in the catheter tip position when compared to an X-ray after port placement via the right subclavian vein (Fig. 3b), as it does not sit against the venous or atrium wall. **b** After port-a-cath[®] placement via the right subclavian vein, because of the catheter direction, its tip can potentially sit against the venous or atrium wall causing transient obstruction of the tip orifice (arrow). In order to avoid cardiac arrhythmia, the catheter tip should be above the level of the tricuspid valve. This can be accomplished if the tip is sitting above an imaginary line connecting the right cardiophrenic angle to the upper border of the left atrium (interrupted line)

pneumothorax was 21.3, categorising these patients in the lower range of BMI within healthy individuals. 3/1,000 patients (0.3 %) developed superficial haematomas, and in 2/1,000 cases (0.2 %), the catheter had to be removed because it had stopped functioning (Table 2). In another patient, the catheter was dislocated into the right jugular

vein, but a revision was not considered necessary. 2/1,000 patients (0.2 %) developed an arrhythmia following device placement, and the catheter had to be repositioned. In 4/1,000 patients (0.4 %), there was thrombosis and the device had to be removed, with all 4 patients having received chemotherapy via the port before thrombosis occurred (Table 2).

No patient had infection associated with implantation, even though almost all patients were heavily pretreated in the hospital setting. Where MRSA colonisation was demonstrated preoperatively, then a course of decontamination with medicated washing and nasal cream was prescribed. There were 19/1,000 infections (1.9 %) recorded after the ports had been used, and in 8/1,000 (0.8 %) of these, their removal was required (Table 2).

Discussion

TIVAPs can offer a long-term and safe access to the vascular system during prolonged courses of chemotherapy [2, 15] and can be placed by either open surgical or radiologically assisted percutaneous techniques with less complications recorded when compared to the open surgical procedure [16–19]. The report from Nocito et al. [20] showed the Seldinger technique to be more effective, with a 90 % primary success rate when compared to a 71 % success rate for the venous cutdown. This is in keeping with several other series and the present report in which our findings in 1,000 patients demonstrate a success rate of vein catheterisation of 95 % (904 out of 952) patients, when the left subclavian vein was chosen for the first attempt of puncture, and a success rate of 97.1 % (951 out of 979) for right or left subclavian vein used as initial site of puncture [20]. The greater effectiveness of the Seldinger technique was demonstrated by other authors over the venous cutdown one in the past as well [21–23].

UK guidelines for the placement of central venous catheters recommend ultrasonographic guidance as it reduces the incidence of failure and mechanical complications [13, 14]. A 7.2 % failure to access either of the

Table 1 Catheterisation, first and second choice puncture sites

Vein used for access	First puncture site	Second puncture site (left subclavian 1st)	Final catheterisation site
Subclavian	998/1000 (99.8 %)	29/1000 (2.9 %)	979/1000 (97.9 %)
Left	952/1000 (95.2 %)	0/1000 (0 %)	904/1000 (90.4 %)
Right	46/1000 (4.6 %)	29/1000 (2.9 %)	75/1000 (7.5 %)
Jugular	2/1000 (0.2 %)	19/1000 (1.9 %)	21/1000 (2.1 %)
Left	0/1000 (0 %)	13/1000 (1.3 %)	13/1000 (1.3 %)
Right	2/1000 (0.2 %)	6/1000 (0.6 %)	8/1000 (0.8 %)
Total		38/1000 (3.8 %)	1000/1000 (100 %)

Table 2 Post-operative complications

Complication	Incidence (patient number)
Pneumothorax	12/1000 (1.2 %)
Infection	19/1000 (1.9 %)
Removal required due to infection	8/1000 (0.8 %)
Established infection of port following removal ^a	3/1000 (0.3 %)
Dislocation (no revision req)	1/1000 (0.1 %)
Haematoma	3/1000 (0.3 %)
Arrhythmia (reposition req)	2/1000 (0.2 %)
Thrombosis	4/1000 (0.4 %)

^a The infection was established by a positive culture from the microbiology laboratory

subclavian veins without the use of US guidance has been reported by Ku et al. [15]. Ultrasound visualisation of the access vein has the advantage of an overview of the anatomical conditions and vessel diameter, enabling thromboses to be detected prior to the vessel puncture and the access site to be adapted without causing trauma to the occluded vessel [24, 25]. In our experience, there was a successful catheterisation of the subclavian vein, with the use of U/S guidance in 97.1 % of patients. Furthermore, in only 19/1,000 patients (1.9 %) was the right or left jugular vein required as a secondary access site. Our findings are suggestive of US guidance significantly increasing the success of subclavian vein access and catheterization.

For authors performing direct puncture to the subclavian for PAC placement, the risk of pneumothorax was greater when compared to introduction of the catheter into the cephalic vein by direct approach; however, this was not the case when the puncture of the subclavian vein was performed using ultrasonographic guidance [4, 26, 27]. Pneumothorax occurred in 12 of our total 1,000 patients (1.2 %). Our rate is considerably lower than those reported in studies that did not use ultrasonographic guidance [28], supporting the importance of a guiding device [18, 29]. We also made the observation that the patients with the complication of pneumothorax had a median BMI of 21.3, categorising them in the lower range of BMI within healthy individuals.

Before standardizing this technique to the left subclavian vein approach in 2004, we spoke to our patients who had ports placed previously and also the nurses in our chemotherapy suite. Several important quality of life issues were apparent. Firstly, the women in particular found the catheter traversing the subclavian in the IJ approach to be uncomfortable and unsightly. Secondly, conscious or unconscious patients were more cautious about using the ipsilateral hand especially during the time of chemotherapy infusion for fear of dislodging or other interference with

the infusion process. Thirdly, but less common, patients found the car seat belt may rub across the port as cars in the UK have a right-sided driving position. Also the health care professionals found the left side more comfortable to access when the patient is seated in the chemotherapy chair. Thrombosis around the catheter can lead to limb swelling. We recorded a thrombotic event in 4/1,000 cases (0.4 %), which is less compared to 0.5 % reported by Ahn et al. on a retrospective analysis of 1,254 patients with port implantation in one single centre [30]. Ignatov et al. reported fewer such complications when the TIVAPs are placed on the right side. We found our technique with the left subclavian vein to be safe and uncomplicated and believe that a possible explanation for the higher thrombosis rate reported by Ignatov et al. is related to catheter tip positioning [8]. If the tip lies in the superior vena cava, it has the potential to strike the vessel wall frequently and cause endothelial inflammation. However, we place our catheter tip always in the mid atrial position where there is more freedom to move without necessarily striking the chamber wall (Fig. 3a). We also note that when the port-a-cath is placed on the right side, the catheter tip can potentially sit against the venous wall, causing transient obstruction of the tip orifice (Fig. 3b). Additionally, we did not record complications such as those previously reported with the use of the subclavian vein, including the consequences of the pinch-off syndrome with disconnection of the system and catheter fragmentation leading to pieces of the catheter travelling to the ventricle [31, 32].

In the latter part of the study period, we switched from middle third to lateral third puncture of the subclavian vein. The latter puncture site was chosen as the needle used for puncture would find resistance against the rib when in the vein, which was evident by the ultrasound as well and thus reduces the potential for pneumothorax especially in the cachectic patient where the risk of pneumothorax is greater.

We prefer a silicone catheter in our protocol because previous reports indicate that they are more resistant to chemotherapy and less prone to rupture while in use, compared to polyurethane catheters [28]. In our 1,000 patients, we did not encounter any incidences of catheter rupture.

In several retrospective studies, external devices were associated with higher infection rates compared to TIVAPs in selected patient populations [33–37]. Groeger et al. reported TIVAPs to be associated with fewer infections when compared to external catheters [38], with the septic events responding most often to administration of appropriate antibiotics, although removal of the port was necessary for persistent or recurrent bacteraemia or for fungal infections in some cases [36, 39, 40]. Compared to external catheters, TIVAPs are irrigated less frequently, require no

home care, and are less prone to environmental or cutaneous contamination. Although we received reports of several suspected infections, which were resolved with administration of antibiotics and without the need for port removal, long-term follow-up was not available on all of our 1,000 patients. Thus, we do not have a reliable infection rate. However, there were no post-operative infections observed in the short-term period following the implantation of the device, which is accordance with the observation of Scordamaglia et al. that improper handling of the device could lead to infection. In the literature, the infection rate ranges from 2.6 to 9 % [41, 42]. Interestingly from our results, there were 19 (1.9 %) infections recorded, and from the 8 (0.8 %) cases, the ports had to be removed; 3 (0.3 %) infections were established by the microbiologic laboratory. Lebeaux et al. have highlighted the importance of therapeutic actions taken, such as antibiotic lock therapy or identification of biofilm biomarkers, with a potential decrease in the rate of port devices removal and changing of the TIVAP management [43]. Additionally Taxbro et al. noted in a prospective study that their major findings included a possible low complication rate being achieved by applying evidence-based guidelines concerning the implantation of the ports and also the care of these subcutaneous vascular access ports [44].

Thrombosis is considered a frequent complication associated with central venous access devices, and there have also been some reports of right atrial thrombi and pulmonary emboli related to implanted ports [34, 45–48]. We recorded 4/1,000 (0.4 %) incidences of thrombosis, with all 4 patients having received chemotherapy via the port before thrombosis occurred.

In conclusion, we have presented a large series of patients with port-a-cath[®] insertions, and our results indicate that port-a-cath[®] insertion performed by a single surgeon and his team with left subclavian vein as the first choice of puncture with U/S guidance, and confirmation of the catheter tip location in the right atrium by X-ray, appears to be safe, effective, and with a low complication rate. Our aim is to provide a service with the maximum safety, liability, comfort, and convenience to the patients.

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Conflict of Interest The authors declare no conflict of interest.

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