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Image-guided chemoport insertion by interventional radiologists: A single-center experience on periprocedural complications

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Abstract

Purpose: To report our early experience in image-guided chemoport insertions by interventional radiologists. **Materials and Methods:** This was a cross-sectional study conducted in a tertiary center with 161 chemoport insertions done from June 2008 to June 2010. The chemoports were inserted either at the angiography suite or at the mobile operation theater unit. Ninety percent of the chemoports had right internal jugular vein (IJV) as the entry site. Other entry sites included the left IJV, subclavian veins and the inferior vena cava. Immediate and early complications were recorded. All insertions were performed under image guidance with the aid of ultrasound and fluoroscopy. **Results:** The technical success rate was 99.4%. In terms of immediate complications, there were only two cases of arterial puncture that resolved with local compression. No pneumothorax or air embolism was documented. Twenty-six early complications were recorded. The most common early complication was catheter blockage (12/161; 7.4%), followed by catheter-related infection (9/161; 5.6%). Other complications were catheter malposition, venous thrombosis and catheter dislodgement or leak. A total of 11 (6.8%) chemoports had to be removed within 30 days; most of them were due to infections that failed to respond to systemic antibiotic therapy. In terms of place of procedure, there were no significant differences in complication rates between the angiography suite and the mobile operation theater unit. **Conclusion:** Image-guided chemoport insertion by interventional radiologist gives low periprocedural complication rates. Using right IJV as the entry site, the image guidance gives good success rate with least complication.

Key words: Central venous catheterization; complications; interventional radiology; vascular access ports

Introduction

The implantable subcutaneous venous access port or chemoport is a common procedure in patients requiring long-term venous access. Chemoport provides safe, easy and cosmetically pleasant venous access.

Previously, chemoport insertions were done predominantly by surgeons. However, in 2008, the interventional radiology unit in our center became active and performed image-guided percutaneous chemoport insertion with good success rates comparable to the surgeons. Interventional radiologists (IRs) differ in the sense that they use ultrasound guidance with the Seldinger technique for access site and fluoroscopy to check catheter placement,[1] whereas surgeons perform venous cutdown or use anatomic landmarks for entry site. Our center prefers the right

internal jugular vein (IJV) as the first choice of entry site, whereas the surgeons prefer the subclavian or the cephalic vein.

The purpose of this study is to report our early experience in percutaneous chemoport insertions, particularly early complications in the interventional radiology setting. In our country, there is no study reporting on the IR's placement of implantable ports.

Materials and Methods

This is a retrospective study in which our center has inserted 161 chemoports in 157 patients from June 2008 to June 2010. The faculty ethical boards of research approved the study. Written consents were obtained from all the patients. The chemoport insertions were done in two places, either at the angiography suite or at the trauma operation theater.

The male to female ratio was 1.2:1, with a median age of 49 years. Majority of the patients were oncology and hematology patients requiring chemoport for chemotherapy administration. Only one case requested for total parenteral nutrition access due to short bowel syndrome.

The implantable port system was mainly a low-profile system of 6.5-8.5 Fr in size. We used the Celeste B. Braun® access port system [Figure 1] in majority of the patients. A low-profile system is recommended to prevent skin perforation, particularly in thin oncology patients.[1] The system has a silicone-based catheter with non-valve titanium port. This will allow injection of medications and aspiration of blood, but not power injections during imaging of computed tomography (CT) scans.

Our center advocates antibiotic prophylaxis of 2 g cefuroxime intravenously 2 h prior to the procedure.

Relative contraindication for chemoport insertion includes abnormal coagulation profile with abnormal prothrombin time and activated partial thromboplastin time, international normalized ration (INR) of more than 1.5 and platelet count of less than 50×10^9/L. However, if the chemoport is needed urgently, platelet transfusion during the procedure is recommended.

Absolute contraindication is when the patient is clinically in bacteremia or sepsis with and without neutropenia. Parameters that are contraindicated include white blood cell count of less than 3 or more than 12×10^9 cells/L, along with a core temperature of more than 38°C. These should be resolved before the chemoport insertion. Contrast allergy is relative as chemoport insertion can be performed without contrast administration. Overall, there were less than five patients that were contraindicated to do chemoport, one case had an allergy with several antibiotics but was done the next day with steroids cover and the procedure was carried out without using contrast. The rest were due to bacteremia or sepsis, and these cases were postponed to a later date.

Implantations of ports were done by IRs and clinical fellowship trainees in interventional radiology. The technique of insertion was routinely standard. Blood pressure and pulse oximeter monitoring of the patients was performed during the procedure. Sedation with intravenous midazolam was optional. Skin preparation was done with 10% povidone–iodine solution and sterile draping was used. Insertion into the entry vein was done with an ultrasound guidance using a 19-G puncture needle [Figure 2]. The angle of the needle should be away from the carotid artery. If the puncture was difficult, a micropuncture set with a 22-G puncture needle and a 0.018″ wire was used, and subsequently replaced with a 4-Fr introducer to facilitate transition to a 0.035″ system.

The most common insertion site was the right IJV. If the right IJV was not seen, or was small in size, then the next choice was the left IJV. The right subclavian vein or the right external jugular vein was chosen if both IJVs were thrombosed. Commonly, a venogram would be performed if both jugular veins were not seen. Before any entry site was chosen, history of multiple line insertion was to be sought.
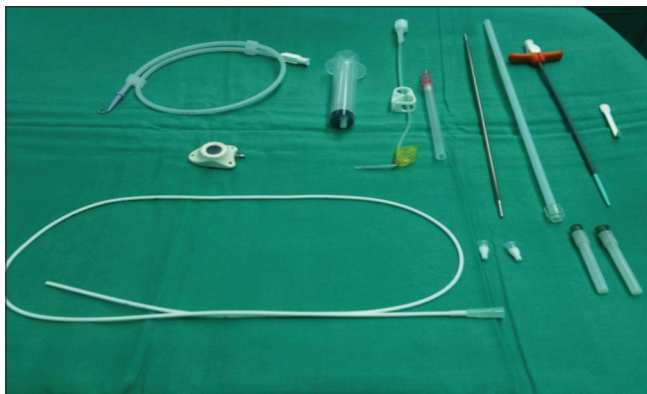

Figure 1: The materials that are used in the chemoport insertion in this study

Figure 2: The insertion of a puncture needle into the right internal jugular vein with ultrasound guidance

The chemoport site should also not be ipsilateral with the breast cancer site or overlap with the proposed radiation therapy field.

Once the entry site was punctured, a guide wire was inserted and the proximal end was secured. The distal end of the guide wire was ideally placed in the inferior vena cava (IVC). Next was the creation of the chemoport pocket. The most common site for the pocket was at the delto-pectoral region, around 2.5 cm from the clavicle. Bupivacaine with adrenaline (0.25%) as a local anesthetic was used for all the chemoport insertions to reduce hematomas and prolong the anesthetic effect. After the pocket was created, the silicone catheter was inserted using a trocar subcutaneously from the pocket to the entry site or vice versa. The tip was measured to reach the cavo–atrial junction. A peel-away sheath was inserted to facilitate the catheter insertion into the venous system. Catheter insertion was done during breath hold or inspiration and pinching of the peel-away sheath to avoid air embolism. The distal end of the catheter was secured to the port after irrigation of the pocket with normal saline. The port was then sutured in at least two sites to the underlying muscle. The tip was then checked for kinks and optimal positioning by fluoroscopy. Aspiration of blood was done to check its function. Contrast injection was also done to reconfirm the tip position and flushing with heparinized saline was done. The port was then closed in two layers using absorbable sutures. Sterile dressings were placed. A post-procedural chest radiograph was taken routinely [Figure 3].

After the insertion, the patient had a 10-day postinsertion check-up by the primary team in preparation for chemotherapy administration and to check the wound site. The primary team informed the interventional radiology

Figure 3: Postprocedural chest radiograph with optimal placement of the catheter tip

department if there was any immediate complication. The primary team initiated the use of chemoport to check its patency. Subsequent follow-up for this study was done by means of the clinical records within 30 days postinsertion.

Analyses were done and aided by the clinical records of the patients and the hospital information database system (IRIS). Data were analyzed with SPSS version 11 using the Pearson's Chi-square test.

We follow the quality improvement guidelines for the Society of Interventional Radiology (SIR).[2] The definition of periprocedural complications is divided into immediate, early and late. Immediate complications are intra-procedural. Early complications are complications that arise within 24 h, which are mostly procedure related and also complications that happen within 30 days postprocedure. Late complications are the ones that are found after 30 days postinsertion. There are many types of published complication rates. In our study, we focused on some of the important periprocedural complications.

Results

The technical success rate was high (99.4%) as most of these patients were inserted early in their course of treatment. There were two cases of successful insertion after venoplasty due to brachiocephalic stenosis. One case was abandoned due to extensive central vein thrombosis.

Regarding the insertion sites, the right IJV was the choice of puncture site (90%), followed by the left IJV (7.5%), left subclavian vein (1.9%) and infrarenal IVC (0.6%). Translumbar infrarenal IVC chemoport was done to a patient who needed intravenous parenteral nutrition. We noticed that the complication rates were also higher if the entry side was left sided; eight out of 15 cases (53%) of left-sided chemoport had complications. The complication that was associated with right IJV in comparison with other sites was significant, with $P < 0.02$.

For immediate complication, there were two cases of accidental arterial puncture. No significant hematoma was present. There were no cases of hemothorax, pneumothorax or symptomatic air embolism recorded.

The most important complication rate that we assessed was of catheter-related infection [Table 1]. There were a total of nine (5%) cases with infection, either local or systemic. Local or port infection is defined as localized erythema, indurations, pus formation or tenderness. Systemic infection is considered positive when blood cultures are positive. When reviewed, five out of nine cases of catheter-related infection had concurrent neutropenia. Overall, four out of nine cases had the chemoport removed after systemic antibiotic failed to improve. The rest of the cases were

successfully treated with antibiotics. Catheter blockage was also seen to be closely associated with infection. Three out of the nine infected cases had concurrent catheter blockage.

There were no significant differences in the rate of infection between the angiographic suite and the operation theater, with $P < 0.743$. The procedure time of the chemoport insertions between the two places did not vary significantly, and ranged between 45 min and 90 min with the exception of the translumbar chemoport insertion, which took 120 min in the angiography suite.

In terms of catheter malposition, there were two cases of malposition that involved catheter kinking at acute angles causing blockage. One had to be removed, but the other was adjusted and was salvageable after heparinized flushing was done. Although one may argue that check fluoroscopy should avoid this complication, small migration of the catheter may occur after the procedure.

There was only one case of catheter dislodgement or leak, which occurred at the port and tube junction causing leakage at the subcutaneous region. The chemoport was successfully removed after one chemotherapy session.

There was one case of venous injury, which was revealed 7 days postprocedure. The chemoport was not functioning. On fluoroscopy, there was a left brachiocephalic vein tear with associated pericatheter thrombosis. The chemoport was then removed.

Two cases of venous thrombosis of the central veins were documented. The first case developed thrombosis with collateral formation, but the tip was still in a patent superior vena cava. The function of the catheter was preserved and the catheter was removed after completion of chemotherapy. In this case, the thrombosis was detected when the patient complained of swollen upper chest each time intravenous hydration or chemotherapy was administered. The other was a case of a left subclavian chemoport insertion as both IJVs were thrombosed and small in caliber. The left brachiocephalic veins were thrombosed after 1 week.

Catheter blockage complications overlapped with venous thrombosis, catheter dislodgement and malposition. There were 12 cases of catheter blockage. Only three cases had to be removed. In most of the cases, the patency of the catheters was restored and preserved with flushing with heparin solution [Table 2].

There were eight cases of chemoport removal (5%) [Table 2]. The most common cause of removal was infection. Other causes were venous thrombosis, catheter malposition, catheter dislodgement and vessel injury, as depicted. However, 94% (153/161) of the cases had usability period of more than 2 weeks and beyond.

Table 1: Early complications ≤30 days

Complications	No.	%
Total	26	16.1
Causes		
Infection	9	5.6
Venous thrombosis	12	7.4
Catheter blockage	2	1.2
Catheter malposition	2	1.2
Catheter dislodge/leak	1	0.6

Table 2: Early complications, salvageability and explantation of chemoports

Complications	Total	Actions taken	Salvageable	Removal
Infection	9/161	Intravenous antibiotics	5	4
Catheter blockage	12/161	Flushing with anti-thrombolytic	9	3
Venous thrombosis	2/161	-	-	2
Catheter malposition	2/161	Readjustment and flushing with anti-thrombolytic	1	1
Catheter dislodge/leak	1/161	-	-	1
Total	26/161 (16.1%)		15/161 (9.31%)	11/161 (6.8%)

Discussion

Chemoport insertions performed by IRs were comparable to those done by surgeons, if not better.[3] Insertions of chemoport by IRs have a higher successful rate of implantation due to their image guidance technique.[4-8] Compared with the conventional venous cutdown using blind or landmark techniques, the time to puncture the entry site is shorter as IRs are trained to puncture lesions and vessels under ultrasound guidance. If there is thrombosis, a simple upper limb and central venography can be done. IRs are also trained to access nonconventional venous sites such as transhepatic, transcollateral or translumbar approach.

Previous studies comparing IR and surgical implantation of chemoport mainly focused on the subclavian approach.[9] However, our study proves that using the IJV as the entry site, technical success rate is high with low immediate and early procedural complication. The IJV provides a straight access to the superior vena cava.[10]

The rate of infection was comparable to that of the surgical approach.[5] There are many factors that can lead to catheter-related infection, which include preprocedural, intra-procedural and postprocedural factors. In our study, it appeared that postprocedural factor, which was the patients' immune system postchemotherapy, was the common factor. Fifty-five percent of the catheter-related

infected cases were from neutropenic patients who also failed systemic intravenous antibiotics treatment.[11]

The patency rates were good. The main factor in this study was the entry site. We prefer the IJVs as the most common entry site for catheter insertion. The right IJV is the most common entry site as it provides a straight pathway to the IVC. Our study also proves that left-sided insertion tends to have more complications. This is likely due to the pattern of the blood flow and the location. Endothelial injury is more likely to happen if the pathway is not straight.[12]

The brachiocephalic and cephalic veins are preferred by the surgeons because venesections are easier at this site. Venesection at the IJV region is cumbersome as the carotid artery is adjacent and superficially located. Puncturing the IJV is technically easier under ultrasound guidance in the trained hands of IRs.

The patency rate also depends on the location of the catheter tip. The most optimum site of tip location is at the cavo–atrial junction, and not more than 4 cm above it. The optimum tip position is also checked with fluoroscopy. In addition, any kinking or dislodgement can be remedied immediately before closing the procedure.

Image-guided procedure provides a shorter procedural time as it does not involve venesection.[13] We did our chemoport insertions in our angiographic suites and at the trauma operation theater. All our procedures were mostly under local anesthetic, with or without sedation. This is because the entry site only requires a small nick for a small puncture needle. The port that is used routinely in our institution is a low-profile port, which needs small incisions and pocket formation.

We had two cases of arterial injury and one case of brachiocephalic vein injury. On review, it was found that these were not cases of not recognizing a vein over an artery but overshooting the puncture needles across to the adjacent artery, especially if the vein was above the artery. This complication should be absolute with image-guided puncture, but there are technical difficulties encountered with obese and short-necked patients. Arterial injury should be 0.5% only.[1] However, these cases were locally controlled with compression, with no significant hematoma. The brachiocephalic vein injury happened on the left side, and it is likely due to the rigid peel-away sheath that was advanced over a kinked or nonstraightened guide wire.

There were no cases of pneumothorax, hemothorax or air embolism reported in this study.

The limitations to the study were that we did not document the late complications as we wanted to reflect periprocedural complications. The number of samples should be increased and the number of operators should be minimized to provide uniformity and avoid bias.

Conclusion

Image-guided chemoport insertion is proven to have a higher technical success rate and patency rate, and is safe with a short procedural time. The infection rate and overall early complication rate is comparable to other studies.

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