Background: Implantable venous access devices (IVAD) are preferred over long-term external catheters in children due to less infection rates and better patient compliance in pediatric malignancies. Use of IVAD is a routine practice in developed part of the world. However it needs more emphasis for its widespread use in developing nation in order to improve the quality of care in children with malignancy.

Aims and Objectives: We aimed at analyzing the outcome of IVAD in pediatric malignancies in a tertiary care set up of developing nation. Our objective is to enlighten the importance and feasibility of IVAD in childhood malignancies with review of literature.

Materials and Methods: There were 152 children who underwent IVAD insertion in the study period. The parameters analyzed were indications, patient demography, size of the port, laterality of insertion, method of access to internal jugular vein (IJV), duration of surgery, time for access, complications, indication for removal and the parental satisfaction.

Results: Mean age was 48 months. 112/152 patients had hematological malignancies. Right sided IJV was used by default in 97.4% patients, while remaining 2.6% had their left IJV cannulated. Open venotomy was used in 14 cases and 138 underwent ultrasound guided IJV access. The position of the catheter was reconfirmed in the X-ray, 6-8 hours after surgery. 149/152 ports were accessed 12 hours after surgery, whereas remaining 3 had a delay in access for 24 hours. Post operative complications were divided into early and late. 141 ports were removed after completion of chemotherapy, 4 were removed due to complications. 93 of parents gave the response as “satisfied”

Conclusion: With proper training and expertise, insertion and care of IVAD is safe in pediatric malignancies without significant complications.

Keywords: Chemoport, complications, implantable venous access devices, internal jugular vein

INTRODUCTION

In the modern era of early and effective diagnosis of pediatric malignancies, chemotherapy becomes one of the mainstay of treatment. These children require a long-term and reliable venous access due to the inherent difficulty of securing venous access in them which is superadded by thrombophlebitis by vesicant chemotherapeutic agents. Use of implantable venous access devices (IVAD) is preferred over long-term external catheters in children due to high infection rates, patient discomfort, need for dressing, inability to play, and socially unacceptable externally hanging

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catheter in the later.[1] We analyzed the outcome of IVAD in pediatric malignancies in a tertiary care setup of developing nation.

**Materials and Methods**

**Assessment technique**

There were 152 children who required long-term chemotherapy in the period from July 2012 to June 2015 (3 years). Majority of them were hematological malignancies (leukemia and lymphoma) constituting 73.6% of the cases, while others were solid organ malignancies and sarcomas. The parameters analyzed were the oncologic indications for the chemoport, patient demography, size of the port, laterality of insertion, method of access to internal jugular vein (IJV), duration of surgery, time for accessing the port after surgery, early/late complications, indication for removal of port, and the parental satisfaction levels. Parental satisfaction was recorded by questionnaire at the end of treatment with response as either satisfied or unsatisfied.

**Operative technique**

Preoperatively, the children were optimized for surgery with hematological parameters since most children with chemotherapy-induced low counts needed waiting period of at least 2 weeks for the recovery of their cell counts. The skin is inspected for infective lesions if any, which were treated preprocedure. The procedure was done under general anesthesia in the operating room preferably as first in the list as a protocol so as to avoid infection. We used single lumen catheters with guidewire and peel-away sheath in all the children. Size of the catheter was 5 French (F) in children <2 years, while it was 6 F in kids with age 2 years or more. We used open technique in the initial part of our series, and then, we switched over to ultrasonography (USG)-guided technique. Under anesthesia, USG was done to look for the patency of vein and to mark the ideal site of venous entry on the surface. Patients were placed in the supine position with neck tilted toward contralateral side and shoulder elevation by support. Trendelenburg position was routinely used to aid the venous access by physiological venous engorgement. Intravenous cefotaxime (50 mg/kg) was given an hour before incision in all the children. A transverse incision of 2–3 cm was made on the anterolateral aspect of the chest, away from the nipple and areola. A subcutaneous pocket is created on the inferior aspect to accommodate the chamber of chemoport. Small stab incision is made at the marked site on the neck. A subcutaneous tunnel is created connecting both the incisions, and the catheter is guided along that tunnel. Then USG-guided venepuncture is made through which the guidewire is inserted. The tract is dilated with serial dilators. Peel-away sheath is inserted along the guidewire with gentle rotating movements, and the stylet of the sheath is removed. This step is of paramount importance because gush of blood effluxes out, and if insertion of catheter is delayed, there will be significant blood loss, especially in small babies. Hence, this step has to be well coordinated between the surgeon and assistant. Trendelenburg position has to be reverted to flat position during this step to avoid excess blood loss. While the catheter is introduced, the sheath is peeled simultaneously under vision outside the wound, taking care not to extend to venous wall and iatrogenic rent of the venous wall. The catheter tip is positioned at superior vena cava (SVC)-right atrial junction and is confirmed by C-arm [Figure 1]. Care is taken to avoid kinking at venous entry site. Excess length is cut, and catheter is connected to the chamber, which is placed in the subcutaneous pocket and fixed over the chest wall with absorbable polyglactin sutures. Patency and backflow are ensured by injecting heparin solution (100 U/ml) and by aspiration. Both chest and neck incisions are closed with absorbable sutures.

**Postoperative care**

All children received intravenous antibiotics for 48 h after surgery. Port was accessed 12 h after surgery in usual circumstances unless contraindicated by clinical situation. Children were followed up in outpatient clinic after 1 week for review of the wound. Port access was done exclusively by the nursing staff trained in the sterile handling of chemoport. Patency of the port was maintained by flushing with heparin solution each time after use and every month in the maintenance period. Pre- and post-insertion data are maintained in our records.

![Figure 1: X-ray showing the normal position of catheter tip](#)
**Results**

There were totally 152 patients who underwent chemoport insertion during the study period with age ranging from 1 month to 216 months (18 years) with mean age of 48 months (4 years). There were 104 males and 48 females. Most of our patients (112/152) had hematological malignancies while others had solid tumors such as soft tissue sarcomas and intra-abdominal solid tumors. Acute lymphoid leukemia was the most common indication with 60.5% of patients \((n = 92)\). We used 5F catheters for children <2 years \((n = 40)\) and 6F catheter for those ≥2 years \((n = 112)\). Right-sided IJV was used by default in 97.4% patients \((n = 148)\), while remaining 2.6% had their left IJV cannulated \((n = 4)\). Of those 4 kids, 3 had their primary tumor on the right side, and one patient had multiple failed attempts over right IJV, necessitating the left insertion. Open venotomy was used in initial 13 cases following which we transformed to USG-guided IJV access which was found to be safe. Intraoperative period was uneventful in 149/152 cases. One patient had pricking site hematoma which subsided with compression bandage, one had anterior chest wall swelling due to extravasation from venous entry site, and another child had the catheter tip going into right subclavian vein from IJV (identified by intraoperative C-arm); hence, it was pulled out and reinserted into SVC. The operating time for open method ranged from 80 to 130 min (mean - 96 min), whereas it was 40–70 min (mean - 49 min) for USG-guided technique. The position of the catheter was reconfirmed in the X-ray, 6–8 h after surgery. 149/152 ports were accessed 12 h after surgery, whereas the remaining 3 had a delay in access for 24 h in view of IJV tear and/or suture line hematoma. In the postoperative X-ray, 2 patients had the catheter tip reaching up to the ventricle. But since they were patent and did not cause any disturbance in the cardiac rhythm, they were accessed and used for chemotherapy without any intervention till the end. On the first access, 98% \((n = 149)\) did not face any issues. Of remaining 3, one patient had chest wall swelling due to extravasation from venous entry site, one had severe oozing from suture line probably due to steroid-induced fragile skin (both controlled by compression dressing), while the other had absence of back flow and block; X-ray revealed a kink at the IJV entry site, which needed re-exploration of neck wound to relieve the kink on the same day. Postoperative complications were divided into early (≤14 days) and late (>14 days) as depicted in Table 1. Of 152 ports, 141 were removed after completion of chemotherapy, 4 were removed due to complications, 5 children expired during therapy, and 2 were lost to follow-up. Parental satisfaction could be assessed in 145 (5 expired and 2 lost to follow-up). In that, 93% \((135/145)\) of parents gave the response as “satisfied,” whereas remaining 10 gave response as “unsatisfied.” Totally 11 children had one or the other complications. All those 10 cases with “unsatisfied” parental satisfaction response had encountered some complications.

| Time of Complication | Complication | Intervention |
|----------------------|--------------|--------------|
| Early complications  | 1-Redness of suture line after 10 days | Treated with topical and oral antibiotics-port blood culture-negative Port removed after 2 days |
| (≤14 days) 4% (6/152) | 1-developed subclavian and IJV thrombosis, Subcutaneous hematoma, thrombocytopenia | Subsided by compression bandage |
| | 1-anterior chest wall swelling due to extravasation from venous entry site | |
| | 3-no backflow/block-X-ray revealed kink at IJV entry | Neck wound re-explored on same day and kink relieved |
| | Tip kinked in right ventricle | Repositioning done under GA after 3 days |
| | 1-block- X-ray-normal- after 1 week | Relieved by forceful heparin flush |
| | 1-block after 5 months | Port removed and re-inserted on the other side |
| Late complications  | 1-lost to follow up for 4 years, on presentation found to have chamber alone in subcutaneous region catheter migration into pulmonary vasculature | Removed by interventional cardiology [Figure 2] |
| (>14 days) 4.1% (6/151) | 1-skin thinning and exposure of chamber after 4 months | Chamber repositioning done |
| | 1-port exposure due to skin thinning and complete dehiscence [Figure 3] | Port removed |
| | 2-port infection-blood stream (1 fungal) | Port removed |
**Discussion**

Chemotherapy in children mandates the insertion of long-term venous access devices. IVAD are preferred over other external catheters, especially in smaller children. IVAD are commonly inserted into the right IJV, although other veins are preferred in some specific situations. Technique of insertion into IJV can be done either by open venotomy or by USG-guided venepuncture. USG-guided technique was found to be better in our series with respect to operative time and intraoperative morbidity. A large Korean study with more than 1000 cases in their series found that radiologically guided placement of central venous port is safe and efficient with high success rate and low complication rate. However, a recent trial showed no difference in the complication rates with respect to insertion modality and site. Harvey et al. claimed that open technique was the factor which prevented catheter migration and embolization.

As per the literature, infection is the most common complication necessitating removal of the port, ranging from 0.6% to 27% depending on device and patient-related factors. However, when compared to other long-term catheters, the infection rates in IVAD are considerably low. It has been proposed that less handling of the device surface, less exposure to environment, and comparative lesser need for irrigation are the factors reducing the infection rates in IVAD.

The complications encountered in our series were incision site bleeding, hematoma, infection, early/late wound dehiscence, catheter kinking, thrombotic blockage, catheter fracture, and catheter migration. Most of the children in our series were hematological malignancies and they were the ones who had infection and hematoma, which can be attributed to inherent cytopenic state of their primary illness.

Port pocket infection, when occurred early (≤14 days), responded to antibiotics (0.6% of cases), whereas the late port pocket infection resulted in removal due to unhealthy overlying skin (1.3% of cases). The overall infection rate in literature ranged from 2.6% to 9%. The infection rate in our series was less probably due to the practice of doing the insertion before any other contaminated cases in the operating room. Infection rate in toto is less with IVAD when compared to other types of central venous access catheters due to less handling, nonexposure to environment, and nonhandling at home with IVAD.

Thinning of skin over port pocket with exposure happened in 2 (1.3%) cases. One was due to extravasation of the vesicant medication and the other probably due to cachexia built of the child with neuroblastoma. Similar complication was encountered in previous studies also, up to 4%. Thromboembolic complication was reported in the range of 37%–66% in the literature. Series with more of adult cases preferred placement of chamber in the infraclavicular position, whereas almost all the pediatric series preferred infra-axillary position, to maintain adequate length of subcutaneous tunnel. The incidence of chamber related complications does not have any relation with the chamber position. In our study, only one patient had subclavian and IJV thrombosis in the 1st week after insertion. No cases of thromboembolism was encountered as a late complication in our series, probably attributed to meticulous flushing of catheter with heparin saline on a regular basis which is supported by some studies.

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**Figure 2:** Fluoroscopy image showing catheter embolized into pulmonary vasculature (thick arrow) and being retrieved with a snare (thin arrow)

**Figure 3:** Port chamber exposure due to skin necrosis
Although we used only IJV access in our series, the older studies have used subclavian vein as an equivalent next option for chemoport insertions, in situations where IJV access is not possible due to thrombus or failed access with multiple attempts. Subclavian access has a chance of a specific complication due to pinch-off effect between first rib and clavicle causing catheter occlusion and fracture (subclavian pinch-off syndrome). Redkar et al. suggested puncturing the subclavian vein at a relatively lateral position to avoid the pinch-off effect.[12]

Catheter embolization is a reported up to 0.1%–2.1% in the previous studies.[13] In our study, we had one case of catheter embolism into pulmonary vasculature retrieved by interventional cardiologist [Figure 2]. This complication happened in a patient who did not follow up for port removal after completion of chemotherapy and came for port removal after 4 years. As per the literature, most of the reported cases of catheter embolization were asymptomatic and usually found incidentally by difficult flushing and significant extravasation from chamber into subcutaneous plane of chest wall. However, few reports of complications in the form of arrhythmias, pulmonary thromboembolism, and cardiac perforation have also been reported.[14] Parental satisfaction in our series seems to be 93%, depicting the advantage of IVAD in terms of ease of handling, less infection, and child’s comfort.

Conclusions
With proper training and expertise, insertion and care of IVAD is safe in pediatric malignancies without significant complications. They should be considered over tunneled catheters in view of reducing the infection rate and improved quality of life of kids on chemotherapy. We recommend that use of ultrasound guidance for venous access is safe and time-saving. Periodic training of paramedical personnel for accessing and flushing the IVAD will decrease the complication rate further.

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Conflicts of interest
There are no conflicts of interest.

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