



# Chemoport-A Savior in Children Who Require Chronic Venous Access: An Observational Study

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**Purpose:** Long-term venous access is cumbersome in children because of their thin caliber veins, less cooperative nature, and easy compromise of venous integrity. Hence, a study was conducted to evaluate the indication, efficacy, and safety of chemoport in children who require chronic venous access.

**Materials and Methods:** Children who underwent chemoport insertion between January 2008 and December 2017 were retrospectively evaluated.

**Results:** A total of 159 children (169 chemoports) were included in the study. The most common indication for chemoport insertion was acute lymphoblastic leukemia (51.5%). The mean chemoport days were 832±666 days. Among the 169 chemoports, 55.0% were removed after treatment completion. The chemoport was not removed in 35.5% of the patients, as 28.4% of the patients were still under treatment and 7.1% died during the treatment. Sixteen patients (0.1 per 1,000 chemoport days) had a premature chemoport removal. The indications were port-related bloodstream infection (12 patients), port pocket infection (1 patient), exposed chemoport (1 patient), and blocked chemoport catheter (2 patients). Twenty-two patients (0.15 per 1,000 chemoport days) had complications of port-related bloodstream infection (0.09 per 1,000 chemoport days), making it the most common. Other complications include block, fracture, arrhythmias, avulsion, bleeding, decubitus-over-port, and port pocket infection.

**Conclusion:** Owing to the safe, reliable, and low complication rate of chemoports, more children can be saved from deadly illnesses. Chemoport is the best option for children who require chronic venous access.

**Key Words:** Indwelling catheter, Adverse effects, Child, Leukemia, Neoplasms, Vascular access devices

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## INTRODUCTION

Long-term venous access is a challenge in patients who require chemotherapy and frequent transfusions. It becomes even more cumbersome in the pediatric age group because of their thinner caliber veins, less cooperative na-

ture, and easy compromise of venous integrity. Peripherally inserted central venous catheters don't last long, and the centrally inserted indwelling tunneled exteriorized catheters such as the Broviac and Hickman types carry higher risks of infection and more patient discomfort [1]. The totally implantable venous access ports, also known as chemo-

ports, carry fewer risks of complications and greater patient comfort [2]. Few studies have examined the use of these devices in children and their complications. Hence, a study was conducted to evaluate the indications, insertion techniques, efficacy, and safety of chemoport in the pediatric age group at a tertiary center.

## MATERIALS AND METHODS

A retrospective study was conducted in the Department of Paediatric Surgery in a tertiary center. Ethical clearance was obtained from Manipal Hospital Institute Ethics Committee. Children who underwent chemoport insertion between January 2008 and December 2017 were included in the study. The hospital database was checked. The age, sex, indication for chemoport insertion, and date of insertion were noted. The time taken for insertion, vein accessed, and insertion technique (percutaneous or venous cutdown) were determined. The date of chemoport removal, indication for removal, and complications were included.

### 1) Techniques of chemoport insertion

Informed and written consent were obtained from the parents of the child. Pre-anesthetic clearance was obtained. Adequate blood and blood products were kept ready, as most of these patients had hematological malignancy with anemia and thrombocytopenia. The children with thrombocytopenia received platelet transfusion just before shifting to surgery. A dose of prophylactic antibiotic was administered at the time of anesthetic induction in the children

who were not receiving antibiotic therapy.

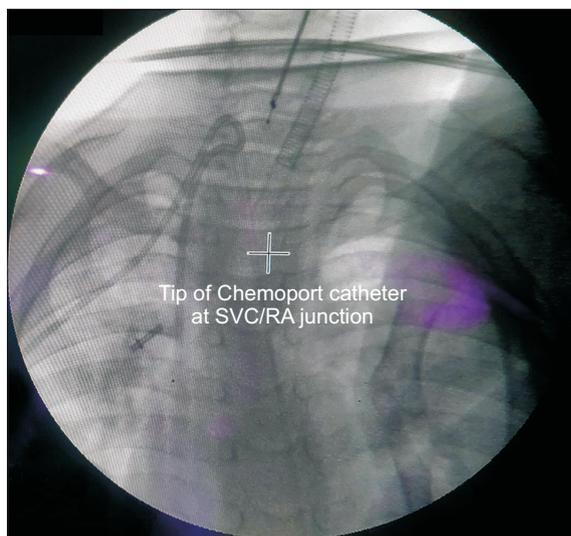
#### ① Percutaneous technique

The right subclavian vein (RSCV) was conventionally selected. In cases of difficult/previous cannulation, a left subclavian vein or internal jugular vein (IJV) approach was attempted. The Seldinger technique was used to cannulate the vein [3].

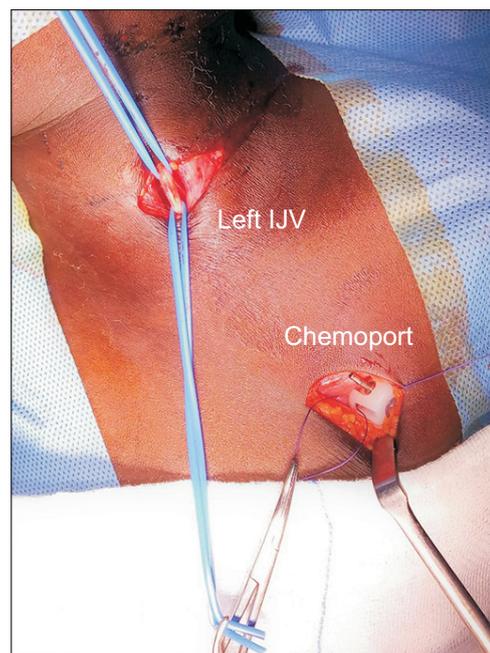
#### ② Cutdown technique

Under anesthesia, the patients were examined for good visibility of external jugular veins (EJVs). The EJV was preferred to safeguard the IJV for future use. In small-caliber EJV or failed EJV cannulations, the IJV was used.

The tip of the chemoport catheter (6 F attachable polyurethane) was placed at the junction of the superior vena cava and right atrium with fluoroscopic guidance (Fig. 1). The plastic, single-lumen ultra-low-profile chemoport (6 F magnetic resonance imaging Ultra Slim Port Implantable Port; Bard Access Systems, Salt Lake City, UT, USA) was placed in the infraclavicular subcutaneous pouch and connected to the chemoport catheter (Fig. 2). Backflow from the chemoport was checked and then flushed with a diluted heparin solution (Hep-Lock 10 IU/mL). The use of the chemoport was started from the immediate postoperative period. A Huber needle was used to cannulate the chemoport for venous access. The Hep-Lock flush was used after each



**Fig. 1.** Fluoroscopic image showing a chemoport catheter with the tip at the right atrium (RA)/superior vena cava (SVC) junction.



**Fig. 2.** Intraoperative image showing the left internal jugular vein (IJV) controlled by a vascular loop and port in a subcutaneous pouch in the left infraclavicular area.

usage. In case of non-usage of the port, it was flushed once a month with Hep-Lock.

### 2) Complications

The complications studied were port pocket infection, catheter-related bloodstream infection, blocked chemoport or catheter, catheter dislocation or migration, decubitus-over-port, and others. The complications that occurred in <30 days were considered early, while those that occurred >30 days were considered late-onset complications.

Port pocket infection was defined as an infection at the port insertion site with erythema, edema, local tenderness, or pus discharge. Catheter-related bloodstream infection

was defined as suspected systemic infection (fever, leukocytosis/leukopenia, neutrophilia/neutropenia, increased C-reactive protein level), due to the chemoport with or without positive culture (catheter tip or blood) [4]. All the patients underwent blood culture and immediate empirical antibiotic therapy. The chemoports were removed, and susceptible antimicrobials were administered in accordance with the sensitivity pattern. The follow-up was ended once the chemoport was removed, once the child died, or at the end of the study on July 1, 2019. The chemoport days (catheter indwelling days) were calculated from the interval between the insertion and follow-up endpoint.

### 3) Statistical analyses

Age, time taken for insertion, and chemoport days were expressed as mean with standard deviation. Sex, indication for port insertion, veins used, and techniques used were expressed as number and percentage. The complications were expressed as number, percentage, and per 1,000 chemoport days.

## RESULTS

A total of 170 children underwent chemoport insertion during the study period. Eleven patients were excluded because of incomplete data. Hence, 159 children (169 chemoports) were included in the study. The mean age of the study group was 4.5±3.7 years. Ninety-three patients (58.5%) were males. The most common indication for a

**Table 1.** Clinical profile of the study population

Variable	Value
Total number of children	159
Total number of chemoports	169
Mean age of the study group (y)	4.5±3.7
Male-to-female ratio	93:66
Indications for chemoport insertion (n=169)	
Malignancy	
Acute lymphoblastic leukemia	87 (51.5)
Acute myeloid leukemia	8 (4.7)
Lymphoma	20 (11.8)
Wilms' tumor	11 (6.5)
Neuroblastoma	7 (4.1)
Hepatoblastoma	2 (1.2)
Astrocytoma	1 (0.6)
Intracranial germ cell tumor	1 (0.6)
Ependymoma	1 (0.6)
Intracranial thymic tumor	1 (0.6)
Medulloblastoma	4 (2.4)
Optic nerve tumor	2 (1.2)
Retinoblastoma	2 (1.2)
Dysgerminoma	1 (0.6)
Primitive neuroectodermal tumor	1 (0.6)
Nasopharyngeal carcinoma	1 (0.6)
Immature teratoma	1 (0.6)
Langerhans histiocytosis X	8 (4.7)
Hematological disorders	
Thalassemia major	5 (3.0)
Aplastic anemia	2 (1.2)
Pure red cell aplasia	1 (0.6)
Hypogammaglobulinemia (Bruton's disease)	1 (0.6)
Factor VII deficiency	1 (0.6)

Values are presented as number only, mean±standard deviation, or number (%).

**Table 2.** Operative and postoperative parameters

Variable	Value
Mean time taken for chemoport placement (min)	43.3±12.6
Percutaneous:cutdown technique	71:98
Veins cannulated	
Right external jugular vein	37 (21.9)
Left external jugular vein	2 (1.2)
Right internal jugular vein	72 (42.6)
Left internal jugular vein	10 (5.9)
Right subclavian vein	42 (24.9)
Left subclavian vein	6 (3.6)
Total chemoport indwelling days	140,635
Mean chemoport indwelling days	832±666
Chemoports removed after treatment completion	93 (55.0)
Premature removal	16 (9.5)
Chemoports still in situ	48 (28.4)
Deceased patients (chemoports not removed)	12 (7.1)

Values are presented as mean±standard deviation, number only, or number (%).

chemoport insertion was acute lymphoblastic leukemia (87 children; 51.5%; Table 1).

The right IJV was the most common vein used (72, 42.6%), followed by the RSCV. The mean time taken for chemoport placement was  $43.3 \pm 12.6$  minutes. The percutaneous technique was used in 71 procedures (42.0%), while venous cutdown was used in 98 procedures (58.0%, Table 2).

The total chemoport days were 140,635 days, with a mean of  $832 \pm 666$  days. Among the 169 chemoport inserted, 93 (55.0%) were removed after treatment completion. The chemoport was not removed in 60 patients (35.5%), as 48 (28.4%) were still undergoing treatment and 12 (7.1%) died during the treatment. Sixteen patients (0.1 per 1,000 chemoport days) had a premature chemoport removal. The indications were port-related bloodstream infection (12 patients), port pocket infection (1 patient), exposed chemoport (1 patient), or blocked chemoport catheter (2 patients, Table 2).

A total of 22 complications (0.15 per 1,000 chemoport days) occurred.

#### 1) Early complications

A child had avulsion of the subclavian vein (SCV) during the percutaneous technique. She underwent open repair of the SCV and received chemoport placement (into IJV) a week later. The follow-up was uneventful. The immediate postoperative complications included operative site oozing (1 patient) and distal chemoport catheter migration that caused arrhythmias. Operative site oozing occurred in a child with acute lymphoblastic leukemia whose platelet count was  $25,000/\text{mm}^3$ . On re-exploration, no active bleeding site was found. She was treated with evacuation of the hematoma and platelet transfusion. The patient with arrhythmia underwent repositioning of the catheter on the first postoperative day (Table 3).

#### 2) Late complications

Late complications occurred most commonly around 200 days after chemoport insertion. One case (0.007 per 1,000 chemoport days) of port pocket infection occurred 167 days after chemoport insertion and was treated with chemoport removal, drainage of pus, and antibiotic therapy. Twelve patients (0.09 per 1,000 chemoport days) had a suspected port-related bloodstream infection. *Candida* was the most common organism isolated (3 patients, 25.0%). The other organisms isolated were *Pseudomonas aeruginosa* (2 patients, 16.7%), *Escherichia coli* (1 patient, 8.3%), *Staphylococcal aureus* (1 patient, 8.3%), and *Rastonia picketti* (1 patient, 8.3%). Blood and catheter tip cultures were negative in three patients (25.0%, Table 3). All the ports were removed and sent for catheter tip culture. The children were treated with sensitive antimicrobial agents.

Two patients (0.014 per 1,000 chemoport days) had a blocked chemoport. The chemoport was removed in both patients. One patient (0.007 per 1,000 chemoport days) had an exposed chemoport, which was removed, and a new chemoport was inserted on the opposite side. One patient (0.007 per 1,000 chemoport days) had decubitus-over-port, which was managed with port refixation. Two patients (0.014 per 1,000 chemoport days) were found to have a fractured chemoport catheter at the time of removal, but the catheters were completely retrieved in both cases (Table 3).

## DISCUSSION

Prolonged venous access is a part of the management of conditions such as malignancy and thalassemia. Multiple venous punctures in these patients for delivering chemotherapeutic agents, parenteral nutrition, and blood products cause thrombophlebitis, rupture of veins, venous extravasation, cellulitis, and so on. This leads to physical

**Table 3.** Complications of chemoport use

Complications	Number (%)	Incidence (per 1,000 chemoport days)	Management
Operative site bleeding	1 (0.6)	-	Re-explored and hematoma evacuation
Avulsion of vein	1 (0.6)	-	Thoracotomy and repair
Distal migration causing Arrhythmias	1 (0.6)	0.007	Catheter reposition
Port related bloodstream infection	12 (7.1)	0.09	Antimicrobial therapy+port removal
Port pocket infection	1 (0.6)	0.007	Antibiotics+port removal
Blocked chemoport	2 (1.2)	0.014	Port removal
Decubitus-over-port	1 (0.6)	0.007	Port refixation
Exposure of the port	1 (0.6)	0.007	Port removal
Fractured catheter at removal	2 (1.2)	0.014	Catheter retrieval in toto
Total	22 (13.0)	0.15	

and psychological trauma to the patient with primary illness. The problem worsens if the patient is a child. The less cooperative nature of children, thinner caliber veins, and easy compromise of venous integrity in children are major concerns for the treating physician. Broviac et al. [5] and Hickman et al. [6] introduced indwelling tunneled exteriorized catheters. However, these exteriorized catheters were found to confer an increased risk of bloodstream infection and increased discomfort to patients [1]. Hence, in 1982, Niederhuber et al. devised a totally implantable venous access port (TIVAP) [2]. The use of TIVAP was found to have increased owing to its better comfort and lower prevalence of infective complications. The chemoport can be used to draw blood for investigations, administer hyperosmolar solutions, extreme-pH drugs, chemotherapeutic agents, blood and blood products, and nutrients. Owing to its increased use in oncology, TIVAP is also called chemoport [2].

Several studies reported in the literature have used chemoports in adults. However, studies in children are rare. Hence, a retrospective study was conducted to evaluate the indication, efficacy, and safety of chemoport in children.

Acute leukemias combined with lymphomas constituted 69% of our study group (Table 1), which is similar to the incidence reported in most of the studies published [7-9]. This is because leukemia is the most common pediatric malignancy, constituting 25% of cases [10].

The IJV was the preferred vein in most of the studies including ours [1,3,7,9,11]. The advantages of the IJV over the SCV are that it is associated with lower incidence rates of pneumothorax, upper extremity deep vein thrombosis, chylothorax, catheter pinch-off, and no brachial plexus injury [1]. Of our study population, 29% underwent port insertion via the SCV. None of the patients had a pneumothorax, chylothorax, brachial plexus injury, or upper extremity deep vein thrombosis.

The mean chemoport days in our study was  $832 \pm 666$  days, which is significantly higher than those in other studies such as Charvát et al. [1] (407 days), Kim et al. [2] (262 days), Teichgräber et al. [3] (292 days), Ng et al. [4] (158 days), Aparna et al. [7] (270 days), Chandrasekaran and Somasundaram [8] (216 days), and Seok et al. [12] (307 days). The proper care of the chemoports helped us achieve the longer chemoport indwelling days.

Port-related bloodstream infection is the most common complication of chemoport use and is the most common indication for premature chemoport removal. The other indications for premature removal are thrombosis of the chemoport or catheter, which causes blockage, thrombosis of the superior vena cava, kinking, decubitus-over-port, exposed chemoport due to the erosion of the overlying skin, and spontaneous disunion of the port and the catheter [1-

4,7-9,11,12].

To the best of our knowledge, we had the lowest (0.15 per 1,000 chemoport days) complication rate ever published in the literature [1-4,7,8,11]. Early complications are defined as those that occur within 30 days and include vein avulsion, bleeding, hematoma, arterial puncture, air embolism, pneumothorax, hemothorax, chylothorax, arrhythmia, brachial plexus injury, early bloodstream infection, surgical site infection, thoracic duct injury, and arteriovenous fistula.

We had an avulsion of the SCV by the peel-away sheath. The child with avulsion had to undergo thoracotomy and repair of the SCV. She underwent chemoport insertion a week later (in the IJV), and the follow-up was uneventful. The friable nature of veins in the pediatric age predisposes patients to the risk of vein avulsion by the stiff peel-away sheath. Hence, we had to stop using the peel-away sheath and start using an open technique to insert the chemoport catheter. However, the recent change in the quality of the peel-away sheath made us use the percutaneous technique again. In addition, we use the C-arm to identify and place the catheter tip.

As the most common indication of chemoport insertion in pediatric age is hematological malignancies, children are prone to bleeding and hematoma. This can be managed by optimizing the patient for surgery by transfusing platelets at the time of starting the procedure. Malposition of the catheter leads to arrhythmias. This can be prevented by placing the tip of the catheter at the superior vena cava and right atrium junction under C-arm guidance. We had one child with arrhythmias treated with repositioning of the catheter.

Hemothorax, pneumothorax, chylothorax, arterial puncture, injury to the brachial plexus, and injury to the thoracic duct can all be prevented by using ultrasonography. Image guidance helps in reducing several of these complications. Ultrasonography is a good imaging modality to locate the vein, and C-arm guidance can be used to place the catheter. Studies such as that by Yaacob et al. [13] found that image-guided chemoport insertion reduces the risk of periprocedural complications. Hemothorax, chylothorax, and pneumothorax will need intercostal drainage. The arterial puncture can be managed by removing the needle and continuous pressure for a few minutes.

Owing to an immunocompromised state, children with hematological malignancy are at risk of surgical site infection and early bloodstream infection. A strict aseptic precaution during surgery and chemoport use will help to prevent these two complications. The surgical site infection is managed by wound care and sensitive systemic antibiotic therapy. Early port-related bloodstream infection is managed in accordance with the Infectious Diseases Society of America guidelines for intravascular catheter infection [14].

Late complications occur after 30 days and include port-related bloodstream infection, port pocket infection, blocked chemoport chamber or catheter, exposure of the chemoport, leakage of the chemoport, catheter pinch-off, decubitus-over-port, fracture of the chemoport catheter, dislocation of the catheter from the chemoport, and thrombosis of the superior vena cava [1-4,7-12].

The most common organism causing port-related bloodstream infection is staphylococcus, which migrates from the skin surface during needle insertion [1]. The risk factors of bloodstream infection in these patients are the immunocompromised state of the child, poor nutrition, neutropenia, lack of skilled manpower, lack of appropriate medical supplies, lack of resources, and prolonged use of the chemoport. The incidence of port-related bloodstream infection in the developing nation is higher than that in the developed nation [7]. In our developing country, the incidence of port-related infection is lower owing to proper care of the chemoport. Hence, in our study, the most common organism that caused port-related bloodstream infection was *Candida* rather than skin flora. The immunocompromised status of the children in our study population predisposes them to an increased risk of fungal infection. In all suspected cases of bloodstream infection, we removed the port and treated them with appropriate antibiotics or antifungal agents.

Port pocket infection can occur in the immediate postoperative period or as a delayed complication. This is caused by skin flora, most commonly *Staphylococcus*. Blocked chemoport due to thrombus formation in the chemoport chamber, chemoport catheter, or superior vena cava is the second most common complication of chemoport insertion [1,2,7]. The risk factors of thrombosis are chemotherapeutic agents, poor hydration, the presence of a foreign body in the vein (chemoport catheter), infection, immobility, age, and hypercoagulable states. Thrombosis is prevented by flushing the catheter with diluted heparin solution after each use and once every month when it is not in use. Overlying skin necrosis exposing the chemoport occurs due to malnutrition, thinning of the skin, and constant pressure by the chemoport. This can be reduced by using low-profile chemoports [7,9].

Decubitus-over-port can occur due to suture cutting

through, more space in the chemoport pouch, and the heavy nature of the port. This can be reduced by using low-profile ports or fixing the chemoport at least at three points. Fracture of the chemoport catheter can occur after years of use. As the child grows, the chemoport catheter is stretched, which leads to either fracture of the catheter or disconnection of the catheter from chemoport [7].

Leakage of chemoport can occur due to disconnection of the chemoport catheter from the chemoport, fracture of the chemoport catheter, penetration of the posterior wall of the chemoport, or damaged septum of the chemoport. Sharp et al. found penetration of the posterior wall in 3.2% of their ports, which were all plastic ports [11]. Using a port with posterior wall metal backing can avoid its penetration. Proper care of the chemoport by using only a Huber needle to penetrate the septum of the chemoport will avoid damage to the septum. We had no case of chemoport leakage in this study.

## CONCLUSION

The use of chemoports can save the lives of children who require prolonged venous access. The most common indication for chemoport insertion in children is acute lymphoblastic leukemia. The safe, reliable, and low complication rate of chemoports help save children from deadly illnesses.

## CONFLICTS OF INTEREST

The authors have nothing to disclose.

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