Original Article

Percutaneous Central Venous Catheterization in Children, is it Efficient?

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ABSTRACT

Objective

To evaluate the frequent use of percutaneous central venous catheters (CVCs) in pediatric age group.

Methods

Retrospectively we reviewed the records of all children that had percutaneous CVCs in the pediatric surgical ward and pediatric intensive care unit at King Hussein Medical Center between January 2007 and December 2007 (one year). Patients were evaluated with respect to their age, gender, catheter type, indication for CVC insertion, site of CVC insertion. The duration of catheter use and eventual complications were also taken into consideration.

Results

A total of 120 percutaneous CVCs were inserted in 104 children. Patient age ranged from one day to14 years. The average catheter insertion time was 12.5 days. We noted 66 (18.8%) CVC- related complications. Complications related to percutaneous CVCs insertion were malposition of catheter (5.4%) and pneumothorax (0.9%). Occlusion of CVCs (4.3%), catheter related bloodstream infections (CRBI) (4.0%), dislodgment (3.7%) and catheter damage (0.6%) were complications associated with lenght of CVCs use.

Conclusion

We conclude that percutaneous central venous catheterization is a safe and efficient procedure that can be done at bedside with minimal complications in pediatric age group.

Keywords: Percutaneous, indications, complications, children.

Percutaneous central venous catheters (PCCVCs) have now become indispensable in intensive care units[1-3]. Insertion of PCCVC is amongst the most frequently performed invasive procedures [2,3]. In severely ill and long-stay patients, inserted PCCVCs enable relatively safe and painless application of total parenteral nutrition (TPN), long-term antibiotics, intravenous fluids, blood components and are also used for repetitive blood sampling[3-6].

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Furthermore, PCCVCs are used for invasive hemodynamic monitoring and in case of shortage of a peripheral access.

PCCVCs intended for children are made of a variety of materials, including silicone, polyurethane, polyvinyl chloride and polyethylene[3].

Access to a vessel can be gained via percutaneous puncture instead of the use of open surgical techniniques. "Seldinger"

Percutaneous technique is the most frequently used. PCCVCs are inserted via the internal and external jugular veins, subclavian umbilical vein or femoral vein. The tip of the

catheter can be placed into the right atrium, superior or high inferior vena cava[7-14].
When inserting PCCVC, the operator should be very experienced and cautious, given that possible complications are numerous and some of them can be very serious[2, 3, 12]. The percentages of known catheter-related complications range from 0.7 to 12%[1, 3, 12-16].
The objective of this study was to determine the frequency of application, indications and complications of PCCVCs in the Pediatric age group at KHMC. By analyzing the obtained results, our intention was to compare them with published data pertaining to this issue and to verify our methods and procedures.

MATERIAL AND METHODS

We retrospectively studied all patients' records identified as having PCCVCs from January 2007 to December 2007 in the PICU of the KHMC.
The data on indications for PCCVC placement, character of illness of patients with CVCs, total number of inserted CVCs, the most frequent insertion place and side, the average and total number of days of CVCs use and the most frequent complications related to CVCs, were evaluated.

All PCCVCs were placed by a pediatric surgeon and were carried out either at the bedside or in the operation room. The procedures were performed in aseptic conditions with continuous monitoring of patient's electrocardiogram, heart rate and oxygen saturation. An appropriate catheter was chosen on the basis of the size of the patient. Polyurethane catheters were most commonly used, except in case of umbilical insertion when a silicone catheter was used.
One-lumen catheters were used predominantly. Sedation of most patients was achieved with appropriate dosage of morphine, others by general anesthesia if the patient was conscious and vigorous.
Patients were adequately positioned for the procedure. The site of catheter insertion was cleaned initially with clorhexidin gluconate, with sterile saline and finally with clorhexidin in 70% isopropyl alcohol. Standard sterile technique including the use of sterile gloves, gown, mask and cap - was used in all cases. The place of insertion was covered with a sterile covering. Catheters were inserted percutaneously following the Seldinger technique[6, 7]. The preferred site for primary attempts was chosen according to the clinical condition of the patient. After the catheter was inserted, blood flow was checked and the lumen was flushed with normal saline. Catheters were fixed by sutures and covered with a transparent dressing. The catheters were maintained by either continuous infusion of heparin (1 unit/ ml) or by heparin flushes of 10 units/ml.
Within two hours of PCCVC insertion, chest X-ray obtained to confirm the tip was positioned above the pericardium, and to identify potential complications[8,15]. Following catheter insertion, the patient's electrocardiogram, heart rate and oxygen saturation were monitored for two to three hours.
Catheter blood flow and insertion site were checked and maintained daily.
Patients were carefully monitored for signs of catheter occlusion and catheter- related bloodstream infections.
Isolation of the same microorganism from the catheter lumen and from the blood drawn from a peripheral vein, with accompanying clinical symptoms of sepsis, was accepted as proof of a catheter related blood stream infection (CRBI) [16]. Whenever CRBI was diagnosed, the catheter was removed, and appropriate antibiotics were initiated.
The frequency of CRBI was expressed by number of sepsis cases per 100 days of catheter stay.
Catheter malposition was defined as placement that required repositioning before use. Catheter damage was defined as separation or cracking of catheter line components during use[14].

Kruskal Wallis and Mann-Whitney tests were used to determine factors associated with

complications. A probability value of 0.05 was accepted as significant.

RESULTS

During the study period 104 patients aged from 0 to 14years were admitted to the pediatric surgical ward and the pediatric ICU at KHMC. A total of 120 PCCVCs were inserted into 104 patients. There were 60 female and 44 male patients (57% and 43% respectively). Newborns were the biggest age group that needed PCCVC insertion; 68 patients (65%).

The difference between the number of patients and number of inserted PCCVCs is caused by multiple insertions of CVCs in some patients: 14 (13%) had two and 2 (2.1%) had three catheters inserted while the other 88 (85%) had one catheter. The average catheter placement time was 12.5 days with a range between 1-34 days.

Table 1: Indications for CVC insertion.

Indications	No of inserted PCCVCs (%)
IHM	7 (%)
I.v. therapy longer than14days	41 (%)
Parenteral nutrition	47 (%)
Lack of peripheral i.v. access	16 (%)
Prematurity	6 (%)
Others	3 (%)
Total	120 (%)

IHM= Invasive hemodynamic monitoring

The right internal jugular vein was the preferred place for insertion of CVCs in our patients (80 catheters, 66.6%)

The high proposition of newborns in our study accounted for the large percentage of umbilical vein catheters used (28, 23%). Two-lumen catheters were inserted in 25 patients while one lumen catheters were inserted in the other patients.

The most frequent indication for CVC insertion was Total Paenteral Nutrition in new born babies, followed by intravenous therapy longer than 14 days. Indications for CVC insertion were show in table 1.

Out of 120 placed CVCs, 16 (13%) had one of the complications related to CVC insertion.

The most frequent complication was malposition of CVC occurring in 20 (16%) patients, then occlusion occurring in 10 (8%) patients (Table 2).

Table 2: General Complications of CVC insertion.

Complications related to PCCVCs	No
Occlusion	15
Malposition	19
CRI	14
Pneumothorax	3
Dislodgment	13
Catheter damage	2
Total	66

Dislodgment occurred in 5 (4%) patients, but in 4 patients it happened after their relocation to the department of Pediatrics.

The most serious, among all notified complications, was CRBI. No catheter became infected during the first 48 hours after insertion. CRBI developed in 14 (4.0%) patients. There were 3.1 CRBI per 1000 catheter-days. In five out of a total of 14 cases, the isolated organism was methicillin-resistant *Staphylococcus epidermidis*(Table3).

Table 3. Infectious Complications related to CVCs insertion.

Organism	Total
Staphylococcus aureus	1
Coagulase-negative Staphylococcus	3
Candida albicans	1
Klebsiella pneumoniae	2
MSSE	1

MSSE= Methicillin-sensitive Staphylococcus epidermidis.

A significantly higher number of CRBIs occurred in newborns than in other age

groups. Three times more cases of CRBI were recorded when CVCs were inserted for provision of parenteral nutrition. CRBI occurred in six cases when the CVC was inserted into umbilical vein, in two cases when it was inserted into the left subclavian vein, in five cases when it was inserted into the right subclavian vein and in one case following insertion into the right femoral vein.

CRBI was not significantly associated with gender, catheter type or mechanical ventilation.

DISCUSSION

Most complications related to PCCVCs are minor, but some of them can be serious and can result in patient death [1, 7]. Our complication rate is within the limits of published data. Furthermore, major complications in our patients were rare.

The incidence of the most important complication, CRI, varies from 5% to 26% in adults[15]and from 3% to 20% in children[7]. When calculated in relation to the length of stay, the incidence of CRI in adults varies from 2.4 to 12 per 1000 catheter days[23,27].The incidence is higher in newborns (4.9 episodes of CRI per 1000 catheter days) than in older children (2.4 episodes of CRI per 1000 days) [19, 20]. The low incidence of CRIs in our patients is probably related to the expertise of our staff members who maintain aseptic condition in all procedures involving both insertion and managing of CVCs. In accordance with published data.

Coagulase-negative Staphylococcus and Methicillin-resistant Staphylococcus epidermidis were the most common isolates in our patients with CRI[7].

It was found that the duration of the catheter use was critical for the occurrence of infections[7, 20]. When catheters are in place for extended periods, the catheter hub probably plays a major role in providing access for microorganism to the bloodstream by migrating endoluminally[20]. A higher catheter infection rate was noted in PCCVCs inserted for parenteral nutrition. This high rate is associated not only with the high concentration of nutrients in total parenteral nutrition solutions, but also with the length of stay of catheters designed for parenteral nutrition[26].

Likewise, the majority of CRIs in our study occurred in patients who were receiving parenteral nutrition, and all our patients with CRIs were newborns.

The use of multilumen catheters for parenteral nutrition is highly desirable because it provides multipurpose access to central circulation and eliminates a need for additional intravenous access[19]. However, the multiple lumen catheters bear the increased risk for CRI[7, 19, 21, 23]. This statement is not unequivocal, and the results of our study support studies stating that multilumen catheters did not increase the risk for CRI2[27,28]. It can be emphasized again that the adherence with the procedures for maintaining sterile conditions has a major influence on the occurrence of CRI.

All other complications that occurred in our study presented minor problems with no influence on morbidity. The most common complications during the procedure of insertion were malposition and pneumothorax. The malposition of PCCVCs required repositioning before catheter use, but was never associated with any further complications. Pneumothorax can be a serious complication, with the frequency of occurrence that varies between 0.01 and 6%[7].

In our study pneumothorax was only an incidental finding, that needed no intervention, and with a significantly low rate. Other serious complications reported in the literature include cardiac perforation, arteriovenous fistulas, nerve injuries (mostly brachial plexus injuries), cardiac tamponade, tension pneumothoraces, significant hemothoraces, delayed pneumothoraces, life-threatening arrhythmias, thoracic duct injuries and death[1, 24]. None of our patients had any of these serious complications.

Thrombosis is reported to occur in 2 to 67% PCCVCs[7, 15, 29]. We didn't notice any clinically apparent thromboses in our patients.

However, most thromboses due to PCCVCs are asymptomatic[7, 25, 26]. Therefore, ultrasound follow-up, that would reveal asymptomatic thrombosis, should be performed regularly[25, 26, 30].

Occlusion of the PCCVCs was one of the most frequent complications in our study, but again within the expected range of 0% - 7%[17, 22].

When occlusion occurred, it was tried to be relieved by flush with heparinised saline.

Conclusion:

Published data on long-term central venous access can be compared only with great difficulties, due to considerable variations in study designs, patient populations, access routes and insertion techniques. The rates of infections and other complications in our study are in accordance with the results obtained from the pertinent literature**.** *Therefore, we can conclude that* percutaneous central venous catheterization can be recommended as a safe and efficient procedure with minimal complications in pediatric patients. However, the emphasis should be on strict adherence to existing guidelines when PCCVCs are inserted, and during subsequent care for those lines.

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