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AN EVALUATION OF PATIENTS PLACING CENTRAL VENOUS CATHETERIZATION IN THE PEDIATRIC INTENSIVE CARE UNIT

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ABSTRACT

The use of central venous catheters (CVC) is an invasive procedure widely used for procedures such as hemodynamic observation, drug and fluid administration, blood collection, hemodialysis and plasmapheresis. The purpose of this study was to evaluate patients receiving CVC in the Pediatric Intensive Care Unit for various reasons and to assess the complications encountered. Patients undergoing central venous catheterization in the Pediatric Intensive Care Unit for various reasons between January 2014 and January 2015 were included in the study. One hundred two CVC procedures were performed on 85 (50%) out of 170 patients. Forty-six (54.2%) patients were girls and 39 (45.8%) boys. Mean age was 41.9±50.8 months (min.2, max.185). Sixty-six (64.7%) CVC procedures were performed for nutrition and drug administration, 27 (26.5%) for continuous renal replacement and 9 (8.8%) for plasmapheresis. Fifty-four (52.9%) catheters were placed in the femoral vein, 28 (27.5%) in the internal jugular vein and 20 in the subclavian vein. Fourteen (13.7%) complications (7 arterial puncture, 4 minor bleeding, 2 hematoma and 1 pneumothorax) were observed during catheter placement, 3 thromboses (2.9%) during monitoring, 8 accidental removals (7.8%) and 5 infections (4.9%). No significant relation was determined in terms of catheter placement sites and development of complications during the procedure ($p<0.05$). No relation was also determined between catheter placement sites and catheter-related infection and thrombosis (p: 0.062 and p: 0.46). Despite technical difficulties and complications, central venous catheterization is still a reliable technique in children in experienced hands. In addition to facilitating treatment in critically ill children, it is also an indispensable element of intensive care because it permits monitoring.

INTRODUCTION

Use of the central venous catheter (CVC) is a procedure widely used in intensive care units for total parenteral nutrition (TPN), in hemodialysis and plasmapheresis, in hemodynamic monitoring and in complicated cases requiring wide vascular access. The subclavian vein (SCV), internal jugular vein (IJV) and femoral vein are widely used, and the external jugular vein less frequently. Following successful use in adults, use in pediatric intensive care units is also increasing due to the advantages it provides. Technical placement difficulties and complications are more frequent in child patients, however [1,2].The purpose of this study was to evaluate patients undergoing central venous catheterization in the Pediatric Intensive Care Unit for various reasons and to assess the complications encountered.

MATERIALS AND METHODS

One hundred seventy patients hospitalized in an open pediatric intensive care unit between January 2014 and January 2015 were included in the study under ethical approval No. 72 dated 09.03.2015. CVCs were inserted for purposes of TPN, fluid and drug administration, continuous renal replacement and monitoring central venous pressure. The femoral, internal jugular and subclavian veins were used for catheterization. 4F non-tunneled catheters were used for subjects with body weight

less than 5 kg, 5F for those with body weight 5-20 kg and 7F for those with body weight above 20 kg. Hemodialysis catheters were used for patients scheduled for continuous renal replacement and plasmapheresis. All patients received intravenous midazolam (0.1 mg/kg) for sedation before the procedure and fentanyl (1 mcg/kg) for analgesia. Ketamine (1 mg/kg) was used for sedation in hypotensive patients. Blood product support was given to patients with bleeding diathesis, target values being platelet number > 50,000 mm^3 and PTT 60 sec. The SCV was used in these patients. Appropriate handwashing and aseptic conditions were ensured before the procedure. Sterilization of catheterization site was performed with 10% povidone iodine. Inability to place catheters accompanied by USG or conventionally was regarded as failure. Jugular and subclavian vein catheters were evaluated with pulmonary x-ray in order to evaluate post-procedural catheter locations and complications. Following catheter placement, continuous fluid was provided to avoid catheter obstruction. Catheter dressing was performed to prevent catheter infections, and catheters were covered with transparent polyurethane. Caps were changed every 7 days. However, earlier dressing and capping were performed if dirt or bleeding were observed, or if reddening or discharge were detected. Date of dressing and capping was recorded.

Erythema and induration within 2 cm of the catheter exit site without bloodstream infection was evaluated as catheter site infection. Growth of the same micro-organism in blood culture taken from the catheter and in peripheral blood culture and presence of clinical symptoms and findings of sepsis was evaluated as catheter-related bloodstream infection.

Cases' mortality risks were calculated online using PIM II (Pediatric Index of Mortality II)(http://www.sfar.org/scores 2/pim22.php) and PRISM (Pediatric Risk of Mortality) (http//www.sfar.org/scores 2/prism2.php).

Statistical analysis was performed on SPSS 21.0 software. Numerical data were expressed and mean±standard deviation and median range (min, max), and categoric data as percentages (%). Normally distributed numerical data were analyzed using the Student t test, non-normally distributed numerical data using the Mann-Whitney U test and categoric data using the chi square test. $p<0.05$ was regarded as statistically significant.

RESULTS

One hundred two CVC procedures were performed on 85 (50%) out of 170 patients during the study period. Forty-six patients (54.2%) were girls and 39 (45.8%) boys. Fifty (58.8%) patients had acute onset disease and 35 (41.17%) had chronic disease. Mean age was 41.9±50.8 months (min. 2, max. 185). Mean PIM score was 34.2±23.9 (min. 2, max. 96) and mean PRISM score 19.59±7.47 (min. 3, max. 42). Thirty (36%) patients died during monitoring, and 55 (64%) survived. The most common diagnoses at admission to intensive care were neurological diseases (17 cases) and sepsis (13 cases) (Table 1).

Sixty-six (64.7%) CVCs were installed for nutrition and drug administration, 27 (26.5%) for continuous renal replacement and 9 (8.8%) for plasmapheresis. Fifty-four (52.9%) catheters were placed in the femoral vein, 28 (27.5%) in the internal jugular vein (IJV) and 20 in the subclavian vein (SCV). Ninety-five catheters were inserted by pediatric critical care subspecialty interns using the conventional method, and 7 in the operating room by an anesthesiology and reanimation specialist accompanied by USG. Placement failed in 2 patients, and temporary intraosseous access was employed. Mean length of CVC use was 10.2 days (min. 1, max. 53).

Complications developed in 14 cases (13.7%) during catheter placement (7 arterial puncture, 4 minor bleeding, 2 hematoma, 1 pneumothorax), thrombosis during monitoring in 3 (2.9%), obstruction in 3 (2.9%), accidental displacement in 8 (7.8%), and infection in 5 (4.9%) (Table 2). Three of these infections were catheter site-related local infections and 2 were sepsis-related. Two exit site infections were femoral catheter-related and 1 was subclavian catheter-related. One case developing sepsis had received subclavian placement and 1 femoral placement. Candida spp grew in 2 catheter cultures and *Acinetobacter Baumannii* in one.

No significant difference was determined between groups established in terms of catheterization site and age, PIM score or PRISM score (p:0.237, p:0.698 and p:0.268, respectively).

No significant difference was determined between sites of catheter placement and complications during the procedure ($p<0.05$). Similarly, no correlation was determined between area of catheterization and catheter-related infection and thrombosis (p:0.062 and p:0.46).

Table 1. The diagnosis of patients

Type of Disease	n	%
Neurological diseases	17	20
Sepsis	13	15.2
Nephrological diseases	12	14.1
Cardiological diseases	12	14.1
Lung diseases	11	13
Hemato-oncological diseases	10	11.8
Gastroenterologic diseases	6	7

Metabolic disease	2	2.4
Others	2	2.4
Total	85	100

Table 2. The evaluation of our catheterization complications

Complications	Femoral vein	Internal jugular vein	Subclavian vein	Total
Arterial punctures	4	1	2	7
Minor bleeding	3	1	0	4
Hematoma	1	1	0	2
Pneumothorax	0	0	1	1
Catheter site infection	2	0	1	3
Catheter related blood stream infection	1	0	1	2
Venous thrombosis	2	0	1	3
Obstruction	1	1	1	3
Accidental displacement	4	3	1	8

DISCUSSION AND CONCLUSION

Central venous catheterization plays an important role in the management of critical patients. Catheterization in our pediatric intensive care unit was most commonly performed in order to provide venous access suitable for nutritional support and drug administration. This was followed, in order, by extracorporeal treatments such as continuous renal replacement and plasmapheresis. The presence of CVC also permitted hemodynamic monitoring and blood provision when required.

CVC placement in children is more difficult and dangerous compared to adults. Our catheterization level was 50% and out general success rate 98%, these figures being compatible with the literature. Catheterization failed in only 2 cases, in which temporary intraosseous procedures were performed. One of the most important factors in catheter-related mechanical complications is physician experience, and having inserted 50 catheters is regarded as sufficient experience [3]. We think that, in addition to appropriate conditions being ensured, catheter placement being performed by an experienced pediatrician and anesthesia and rehabilitation specialist also played a role in this high success rate.

Fourteen (13.7%) mechanical complications developed during placement of the 102 catheters, 7 arterial puncture, 4 minor bleeding, 2 hematoma and 1 pneumothorax. The level in the literature ranges between 5% and 19% [4,5]. No arrhythmia was observed in any of our patients during the procedure. Minor bleeding and hematoma were brought under control with pressure. A high or low body mass index, previous catheter placement to the same vein, surgery to the region of catheter placement, receipt of radiotherapy to the same region and lengthy duration of catheter placement have been described as risk factors increasing mechanical complications. Additionally, emergency indication for CVC placement, time of day of placement and the patient's state of consciousness have also been reported as potential factors in complications [6,7]. Although the great majority of complications apply to both routes, there may be complications specific to some venous interventions, and rates of the same complication may vary depending on intervention site. Pneumothorax and hemothorax rates are higher in SCV catheterization and arterial intervention rates in IGV catheterization. Even if subclavian vein procedures are guided by imaging, these still have the highest pneumothorax rates among the intervention sites. Pneumothorax developed during subclavian catheterization in one of our patients. A chest tube was inserted and drainage performed. The tube was removed on the 3rd day. The CVC-related mortality level is unknown, but potentially fatal mechanical complications include ventricular arrhythmia, air embolism, cardiac tamponade, pneumothorax, hemothorax and coronary sinus thrombosis. USG is recommended as a method that reduces complications in central vein catheterization. USG both facilitates the procedure and can reveal the openness and variations of the vein to be used. Various studies have shown that IJV catheterization accompanied by USG reduces mechanical complications, procedure failure rate and time required for the procedure [8]. IJV placement accompanied by USG is the first routine procedure if physicians experienced in performing it with USG are available in the center concerned and if IJV placement is appropriate for the patient. IJV catheterization accompanied by USG was performed by an anesthesiology and rehabilitation specialist in 7 cases in this study.

Catheter exit site infection developed during monitoring in 3 (2.9%) cases and catheter-related sepsis in 2 (1.9%). The level in the literature is 5-26% [9, 10]. We think that compliance with sterilization rules and regular and sterile catheter maintenance reduced the catheter-related infection level in our unit. Although the level of bloodstream infection has been reported to increase with femoral catheterization in several studies, we determined no correlation between catheter placement sites and catheter-related infections (p:0.062).

Sheridan *et al.* [11] reported that SVC being maintained for more than 10 days increased the risk of infection, and that if maintained for 14 days, the infection rate was 37.5%. Catheterization exceeded 6 days in all our patients developing infection. The Gram-negative bacterium A.*Baumannii* grew in catheter culture in one case and Candida spp. in another.

The rate of catheter-related thrombosis in patients receiving CVC is reported at between 2% and 26%. One study from 2012 of children aged under 1 year with CVC placement reported that deep venous thrombosis (DVT) developed in 18% of patients. Catheter was placed in the femoral vein in 60% of these cases, and multi-lumen CVC exhibited a higher rate of DVT compared to single lumen SVCs (54% and 6%, respectively)[12]. DVT was determined in 3 of our patients, 2 with catheter in the femoral vein and 1 in the SCV. No significant difference was determined between femoral, SCV and IJV catheterization in terms of DVT development (p:0.46).One meta-analysis of 1513 patients from 2012 reported no difference between SCV and IJV in terms of long-term catheter use in patients with cancer, but emphasized that the SCV region is preferable to the femoral region since it leads to lower colonization and thrombotic complications. The IJV and femoral regions have been reported to involve similar risks in short-term hemodialysis in terms of catheter colonization, catheter-related bloodstream infection and thrombotic complications, although there is a greater risk of mechanical complications in the IJV region [13]. We determined statistically significant difference between catheter region and thrombosis and catheter-related infections during monitoring (p>0.05).

Despite technical difficulties and complications, central venous catheterization is still a reliable technique in children in experienced hands. In addition to facilitating treatment in critically ill children, it is also an indispensable element of intensive care because it permits monitoring.

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CONFLICT OF INTEREST:
The authors declare that they have no conflict of interest.

STATEMENT OF HUMAN AND ANIMAL RIGHTS

All procedures performed in human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

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