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Retrospective Evaluation of Central Venous Catheters Applications in Pediatric Patients in Tertiary Hospital

Üçüncü Basamak Hastanede Pediatrik Hastalarda Santral Venöz Kateter Uygulamalarının Retrospektif Değerlendirilmesi

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ABSTRACT

Objective: Central venous catheters are mainly used for safe fluid infusion, total parenteral nutrition, and evaluation of hemodynamic parameters. Complications related to central venous access can occur during insertion, after insertion or during catheter maintenance. The aim of this study was to investigate the demographic data and the presence of catheter-related complications in pediatric patients with central venous catheters in our hospital.
Methods: This study retrospectively reviewed demographic data and the presence of catheter-related complications in pediatric patients with central venous catheters in our hospital from June 1, 2019, to February 28, 2023.
Results: Patients who underwent central venous catheterisation in our hospital between June 2020 and February 2023 were included in the study. When the demographic data of the patients were evaluated, 141 (57.8%) of our patients were male and 103 (42.2%) were female, and there was no statistically significant difference between the groups. In the femoral group, catheterisation of the right femoral vein was preferred more than the left vein (72.2%-27.7%), whereas in the jugular-subclavian group, the right internal jugular vein was preferred more than other sites. The risk of infection was statistically higher in the femoral group compared to the subclavian group.
Conclusion: In clinical practice, we think that the risk of complications can be reduced in central venous catheter applications in pediatric patients by experienced personnel by complying with asepsis/antisepsis conditions and using appropriate imaging devices.

Keywords: Central venous catheter, pediatric, complication

ÖZ

Amaç: Santral venöz kateterler esas olarak güvenli sıvı infüzyonu, total parenteral beslenme ve hemodinamik parametrelerin değerlendirilmesi için kullanılır. Santral venöz erişimle ilgili komplikasyonlar yerleştirme sırasında, yerleştirmeden sonra veya kateter bakımı sırasında ortaya çıkabilir. Bu çalışmanın amacı hastanemizde santral venöz kateterli pediatrik hastalarda demografik verileri ve kateterle ilişkili komplikasyonların varlığını araştırmaktır.
Yöntemler: Bu çalışmada 1 Haziran 2019 ile 28 Şubat 2023 tarihleri arasında hastanemizde santral venöz kateterli pediatrik hastalarda demografik veriler ve kateterle ilişkili komplikasyonların varlığı retrospektif olarak incelenmiştir.
Bulgular: Haziran 2020 ile Şubat 2023 tarihleri arasında hastanemizde santral venöz kateterizasyon uygulanan hastalar çalışmaya dahil edildi. Hastaların demografik verileri değerlendirildiğinde hastalarımızın 141'i (%57,8) erkek, 103'ü (%42,2) kadındı ve gruplar arasında istatistiksel olarak anlamlı bir fark yoktu. Femoral grupta, sağ femoral ven kateterizasyonu sol venden daha fazla tercih edildi (%72,2-%27,7), juguler-subklavian grubunda ise sağ internal juguler ven diğer bölgelere göre daha fazla tercih edildi. Enfeksiyon riski femoral grupta subklavian gruba göre istatistiksel olarak daha yüksekti.
Sonuç: Klinik pratikte, deneyimli personel tarafından asepsi/antisepsi koşullarına uyularak ve uygun görüntüleme cihazları kullanılarak pediatrik hastalarda santral venöz kateter uygulamalarında komplikasyon riskinin azaltılabileceğini düşünüyoruz.

Anahtar kelimeler: Santral venöz kateter, pediatrik, komplikasyon

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INTRODUCTION

Central venous catheters are mainly used for safe fluid infusion, renal replacement therapy, total parenteral nutrition, administration of potentially irritating drugs and evaluation of hemodynamic parameters. Central venous cannulation in babies poses challenges due to their diminutive size and is linked to heightened morbidity. Central venous access in children can be achieved via the internal jugular vein, subclavian vein, or femoral vein. [1,2]

Complications related to central venous access may occur during insertion, after insertion, or during catheter care. These include catheter-related infections, pneumothorax, venous air embolism, guidewire embolism or retention, vascular injury, thrombotic events, carotid artery puncture, airway obstruction by hematoma, damage to surrounding structures, retroperitoneal hematoma, azygos cannulation, catheter misposition. [3] The positioning of the catheter tip is crucial to reduce catheter-related problems. The optimal position for the catheter tip in subclavian and internal jugular vein placements is the distal third of the superior vena cava (SVC). This posture is thought to reduce the likelihood of problems during clinical use, including vascular perforation, venous thrombosis, catheter dysfunction, and cranial retrograde injection. [4]

Utilizing ultrasonography during catheter installation lowers the frequency of interventions and mechanical difficulties relative to normal procedures, and is endorsed by guidelines. Two-dimensional ultrasonography is preferred over Doppler ultrasound, and the catheter insertion site may differ based on anatomical considerations, complication concerns, the availability and usefulness of bedside ultrasound, and the expertise of the catheter inserter. [5]

The aim of this study was to investigate the demographic data and the presence of catheter-related complications in pediatric patients with central venous catheters in tertiary hospital.

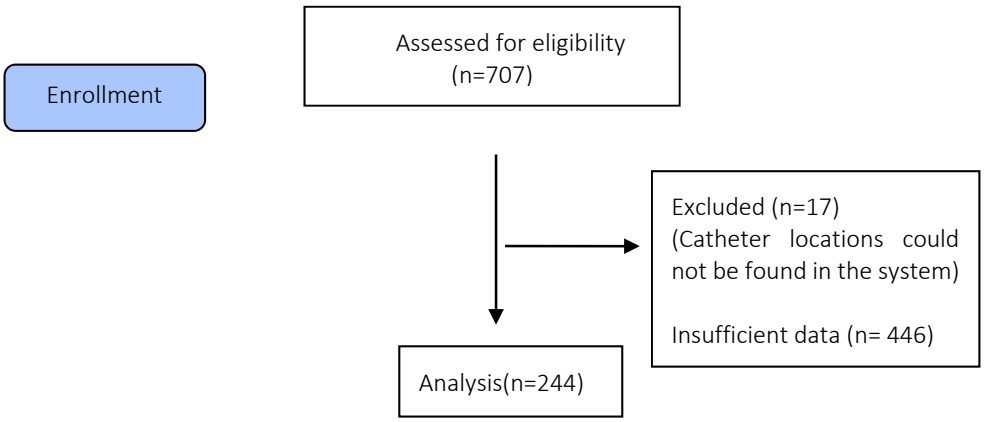

Figure 1: CONSORT Diagram.

METHODS

The ethical approval for our study was obtained in the Atatürk University Clinical Research Ethics Evaluation Committee's Clinical Research Meeting No: Resolution No:64, dated 26.01.2023. After ethics committee approval, catheters inserted in pediatric patients treated in Erzurum City Hospital between 01.06.2019-28.02.2023 were retrospectively analyzed. A list of patients with femoral vein catheterization (F) and subclavian-jugular (SJ) vein catheterization codes was obtained from the hospital data system. Demographic data of the patients were noted from the hospital data system. During this period, catheters were inserted in 707 patients and patients with duplicate data, missing data and patients with missing data in their files were excluded from the study. In total, 244 catheters inserted in 165 patients were included in the study. Catheters were grouped as femoral vein catheterization and subclavian-jugular vein catheterization according to the hospital data system code. The catheter sites were then specified as right femoral, left femoral, right subclavian, left subclavian, right internal jugular, and left internal jugular veins according to the patients' control radiographs and consultation notes. The presence of a catheter infection was detected in the hospital data system on the basis of consultation notes and the results of culture growth. Catheter-related complications were identified and grouped from consultation notes in the hospital data system.

Statistical Analysis

For statistical analyses, SPSS.22 software package (IBM SPSS Corp. Armonk, NY, USA) was used. Numerical data

were presented as mean and standard deviation, categorical data were presented as numbers and percentages. If conditions for parametric analysis were met when analyzing numerical data and intergroup differences, Independent Samples T-test was used, if not, Mann-Whitney U test was used, and when analyzing categorical data, chi-square test was used. A *P*<.05 was considered statistically significant.

RESULTS

Patients who underwent central venous catheterisation in our hospital between May 2020 and March 2023 were included in the study. When the demographic data of the patients were evaluated, 141 (57.8%) of our patients were male and 103 (42.2%) were female, and there was no statistically significant difference between the groups (*P*>.05). When the incidence of complications between the groups was evaluated in terms of catheter infection, no statistically significant difference was observed (*P*>.05) (Table 1). In the femoral group, catheterisation of the right femoral vein was preferred more than the left vein (72.2%-27.7%), whereas in the jugular-subclavian group, the right internal jugular vein was preferred more than other sites (Table 2). The risk of infection was statistically higher in the femoral group compared to the subclavian group (*P*<.05). (Table 3).

Table 1: Demographic Data and Catheter Location

		Femoral (n=65)	Juguler-Subclavian (n=179)	*P*
Age		1.66 ± 3.75	2.65 ± 4.53	.281[a]
Gender	F	40	101	.558[b]
	M	25	78	
Catheter İnfection	Yes (n / %)	13 (20%)	22 (12.3%)	.149[b]
	No (n / %)	52 (80%)	157(87.7%)	

Values are expressed as a mean ± standard deviation (SD), number and percentage (%),
[a] Mann-Whitney U test,
[b] Pearson's chi-squared test

Table 2: Detailed Examination of Catheter Sites

	Femoral (n=65)	Juguler-Subclavian (n=179)	*P*
Right Juguler Vein	0 (0.0%)	136 (76.0%)	.000[a]
Left Juguler Vein	0 (0.0%)	36 (20.1%)	
Right Femoral Vein	47 (72.3%)	0 (0.0%)	
Left Femoral Vein	18 (27.7%)	0 (0.0%)	
Right Subclavian Vein	0 (0.0%)	2 (1.1%)	
Left Subclavian Vein	0 (0.0%)	5 (2.8%)	

Values are expressed as a percentage (%),

DISCUSSION

This study demonstrated that catheter infection rates were lower than those reported in the literature. Furthermore, the utilization of ultrasound guidance in clinical practice significantly influenced the choice of catheter insertion site.

In neonatal and paediatric patients, providing stable venous access for blood collection, fluid replacement, intravenous drug administration and parenteral nutrition in the medium to long term remains a significant challenge. Appropriate intravenous access in this patient group is a critical factor in the care and treatment management process. In this context, peripherally placed central catheters are one of the main alternatives that can be effectively implemented. [6] In a recent large-scale study conducted in our country, 885 paediatric central venous catheter (CVC) applications were performed in a study in which 6-year experiences were shared and the most common indication (28.4%) was reported as providing venous access for multiple drug infusion. [7]

It has been shown that the age of the paediatric patient affects cannulation success. Accordingly, cannulation success decreases in younger children. [8] Similarly, the mean

age of the patients in our study was 2.38±4.35 and the unsuccessful application was found in 5 patients. CVC can be performed via various routes, including the jugular, subclavian and femoral veins. Each anatomical site carries its own risks. [9] In our study, the jugular region was more frequently preferred as the anatomical region. We prefer the jugular veins in daily practice because of easy visualisation of the jugular veins by USG and anatomically easier access.

Complications during catheterisation, which we frequently use in clinical practice, may adversely affect the treatment processes of patients and therefore require a very careful approach. [10] These risks include both mechanical and infectious risks. The most common complications of CVC include arterial puncture, vessel perforation, pneumothorax, thrombosis, catheter misdirection and catheter-associated bloodstream infection. [11] In particular, the small size of paediatric vessels compared to adults increases the risk of complications and leads to repeated attempts. [12] Therefore, a careful approach is required in central catheter applications in the neonatal and paediatric age group. The experience of the practitioner is also important. [13]

Table 3: Complications of Catheters

	Femoral (n=65)	Juguler-Subclavian (n=179)	*P*
None	52 (80%)	153 (85.5%)	<.05[a]
İnfection	10 (15.4%)	20 (11.2%)	
Catheter Blockage	1 (1.5%)	0 (0.0%)	
Malposition	0 (0.0%)	5 (2.8%)	
Thrombosis	2 (3.1%)	0 (0.0%)	
Guide Knotting	0 (0.0%)	1 (0.6%)	

Values are expressed as a percentage (%),
[a] Pearson's chi-squared test

The likelihood of pneumothorax and arterial puncture is diminished with catheter insertion into the internal jugular vein compared to the subclavian vein. Research in adult patients indicates that the right internal jugular vein is broader than the left and is positioned nearer to the dermis. [14] The right internal jugular vein is favored in our hospital due to the prevalence of right-handed practitioners, its more direct connection to the superior vena cava relative to the left internal jugular vein, and its improved accessibility for right-handed individuals.

Nowadays, ultrasound-guided CVC application provides better visualisation of anatomical structures and the possibility of complications is significantly reduced. [10] One of the complications that may occur during CVC application is the development of pneumothorax. A recent study of 137 patients reported a pneumothorax rate of 1.5%. [15] In a similar study, pneumothorax was reported in 4 out of 257 USG-guided CVC applications. [16] In our study, the CVC practitioners were anaesthesiologists, paediatric intensive care unit specialists and paediatric cardiovascular surgeons, all of whom had at least 5 years of experience. No pneumothorax developed in any patient. The reason for this is that although CVC is performed by experienced practitioners, USG-guided access clearly shows the anatomical structures and reduces the complication rate. One of the acute complications of CVC is catheter-related infection. USA data show that catheter-associated infections in neonates and children are associated with increased mortality, prolonged hospitalization and higher costs. [17] An incidence rate between 16.4% and 28.8% has been reported in the literature. [18] In our study, the infection rate was found to be 14.3%. This low rate was due to the fact that asepsis and antisepsis rules were followed during the procedure and the catheter stay was kept short. In our institution, infection prevention measures mandate the review of potential infection sources, with stringent controls implemented according to established guidelines. Upon the cessation of necessity for central venous catheters, they are promptly extracted, and treatments proceed through peripheral intravenous pathways. We assert that this condition renders our infection rate compatible with the literature. An important problem in paediatric patients is catheter-related thrombosis. It has been shown that thrombosis rates associated with CVC are high. [19,20] In our study, thrombosis was observed in 2 of the applications. We think that this may be related to mechanisms such as damage to the vessels during catheter insertion and obstruction of blood flow during and after the procedure

In clinical practice, we think that the risk of complications can be reduced in central venous catheter applications in pediatric patients by experienced personnel by complying with asepsis/antisepsis conditions and using appropriate

imaging devices.

Limitations of the Study

Weight and height data for all patients were not available in the hospital data system. Therefore, these data could not be included in the study. Our investigation was a single-center, retrospective study, which constrained the patient population. A further constraint was our inability to ascertain the lumen number of the catheters from the system.

Ethics Committee Approval: The ethical approval for our study was obtained in the Atatürk University Clinical Research Ethics Evaluation Committee's Clinical Research Meeting No: Resolution No:64, dated 26.01.2023.
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Hakem Değerlendirmesi: Dış bağımsız.
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