

CLINICAL RESEARCH / KLİNİK ÇALIŞMA

**CENTRAL VENOUS CATHETERIZATION IN PEDIATRIC BURN PATIENTS:
SIX-YEAR CLINICAL OUTCOMES IN A SINGLE CENTER EXPERIENCE**

**PEDİYATRİK YANIK HASTALARINDA SANTRAL VENÖZ KATETERİZASYON:
TEK BİR MERKEZ DENEYİMİNİN ALTI YILLIK KLİNİK SONUÇLARI**

**¹Gülşen KESKİN, ¹Mine AKIN, ¹Sibel SAYDAM, ¹Yeşim ŞENAYLI,
¹Devrim TANIL KURT, ¹Sengül ÖZMERT, ¹Feyza SEVER, ²Atilla ŞENAYLI**

**¹University of Health Sciences, Department of Anesthesiology, Ankara Child Health and Diseases
Hematology-Oncology Training and Research Hospital, Ankara, Turkey**

²Yıldırım Beyazıt University, Faculty of Medicine, Department of Pediatric Surgery, Ankara, Turkey

¹Sağlık Bilimleri Üniversitesi, Anesteziyoloji Anabilim Dalı, Ankara Çocuk Sağlığı ve Hastalıkları Hematoloji-Onkoloji
Eğitim ve Araştırma Hastanesi, Ankara, Türkiye

²Yıldırım Beyazıt Üniversitesi, Tıp Fakültesi Çocuk Cerrahisi Anabilim Dalı, Ankara, Türkiye

ABSTRACT

Objective: There is a limited number of studies in which the central venous catheterization practices in pediatric burn patients is discussed. The aim of this study is to share 6 years of experience of central venous catheterization practices performed by the department of anesthesia in a pediatric burn intensive care unit.

Method: Anesthesia forms and laboratory records of 84 pediatric patients, who underwent central venous catheterization by the anesthesiologists in the pediatric burn intensive care unit of Ankara Child Health and Diseases Hematology-Oncology Training and Research Hospital between January 2009-December 2015, were retrospectively analyzed.

Results: Between January 2009-December 2015, 122 central venous catheters were inserted in 84 pediatric burn patients aged between 15 days and 17 years. In 73 patients (59.8%) the internal jugular vein and in 49 patients (40.2%) femoral vein were preferred for catheterization. 63.9% of the patients were aged 4 years or under. No major complications were encountered during and after the catheterization. *Acinetobacter* species was the most isolated organism from the catheter cultures.

Conclusion: Burn injury more than 40% of total burn surface area is responsible for the mortality regardless of the localization of the catheter and the cause of burn. Although not statistically significant, infection rates were high in the catheterization of the femoral vein.

KEYWORDS: Burn, Central venous catheter, Pediatric patient

ÖZ

Amaç: Çocuk yanık hastalarındaki santral venöz kateter uygulamaları az sayıda çalışma vardır. Bu çalışmada ciddi yanık yüzdesi ve derecesine sahip hastaların takip edildiği 10 yataklı çocuk yanık ünitesinde anestezi bölümü tarafından takılan santral venöz kateter uygulamaları ile ilgili 6 yıllık deneyimin paylaşılması amaçlandı.

Yöntem: Ocak 2009- Aralık 2015 tarihleri arasında Ankara Çocuk Sağlığı ve Hastalıkları Hematoloji-Onkoloji Eğitim Araştırma Hastanesi, çocuk yanık yoğun bakım ünitesinde anestezi bölümü tarafından santral venöz kateter uygulanan 84 pediatrik hastanın anestezi formları, laboratuvar kayıtları retrospektif olarak analiz edildi.

Bulgular: Ocak 2009- Aralık 2015 tarihleri arasında 15 gün-17 yaş aralığında 84 çocuk yanık hastasına 122 santral venöz kateter takıldı. 73 (59.8 %) internal juguler ven, 49 (40.2 %) femoral ven kullanıldı. Hastaların %63.9'u 4 yaş ve altında idi. Kateterizasyon sırasında ve sonrasında major komplikasyon ile karşılaşmadı. Kateter kültürlerinde en çok *Acinetobacter* izole edildi.

Sonuç: Çocuk yanık hastalarında, %40 ve üzeri yanık alanına sahip olmak kateter yeri ve yanık nedeninden bağımsız olarak mortaliteden sorumludur. Femoral ven kateterizasyonlarında enfeksiyon oranları istatistiksel olarak anlamlı olmasa da yüksektir.

ANAHTAR KELİMELEER: Yanık, Santral venöz kateter, Çocuk hasta

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Yazışma Adresi (Correspondence):

Dr. Yeşim ŞENAYLI, Sağlık Bilimleri Üniversitesi, Anesteziyoloji Anabilim Dalı, Ankara Çocuk Sağlığı ve Hastalıkları Hematoloji-Onkoloji Eğitim ve Araştırma Hastanesi, Dışkapı, Altındağ, Ankara, Türkiye

E-posta (E-mail): ysenayli@gmail.com

INTRODUCTION

Major burn injury is an important cause of childhood morbidity and mortality in the developing countries. Central venous catheters (CVC) provide an efficient and reliable vascular access for follow-up, treatment and general anesthesia practices of the patients receiving inpatient treatment. As catheterization is an invasive and difficult procedure in pediatric burn patients and as the complications are more frequently observed in pediatric patients, CVC insertion should be performed under sterile conditions by an experienced team, accompanied by ultrasonography (US) (1, 2).

However, there is a small number of studies in the literature on the central venous catheterization procedures in childhood burn injury. As a pediatric burn center, our hospital is a place where many patients with major burn injuries are followed-up and treated.

The aim of this study is to record the demographic data, burn percentage, areas of CVC insertion, complications during and after the procedure and catheter culture results of the pediatric burn patients on whom central venous catheterization was performed under general anesthesia by the department of anesthesiology in the operation room and to share our experiences in pediatric burn patients.

MATERIAL AND METHOD

After obtaining the approval of our hospital ethics committee, records of 84 pediatric burn patients between 0-18 years old who had central venous catheterization by the department of anesthesiology between January 2009 and December 2015 were evaluated retrospectively. Demographic data, burn percentages, areas of catheter insertion, complications during and after the procedure and catheter culture results were recorded by analyzing the pre-anesthesia assessment forms and their anesthesia record medical forms.

The insertions were performed in the operation room under general anesthesia and sterile conditions, guided by US (SonositeMikromaxx®, USA), using Seldinger technique. After the procedure, radiography was performed to see if the tip of the catheter is at the junction of vena cava superior and right atrium for the jugular catheters and at the vena cava inferior for the femoral catheters. The size of the temporary catheters with double lumen should be 4 Fr if the body weight was less than 5 kg, 5 Fr if the body weight was between 5-20 kg and 7 Fr if the body weight is more than 20 kg.

Statistical Analysis

First, the descriptive characteristics (mean, median,

number and percentage) of the variables were determined. Numerical variables were checked for normal distribution. When two groups are compared, student t-test was used for the numeric variables with normal distribution, and Mann-Whitney U test was used for the numeric variables without normal distribution. The comparison between categorical variables was made with Chi-square and Fisher's Exact test. A p-value<0.05 was considered significant. "Statistical Package for Social Sciences 17 (SPSS, Chicago, IL, USA)" program was used for the analysis of the data.

RESULTS

Between January 2009 and December 2015, 122 CVCs were inserted in 84 pediatric burn patients aged between 15 days and 17 years. The median age of the patients was 3.0 (2.0-7.8) and 49 were boys (58.3%) and 35 were girls (41.7%). 63.9% of the patients were aged 4 years or under.

The most frequent cause of burn was flame (47.6%) and scalding (46.4%) and total burn surface area (TBSA) in 56.2% of the patients was 40% and higher (Table I). Head-neck burns were found in 45 patients (54.9%). Grafting was performed on 76 patients (90.5%).

Table I. TBSA, degrees of burn and the causes of burn of the patients

	Patient (n)	Percentage (%)
TBSA* (%)		
1-19	6	7.2
20-39	32	38.6
40≥	46	56.2
Degree of burn		
2°	28	33.3
2-3°	41	48.8
3°	14	16.7
4°	1	1.2
Burn agent		
Flame	40	47.6
Scalding	39	46.4
Electrical injury	5	6.0

*TBSA: Total burn surface area

Of 122 catheterizations, 73 were into internal jugular vein (59.8%) and 49 were into femoral vein (40.2%) (Table II). No major complications were encountered during the catheterization but as a minor complication, hematoma was observed in 2 femoral insertions. Malposition was detected in one of the internal jugular vein insertions.

Table II. CVC application areas and presence of head and neck burn

	Number of catheters (n)	Percentage (%)
Placement area of the catheter		
Jugular vein	73	59.8
Femoral vein	49	40.2
Face-neck burn injury		
Present	46	54.8
Absent	38	45.2

There were no culture results in thirty-three catheters (27.1%). While no growth was detected in 63 catheter cultures (51.6%), there was growth in 26 catheter cultures of 89 catheters (Table III). The most frequently isolated organism from the catheter cultures was *Acinetobacter* spp (14.6%) (Table IV).

DISCUSSION

CVC is necessary for administration of fluids, medication, nutritional support to burn patients and monitoring their hemodynamic status (3). However, vascular catheter insertions are difficult in burn patients due to vasoconstriction during the acute phase, tissue

Table III. Distribution of culture results according to catheter location, burn agents, burn grade and percentage

	(-) culture		(+) culture		p
	Number (n)	Percentage (%)	Number (n)	Percentage (%)	
Area of catheter					0.278
Jugular vein	41	65.1	14	53.8	
Femoral vein	22	34.9	12	46.2	
Degree of burn					0.829
2nd	16	25.4	6	23.1	
2nd-3rd	34	54.0	13	50.0	
3rd	13	20.6	7	26.9	
Percentage of burn					0.007*
1-19	4	6.3	0	0.0	
20-39	28	44.4	5	19.2	
≥40	31	49.2	21	80.8	
Burn agent					0.984
Flame	34	54.0	16	61.5	
Scalding	27	42.8	10	38.5	
Electrical injury	2	3.2	0	0.0	

*p<0.05

Table IV. Distribution of isolated microorganisms in cultures

Distribution of isolated microorganisms	Number (n)	Percentage (%)
Gram negative bacteria		
<i>Acinetobacter</i> spp	13	14.6
<i>Klebsiella</i>	5	5.6
<i>Pseudomonas</i>	3	3.4
Other	3	3.4
Gram positive bacteria		
Coagulase (-) staphylococcus	1	1.1
Fungi		
<i>Candida crusei</i>	1	1.1

loss, edema or scar tissue at the site of the burn. Procedure-related morbidity and mortality can be reduced by using US or peripherally inserted CVC. The success rate of the first attempt for CVC is 96% when guided by US and 52% in patients marked with anatomic landmarks (4,5). In our study group, internal jugular venous catheterizations were guided by US and femoral venous catheterizations were performed using anatomical landmarks. Catheterization procedures were performed under general anesthesia by experienced anesthesiologists and all procedures were successfully completed.

Central venous catheterization in the pediatric group is technically difficult and risky. During the procedure, artery puncture or catheter malposition or mechanical complications such as arrhythmia and pneumothorax or hemothorax can be seen (6). In two attempts of femoral venous catheterization, hematoma occurred due to artery puncture; as we did not have US experience for this area, the procedure was performed by using anatomical landmarks. In one of the patients, US-guided internal jugular venous catheterization was performed and in the chest radiography after the procedure, it was seen that the catheter was directed caudally, and thus the catheter was removed and inserted in the right internal jugular vein. At our outpatient clinic, to detect malposition, thorax X-ray is routinely performed in internal jugular venous catheterization procedures. Mechanical complication rates reported in the literature is between 0.3-22% and this rate was 2.45% in our group, which is very low (7). These mechanical complications did not cause major problems in patients.

In the literature, because of the high mortality of catheter infections in burn patients, peripherally inserted CVC have been reported to be a safer central venous route, except for burn patients, who require aggressive volume replacement (8).

Peripheral CVCs were not preferred as our patients were in the group that requires aggressive volume replacement (56.2% of the patients had TBSA equal to or more than 40%). Mortality rates in burn patients are variable and there are many studies which find the rate of 0.49-60.8%. Mortality rates depend on different factors such as the age of the patient, particularly if aged 4 or under, full thickness burns, flame burns and accompanying inhalation injuries (9,10). 65.5% of our patients were aged 4 or under and 56.2% of our patients had TBSA equal to or more than 40%. Of 84 patients, 8 died in the early stage and 1 patient died on the 17th day. Mortality rate was 10.7%. In our study group, having a burn percentage of 40% or more was considered a statistically significant risk factor for mortality. Catheter

location and cause of burn were not identified as risk factors for mortality.

The most frequently observed complications of central venous catheterization in the long term are infection and thrombus development, and despite the improvements in the survey, infection is still the most common cause of mortality and morbidity in burn patients (11). The studies have found that the infection rates are higher in venous catheters placed at the burn area or close to it, and in femoral venous catheterization, but the difference was not statistically significant (12,13,14). However, in patients with large burns, if the patient has underpad, the femoral catheter must especially be avoided (15). In our study, localization of the catheter was chosen based on the general status of the patient, burn area and the presence of inhalation complication. For catheterization, the internal jugular vein that remains outside the burn area or femoral vein was chosen. In this study, for central venous catheterization, the internal jugular vein was preferred the most. The use of internal jugular vein was 59.8% and the use of femoral vein was 40.2%. The subclavian vein was not preferred since the risk of complication was high.

Considering the mechanical complications and cost of CVC procedures in pediatric patients, in order to reduce the frequency of catheter exchange, Sheridan et al. (16) applied the protocol which involves changing the existing catheter with guideline in every 7 days unless there is a new area or the skin is not clear and inflammation is present; and it was found that the risk of catheter sepsis was low. A similar protocol was used in our patients, but although it was not statistically significant, more growth was detected in femoral catheters based on the results of the catheter and blood culture.

Since the immune development is not yet complete in the pediatric patient group, infections following the burn trauma and invasive procedures easily develop into sepsis and cause an increase in the mortality. Although it depends on the type of the catheter and area of insertion, coagulase-negative staphylococci are the most common cause of infection in all catheter types (30-60%) and in our patient group, gram-negative bacteria (*Acinetobacter* spp 14.6%, *Klebsiella* 5.6%, *Pseudomonas* 3.4%) were the most commonly detected infectious agents. Studies have shown that the number of *Acinetobacter* infections increase as a result of the resistance that develops due to the widespread use of broad-spectrum antibiotics in burn patients (17). In the study by Yali et al. (18) on burn patients in intensive care, the rate of *Acinetobacter baumannii* infection was 34.4%. In another study from Turkey, the rate of *Acinetobacter baumannii* infection

was 23.6% (19). In our study, we detected *Acinetobacter* spp growth in 14.6% of the catheter and blood cultures and based on the culture antibiogram results, it was only sensitive to colistin. The fact that the rate is low, although our patient group was the high-risk group is due to the lack of prophylactic use of antibiotics.

Fungal infections are the most important cause of mortality and morbidity in burn patients (20). *Candida* infections are observed a rate of 13-31.8%. (21) It is correlated with burn surface area and increase in the depth of the burn injury. In our study, only one patient had *Candida* growth (1.1%) in the catheter in blood culture and it was not a cause of mortality for the patient. Changing the dressing of the burn injury every day, grafting them in a short time and leaving them open can be the causes of the low rate of fungal infections in our study.

In conclusion, as expected, the mortality was high in pediatric burn patients with a TBSA of 40% or more. We propose that, in order to reduce the rate of mortality, a multidisciplinary team must be established, prophylactic use of antibiotics must be avoided, CVC must be inserted in an area outside of the burn area and the use of US must become widespread to reduce the mechanical complication in CVC procedures.

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