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ORIGINAL ARTICLE

Investigation of Risk Factors for Tunneled Hemodialysis Catheter Dysfunction

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ABSTRACT

Introduction: Tunneled central venous catheters (CVC) is a flexible tube with prolonged vascular access providing for the management of intravenous medication treatments, fluids, or total parenteral nutrition, repeated blood sampling, and hemodialysis (HD).

Objectives: The main objective of the study is to investigate the risk factors for tunneled hemodialysis catheter dysfunction.

Material and methods: This observational study was conducted in Akbar Niazi Teaching Hospital, Barakahu, Islamabad during June 2022 till October 2022. All patients who underwent central venous catheterization for the first time in the hospital were included in the study. All catheterizations were performed ultrasound-guided and rechecked by fluoroscopy to confirm the proper replacement of the catheter in the Cava-atrial junction.

Results: The data was collected from 235 patients. One hundred sixty-three patients (72.4%) had no CVC malfunction and sixty-two (27.6%) patients had malfunction. The median duration of follow-up was 162 days for patients with no malfunction and 48.5 days for patients with CVC malfunction.

Practical implication: We can easily find the catheter related complications after reading this research analysis.

Conclusion: It is concluded that the placement of TDCs in patients should be considered the last resort; however, with the increased use of TDCs and experience, the number of catheter-related complications can be expected to decrease.

Keywords: TDCs, Catheter, CVC, Malfunction, Complications

INTRODUCTION

Suitable vascular access is the main concern in chronic hemodialysis patients. Tunneled central venous catheters (CVC) is a flexible tube with prolonged vascular access providing for the management of intravenous medication treatments, fluids, or total parenteral nutrition, repeated blood sampling, and hemodialysis (HD)[1]. CVCs are used as temporary access to the vascular until permanent access to the vascular (arteriovenous fistula or arteriovenous graft [AVG]) can be placed. Approximately 80% of newly hemodialysis patients require a CVC because they do not have suitable AFV to use or they have not had permanent access placed before dialysis initiation[2].

Current guidelines recommend hemodialysis (HD) vascular access via an arterio-venous fistula. However, central venous catheters (CVC) are used by approximately 70% of incident HD patients in North America[3]. Complications associated with CVC use include thrombosis and decreased dialysis adequacy due to catheter malfunction. These complications are associated with increased healthcare resource utilization; up to 50% of all tunnelled CVC's fail within one year[4].

CVC locking solutions are used in the interdialytic period to decrease the risk of complications; the optimal strategy to minimize CVC complications remains to be determined. We previously reported that using once-weekly rt-PA as a locking solution leads to a two-fold reduction in CVC malfunction, compared with thrice-weekly heparin[5]. However, given the potential costs associated with this strategy, its use and uptake may be limited. Identifying patients at greatest risk of CVC malfunction would permit targeted use of this strategy. Using data from the prior randomized trial[6].

The use of tunneled catheters for hemodialysis vascular access is associated with a relatively high incidence of complications, the most frequent of which is catheter dysfunction or low flow, which can lead to thrombotic complications[7]. Catheter dysfunction is a major problem, with between 17 and 33 percent of chronic hemodialysis catheters requiring removal due to blood flow that is inadequate for hemodialysis. The exact incidence of catheter dysfunction (generally expressed as cases per 1000 catheter-days) is not known for certain but is estimated to be between 0.5 and 3.42 episodes/1000 catheter-days, depending on the definition used. As a surrogate marker, the use of intraluminal thrombolysis to restore flow has been reported in the range of 1.8 to 8.0 administrations/1000 catheter-days[8]. The incidence of catheter dysfunction is increased for subclavian vein compared with the internal jugular vein access sites, the presence of catheter malposition, prior catheter-related thrombosis, and increased body mass[9].

Objectives: The main objective of the study is to investigate the risk factors for tunneled hemodialysis catheter dysfunction.

MATERIAL AND METHODS

This observational study was conducted in Akbar Niazi Teaching Hospital, Barakahu, Islamabad during June 2022 till October 2022. All patients who underwent central venous catheterization for the first time in the hospital were included in the study. All catheterizations were performed ultrasound-guided and rechecked by fluoroscopy to confirm the proper replacement of the catheter in the Cava-atrial junction. Based During the observed period, all patients underwent hemodialysis 2–4 times per week, and their catheters were heparin locked by 2500 units after each dialysis session. Patients with a history of a thrombotic event, thrombotic dysfunction, immunodeficiency, and also recent use of antithrombotic, antibiotics or chemotherapy medication were excluded. Patients' information, including demographic, past medical, and current medical situation, was extracted from the hospital information system (HIS) and digital records.

All statistical tests were two-sided, and reported P values were considered significant if less than 0.05.

RESULTS

The data was collected from 235 patients. One hundred sixty-three patients (72.4%) had no CVC malfunction and sixty-two (27.6%) patients had malfunction. The median duration of follow-up was 162 days for patients with no malfunction and 48.5 days for patients with CVC malfunction.

Table 1: Analysis of socio demographical variables of patients and control group

Variable	Overall	CVC	
		No CVC malfunction	CVC malfunction
Age (yr)	57.9 ± 11.7	59.1 ± 15.0	54.8 ± 11.1
Treatment with heparin	180.1 ± 65.8	140.2 ± 94.2	63.5 ± 31.8
FS (mL)	322.1 ± 81.7	178.3 ± 136.1	66.3 ± 49.6
US (mL)	403.5 ± 104.0	195 ± 133.9	79.3 ± 62.4*
CBC (mL)	404.8 ± 113	204.5 ± 149.1*	79.3 ± 62.4*
Pdet (cm H_2O)	24.4 ± 15.7	26.9 ± 20.0	10.5 ± 9.19
Qmax (mL/sec)	18.2 ± 11.6	11.7 ± 11.3	0

PVR (mL)	51.8 ± 84.0	104.8 ± 164.5	95 ± 77.8
Volume (mL)	363.9 ± 175.1	145.7 ± 130.1*	3.33 ± 5.77*
Dialysis	32.4 ± 17.1	32.8 ± 20.8	28.5 ± 16.3

The risk of CVC malfunction decreased as blood processed or mean blood flow increased ($p < 0.001$). A trend to increased risk was found for female patients. Age, diabetes, dialysis duration, first CVC status, hemoglobin, and number of CVC in the prior year were not significantly associated with malfunction.

Table 2: Analysis of catheter dysfunction

Variable	Hazard ratio (95% CI)	P-value
Heparin-only	1.89 (1.13, 3.22)	
Duration of dialysis	0.61 (0.26, 1.41)	0.224
Hemoglobin	1.01 (0.11, 1.02)	0.961
Albumin	1.00 (0.96, 1.04)	0.927
Platelets	1.01 (1.00, 1.00)	0.509
First dialysis catheter ever		0.878
No	Ref.	
Yes	1.09 (0.71, 1.81)	
Diabetes		0.352
No	Ref.	
Yes	1.27 (0.76, 2.12)	
History of rt-PA use for catheter malfunction		0.082
No	Ref.	
Yes	1.89 (1.04, 3.46)	
CVC reversed at the session prior to the event or censoring:		<0.001
No	Ref.	
Yes	11.2 (6.35, 19.7)	
Number of HD sessions with CVC reversed in the 6 sessions prior to the event or censoring	1.71 (1.51, 1.93)	<0.0001
Mean blood processed in the prior 6 runs (L)	5.26 (2.00 – 13.87)	<0.001
< 65		
65 – 74	3.23 (1.22 – 8.58)	
75 – 84	1.50 (0.51 – 4.41)	
85+	Reference	
Mean blood flow in the prior 6 runs (mL/min)		<0.001
< 300	8.45 (3.20 –22.34)	
300 – 324	6.80 (2.49 – 18.56)	
325 – 349	2.77 (0.90 – 8.49)	

DISCUSSION

CVC malfunction is the most common cause for CVC removal. However, few studies have identified and quantified risk factors or predictors of CVC malfunction [10]. Previous studies of patients with tunnelled CVCs reported that diabetic status and prior CVC exposure were associated with malfunction[11]. However, data lacking on malfunction definition, locking solution, and the inclusion of infections and non-infectious criteria for CVC removal make extrapolation of these results difficult. While CVC location has been identified as a risk factor for malfunction, this study examined non-tunnelled catheters only[12]. An observational cohort study of 3,364 incident and prevalent HD patients with a CVC in the United States reported the risk of CVC malfunction (blood flow <300 mL/min) was lower for males and black race (compared with white) and higher if CVC was not the first access modality[13]. Male patients in our study were also at decreased risk but, possibly due to small numbers, we saw no significant effect of first CVC ever or ethnicity[14].

Diabetics are more susceptible to infections, including CRBSI. A hyperglycemic environment may impair host responses, namely neutrophil chemotaxis, adhesion and intracellular killing, and humoral immunity, increasing the likelihood of infection[15]. This emphasizes the need to ensure that diabetic patients with renal impairment are carefully considered for timely permanent RRT access[16].

Despite high complication and mortality rates, TDC placement still remains an effective option for vascular access in patients with ESRD. Patients with hemodialysis catheters dissatisfy with living with these catheters, although they cannot survive without them. Coentrao et al. reported that the one-year survival rate of patients with TDCs was lower than other types of vascular access. The present study was unable to evaluate survival rate in other hemodialysis patients; however, it exhibited a mortality rate up to 20%. Thus, we cannot conclude that it is the highest rate, while it is not low[17].

CONCLUSION

It is concluded that the placement of TDCs in patients should be considered the last resort; however, with the increased use of TDCs and experience, the number of catheter-related complications can be expected to decrease.

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