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Research Article

Impact of Mobility Interventions on Dialysis Catheter Dysfunction in Critically Ill Patients Requiring Renal Replacement Therapy: A Prospective Observational Study

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Abstract

Background: Early physical therapy is crucial in the management of critically ill patients and it is associated with decreased Intensive Care Unit (ICU) and hospital length of stay. Data are scarce on the impact of active mobilizations on dialysis catheter dysfunctions. **Objective and methods:** In this prospective observational monocentric study, we aimed to assess: the impact of active mobilizations on catheter dysfunctions in patients requiring renal replacement therapy in ICU. We considered as “active mobilizations” mobility activities included sitting on the side of bed, standing at the bedside, transfer to chair, and walking. We also included in the analysis prone positioning and lateral positioning. The primary outcome was catheter dysfunction, including nonfunctioning catheter, necessity of inverting the lines, removal of catheter before renal replacement or plasma exchange withdrawal, bleeding at the catheter site, catheter-related infection or thrombosis. **Results:** Forty-eight patients were included in the analysis. Sixteen of them presented at least one catheter dysfunction. Among the 63 catheters, 32 had at least one episode of catheter dysfunction by multivariate analysis, nor active mobilizations, nor the femoral localization of the dialysis catheter, nor a body mass index over 30 kg/m^2 were associated with dialysis catheter dysfunction. **Conclusion:** This study did not found any association between active mobilizations and dialysis catheter dysfunction. Additional multicenter prospective studies are warranted to further evaluate the impact of intensive early physical therapy on dialysis catheter related adverse events.

Keywords: Acute kidney injury; Catheter, Mobilization, Renal replacement therapy

Introduction

Intensive Care Unit (ICU)-acquired weakness is a frequent complication in ICU, occurring in 25% to 35% of the critically ill patients [1,2]. Indeed, critically ill patients often experience immobility, deconditioning and weakness that may contribute to prolonged hospitalizations [3]. Acute kidney injury and renal replacement therapy are risk factors of malnutrition and ICU acquired weakness [4]**.** Early physical therapy in crucial in the management of critically ill patients and it is associated with decreased ICU and hospital length of stay [5]. However, paramedical teams are sometimes reluctant to mobilize patients with dialysis catheter, especially when the catheter is positioned in a femoral central vein. One perceived barrier to early physical therapy is concerns about catheter dysfunction, bleeding, infection or catheter removal due to active mobilizations. Data are scarce on the impact of active mobilizations on dialysis catheter dysfunctions. In the present study, we aim to assess: the impact of active mobilizations (including sitting in a chair sit-to-stand practice, March on spot +/- gait aid, mobilization away from bed space +/- gait aid, prone positioning and lateral positioning) on catheter dysfunctions in patients requiring renal replacement therapy in ICU.

Methods

The study was approved by our local ethical committee

Design and setting

This prospective observational study included all consecutive adult patients admitted to the ICU of our hospital who required renal replacement therapy (including continuous veno venous hemofiltration and hemodialysis) or plasma exchange for more than 48h during their ICU stay, between January 1, 2018 and January 1 2019. The hospital is a 650 - bed public hospital with 350 beds dedicated to immunocompromised patients (hematological malignancies, solid organ transplantation, solid tumors and autoimmune diseases). The medical ICU is a 12 - bed unit that admits 1000 patients per year. Information on the ICU the organization and criteria for ICU admission have been published previously [6,7]. Initiation, modalities and discontinuation of renal replacement therapy were discussed with two senior nephrologists based on the guidelines from Bellomo et al. [8] and Kidney Disease Improving Global Outcomes (KDIGO) guidelines [9].

Data collection

All data were obtained from medical records. Baseline patient characteristics included demographics, medical history, and underlying diseases. The following data regarding ICU admission and treatments were recorded: clinical symptoms, etiologies of ICU admission, time of admission and length of stay, diagnosis, treatments, and outcome data. The Sepsis-Related Organ Failure Assessment (SOFA) score was computed at admission, as previously described [10]. Sepsis and septic shock were defined according to the third international sepsis definitions conference [11]. Mortality at ICU and hospital discharge was recorded for all patients. All data related to plasma exchange procedures and renal replacement therapy were recorded. The nurse in charge of the patient during the procedure reported all adverse events. Catheter-related adverse events to rehabilitation therapy were evaluated. Catheter-related adverse events were: nonfunctioning catheter, necessity of inverting the lines, removal of catheter before renal replacement or plasma exchange withdrawal, bleeding at the catheter site, catheter-related infection or thrombosis. The catheter was nonfunctioning when it was not consistently functioning after the renal replacement therapy or plasma exchange. Bleeding at the catheter site was defined as blood leaking at the insertion site. Catheter-related bloodstream infection was defined as the presence of bacteremia originating from an intravenous catheter.

Mobility interventions

We considered as "active mobilizations" mobility activities included sitting on the side of bed, standing at the bedside, transfer to chair, and walking. We also included in the analysis prone positioning and lateral positioning. Mobility interventions are all recorded in medical records and are performed by the paramedical team, including a physical therapist.

Catheters

The catheters included in this study were venous dialysis polyurethane catheters. Femoral dialysis catheters have a length of 25 cm and a diameter of 14 French. Jugular dialysis catheters have a length of 15 mm or 20 mm and a diameter of 14 French. Catheters were locked using saline. Catheter dressing was performed with a sterile transparent occlusive dressing.

Statistical analysis

Continuous variables are described as median and interquartile range (IQR) and compared using Wilcoxon's rank sum test; categorical variables are summarized by counts (Percent's) and compared using exact Fisher test. The primary outcome was catheter dysfunction (as defined above) analysed as a binary variable. Active mobilization was treated as a time varying exposure. To investigate the effect of active mobilization on catheter dysfunction, we used Cox model for time varying covariates and robust variance estimator, taking into account the clustered nature of the data. Model was adjusted on predefined confounders (catheter site and body mass index >30 Kg/m2). Assumption of Cox model was carefully checked.

The measures of associations are presented with Hazard ratios and confidence intervals at 95%. All tests were two-sided and p-values lower than 5% were considered to indicate significant associations. Analyses were performed using R statistical platform, version 3.0.2 (https://cran.r-project.org/).

Results

Characteristics of patients are detailed in (Table 1 and Table 2). Forty-eight patients were included in the analysis. Sixteen of them presented at least one catheter dysfunction. More than half of the patients has underlying hematological malignancy and median SOFA score at ICU admission was high (7.50 [5.00, 10.00]) with almost 60% of the patients requiring invasive mechanical ventilation. Catheter dialysis were used for CRRT (66.7%) and/or intermittent hemodialysis (91.7%) and/or plasmatic exchanges (12.5%).

	All patients **n= 48** **Median (IQR) or n (%)**	**Patients with catheter dysfunction** **n= 16** **Median (IQR) or n (%)**	**Patients without catheter dysfunction** **n=32** **Median (IQR) or n (%)**	**P-value**
Age	66.00 [57.00, 71.00]	67.50 [60.75, 71.25]	63.00 [56.75, 70.25]	0.504
Male	34 (70.8)	12 (75.0)	22 (68.8)	0.911
Body Mass Index	27.00 [24.00, 29.50]	26.00 [24.00, 28.75]	27.00 [24.00, 29.50]	0.769
Chronic kidney disease	8 (16.7)	3 (18.8)	5 (15.6)	1.000
Mellitus diabetes	15 (31.2)	7 (43.8)	8 (25.0)	0.322
Haematological malignancy	26 (54.2)	10 (62.5)	16 (50.0)	0.609
Solid Tumour	6 (12.5)	1 (6.2)	5 (15.6)	0.643
Hypertension	25 (52.1)	9 (56.2)	16 (50.0)	0.919
SOFA score at ICU admission	7.50 [5.00, 10.00]	8.50 [5.75, 10.00]	7.00 [5.00, 11.00]	0.826
Vasopressors	23 (47.9)	8 (50)	17 (53.1)	0.961
Sepsis	38 (79.2)	10 (62.5)	28 (87.5)	0.145
Acute respiratory failure	30 (62.5)	11 (68.75)	19 (59.38)	0.849
Mechanical ventilation	28 (58.3)	11 (68.8)	17 (53.1)	0.595
Intermittent hemodialysis	44 (91.7)	14 (87.5)	30 (93.8)	0.781
CVVHF	32 (66.7)	11 (68.8)	21 (65.6)	1.000
Plasma exchange therapy	6 (12.5)	2 (12.5)	4 (12.5)	0.999

Active physical therapy	12 (25)	6 (18.8)	6 (37.5)	0.289
ICU length of stay	5.00 [3.00, 12.25]	8.50 [5.00, 18.50]	4.50 [3.00, 8.50]	0.031
Mortality	11 (22.9)	3 (18.8)	8 (25)	0.948

Table 1: Characteristics of patients.

Physical therapy and catheter dysfunctions

Only 25% of the patients (n = 12) received active physical therapy. Among these active mobilizations, sitting in a chair was performed in 66.6 % (n = 8), sit-to-stand practice in 41.7% of the patients (n = 5), March on spot in 41.7% of the patients (n = 5), mobilization away from bed space in 2.5% of the patients (n = 3), prone positioning in 2.5% of the patients (n = 3). Ninety-four percent of the patients (n = 45) received passive physical therapy including passive movements consisting of hip, knee and shoulders flexion-extension movements.

	All patients n=48 Median (IQR) or n (%)	**Patients who did not received active physical therapy** n=36 Median (IQR) or n(%)	**Patients who received active physical therapy** n=12 Median (IQR) or n(%)	p-value
Type of catheter				0.631
Right femoral catheter	17 (35.4)	14 (38.9)	3 (25.0)	
Left femoral catheter	10 (20.8)	8 (22.2)	2 (16.7)	
Right jugular catheter	19 (39.6)	13 (36.1)	6 (50.0)	
Left jugular catheter	2 (4.2)	1 (2.8)	1 (8.3)	
Catheter duration (days)	5.00 [3.00, 7.00]	4.00 [2.00, 6.00]	7.00 [6.00, 9.00]	0.002

Table 2: Type of dialysis catheters and duration.

Forty-eight patients had 63 dialysis catheters. 16 patients had at least one catheter dysfunction. Among the 63 catheters, 32 had at least one episode of catheter dysfunction. Lines were inverted in 19 % of the cases (n = 6), removal of catheter was necessary because of catheter dysfunction in 25% of the cases (n = 8), bleeding at the catheter site was observed in 12.5 % of the cases (n = 4), thrombosis of the catheter was present in 19% of the cases (n = 6), catheter-related infection was present in 6.25% of the cases (n = 2) and catheter plication in 3% (n = 1). Repeated increased catheter venous pressure was observed in 40 % of the cases (n = 13). Seven catheters were non-functional at the first utilization. Number and timing of catheter dysfunction and physical therapy are illustrated in (Figure 1).

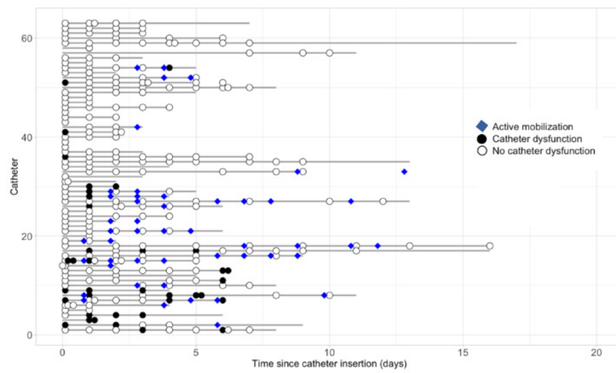

Figure 1: Number and timing of catheter dysfunction and physical therapy.

Impact of active mobilizations on catheter dysfunction

To evaluate the impact of active mobilizations on catheter dysfunction, only the catheter dysfunctions that occurred after physical therapy were taken into account. By multivariate analysis, nor active mobilizations, nor the femoral localization of the dialysis catheter, nor a body mass index over 30 kg/m2 were associated with dialysis catheter dysfunction (Figure 2).

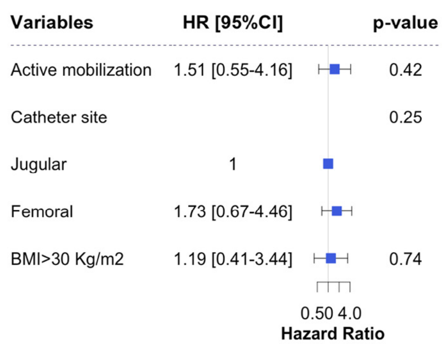

Figure 2: Risk factors associated with catheter dysfunction by multivariate analysis.

Discussion

In the present study, we did not found any impact of active mobilizations on dialysis catheter dysfunction. Few studies have focused on mobilization of patients having central intravenous catheters and even fewer on patients having dialysis catheter and their impact on dysfunction: Perme, C *et al.* retrospectively studied the safety of femoral arterial catheters in patients receiving physical therapy sessions (30 patients who received 47 physical therapy treatment sessions): they did not found any femoral arterial catheter related adverse event [12]. Similarly, Damluji, A et al. evaluated 101 ICU patients who received physical therapy sessions with a femoral venous, arterial, or hemodialysis catheter(s) in situ. During 253 physical therapy sessions, there were no catheter-related adverse events giving a 0% event rate [13]. Data are scarce on the impact of physical therapy on dialysis catheter dysfunction. Wang *et al*. studied the impact of mobilization interventions on filter pressure parameters and lifespan in 33 patients undergoing continuous renal replacement therapy via femoral, subclavian or internal jugular vascular access catheters. No episodes of filter occlusion or failure occurred during any of the interventions. No adverse events were detected [14]. Advances in materials with less rigid catheters than historically used may have contributed to the decrease of catheter-related adverse events that our study and others have reported [15].

Of note, the percentage of bleeding (12.5%) in our cohort was higher than previously reported in the literature. This is probably due to the recruitment of patients in our center with a large proportion of them having hematological malignancies and thrombocytopenia. However, even in high risk patients, this study confirms that the presence of a dialysis catheter should not be a barrier in providing physical therapy. As physical therapy has previously been shown to be associated with improved physical function and quality of life in ICU survivors, one should encourage nursing staff and physical therapists to mobilize patients undergoing renal replacement therapy and plasma exchanges.

This study has several limitations. First, only 25 % of the patients had active mobilizations. Ninety-four percent of the patients received passive physical therapy, such as hip, knee and shoulders flexion-extension movements. We cannot exclude a lack of power in our study to show an association between active mobilizations and catheter dysfunction. One explanation is that patients had severe and unstable illnesses, as assessed by the high median SOFA scores. The paramedical and medical team may have therefore been more reluctant to perform physical therapy. Another explanation is that although 2 physical therapists are dedicated to the ICU during the week, active physical therapy is sometimes not possible during the week end, because of a lack of staff. Finally, there was no specific implemented protocol for the study and sessions of physical therapy may vary among therapists. However, all the sessions were detailed in the medical records, and sessions were homogenous among the 2 main therapists who work in our ICU.

Conclusion

In conclusion, we did not found any association between active mobilizations and dialysis catheter dysfunction. Additional multicenter prospective studies are warranted to further evaluate the impact of intensive early physical therapy on dialysis catheter related adverse events.

Author’s contribution

CB, JB, AB, AS, JL collected the data. VL and GD performed the statistical analysis of the study. NG is the physical therapist in the department and participated to the collection of data. LZ wrote the manuscript and supervised the study. EA, MD and AL supervised the study, provided critical suggestions and discussions throughout the study, and revised the manuscript.

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