

Contribution of 4% Sodium Citrate in Hemodialysis Catheter Lock

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Abstract

Context: Due to its antithrombotic and antibacterial properties, 4% sodium citrate is an alternative to unfractionated heparin in locking hemodialysis catheters. Our study aims to assess the clinical efficacy, risks and cost of the 4% sodium citrate lock compared to the heparin lock for hemodialysis catheters.

Methodology: This is a single-center, prospective, randomized study. The patients were divided into two groups in which the catheters were locked either with 4% sodium citrate solution or with unfractionated heparin; this. We studied thrombotic, infectious, hemorrhagic complications and the cost of each type of lock.

Results: 47 patients made up our population. 23 catheters had 4% sodium citrate as their lock and 22 unfractionated heparin. There was no significant difference in thrombotic catheter dysfunction ($p = 0.4$) as well as in the occurrence of infectious events ($p = 0.7$). No local hemorrhagic complication was found in the 4% citrate lock group. The citrate lock allowed a saving of more than 100% compared to heparin.

Conclusion: 4% sodium citrate is as effective as heparin in maintaining catheter patency. It is less expensive than the latter and would lead to fewer local bleeding complications. However, its effectiveness in preventing catheter-related infections remains to be demonstrated. there was no significant difference in thrombotic catheter dysfunction ($p = 0.4$) as well as in the occurrence of infectious events ($p = 0.7$). No local hemorrhagic complication was found in the 4% citrate lock group. The citrate lock allowed a saving of more than 100% compared to heparin.

Keywords: Lock; Catheter; Sodium Citrate; Hemodialysis

Introduction and Purpose of the Study

Complications of hemodialysis catheters are well known, namely: infectious, hemorrhagic and thrombotic complications. Catheter-related infections strongly contribute to the mortality and morbidity of hemodialysis patients [1,2]. In acute hemodialysis, temporary hemodialysis catheters and all of their complications considerably increase the cost of care for these patients, who often have their hospital stay extended [1,2]. Hence a renewed interest in sodium citrate 4% (SC4%) or trisodium citrate, as an

alternative to unfractionated heparin (UFH) by locking temporary central venous hemodialysis catheters (CVHC), this due to of its antithrombotic and antibacterial properties and of its reduced cost compared to heparin [3]. The objective of our study was to assess the clinical efficacy and benefits of SC4% as a hemodialysis catheter lock compared to UFH.

Materials and Methods

Our study is prospective, randomized, with parallel design and double blind. It is spread over a period of 4 months; and concerns

the locks of temporary venous hemodialysis catheters in patients hospitalized in the nephrology department of the University hospital center Hassan II in Fez (Morocco Kingdown). After each hemodialysis session, the catheters were locked with a 4% sodium citrate or unfractionated heparin solution (5000 IU/ml). The citrate came in the form of a 5 ml pre-filled syringe containing 2.5 ml of 4% citrate per patient and per dialysis session. Each type of lock was instilled in a volume determined by the catheter manufacturer's specifications; We have studied infectious, local hemorrhagic and thrombotic complications; as well as the cost generated by the use of each type of lock.

- A CVHC-related bacteremia (BLC) was defined by the association of a bacteremia occurring within 48 h surrounding the removal of the CVHC (or the diagnostic suspicion of catheter infection if it is not removed from 'straight away) and a positive culture with the same microorganism on one of the following samples: culture of the insertion site or culture of the CVHC [3].
- Local CVHC-related infection (LCI) was defined by positive culture of CV HC and purulence of the catheter entry port [4].
- General ILC was defined by a positive CVHC culture and total or partial regression of general infectious signs within 48 hours of catheter ablation [4].
- Catheter dysfunction was defined as the inability of the catheter to provide sufficient blood flow for adequate dialysis. It was considered to be of thrombotic origin after elimination of the other causes of dysfunction, namely: an aberrant path, a malposition of the distal end, a bend or striction of the catheter by an aponeurosis [5].
- Local hemorrhage was defined as bleeding or bruising visible at the catheter exit site [5].
- The cost of the 5 ml citrate syringe is \$ 1.07, and an between-port syringe was used. The cost of unfractionated heparin is \$ 2.20 for 25,000 units/5ml, and a 10ml syringe (\$ 0.11) was used to aspirate heparin.

Inclusion criteria

All patients hospitalized in the nephrology department of University hospital center Hassan II in Fez were included in the study, having benefited from the installation of a hemodialysis CV H in the procedure room of our department. Patients were enrolled in

the study until their catheters were removed or until the study completion date.

Exclusion criteria

Have been excluded

- Hemodialysis catheters placed outside the gesture room of the nephrology department of University hospital center Hassan II in Fez.
- Patients with a known haematological abnormality predisposing to thrombotic or hemorrhagic events.
- Patients with fever or biological infectious syndrome at the time of insertion.
- CVHC changed on guide
- CVHC with a duration of less than 48 hours.

Statistical analysis

The data were collected and statistically analyzed using Excel 2007 and Epi info 3.4 software.

Results

Our study consists of 47 patients including 22 men and 25 women. The mean age was 48.7 ± 15.8 years with extremes ranging from 19 years to 74 years and a median of 47.6 years. 24 catheters were locked after each hemodialysis session with SC4% and 23 with UFH; all catheters were placed femoral. The mean duration of the catheter was 13.1 ± 7.3 days for the citrate group and 12.8 ± 6.02 days. A total of 284 hemodialysis sessions were performed including 138 with UFH as the lock and 156 with 4% sodium citrate. The mean duration between 2 hemodialysis sessions in the citrate group was 2.96 days and 2.79 days in the heparin group.

Catheter dysfunctions

Catheter dysfunction by thrombosis occurred in 3 cases in the SC4% group (13.4%) and in 4 cases in the UFH group (16.7%).

Haemorrhagic complications

No local hemorrhagic complication was found in the citrate group. In the heparin group, three cases of local hemorrhagic complications such as ecchymosis and bleeding at the site of the catheter insertion were found. ($p = 0.1$).

Infectious complications

Lock type	SC 4%	UFH
CVHC (n)	24	23
Day -CVHC (n)	309	278
CRB Incidence/ID per 1000 days of CV HC	4.2%/3, 2 episodes	3%/3, 6 episodes
ILC Incidence/ID per 1000 days of CVHC	8.3%/6.5 episodes	13%/10.8 episodes

Table 1 : Incidence and Incidence Density of Hemodialysis Catheter-Related Infections by Lock Type.

SC4%: Sodium citrate 4%

UFH: unfractionated heparin

CRB: catheter-related bacteremia

ILC: Infection linked to the catheter

CVHC: Central venous hemodialysis catheter.

Infectious risk factors	Lock type			
	SC4 %		UFH	
	ILC+CRB(%)	p	ILC+CRB (%)	P
Age > 60 years old	15,3%	0,5	11,2%	0,2
Female sex	15,4%	0,7	9,1%	0,1
Diabetes	20%	0,3	33,3%	0,3
CVHC duration ≥ 10 days	37,5%	<0,001	36,4%	<0,001
Number of sessions ≥ 5	42,9%	<0,001	40,0 %	<0,001

Table 2: Risk factors for infections linked to hemodialysis catheters according to the type of lock.

SC4%: Sodium citrate 4%

UFH: unfractionated heparin

CRB: catheter-related bacteremia

ILC: Infection linked to the catheter

CVHC: central venous hemodialysis catheter.

The cost

The use of the citrate lock for the 119 sessions performed for this group cost US \$ 127.33 or US \$ 107 for 100 sessions. For the 125 sessions of the heparin group, the lock cost US \$ 288.75 or US \$ 231 for 100 sessions.

Discussion

With a size greater than 30 patients, our study, prospective, randomized in a parallel plan, compares the use of the 4% CS lock to that of the UFH lock in CVHC in hemodialysis, thus adding to the current literature on the use of SC 4% in hemodialysis. Our study found that there was no significant difference in the occurrence of CRB between the two groups (ID = 3, 2 episodes/1000 days of CVC in the citrate group, and ID = 3.6 episodes/1000 days of CVC in the heparin group) with $p > 0.5$ as well as in the occurrence of ILC (ID = 6.5 episodes/1000 days of CVHC in the citrate group and ID = 10.8 episodes per 1000 days of CVHC in the group heparin) with $p = 0.7$. However, the incidence of ILCs in the heparin group (13.0%) was higher than that of the citrate group (8.3%). Our results match those of Jennifer, *et al.* [6] in Canada who carried out a randomized trial involving a sample of 61 patients and like us did not find a difference in the development of CRB (2.2/1000 days of CVHC for the citrate group against 3.3/1000 catheter days for the heparin group; $P = 0.607$) or ILC (2.2/1000 catheter days for both groups). The non-significant difference in the occurrence of ILCs in our study can be explained by the size of the sample at 47 patients considered small to demonstrate a degree of difference. Trisodium citrate is also available in 7%, 10%, 15%, 30% and 43% concentrations. The use of 43% citrate is limited by the potential for cardiac arrest following hypocalcemia. Weijmer, *et al.* [7] conducted a prospective study, randomized to a large population of 291 patients who were randomized to high concentration citrate (30%). In the citrate group, infectious complications were significantly less frequent than in the heparin group: 1.1 bacteremia per 1000 catheter days vs 4.1 in the heparin group ($p < 0.001$). It is possible that higher citrate concentrations have strong antibacterial properties, without the adverse effects of cardiac toxicity associated with the 43% solution. Future studies may consider investigating these concentrations. 1 in the heparin group ($p < 0.001$). Higher citrate concentrations may have strong antibacterial properties without the adverse effects of cardiac toxicity associated with the 43% solution. Future studies may consider investigating these concentra-

tions. 1 in the heparin group ($p < 0.001$). Higher citrate concentrations may have strong antibacterial properties without the adverse effects of cardiac toxicity associated with the 43% solution. Future studies may consider investigating these concentrations.

Our study revealed two infectious risk factors, namely a duration of catheterization ≥ 10 days ($p < 0.001$) and a number of sessions ≥ 5 days ($p < 0.001$). These factors were found in both groups and agree with the data in the literature [1,2]. This proves that the handling of hemodialysis catheters still plays an important role in the prevention of infections linked to catheters. Whatever the type of lock, compliance with the rules of asepsis must therefore remain rigorous. For local hemorrhagic complications, our study did not reveal a significant difference between the two groups ($p = 0.1$) but should be noted that no hemorrhagic complication was found in the citrate group; a larger sample might have revealed a significant difference. Jennifer, *et al.* [6] found no significant difference in the number of local bleeds between the two groups (16 events in the heparin group versus 18 in the citrate group, $P = 1.0$). Regarding thrombotic complications, in our study were certainly more frequent in the UFH group than in the SC4% group, but the difference was not significant. ($p = 0.4$). Plamondon, *et al.* [8] performed a one-week crossover study on the locking of temporary CVHC of hemodialysis with SC4% versus UFH (5000 U/lumen) in 44 patients. Their primary endpoint was catheter thrombosis requiring intraluminal thrombolytic therapy. They found no difference between the two groups (0.8% for citrate and 1.1% for heparin). It is perhaps due to the duration of our short study as well as that of Plamondon, *et al.* that no significant difference was found. In our study, the use of 4% sodium citrate was more than 100% cheaper than that of heparin, not to mention the time it takes to aspirate the heparin from its vial. Jennifer, *et al.* [6] found a more significant difference with heparin lock 300% more expensive than citrate lock. The relatively small sample size is one of the limitations of this study, as it was considered small to demonstrate significant differences compared to CRB or ILC. Future studies using a larger sample may demonstrate a benefit of 50 citrate 4% over heparin, but our study does not provide this evidence.

Conclusion

Our study shows that like heparin, 4% SC is also effective in maintaining the permeability of CVHC. Our study does not prove the superiority of the SC 4% lock over that of heparin in the pre-

vention of infectious events related to hemodialysis CVHC. However, whatever the type of lock, the duration of catheterization and the number of manipulations remain preponderant factors in the occurrence of infectious events linked to the catheters. However, since citrate is much cheaper and would lead to less local bleeding complications, it can be considered a better lock for hemodialysis catheters.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

All the authors participated in the realization of the study, read and approved the final version.

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