Efficacy and tolerance of sustained low-efficiency dialysis with calcium-free citrate-containing dialysate anticoagulation

Clara Vigneron, Matthieu Jamme, Juliet Schurder, Adrien Joseph, Eric Rondeau, Guillaume Lefèvre, Christophe Ridel, Cédric Rafat

Clinical Kidney Journal, 2021, vol. 14, no. 3, 1025–1026

doi: 10.1093/ckj/sfaa128
Advance Access Publication Date: 24 September 2020
Letter to the Editor

LETTER TO THE EDITOR

Efficacy and tolerance of sustained low-efficiency dialysis with calcium-free citrate-containing dialysate anticoagulation

Clara Vigneron [1], Matthieu Jamme[1], Juliet Schurder[1], Adrien Joseph[1], Eric Rondeau[1], Guillaume Lefèvre[3], Christophe Ridel[2] and Cédric Rafat[1]

[1]Service des Urgences Néphrologiques et Transplantation Rénale, Hôpital Tenon, Assistance Publique - Hôpitaux de Paris, Paris, France, [2]Centre d'hémodialyse et d'aphérèse, AURA Paris Plaisance, Paris, France and [3]Laboratoire de Biochimie, Hôpital Tenon, Assistance Publique - Hôpitaux de Paris, Paris, France

Correspondence to: Clara Vigneron; E-mail: claravigneron@hotmail.fr

Sustained low-efficiency dialysis (SLED) is a hybrid renal replacement therapy (RRT) using intermittent haemodialysis (iHD) equipment with lower blood flow (Q_B) and dialysate flow (Q_D) combined with prolonged sessions. The popularity of SLED stems from its more efficient ultrafiltration (UF) and enhanced haemodynamic tolerance. Regional citrate anticoagulation has emerged as the preferred anticoagulation technique in continuous RRT thanks to decreased bleeding risk and increased extracorporeal circuit lifetime [1–3]. Herein we describe a modified protocol using dialysate as a source of citrate anticoagulation as citrate enters to blood compartment by diffusion from dialysate. Citrate dialysate without calcium and magnesium allows better anticoagulation, avoiding heparin use and citrate infusion [4]. It deserves to be evaluated during SLED in case of major fluid overload.

Patients requiring extensive UF in a setting of fluid overload were included in a single renal intensive care unit over a 6-month period. Patients with a mandatory indication for curative anticoagulation were excluded.

Patients had alternatively iHD over 4 h or SLED over 6 h using a Gambro AK 200 generator (Gambro, Lund, Sweden) and a Nipro Elisio 21H dialyzer (Nipro, Osaka, Japan) in every case. Both RRT modalities were evaluated using crossover comparisons. During iHD, Q_B was set between 250 and 300 mL/min while Q_D was set at 700 mL/min. On SLED, Q_B and Q_D were set at 250 mL/min and 300 mL/min, respectively. UF was left to the physician's discretion. The dialysate composition for SLED was potassium 3 mmol/L, magnesium 0.5 mmol/L, calcium 0 mmol/L, citrate 0.8 mmol/L and glucose 1 g/L. Conductivity was 14.0 mS/cm. Calcium and magnesium were reinjected according to ionic dialysance following a chart previously devised for iHD [5].

The 44 sessions prescribed for five patients were analysed including 19 iHD and 25 SLED. Total UF was significantly greater following SLED {median 3.98 L [interquartile range (IQR) 3.11–4.22]} compared with iHD [2.13 L (1.39–2.51), P = 0.0004] as well as weight loss over 24 h, respectively [median 2.5 kg (IQR 1.0–3.0)] compared with iHD [0.5 kg (0–1.5), P = 0.0006], despite similar maximal hourly UF [0.76 L/h (IQR 0.68–0.82) versus 0.80 (0.69–0.88), P = 0.5].

Regarding safety outcomes, there was no episode of intradialytic hypotension requiring UF interruption in any session. No bleeding event was observed.

During SLED, there was a slight but significant increase in ionized calcium (iCa) measured at 2 h and after the session, although iCa remained within the physiological range at all times. No patient presented with citrate overload (Table 1). Levels of sodium, magnesium, potassium, phosphate, bicarbonate and anion gap after the session were not different. The iCa

Received: 27.11.2019; Editorial decision: 2.6.2020

Table 1. Biological variables during iHD and SLED sessions

Variables (mmol/L)		iHD	SLED	P-value
Pre-filter blood serum	iCa before session	1.04 (1.00–1.06)	1.04 (1.00–1.07)	1.00
	iCa at 5 min	1.01 (0.99–1.05)	1.06 (1.04–1.10)	0.06
	iCa at 1 h	1.04 (0.95–1.08)	1.09 (1.07–1.14)	0.07
	iCa at 2 h	0.99 (0.92–1.05)	1.11 (1.05–1.14)	0.03
	iCa (dialyzer outlet) at 1 h	0.36 (0.27–0.41)	0.32 (0.29–0.40)	1.00
After session (venous blood serum)	iCa	1.10 (1.04–1.11)	1.18 (1.12–1.22)	0.01
	Citrate	0.30 (0.29–0.31)	0.30 (0.21–0.32)	0.80
	Sodium	138 (136–140)	138 (136–140)	0.80
	Magnesium	1.30 (1.23–1.35)	1.34 (1.30–1.36)	0.11
	Bicarbonate	25 (22–26)	24 (22–26)	0.53
	Anion gap	13.7 (11.4–15.5)	11.8 (9.6–13.3)	0.27
	Potassium	3.9 (3.8–4.2)	3.8 (3.6–4.1)	0.85
	Phosphate	1.07 (0.75–1.30)	0.80 (0.61–0.99)	0.11

Results are presented as medians and IQRs and compared using the Mann–Whitney test.

measured at the dialyzer outlet was within predefined ranges and did not differ whether patients received iHD or SLED.

Membrane clotting mandating early termination of the session did not occur at any time. Final membrane and circuit coagulation were not significantly different between both RRT modalities.

This study expands on previous reports using citrate infusion in SLED and citrate dialysate with iHD [3–5]. SLED using a modified dialysate as a source of citrate appears to be a safe and efficient technique to provide UF. It may represent a useful RRT modality for patients with major fluid overload and a high bleeding risk. By obviating the need for citrate infusion and repeated blood tests, it may ultimately prove to be an uncumbersome alternative for delivering citrate. Nevertheless, this technique mandates further testing in broader settings, on a larger scale and with longer sessions.

CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

1. Oudemans-van Straaten HM, Bosman RJ, Koopmans M *et al.* Citrate anticoagulation for continuous venovenous hemofiltration. *Crit Care Med* 2009; 37: 545–552
2. Davenport A. What are the anticoagulation options for intermittent hemodialysis? *Nat Rev Nephrol* 2011; 7: 499–508
3. Schneider M, Liefeldt L, Slowinski T *et al.* Citrate anticoagulation protocol for slow extended hemodialysis with the Genius dialysis system in acute renal failure. *Int J Artif Organs* 2008; 31: 43–48
4. Faguer S, Saint-Cricq M, Nogier M-B *et al.* Heparin-free prolonged intermittent hemodialysis using calcium-free citrate dialysate in critically ill patients. *Crit Care Med* 2017; 45: 1887–1892
5. Robert T, Bureau C, Lebourg L *et al.* A simple and novel technique for regional citrate anticoagulation during intermittent hemodialysis may obviate the need for calcium monitoring. *Intensive Care Med* 2017; 43: 1927–1928