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Prevention of hemodialysis-related muscle cramps by intradialytic use of sequential compression devices: A report of four cases

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Abstract

Background: Hemodialysis (HD)-related lower extremity (LE) muscle cramps are a common cause of morbidity in end-stage renal disease patients on maintenance HD. Numerous pharmacologic and physical measures have been tried with variable success rates.

Methods: Sequential compression devices (SCD) improve venous return (VR) and are commonly used to prevent LE deep venous thrombosis in hospitals. We hypothesized that LE cramps are triggered by stagnant venous flow during HD and are preventable by improving VR. We prospectively studied four adult patients (mean age 61 ± 14 years) on thrice-weekly HD who experienced two or more episodes of LE cramping weekly in the month before the study. SCD were applied before each HD on both legs and compressions were intermittently applied at 40 mmHg during treatment.

Results: All four patients reported complete resolution of cramping during the study period that lasted 1 month or 12 consecutive dialysis treatments.

Conclusion: Application of SCD to LE may prevent the generation of LE HD-related cramping in a select group of patients. Larger, controlled studies are needed to establish the utility of this noninvasive alternative for the prevention of LE HD-related cramps.

INTRODUCTION

Hemodialysis (HD)-related lower extremity (LE) cramps remain a common cause of morbidity during dialysis. According to one report, the most frequent reason for discontinuation of HD treatments prematurely was muscle cramps.[1] The precise incidence is uncertain, but in one study at least 23% of patients reported occurrence of cramps during dialysis.[2] The etiology of this condition is not exactly established; however, dialysis induced volume contraction and hypoosmolality are common predisposing factors.[3] Although any muscle group can be involved, cramps typically involve the legs, feet, abdominal wall, and hands. LE cramps seem to be the most common. Delayed cramps are also observed and may occur for several hours after the end of dialysis.[4] Muscle cramps are often preceded by hypotension, although they can persist even after restoration of adequate blood pressure (BP). In a minority of patients cramps during dialysis may occur without any hypotension.[5] HD adequacy may be compromised when cramps and associated hypotension is treated by temporarily decreasing blood flow, ultrafiltration (UF) or even stopping dialysis treatment. Elective use of a high-dialysate sodium concentration or saline administration to stabilize BP to ameliorate cramps and hypotension results in increased thirst and aggravation of interdialytic hypertension.[6]

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Numerous pharmacologic therapies to improve or prevent muscle cramps have been reported in the literature. These include hypertonic saline,[7] quinine sulfate,[8] 50% dextrose water, 25% mannitol,[9,10] vitamin E,[11] chloroquine phosphate,[12] L-carnitine,[13] and low-dose prazosin.[14] Response to head-up tilt[15] and various stretching exercises of the LE[16] are some of the few nonpharmacologic modalities studied so far.

Sequential compression devices (SCD) improve venous return (VR) and are commonly used to prevent LE deep venous thrombosis (DVT) in hospitalized nonambulatory patients. We hypothesized that LE dialysis-related cramps are triggered by stagnant venous flow during dialysis and are preventable by improving VR. This pilot study was the first effort to evaluate the feasibility of intradialytic SCD use for the prevention of HD-related LE cramps.

CASES AND METHODS

Patient selection

Two-hundred patients undergoing three-times-weekly HD at Henry Ford Hospital/Greenfield Health System's West Pavilion dialysis were interviewed and their dialysis records were reviewed for documented episodes and number of LE cramps. Inclusion criteria were two or more episodes of LE cramps during or after dialysis each week for the previous 4 weeks (pre-SCD period), ability to give informed consent, at least 6 months on dialysis therapy, and a stable dry weight the month before the study period.

Patients with severe atherosclerosis of LE, congestive heart failure, known history of DVT, or any local condition interfering with the application SCDs like open wound or dermatitis were excluded. Muscle cramps were defined as contraction of large muscle group of LE sufficiently painful requiring an intervention by the dialysis nurse for relief. Four patients met the above-noted criteria and enrolled and studied for 1 month with SCD application before each HD (post-SCD period). The study was approved by the Institutional review board of the Henry Ford Health system, Detroit Michigan. All patients gave informed consents.

Treatment protocol

During the study phase, at the onset of each dialysis SCD, also known as calf garment DVT 10 or simply Flowtron (Huntleigh, Manalapan, NJ), were wrapped firmly around both calves and compressions were intermittently applied at 40 mmHg throughout the treatment. Frequencies of the compressions were three cycles of compressions and decompressions per minute. Each cycle of compression and decompression lasted for approximately 10 sec. Lower extremities of all patients were kept horizontal during each dialysis session. Patients were monitored for location and severity of cramps during each dialysis session. The usually monitored dialysis parameters such as pre- and postdialysis weights, BP—reported as mean arterial pressure—and UF were also recorded for each treatment. Episodes of intradialytic hypotension (IDH) were carefully recorded. IDH was defined as a sudden drop in systolic BP (SBP) of 20 mmHg, SBP 90 mmHg, or any decrease in BP requiring nursing intervention including saline bolus, intravenous albumin, a decrease in or termination of UF, or placement of patient in Trendelenburg position. Dialysate temperature remained unchanged during both phases at 37°C. The HD prescription including the duration of treatment, dialysate composition, and antihypertensive therapy remained unchanged during both phases.

Case reports

Comparative clinical data of cases are presented in Table 1.

Case 1

A 59-year-old African American (AA) male who initiated maintenance dialysis 4 years ago due to the development of end-stage renal disease from hypertensive nephrosclerosis. He is being dialyzed from forearm arteriovenous (AV) graft. He reported daily LE cramping during the pre-SCD period without any documented IDH. During the post-SCD phase he remained totally asymptomatic without LE cramping and had no IDH. His dry weight and antihypertensive therapy remained unchanged.

Case 2

A 66-year-old AA woman on maintenance HD for 9 years due to diabetic glomerulosclerosis, now from a cuffed catheter. She reported 13 episodes of LE cramping during the pre-SCD phase and no LE cramps, but two episodes of hand cramping during the post-SCD phase. There was no IDH in either period. Her dry weight and BP medications remained unchanged.

Case 3

A 43-year-old AA man on HD for 4 years due to hypertensive nephrosclerosis. He has an AV graft. He had almost daily severe LE cramping in the pre-SCD phase, but did not experience a single episode of LE cramping during the

Table 1 Comparative clinical data of cases

Clinical characteristics	Case 1	Case 2	Case 3	Case 4
Age (years)	59	66	43	78
Sex/race	M/AA	F/AA	M/AA	F/AA
Dry weight (kg)				
Pre-SCD (N = 12)	69.5	58	66	68.5
Post-SCD (N = 12)	69.5	58	65	71.5
No. of cramps				
Pre-SCD (N = 12)	12	13	9	8
Post-SCD (N = 12)	0	0[a]	0	0
Average UF (L)				
Pre-SCD (N = 12)	3.3	3.0	4.4	2.6
Post-SCD (N = 12)	3.1	2.9	5.0	2.3
Intradialytic hypotension				
Pre-SCD (N = 12)	No	No	No	Yes
Post-SCD (N = 12)	No	No	No	Yes

[a]Reported two episodes of hand cramps.
M = male; F = female; AA = African American; SCD = sequential compression device; UF = ultrafiltration.

post-SCD phase. There was no IDH and his dry weight was in fact decreased from 66 to 65 kg during the post-SCD period although his BP medications were not changed.

Case 4

A 78-year-old AA woman on HD for 2 years due to hypertensive nephrosclerosis and has an AV graft. She was experiencing daily LE cramps lasting for a few hours after every dialysis during the pre-SCD phase but reported complete resolution during the post-SCD phase. Her dry weight was gradually increased from 68.5 to 71.5 kg during the post-SCD period due to IDH (without cramps). She, however, continues to develop sudden episodes of IDH.

DISCUSSION

The exact mechanism of HD-related cramping is not known. Previous studies have shown that both flow and permeability contribute to intercompartmental solute clearance.[17] There is a reduction in slow intercompartmental clearance of urea during dialysis.[18] It is likely that VR drops during dialysis due to nonambulation and the often dependent position of the lower extremities. This stagnation of blood flow could result in accumulation and delayed clearance of various "cramp-inducing metabolites" and creates a favorable milieu for cramp generation in a small subgroup of patients. Dialysis induced decreases in the red blood cell 2,3-diphosphoglycerate and increases in the arterial pH may result in less oxygen delivery to tissues because of increased hemoglobin-oxygen affinity; therefore, it has been suggested that HD-associated muscle cramps could be a manifestation of acute oxygen deficiency in muscles.[19]

SCD provides intermittent compressions to the calf muscles and in fact acts like an external venous pump and was effective in preventing cramps. We applied intermittent compressions at a pressure of 40 mmHg, which was sufficient to improve the VR and would not have caused arterial compromise. We are not certain about the exact mechanism of prevention of LE cramps, but it appears that venous pooling in LE plays a role in causation and improving the VR by external compressions prevented this painful condition. The patients' medications, especially antihypertensive therapy, remained unchanged during both study phases. This suggests that the main factor that contributed to the cramp prevention was the improved VR.

We propose that intradialytic venous pooling in LE creates a favorable environment for cramp generation in susceptible patients and application of intermittent external calf compressions during dialysis is a useful maneuver, which can prevent LE cramps by improving VR. Larger controlled studies are needed to establish the role of this potentially useful noninvasive modality for the prevention of LE HD-related cramps.

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