



The Effect of Gradual Reduction in Sodium Dialysate on Occurrence of Muscular Cramp, and the Serum Level of Calcium and Magnesium in Patients Undergoing Hemodialysis: A Cross-Over Clinical Trial

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Abstract

Background: The aim of study was to determine the effect of gradual reduction in sodium dialysate on occurrence of muscular cramp, and the serum level of calcium and magnesium in patients undergoing hemodialysis.

Methods: This triple-blinded cross-over clinical trial was conducted on 56 hemodialysis patients. After random allocation of patients into group A by the routine method (fixed sodium dialysate) and group B with gradual reduction in sodium dialysate, they underwent a 3-session dialysis. After one week of dialysis through routine method (wash out), patients underwent 3-session dialysis in group B by routine method and in group A by gradual reduction in sodium dialysate. Occurrence of muscular cramp was recorded by using a check list. Patients, serum level of calcium and magnesium before and after intervention was measured. Descriptive statistics indices and inferential statistics tests (repeated measures Analysis of variance) were used.

Results: The rate of muscular cramp in routine method was 3.8% in one muscle, 1.9% in two or more muscles, and in the method of gradual reduction of sodium dialysate was 1.9% in one muscle, and 7.5% in two or more muscles. The mean difference of plasma calcium and magnesium before and after the dialysis with routine method was 0.43 and 0.26, respectively, and in the method of gradual reduction of sodium dialysate was 0.45 and 0.34. In this study no significant difference was observed for the rate of occurrence of muscular cramp and serum level of calcium and magnesium between two methods.

Conclusions: The results showed that gradual reduction of sodium dialysate, has no effect on occurrence of muscular cramp during dialysis, serum level of calcium and magnesium in hemodialysis patients. Further investigations are needed to better understand the exact effect of this method, and also eliminate the study limitations.

Keywords: Calcium, Hemodialysis, Magnesium, Muscle cramp, Sodium dialysate.

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Mean prevalence of renal failure in the world is 465 in one million individuals; however, this rate reached 680 in one million individuals in Iran, which is higher than global average.² This therapeutic approach has complications despite many advantages, which result in discomfort for patients and reduction in efficiency of dialysis, and also these complications increase the workload of nurses and physicians, and add a lot of costs to treatment system, and reduce acceptance of patients to perform regular program of dialysis. Therefore, control and prevention of these complications is of most important.^{3,4}

One of the common complications during hemodialysis is muscular cramp.⁵ Muscular cramp is a long-lasting complication in which painful contractions occurred in lower limbs, and affect other organs. This complication is occurred during dialysis, and might adversely affect quality of life of hemodialysis patients and the severe complications might occur in some patients, and leads to discontinuation of dialysis.⁶⁻⁸

In the conducted study in London at 2011 the most common symptoms reported were intradialytic hypotension (76%) and muscular cramp (74%), and the main reason of muscular cramp during hemodialysis is not known to date.⁹ Muscular cramp is a bothering problem and is one of the reasons of low efficiency of dialysis.

This complication has many effects on quality of hemodialysis and is one of the reasons for lack of adoption to hemodialysis.¹⁰ Since this complication leads to early discontinuation of hemodialysis, prevention of this complication can be one of the greatest problems of staff at dialysis ward especially nurses.¹¹ Electrolyte imbalance and disturbances in mineral metabolism such as reduction in calcium and magnesium level can increase muscular cramps.¹² One study showed that calcium and phosphorus level of saliva in dialysis patients is higher, but has no association with level of calcium and phosphorus in serum of dialysis patients.¹³

Many recent studies showed deficiency of electrolytes such as calcium, magnesium, and vitamin B in most individuals with painful spasm of calf, on the other hand, several clinical trials were conducted to investigate the effect of therapeutic supplements such as calcium and magnesium and vitamins in improvement of muscular cramps. As a result of these treatments, partial but not fully improvement has been reported.¹⁴⁻¹⁶

Introduction

Chronic renal failure (CRF) is the irreversible defect in kidney's function which occurs progressively, and most of the patients finally need permanent hemodialysis.¹ Renal replacement therapy in end stage renal disease (ESRD) is the major and growing part of health costs in various countries.

In addition, magnesium plays an important role in calcification of vessels in patients with chronic renal failure and pre-dialysis caused by diabetes.^{17,18} For prevention or attenuation of muscular cramp in hemodialysis various methods are used such as change in dialysis time, change in dialysate temperature, programmed nursing care, gradual reduction in sodium dialysate, and change in ultra-filtration and also linear and stepped profile.¹⁹⁻²³

One of the methods used to reduce complications during dialysis is using dialysis through sodium profile. One of the benefits of this profile is that using high concentration sodium at the initiation of dialysis causes facilitation in transforming water from intracellular space to intravascular space, and by maintenance of intravascular volume, reduced blood pressure and muscular cramp are prevented.²⁴ One study recommended using sodium profile and ultra-filtration in reducing muscular cramp during dialysis as a simpler and inexpensive method than routine method.²⁵

On the other hand, a prospective study on pregnant women showed that despite the effect of mode of feeding on occurrence of cramp, consumption of magnesium in patients with magnesium deficiency is useful in prevention and improvement of cramp.²⁶ Some studies reported reduction in blood level of electrolytes such as calcium is a leading cause of spasm, and also stated that partial improvement after calcium-therapy occurs as reduction in recurrence of muscular cramp.^{16,27-28}

There is no consensus on the most effective method for prevention of muscular cramp during dialysis. Due to abovementioned findings, this study aimed to determine the effect of gradual reduction of sodium dialysate on occurrence of muscular cramp and the serum level of calcium and magnesium in patients undergoing hemodialysis.

Materials and Methods

This is a triple-blind; crossover randomized clinical trial study with Iranian registry of clinical trial number "IRCT2017040833295N1", which is carried out on 56 CRF patients referred to Shahroud Imam Hossein dialysis center in 2017.

Inclusion criteria were 18-75 years-old patients with ESRD, patients who they have been undergoing hemodialysis for at least two months (2-3 times a week). The exclusion criteria were considered as follows:

1. The patients' blood pressure had not been controlled.
2. Pre-dialysis blood pressure lowering medications had been used (the corresponding patients have prescribed blood pressure medication in consultation, with consulting the physician, after dialysis).
3. Myocardial infarction had been occurred in the last six months.
4. The ejection fraction had been less than 30%.
5. A pacemaker had been existed.

The medical records of patients suffering from a CRF were investigated. These patients underwent hemodialysis at the dialysis centers affiliated to Shahroud university of medical sciences. Then, 56 eligible patients were selected among them using consecutive sampling, based on the inclusion and exclusion criteria. It should be noted that a written consent was received from all of them. Subsequently, these patients were randomly assigned to either A or B groups using a quadruple blocking method.

Data gathering tools in this study were demographic characteristics form (age, gender, patient's weight), muscular cramp check list and measuring laboratory indices of plasma calcium and magnesium. Auto-analyzer Mendriy-800 was used to measure serum level of calcium and magnesium pre- and post-dialysis.

The method of intervention was implemented in such a way that the control group patients (group A) were dialyzed using a routine method (fixed 138 mill equivalents per liter sodium dialysate). Moreover, the intervention group patients (group B) were dialyzed hemodialysis patients using the gradual reduction of sodium dialysate. They were dialyzed for one week (three sessions). The dialysis of group B was performed such that the reduction began with 150 mill equivalent per liter. This was carried out every 15 minutes per mill equivalent per liter, and it was continued until the concentration reached 138 mill equivalents per liter. After wards, both groups were dialyzed for one week using a routine method (wash out).²⁹ Then, dialysis was performed using a crossover method, based on which the group B was dialyzed using the routine method, whereas group A was dialyzed using the gradual reduction of sodium dialysate, under three times. The type of dialysis machine, nurse, pump flow rate and dialyzer were constant for each patient during the period of study.

Before and after the intervention, the muscular cramp was assessed for one or more muscles and was recorded in checklist. Before and after each intervention (three sessions of dialysis), 5cc venous clot sample were taken to measure serum level of calcium and magnesium. This was carried out both before and after the intervention (at the end of third session of dialysis). It is worthwhile to mention that 56 patients who were undergoing hemodialysis in the dialysis ward of Imam Hossein hospital in Shahroud were registered by the first author using sequential sampling among the eligible patients. Afterwards, they were entered to the research after understanding the objectives of the study and receiving a written consent. Then, the patients were randomly divided into two groups (group A and group B) using a predetermined random pattern based on the quadratic blocks. In this matter, the researcher distinguished 56 series of A and B cards based on a 4-block random block pattern. These cards were provided to the hemodialysis ward supervisor in separate envelopes. In this way, the patients were assigned into two groups A and B, in the blind concealment envelope. Data were collected by a dialysis nurse who was unaware of the patients' allocation in the groups.

In the current research, the patients, data collector, and data analyzer were unaware of the type of intervention in the groups A and B until the end of the study.

A consent form was received from all patients after necessary explanation of the research aims. It is worthwhile to mention that this study was approved by the ethics council of the University of Medical Sciences under code "IR.SHMU.REC.1396.35".

The collected data were then analyzed through the descriptive statistics (e.g. mean, standard deviation, absolute and relative frequency) and inferential statistics (ANOVA via repeated measure).

Results

According to the results of study, mean age of the patients was 57.6 ± 16.7 years. In addition, most of the patients was man (57%), mean and standard deviation of the weight of the patients in the study was 65.9 ± 11.9 kg.

The results of the study showed that the incidence rate of muscular cramp by routine method for one muscle was 3.8%, and for involvement of two or more muscles was 1.9%, and by the method of gradual reduction in sodium dialysate for one muscle was 1.9% and for two or more muscles was 7.5%.

The therapeutic effect was compared by regression model of GEE, and no significant effect was observed, in other words, the occurrence rate of muscular cramp was not significantly different between the method of gradual reduction in sodium content of dialysis solution and routine method. Moreover, the arrangement of interventions has also no significant effect on occurrence of muscular cramp during dialysis (Pvalue > 0.05) (table 1).

The results of analysis showed that there was no significant difference between the serum level of calcium and magnesium based on occurrence of muscular cramp in one or more muscles (table 2).

Analysis of the data showed that the difference between mean serum level of calcium and magnesium pre- and post-dialysis in the method of gradual reduction in sodium dialysate and routine method was not significant (table 3).

Discussion

The prevalence of muscular cramp in the current study by the routine method was 9.43%, and by the gradual reduction in sodium dialysate was 5.66%. The results of the study by Tang et al (2006) showed that the prevalence of muscular cramps by the routine method was 35.9%, and by the linear sodium profile method and ultra-filtration was 3.8%.³⁰ The underlying probable reason was due to different time-periods of assessment, so that in the abovementioned study, the patients were also assessed up to four weeks after the end of the intervention.

In this study, the occurrence rate of muscular cramp was not significantly different between the method of fixed sodium dialysate and gradual reduction in sodium dialysate. Whereas, Molaei et al (2012) investigated the effect of sodium profile and ultra-filtration and some common complications during hemodialysis, and found that sodium profile and ultra-filtration reduce the occurrence of complications during dialysis include muscular cramp, which is not in line with our results.²⁵ This inconsistency might be due to limited assessment sessions of patients (three sessions in each intervention), whereas, in abovementioned study, patients were assessed six sessions for each intervention. The study by Iseline et al in Switzerland known as "using neutral sodium balance profile does not lead to improvement of dialysis tolerance" showed that using sodium profile has no effect on reduction of occurrence of complications during dialysis, which is in line with this study.³¹

Table 1. Comparison of the prevalence of muscular cramp in both groups

Groups	Gradual reduction of sodium dialysate	Control	Significance level
Prevalence of muscular cramp			
- In one muscle (percentage)	1.9	3.8	0.5
- In several muscles (percentage)	7.5	1.9	0.17

Table 2. Comparison of blood level of calcium and magnesium based on muscular cramp in one or more muscles in hemodialysis patients

Muscular cramp	Variable	Serum level of calcium	Statistical indices	Serum level of magnesium	Statistical indices
		Mean (SD)		Mean (SD)	
One muscle	with	9.4 (0.2)	t = 0.86 df = 94 Pvalue = 0.39	3 (0.7)	t = 0.29 df = 94 Pvalue = 0.7
	without	9.07 (0.66)		2.9 (0.44)	
Several muscles	with	9.04 (0.8)	t = 0.14 df = 94 P = 0.9	2.82 (0.46)	t = 0.52 df = 94 P = 0.6
	without	9.08 (0.65)		2.9 (0.45)	

Table 3. Comparison of mean differences in serum level of calcium and magnesium pre- and post-dialysis in both groups

Groups	Mean differences and SD of serum level of calcium	Mean differences and SD of serum level of magnesium
Control	0.43 ± 0.77	-0.26 ± 0.44
Gradual reduction of sodium dialysate	0.45 ± 0.69	-0.34 ± 0.49
Statistical indices	t = 0.13 df = 104 P = 0.89	t = 0.933 df = 104 P = 0.35

SD. Standard deviation

The results of this study showed that mean muscular cramp and involvement of one or more muscles in intervention group in comparison to control group has no significant relationship with calcium concentration of the patients. In the study by Khoramverdi et al (2011) entitled "comparison of the effect of calcium and placebo in muscular cramp in pregnant women" and conducted on 57 pregnant women with muscular cramp and the severity of cramp in patients in four weeks during treatment. The results showed that calcium is very effective in attenuating muscular cramp.³² Sohrabvand et al (2006) investigated the prevalence of muscular cramp in pregnancy period and the effect of supplement therapy on it. This study was conducted on 104 individuals with muscular cramp, and the results showed that calcium supplement is very effective in attenuating muscular cramp.³³ The probable reason for this inconsistency is the intervention type, so that in both interventions, calcium supplement was administered to patients, whereas, in the current study, the effect of gradual reduction of sodium dialysate.

In the current study, the incidence of muscular cramp in one or more muscles was not significantly different between intervention group and control group. In addition, no significant difference was observed between serum magnesium levels between both groups. In the study by Dahle, 73 patients with calf cramp were assessed in a prospective and double-blinded randomized design, and the serum magnesium level and daily excretion of it were firstly recorded, and then the oral magnesium or placebo were administered to patients for three weeks. The results showed that serum level of magnesium level at the time of occurrence of calf cramps is less than patients without cramp, and also magnesium therapy is effective in a wide spectrum of pathologic disorders such as cramp.¹⁷ The probable reasons for this inconsistency are difference in study population and the type of intervention.

The results of the current study showed that gradual reduction in sodium dialysate had no role in reducing the muscular cramp, serum level of calcium and magnesium of patients undergoing hemodialysis. Although, more studies are needed to confirm or reject this finding, significant occurrence of muscular cramp during dialysis is one of the issues which should be considered by nurses caring these patients, and also they should make attempts to reduce it.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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