J Nephropharmacol. 2017; 6(2): 85–89.

http://www.jnephropharmacology.com DOI: 10.15171/npj.2017.10

Journal of Nephropharmacology

Impact of a designed isotonic exercise program on pain intensity of muscle cramps in legs of patients undergoing hemodialysis; a randomized clinical trial

Mahdi Poornazari[1], Khadijeh Dehghani[2], Sara Shahbazi[3*], Firooz Khaledi Sardashti[1]

[1]Department of Emergency Medicine, Borujen Nursing Faculty, Shahrekord University of Medical Science, Shahrekord, Iran
[2]Department of Nursing, Nursing and Midwifery Faculty, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
3Department of Nursing, Borujen Nursing Faculty, Shahrekord University of Medical Science, Shahrekord, Iran

ARTICLEINFO

Article Type:
Original

Article History:
Received: 19 January 2017
Accepted: 24 April 2017
ePublished: 3 May 2017

Keywords:
Hemodialysis
Exercise
Muscle cramps
Pain

ABSTRACT

Introduction: Pain due to muscle cramp is a common complication during hemodialysis. Studies have shown that exercise can reduce pain and fatigue through reduction of muscle stiffness and sensitivity, and improvement blood flow.
Objectives: The aim of this study was to evaluate the impact of a designed program of isotonic exercise on pain intensity of leg muscle cramps in patients undergoing dialysis.
Patients and Methods: This clinical trial was conducted on 60 patients with muscle cramps during dialysis. The participants were randomly divided into experimental and control groups. The intensity of muscular cramps and pain were recorded before and after the implementation of the exercise package. The isotonic exercise package included 10 sessions of exercise with a stationary bicycle lasting 10 minutes before hemodialysis. SPSS statistical software was used for data analysis. Descriptive statistics, *t* test, and analysis of variance (ANOVA) were used for comparison of means of variables.
Results: The results showed a significant reduction in the severity and frequency of muscle cramps after exercise. The mean pain severity in the experimental and control groups had, respectively, differed from 8.73 ± 1.01 and 8.83 ± 1.05 before the intervention, to 4.97 ± 1.67 and 9.39±3.31 after the intervention ($P<0.001$, $P<0.05$). Age, sex, weight, blood pressure, round per minute (rpm) of pump, and dialysis duration showed no significant relationship with pain severity and frequency during dialysis ($P > 0.05$).
Conclusion: The results showed that exercise dramatically decreased the severity and frequency of leg muscle cramps. Therefore, this method can be used in dialysis units.

Implication for health policy/practice/research/medical education:
In a study on 60 patients with muscle cramps during hemodialysis, with the age 50.5 ± 3.65 years, after the implication of the exercise package, we found that exercise dramatically decreased the pain severity and frequency of leg cramps.
Please cite this paper as: Poornazari M, Dehghani K, Shahbazi S, Khaledi Sardashti F. Impact of a designed isotonic exercise program on pain intensity of muscle cramps in legs of patients undergoing hemodialysis; a randomized clinical trial. J Nephropharmacol. 2017;6(2):85-89. DOI: 10.15171/npj.2017.10.

Introduction

The critical role of the kidneys in the body illustrates their importance in preserving human health. The kidneys' inability to function normally is referred to as chronic renal failure. Chronic failure is diagnosed based on the presence of a set of signs and symptoms including high concentration of creatinine and blood urea nitrogen. Almost 91% of patients who are diagnosed with end-stage renal disease (ESRD) (in which almost 90% of kidney function is lost) start dialysis instead of renal treatment (1-3). The overall incidence of ESRD is 260 cases per one million people per year in the world and it increases by almost 6% annually (4). According to the Kidney Foundation of Iran, out of a total of 40 000 kidney patients, more than 1500 patients have lost their lives (5).

Muscle cramps are severe, painful contractions which occur in one muscle or a group of muscles in patients without myopathy or neuropathy. These cramps are usually limited to the calf muscles, but can also engage other skeletal muscles (6). Various factors have been

***Corresponding author**: Yassamine Bentata MD, PhD, Email; bentatayassamine@yahoo.fr

recognized as the cause of muscle pains, but most of them are idiopathic. Increased muscle stimulating secretion, disruption of intracellular calcium release, increased secretion of acetylcholine or noradrenaline, coma, cirrhosis of the liver, electrolyte imbalance, sarcoidosis, use of certain medications and narcotics are factors which cause muscle cramps (6,7).

Muscle cramps are one of the complications which occur during hemodialysis in 5% to 20% of the patients (8). The most common causes of cramps are hypotension, hyponatremia, and dry weight loss. Studies have shown that limb ischemia during filtration is one of the causes of cramps. Hyponatremia causes vasoconstriction and decreased blood supply to the muscles and, in response to ischemia, it causes cramps and pain through pain stimulus factors such as histamine and bradykinin secretion (9). These painful muscle cramps often complicate hemodialysis, but their exact mechanism is unclear (8-11). The results of a previous study showed that variables related to the hemodialysis process such as the round per minute (rpm) of pump, and the patient›s blood pressure and weight also affect the incidence of muscle cramps (12).

Muscle cramps can cause physical and psychological problems in patients, and therefore, controlling these symptoms is an important goal of the treatment. Pharmacological and non-pharmacological strategies are available for the treatment of cramps in patients undergoing hemodialysis, and most of these strategies are based on pharmacological methods (8,11,13-16). Since most of the methods used were pharmaceutical and most drug metabolites are excreted through the kidneys, the use of this technique can increase the likelihood of drug intoxication.

Studies have shown that exercise can reduce pain and fatigue by reducing muscle sensitivity and stiffness and improving blood flow (17,18). Moreover, exercise reduces pain and edema through the obstruction of impulses to the brain and secretion of endorphins (19).

On the other hand, exercise improves the transportation of fluids, and decreases blood pressure, chills, muscle cramps, and fatigue after dialysis. Closing of the vessels around the fascia of the muscle and the accumulation of metabolites cause cramps, muscle chill and inactivity during hemodialysis, lack of oxygen in the muscular system, and pain (19,20).

Therefore, exercise prevents the muscles from cooling down and increases blood flow to the muscle resulting in metabolites elimination and pain relief (20). Other studies have shown that exercise reduces stress hormones (21). Generally, the impact of exercise can be divided into the four categories of effects on blood circulation, lymph flow, muscle spasms, and endogenous endorphin secretion (22,23).

Exercise during dialysis may be a method to maintain physical endurance and independent performance and help improve the patient's health status. It not only has personal benefits, but also has social benefits such as reducing health care and social care costs (24).

Numerous studies have emphasized the effects of exercise on reducing the number of cramps and results showed that stretching exercises were effective on prevention and reduction of pain due to cramps (11,20-26).

Despite the high prevalence of cramp pains during dialysis and its complications, the experience of the researcher in this case, and the importance of exercise in patients with hemodialysis, there has been limited research in Iran and the world in this regard. In addition, no effective care method has yet been provided for medical centers. Most of the methods to reduce the pain of muscle cramps in these patients were pharmaceutical procedures and exercise methods were less used or a small number of patients have been tested.

Objectives

The aim of this study was to determine the effect of isotonic exercise on the intensity of muscle cramps in patients undergoing hemodialysis.

Patients and Methods

Subjects

In this study, 60 patients who met the inclusion criteria were randomly selected, and divided into two groups of intervention (n = 30) and control (n = 30). The control group underwent routine hemodialysis and received no intervention.

Patients in the intervention group received the previously designed isotonic exercises package and training by a master of arts (MA) in physical education with a focus on exercise physiology.

The exercise program included 10 sessions of exercising with a stationary bike before hemodialysis, because the effects of exercise can be observed with at least 10 sessions (30). The exercise intervention duration was 10 minutes for each patient.

After obtaining the consent of the patients, the eligible patients in the intervention group, before dialysis, pedaled for 2 minutes at low rpm to warm up with the stationary bikes which were mounted on their beds, and continued pedaling on medium speed for the next 8 minutes.

During this time, the patients were controlled for cramp pains, blood pressure, pulse rate, and respiratory rate. In case of any problems, the patients were prevented from continuing the exercise. The intervention was conducted without the two groups seeing each other; the intervention and control groups were placed in separate rooms. In both groups, the performance of any exercise, such as walking, was recorded as a confounding variable by the researcher in the questionnaire.

The intensity of pain was recorded before the intervention (which began after the last hemodialysis and lasted until the beginning of the next round of dialysis) based on visual analog scale. The patients were asked to indicate their pain intensity on a 10-cm ruler; 0 was considered as no pain and 10 as the highest intensity of pain that the patient had ever experienced. Patients› demographic information,

including age, gender, weight, duration of hemodialysis, and the number of hemodialysis sessions per week, were also asked and recorded.
Variables during the dialysis, including pump rpm, were evaluated and recorded before and after the intervention. The researcher also assessed the pain intensity of cramps and monitored the exercise sessions.

Ethical issues

The research followed the tenets of the Declaration of Helsinki; informed consent was obtained; and the research was approved by the ethical committee with the code of 205802 of Shahid Sadoughi University of Medical Sciences of Yazd. This was a randomized clinical trial with the code IRCT2015021521081N1 in the clinical trials website (http://en.search.irct.ir/view/22306). This study was performed in patients undergoing hemodialysis whom referred to the dialysis center of Hajar Hospital of Shahrekourd, Iran, and Valiaasr Hospital of Bourojen, Iran.

Statistical analysis

The obtained data, after editing and data management, were entered into a computer and analyzed in SPSS software version 18. Data were analyzed using *t* test, ANOVA (to compare the mean quantitative data), and chi-square test (to compare qualitative and nominal data).

Results

The mean age of the subjects was 50.5 ± 3.65 years. The highest frequency was related to the age groups of 60 years with 12 individuals and 45 years with 10 subjects, and the lowest frequency was related to the age groups of 20-25 years and 70-75 years with one subject in each age group. Among the participants, 24 patients (38%) were men and 37 patients (62%) were women. In terms of education level, 41 participants had less than diploma, 15 had diplomas, 2 had higher than diploma, and 2 had bachelor degrees. The highest frequency was related to the group with high school diploma (68%) and the lowest to the group with undergraduate and graduate degrees (2% each). The mean dry weight of the subjects was 64.40 ± 14.71 kg, and the minimum and maximum weights were 40 and 98.5 kg, respectively. There was no significant difference between the variables of the two groups.
The results presented in Table 1 shows no significant difference between the two study groups before the intervention ($P > 0.05$).
The results presented in Table 2 shows a significant difference between the two study groups after the intervention $P < 0.05$).

Table 1. Comparison of the mean intensity of pain of leg muscle cramp before the intervention in the experimental and control groups

Variable	Group	Mean ± SD	*P* value
Intensity of pain before the intervention	Experimental (n = 30)	8.83 ± 1.05	0.709
	Control (n = 30)	8.73 ± 1.01	

Table 2. Comparison of the mean intensity of leg muscle cramp pains after the intervention in the experimental and control groups

Variable	Group	Mean ± SD	*P* value
Intensity of pain after the intervention	Experimental (n = 30)	4.97 ± 1.67	0.709
	Control (n = 30)	9.39 ± 3.31	

Discussion

The results of this study showed no difference between the intervention and control groups regarding the intensity of leg muscle cramps before the intervention and this result confirms the effects of the isotonic sports package after the intervention.

In this study, the pain intensity of leg muscle cramps was evaluated and compared after performing the exercise intervention in the experimental group and the routine program in the control group.
This comparison showed that the mean pain intensity was significantly decreased in the experimental group. Age, gender, weight, blood pressure, pump rpm, and the duration of dialysis showed no significant relationship with pain intensity during dialysis. On the other hand, the amount of difference in the pump rpm before and after the intervention was scientifically negligible; therefore, it could be stated that the factors involved had no effect on reducing cramps whatsoever.
The comparison of the mean pain intensity of leg muscle cramps before the intervention of the designed isotonic exercise between the two study groups showed no significant difference ($P > 0.05$). This indicates that the two groups had no differences regarding pain intensity and were identical in this respect before the intervention. The results confirmed the effect of the isotonic exercise package after the intervention.
The comparison of the mean intensity of leg muscle cramp pains in the study groups before and after the intervention indicated that the mean score of pain intensity of leg muscle cramps had dramatically decreased in the experimental group after the intervention.
This implies that the isotonic stationary bike exercise had an effective role in the improvement and reduction of the pain intensity of leg muscle cramps.
This result was consistent with that of the study by Young et al which showed that a designed exercise program had significantly reduced intensity of muscle cramps (27).
The results of another study by Rambod et al also indicated that Benson's relaxation technique had positive effects on the reduction of pain intensity of cramps in patients (28).
Ozdemir et al also showed a significant difference in patients after exercise (29). This advantage aligned to Zhang et al's reports (30).
Nevertheless, exercise had positive effects on the prevention of muscle cramps and in cases in which it did not prevent the cramps, it reduced the onset of pain intensity of cramps. In another study by Hyodo et al, Shakuyaku kanzo, a herbal medicine, was injected at the

time of cramps to relieve the pain of cramps. This herb was effective in 88.5% of the patients and relieved pain after 3.9-5.3 minutes of injection (31). However, exercise prevented cramps in 47.5% of the patients and reduced the intensity of cramps in 52.5% of the patients.

In the research conducted by Hyodo et al, the drug was injected at the time of cramps and the patients experienced severe pain. However, exercise resulted in better fluids circulation and reduced blood pressure, chills, muscle cramps, and fatigue after dialysis. The closing of the vessels around the fascia of the muscle and the accumulation of metabolites cause cramps which in turn causes chill and inactivity of the muscle during hemodialysis, lack of oxygen in the muscular system, and pain (31). Therefore, exercise prevents muscle chill and increases blood flow to the muscle, resulting in metabolites elimination and pain relief (32).

Toulabi et al found a significant improvement in mean physical activity and reduction in muscle pain after exercise in the subjects (33).

In almost all the examined studies, exercise prevented and improved the intensity of pain of leg cramps. It can be argued that exercise is an appropriate non-pharmacological intervention in order to improve and reduce the severity of leg pain muscle cramps.

Conclusion

The results of this study suggested that the isotonic exercise of pedaling on a stationary bike for 10 sessions lasting 10 minutes dramatically decreased the mean pain intensity of leg muscle cramps. Therefore, regular exercise could be performed at dialysis centers as a therapeutic intervention so that dialysis patients can change their inactive lifestyle and become closer to their life before the illness.

Limitations of the study

The low proportion of patients is a limitation of our study. However, we were able to recruit 60 patients within our hospital region. Therefore, the implementation of this study with more patients is recommended.

Acknowledgments

This article is extracted from MSc thesis in nursing of Mahdi Poornazari (# 102, 2015). Our sincere appreciation goes to the professors of the School of Nursing and Midwifery and the authorities of Shahid-Sadoughi University of Medical Sciences, the honorable officials and personnel of the dialysis units of Hajar hospital of Shahrekord and Vali-Asr Hospital of Borujen, and all the patients who helped in conducting this study.

Authors' contribution

MP and SS participated in all experiments, coordinated the data-analysis and contributed to the writing of the manuscript. FKS coordinated the acquisition of data. MP and KD designed the research plan and organized the study. FKS performed analysis and interpretation of data. SS prepared the final manuscript.

Conflicts of interest

The authors declare no conflict of interest.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors. The permission of the ethics committee of Shahid Sadoughi University of Medical Sciences of Yazd, Iran, was obtained with the code 205802.

Funding/Support

This article is extracted from MSc thesis of Mahdi Poornazari with high score. This study was supported by a grant from Shahid Sadoughi University of Medical Sciences of Yazd (#1025, 2015).

References

1. Brown EA, Finkelstein FO, Iyasere OU, Kliger AS. Peritoneal or hemodialysis for the frail elderly patient, the choice of 2 evils? Kidney Int. 2017;91:294-303. doi: 10.1016/j.kint.2016.08.026
2. Chang JH, Koo M, Wu SW, Chen CY. Effects of a 12-week program of Tai Chi exercise on the kidney disease quality of life and physical functioning of patients with end-stage renal disease on hemodialysis. Complement Ther Med. 2017;30:79-83.
3. Erickson KF, Winkelmayer WC, Chertow GM, Bhattacharya J. Hemodialysis Hospitalizations and Readmissions: The Effects of Payment Reform. Am J Kidney Dis. 2017;69:237-46.
4. Garg AX, Suri RS, Eggers P, Finkelstein FO, Greene T, Kimmel PL, et al. Patients receiving frequent hemodialysis have better health-related quality of life compared to patients receiving conventional hemodialysis. Kidney Int. 2017; In Press.
5. Red S. Nocturnal leg cramps in adults. MMW Fortschr Med. 2016;58:75-80 . doi: 10.1007/s15006-016-7894-9
6. Stolze I, Trautmann A, Goebeler M, Stoevesandt J. Dangerous leg cramps: severe pustular exanthema caused by an over-the-counter drug. Acta Derm Venereol. 2016;96:703-4. doi: 10.2340/00015555-2324.
7. El-Tawil S, Al Musa T, Valli H, et al. Quinine for muscle cramps. Cochrane Database Syst Rev. 2010;(12):CD005044. doi: 10.1002/14651858.CD005044.pub2.
8. Daugirdas JT, Blake GP, Ing ST. Handbook of dialysis. Philadelphia: Lippincott Williams & Wilkins; 2007.
9. Fujiwara M, Ando I, Yagi S, Nishizawa M, Oguma S, Satoh K, et al. Plasma levels of biotin metabolites are elevated in hemodialysis patients with cramps. Tohoku J Exp Med. 2016;239:263-7. doi: 10.1620/tjem.239.263.
10. Beladi Mousavi SS, Zeraati A, Moradi S, Mousavi MB. The effect of gabapentin on muscle cramps during hemodialysis: a double-blind clinical trial. Saudi J Kidney Dis Transpl. 2015;26:1142-8. doi:

10.4103/1319-2442.168588.
11. Caravaca F, Gonzales B, Bayo MÁ, Luna E. Musculoskeletal pain in patients with chronic kidney disease. Nefrologia. 2016;36(4):433-40. doi: 10.1016/j.nefro.2016.03.024.
12. Mastnardo D, Lewis JM, Hall K, Sullivan CM, Cain K, Theurer J, Huml A, Sehgal AR. Intradialytic massage for leg cramps among hemodialysis patients: a pilot randomized controlled trial. Int J Ther Massage Bodywork. 2016;9(2):3-8.
13. Allen RP, Montplaisir J, Walters AS, Ferini-Strambi L, Högl B. Restless legs syndrome and periodic limb movements during sleep. In: Dement WC, ed. Principles and Practice of Sleep Medicine. 6th ed. Philadelphia, PA: Elsevier; 2017:923-34.
14. Altieri P, Sorba G, Bolasco P, Asproni E, Ledebo I, Cossu M, et al. Predilution haemofiltration-the Second Sardinian Multicentre Study: comparisons between haemofiltration and hemodialysis during identical Kt/V and session times in a long-term cross-over study. Nephrol Dial Transplant. 2001;16(6):1207-13. doi: 10.1093/ndt/16.6.1207 .
15. Hyodo T, Taira T, Kumakura M, Yamamoto S, Yoshida K, Uchida T. The immediate effect of Shakuyaku-kanzo-to, traditional Japanese herbal medicine, for muscular cramps during maintenance hemodialysis. Nephron Clin Pract. 2006;104:28-32.
16. Moledina DG, Perry Wilson F. Pharmacologic treatment of common symptoms in dialysis patients: a narrative review. Semin Dial. 2015;28(4):377-83. doi: 10.1111/sdi.12378
17. Graham J. Research review: the effect of acupressure with massage on fatigue and depression in patients with end-stage renal disease. Geriatr Nurs. 2005;26(3):164-165. doi: 10.1097/01.JNR.0000387488.63438.9a
18. Paul J, Fons G, Baziel V. Diagnosis and differential diagnosis of muscle cramps: a clinical approach. J Clin Neur Dis. 2002;4:89-94.
19. Unal KS, Balci Akpinar R. The effect of foot reflexology and back massage on hemodialysis patients' fatigue and sleep quality. Complement Ther Clin Pract. 2016;24:139-44. doi: 10.1016/j.ctcp.2016.06.004.
20. Davenport A. New dialysis technology and biocompatible materials. Contrib Nephrol. 2017;189:130-6.
21. Mastnardo D, Lewis JM, Hall K, Sullivan CM, Cain K, Theurer J, et al. Intradialytic massage for leg cramps among hemodialysis patients: a pilot randomized controlled trial. Int J Ther Massage Bodywork. 2016;9(2):3-8.
22. Nonyama ML, Brooks D, Ponikvar A, Jaddal SV, Kontos P, Devins GM, et al. Exercise program to enhance physical performance and quality of life of older hemodialysis: a feasibility study. Int Urol Nephrol. 2010;42(4):1125-30. doi: 10.1007/s11255-010-9718-7.
23. Kim MS, Cho KS, Woo HM, Kim JH. Effects of hand massage on anxiety in cataract surgery using local anesthesia. J Cataract Refract Surg. 2001; 27(6):884-90 doi: 10.1016/S0886-3350(00)00730-6.
24. Small DM, Beetham KS, Howden EJ, Briskey DR, Johnson DW, Isbel NM, et al. Effects of exercise and lifestyle intervention on oxidative stress in chronic kidney disease. Redox Rep. 2017;11:1-10. doi: 10.1080/13510002.2016.1276314.
25. Coppin R, Wicke D, Little P. Managing nocturnal leg cramps calf stretching exercises and cessation of quinine treatment: a factorial randomized controlled trial. Br J Gen Pract. 2005;55:186-91.
26. Evans EC. Hemodialysis-related cramps and nocturnal leg cramps--what is best practice? Nephrol Nurs J. 2013;40:549-53.
27. Young H, Dungey M, Burton J, Smith A. Haemodialysis-associated cramping: role and implications of exercise. Br J Ren Med. 2012;17:12-14.
28. Rambod M, Sharif F, Pourali-Mohammadi N, Pasyar N, Rafii F. Evaluation of the effect of Benson's relaxation technique on pain and quality of life of haemodialysis patients: a randomized controlled trial. Int J Nurs Stud. 2014;51:964-73.
29. Özdemir G, Ovayolu N, Ovayolu Ö. The effect of reflexology applied on haemodialysis patient with fatigue pain and cramps. Int J Nurs Pract. 2013; 19:265-273. doi: 10.1111/ijn.12066
30. Zhang L, Luo H, Kang G, Wang W, Hu Y. The association between physical activity and mortality among patients undergoing maintenance hemodialysis. Int J Nurs Pract. 2016. doi: 10.1111/ijn.12505.
31. Hyodo T, Taira T, Kumakura M, Yamamoto S, Yoshida K, Uchida T, et al. The immediate effect of Shakuyaku-kanzo-to, traditional Japanese herbal medicine, for muscular cramps during maintenance hemodialysis. Nephron. 2002;90(2):240. doi: 10.1159/000049057
32. Nette RW1, van den Dorpel MA, Krepel HP, Ie EH, van den Meiracker AH, Poldermans D, et al. Hypotension during hemodialysis results from an impairment of arteriolar tone and left ventricular function. Clin Nephrol. 2005;63:276-83.
33. Toulabi T, Mohammadi K. S, Ghasemi F, Anbari K. The impact of multidisciplinary rehabilitation on the quality of life of hemodialysis patients in Iran. Journal of the Formosan Medical Association. 2016;115:553-559. doi: 10.1016/j.jfma.2015.05.013