



The Effect of Muscle Relaxation on Serum Calcium and Phosphorus Levels in Patients Undergoing Hemodialysis

El efecto de la relajación muscular en los niveles de calcio y fósforo en suero en pacientes sometidos a hemodiálisis

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Abstract

Improvement of calcium and phosphorus level is considered as an important factor in reducing mortality in hemodialysis patients. This study aimed to investigate the effect of muscle relaxation techniques on calcium, phosphorus and phosphorus concentrations in patients undergoing hemodialysis. A total of 90 hemodialysis patients in Zahedan hemodialysis centers were selected by purposive sampling and randomly divided into control and test groups with permutation blocks. Serum levels of calcium and phosphorus were measured before the intervention. Benson's muscle relaxation response was taught to the test group during three sessions and they were asked to perform relaxation techniques for 2-15 times each day for one month. The routine care group was provided. Then, the levels of calcium and phosphorus were compared in two groups and the data were analyzed using statistical tests at a significance level of $0 < 0.05$. The results showed that the mean of calcium in the test group before and after the intervention was $8.69 \pm 1.8.1$ and 8.79 ± 0.95 , respectively. Independent t-test showed that the mean of calcium after the intervention in the test group was significantly higher than the control group ($p=0.005$). The mean of p-value before and after the intervention in the two groups was not statistically significant ($P \leq 0.05$). Regarding the improvement of calcium level to protect patients against complications caused by disorders of these indices, teaching this technique in hemodialysis sections is recommended.

Keywords: Muscle relaxation, serum index, hemodialysis, calcium, phosphorus

Resumen

La mejora del nivel de calcio y fósforo se considera un factor importante para reducir la mortalidad en pacientes en hemodiálisis. El objetivo de este estudio fue investigar el efecto de la técnica de relajación muscular sobre las concentraciones de calcio, fósforo y fósforo en pacientes sometidos a hemodiálisis. Un total de 90 pacientes de hemodiálisis en los centros de hemodiálisis de Zahedan se seleccionaron por muestreo específico y se dividieron al azar en grupos de control y de prueba con bloques de permutación. Los niveles séricos de calcio y fósforo se midieron antes de la intervención. La respuesta de relajación muscular de Benson se enseñó al grupo de prueba durante tres sesiones y se les pidió que realizaran una técnica de relajación de 2 a 15 veces por día durante un mes. Se proporcionó el grupo de atención de rutina. Luego, los niveles de calcio y fósforo se compararon en dos grupos y los datos se analizaron mediante pruebas estadísticas con un nivel de significación de $0 < 0.05$. Los resultados mostraron que la media de calcio en el grupo de prueba antes y después de la intervención fue de $8.69 \pm 1.8.1$ y 8.79 ± 0.95 , respectivamente. La prueba t independiente mostró que la media de calcio después de la intervención en el grupo de prueba fue significativamente mayor que el grupo control ($p=0,005$). La media del valor de p antes y después de la intervención en los dos grupos no fue estadísticamente significativa ($P \leq 0,05$). Con respecto a la mejora del nivel de calcio para proteger a los pacientes contra las complicaciones causadas por trastornos de estos índices, se recomienda enseñar esta técnica en las secciones de hemodiálisis.

Palabras clave: relajación muscular, índice sérico, hemodiálisis, calcio, fósforo.

End-Stage Renal Disease (ESRD) is an important health issue around the world¹. The number of patients with ESRD in the world by the end of 2011 was 2,786,000 that year, a 7.16% increase is witnessed where 2,164,000 are under treatment and 1,929,000 undergo dialysis². Prevalence and incidence of ESRD in Iran are 357 and 57 per million per year, respectively³.

Dialysis is a stressful process and causes many psychological problems for patients. The inappropriate response of stresses decreases the life quality of these patients and causes many problems for them⁴.

High level of stress causes many consequences such as anxiety, depression, and physical and mental problems⁵. Moreover, increased heart rate, high blood pressure, secretion of cortisol hormones, epinephrine, and norepinephrine are the signs of mental pressures⁶. Cortisol is one of the important steroid hormones that regulate important body functions such as cardiovascular, metabolic, and immunological functions⁷. One of the important functions of this hormone is its effect on serum calcium levels. Cortisol, in addition to increasing calcium urinary excretion, decreases its intestinal absorption⁸. Hemodialysis patients have low calcium and high phosphorus levels: 1. Due to reduced glomerular filtration, phosphorus excretion in urine decreases and its level in blood increases; on the other hand, calcium reabsorption in tubules and blood decreases; 2. Due to digestive phosphorus excretion that is accompanied by calcium excretion, serum calcium level decreases⁹.

Low calcium and high phosphorus levels in these patients lead to renal osteodystrophy. To correct calcium and phosphorus and treat this problem, drug therapies are used in hospitals¹⁰.

Due to the high costs and consequences of drug therapies for stress control and its consequences such as increased cortisol level and decreased calcium level, non-drug methods should be used to control stress and its consequences¹¹. Varied nursing measures function as non-drug and complementary treatment and relaxation are one of them^{12,13}. Relaxation, decreasing the sympathetic nervous system and decreasing secretion of catecholamine and cortisol leads to decreased muscle stress and undesirable effects of secreted cortisol and catecholamines due to stress¹⁴. Relaxation has different methods but the method proposed by Benson (1970) is more popular due to easy learning and training¹⁵.

According to the positive effects reported from the implementation of this technique, especially in decreasing stress level of hemodialysis patients¹⁶, positive effects reported

regarding fatigue of hemodialysis patients¹⁷ and the effect of this technique on insomnia of these patients¹⁸, it is expected that according to the effect of this technique on decreasing the stress level of these patients¹⁶, it influences calcium and phosphorus levels of serum that is under the influence of catecholamines and stress hormones. Therefore, the present study aimed to investigate the effect of Benson's muscle relaxation response on serum calcium and phosphorus levels among hemodialysis patients.

Methods:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 (S_1^2 + S_2^2)}{(\bar{X}_1 - \bar{X}_2)^2}$$

This study is a randomized clinical trial and its population included all hemodialysis patients under hemodialysis treatment in Zahedan Hospital during 2013-2014. Subjects for control and test groups were selected equally. After the pilot study, subjects were assigned to test and control groups according to permutation blocks. Considering the confidence coefficient of 0.95 and test power of 80%, 45 subjects were estimated for each group that considering drop rate, 45 subjects for each group and in sum, 90 subjects for both groups were appointed (1 person excluded from the study due to death). Inclusion criteria included 18 to 65 years old patients, history of hemodialysis at least for two months, undergoing hemodialysis 2-3 times a week, having complete vigilance, acceptable oral and verbal abilities to learn relaxation method, no known psychological problem such as severe anxiety and depression, no history in muscle diseases, and having active file at the center of interest. Exclusion criteria included every condition that causes interference during the intervention and makes it impossible to continue the intervention such as mortality, travel, no interest for cooperation, and not attending the training sessions.

After selecting the subjects according to the inclusion criteria and receiving written consent, the subjects were randomly assigned into control and test groups based on the permutation blocks method. Instruments used in this study included demographic information questionnaire in two sections of personal information (e.g. gender, age, marital status, education, job) and information related to disease and treatment (e.g. history of blood pressure and diabetes, renal failure duration, hemodialysis, and number of dialysis sessions per week), checklist before recording calcium and phosphorus indices before and after the intervention, and relaxation recording form. Consistent with the research method, the patients were asked to complete demographic information questionnaire and phosphorus and calcium serum levels of all subjects were measured. Then, the muscle relaxation technique was trained individually in three sessions for the test group. After that, the patients performed the technique at home, 2 times per day for 30 days. The method was as follows: 1. The patient takes a comfortable position; 2. Closes the eyes; 3. Relaxes all muscles from feet gradually toward the

face and keep calm; 4. Breathes from nose and awareness about it and exhales from the mouth gradually and repeats number 1 silently and breathes comfortably and normally; 5. Performs this task for 15-20 minutes while muscles are relaxed. Then, he opens the eyes and does not stand up for several minutes; 6. Do not worry about deep level of relaxation; let relaxation occur with its peace. When the disturbing thoughts came about, try to ignore them¹⁹. To ensure the implementation of the relaxation technique during the intervention period, give a checklist (relaxation recording form) to the subjects to record day, hour, relaxation duration, and its unsuccessful implementation. Moreover, an audiovisual file for relaxation training was given to the patients. Also, to solve the potential problems about the implementation of the technique during the study, the researcher, every day called the subjects and followed the procedure for the implementation of the technique and completing a relaxation recording form. Finally, after the intervention, laboratory indices of interest were studied in patients. To obtain a blood sample, after turning on the blood pump of the dialysis machine, blood was taken from the arterial side and immediately transferred to the laboratory. Samples were prepared in a certain type of test tube (serum tube) with 5 cc syringe and a certain type of kit (Pars Azmoon) was used for tests before and after the intervention.

For data analysis, data distribution in research groups was performed using the Kolmogorov-Smirnov test for normality. According to the normal distribution of data, an independent t-test was used to compare the mean of quantitative data and also to investigate the relationship between the qualitative variable, chi-square test at the significance level of $0 > 0.05$ was used.

Findings: The findings showed that of all the sample studied (89), 52 were male and 37 were female and also showed that 68 were married and 21 were single. The average age of the sample was 43 ± 15 . Independent t-test did not show any significant difference between research groups in terms of age. Most of the sample were male, married, illiterate, and housewife. According to the chi-square test, research groups did not show any significant difference in terms of demographic variables of gender, marital status, education, and job and they were homogenous. Also, about information related to the disease, most of the units had a history of elevated blood pressure but did not show a history of diabetes. The chi-square test did not show any significant difference in terms of the mentioned variables and the groups were homogenous in this regard (Table 1).

Average calcium levels in the test group before and after the intervention were 8.69 ± 1.18 and 8.79 ± 0.95 , respectively. According to the results of paired t-test in the test and control groups, no significant difference was observed before and after the intervention. Also, according to the results of the independent t-test, average calcium after the intervention was significantly higher in the test group ($p=0.005$). However, no significant difference existed before the intervention ($p=0.2$). Average phosphorus in the test group before the intervention was significantly higher than its value after the intervention ($p=0.002$, 4.76 ± 1.58 vs 5.43 ± 1.65) but no significant difference was observed in the control group before and after the intervention. The results of the independent t-test showed that average phosphorus did not show any significant difference before and after the intervention (Table 2).

Table 1. Frequency distribution of demographic characteristics and information related to research units' diseases

Variables	Subgroup	Control Number (percentage)	Intervention Number (percentage)	Statistical test	p-value
Gender	Male	29 (4/64)	23 (3/52)	35/1= χ^2	24/0
	Female	16 (6/35)	21 (7/47)		
Marital status	Single	8(3/18)	11(6/26)	07/0= χ^2	404/0
	Married	36(7/81)	32(4/73)		
Education	Illiterate	15 (3/33)	15 (1/34)	42/2= χ^2	69/0
	Elementary	11 (4/24)	11 (25)		
	Middle school	8 (8/17)	6 (6/13)		
	High school	5 (1/11)	9 (5/20)		
Job	Higher-education	6 (3/13)	3 (8/6)	46/1= χ^2	50/0
	Employee	11 (4/24)	7 (9/15)		
	Free job	18 (40)	17 (6/38)		
History in elevated blood pressure	Housewife	16 (6/35)	20 (5/45)	28/0= χ^2	59/0
	Yes	33 (3/73)	30 (3/68)		
History in diabetes	No	12 (7/26)	14 (8/31)	09/1= χ^2	29/0
	Yes	9 (20)	13 (5/29)		
History in hemodialysis (months)	No	36 (80)	31 (5/70)	3.24= χ^2	19/0
	Less than 24	8 (7/17)	12(3/27)		
	24 to 124 months	34(5/75)	31(4/70)		
Age	More than 120 months	3(6/6)	1(3/2)	79/1=t	08/0
	-	754/14 \pm 11/46	221/15 \pm 41/40		

The results of the Pearson correlation coefficient showed that no significant relationship exists between calcium and phosphorus before and after the intervention ($p>0.05$). The results of Table 3 showed that a significant relationship exists between average serum calcium before and after the intervention and job status of people. The results of Tukey's post hoc test showed that average calcium

in employees before and after the intervention is significantly higher than housewife subjects ($p=0.01$). Also, no significant relationship exists between calcium levels before and after the intervention and gender and education. The results of Table 4 showed that no relationship exists between average phosphorus levels before and after the intervention and gender, education, and job status.

Table 2. Comparison of the mean and standard deviation of calcium and phosphorus before and after the intervention for each group

Variables		Intervention means \pm SD	Control means \pm SD	The result of independent t-test
Calcium	Before intervention	18/1 \pm 69/8	67/1 \pm 29/8	20/=p ,28/1=t
	After intervention	95/0 \pm 79/8	91/0 \pm 22/8	005/0=p ,85/2=t
The result of paired t-test		51/0=p ,66/0=t	91/0=p ,03/0=t	
Phosphorus	Before intervention	65/1 \pm 43/5	19/1 \pm 40/5	91/0=p ,11/0=t
	After intervention	58/1 \pm 76/4	36/1 \pm 17/5	22/0=p ,24/1=t
The result of paired t-test		002/0=p ,39/3=t	25/0=p ,16/1=t	

Table 3. The relationship between average serum calcium and demographic variables before and after the intervention

Variable		Before intervention		After intervention	
		Mean	SD	Mean	SD
Gender	Male	65/8	88/0	52/8	97/0
	Female	29/8	96/1	49/8	99/0
The result of independent t-test		26/0=p ,13/1=t		89/0=p ,13/0=t	
Education	Illiterate	98/7	97/1	36/8	83/0
	Elementary	62/8	88/0	70/8	05/1
	Middle school	87/8	71/0	49/8	28/1
	High school	79/8	08/1	72/8	09/1
	Higher education	94/8	43/1	22/8	97/0
The result of the analysis of variance		18/0=p ,58/1=F		58/0=p ,72/0=F	
Job	Employee	96/8	06/0	60/8	61/0
	Free job	56/8	07/1	26/7	11/1
	Housewife	70/7	97/1	27/8	92/0
The result of the analysis of variance		03/0=p ,74/2=F		01/0=p ,39/3=F	

Table 4. The relationship between average serum phosphorus and demographic variables before and after the intervention

Variable		Before intervention		After intervention	
		Mean	SD	Mean	SD
Gender	Male	32/5	46/1	09/5	66/1
	Female	56/5	39/1	80/4	18/1
The result of independent t-test		44/0=p ,77/0=t		38/0=p ,87/0=t	
Education	Illiterate	43/5	41/1	61/4	15/1
	Elementary	61/5	69/1	24/5	59/1
	Middle school	12/5	34/1	65/5	47/1
	High school	63/5	46/1	67/4	37/1
	Higher education	98/4	90/0	80/4	94/1
The result of the analysis of variance		73/0=p ,51/0=F		23/0=p ,43/1=F	
Job	Employee	25/6	82/0	17/5	56/1
	Free job	98/5	89/1	80/5	52/1
	Housewife	80/5	39/1	95/4	16/1
The result of the analysis of variance		14/0=p ,76/1=F		75/0=p ,48/0=F	

In this study, the effect of muscle relaxation based on Benson's muscle relaxation response on serum calcium and phosphorus levels of hemodialysis patients was investigated. The results showed that this technique increases serum sodium level in the test group while no significant effect was observed on serum phosphorus level of these patients.

Searching in authoritative research databases did not find any study on the effect of relaxation techniques on serum indices of patients. The findings were related to the effect of diet training on the levels of certain serum indices of hemodialysis patients. The results of studies by Salehi²⁰ and Baraz showed that average calcium for three months after diet training for hemodialysis patients did not show any significant increase while the results of a study by Schalatter showed that calcium level after training increased significantly. Ebrahimi and Sadeghi also showed that diet training has a significant effect on increased serum calcium among hemodialysis patients.

Muscle relaxation influences the sympathetic system and decreases catecholamine secretions that lead to decreased cortisol secretion and increased calcium serum level in the body.

The results of the present study did not show any significant effect of relaxation on the phosphorus serum level in the test group. The results of studies by Salehi et al., Ebrahimi and Sadeghi, and Oka et al. showed a significant decrease in phosphorus level among hemodialysis patients after diet training.

Also, the results showed that there is no significant relationship between age, gender, and education of subjects with calcium and phosphorus levels (before and after the intervention). However, average calcium in employees is significantly higher than housewives after the intervention ($p < 0.01$). It seems that increased serum calcium level that is observed both before and after the intervention, is related to the diet of these patients due to better financial level and following a particular diet compared with housewives.

Since this technique did not significantly decrease the phosphorus level, it is recommended to investigate the effect of other non-drug techniques and methods on the serum phosphorus level of these patients.

Due to the low cost and non-drug nature of Branson's muscle relaxation and positive effects on serum calcium level due to decreased adrenaline and catecholamine secretions, it is recommended to train this technique in hemodialysis units.

Acknowledgment: This article is the result of a thesis to receive a Master's Degree in Critical Care Nursing with the ethics code of recGMU/1392/43 and the Center for Clinical Trials Registration's code of IRCT2014051117656N1. The authors appreciate the Graduate Council and Research Council of Gonabad University of Medical Sciences. Also, the authors appreciate the sincere cooperation of staff and hemodialysis patients of 22 Bahman Hospital of Gonabad, Khatamolanbia Hospital, and Emam Ali Hospital and special thanks to Mrs. Nikpour, Mrs. Khaghani, Mrs. Nikbakht, Mrs. Maghsoodpour, Mr. Mohammadi, and Mr. Rafi.

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