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The Effect of Intradialytic Isometric Resistance Training on Muscle capacity and Serum Albumin Levels in Hemodialysis Patients

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Abstract

Background: Muscle wasting and protein malnutrition is a common problem in hemodialysis patients and has different complications such as a reduced quality of life, longer hospital stays, and higher mortality rates. The aim of this study was to evaluate the effect of 8 weeks of intradialytic isometric training on muscle capacity and serum albumin levels in hemodialysis (HD) patients.
Methods: In a clinical trial, 34 patients were randomly allocated into 2 groups: exercise group (EX) (n = 17) and control group (n = 17). The training program was conducted twice a week for 2 months (24 sessions). Forearm endurance, leg raise endurance, and grip strength were measured for muscle capacity aspect and serum albumin levels, which were evaluated before and post-intervention.
Results: There was no significant difference between the groups in terms of demographic variables (P and gt; 0.05). After the intervention, the muscle capacity variable presented a significant difference between the exercise group and the control group (P and lt; 0.001). As for the albumin levels, there was no significant difference between the 2 groups.
Conclusions: The results showed that exercise during hemodialysis could increase muscle capacity and could be helpful for maintaining the albumin levels in hemodialysis patients.

Keywords: Hemodialysis, BCAA, Resistance Training, Exercise, Albumin, Muscle Capacity, Isometric

1. Background

Patients with chronic kidney disease (CKD), undergoing hemodialysis, have multiple catabolic problems and suffer from a unique form of protein and energy wasting (PEW), which is characterized by increased muscle protein catabolism and decreased visceral protein stores. Muscle weakness and decreased muscle function, low exercise performance, and low physical activity begin in the earlier stages of chronic kidney disease and progressively get worse as an end-stage renal disease (1-4). Studies showed that resistance training (RT) could improve inflammation and PEW status in hemodialysis (HD) patients (5, 6). Resistance exercise could also help to counteract the catabolism of a low-protein diet in patients with chronic renal insufficiency (7). Intradialytic exercise (exercise performed during hemodialysis session) improves the physical capacity and the quality of life of HD patients as well as may lead to greater effectiveness of dialysis. Moreover, considering exercise adherence, intradialytic exercise seemed to be better than interdialytic exercise (physical training practiced on non-dialysis days and could be performed inside gymnasiums and outdoor) and could provide effective intervention to increase motivation during an HD session (8, 9). Intradialytic exercise could also reduce antihypertensive medication requirements (8, 10). Although RT has been applied in HD patients across different studies, there is no consensus concerning its use in these patients (8, 11). Chronic kidney disease patients, undergoing hemodialysis frequently, present low bone mineral density (BMD); a study showed that resistance exercise could improve the BMD of HD patients (12). Another study found that the acute effect of resistance exercise in HD patients could increase the acyl-gherlin (the hunger hormone) and decrease obestatin (the hormone that leads to feeling full) levels, which means it could be beneficial for increasing the appetite of these patients, which was another problem for them (13). Some studies examined the role of resistance exercise; it was shown that resistance exercise increased muscle mass, strength, and reduction of muscle weakness in HD patients (8). Resistance exercise could stimulate muscle growth through an increased consumption of oxygen in HD patients (14). Since resistance training could preserve muscle mass and improve exercise capacity in people with CKD, who also had low-protein diets because of their condition, according to the result of a review article, many studies have evaluated the effects of resistance exercise in this population (8). Hemodialysis pa-

tients need to improve their strength and endurance levels to a point where they are able to adopt the recommended levels of physical activity (15). "Strategies are needed to increase healthcare, provide confidence in promoting exercise training, improve exercise adherence from patients, and encourage the development of exercise guidelines by scientific committees" (16). Currently, resistance training is widely suggested and prescribed for health benefits in several healthy and chronically-diseased cohorts (8, 17).

Based on studies and HD-patient complications, this study aimed to investigate the effect of 8 weeks of intradialytic isometric resistance training on muscle capacity in hemodialysis patients.

2. Methods

This study was a clinical trial that was performed in the hemodialysis (HD) ward of Baqiyatallah Hospital in Tehran from May to June 2017. Each group (exercise group (EX) and control group) was assigned 17 patients; a total of 34 patients were present. At first, the eligible patients were randomly allocated into 2 groups based on the following inclusion criteria: patients between ages of 18 - 80, patients who had undergone hemodialysis for a minimum of 6 months, no severe cardiovascular problem, no severe infections; no chronic liver disease, no chronic disease with unknown origin, cancer, nephritic syndrome, Type B hepatitis, Type C hepatitis or active infection during the previous 4 months, dementia, neurologic disease, and recent surgery during the previous 3 months or lack of follow-up.

2.1. Ethical Considerations

After receiving permission from the research committee of Baqiyatallah University of Medical Sciences and receiving the ethical code from the physical education and sports science research center (IR.SSRI.REC.1396.127), and coordination with hospital administrators, the aim of the study was explained to the patients and the care givers; they gave their consent regarding conscious participation in the study. This study is registered in the Iranian Registry of Clinical Trials by IRCT2017101014998N2 code.

2.2. Measurement Tools and Method

For the muscle capacity variable, this study measured forearm endurance by the duration of the contraction of the ring in the hand, the leg-raise endurance by the duration of the leg raise, and power of the grip with a hydraulic hand grip dynamometer before and after the intervention, and serum albumin levels were measured with blood samples before and after the intervention. The preceding tests were performed 24 hours before the beginning of the intervention and the succeeding tests were performed 24 hours after the intervention. The blood samples were drawn by the ward nurses and then the samples were delivered to the hospital lab for analysis.

2.3. Interventions

On the first day of intervention, patients were briefed about exercise. The patients started their dialysis session and the exercise program started after 30 minutes. The program included the isometric grip exercise, which was performed with a grip ring for 10 seconds. Patients who had fistula in their arms were advised to make a fist and open it again; those who had a catheter were advised to perform the same action with their other hand. After that, an isometric contraction of the leg and core was performed, which was concluded with a leg raise while the patients were lying on the hospital beds for 10 seconds. Of course, 10 seconds was the starting point and overloading was applied each week and 20 seconds of isometric contraction was the highest level; the number of sets for each session was at least 10 and gradually increased to 15 sets. Exercise counseling was performed during the intervention and a project executive was responsible to answer the patient's questions during intervention. At the end of the 2nd month of intervention, blood samples were taken, and an endurance as well as power test were performed on the groups.

2.4. Statistical Analysis

The IBM SPSS Statistics 22 software was used along with the paired t-test, the Kolmogorov–Smirnov test, and the one-way analysis of variance (ANOVA) test in order to analyze the data obtained. The minimum significant level was 0.05.

3. Results

Out of the 34 patients, 31 patients completed the study period with all the assessments. Of the 17 patients in the control group, 3 patients were excluded due to the fact that 1 of them had undergone surgery and 2 of them were shifted to other hospitals. There was no significant difference between the 2 groups based on arm endurance, grip strength, leg endurance and serum albumin levels in the pre-test. However, there was a significant difference between the groups after the intervention in all of the variables, except serum albumin levels (Tables 1 and 2).

Table 1. Demographic Quantitative Variables in Ex and Control Groups[a]

Parameter	Ex	Control	ANOVA	
			F	P Value
Age, y	64.4 (8.4)	63.2 (11.6)	1	0.354
BMI, kg/m²	25 (3)	24.3 (3.2)	2.1	0.134
HD duration, y	3.81 (4.3)	3.12 (3.9)	0.94	0.611

[a]Values are expressed as mean (SD).

Table 2. Frequency Distribution of Gender in EX and Control Groups[a]

Gender	Groups		Chi-Square
	EX	Control	
Male	12 (70)	7 (50)	$X^2 = 0.437$; P = 0.43
Female	5 (30)	7 (50)	

[a]Values are expressed as No. (%).

4. Discussion

The present study aimed to investigate the effect of 8 weeks of intradialytic isometric training on muscle capacity and serum albumin levels in hemodialysis (HD) patients.

Initially, the exercise and control groups did not show a significant difference with regard to qualitative and quantitative variables as well as muscle capacity and albumin levels. Almost half of the patients in this study had albumin levels lower than 4 g/dL and for each 0.1 g/dL of albumin lower than 4 g/dL, the mortality rate significantly increased (18, 19). As for their muscle capacity, most of the patient's grip strength was lower than normal standards. According to the findings of the present study, resistance exercise during the dialysis session could significantly improve the muscle capacity. After 2 months of intervention, albumin levels in the control group decreased significantly; there was, however, an increase in the albumin levels for the exercise group, although the difference between the average changes of the albumin levels was not significant (Table 3). The muscle capacity of the groups' results showed significant improvement for all variables, including forearm endurance, leg-raise endurance, and grip strength in comparison to the control group (Table 4).

The findings of a study conducted by Majchrzak et al. (1) showed that exercise combined with the supplement group had a significantly higher net muscle protein balance compared to the supplement-only group. In a review article conducted by Bessa et al. (8), which reviewed many articles about resistance training and hemodialysis patients, exercise, especially resistance exercise, during dialysis sessions was shown to be beneficial in improving muscle capacity, such as in the strength of knee flexors, arm flexors, and even improvements in the cephalic vein size without tourniquet (20). In another study conducted by Dong et al. (21), the results showed that there was no significant difference in the augmentation of exercise with supplement, and supplement alone could improve weight and strength. However, the exercise regimen of that study was conducted before the hemodialysis session and it included only 3 sets of 12 repetitions of a leg press exercise; the supplement used in their intervention was a high-calorie supplement containing protein, carbohydrates, and fats. The results of many studies showed significant improvement in muscle capacity with intradialytic resistance training and these results suggested that an exercise program could be beneficial for improving muscle capacity and physical activity in hemodialysis (HD) patients; it could lead to a better quality of life (8, 9, 22).

4.1. Conclusions

According to the findings of this study, it could be concluded that intradialytic resistance training could improve muscle capacity in hemodialysis patients, which would eventually lead to better physical and social activity.

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Table 3. Average of Albumin Levels Before and After the Intervention[a]

Parameter	EX	Control	ANOVA	
			F	P Value
Serum albumin (before)	3.87 (0.42)	3.91 (0.26)	0.275	0.76
Serum albumin (after)	3.93 (0.45)	3.62 (0.32)	5.3	0.065

[a]Values are expressed as mean (SD).

Table 4. Average of Muscle Capacity Variables Before and After the Intervention[a]

Parameter	EX	Control	ANOVA	
			F	P Value
Forearm endurance (before),S	11.4 (2.4)	13 (2.8)	1.7	0.18
Forearm endurance (after), S	22 (4.1)	12.9 (2.7)	37.6	< 0.001
Leg raise endurance (before),S	16.8 (2.4)	16.7 (5.2)	2.5	0.089
Leg raise endurance (after), S	29.9 (7)	16.4 (5)	17.8	< 0.001
Grip strength (before), kg	12.8 (3.3)	11.4 (3.9)	1.8	0.17
Grip strength (after), kg	16.4 (3.3)	11.3 (3.7)	9.4	< 0.001

[a]Values are expressed as mean (SD).

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