JRSR 5 (2018) 68-73

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Effects of Selected Core Stability Exercises on Dialysis Quality and Muscular Strength of Male Hemodialysis Patients

Mehrdad Bastani[1], Gholamali Ghasemi[1]*, Morteza Sadeghi[1], Vazgen Minasian[2]

[1]Department of Sport Injuries and Corrective Exercise, Faculty of Sports Sciences, University of Isfahan, Isfahan, Iran
[2]Department of Sport Physiology, Faculty of Sports Sciences, University of Isfahan, Isfahan, Iran

ARTICLE INFO

Article History:
Received: 27/01/2018
Revised: 11/ 05/2018
Accepted: 26/09/2018

Keywords:
Core stability
Hemodialysis
Dialysis quality

ABSTRACT

Background: Hemodialysis patients with end-stage renal disease (ESR) have lower physical, emotional, and cognitive functions than healthy people of the same age due to their inactive lifestyles and treatment approaches. This study aimed to investigate the effects of selected core stability exercises on the dialysis quality and muscular strength of male hemodialysis patients.
Methods: In this quasi–experimental study, 30 male hemodialysis patients (age: 62.24±6.51 years; history of dialysis: 9.4±18.44 months) were selected by convenience sampling and assigned into experimental (n=15) and control (n=15) groups. The quality of dialysis and muscular strength of the subjects were assessed by blood sampling before and after dialysis and 5× sit-to-stand tests, respectively. A core stability exercise program was performed for 6 weeks, 3 sessions per week, 45 minute per session.
Results: Data analysis showed that there was no significant difference in the quality of dialysis between the experimental and control groups (P=0.485), but a significant difference was observed in muscular strength between the two groups (P=0.001). Exercise has a significant effect on the variable.
Conclusion: Based on the results of this study, core stability exercises can be recommended to male hemodialysis patients as a safe and practical strategy for improving their muscular strength and quality of life.

Introduction

Patients with ESR suffer from certain physical handicaps that eventually lead to progressive and irreversible failure in the structure and function of the kidneys. Annually, more than sixty thousand people around the world die from ESR. In Iran, 1200 to 1600 people suffer from this disease, a figure more than three times the world indices [1]. One of the most common treatment methods known to ESR patients is hemodialysis [2]. Current evidence shows that the average age of hemodialysis patients has increased in recent years, so that more than 70% of hemodialysis patients are 55 years or older [3].

Despite the great deal of progress made in renal treatment technology, hemodialysis patients still face physical and physiological problems caused by the dialysis procedure [4]. In addition to its side effects such as hypotension and muscular cramps during dialysis, hemodialysis may also cause other long-term problems, such as uremic syndrome, motor neuropathy, myopathy of skeletal muscles, increased vascular resistance, anemia, fatigue, and other physical complaints [4]. The severity of uremic syndrome symptoms is directly related to the dialysis adequacy [5]. In general, if the hemodialysis treatment is not adequate, the clinical signs and blood toxins cannot be well controlled, and the risk of disability, dialysis complications, and death is increased [5]. Typically, urea reduction ratio (URR) and kt/v are

Corresponding author:* Gholamali Ghasemi, Department of Sport Injuries and Corrective Exercise, Faculty of Sports Sciences, University of Isfahan, Isfahan, Iran. **Tel: +98 913 129 9817
E-mail: gh.ghasemi@yahoo.com

used to evaluate the quality of dialysis [5]. The higher the rate of these two indicators is, the better the quality and effectiveness of dialysis will be in the removal of blood uremic toxins [4, 6]. Research carried out in the last three decades has shown that exercise training can increase blood flow to muscles and superficial vessels and result in better excretion of urea and toxins from tissue to the blood vessels, leading to further excretion of substances in subsequent dialysis sessions. Exercise can also increase the permeability of the cell membrane to water-soluble molecules such as creatinine [6, 4]. According to Kung et al., exercise leads to a significant reduction in urea, creatinine, and potassium rebound and an increase in kt/v (from 1 to 1.5) and URR values (from 63% to 68%), respectively [6]. According to Steck et al., about 56% of hemodialysis patients exercise less than once a week, and only 6% exercise 4 times a week; the mortality risk is highest in patients who exercise less than once a week [7]. Elderly age and long-term bedrest are factors that reduce blood flow, which, in turn, can contribute to delayed urea homeostasis between different parts of the body during dialysis and diminish dialysis adequacy [7, 8].

Some studies have shown extensive constraints in the physical function of hemodialysis patients, especially in elderly individuals [1, 8]. More specifically, because of treatment-induced physical debility, elderly hemodialysis patients are four times more likely to experience falls and subsequent complications compared to their healthy counterparts [9]. Factors associated with physical weakness in chronic renal patients include increased catabolic processes, malnutrition, muscle mass loss, and reduced physical activity. Excessive weakness due to skeletal muscle atrophy is an important reason for muscle weakness [10]. The functional results of catabolism include weakness, decreased muscle strength, reduced exercise threshold, fatigue, the inability to perform daily activities, and decreased quality of life [10, 11]. Among nontherapeutic and alternative strategies, Parson et al. (2006) concluded that 60 min of cycle ergometry three times per week during dialysis can weaken the uremic neuropathy and myopathy, improve cardiac function, decrease blood pressure, and enhance the physical work capacity of subjects [4]. Julien et al. (2010) also concluded that 48 sessions of strength and stretching exercises, two sessions per week during dialysis, can significantly improve physical activity capacity, nutritional status, and lean body mass and reduce the percentage of fat in patients [12].

Although previously proposed protocols have been useful in reducing uremic complications during dialysis, they have failed to take the elderly's limitations and conditions into account. In most dialysis centers, patients of a different age, gender, alertness, financial status, and physical condition undergo treatment in a common space. Therefore, the application of any interventions during dialysis can bring about different reactions from the patients. The findings of some studies have revealed that despite the usefulness of some training programs aimed at strengthening body functions, the trunk and back muscles have a greater effect on the promotion and maintenance of minimal daily activities [13]. Core stability exercises focus on strengthening the body's core muscles, i.e. the muscles that provide mechanical support for organ movements [14]. Some elderly hemodialysis patients have special conditions that leave them unable to perform dynamic physical activities due to neuropathy or the attachment of a graft or catheter (devices that allow the transfer of blood between the dialysis device and the body) to the arms or legs. For such patients, core stability exercises can provide more safety and flexibility and motivate them to continue exercise training [15]. Golpaygani et al. (2009) found that core stability exercises with a physio-ball are effective in improving the physical performance of elderly patients, and thus help them maintain their autonomy. These exercises can also be used in conjunction with other programs for rehabilitation purposes [15]. Considering the necessary role of exercise in the physiological and physical health of hemodialysis patients [4, 6, 7], an extracurricular intervention such as core stability exercises is expected not only to improve performance and fitness factors such as strength [15], but also, by motivating individuals to be physically active, to enhance blood circulation, increase urea removal, and improve the adequacy of dialysis in patients. To complete non-pharmacological strategies and confirm the desired effect of exercise training on the basic symptoms in elderly hemodialysis patients, the current study investigated the effects of selective core stability exercises on the quality of dialysis and the strength of hemodialysis patients.

Methods

This quasi-experimental consisted of pre-/posttests performed by control and experimental groups. The main purpose of this study was to evaluate the effects of a six-week course of core stability exercises on dialysis quality and muscular strength in male hemodialysis patients. The population of this research consisted of all hemodialysis patients at Montazeri Hospital, Najafabad, Iran from March to May 2017. After obtaining approval from the Ethics Committee, the physicians checked the patients' files and interviewed them to identify those who qualified to participate in this study.

Inclusion Criteria

The inclusion criteria consisted of being 55 to 77 years of age, having an acceptable awareness for answering questions, a lack of psychiatric, cardiovascular, pulmonary and respiratory, dermatological, infectious (AIDS and hepatitis), skeletal, thyroid, or sensory diseases (based on medical examinations), the implementation of dialysis 3 times per week (4 hours per session), a history of at least 12 months of dialysis treatment, independence in daily activities, and no numbness or paralysis in the body.

Exclusion Criteria

Those patients who had certain orthopedic problems, asthma, dizziness, or repetitive changes in general health, those using aids, and those who had a lack of intention to participate in the study were excluded.

To control drug interactions, patients were under the supervision of a physician in the dialysis unit and took no medication other than drugs associated with hemodialysis. Anemia associated with chronic renal failure was a common characteristic of all patients. Based on the severity of the anemia, different doses of Eprex (Erythropoietin) were administered to the patients, which was beyond the control of the researcher. Before exercise interventions, a demographic questionnaire was completed for all participants through interviews with the researcher. After applying exclusion and inclusion criteria, 30 qualified participants were selected, and after having the purposes and processes of this research explained to them, they were asked to give informed written consent for voluntary participation in the study. The competency of patients to participate in exercise interventions was approved by expert physicians, and the patients were randomly assigned to either the control (n=15) or the experimental (n=15) group. All patients had to undergo three sessions of dialysis per week, each session lasting four hours, and had to have undergone dialysis for at least twelve months prior to participating in this study. The experimental subjects participated in selected core stability exercises under the supervision of a qualified exercise training coach and nurses for six weeks, while control subjects were recommended to continue their usual exercises. Exercises were carried out in the first-floor hall of the hospital (20×20 m) which was properly covered with mattresses. The vital signs of each patient were monitored every 15 minutes, and patients were provided with first aid and drinking water. Necessary recommendations and care were provided during testing, especially for diabetes patients who required extra sugar sources before exercising. Moreover, exerting pressure on insulin injection sites was avoided, and the times between insulin injections was taken into account. For all subjects, dependent variables were assessed 48 h before and 48 h after the last session of exercise, and the rates of dialysis quality and muscular strength were recorded. Three patients from the experimental group due to dizziness, absence, and withdrawal and two patients from the control group due to dependence upon a wheelchair and withdrawal were excluded from this study.

Measures and Procedures

To measure dialysis quality, blood samples were gathered from the insertion needles, and blood uric samples before and after dialysis were taken from the vessel line. The samples were immediately transferred to the lab. The dialysis quality of patients was determined by calculating Kt/v and URR using the following formula [16]:

Kt/v=0.04 (Co-Ct/Co)-1.2 K URR=(Urea pre-Urea post×100)/urea pre,

where K=clearance of using uric, T=time of dialysis, V=volume of uric distribution or volume of water distribution, Co and Ct stand for the level of blood uric before and after dialysis (mmol/l), respectively [5].

The 5× sit-to-stand test is usually used to evaluate the strength of the lower limbs of patients; accordingly, it was employed here. It was accomplished on a chair with a height of 40 cm and possessing a smooth backrest. The patients were required to sit up rapidly five times continuously and stick their arms to their chest and touch their wrist to the chair in each repetition. The examiner counted aloud the number of times the patient sat up to inform them of the remaining numbers in each repetition. A stopwatch was set to record the time of each test. The validity and reliability of this test was reported as being acceptable (r=0.81) [17].

Core stability exercises were also used in the current study. The selected exercises were those used in a study by Seo, with some modifications (Table 1) [14]. The exercise protocols of this study were adjusted by a qualified physiotherapist based on the physical fitness of subjects as well as their health status and hemodialysis requirements. Since the program was implemented in patients undergoing hemodialysis for the first time, a preliminary pilot study prior to the intervention was conducted to ensure the compatibility of the exercises with patients' conditions and to prevent any undesirable consequences. The main protocol included warm-up (10 minutes), core stability exercises (30 minutes), and cool down (5 minutes). Sessions lasted for six weeks, three sessions per week, on the patients' off-dialysis days [18]. Based on the physical conditions of the subjects, 75-cm

Table 1: Selected core stability exercises protocol

Warm up			**10 minutes**	**Walking and stretching exercises**			
Core stability exercises for 30 minutes	Without ball	**S/N**	**Type of exercise**	**1st week**	**2nd and 3rd weeks**	**4th-6th week**	**6th week**
		1	Bridging (supine position)	3×8 seconds	3×10 seconds	3×10 seconds	3×15 seconds
		2	Biking (supine position)	3×8 seconds	3×10 seconds	3×10 seconds	3×15 seconds
		3	Semi-sit-ups	3×8 rep	3×10 rep	3×10 rep	3×12 rep
	With ball	4	Bridging on the ball	3×8 rep	3×10 rep	3×10 rep	3×12 rep
		5	Raising the feet and keeping the ball between the legs	3×8 rep	2×10 seconds	3×10 seconds	3×12 seconds
		6	Opening the trunk on the ball (prone position)	3×8 rep	2×10 rep	3×10 rep	3×10 rep
		7	Opening the trunk on the ball (supine position)		2×10 rep	2×10 rep	3×10 rep
		8	Spinning the hip on the ball			2×10 rep	3×10 rep
		9	Pushing the ball to the wall			2×10 seconds	3×10 seconds
Cool down			5 minutes	Walking and stretching exercises			

Swiss balls were used; more rest intervals were taken in the 3 first weeks of intervention than the last three weeks.

Data Analysis

Data was analyzed using RMANOVA statistics and SPSS Software Version 22.0 (American Multinational Technology), and the level of significance was set at ($P<0.05$).

Results

The demographic data of the subjects is shown in Table 2. Normal distribution of the data was confirmed by the Kolmogorov-Smirnov test. There were no significant differences between the groups in terms of demographic characteristics or medical history ($p>0.05$); hence, both groups were homogeneous prior to the intervention.

The descriptive data of variables and analysis variance are shown in Tables 3 and 4. The most important part of the analysis variance for repeated data was the interaction. This part shows the process of change (slope) in both groups in relation to each other and represents the possible effects of groups on each other.

According to Table 3, no significant difference was seen between the experimentals and the controls in terms of dialysis quality indices, like uric clearance, the rate of reduction in blood uric before and after accomplishing a six-week period of SCSE ($P>0.05$). Conversely, the data in Table 4 shows a significant difference between the experimental group and the control group in terms of muscular strength ($P<0.05$).

According to the results of Figures 1 and 2, the uric clearance (life quality) and muscular strength in experimental subjects changed from 1.21 to 1.4 and 17.92 to 13.21, respectively. As a rule, the line slope of experimentals on both variables was observed to be higher than that of the controls, indicating more changes occurred in the dialysis quality and muscular strength of the experimental subjects after receiving treatments compared with the control subjects.

Discussion

Based on the results of the present study, there was no significant improvement in dialysis quality variables in the experimental group after exercise interventions, but the muscular strength of the patients was significantly improved.

Table 2: Demographic characteristics of the sample (mean±standard deviation)

Group	Age (year)	History of dialysis (month)	Height (cm)	Weight (Kg)
Experimental (n=12)	62.58±6.77	30.75±14.97	171.08±4.07	72.41±10.6
Control (n=13)	61.92±6.52	28.15±21.7	172.15±4.84	72.76±14.74

Table 3: Descriptive data and the results of variance analysis of dialysis quality indices

Variable	Test	Experimental group mean±SD	Control group mean±SD	Interaction
Uric clearance (dialysis quality)	Pre-test	1.21±0.51	1.44±0.51	F=0.503
	Post-test	1.4±0.4	1.47±0.41	P=0.485
Rate of reduction in blood uric	Pre-test	61.83±12.76	67.46±11.52	F=0.930
	Post-test	67.33±10.04	67.84±9.3	P=0.345

Table 4: Descriptive data and the results of variance analysis of muscular strength

Variable	Test	Experimental group mean±SD	Control group mean±SD	Interaction
Muscular strength	Pre-test	17.92±5.83	17.0±8.13	F=27.24
	Post-test	13.21±3.77	17.62±8.16	P=0.001

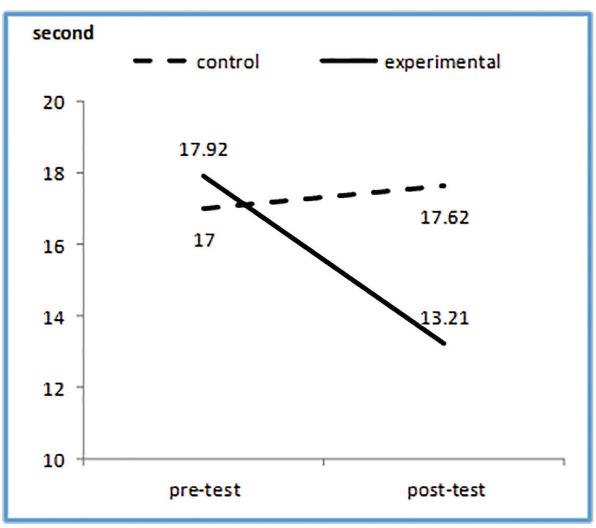

Figure 1: Changes in muscular strength of the studied groups

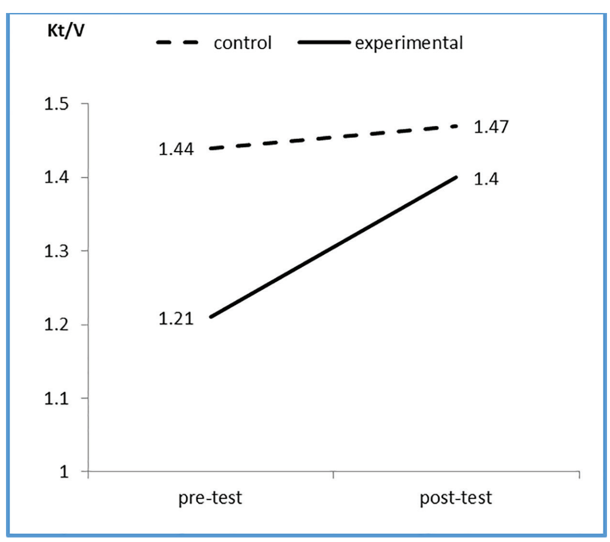

Figure 2: Changes in dialysis qualities of the studied groups

Uric accumulation in some parts of body, due to the slowing down of uric distribution among cellular membranes or reduced blood circulation, is one disturbing factor in hemodialysis. It is true that some issues like applying high level dialyzers, intensifying blood circulation, and increasing the time of dialysis can initiate improvement, but these approaches are not commercially viable for each dialysis [19]. While using complementary approaches, based on previous studies, body activities caused the evacuation of more uric and toxins from tissue into blood vessels by rapidly transferring blood into active muscles and surficial veins; this facilitates the better evacuation of substance in the next dialysis. Also, the permeability of cell membranes to water-soluble molecules like keratin is increased by sport exercises [4, 6,7]. In the present study, after completion of the exercise intervention (45-min exercise training, three sessions per week for six weeks), significant changes were not observed in the quality of dialysis; however, the data showed a slight improvement in the rate of Kt/v (from 1.21 to 1.4) and URR (from 61 to 67) in the experimental groups. Kung et al. also reported that exercise training may cause a significant reduction in the rebound of urea, creatine, and potassium, an increase in Kt/v (from 1 to 1.5), and an increase in URR (63% to 68%) [6]. Parson et al. reported that after 5 months of aerobic exercise training during dialysis, the dialysis quality of the experimental group improved by 18% [4]. As for the inconsistency between the results of the previous studies, it can be argued that patients in the Parson and Kung studies were aged 18 to 78 years and had a dialysis history of at least four months, while participants in the present study were aged 55 to 70 years and had a dialysis history of at least 12 months. Therefore, the chronicity of the uremia symptoms and the lower physiological effectiveness of exercise interventions in the present study could be attributed to the longer dialysis history and older age of subjects. Of course, other differences such as the timing of the interventions (intra-dialysis versus off-dialysis), the type of exercises (aerobic vs. resistance), the duration of the interventions (6 weeks vs. 5 months), and the duration of each training session (45 minutes vs. 60 minutes) may have contributed to this inconsistency. The time of interventions seemed to have a more significant contribution to the inconsistencies, since most studies show that intra-dialysis exercises lead to better blood circulation in the limbs and organs of the body; therefore, this process leads to increased urea homeostasis between different parts of the body and enhanced removal of urea and serum urea clearance by the dialysis device [6, 12]. Further reviews of the results showed that although the URR differences in the present study and Kung's study were greater in the experimental group (by 1 unit), the results are not significant. Of course, some of these differences could be attributed to the computation tools or the difference in the number of participants. Riahi et al. reported that there was no statistically significant result obtained for dialysis adequacy even after 20 weeks of intra-dialysis intervention [20], and the authors believed that the ineffectiveness of exercise training on the dialysis adequacy (as was the case in the present study) could be attributed to the patients' long history of hemodialysis (at least 3 years) [20].

The findings of this study showed a significant improvement in the functional capacity of the lower extremities of elderly hemodialysis patients, consistent with the results of most relevant studies [4, 13]. In the study of Chen et al., moderate intensity exercise training twice weekly for a total of 48 sessions improved muscle performance in hemodialysis patients [21]. The results of the study conducted by Stourer et al. showed that 8-week, 20-40-min endurance exercises during dialysis (3 sessions per week) improved cardiorespiratory function, muscle strength, and physical function in hemodialysis patients [22]. After exercise training, the level of skeletal muscle growth factors that lead to muscle hypertrophy increased by about 41%, and myostatin, which prevents skeletal hypertrophy, declined by about 51%. Hypertrophy is directly related to strength [22]. In this study, the hypertrophy of patients was not investigated, and since most of the intervention exercises focused on the core muscles of the body, the likelihood of increased muscle strength as a result of leg muscle hypertrophy is very low. As for the desired effect of core stability exercises on the functional strength of the lower limbs in the present study, it was argued that core stability exercises reduce the muscular co-contraction by stimulating the increase in core muscle mass and contribute to improved tolerability and stability of the body during activity. On the other hand, exercises increase the supply of blood to the nervous system and lead to increased efficiency of the cerebellum and pyramidal cells, which results in increased quality of messages sent to the organs [23]. Strengthening the muscles can be regarded as an important factor contributing to improvement in the function of neuromuscular systems and providing an effective support for the better functioning of the lower extremities among elderly hemodialysis patients. Certainly, the usefulness of other training programs has been considered, but the proposed protocol in the current study can be considered unique in terms of compatibility with hemodialysis patients' needs and requirements and coverage of the majority of hemodialysis (elderly patients who have not been taken into account in previous studies).

The limitations of this research include the lack of control over the subjects' diets and psychological stresses, the segregation of subjects according to the cause of chronic renal failure, and the lack of cooperation on the part of female patients due to cultural prejudices. To obtain more accurate findings, it is recommended that the afore-mentioned factors be taken under control in future studies. It is suggested that the effect of the protocol proposed in the present study on other uremic symptoms of hemodialysis patients be investigated and other non-pharmacological methods be compared with the method used in this study, because at the end of the study, subjects reported improvements in digestive function, including a reduction in nausea, which could be proved through quantitative and qualitative methodology.

Conclusion

Generally, the present study showed that the selected core stability exercises had a desirable and significant effect on the lower extremity strength of elderly hemodialysis patients. However, its effectiveness on dialysis quality indices is negligible, which is probably due top off-dialysis intervention or the prominent role of other important factors in dialysis quality. Some evidence suggests that core stability exercises can be used to motivate dynamism in elderly hemodialysis patients in order to help them retrieve their pre-disease life performance.

Acknowledgment

This article is part of an MSc thesis, and the project was approved by the Isfahan University of Medical Sciences Ethical Committee (No: IR.UI.REC.1396.017). The rights of subjects, organizations, and institutions, as well as the authors have been observed. The authors are very grateful to the hemodialysis patients of this study, the officials of the Shahid Mohammad Montazeri Hospital, and Ghamar-e Bani Hashem Charity Association, who were involved in the implementation of this project.

Conflict of interest: None declared.

References

1. Mozafari N. Survey dialysis efficacy hemodialysis patients' referral to dialysis center in Ardabil town. J Ardabil Univ Med Sci, 2002. 4:p. 1-7.
2. Parsons TL, Toffelmire EB, King-VanVlack CE. Exercise training during hemodialysis improves dialysis efficacy and physical performance. Arch Phys Med Rehabil, 2006. 87(5): p. 680-7.
3. Gray NA, Grace BS, McDonald SP. Peritoneal dialysis in rural Australia. BMC Nephrol, 2013. 14:278.
4. Parsons Tl, Edwin B, Toffelmire MD. Exercise training during hemodialysis improves dialysis efficacy and physical performance. Arch Phys Med Rehab, 2006. 87(5): p. 680-7.
5. Hojjat M. Hemodialysis adequacy in patients with chronic renal failure. Iranian Journal of Critical Care Nursin,, 2009. 2(2): p. 61-66.
6. Kong CH, Tattersall JE, Greenwood RN, Farrington K. The effect of exercise during hemodialysis on solute removal. Nephrol Dial Transplant, 1999 Dec. 14(12): p. 2927-31.
7. Stack AG, Molony DA, Rives T, Tyson J, and Murthy BV. Association of physical activity with mortality in the US dialysis population. Am J Kidney Dis, 2005 Apr. 45(4): p. 690-701.
8. Jindal K, Chan C, Deziel C. Hemodialysis adequacy in adults. Journal of the American Society of Nephrology, 2006. 17(12): p. 4-7.
9. Leinau L, Perazella MA. Hip fractures in end-stage renal disease patients: Incidence, risk factors, and prevention. Semin Dial, 2006. 19: p. 75-79.
10. Hadi N, Rahmani Z, Montazeri A .Health-related quality of life in chronic renal failure patients receiving hemodialysis. Payesh, 2010. 11(3): p. 349-54.
11. Nonoyama ML, Brooks D, Ponikvar A, Jassal SV, Kontos P, Devins GM, et al. Exercise program to enhance physical performance and quality of life of older hemodialysis patients: a feasibility study. Int. Urol. Nephrol, 2010. 42(4): p. 1125-30.
12. Joline L, Godfrey S, Moorthi R. Effect of intra–dialytic, low –intensity strength training on functional capacity in adult hemodialysis patients: a randomized pilot trail. Nephrol dial transplant, 2010. P. 1-8.
13. Crapes FP, Reinehr FB, Mota CB. Effects of a program for trunk strength and stability on pain, low back and pelvis kinematics, and body balance. J of Bodywork and Movement Therapies, 2008. 12(1): p. 22-30.
14. Seo B D, Kim B J, Singh K. The comparison of resistance and balance exercise on balance and falls efficacy in older females. European Geriatric Medicine, 2012. 3: p. 312-6.
15. Golpayegani M, Mahdavi S. Hesari A. The Effect of 6 Weeks of Core Stabilization Training Program on Falling in the Elderly. Journal of Sports Medicine, 2009. 2(1): p. 95-106.
16. Vahed Parast H, Ravanipour M. Assessing the adequacy of dialysis in patients undergoing Hemodialysis in hemodialysis center in Boshehr City. Sci. J. Hamadan Nurs. Midwifery Fac, 2008. 16(2): p. 50-4.
17. Mong, Y., Teo, T. W., et al. "5-repetition sit-to-stand test in subjects with chronic stroke: reliability and validity." Archives of Physical Medicine and Rehabilitation, 2010. 91(3): p. 407-413.
18. Gage M J. The effects of abdominal training on postural control, lower extremity kinematics, kinetics, and muscle activation. (Doctoral dissertation). Brigham Young University; Provo, Utah, United States, 2009.
19. Borzou SR, Gholiaf M, Amini R, Zandieh M, Torkman B. The effect of increasing blood flow rate on dialysis adequacy in hemodialysis patients. J Shahrekord Univ. Med Sci, 2006. 8(2): p. 60-66.
20. Reyahi Z, Sfarjani F, Marandi SM, Bayat A, Kalali N. The effects of regular exercise program on dialysis efficacy, muscle atrophy and physical performance in hemodialysis patients. J Shahrekord Univ. Med. Sci, 2012 Dec. 14(5): p. 63-73.
21. Chen JL, Godfrey S, Ng TT, Moorthi R, Liangos O, Ruthazer R, et al. Effect of intra-dialytic, low-intensity strength training on functional capacity in adult haemodialysis patients: a randomized pilot trial. Nephrol Dial Transplant, 2010. 25(6): p. 1936-43.
22. Storer TW, Casaburi R, Sawelson S, Kopple JD. Endurance exercise training during hemodialysis improves strength, power, fatigability and physical performance in maintenance hemodialysis patients. Nephrol Dial Transplant, 2005 Jul. 20(7): p. 1429-37.
23. Dostan M, Aslankhani MA, Ebrahim KH, Seyforian M. The effect of eight weeks of resistance training and stretching on balance and reaction time elderly disabled man. Journal of Motor Behavior and Psychology of Sport, 2010. 2(1): p. 323-34.