Original Article

Evaluating the effect of intradialytic cycling exercise on quality of life and recovery time in hemodialysis patients: A randomized clinical trial

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Background: The aim of this study was to assess the effect of intradialytic cycling exercise on quality of life (QOL) and recovery time in patients who underwent hemodialysis. **Materials and Methods:** Hemodialysis patients were recruited from the referral dialysis centers affiliated with Isfahan University of Medical Sciences, Isfahan, Iran. Patients were randomly assigned into the intervention and the control groups. Patients in the intervention group exercised on a stationary bike for 12 weeks (3 times per week for 30 min); however, patients in the control group received usual hemodialysis. The kidney disease QOL (KDQOL)-short-form version 1.3 was used to assess QOL. Patients were asked to answer the question "How long does it take to recover from a dialysis session?" to assess recovery time. **Results:** A total of 110 hemodialysis patients, including 60 in the intervention group and 50 in the control group were analyzed. A significant increase was observed in the generic (mean difference ± SE: 1.50 ± 0.44, $P = 0.001$), kidney disease (mean difference ± SE: 0.84 ± 0.28, $P = 0.004$), and overall QOL (mean difference ± SE: 1.18 ± 0.33, $P = 0.001$) scores after 12 weeks of intradialytic cycling exercise in the intervention group. Furthermore, a significant difference was noted between the intervention and the control group regarding the mean difference of all QOL scores after the intervention ($P < 0.05$). We also found a significant difference in the mean difference of recovery time between the intervention and the control group after the intervention ($P < 0.001$). **Conclusion:** KDQOL and recovery time could improve in hemodialysis patients after 12-week intradialytic exercise.

Key words: Hemodialysis, intradialytic exercise, quality of life, recovery time

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INTRODUCTION

End-stage renal disease (ESRD) is a significant public health issue with a rising prevalence worldwide. ESRD patients are treated with renal replacement methods comprising kidney transplantation or dialysis.[1,2] Kidney transplantation is known as the optimal treatment option for ESRD patients; however, it is limited by the shortage of available organs. As a result, dialysis has become the more prevalent treatment in many parts of the world. Despite all advances in dialysis technology and care, the rate of morbidity and mortality remains high in ESRD patients.[3]

Quality of life (QOL) is a principal representative of medical care outcomes, which is considered a predictor of mortality and hospitalization in dialysis patients.[4,5] Therefore, improving QOL through various interventions is crucial in dialysis patients. Exercise has been reported as a key element to enhance QOL in dialysis patients. A recent systematic review and meta-analysis of 20 randomized clinical trials (RCTs) comprising 677 ESRD patients receiving hemodialysis have reported that performing aerobic

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or combined exercises for at least 8 weeks improves health-related QOL.[6]

Recently, intradialytic exercise is considered an appropriate choice for dialysis patients considering its advantages compared to other exercise approaches such as higher removal of toxic agents, being time-efficient, and safe.[7,8] Previous research has investigated the impact of intradialytic exercises on QOL in hemodialysis patients.[9-12] Although, their results did not reach much consensus regarding differences in tools used to assess QOL as well as length, and type of exercise interventions. The results of a systematic review and meta-analysis of 24 studies with 997 hemodialysis patients indicated that intradialytic exercise could improve the physical subscale of QOL; however, no significant change was observed in the mental subscale of QOL.[7] This finding was approved by another systematic review and meta-analysis of the impact of intradialytic exercise on QOL in hemodialysis patients by Chung *et al*.[13] Due to the small number of included RCTs in these meta-analyses as well as their poor methodological quality, further RCTs are required to obtain more robust data on the effectiveness of intradialytic exercise on QOL in hemodialysis patients. The aim of the present study was to determine the impact of intradialytic exercise programs on QOL, and recovery time after dialysis sessions, as an important determinant of QOL in hemodialysis patients.

METHODS

Study design and patients

This randomized controlled clinical trial study was done on hemodialysis patients referred to Alzahra and Khorshid hospitals, Isfahan, Iran. The study protocol was approved by the ethics committee of the Isfahan University of Medical Sciences (Research project code: IR.MUI.MED.REC.1398.368). The protocol of the study was also registered in the Iranian Registry of Clinical Trials (IRCT code: IRCT20090905002417N22). All patients were fully informed of the research objectives and signed informed consent forms. Patients were eligible for inclusion in the study if they were adults (age ≥18 years) on hemodialysis for more than 3 months with a stable clinical condition. Patients with conditions that limit exercise ability such as cardiovascular diseases, respiratory diseases, and musculoskeletal abnormalities were excluded from the study. Furthermore, patients with catabolic conditions such as acute infection were excluded from the study.

Intervention

Patients were randomly assigned to the intervention and the control groups based on the random numbers table. Patients in the intervention group were trained to use a mini stationary bike (Medi-Bike Medical Exercise Peddler 3000, Medi-Bike, Taiwan) in a supine position for 30 min within the first 2 h of hemodialysis with a frequency of three times per week for 12 weeks. The exercise was performed under the supervision of a trained nurse. The blood pressure and heart rate were also monitored by dialysis nurses every 60 min.

Each exercise program comprised a 5-min warm-up, 20-min cycling at a desirable intensity following a 5-min cool-down. Depending on each patient's ability, the duration of cycling increased by 5 min gradually until they could cycle 20 min continuously. Patients in the control group continued a standard dialysis treatment and received no exercise plan.

Biochemical tests

Fasting blood samples were drawn before the midweek hemodialysis session to assess biochemical indices, including, the levels of serum triglyceride, total cholesterol, albumin, ferritin, total iron-binding capacity, and iron according to standard procedures. All patients were assessed biochemically at baseline and at the end of the intervention.

Data collection

The validated Persian version of the kidney disease QOL short form (KDQOL-SF) questionnaire, version 1.3, was used to collect data on QOL.[14] The questionnaire is divided into three main domains including physical component summary (PCS), mental component summary (MCS), and kidney disease domain. The kidney disease domain encompasses 11 subscales comprising symptoms, the effect of kidney disease on QOL, burden of kidney disease, work status, cognitive function, quality of social interactions, sexual function, sleep, social support, dialysis staff encouragement, and patients' satisfaction. PCS encompasses four subscales of physical function, role physical, pain, and general health. Energy/fatigue, social function, emotional well-being, and role emotional are four subscales of MCS. In the present study, we calculated the scores for the kidney disease, and generic domains (comprising PCS and MCS) separately. The mean of estimated scores was considered as the total KDQOL score. Patients were asked to reply to the question "How long does it take to recover from a dialysis session?" to assess recovery time.[15] All variables were assessed at baseline and 12 weeks after the intervention.

Statistical analysis

Quantitative data were expressed as mean + standard deviation (SD); while, qualitative data were presented by percentages. The normality of quantitative data was evaluated using the Kolmogorov–Smirnov test and Q-Q plot. To compare basic characteristics between the intervention and the control groups independent sample *t*-test and Chi-square test were used for continuous and categorical variables, respectively. A Paired samples *t*-test was used to compare means before and after intervention in the intervention and control groups. Means of study variables after intervention between the intervention and control groups were compared using analysis of covariance considering the baseline values as a covariate. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago IL, USA; version 15). $P < 0.05$ was considered statistically significant.

RESULTS

In total, 150 patients were screened for possible inclusion in the study, of whom 139 patients were included and randomized in the intervention ($n = 70$) and the control ($n = 69$) groups. Of these, 60 patients in the intervention group and 50 patients in the control group completed 12 weeks of the intervention [Figure 1]. The basic characteristics of hemodialysis patients in the intervention and the control groups are summarized in Table 1. We found a significant difference in the mean age between the intervention and the control group (54.63 ± 14.96 vs. 62.54 ± 14.12) ($P = 0.006$). There was also a significant difference between the intervention and the control group regarding ESRD causes ($P = 0.01$). However, no significant difference was observed between the two groups regarding other basic variables ($P > 0.05$).

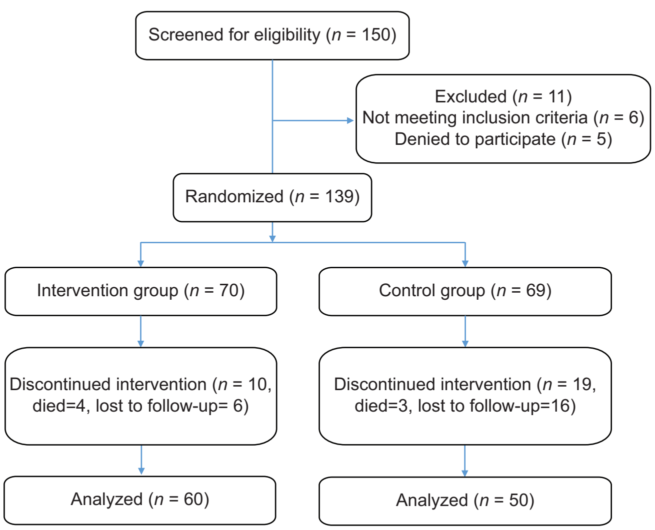

Figure 1: Study flow diagram

Table 1: Comparing basic characteristics of hemodialysis patients in the intervention and control groups

Variables	Intervention	Control	P
Age (years)	54.63±14.96	62.54±14.12	0.006
Male	50.0	60.0	0.34
Dialysis duration (years)	5.10±5.15	3.82±3.96	0.15
Etiology of ESRD			
Hypertension	31.7	12	0.01
Diabetes mellitus	38.3	68	
ADPKD	6.7	0.0	
Others	23.3	20.0	

P<0.05 is considered significant. *P* values were obtained from independent samples *t*-test for continuous variables and Chi-square test for categorical ones. Values in table are mean±SD for continuous variables and percentage for categorical variables. ADPKD=Autosomal dominant polycystic kidney disease; ESRD=End-stage renal disease; SD=Standard deviation

A significant increase was observed in the generic (mean difference ± SE: 1.50 ± 0.44, $P = 0.001$), kidney disease (mean difference ± SE: 0.84 ± 0.28, $P = 0.004$), and overall QOL (mean difference ± SE: 1.18 ± 0.33, $P = 0.001$) scores after 12 weeks of intradialytic cycling exercise in the intervention group. However, hemodialysis patients in the control group showed a significant reduction in the generic (mean difference ± SD:-0.65 ± 0.17, $P < 0.001$) and overall QOL (mean difference ± SE:-0.53 ± 0.17, $P = 0.003$) scores after 12 weeks of intradialytic cycling exercise. Furthermore, a significant difference was noted between the intervention and the control group regarding the mean difference of all QOL scores after the intervention ($P < 0.05$) [Table 2].

After 12 weeks of intradialytic cycling exercise, recovery time significantly decreased in the intervention group (mean difference ± SE: −3.67 ± 0.46, $P < 0.003$); while, no significant change was observed in the control group (mean difference ± SE: −0.09 ± 0.42, $P = 0.83$). There was also a significant difference in the mean difference of recovery time between the intervention and the control group after the intervention ($P < 0.001$) [Table 2].

The assessment of biochemical parameters after 12 weeks of intervention showed a significant increase in mean serum albumin (mean difference ± SE: 0.16 ± 0.07, $P = 0.02$) and iron (mean difference ± SE: 25.48 ± 10.29, $P = 0.02$) in the intervention group. However, no significant changes were observed in the mean of other biochemical variables ($P > 0.05$). In the control group, there were no significant changes in the mean of biochemical variables ($P > 0.05$). In addition, the between-group comparison showed a significant difference between the intervention and the control group in the mean difference of serum albumin, triglyceride, and iron levels after the intervention ($P < 0.05$) [Table 2].

DISCUSSION

The level of daily physical activity and physical performance in hemodialysis patients is much less than in healthy individuals. Many reports have indicated that decreased physical activity affects various outcomes, including QOL in hemodialysis patients.[16,17] The results of the present study indicated that intradialytic cycling exercise improved the KDQOL score. While many previous studies have investigated the effect of intradialytic exercise on QOL, there is a lack of agreement across their outcomes. Ouzouni *et al.*

Table 2: Comparing aspects of quality of life, biochemical variables, and recovery time change between the intervention and control groups

Variables	Intervention group				Control group				*P*
	Baseline, mean±SD	After 12 weeks, mean±SD	Difference, mean±SE	*P*	Baseline, mean±SD	After 12 weeks, mean±SD	Difference, mean±SE	*P*	
Quality of life									
Generic domain	74.66±6.34	76.16±6.50	1.50±0.44	0.001	79.34±5.73	78.69±6.31	−0.65±0.17	<0.001	<0.001
Kidney disease domain	78.60±5.63	79.44±5.87	0.84±0.28	0.004	78.00±5.97	77.60±6.03	−0.41±0.21	0.06	0.001
Overall quality of life	76.64±5.34	77.82±5.58	1.18±0.33	0.001	78.67±5.20	78.14±5.50	−0.53±0.17	0.003	<0.001
Biochemical variables									
Albumin (g/dL)	4.16±0.44	4.32±0.53	0.16±0.07	0.02	3.89±0.32	3.85±0.32	−0.04±0.03	0.13	0.007
Total cholesterol (mg/dL)	153.24±47.89	144.46±40.37	−8.78±4.97	0.08	146.58±53.25	147.70±44.74	1.12±4.77	0.81	0.15
Triglyceride (mg/dL)	150.80±96.26	136.90±75.38	−13.90±8.85	0.12	152.06±84.74	158.90±78.13	6.84±3.92	0.09	0.04
Ferritine (μg/dL)	312.02±282.27	330.15±253.15	18.13±41.22	0.66	372.50±247.38	378.64±217.18	6.14±13.02	0.64	0.78
Total iron biding capacity (μg/dL)	264.48±57.27	249.26±53.12	−15.52±10.33	0.14	239.50±46.66	240.30±43.75	0.80±2.69	0.77	0.13
Iron (μg/dL)	80.20±51.91	105.68±63.84	25.48±10.29	0.02	84.42±34.56	83.56±39.48	−0.86±1.77	0.63	0.01
Recovery time (h)	9.86±8.71	6.19±6.66	−3.67±0.46	<0.001	6.82±6.41	6.73±4.75	−0.09±0.42	0.83	<0.001

P<0.05 is considered significant. SD=Standard deviation; SE=Standard error

found a significant increase in the PCS score of the SF-36 after 10 months of intradialytic exercise training (a combination of cycling, strengthening, and flexibility exercises three times a week for 60–90 min); while, no significant change was observed in MCS score.[10] It has been suggested in a study by Musavian *et al*. that both active and passive intradialytic exercise significantly improved several aspects of the SF-36.[18] On contrary, the results of a multicenter RCT by Greenwood *et al*. indicated that 6 months of cycling exercise during dialysis resulted in no significant improvement in any KDQOL-SF scales.[12] We postulated that differences in sociodemographic and clinical variables, intradialytic exercise type and duration, and QOL assessment tools are associated with diverse outcomes of these studies.

Previous studies have reported that health-related QOL is strongly associated with recovery time in hemodialysis patients. According to these researchers, patients with longer recovery times have lower QOL compared to those with shorter recovery times.[15,19] In the present study, we found that intradialytic cycling exercise significantly decreased dialysis recovery time. Although, the mechanisms through which intradialytic exercise improved recovery time remain to be explored.

Hypoalbuminemia is known as an important determinant of cardiovascular mortality in hemodialysis patients.[20] Meanwhile, the effect of intradialytic exercise on serum albumin levels remains controversial. In the present study, a significant improvement was noted in serum albumin levels in the intervention group. Moreover, the mean difference of albumin was comparable between the intervention and the control groups. Similarly, the results of a pilot RCT by Assawasaksakul *et al*. showed that serum albumin increased significantly after 6 months of intradialytic cycling exercise.[21] Contrary, the results of a study by Parsons *et al*. did not show a significant difference in serum albumin levels after 20 weeks of intradialytic exercise.[22] No significant inter or intragroup difference was also observed in serum albumin levels in a multicenter RCT by Cheng *et al*. on 132 hemodialysis patients.[23]

Our results failed to show a significant change in mean serum total cholesterol and triglyceride levels in the intervention group. However, there was a significant between-group difference in mean serum triglyceride level after 12 weeks of intradialytic cycling. Groussard *et al*. observed a significant reduction in serum triglyceride level after 3 months of intradialytic exercise; while, other lipid profile components did not change significantly across the intervention.[24] On the contrary, other studies failed to show the effect of intradialytic exercise on lipid profile.[25,26]

There are several study limitations. A main limitation of the present study was the inclusion of higher functioning hemodialysis patients, which are not representative of the whole dialysis patients. Moreover, the current study was an unblinded RCT, which is susceptible to bias. Finally, we did not perform a comprehensive assessment and adjustment for QOL confounding variables. Thus, further long-term clinical trials by controlling confounding variables are suggested to determine the impact of intradialytic exercise on QOL and related determinants.

CONCLUSION

Shor-term intradialytic cycling exercise is found to improve hemodialysis patients' QOL and dialysis recovery time. As a result, intradialytic cycling exercise should be considered an adjuvant therapeutic modality in hemodialysis patients.

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Conflicts of interest

There are no conflicts of interest.

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