Effect of Intradialytic Exercise on Echocardiographic Findings in Hemodialysis Patients

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Introduction. Cardiovascular disease is the major cause of death in hemodialysis patients. Regular aerobic or intradialytic exercise may play a role in reducing cardiovascular mortality in these patients. The aim of this study was to evaluate the relationship between intradialytic exercise and echocardiographic findings.
Methods and Materials. Forty patients were enrolled in the study from Shahrekord Hemodialysis Center. They were randomly assigned into the exercise and control groups. In the exercise group, the patients had a 30-minute exercise program per dialysis session, 3 times a week, for 3 months. Electrocardiography and echocardiography were done at the beginning of the study and 3 months later.
Results. The mean age and body mass index of the patients were 43.2 ± 10.5 years and 21.7 ± 5.4 kg/m^2, respectively. Left ventricular ejection fraction increased and systolic pulmonary artery pressure and right ventricular size decreased significantly after the study in the exercise group patients.
Conclusions. Our results showed the improvement of cardiac systolic and diastolic function in patients who had physical exercise during dialysis sessions. Regular intradialysis exercise can be suggested for hemodialysis patients without cardiac disease.

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INTRODUCTION

The most common cause of mortality in hemodialysis patients is cardiovascular events.[1] Diabetes mellitus, hypertension, prolonged anemia, arterial calcification, and electrolyte imbalance are some predisposing factors to cardiovascular mortality in these patients.[2] There is also evidence that intradialysis exercise may improve quality of life, blood pressure, cardiac function, and anemia in dialysis patients.[3] Moreover, muscle wasting and protein energy malnutrition are common in patients with end-stage renal disease (ESRD).[4] In addition, insufficient intake of dietary nutrients, chronic inflammation, excessive catabolism due to dialysis, metabolic acidosis, and hormonal derangements are potential reasons for muscle wasting in hemodialysis patients. Muscle wasting in turn could increase mortality in dialysis patients, so its prevention and treatment may be useful and lead to improved quality of life (QOL) and survival of the patients.[5,6] Exercise is one of the potential preventive methods to improve muscle function, and also effective for prevention of muscle wasting, it could also improve self-reported physical functioning, and QOL in ESRD patients too. In addition, since cardiovascular disease is the major cause of death in patients with advanced chronic kidney disease, regular exercise may play an important role for reducing cardiovascular mortality in ESRD patients.[7-9]

Although it has been suggested that the best time for most of exercise programs is between dialysis

sessions, recently some studies were conducted on intradialysis exercise to assess dialysis efficacy, QOL, electrolyte, and waste products removal in hemodialysis patients.[10-12] In a study performed by Koh and colleagues, intradialysis exercise was compared with home-based aerobic exercise. They concluded that the two methods had the same effects on physical function and arterial stiffness of the dialysis patients.[13] Moreover, some studies on evaluation of the effect of intradialysis exercise on urea removal have shown the increased dialysis efficacy as well as improvement of QOL.[13-15] Intradialysis exercise might decrease the inflammatory indexes in ESRD patients, but its effect on anemia and lipid profile remains unclear.[16]

To our knowledge, there are a few studies concerning the effect of intradialysis exercise on cardiovascular function; therefore, the aim of this study was to assess the influence of intradialysis exercise on echocardiographic findings among dialysis patients.

MATERIALS AND METHODS

This study was approved by ethical committee of Shahrekord University of Medical Sciences. Forty patients on maintenance dialysis at Shahrekord Hemodialysis Center were enrolled from April to December 2011. Inclusion criteria were an age greater than 18 years and dialysis duration greater than 3 months. Exclusion criteria were an age greater than 60 years, history of ischemic heart disease, use of anti-arrhythmic agents, a left ventricular ejection fraction (LVEF) less than 40% on echocardiography, inability of doing intradialysis exercise, dyspnea or chest pain during exercise, and blood pressure equal to or greater than 160/100 mm Hg before exercise program. The patients were on dialysis, 4 hours, 3 times per week. Blood flow velocity was 280 mL/min to 350 mL/min and dialysate flow rate was 500 mL/min. Ultrafiltration rate was done based on patient's volume status.

The patients were randomly assigned into 2 groups of exercise and control. In the exercise group, the patients had a 30-minute exercise program per dialysis session, 3 times a week, for 3 months. Minibike equipment was used for intradialysis exercise. Control group patients had a similar hemodialysis procedure, without intradialytic exercise program. At the beginning of the study and 3 months later, electrocardiography and echocardiography were done for all of the patients.

Data were analyzed using the SPSS software (Statistical Package for the Social Sciences, version 19.0, SPSS Inc, Chicago, Ill, USA) and *P* values less than .05 were considered significant. The chi-square test, Mann Whitney U test, Student *t* test, paired *t* test, and Fisher exact test were used for statistical analysis.

RESULTS

The mean age of the patients was 43.1 ± 10.5 years. Ten patients (25%) were women. The mean body weight and body mass index of the patients were 59.0 ± 16.6 kg and 21.69 ± 5.38 kg/m^2, respectively. Systolic blood pressure of the patients before and after the dialysis were 135.7 ± 21.8 mm Hg and 125.2 ± 21.1 mm Hg, respectively, and diastolic blood pressure were 81.0 ± 10.3 mm Hg and 75.8 ± 10.6 mm Hg, respectively. There were no significant differences between two groups in terms of age, sex distribution, body mass index, or systolic and diastolic blood pressure. Laboratory findings of the patients before and after the study are shown in Table 1. While there were no significant differences between the two groups before the study in none of the laboratory parameters, serum potassium decreased and hematocrit increased significantly in both groups after the study period.

Table 1. Comparisons of Mean Laboratory Parameter Values Between the Exercise and Control Groups Before and After Study

	Exercise Group			Control Group			*P* for Group Comparisons	
Parameter	Before	After	*P*	Before	After	*P*	Before	After
Hemoglubin, g/dL	9.97 ± 1.69	10.03 ± 2.07	.64	9.75 ± 1.71	9.80 ± 1.70	.66	.68	.68
Hematocrit, %	29.75 ± 5.30	32.95 ± 6.18	.001	29.24 ± 5.11	32.65 ± 5.43	.001	.76	.87
Serum calcium, mg/dL	8.75 ± 0.60	8.99 ± 0.57	.09	9.00 ± 0.91	9.10 ± 0.61	.46	.48	.38
Serum phosphorus, mg/dL	5.50 ± 0.95	5.51 ± .091	.98	5.25 ± 0.79	5.24 ± 0.84	.98	.51	.51
Serum Potassium, mg/dL	5.65 ± 0.78	5.40 ± 0.81	.02	5.82 ± 0.74	5.47 ± 0.95	.01	.57	.88
Blood urea nitrogen, mg/dL	85.75 ± 19.01	28.10 ± 9.28	.12	75.80 ± 16.40	25.01 ± 7.10	.17	.08	.24
Serum creatinine, mg/dL	11.16 ± 3.12	10.97 ± 2.94	.30	10.87 ± 2.27	10.65 ± 2.50	.40	.74	.72

As shown in Table 2, LVEF of the patients after the study improved in the exercise group. Systolic pulmonary artery pressure and right ventricular size decreased significantly after the study in exercise group, too. Other echocardiographic findings were similar in the exercise and control groups before and after the study (Tables 2 and 3).

DISCUSSION

This study was carried out on dialysis patients to assess intradialysis exercise effects on laboratory and echocardiographic findings. It showed that improvement of LVEF, diastolic function, and mitral valve minimum pressure gradient in the exercise group after the study. The systolic pulmonary artery pressure, mitral valve velocity time integral, and right ventricular size decreased significantly after the study in exercise group versus control group. In laboratory findings, only serum potassium and hematocrit changed significantly after the study in both groups.

A few studies on intradialysis exercise showed different results. For example, in Delgiannis and colleagues' study on 38 dialysis patients, after supine sub-maximal exercise during dialysis, LVEF and maximal oxygen consumption improved significantly.[17] In Banerjee and coworkers' study on two groups of 10 patients, submaximally exercises during dialysis session resulted in increasing of cardiac output and decreasing of relative blood volume. Parsons and coworkers showed that 8-week exercise by cycle ergometry did not tend to any

Table 2. Comparisons of Mean Echocardiography Parameter Values Between the Exercise and Control Groups Before and After Study

Parameter	Exercise Group			Control Group			*P* for Group Comparisons	
	Before	After	*P*	Before	After	*P*	Before	After
Left ventricular ejection fraction, %	55.00 ± 2.81	58.5 ± 3.67	.001	54.00 ± 6.41	54.25 ± 4.66	.91	.95	.004
Systolic pulmonary artery pressure, mm Hg	39.96 ± 18.88	33.41 ± 20.21	.005	40.05 ± 25.57	36.00 ± 16.70	.27	.82	.36
Left ventricular end-diastolic diameter, cm	5.05 ± 0.86	5.04 ± 0.64	.92	4.63 ± 0.69	4.75 ± 0.65	.31	.11	.20
Left ventricular end-systolic diameter, cm	3.32 ± 0.66	3.50 ± 0.45	.13	2.77 ± 0.93	3.02 ± 0.77	.08	.04	.02
E/A ratio	1.18 ± 0.43	1.08 ± 0.31	.29	1.01 ± 48	1.03 ± 0.51	.78	.04	.21
Left atrial size, cm	3.91 ± 0.65	3.97 ± 0.87	.68	3.84 ± 0.63	4.19 ± 0.62	.006	.78	.36
Right ventricular size, cm	3.43 ± 0.70	3.17 ± 0.54	.04	3.33 ± 0.75	3.37 ± 94	.86	.70	.42
Mitral valve velocity time integral	25.76 ± 7.91	22.66 ± 6.69	.001	27.14 ± 8.58	25.93 ± 10.61	.56	.60	.25
Mitral valve minimum pressure gradient	1.90 ± 0.96	2.26 ± 0.96	.02	2.65 ± 2.52	2.33 ± 1.70	.55	.21	.86
Mitral valve maximum pressure gradient	4.51 ± 2.13	4.77 ± 1.72	.40	6.19 ± 4.54	5.63 ± 3.73	.56	.14	.35

Table 3. Qualitative Electrocardiographic Findings in Exercise and Control Groups Before and After study*

Parameter	Before Study			After Study		
	Exercise Group	Control Group	*P*	Exercise Group	Control Group	*P*
Left ventricular hypertrophy						
No	6 (30)	2 (10)		5 (25)	1 (5)	
Mild	12 (60)	12 (60)		14 (70)	14 (70)	
Moderate	1 (5)	6 (30)		0	5 (25)	
Severe	1 (5)	0	.10	1 (5)	0	.08
Diastolic dysfunction						
Normal	1 (5)	2 (10)		13 (65)	2 (10)	
Grade 1	15 (75)	13 (65)		7 (35)	14 (70)	
Grade 2	4 (20)	5 (25)	.97	0	4 (20)	.001
Pericardial effusion						
No	16 (80)	19 (95)		18 (90)	20 (100)	
Minimal	4 (20)	1 (5)	.34	2 (10)	0	.49

*Values are frequencies (percentages).

change in QOL or dialysis efficacy.[18] In another study, Afshar and colleagues have studied on 21 hemodialysis patients, and found that 8-week intradialysis exercise program had decreased serum C-reactive protein, but had not any effect on lipid profile, KT/V, hemoglobin, serum albumin and body weight.[19] In Sun and colleagues' study, 14 hemodialysis patients had intradialytic exercise by bicycle ergometer for 12 weeks which tended to increased maximal oxygen consumption and improved QOL and depression of these patients.[20]

Unlike our results, in another study, intradialysis exercise has improved dialysis adequacy in dialysis patients, for example in 13 hemodialysis patients intradialysis exercise program was done for 5-month, 30 minutes per session, 3 times a week with cycle ergometer, and Parsons and colleagues showed improvement of dialysis efficacy (measured by KT/V) and quality of life in the patients.[14] In another study, intradialysis exercise could increase the KT/V in 20 chronic dialysis patients.[21] In addition, Giannaki and colleagues studied on 10 hemodialysis patients and showed that supine form of intradialysis exercise may increase dialysis efficacy indices such as KT/V and urea reduction ratio.[22] These various results may be due to different duration of exercise time. In our study, the patients had a schedule of 3-month exercise but in above-mentioned studies, the duration of exercise was about 6 months.

There were also some limitations in this study such as low cooperation of patients during the study, short-time duration of exercise and patients' follow-up. Our recommendation is to have a regular intradialysis exercise for ESRD patients without cardiac disease and also a long-term follow-up of patients on cardiac and all-cause mortality.

CONCLUSIONS

The majority of previous studies concerning intradialysis exercise had not have a long-term follow-up of the patients on cardiac or all-cause mortality as well as long-time effect of exercise on dialysis efficacy and QOL.[3,13,16,23] As it mentioned before, it seems that our study is the first research on the effect of intradialysis exercise on echocardiographic findings such as mitral valve minimum pressure gradient, systolic pulmonary artery pressure, mitral valve velocity time integral, and right ventricular size. We found that intradialysis exercise could improve some aspects of cardiac function such as increasing LVEF, diastolic function and decreasing systolic pulmonary artery pressure, and right ventricular size. This improve cardiac function may lead to a long-time decline in cardiac mortality.

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CONFLICT OF INTEREST

None declared.

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