Exercise Rehabilitation in Hemodialysis Patients

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ABSTRACT

Objective: *In the present study we investigated the effect of outpatient supervised aerobic exercise training program on the functional capacity, work performance and health related quality of life of end-stage renal disease (ESRD) patients.* ***Methods:*** *The interventional study was conducted on forty patients with end stage renal disease receiving maintenance hemodialysis for four hours three times per week- volunteered with informed consent to participate in the rehabilitation program which was consisting of three weekly sessions of walking on electronic treadmill held on nondialysis days. The dropout was thirteen patients. No adverse effects of exercise training were reported in the studied group including the dropout. The twenty seven patients (eighteen males and nine females) who completed the rehabilitation program underwent the clinical examination, laboratory investigation, cardiopulmonary exercise testing (CPX) pre and post training program.* ***Results:*** *Significant improvement of functional capacity as assessed by maximal oxygen consumption (VO2max %) from 57±12 to 73 ±11 (P<0.01), anaerobic threshold (AT %) from 45 ±12 to 61±12 (P<0.01) and exercise time from 8.4 ±0.7 to 10±0.2. Measurement of hemoglobin concentration, blood urea, serum creatinine, lipid profile and blood pressure also improved significantly (P<0.05) after the exercise training.* ***Conclusion:*** *Outpatient supervised aerobic exercise training rehabilitation program for three months improved the functional capacity, work performance and health related quality of life of ESRD patients.*

Key words: *ESRD, CPX, renal rehabilitation.*

INTRODUCTION

End-stage renal disease (ESRD) patients on hemodialysis (HD) are characterized by poor exercise tolerance and debilitation symptoms, despite advances in dialysis procedures and erythropoietin use[1].

The main predisposing factors for their poor functional ability are anemia, deconditioning, cardiac dysfunction, impairment of cardiac autonomic control and skeletal muscles weakness and fatigue, primarily because of 'uraemic' myopathy and neuropathy[2].

Renal replacement treatment options are life saving treatment. However, prolonged survival in patients is associated with various functional and morphological disorders from almost all systems[2]. Specifically, the muscle strength and endurance are diminished, as results of skeletal muscle dysfunction and atrophy[3]. Studies in the field of renal rehabilitation support the fact that exercise training in hemodialysis patients can ameliorate many of functional and morphological disorders that accompany

ESRD, as well as enhance physical activity, physical fitness and health related quality of life[4,5]. There are no applicable renal rehabilitation programs in Egypt. This study is aiming to investigate the effect of implementation of rehabilitation program in the form of endurance exercise training on the functional capacity and work performance in the maintenance hemodialysis patients.

SUBJECTS AND METHODS

Subjects

Forty patients with ESRD on maintenance HD -for four hours three times per week and all have sedentary physical activity status- from kidney dialysis units in Kasr El Eini hospital have volunteered with an informed consent to participate in the present study.

The exclusion criteria were forced expiratory volume at 1 second (FEV_1) less than 30% of the predicted value, congestive heart failure (class II of New York Heart Association), rapid ventricular or atrial arrhythmias, recent myocardial infarction, unstable angina, active liver disease, uncontrolled diabetes mellitus, significant cerebral or peripheral vascular disease, severe orthopedic limitation, uncontrolled hypertension and severe pulmonary hypertension.

Methods

Patients were assessed pre and post the rehabilitation program by the following:

1- Full History Taking: including structural kidney questionnaire
2- Full clinical examination:
3- Laboratory investigations: including hemoglobin concentration, blood urea and serum creatinine, serum electrolytes (sodium, potassium, calcium and phosphorous), lipid profile (cholesterol, triglyceride high density lipoprotein, low density lipoprotein).
4- Electrocardiograph (ECG): A resting ECG was performed to detect the presence of ischemic changes, pulmonary hypertension, or any arrhythmias, which may interfere with exercise testing.
5- Ventilatory function tests (spirometry): The following parameters were measured in percentage of predicted value (% of predicted): *Slow Vital Capacity (SVC). *Forced Vital Capacity (FVC). *Maximum Voluntary Ventilation (MVV). *Tidal volume (VT). *Respiratory dead space (VD).
6- Cardio-pulmonary exercise testing (CPX): Exercise testing was performed using an electronic treadmill in an air-conditioned laboratory in Fitness and Rehabilitation Unit using the Modified Bruce Protocol. All patients were asked to perform maximally till reaching maximal oxygen consumption (VO_{2max}) & Anaerobic threshold (AT).

The renal rehabilitation program:

The outpatient supervised exercise program consisted of three weekly sessions of aerobic exercise in the form of walking on electronic treadmill for three months based on the preliminary cardiopulmonary exercise testing. The exercise training divided into warm up phase, active phase, and cool down phase. Each of warm up and cool down phases consisted of low speed exercise for 3-5 minutes.

1- Exercise intensity: The active phase was formed of 50% of VO_{2max} then increased gradually to reach 60 to 65% of VO_{2max} at the end of the program.
2- Training session frequency and program duration: The program was done three

times per week in nondialysis days for three months.

3- Training session duration: The time initially will be 15 minutes till reaching 45 minutes. The intensity, and duration were adjusted until the patient become tired then progressively increased for a total period of 12 weeks. The dropout during the program was 13 patients occurred during the first month of the training due to: *The time of the exercise unsuitable for them. *Unstable health condition. *Private problems interfere with completion of the program.

Statistical analysis

For comparing the difference between the quantitative variables before and after the exercise rehabilitation program 'the paired t-test' was done. All differences considered statistically significant at P value ≤ 0.05.

RESULTS

In this study 27 patients with end stage renal disease on maintenance hemodialysis–for four hours three times per week underwent exercise rehabilitation program. Table (1) showed that in this study there were 18 males (67%) and 9 females (33%), their mean age was 40.85 ±10.37 years, their weight mean was 68.37 ±11.86 kg, their mean height was 163.59 ±6.62 cm & duration of dialysis 44.81 ±25.1 months.

Table (1): General Characteristics of the studied group.

	Minimum-Maximum		Mean ±SD
Age (years)	20-55		40.85 ±10.37
Height (cm)	156-179		163.59 ±6.62
Weight (Kg before HD)	46-91		68.37 ±11.86
Duration of Dialysis (month)	6-96		44.81 ±25.1
	Frequency		Percent
Sex	Male	18	67%
	Female	9	33%
	Total	27	100%

Table (2): Laboratory findings of the studied group.

	Minimum-Maximum	Mean ±SD	Reference ranges
Serum Creatinine (mg/dl)	2.9-10	5.31 ±1.80	0.6-1.4
Blood urea (mg/dl)	65-139	94.11 ±18.61	10-50
Hemoglobin (gm/dl)	7-11.5	9.64 ±1.11	Males13.5-18 Females12-16
Cholesterol (mg/dl)	172-300	228.38 ±38.4	Up to 200
Triglyceride (mg/dl)	122-230	183.90 ±28.99	0-140
High density lipoprotein ((mg/dl)	20-71	41.14 ±15.08	40-75
Low density lipoprotein (mg/dl)	86-195	149.23 ±34.89	100-130
Calcium (mg/dl)	8-10.3	8.89 ±0.77	8.2-10
Phosphorous (mg/dl)	3-6.4	4.78 ±1.13	2.5-5.5
Sodium (mEq/L)	130-152	136.55 ±5.65	135-145
Potassium (mEq/L)	4.8-6.3	5.43 ±0.41	2.5-5.5

Reference ranges are from Jacques 2002[6]

Table (2) showed that the means of serum creatinine, blood urea, serum cholesterol, triglycerides, and LDL were more than the normal levels, the means of serum phosphorous and potassium at high normal level, the means of serum calcium, sodium, at low normal level, while the mean hemoglobin concentration was less than the normal levels.

Table (3): Changes of laboratory findings pre and post renal rehabilitation (RR).

	Pre RR (Mean ± SD)	Post RR (Mean ± SD)	P value
Creatinine (mg/dl)	5.31 ±1.80	4.99 ±1.85	< 0.05
Urea (mg/dl)	94.11 ±18.61	91.72 ±17	< 0.05
Hemoglobin(gm/dl)	9.64 ±1.11	10.04 ±0.60	< 0.05
Cholesterol	228.38 ±38.4	217.80 ±32.07	< 0.05
Triglyceride	183.90 ±28.99	181.09 ±25.49	< 0.05
HDL	41.14 ±15.08	45.19 ±19.5	< 0.05
LDL	149.23 ±34.89	135.19 ±37.36	< 0.05

Table (3) revealed that there was a statistically significant difference in the laboratory findings after the rehabilitation program, ($P<0.05$).

Table (4): Changes of blood pressure pre and post rehabilitation program.

Parameter	Pre RR	Post RR	P-Value
Systolic blood pressure At rest	153.5 ±20.5	141.4 ±12.6	< 0.05
Diastolic Blood pressure At rest	98.3 ±13.2	91.8 ±9.9	< 0.01
Systolic blood pressure At maximal work	165.5 ±16.7	160 ±17.09	< 0.01
Diastolic blood pressure At maximal work	109.2 ±9.5	102.2 ±5.6	> 0.05

Table (4) revealed that there was a statistically significant reduction in resting diastolic blood pressure post rehabilitation ($P < 0.01$).

Table (5): Changes in ventilatory function test parameters pre and post rehabilitation.

	Pre rehab	Post rehab	P value	Reference range
SVC% of predicted	74.37 ±14.4	84.25 ±15.8	<0.01	≥ 80 %
FVC% of predicted	73.33 ±14.9	83.44 ±12.9	< 0.01	≥ 80 %
FEV_1% of predictive	70.95 ±15.9	74.83 ±25.1	< 0.01	≥ 80 %
FEV_1/FVC%(absolute value)	79.38 ±6.78	78.23 ±8.54	> 0.05	≥ 80 %
FEF max% of predicted	84.36 ±8.54	89.05 ±16.71	< 0.01	≥ 60 %
MVV% of predicted	58.70 ±11.97	70.29 ±12.7	< 0.01	≥ 80 %

Refernce ranges are from Rupple, 2003[7]

Table (5) revealed that there were significant improvement in all pulmonary function tests parameters except in forced expiratory volume in first second/ forced vital capacity FEV_1/FVC $P>0.05$ after the rehabilitation.

Table (6): Changes in cardiopulmonary test parameters (CPX) pre and post renal rehabilitation.

	Parameter	Pre RR	Post RR	P value	Reference value
Respiratory parameters	BR%	40.96 ±18.74	43.59 ±14.05	< 0.01	>40
	Respiratory rate (at rest)	20.81 ±3.35	16.59 ±3.48	> 0.05	12-50 breath/ min
	Respiratory rate (at maximal work)	44.2 ±11.08	47.33 ±8.48	> 0.05	
	VO_{2max}% of predicted	57.11 ±12.73	73.74 ±11.31	< 0.01	>83
	AT % of VO_{2max}	45.35 ±12.02	61.35 ±12.95	< 0.05	>60-70
Cardiac parameters	Resting heart rate (beats/min)	92.03 ±14.18	90.9 ±7.39	< 0.05	60-80
	Maximal heart rate (beats/min)	144 ±23.16	146 ±20.10	< 0.01	220-age
	Heart Rate Reserve% HRR%	24.81 ±10.48	19.07 ±7.52	< 0.01	<15
	O_2 pulse at rest	2.94 ±1.21	4.58 ±2.44	< 0.05	2.5-4 mlo2/beat
	O_2 pulse at max work	9.84 ±1.97	11.87 ±2.40	< 0.01	12.5-15.5 mlo2/beat
Ventilation/Perfusion relationship	Ventilatory equivalent for O_2 (VE/O_2) at AT	35.14 ±7.12	28.38 ±3.24	< 0.05	22-27
	Ventilatory equivalent For CO_2(VE/CO_2)at AT	37.33 ±7.18	30.33 ±3.16	< 0.01	26-30
	VD/VT (at rest)	0.32 ±7.12	0.28 ±8.74	> 0.05	0.35-<0.25
	VD/VT (at maximal work rate)	0.20 ±8.95	0.18 ±6.58	< 0.01	
Exercise time	Exercise time	8.48 ±0.75	10.12 ±0.21	< 0.01	

Reference ranges are from Wassermann, 2005[8]

Table (6) revealed that there was statistically significant difference in the breathing reserve percent (BR %) ($P<0.01$), maximal oxygen consumption percent (VO_{2max} %), anaerobic threshold percent (AT %), in all cardiac parameters, ventilatory equivalent for both oxygen and carbon dioxide and exercise time between pre and post rehabilitation.

Table (7): Work tolerance of the according to VO_{2max} (ml/Kg/min) pre and post renal rehabilitation.

	Pre RR		Post RR	
VO_2 ml/kg	No of patients	% of total N	No of patients	% of total No
<15ml/kg/min (unable to work)	4	15%	0	0%
16-20 ml/kg/min (able to do light physical work)	14	52%	3	11%
21-24 ml/kg/min (able to do 8 hours mild to moderate work)	5	19%	6	22%
>25 ml/kg/min (able to do 8 hours of active work)	4	15%	18	67%

Table (7) showed that before rehabilitation only 15% of the patients are able to do 8 hours of active work. After rehabilitation 67% of the patients are able to do 8 hours of active work.

Table (8): Kidney disease questionnaire scoring for assessment of the quality of life pre renal rehabilitation.

Items	Score 1 All of the time		Score 2 All of the time		Score 3 All of the time		Score 4 All of the time	
No=27	No	%	No	%	No	%	No	%
Leg pain during walking	27	100%	00	00%	00	00%	00	00%
Fatigue	22	81%	05	19%	00	00%	00	00%
Depression	14	52%	13	48%	00	00%	00	00%
Dependent on others	12	44%	15	56%	00	00%	00	00%
Troubles getting to sleep	08	30%	09	33%	07	26%	03	11%
Palpitation	00	00%	22	81%	05	19	00	00%

Table (8) showed that the highest percentage of all items of the kidney questionnaire scored under the score 1 and 2 before the rehabilitation.

Table (9): Kidney disease questionnaire scoring for assessment of the quality of life post renal rehabilitation.

Items No=27	Score 1 All of the time		Score 2 All of the time		Score 3 All of the time		Score 4 All of the time	
	No	%	No	%	No	%	No	%
Leg pain during walking	00	00%	13	48%	09	33%	05	19%
Fatigue	00	00%	5	19%	18	67%	04	15%
Depression	00	00%	0	0%	19	70%	08	30%
Dependent on others	00	00%	12	44%	10	37%	00	00%
Troubles getting to sleep	00	00%	0	0%	14	52%	13	48%
Palpitation	00	00%	10	37%	02	07%	15	56%

Table (9) showed thad The highest percentage of all items of the kidney questionnaire scored under the score 3 and 4 after the rehabilitation.

DISCUSSION

Patients with advanced chronic renal failure including those undergoing maintenance hemodialysis (MHD), commonly suffer from reduced physical exercise capacity[9]. Exercise training has been shown to improve the low functional capacity and quality of life in dialysis patients and is being recommended as a complementary therapeutic modality[4].

The aim of this study was to investigate the effect of implementation of rehabilitation program on the functional capacity and work performance of hemodialysis patients. The results of the present study revealed that there was significant effects on improving laboratory findings, blood pressure at rest and maximum work, pulmonary function test parameters, CPX parameters & work tolerance relationships and exercise time.

When we analyzed the laboratory findings of the studied group we found that the

mean of hemoglobin concentration was 9.64 ±1.1gm/dl pre training with significant increase after the rehabilitation program by 4%. The post treatment results of this study agrees with previous studies which mentioned that exercise training in ESRD patients improves the degree of anemia. In this study there was significant decrease in serum creatinine (6%) and blood urea (3%) after the exercise program. These results may be explained as reported by a recent study which stated that uremia is associated with decreased protein synthesis and increased protein degradation and exercise training could positively alter the protein synthesis-degradation balance which was reflected on the serum creatinine and blood urea which are byproducts of protein degradation process[10]. On the contrary; in a study of thirteen patients with ESRD on peritoneal dialysis after three months of exercise training, there was no significant decrease in blood urea or serum creatinine after the exercise training, but the small sized sample and/or the use of different dialysis modality may explaine this contrast[11].

The lipid profile components of the studied group showed dyslipidemia in the form of increased cholesterol, triglyceride, and low density lipoprotein (LDL) & decreased high density lipoprotein (HDL) levels with significant improvement in the all components after exercise training. This is consistent with a study which stated that exercise training in ESRD leads to increasing serum level of HDL, probably by increasing the formation of apo lipoprotein A, which is the major structural protein of HDL & cellular lipids[12]. The exercise reduced chylomicron level and produced a fall in triglyceride level[13].

On the contrary, another study found that there was insignificant improvement in the cholesterol level after three months of aerobic exercise training in fifty three patients with ESRD[14], and a previous study which found that there was insignificant increase in HDL level (P=0.06) post training[11]. This contrast may be explained to occur by heritable factors which in part, determine the lipid profile responses to exercise in the studied group. Also the difference in exercise intensity, sample size and/or dialysis modality may also play a role in explanation of this contrast[15].

Readings of arterial blood pressure of the studied group revealed the following: resting blood pressure either systolic or diastolic was high, with significant reduction after the exercise training by 8% and 7%, respectively. This is consistent a previous study which stated that exercise training program in the patients with ESRD reduces blood pressure in hypertensive patients[2]. This may be explained by another study which examined the effect of local physical training on the forearm arteries & veins in fourteen patients for two months and found that there was significant increase in the diameters of the forearm vessels and the endothelium-dependent vasodilatation which leads to reduction in the peripheral resistance and diastolic blood pressure[16]. In the same line, a recent study which analyzed the radial artery pressure waveform in eleven patients with ESRD after three months of aerobic exercise training, found that there was significant improvement in arterial stiffness[17]. In contrast, another recent study stated that there was no statistically significant difference in blood pressure readings detected after three months of aerobic exercise training in forty five patients with ESRD; this contrast may be due to the difference in exercise intensity and the method of its calculation in the study protocol[14].

Maximal oxygen consumption (VO_{2max}), anaerobic threshold (AT), and duration of exercise training were taken by many authors

as widely accepted and highly reproducible measures of cardiopulmonary fitness and/or exercise tolerance in many studies in patients with ESRD before and after HD[18,19,20]. The current study measured VO_{2max}% of predicted before and after the exercise rehabilitation program which indicated that it was less than the predicted values pre training with significant improvement by 16% post training. This is consistent with a study on thirty eight ESRD patients after one year of exercise training and revealed a significant improvement in VO2 max by 47% post training[18]; another study mentioned that there was significant improvement in VO_{2max} by 43% in forty eight patients with ESRD after six months of aerobic exercise training (21); and a study which stated that VO_{2max} was significantly improved by 43% in thirty eight ESRD patients after six months of aerobic exercise training[22]. The difference in the percent of improvement between the current study and the others may be due to the difference in exercise intensity, sample size and/or the duration of exercise training.

Measurement of anaerobic threshold percent (AT%) of maximal oxygen consumption revealed that it was less than the pretraining predicted values with significant improvement by 16% after the exercise training. This finding was supported by a previous study by which found that AT% was significantly improved by 37% after six months of exercise training[17]. Again the difference in the percent of improvement between the two studies may be due to the difference in exercise intensity, sample size, and/or the duration of exercise training. A previous study stated that there was significant increase in exercise time by 33% after six months of aerobic exercise training in thirty patients with ESRD[22]. On the same line; another study found that the exercise time was significantly increased by 33% in his patients after six months of exercise training[21]. The present study supported their findings as it demonstrated a significant increase in exercise time post training. The improvement of the previous three parameters (VO_{2max}%, AT%, and exercise time) reflects significant improvement of physical fitness of the studied group.

Cardiopulmonary exercise testing was helpful in assessment of breathing reserve (BR%) which was low before exercise training with significant increase after the training. This result was consistent with the previously mentioned resting ventilatory function results which cleared that the patients had ventilatory disorders before training which was significantly improved post training. Besides, there is no statistically significant difference in the respiratory rate of the studied group either at rest or at the maximal work. The resting heart rate was significantly reduced after the exercise training; this finding may be explained by the fact that the exercise training leads to increase the cardiac vagal activity which leads to reduction in the heart rate and heart rate variability in the patients with ESRD[2]. Also, the increase of cardiac vagal outflow and the decrease of sympathetic over activity at rest are significantly beneficial results of exercise training in HD patients[3].

On the other hand, during maximal work load, there was significant increase in the post training maximal heart rate. This may be due to increase in patient effort and exercise time consequently with increase physical fitness of the patients which make them reach near the predicted maximal heart rate. The estimated HRR% was higher than the predicted values, which may be due to many causes, as reported by a recent study which explained the increased HRR% by poor motivation, lung diseases (this goes with low BR mentioned

above which may stop exercise early and prevent the patients to stress the heart maximally), peripheral vascular disease and/or musculoskeletal disorders (this goes with leg pain reported in all patients[20]. These causes may be present in patients of this study preventing them to stress the heart maximally. After the exercise training, there was significant reduction in HRR% which means that the patients were able to stress the heart better and their performance was getting better after the rehabilitation program. As the HRR equal the difference between the predicted maximal heart rate and the actual maximal heart rate, so, this result is consistent with the previous results of the increased maximal heart rate after the exercise training.

The current study showed that oxygen pulse before exercise training either at rest or at the maximal work was low (which is consistent with low VO_{2max} and hemoglobin concentration pre training), with significant post training improvement consequently with the improvement in VO_{2max} and hemoglobin concentration.

The presence of the low oxygen with the previously mentioned elevated blood pressure in our patients indicate that the patients have peripheral vascular disease which is confirmed clinically by the presence of leg pain and claudication in almost all patients. This conclusion is supported by a recent study by which stated that peripheral vascular disease is frequently diagnosed in subjects with chronic kidney disease. There was improvement in the oxygen pulse and blood pressure post training that was reflected on the peripheral vascular disease and supported by the improvement of the previously annoying symptoms as reported by the same author[23].

Regarding the evenness of ventilation/ perfusion; the present study demonstrated that the ventilatory equivalent for oxygen (VE/O_2) and ventilatory equivalent for carbon dioxide (VE/CO_2) at anaerobic threshold were high pre training indicating ventilation /perfusion mismatching. The results may be explained by either pulmonary disorders in which ventilation perfusion relationships are uneven and/or pulmonary vascular disease in which alveoli are poorly perfused. These two possibilities are common in the patients with ESRD as supported by a recent study performed by Zakaria et al., 2004[20]. After training there were significant reduction in both VE/O_2 andVE/CO_2 indicating that the unevenness of ventilation/perfusion was getting better. This improvement was explained by:

- Improvement of ventilation as previously noticed in the post training improvement of resting ventilatory function and breathing reserve.
- Improvement of perfusion which may be explained as mentioned by a the study performed by Leaf et al., 2003 which stated that exercise training in ESRD patients leads to improvement of perfusion due to increased arterial and venous diameters and increased endothelium-dependent vasodi-latation[24].

On the other hand, measurements of VD/VT either at rest or at maximal work rate were within normal range but still there was significant improvement at the maximal work rate indicating that ventilation/ perfusion was getting better, but this parameter is estimated value and need another parameters to be confirmed as alveolar arterial oxygen difference and arterial end tidal carbon dioxide difference but these parameters required arterial blood gases sample which was refused completely by the patients.

Lastly, consistent with all previously mentioned results, on assessing the work tolerance according to VO_{2max} ml/Kg/min we

found that the majority of the patients (85%) were unable to do eight hours of active physical work pre training, with reduction of this percent to (33%) only after the implementation of the exercise training rehabilitation program. Besides, consistent with the recent performed by Vilsteren et al., 2005[14], the present study found that the exercise training rehabilitation program showed beneficial effects on health related quality of life of the patients as shown by the presence of highest percentages of all items of the structured kidney questionnaire under score1and score 2 pre training with observed shifting of almost all items to score 3 and score 4 post training.

From all of the above, there were beneficial effects of exercise rehabilitation for the patients with end-stage renal disease which give them the chance to return to their work and actively share in their family and social life. From the previously mentioned results we conclude that patients with ESRD had low functional capacity and work performance in comparison to age matched healthy persons. The rehabilitation program has a significant effect in improving functional capacity, laboratory findings and quality of life.

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الملخص العربي

تأهيل بالتمرينات لمرضى الغسيل الكلوي

الهدف من البحث فحص تأثير برنامج رياضي تأهيلي على الكفاءة الوظيفية و الأداء البدني لمرضى الفشل الكلوي المتأخر وتحت العلاج بالغسيل الدموي . وقد تمت هذه الاختبارات على أربعين مريضا متبرعا للاشتراك في البرنامج التأهيلي ، وهو عبارة عن السير على السير الكهربائي لمده زمنيه تبدأ بنصف ساعة لمدة ثلاثة أشهر متتالية. تم عمل تقييم للمرضى قبل و بعد البرنامج التـأهيلي (أخذ التاريخ المرضى كاملا ، وعمل تحاليل الدم وهى نسبة الهيموجلوبين ، ونسبة الدهون بالدم ، ووظائف الكلى) ، كذلك تم عمل وظائف التنفس ورسم القلب أثناء الراحة ، واختبار القلب والرئتين أثناء المجهود لجميع المرضى لتقييم كفاءتهم الوظيفية قبل تنفيذ البرنامج التأهيل ي . وقد أظهرت النتائج وجود تحسن ذو دلالة إحصائية للكفاءة الوظيفية حيث لوحظ تحسن ملحوظ في نسبة الحد الأقصى من استهلاك الأكسجين، و العتبة اللاهوائية وقد وجد أيضا ارتفاعا ملحوظا في نسبة الهيموجلوبين وانخفاضا ملحوظا ف ي نسبة البولينا والكرياتينين وأيضا تحسنا ملحوظا ف ي نسبة الدهون بالدم بعد تنفيذ البرنامج التأهيلي . مما سبق نستنتج أن البرنامج الرياضي التأهيلي لمرضى الفشل الكلوي لمدة ثلاث أشهر يؤدى إلى تحسن في مستوى الكفاءة الوظيفية واللياقة البدنية ونسبة الهيموجلوبين بالدم .