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Intradialytic Aerobic Exercises versus Home Training Program on Physical Performance in Hemodialysis Patients

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ABSTRACT

Background: Patients with advanced chronic kidney disease, especially those on long-term dialysis, often suffer from reduced physical performance which is associated with increased mortality rate. Exercise training during dialysis or in non-dialysis days can significantly improve many outcomes such as improving physical functioning and increasing work related activities. **Purpose:** The purpose of this study was to evaluate the effect of intradialytic aerobic exercises versus home training program on physical performance in hemodialysis patients. **Subjects and Methods:** Thirty men patients who received regular hemodialysis with age from 40 to 50 years were enrolled in this study. Patients were divided into two equal groups: group A received pedaling exercises and group B received home program exercises three times per week for two months. Serum creatinine level, serum urea level, and 6 minute walk test (6MWT) were measured before, after 1 month and after 2 months of treatment. **Results:** The results of this study revealed no statistically significant improvement in serum creatinine level (P-value = 0.27) for group (A) and (P-value = 0.38) for group (B) and serum urea level (P-value = 0.49) for group (A) and (P-value = 0.23) for group (B) post treatment. For both groups 6 min walk distance showed significant improvement after one and two months. Group A after one month of the treatment showed an improvement that reached 5.97%, while at the period between one & two months the improvement reached 6.12%. Group B after one month of the treatment showed an improvement that reached 7%, while at the period between one & two months the improvement reached 6.48%. However there was no significant difference between both groups in the 6 min walk distance before treatment (P-value = 0.76), after 1 month of treatment (P-value = 0.89), and after 2 months of treatment (P-value = 0.93). **Conclusion:** It was concluded that physical performance was improved in hemodialysis patients in both intradialytic aerobic exercises group Group A and home training program Group B, however no statistically significant difference was achieved between both groups after one and two months of treatment.

Key words: Intradialytic Aerobic Exercises, Home Training Program, 6MWT, Hemodialysis.

INTRODUCTION

Hemodialysis (HD) is a renal replacement therapy used to compensate kidney functions in patients with end stage renal failure. Despite renal replacement treatment that reduces morbidity and mortality rate, progressive skeletal muscle weakness and gradual decrease in physical work capacity were commonly associated with the deterioration of kidney function compared with the normal expected values once the patient joins regular dialysis treatment. The functional consequences of catabolic changes that may be presented in patients on hemodialysis include reduced ability to generate force, reduced exercise tolerance, impaired performance of daily activities, depression, and significantly reduced quality of life. Moreover, Lifestyle restrictions, associated with the inactivity imposed by 12 to 18 hr weekly of dialysis treatment may also contribute markedly to this degenerative process[14].

Physical exercises performed during hemodialysis procedure may lead to maintenance of physical endurance and functional independence. Regular physical exercise program can maintain normal muscle function in addition to physical and functional abilities[16].

Storer et al.,[28] stated that ntradialytic cycling ergometer exercise has been shown to improve peak oxygen consumption, endurance time, dialysis efficacy and physical functioning. Moreover, Goldberg et al.,[7] reported that interdialytic aerobic exercise also increases maximum aerobic capacity, decreases blood pressure, depression, triglycerides and increases hematocrit/hemoglobin values, HDL, and insulin sensitivity. Shalom et al.,[27] in a study of interdialytic aerobic exercise

(exercises in non-dialysis days), reported that work capacity was increased for those patients despite their poor compliance to the program.

Furthermore, Kouidi et al.,[16] reported that aerobic exercise on non-dialysis days resulted in increased type II fibers, muscle fiber area, maximal oxygen uptake, and exercise time. Therefore, this study provides an opportunity to set new guidelines for establishing a rehabilitation exercise program for both ntradialytic and interdialytic periods for patients in hemodialysis departments in Egyptian hospitals.

The purpose of this study was to evaluate the effect of ntradialytic leg cycling exercise versus interdialytic home based training program on physical performance in hemodialysis patients.

SUBJECTS AND METHODS

Subjects:

Thirty chronic kidney disease men patients who received regular hemodialysis from hemodialysis unit of Red Crescent Palastine Hospital were recruited in the study for 2 months (3 times per week). All study patients were initially evaluated at the Renal Dialysis Unit where detailed medical history was recorded and careful clinical examination was performed by a specialized physician. All patients were fully understood the purpose and procedures of the study and so an informed consent was signed from each patient agreed to participate in the study.

Inclusion criteria:

Patients who had the following features were included in the study. Their ages ranged from 40 to 50 years old, Those patients who received regular hemodialysis for at least 3 months before starting the program.

Exclusion criteria:

Patients who had the following features were excluded from the study: Thermo-dynamically unstable during dialysis treatment, Sever cardiovascular, neurologic, and/or orthopedic complications.

Withdrawal criteria:

All patients, regardless of health status, should be advised to discontinue exercise when they experience adverse symptoms other than transient muscle and joint soreness, such as sharp, intense, or persisting pain; heavy or tight feelings in the chest; irregular heartbeat; breathing difficulties, atypical sweating, dizziness, numbness, headache, or nausea. Compromised cardiovascular system response to physical effort as marked blood pressure falls during physical exercise[5,20].

Patients were divided into two groups: group A (n=15) received leg pedaling exercise three times per week for two months and group B (n=15)received home program exercise three times per week for two months.

Methods:

A) Evaluative Methods: All patients underwent the following sequence:

1- Assessment of kidney functions: Blood sample was taken to assess urea and creatinine by using biochemical analyzer (model AE-600N ERMA INC) before the study, after one month and after 2 months. Twelve to twenty four hours after the last exercise session to eliminate the acute effect of exercise. All common instructions for lab analysis were followed.

2- Assessment of Functional performance (6-minute walk test) (6MWT): This test was conducted in a temperature-controlled-measured corridor (30 meters long). The corridor was marked by cones in turn-around points. A brightly colored tape was marked on the floor to determine the beginning and the end of each 30 meters as a starting line. All patients were encouraged to continue walking as fast as possible without running every 30 seconds. During this walk test, the examiner recorded the time (in minutes) and the walked distance (in meters).All patients performed this test twice on the same day with an interval of 30 minutes then the average value was calculated for more accuracy[6,9]. All patients performed this test at the beginning then after one month and after 2 months of the study.

B) Treatment Methods:

Group A:

Fifteen patients received leg pedaling exercise in a semi-supine position using leg ergometer (China Technology) Fig. (1). Leg pedaling exercise was performed through a period of 2 months, three times a week in the first two hours during hemodialysis procedure to avoid dialysis hypotension episodes[21]. A total number of 24 training sessions were planned. The training was performed under constant supervision of a physiotherapist. Each training session consisted of three parts[5].

- First part – warm-up (5 minutes) – free active exercises of the lower extremities.
- Second part – the main part (20 minutes) – exercise on a leg pedaling (the speed was set at one cycle per second).
- Third part – cool-down (5 minutes) – free active exercises of the lower extremities.
- Duration of the training exercise was gradually prolonged; the first exercise session was for 10 min, the second for 20 min and the third and all subsequent sessions for 30 min[3].
- The prescription of exercise intensity was based on Borg's Perceived Exertion Scale [(12)]. According to this scale, patients assign a score to the intensity of fatigue that varies from 6 to 20 points. During the leg pedaling, at every 5 minutes, patients were asked about the score they would assign to their fatigue at that moment, and the pedaling load was maintained to achieve an intensity of stress enough to determine a score of fatigue between 11 and 13 points (i.e. less than a little tired), which corresponds to an exercise of "mild" intensity to "quite hard" in this scale. They were permitted to rest or request to train at a lower intensity if they were stressed and the physical exercise was not allowed to induce symptoms of physical effort intolerance. If changes were noted, exercise was discontinued for 10 min. After which, if symptoms resolved, patients were allowed to resume. If symptoms did not resolve then no more exercise was permitted for that day. Prolongation of a single

training session and change in intensity depend on patient's reaction to physical effort.

- Termination of exercises during the training session took place in the following cases: inability to maintain the recommended rate of pedaling; occurrence of retrosternal, muscular, articular pain; occurrence of nausea, dizziness, muscle cramps; or patient's request (malaise, fatigue)[5].

Fig. (1): A patient performing pedaling exercises during hemodialysis session.

Group B:

Fifteen patients received home-based exercise for 30 minutes\ three times per week for two months. Home-based participants were asked to perform unsupervised walking 3 times weekly for two months at perceived exertion of 11–13 on the Borg 6–20 scale[13]. To ensure a similar treatment to the intradialytic group's training duration, home-based participants were requested to start and progress their walking program according to individual capabilities. They were encouraged to start at 10 minutes in the first session, 20 min in the second session and 30 min for the third and all subsequent sessions for 2 months. Participants were phoned to be encouraged to regularly increase intensity by walking faster and to allow feedback on progress. All participants were requested to maintain their usual daily activities throughout the study. Each training session consisted of three parts:

- First part – warm-up (5 minutes) – walking with low speed.
- Second part – the main part (20 minutes) – brisk walking.
- Third part – cool-down (5 minutes) – walking with low speed.

All participants were trained about different walking speed and recording their perceived exertion before their home program.

Statistical Analysis

The SPSS (version 17) statistical software package was used for statistical analyses. All data were expressed as mean and standard deviation. The level of significance was set at $P < 0.05$. Repeated measure analysis of variance (ANOVA) was used to show the change in the measured variables in each group. If repeated measure ANOVA test was significant for any variable, Bonferroni post hoc test conducted to show difference between before treatment, after 1 month, and after 2 months of treatment values. Independent t-test was conducted to compare between both groups.

RESULTS

This study was conducted on 30 patients with 15 patients in two groups. The mean age for patients in group (A) was (44.33±2.87) years and the mean age for patients in group (B) was (45.26±3.59) years.

Comparing the mean values and standard deviations of serum Creatinine level, serum Urea level, and the distance walked in 6 min before treatment, after 1 month of treatment, and after 2 months of treatment were shown in both groups, Table (1).

Table (1): Comparison between the mean values and standard deviations of measured variables before treatment, after 1 month of treatment, and after 2 months of treatment.

Variables		Before treatment	After 1 month	After 2 months	P-value (t-test before and after 2 months)	Significance
Creatinine level	Group (A)	7.56±1.6	7.28±1.56	7.5±1.41	0.9	NS
	Group (B)	7.15±1.42	7.04±1.48	7.07±1.39	0.466	NS
Urea level	Group (A)	138.86±19.47	141.6±16.68	139.46±13.16	0.322	NS
	Group (B)	134.33±21.67	139.46±20.08	136.2±23.85	0.98	NS
Distance walked in 6 min	Group (A)	306.13±49.11	324.4±54.81	344.26±58.18	<0.0001	S
	Group (B)	300.53±50.52	321.73±52.43	342.6±46.73	<0.0001	S

P- value: probability value NS: non significant S: significant min: minutes

Change in measured variables within each group:

Serum Creatinine Level:

The results of serum Creatinine level showed no statistical significant change after 2 months of treatment (P-value = 0.27) for group (A) and also no statistical significant change after 2

months of treatment (P-value = 0.38) for group (B) as revealed by repeated measures that were analyzed by (ANOVA), Table (2) Fig. (2).

Serum Urea Level:

The results of the serum Urea level showed non- statistical significant change after the2 months of treatment (P-value = 0.49) for group (A) and also no statistical significant change after the2 months of treatment (P-value = 0.23) for group (B) as revealed by repeated measures that were analyzed by (ANOVA), Table (2) Fig. (3).

Six Minute Walk Test:

For group (A) six min walk test results showed statistical significant increase after the2 months of treatment (P-value = 0.0001) as revealed by repeated measure (ANOVA). For group (B) six min walk test results showed statistical significant increase after the 2 months treatment (P-value = 0.0001) as revealed by repeated measure (ANOVA), Table (2) and Fig. (4).

Table (2): The results of the repeated measures of measured variables by ANOVA.

Variables		P-value	Significance
Creatinine level	Group (A)	0.27	NS
	Group (B)	0.38	NS
Urea level	Group (A)	0.49	NS
	Group (B)	0.23	NS
Distance walked in 6 min	Group (A)	0.0001	S
	Group (B)	0.0001	S

P- value: probability value NS: non significant S: significant

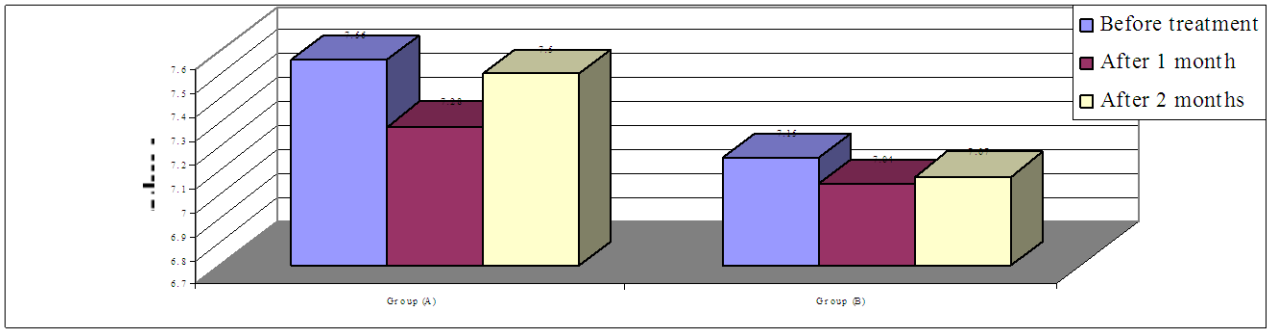

Fig. (2): Change in mean values in serum creatinine level within each group.

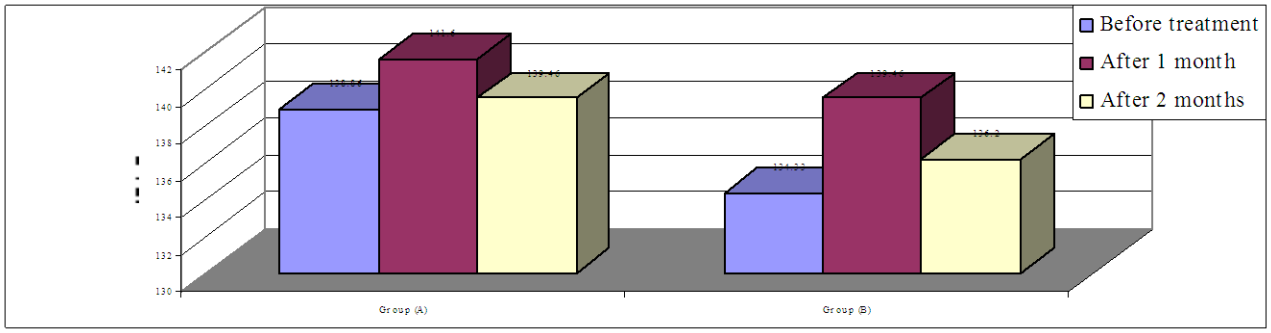

Fig. (3): Change in mean values in serum urea level within each group.

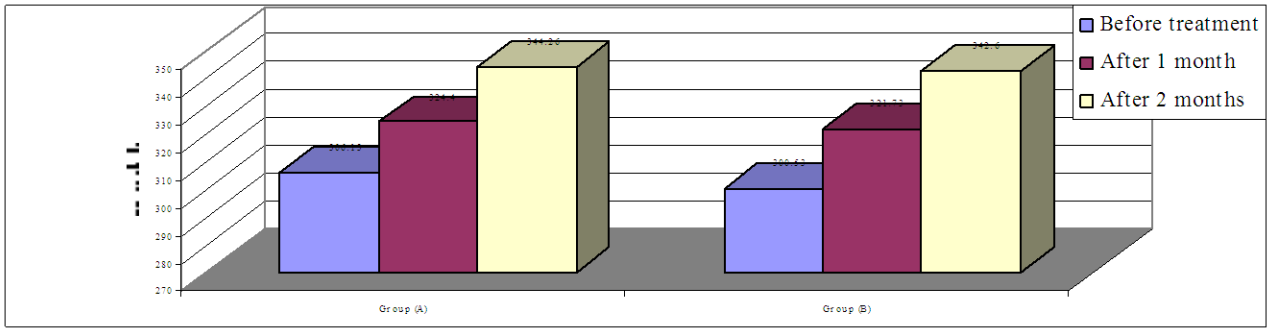

Fig. (4): Change in mean values in 6 min walk test within each group.

Percentage of changes for both groups after treatment:

Serum Creatinine Level:

As regard to serum Creatinine level, the percentage of change was 3.7 % before treatment to 1 month and was 3% from 1 to 2 months in group (A) while it was 1.5 % before treatment to 1 month and was 0.4% from 1 to 2 months in group (B) as revealed by Table (3) and Fig. (5).

Serum Urea Level:

As regard to serum Urea level, the percentage of change was 1.9 % before treatment to 1 month and was 1.5 % from 1 to 2 months in group (A) while it was 3.8 % before treatment to 1 month and was 2.3% from 1 to 2 months in group (B) as revealed by Table (3) and Fig. (5).

Six Minute Walk Test:

As regard to distance walked in 6 minutes, the percentage of change was 5.97% before treatment to 1 month and was 6.12% from 1 to 2 months in group (A) while it was 7% before treatment to 1 month and was 6.48% from 1 to 2 months in group (B) as revealed by Table (3) and Fig. (5).

Table (3): Percentage of changes for both groups after treatment.

Variables	Group (A)		Group (B)	
	From before treatment to 1 month	From 1 month to 2 month	From before treatment to 1 month	From 1 month to 2 month
Creatinine level	3.7%	3%	1.5%	0.4 %
Urea level	1.9%	1.5%	3.8	2.3%
Distance walked in 6 min	5.97%	6.12%	7%	6.48%

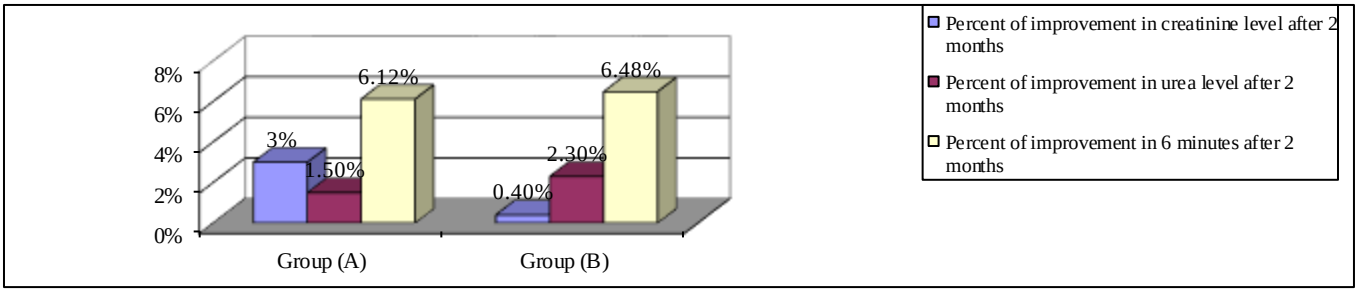

Fig. (5): Percentage of change after 2 months in both groups.

Comparison in measured variables between both groups:

Table (4): Results of comparison between group A and group B by independent t-test.

Variables		Before treatment	After 1 month	After 2 months
Creatinine level	Group (A)	7.56±1.6	7.28±1.56	7.5±1.41
	Group (B)	7.15±1.42	7.04±1.48	7.07±1.39
	P -value	0.46	0.66	0.4
	Significance	NS	NS	NS
Urea level	Group (A)	138.86±19.47	141.6±16.68	139.46±13.16
	Group (B)	134.33±21.67	139.46±20.08	136.2±23.85
	P -value	0.55	0.75	0.64
	Significance	NS	NS	NS
Distance walked in 6 min	Group (A)	306.13±49.11	324.4±54.81	344.26±58.18
	Group (B)	300.53±50.52	321.73±52.43	342.6±46.73
	P -value	0.76	0.89	0.93
	Significance	NS	NS	NS

Serum Creatinine Level:

The results of the current study revealed no statistical significant difference between both groups in Serum Creatinine level before treatment (P-value = 0.46), after 1 month of treatment (P-value = 0.66), and after 2 months of treatment (P-value = 0.4), Table (4) and Fig. (6).

Serum Urea Level:

The results also showed no statistical significant difference between both groups in serum Urea level before treatment (P-value = 0.55), after 1 month of treatment (P-value = 0.75), and after 2 months of treatment (P-value = 0.64), Table (4) and Fig. (7).

Six Minute Walk Test:

There was non- statistical significant difference between both groups in 6 min walk test before treatment (P-value = 0.76), after 1 month of treatment (P-value = 0.89), and after 2 months of treatment (P-value = 0.93), Table (4) and Fig. (8).

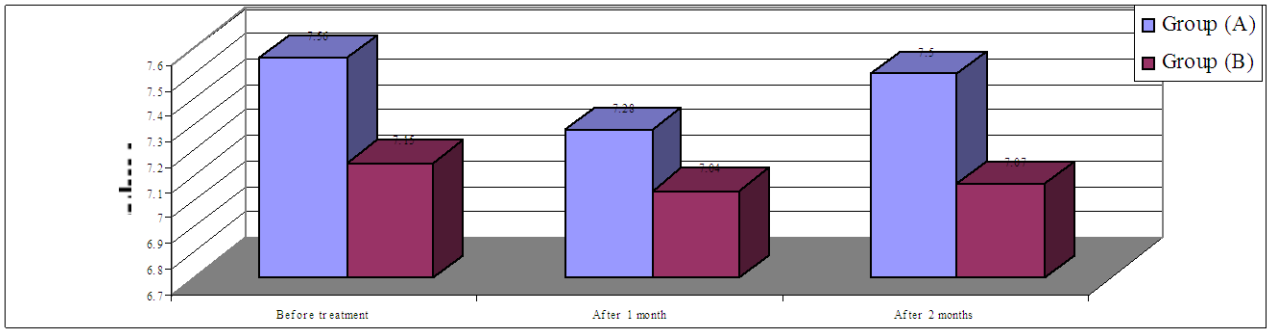

Fig. (6): Change in mean values in serum creatinine level between both groups.

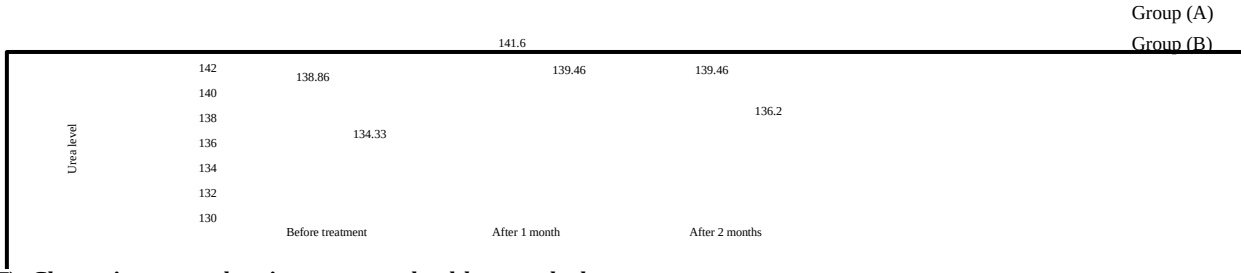

Fig. (7): Change in mean values in serum urea level between both groups.

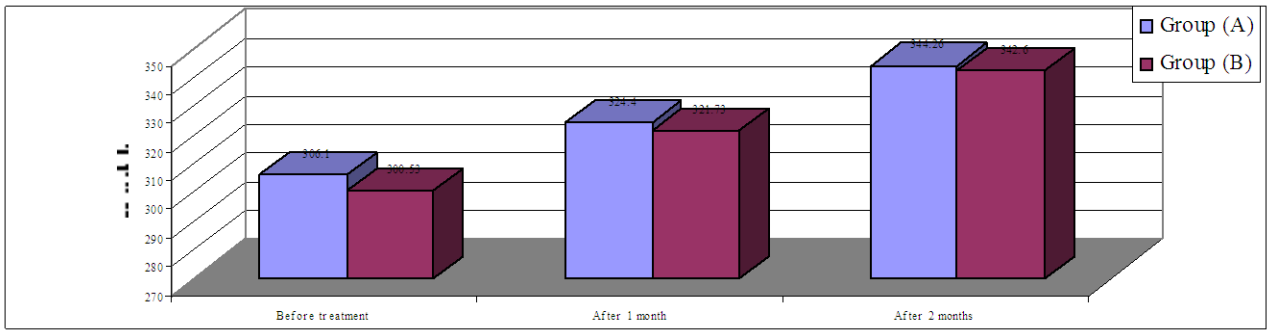

Fig. (8): Change in mean values in 6 min walk test between both groups.

DISCUSSION

The present study showed that 8 weeks of neither supervised aerobic training during hemodialysis sessions nor unsupervised home training program had significant effects on uremic toxins such as urea and creatinine levels after 2 months of the training program. However, 6 min walk distance showed a statistical significant improvement after one and two months for both groups. The results of 6 min walk distance of the supervised aerobic training group Group A showed an improvement after one month of the treatment which reached 5.97%, while at the period between one & two months the improvement reached 6.12%. Moreover, the results of the unsupervised home training group Group B showed an improvement after one month of the treatment reached 7%, while at the period between one & two months the improvement reached 6.48%. However there was no significant difference between both groups in 6 min walk distance before treatment, after 1 month of treatment, and after 2 months of treatment.

It had been suggested that exercises improved removal of uremic toxins into vascular compartments during dialysis. Muscular blood flow increased the efflux of urea and cellular permeability to water soluble molecules as creatinine due to exercises induced higher body temperature[25].

The present study utilized cycle ergometer training during hemodialysis session and this comes in agreement with several researches[8,26], who demonstrated that exercises during dialysis can induce significant physiological, functional, and psychological benefits. They have utilized cycle ergometer training as a major component of the exercise regimen. It appeared to be safe and effective when performed during dialysis, however, it was not the preferred modality for reversing muscle catabolism[25]. Those studies also revealed that cycling exercises improved hematocrit value, peak oxygen consumption, quality of life, dialysis efficacy and physical performance.

The results of this study also comes in agreement with the results of Jung et al.,[12] who stated that cycle ergometer or bicycle training was commonly used for aerobic exercise during dialysis sessions. Initial moderate aerobic training progressing to vigorous training for ≥30 minutes in the first 2 hours of dialysis[24] and lasting from 8 weeks to 12 months had many beneficial effects. The exercise program mostly consisted of two or three times a week. It was reported that aerobic exercises improved peak oxygen consumption (VO2peak) in

hemodialytic patients. Johansen et al.,[10] showed that there was about 17% improvement in VO2peak through aerobic exercise lasting from 8 weeks to 6 months in patients with ESRD. In addition, it was reported that 9 weeks of leg-cycling during hemodialysis improved not only cardiopulmonary fitness and endurance but also muscle strength, power, fatigability, and physical function[11,19].

Target heart rate was usually used to assess the intensity of aerobic exercise however; this was not suitable in hemodialysis patients due to autonomic dysfunction. Rating of perceived exertion (RPE) scale was more preferable than other methods especially for hypertensive patients who were depending on beta blockers medications[8].

It should be considered to individualize intensity in those patients. The current study used Borg's 15-point scale which was more suitable for proposing exercise programs for those patients who participating into the study.

Although interdialytic aerobic exercises had better effects on aerobic capacity, Kouidi et al.,[17] reported that an exercise program performed on non-dialysis days resulted in Type 1 and Type 2 muscle fiber hypertrophy (29%) in hemodialysis patients. Furthermore, it increased quality of life, anemia and psychological disorders related to dialysis patients such as depression. Intradialytic program had higher participation effectiveness that improved patients' compliance and maximized adherence to maintain on training program. It provided motivation in structured environments and facilitated easily patients monitoring. It required no additional time commitment by the patients and may relieve the boredom and anxiety associated with dialysis sessions[1,24].

Afshar et al.,[1] suggested that the effects of intradialytic supervised training were better than the training performed by the patients themselves at their homes. In hemodialysis patients, intradialytic programs have been found to achieve higher adherence rates compared to home exercise programs in non –dialysis days.

The results of this study also comes in agreement with the results of Koh et al.,[13], who determined the efficacy of home training program in hemodialysis patients which may be a more cost effective way of conducting an exercise program as many dialysis units are too crowded to allow for intradialytic exercise programs. Furthermore, there were many factors that impede performing aerobic exercises such as nurses' lack of encouragement to exercise due to concerns of equipment-related injury[8,15].

Painter et al.,[23] proposed that greater benefits were obtained from home based exercise program compared to cycling exercise during hemodialysis days.

Previous studies conducted by Kurdak et al.,[18] and Afshar et al.,[1] investigated that exercise during dialysis enhanced dialysate urea removal but not serum urea clearance. Alterations in the modality and the timing of exercise during dialysis may be required to elicit increases in serum urea clearance. It has been suggested that regular exercises may result in reduction in creatinine clearance levels showing unexpected adverse effects of physical exercises on renal functions.

The results of the present study showed no significant changes in uremic toxins in both studied groups through 2 months duration. This may be attributed to that one bout of 30 minutes of exercise during hemodialysis was insufficient to cause a significant increase in serum creatinine and urea removal and this conclusion comes in agreement with previous studies performed by Parsons et al.,[24] who showed that three or two30-minute bouts of exercise substantially elevated the amount of urea removed in dialysate fluid.

The results of the current study also achieved the same results of a study conducted by Parsons et al.,[24] who concluded that combined training can significantly improve exercise capacity in hemodialysis patients such as 6-min walk distance. The results of another study indicated the ability of this population to increase 6-min walk distance and daily step count with a weight-bearing exercise program compared with a non-weight-bearing exercise program. The weight-bearing group showed greater gains than the non- weight-bearing exercise group over time on the 6-min walk distance and average daily step count ($P<.05$). The mean difference between both group over time was 29m for the 6-min walk distance and 1178 steps for the average daily step count[22].

Also, It was found from the study results that patients underwent unsupervised home training program showed a higher improvement in 6 min walk test (but statistically not significant) than patients underwent supervised intradialytic cycling exercise. This may be attributed to the resemblances of this "unsupervised home training program" in the form of walking to the 6 min walk test form.

Other functional performance outcomes were reported including increased maximal walking speed, habitual walking speed and sit-to-stand movement speed[4].

Independence in activities of daily living in the longest trial of exercise training conducted with hemodialysis patients as demonstrated that combined training on non-dialysis days significantly improved the returning to work after 1 and 4years of training[4].

CONCLUSION

From the obtained results, it can be concluded that both intradialytic aerobic exercises and interdialytic home training program improved physical performance in hemodialysis patients. However, no significant changes occurred in uremic toxins such as serum creatinine and urea levels.

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الملخص العربي

التدريبات الهوائية أثناء جلسة الغسيل الكلوي
مقابل برنامج التدريب المنزلي على الأداء البدني لمرضى الغسيل الكلوي

يعانى مرضى الكلي المزمنة المتقدمة ، خاصة بعد الغسيل الكلوي على المدى الطويل من انخفاض الأداء البدني الذي يرتبط مع زيادة معدل الوفيات . ممارسة التدريبات الهوائية أثناء عملية الغسيل الكلوي أو في غير أيام الغسيل الكلوي يمكن أن تؤدى إلى تحسن نتائج كثيرة مثل تحسين الأداء البدن ي والأنشطة المتعلقة بالوظيفة.وكان الغرض من هذه الدراسة تقييم تأثير التدريبات الهوائية أثناء عملية الغسيل الكلوي مقابل برنامج التدريب المنزلي على الأداء البدن ي لمرضى الغسيل الكلوي.وانتظم ثلاثين مريض من الرجال الذين تلقوا الغسيل الكلوي المنتظم وعمرهم يتراوح من 40 إلى 50 سنة في هذه الدراسة.وتم تقسيم المرضى إلى مجموعتين؛ تلقت المجموعة الأولى التمارين ثلاث مرات في الأسبوع لمدة شهرين والمجموعة الثانية مارست برنامج تمارين منزلي ثلاث مرات في الأسبوع لمدة شهرين.تم تقييم مستوى كرياتينين ومستوى اليوريا في مصل الدم، واختبار 6 دقائق سيرا على الأقدام قبل وبعد شهر وبعد شهرين من العلاج . وقد أظهرت نتائج هذه الدراسة تحسن لا يعتد به إحصائيا في مستوى كرياتينين ومستوى اليوريا في المجموعة الأولى و الثانية بعد العلاج لكلا الفريقين أما مسافة 6 دقائق سيرا على الأقدام أظهرت تحسنا كبيرا بعد الشهر الأول والتلي للمجموعة الواحدة. في المجموعة (أ) كانت نسبة التحسن بعد شهر من بداية العلاج 5.97% ، بينما في الفترة من شهر إلى شهرين وصلت نسبة التحسن 6.12%، في المجموعة (ب) كانت نسبة التحسن بعد شهر من بداية العلاج 7% ، بينما في الفترة من شهر إلى شهرين وصلت نسبة التحسن 6.48% ، ومع ذلك لا يوجد فروق ذات دلالة إحصائية بين كلا المجموعتين في مسافة 6 دقائق سيرا على الأقدام قبل وبعد شهر واحد وبعد شهرين من العلاج.وقد وجد أن التدريبات الهوائية أثناء جلسة الغسيل الكلوي و برنامج التدريب المنزلي قام بتحسين الأداء البدني لمرضى الغسيل الكلوي .

الكلمات الدالة : التدريبات الهوائية أثناء جلسة الغسيل الكلوي - برنامج التدريب المنزلي - واختبار 6 دقائق سيرا على الأقدام - الغسيل الكلوي .