Effectiveness of Intradialytic Leg Exercise on Dialysis Efficacy among Patients Undergoing Hemodialysis

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ABSTRACT

Introduction: *CKD is known to be a universal health problem because of its increasing prevalence and incidence all over the world. Once the kidney stops working, patients cannot sustain life without kidney dialysis or transplantation.* ***Aims:*** *The aim is to determine the effect of exercise during hemodialysis on the efficacy of dialysis among CKD patients in KFHU.* ***Settings and Design:*** *A quantitative experimental design was used in this study. The study was conducted in the hemodialysis unit in KFHU, KSA.* ***Methods and Material:*** *A total number of 30 adult patients who fulfilled the inclusion criteria were selected randomly from Hemodialysis unit. Then, they were divided equally (15 each) into experimental and control groups. In the study group, a six weeks leg exercise program was conducted. Whereas the control group were receiving the routine dialysis care. Data were tabulated and analyzed using SPSS version 16.* ***Results:*** *Statistical significant improvement was seen in blood urea nitrogen in the study group. Also, there was a slight improvement in the hemoglobin level. Whereas, there was no significant difference in the creatinine, URR and the calcium levels.* ***Conclusions:*** *It can be conclude that leg exercise during hemodialysis shows statistical significant improvement in the blood urea nitrogen during the follow up period of studied group. Regarding creatinine, URR and calcium level, and the findings did not show significant difference. This can be explained by the fact that the follow up period was too short to identify the effect of exercise upon the previously mentioned values.*

Keyword: - *Chronic renal failure, Haemodialysis, Adequacy of dialysis, Exercise during dialysis.*

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1. Introduction

Chronic kidney disease (CKD) is known to be a universal health problem because of its increasing prevalence and incidence all over the world [1,2]. ESRD has been increasing rapidly in the last three decades among the Saudi population with highest prevalence in the Western region [3]. Also, the numbers are expected to increase as in 2014, 136 per million populations (PMP) were recorded of having ESRD (SCOT, 2014) [4]. Similarly, in the United states, Kidney disease is affecting more than 20 million Americans and the incidence rates are expected to increase by 2 % yearly [5]. Moreover, the prevalence is expected to increase to 14.4 % in 2020 and up to 16.7 % in 2030 from 13.2 % that was obtained in 2014 [6,7].

Many studies have shown that hypertension and diabetes are the most common causes of chronic renal failure [3,8,9,10]. In ESRD the patient is unable to survive without a renal replacement therapy either dialysis or kidney transplantation [11'12]. Renal replacement therapy is considered a burden for the patients. It is a time consuming, costly and once the patient starts it, it may continue for years or for life [13]. Hemodialysis is commonly used as renal replacement therapy among peritoneal dialysis or kidney transplantation. More than 2 million patients are treated with hemodialysis in around 28,500 dialysis units all over the world. The goal of hemodialysis is to remove excess fluid and waste products (uremic toxins) from the blood through the dialyzer and to return a clear and filtered blood back to the patient [14].

Adequacy of dialysis means the delivery of a treatment dose that is considered efficient to promote optimum long-term outcome. This is usually measured by urea removal and known as urea reduction ratio (URR) or by the treatment index Kt/V. URR is a simple and accepted method for dialysis adequacy. In order for adequate dialysis to take place, it is recommended that URR being equal to or more than 65% [15,16].

The role of exercise in CKD patients is very important and it has a positive effect on physiological and functional function [17,18]. It is recommended by the National Kidney Foundation (NKF) that patients on dialysis therapy maintain physical activity with a goal of 30 minutes of moderate intensity activity in most of the days [19]. Another recommendation by Kidney Disease: Improving Global Outcomes (KDIGO) CKD clinical practice guideline is to do exercise for at least 30 minutes 5 times a week minimally [20]. A large and increasing number of studies showed the benefit of exercise during dialysis and indicated the improvement on those patients. A study was conducted in Saudi Arabia by (Bayoumi, M. M., Saleh, J., & Wakeel, A., 2015) showed that the efficacy of dialysis and quality of life among hemodialysis patients improved with an exercise program performed during the dialysis sessions [19]. Furthermore, a study performed by (Golebiowski, T., et al., 2012), revealed that cycle exercise during dialysis is safe and no direct complications were observed even with old patients or multiple comorbidities [21].

Several experts (Motedayen, Z. et al. 2014; Mihaescu, A. et al. 2013; Gołębiowski, T. et al., 2012) have proven that exercise during hemodialysis is safe, easy and shows significant changes in physical and psychological conditions, which positively influencing their social life [21,22,23,24]. During hemodialysis session, patients spend 3 to 4 hours connected to dialysis machine without doing any activity. They come to dialysis 3 times a week thinking only of the length of the procedure and how bored they will be. Also, they think of the complications and the effect of dialysis. So, incorporating exercise in the dialysis not only showing physical improvement. But also has a positive psychological effect [22].

1.1 Aim of the study

The aim of the study is to determine the effect of exercise during hemodialysis on the efficacy of dialysis among chronic kidney disease patients in KFHU.

1.2 Research Hypothesis

We hypothesize that patients undergoing exercise during hemodialysis will experience improvement in dialysis efficacy.

1.3 Material and Methods

A quantitative experimental design (Pretest-posttest design) was used in this study. The study was conducted in the hemodialysis unit in King Fahad Hospital of the University (KFHU), AlKhobar, Eastern Province, Kingdom of Saudi Arabia. A total number of 30 adult patients who fulfilled the inclusion criteria were selected randomly from Hemodialysis unit. Then, they were divided equally (15 each) into experimental and control groups. Patients who were 20 to 60 years old, being under dialysis for more than 3 months, receiving hemodialysis 3 times per week and compliant on dialysis therapy were included in the study. Where patients with unstable cardiovascular condition, unstable hemodynamic parameters, ambutated lower limbs, with joint replacement or lower limb fractures or had any contact precautions were excluded from the study.

An assessment tool was developed by the researcher based on review of related literature. This tool consisted of the following sections: **Section I** addressed the socio-demographic data of the patients as age, gender, nationality, marital status, education, and occupation. These data was obtained from the medical file and by interviewing the patients. **Section II** addressed medical history. It was including the diagnosis of the disease and whether the patients had any comorbidities. Also, it included the first dialysis session and dialysis access. These data were collected by interviewing the patients. **Section III:** was related to blood tests results. The included tests were Hemoglobin, creatinine, Blood Urea Nitrogen (BUN), Urea Reduction Ratio (URR), Calcium and Lactic Acid Dehydrogenase (LDH). Those data were collected three times during the study (before starting the exercise program, after 3 weeks and after 6 weeks of the program). **Section IV** included the vital signs (Temperature, blood pressure, heart rate and respiratory rate) that were taken before starting the dialysis session as a base line reading. Then, once dialysis started (BP, HR, RR) were taken every 30 minutes. Those data were collected by observation of the cardiac monitor.

Ethical permission for the study was obtained from University of Dammam ethical committee. Also, official permission from the hospital administrator and from the director of hemodialysis unit was obtained to conduct the study. A written informed consent from each patient was obtained. Content Validity of the assessment tool was checked by five experts in both medical and nursing field and needed modifications were done namely rephrasing and utilizing simple samatics for the statement phrases.
The reliability of the tool was determined by test and retest method. A pilot study was carried out on 5 patients in order to assess the clarity and applicability of the tool. This helped in estimating the needed time to obtain the data and complete the form. The researcher noted that the tool is applicable and feasible.

A list of all patients who met the inclusion criteria was made and divided into 2 lists. One with the male patients and another with female patients. Patients were randomly divided into 2 groups (study and control). Each group consisted of 15 patients (10 males and 5 females), in a way where the odd numbers from each list pertained to the control group and the even numbers were related to the study group. All patients were assured that their information would be kept totally confidential and their anonymity is ensured. They were informed that whenever they wished they could leave the study.
The demographic and medical data have been obtained and recorded for each patient in both groups. This data was the first data to be obtained before starting the exercise program, it was collected once. Data collection started from March 22 to May 5, 2016.

In the study group, a six weeks leg exercise program was conducted. Each session lasted for 25 minutes during dialysis. It was done three times a week. The program was explained in details for each patient. The leg exercise program involved the following :

- Each session began with 5 minutes warm up (extension, flexion, internal and external rotation (for the hip, knee and ankle).
- Then, 5 minutes cycling on the cycle ergometer.
- After that, rest for 5 minutes.
- Another 5 minutes cycling on cycle ergometer.
- Finally, the ecercise ends with 5 minutes cooling down (stretching).

1. The exercise program was performed during the first 2 hours of dialysis session and with patients on supine position to avoid intradialytic hypotension.
2. During exercise, the patients were monitored and connected to a cardiac monitor. Blood pressure, heart rate and respiratory rate were monitored.
3. All patients were observed by the researcher during the exercise program.
4. The patients were frequently asked whether they were experiencing any problem such as pain, headache, dizziness, fatigue or chest pain during exercise.
5. Furthermore, the patients were told to notify and stop exercise if they felt the following problems : headache, dizziness, nausea, exhaustion, palpitations or any other problems.

On the other hand, the control group were receiving the routine dialysis care. For both groups, data were recollected using the same tool after three weeks, then after 6 weeks (end of the program). All data were obtained and the lab results recorded and compared with normal levels.

Data Analysis
After data collection, it was coded and entered to the computer. Statistical Package for Social Sciences (SPSS program version 16) was used for data presentation. Data were analyzed using descriptive statistics, which included frequency, percentage, mean, and standard deviation.

2. Results
A total of 30 patients were included in this study.
Part I: Characteristics of the Sample:

1. **Socio-Demographic Data:**

Table 1: Distribution of the studied subjects according to their Socio-demographic data.

Item	Study (n=15)		Control (n=15)		P Value
	Number of Cases	Percentage	Number of Cases	Percentage	
Age					
Min-Max	20 – 57		23 – 54		z=0.707
Mean ±SD	41.8±1.2		44.7±1.2		p = 0.5
Median (IQ)	43 (24)		52 (24)		
Gender					
Male	10	66.7 %	10	66.7	Chi-square = 0
Female	5	33.3 %	5	33.3	P = 1.000
Marital Status					
Single	6	40 %	4	26.7 %	$X^2_1 = 0.600$
Married	7	46.7 %	11	73.3 %	P = 0.4
Divorce	1	6.7 %	0	0	
Widow	1	6.7 %	0	0	
Education					
Illiterate	0	0	3	20 %	
Elementary	0	0	2	13.3 %	FETp = 0.2
Intermediate	1	6.7 %	0	0	
Secondary	9	60 %	6	40 %	
Diploma	2	13.3 %	0	0	
Bachelor	3	20 %	4	26.7 %	
Occupation	3	20 %	4	26.6 %	FETp = 1
Working	12	80 %	11	73.4 %	
Not Working					
Nationality					
Saudi	12	80 %	14	93.3 %	FETp = 0.6
Non Saudi	3	20 %	1	6.7 %	

Table (1) shows the value of mean age for both groups. As regards gender, it was observed that two third of the sample (66.7%) in the two groups were male. Regarding marital status it was observed that less than half (46.7 %) in the studied group were married while the majority in the control group were married (73.3 %). In relation to the level of education, it was noticed that more than half (60 %) of patients in the studied group were secondary school education as compared to the control group (40 %). It also shows that majority of the population was not working in both the studied and control group (80% and 73.4%) respectively. Moreover, it shows that the majority of patients in both groups studied and control were Saudi (80 % and 93.3 %) respectively, with no significant difference among all items.

Table 2: Distribution of the studied subjects according to their medical history

Item	Study N (%)	Control N (%)	Test
Age at Diagnosis			
Min-Max	14 – 56	23 – 54	z= 0.768
Mean ±SD	37.3 ± 1.3	44.7 ± 1.2	p= 0.5
Median (IQ)	41 (23)	52 (24)	
Duration of Disease			
Min-Max	0 – 14	0 – 11	z= 0.506
Mean ±SD	4.5 ± 4.2	4.6 ± 3.2	p= 0.6
Median (IQ)	4 (6)	4 (6)	
Comorbidities			
DM	4 (26.7 %)	6 (40.0 %)	X^2=0.600 p=0.4
HTN	10 (66.7 %)	10 (66.7 %)	X^2=0 p=1
Dialysis Access			
Left arm AVF	4 (26.7%)	8 (53.3 %)	X^2=0.536
Left Arm Perm. Cath.	1 (6.7 %)	0 (0.0)	p=0.5
Right Arm AVF	3 (20.0 %)	1 (6.7 %)	
Right IJ Perm. Cath.	7 (46.7 %)	6 (40.0 %)	

Table (2) illustrate that the mean age at diagnosis of the studied group was (37.3) while in the control group was (44.7) with no statistical significant difference between them (p=0.5). In addition, the observed mean in the studied group was (4.5) and (4.6) in the control group in relation to the duration of disease. It also shows that more than half of patients (66.7%) in both groups were having Hypertension (HTN). Almost half of the control group patients were with left arm AVF access (53.3%) while less than half the studied group patients were with right IJ permanent catheter (46.7). No significant difference was noticed between both groups.

Part II: Blood Test Results:

A. Haemoglobin Levels of blood:

Table 3: Comparison of HGB level before starting exercise, after 3 weeks and after 6 weeks between the two groups

Median			
HGB	**Study**	**Control**	**Test (z)**
Before	**10.6**	**10.5**	**p=0.8**
After 3 Weeks	**10.9**	**11.1**	**p=0.9**
After 6 Weeks	**11.7**	**11**	**p=0.2**
Test (Friedman)	**X^2=5.069** **P=0.08**	**X^2=0.933** **P=0.6**	

Table (3) shows that there is no statistical significant difference between both groups as regards the hemoglobin level during the whole period of the exercise program. However, HGB level improved from (10.6) to (10.9) to reach (11.7) for study group. While in control group it was also improved from (10.5) to (11.1).

B. Blood Creatinine Level (BCL):

Table 4: Comparison of BCL level before starting exercise, after 3 weeks and after 6 weeks between the two groups

Median			
BCL	**Study**	**Control**	**Test (z)**
Before	**4.1**	**4**	**z=0.021** **p=1**
After 3 Weeks	**4.4**	**3.8**	**z=1.224** **p=0.2**
After 6 Weeks	**4.3**	**3.2**	**z=1.597** **p=0.1**
Test (Friedman)	**X^2=4.983** **P=0.143**	**X^2=1.254** **P=0.5**	

Table (4) illustrates statistical insignificance among the studied and control group in the median creatinine levels before, after 3 weeks and after 6 weeks of leg exercise (p=1, p=0.2 and p=0.1) respectively.

C. Urea Reduction Ratio (URR):

Table 5: Comparison of URR before starting leg exercise, after 3 weeks and after 6 weeks between the two groups

Mean			
URR	**Study**	**Control**	**Test**
Before	**69.2**	**71**	**t=0.444** **p=0.7**
After 3 Weeks	**70.1**	**70.6**	**t=0.182** **p=0.9**
After 6 Weeks	**67.5**	**72.5**	**z=1.458** **p=0.2**
Test (Friedman)	**X^2=3.085** **P=0.2**	**X^2=0.241** **P=0.9**	

Table (5) shows that there was no statistical difference between both groups as regards URR during the time of the study before, after 3 & 6 weeks of leg exercise.

D. Calcium (Ca):

Table 6: Comparison of calcium level before starting exercise, after 3 weeks and after 6 weeks between the two groups

Median			
Calcium	**Study**	**Control**	**Test (z)**
Before	**8**	**8.1**	**p=0.5**
After 3 Weeks	**8.5**	**8.1**	**p=0.4**
After 6 Weeks	**8.2**	**8**	**p=0.4**
Test (Friedman)	**P=0.143**	**P=0.7**	

Table (6) shows the median blood calcium levels, results shows no statistical difference between the studied and control groups during the follow-up period.

E. Blood Urea Nitrogen (BUN):

Table 7: Comparison of BUN level before starting exercise, after 3 weeks and after 6 weeks between the two groups

Median			
BUN	**Study**	**Control**	**Test (z)**
Before	26	15	z=2.680

			p=0.007*
After 3 Weeks	24	15	z=2.429 p=0.02*
After 6 Weeks	19	13	z=1.868 p=0.06
Test (Friedman)	X^2=18.717 P=<0.001*	X^2=0.464 P=0.8	
Wilcoxon Before & After 3 weeks Before & After 6 weeks After 3 & 6 weeks	z=3.219 p=0.001 z=3.078 p=0.002 z=2.527 p=0.01		

- * Indicates a significant association (p=value<o.o5)

Table (7) shows the median BUN in both groups. Statistical significance difference was found between the two groups before exercise and after 3 weeks (p=0.007 and p=0.02) respectively. Also it raveled statistical significance during the follow up period of the studied group (p= <0.001) in comparison to the control group (p=0.8).

Table 8: Improvement of the BUN during the follow up period in both groups

BUN	**Improved** **N (%)**	**Not Improved** **N (%)**	**Test**
Study	12 (80.0%)	3 (20.0 %)	X^2=2.400 P=0.1 NNT=4
Control	8 (53.3 %)	7 (46.7 %)	

Table (8) presents the percentage of number of cases improvement in both groups as regards BUN. (80 %) of studied group improved compared to (53.3 %) in the control group but it is not statistically significant (p=0.1). Moreover, number needed to treat (NNT) was 4 representing that exercise is implemented in 4 cases in order to avoid 1 not improved case.

F. Lactate Dehydrogenase:

Table 9: Comparison of LDH level before starting exercise, after 3 weeks and after 6 weeks between the two groups

Median			
LDH	**Study**	**Control**	**Test (z)**
Before	**1.7**	**2**	**z=0.726**

			p=0.5
After 3 Weeks	**1.8**	**1.9**	**z=0.187** **p=0.9**
After 6 Weeks	**1.8**	**1.9**	**z=0.539** **p=0.6**
Test (Friedman)	**X^2=5.103** **P=0.08**	**X^2=0.966** **P=0.6**	

Table (9) shows the median in LDH among the studied and control groups. No statistical significant difference was noticed between both groups.

3. Discussion

Chronic Kidney disease is a progressive and gradual loss of kidney function, which is commonly caused by diabetes and hypertension. The glomerular filtration rate is below 15 mL/min/1.73 m^2 to be diagnosed with end stage renal disease (ESRD) [25]. Early management of chronic kidney disease patients and referral is a key component in order to preserve kidney function and delay complications [26].

Once the kidney stops working, patients cannot sustain life without kidney dialysis or transplantation. Hemodialysis (HD) is one of the methods that are used to remove waste and excess fluid from the body, it is considered as an artificial kidney. Hemodialysis is always a stressful condition to the patients who undergo the procedures of frequent dialysis. Since mobility is limited for the patients undergoing dialysis, many studies put forward the importance of physical activity among them. It is well known that exercise improves muscular activity, which leads to increased blood circulation, subsequently increases the flux of urea, creatinine and other excretory products from the tissue to the blood stream [27]. In despite of the number of many studies that was conducted in proving the benefits of exercise, exercise during dialysis is not implemented in many countries [19].

The results of the present study revealed that there was no significant difference between age, sex, education, occupation, and marital status between the studied and control groups. These findings are consistent with the results obtained by (Mohseni, R., et al.) who reported that there was no significance difference among the intervention group who performed aerobic exercise for 15 minutes per day, three times a week for two months; and the control group in relation to age and sex [28]. Similarly, a total of 66 patients were involved in a study conducted by (Motedayen, Z et al., 2013) where the study group participated in an exercise program twice a week for two months. The study indicated that there is no difference statistically between the study and control subjects as regards age, sex, occupation, education and marital status [22].

In relation to the most common cause of ESRD among the participants, the results of the present study showed that hypertension was the most common comorbidity in both groups. This finding was in line with Esgalhado, M. et al., 2015 who mentioned that hypertension was the highest among the causes of ESRD [29]. On the other hand, Musavian, A. et al., (2014) demonstrated that diabetes mellitus was the highest [30]. The result of the present study showed a slight improvement in the hemoglobin level among the studied group, this was in line with the findings of Musavian et al (2015) who stated that hemoglobin was higher than the base line data among the study group [30]. Furthermore, the findings of Mohseni, R. et al (2013) was in contrast with the findings of the present study where the hemoglobin levels did not change on the studied group [28].

Moreover, the findings of the present study revealed that the calcium level did not show significant change compared to the base line data among the studied group, which was in contrast with Mohamed Soliman (2015) findings that showed decrease in the calcium level among the studied group [31]. In relation to the creatinine level,

the finding of the present study was supported by Ribeiro, R., et al., (2013) finding which reported a slight increase in the creatinine level among the studied group [32]. Furthermore, the finding was in contrast with Esgalhado et al and Kong et al finding which demonstrated statistically significant decreased in creatinine after implementing the exercise program among the exercise group [33,34]. Furthermore, a recent study conducted in Egypt by (Soliman, H., et al., 2015) that engaged 30 patients in which 18 of them practiced exercise for 15 minutes per day for two months, observed that intradialytic leg exercise (ILE) resulted in an improvement of electrolytes like calcium, and improvement of creatinine, urea and hemoglobin levels [31]. This comes into accordance with the findings of many studies resulted that intradialytic exercise program has a significant improvement in urea clearance leading to improved dialysis efficacy [24,28,34,35].

The finding of the present study showed that there was no statistically significant improvement in URR among the studied group. Although, there was improvement in the median URR after 3 weeks of implementing the exercise program in comparison to the baseline data. Similarly, Parsons TL., et al., (2004) stated that exercise during dialysis enhanced dialysate urea removal but not serum urea clearance [36]. In regards to the BUN, the finding of the present study showed statistical significance difference between the studied and control groups before exercise and after 3 weeks. Also, it raveled statistical significance during the follow up period of the studied group in comparison to the control group. Those findings are consistent with the findings of Sun, Y., et al., (2002) which showed that BUN decreasing rate was statistically higher among the exercise group in comparison to the control group [37]. Also, the finding of the present study showed no changes as regards LDH in both groups. The study showed a positive feedback concerning the effect of the exercise program on the patients' quality of life. The following are some comments stated by the patients "I was not able to climb the stairs from the ground to the first floor without being exhausted, but after this program I am capable of climbing up to the third floor without being tired", "After the first week of exercise, I am able to walk without my cane", " I can sleep on both sides now after doing exercise, before I cannot sleep on left side because of pain in my leg". Moreover, one patient mentioned that, "Before the exercise program, I was not able to sleep well at night. But after starting this program, I can sleep comfortable now".

Accordingly, Molsted, S., et al., (2013) reported that a16 weeks resistance training among patients undergoing dialysis increased the muscle strength along with a change in neuromuscular function [38]. This was supported also by the findings of Wu Y et who stated that a personalized exercise program during hemodialysis regular sessions is statistically significant in improving exercise tolerance and health related quality of life in uremic patients in a short period of time [39].

4. Conclusion:

It can be conclude that leg exercise during hemodialysis shows statistical significant improvement in the blood urea nitrogen during the follow up period of studied group.
Regarding hemoglobin, creatinine, Urea reduction ratio and calcium level, the findings did not show significant difference. This can be explained by the fact that the follow up period was too short to identify the effect of exercise upon the previously mentioned values.

5. Recommendations:

The present study recommended that further researches are needed with higher number of subjects and a longer follow up period in order to determine the effect of exercise during hemodialysis on the efficacy of dialysis.

6. Limitations of the Study:

- Limited number of subjects.
- Short period of follow up.

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