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Effect of weight bearing exercise on ionized calcium level in hemodialysis patients

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Abstract
Background: Chronic kidney disease (CKD) is a type of kidney disease in which there is gradual loss of kidney function over a period of months to years. Initially there are generally no symptoms; later, symptoms may include leg swelling, feeling tired, vomiting, loss of appetite, and confusion. Complications include an increased risk of heart disease, high blood pressure, bone disease, and anemia.[1]. In hemodialysis patients, special causes of variations are well known in association with dialysis-induced changes, hemoconcentration, subsequent hemodilution (albumin variation), interdialytic interval, vitamin D and calcium intake, PTH related disorders and bone resistance to PTH action.[2] Blood calcium measurement is recommended in patients on HD. The Kidney Disease Improving Global Outcomes (KDIGO) foundation recommends the measurement of Ionized Ca levels if possible. [3]. Exercise encourage calcium absorption in bone. Like muscles bones respond to increase of blood flow and it is thought that the increased circulation prompted by exercise transports of vital nutrients and minerals such as calcium to bones.[4]
Purpose: The purpose of the study was to determine the effect of weight bearing exercise on ionized calcium status in hemodialysis patients.
Subject and Methods: thirty patients who diagnosed as chronic renal failure with age ranged from 30 to 60 years were selected randomly from Hemodialysis Unit of Ain Shams General Hospital. Only who agreed to be volunteers participated in this study and were randomized into two groups of equal number, 15 patients for each group, Group (A) received weight bearing exercise through walking on treadmill for30mintes,3times/week for 12 successive weeks plus their medical care.Group (B) control group not received any exercise just their medical care.,
Parameters: Laboratory assessment (ionized calcium) before the initiation of the training program and after the completion of the study (after 12 weeks).
Results: The results showed that there was a statistically significant increase in ionized calcium of group (A) with a percentage of improvement that reaches
Conclusion: It can be concluded that weight bearing exercise is very important for hemodialysis patients

Keywords: hemodialysis, lipid profile, renal failure, aerobic exercise, resistance exercises

Introduction
CKD is the progressive deficiency of renal function for months and years. Complications include an increased risk of heart disease, high blood pressure, bone disease, and anemia [5]. CKD limits functional capacity, leading to cardio-vascular complications, and endocrine-metabolic, musculoskeletal problems [6]. Osteoporosis and renal osteodystrophy may coexist in elderly patients with CKD, which makes the issue problematic to define. Osteoporosis in CKD is only a part of the constellation of metabolic bone problems. Therefore, its diagnosis and management may differ from general population. Bones are more severely affected in CKD than that from normal aging [7]. Patients with CKD have low levels of physical fitness and function. Their aerobic capacity tends to be only half of that of normal, their strength is low, and they are likely to have problems with mobility and basic activities of daily living. They have an increased incidence of diabetes mellitus, anemia, peripheral vascular disease, hypertension, coronary artery disease, and stroke. Because of electrolyte imbalance and other factors, individuals usually complain of pain, fatigue, and muscle weakness in the spine, hips, knees, and lower extremities. The pain worsens with weight-bearing activities [8]. Exercise encourage calcium absorption in bone. Like muscles bones respond to increase of blood flow and it is thought that the increased circulation prompted by exercise transports of vital nutrients and minerals such as calcium to bones [4]. Hemodialysis patients should be encouraged to begin a walking program at non dialysis days, starting with 10 to 30 min/d, 3d/wk at a moderate difficulty level as tolerated, then be encouraged to increase their walking time to at least 30 min on 3 d/wk or more, keeping the intensity at a moderate level (or a perceived exertion of "somewhat hard") [9] Weight bearing exercise is more adapted to improve bone mass than any other physical activity, they play a dual role in stressing the bones as they put both gravitational and muscular stress on bones [10].

Material and Methods
Subjects
- Thirty male volunteer patients who established chronic haemodialysis and were stable for a minimum of two months selected randomly from Ain Shams General Hospital, Haemodyalysis unit and classified into two groups each one had 15 patients.
- Their ages ranged from 30-60 years
- Each patient had signed consent form.

Exclusive criteria

Participants were excluded if they met one of the following criteria:

- Unstable blood pressure.
- Congestive heart failure.
- Hyperkalemia > 6 mmol/l.
- Hypokalemia < 3.5 mmol/l.
- Severe osteoporosis.
- Marked anemia. (Ht<25%).
- Serious peripheral vessel disease.
- Marked emotional lability.
- Muscloskeletal deformation.

Evaluation procedures

- All patients were evaluated pre-treatment and post-treatment for:

Laboratory investigation measuring ionized calcium that carried out before the initiation of the training program and after the completion of the study (i.e after 12 weeks)

Treatment procedure

Group A: (Weight bearing exercise group)

- This group of patients composed of fifteen patients who received weight bearing exercise program during non-dialysis days through walking on treadmill for 30mintes,3times/week for 12 successive weeks in addition to their medical care.
- The program of treatment consists of three phases:

Warming up phase

Patient will walk on treadmill for five minutes at a low speed to allow conditioning of the body for the exercise.[11]

Training phase

The patient will gradually increase walking until it reaches the initial intensity of 65-70% of the maximum heart rate (estimated from Karvonen formula MHR= 220-age) for 20 minutes [11].

Cooling down phase

Patient will walk on treadmill for five minutes at lowest speed [11].

Statistical procedure

Descriptive statistics and unpaired t-test were conducted for comparison of age between both groups. Normal distribution of data was checked using the Shapiro-Wilk test. Unpaired t-test was conducted to compare the mean values of ionized calcium between the study and control groups. Paired t-test was conducted for comparison between pre and post treatment in each group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA) [12].

Results

Subject characteristics

Thirty male patients with hemodialysis participated in this study. The mean ± SD age of the study group was 48.2 ± 8.27 years, with maximum value of 60 years and minimum value of 30 years. The mean ± SD age of the control group was 49.66 ± 9.81 years, with maximum value of 60 years and minimum value of 30 years. There was no significance difference between both groups in the mean age values ($p = 0.66$).

Effect of treatment on ionized calcium

- ***Within group comparison***

There was a significant increase in ionized calcium post treatment compared with that pre- treatment in the study and control groups ($p > 0.001$). The percent of increase in ionized calcium in the study group was 67.64%, while that in the control group was 31.34%. (table 1, figure 1).

- ***Between groups comparison***

There was no significant difference in ionized calcium between both groups pre-treatment ($p > 0.05$). Comparison between both groups post treatment revealed a significant increase in ionized calcium of the study group compared with that of the control group B ($p > 0.001$). (table 1, figure 1).

Table 1: Mean ionized calcium pre and post treatment of the study and control groups

	Stud group	Control group			
	$\underline{x}$± SD	$\underline{x}$± SD	MD	t- value	p value
Ionized calcium (mmol/L)					
Pre treatment	0.68 ± 0.12	0.67 ± 0.1	0.01	0.15	0.87
Post treatment	1.14 ± 0.05	0.88 ± 0.09	0.26	9.58	0.001
MD	-0.46	-0.21			
% of change	67.64%	31.34%			
t- value	-15.38	-9.02			
	p = 0.001	*p = 0.001*			

$\underline{x}$, mean; SD, standard deviation; MD, mean difference; p-value, probability value

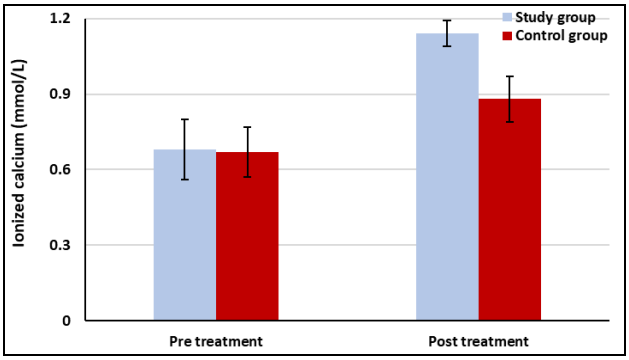

Fig 1: Mean ionized calcium pre and post treatment of the group A and B.

Discussion

This study was designed to evaluate the effect of weight bearing exercise on ionized calcium of hemodialysis patients and it was conducted on thirty patients undergoing hemodialysis in Ain Shams general hospital dialysis unit, their ages ranged between 45 and 60 years. Patients were randomly assigned into two equal groups: group A (weight bearing group) composed of 15 patients received exercise training during non-dialysis days treatment using electronic treadmill. Ionized calcium was measured to both groups prior to treatment and after 3 months of treatment for both groups.

The results of the study showed that, The pre-treatment results of the present study showed that there is no significant difference between the mean values of ionized calcium of both groups.

While, the post-treatment results of this study showed increase in mean value of ionized calcium for weight bearing group (A) than that of controlled group (B)with a percentage of improvement 67.64%, 31.34% respectively by (0.0001) p- value.

The results of our study supported by the following studies, Aucella *et al*. [13] reported that exercise is beneficial in ameliorating cardiovascular risk factors such as hypertension, dyslipidemia, hyperglycemia, obesity, inflammation, and oxidative stress. Moreover, it has been reported that inactivity is associated with the development of major CKD precursors, including albuminuria, reduced glomerular filtration rate and initiates diabetes.

Mauney *et al*. [14] stated that walking is weight bearing activity that has its impact on bone and bone marrow., so there is a close relation between bone tissues and hematopoietic processes.

Dimo *et al*. [10] have found that weight bearing exercise in forming of walking on treadmill at intensity of 80% of maximal heart rate more adapted to improve bone mass than any other physical activity. Weight bearing activities have a dual role in stressing the bones as they put both gravitational and muscular stress on bones.

Brooke *et al*., [4] stated that exercise encourage calcium absorption in bone. Like muscles bones respond to increase of blood flow and it is thought that the increased circulation prompted by exercise transports of vital nutrients and minerals such as calcium to bones.

Capitanini *et al*., [15] exercise has beneficial effects on functional capacity, anemia, cardiovascular risks factors, dyslipidemia, and psychosocial problems. However, few patients are able or willing to participate in an exercise training program organized on an outpatient basis. Several studies have been performed regarding the effects of various exercises in hemodialysis patients, it has been suggested that exercise could improve solute removal during dialysis by increasing muscle blood flow, which results in greater efflux of uremic toxins into the vascular compartment

Ling *et al*, [16] Hemodialysis patients should be encouraged to begin a walking program at non dialysis days, starting with 10 to 30 min/d, 3d/wk at a moderate difficulty level as tolerated, then be encouraged to increase their walking time to at least 30 min on 3 d/wk or more, keeping the intensity at a moderate level (or a perceived exertion of "somewhat hard") (Kouidi, *et al*., [17] Exercise with sufficient bone-loading force such as repetitive weight-bearing aerobic (walking, aerobics) and resistance training are effective in improving BMD in the general adult population.

Snow and Marcus [18] stated that weight-bearing physical exercise has been shown to preserve and also increase bone mass. Disuse is detrimental to bone and reduced physical activity is most likely one of the major reasons for the increase in the rate of hip fractures during the last 30 years

The study was limited to physical and psychological conditions of the patients that might affect the evaluation and treatment and the ability of the patients to apply the treatment procedures.

Conclusion

It was concluded that application of a 3 months weight bearing exercise by treadmill in hemodialysis patients resulted in improvement in ionized calcium and so decrease risk of fractures and enhance physical performance.

Future studies and Recommendations

The results of this study have indicated a need to consider the following recommendations:

1. Further researchers are needed to study effect of exercises in hemodialysis patients at different age group.
2. Further researchers are needed to study exercise effects on quality of life in hemodialysis patients.
3. Further researchers are needed to study exercise effects on psychological condition in hemodialysis patients
4. Further researchers are needed to study effect of weight bearing exercise on physical performance in hemodialysis patients.
5. Further researchers are needed to study effect of weight bearing exercise on anemic hemodialysis patients.
6. Conducting similar experiments using other types of weight training exercise programs and comparing them with the results of this study to choose the best treatment method.
7. Conducting similar trials using longer treatment periods.
8. Conducting more similar experiments and increasing patient numbers to obtain better statistical results.

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