Physical therapy during hemodialyse in patients with chronic kidney disease

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Abstract

Introduction: The aim of this study was to evaluate the effects of a physical therapy program in patients with chronic kidney disease (CKD) during hemodialysis (HD). **Methods:** Fifty-six CKD patients participated for 16 months in a supervised physical therapy program in HD sessions. They underwent evaluation before the start of the program and 16 months after this training. The program consisted of muscle strengthening exercises, stretching and stationary exercise bike. The analysis is composed of test six-minute walk (6MWT), level of effort by the BORG scale test of one repetition maximum (1RM) to measure the quadriceps strength, quality of life (QOL) and arterial blood pressure (BP), heart (HR) and respiratory (RR). **Results:** The results showed an increase in distance traveled for the 6MWT and quadriceps strength, reduction of HR and RR and improvement in total score SF-36, but significantly in functional capacity and pain BP reduced, though not significantly. It was found by the Spearman correlation test, only in the areas correralation pain and functional capacity, individually, with the increase in distance walked in 6MWT; correlation between decreases in HR and RR linked to reduction in the Borg scale. **Conclusion:** Physical therapy, through an exercise program during the intradialytic period, can provided a significant improvement of QOL and physical ability of patients with CKD.

Keywords: dialysis; kidney failure, chronic; physical therapy (specialty); quality of life.

Introduction

Chronic kidney disease (CKD) is considered a major public health problem due to its high morbimortality rates.[1] According to the Brazilian Society of Nephrology (SBN) 2008 census, its prevalence in Brazil has been increasing every year, from 59,153 patients on dialysis in 2004, reaching 87,044 patients in 2008.[1]

According to the SBN,[2] CKD is defined as a slowly progressive and irreversible loss of renal functions; a condition in which the kidneys fail to function due to nephron destruction,[1,3] resulting in the body's inability to maintain renal metabolic and electrolyte balance.[4,5] Kidney failure is considered when the glomerular filtration rate (GFR) is less than 60 mL/min./1.73 m^2, for a period exceeding three months; and when it reaches GFR levels below 15 mL/min./1.73m^2 - it is known as terminal CKD.[6] In such stage, the most frequently used kidney replacement strategy is hemodialysis (HD).[4,6,7]

Although advances in HD have improved patient survival, such treatment alone does not guarantee quality of life (QoL) preservation, and some studies have shown significant reductions in the QoL of patients with chronic renal failure under HD.[7] These findings are related to changes found in muscle structure and function, resulting from uremia,[8] which may manifest as atrophy, proximal muscle weakness - predominantly in the lower limbs, difficulty in walking, cramps, weakness, and decreased aerobic performance.[7,8] Hemodialysis is responsible for a monotonous and restricted daily life, limiting the activities of kidney-diseased patients after treatment onset, thus contributing and supporting habits of sedentism, functional disability and inactivity.[9]

Thus, physical activity, identified as an important factor in improving QoL among patients on HD, can improve, among many other conditions, the physical performance in activities of daily living (ADL).[10] Physiotherapy contributes significant to the prevention, progression delay and improvement of various complications in kidney patients.[11] However, the exercise programs for these patients, in most cases, are not performed during HD.[12] Studies show that physical therapy during HD sessions can be a significant part of physical rehabilitation for these patients.[13] Despite being a topic of current relevance, little has been studied regarding the rehabilitation of patients with CKD undergoing HD. Thus, this study was proposed to evaluate the benefits of a physical therapy program employed before and after 16 months to CKD patients during HD.

Methods

Patients and Methods

We evaluated 75 patients (40 men and 35 women) with CKD in HD, from the Dialysis Service of the Department of Nephrology at Felicio Rocho Hospital (HFR) in Belo Horizonte, MG, aged between 29 and 82 years, for more than 3 months under HD, for 3.7h per session in average (minimum of 3.5h and a maximum of 4h) 3 times per week. This study is based on a prospective analysis of a physical exercise program targeted to CKD patients undergoing hemodialysis. The study was carried out after approval from the Ethics Committee of the institution and obtaining a signed informed consent from patients.

We took off the program those patients with previous disease of the respiratory system, neurological diseases, severe cardiovascular diseases, diseases or physical impairments that would invalidate the study (amputation, deep vein thrombosis, active bleeding in the gastrointestinal system) and electrocardiography compatible and indicating possible severe heart disease or myocardial ischemia. Therefore 19 patients were excluded due to changes in their electrocardiogram, as well as those previously classified by the medical service of the hospital as having severe cardiac dysfunctional class III. Thus, the study was carried out with 56 patients: 34 men and 22 women. All patients had at least one comorbidity, among which the most important were: systemic hypertension (59%) and diabetes mellitus (21%). All patients who were using antihypertensive drugs kept their dosages unchanged throughout the study period.

The participants were assessed before the training protocol onset and after 16 months, through the generic Medical Outcomes Study Short-Form 36 (SF-36) questionnaire,[14] the BORG[15] scale of the perceived exertion level, 6-minute walk test (6MWT)[16] and through the manual muscle strength testing of 1 maximum repetition (1MR)[17] for knee extensors. The physical therapy was performed 5 minutes after the start of HD, with the endorsement from the hemodialysis technician and physician; lasting for 20 minutes. Respiratory and heart rates (RR and HR respectively) and blood pressure (BP) were measured before and after the therapy session. The QoL assessment happened through the generic SF-36 questionnaire.[14] Although this instrument is a self-administered questionnaire, it was applied through direct interviews by the same researcher, so that the patient had no problems to understand the issues. Should there be any doubt, the researcher repeated the question until the patient knew the alternative to choose as the most appropriate answer.

The walk test was performed according to the guidelines from the American Thoracic Society.[18] It was performed on a 30-meter long flat track (hospital hallway), marked by easy viewing white ribbons at every meter. Before starting the tests, the patients were at rest for 10 minutes, sitting down for vital signs stabilization. The test was performed before the hemodialysis session and the patient was instructed to walk for six minutes, from one end to the other, at the highest possible speed. They were assessed at baseline, at 3 minutes and at 6 minutes along the test, with the following vital signs being assessed: BP, HR and RR. Every 2 minutes in the test, the patients were encouraged by standard phrases. During testing, we used a finger pulse oximeter (Onyx 9500 model from Nonin Medical Inc., Minneapolis, MN, USA) for continuous monitoring of oxygen saturation (SpO_2). The level of dyspnea during the 6MWT was assessed using the Borg scale.

The patient was instructed to stop the test when feeling very tired, dyspneic, tachycardic, dizzy or other symptoms of discomfort. The test was also stopped if the SpO_2 levels fell below 85%; however, this never happened during the evaluation or the reassessment. The proposed exercises were performed three times per week for 16 months, lasting for 20 minutes and during the 2 initial hours of HD. The exercise program was designed and performed in this order: 10 minutes in the stationary bike (initial and final two minutes of heating and cooling, respectively), strengthening the upper and lower limbs with weights, medicine ball and Theraband (elastic bands) and passive static stretching exercises. We used dumbbells and the medicine ball to train the fistula vasculature. During the exercise, the limb with the arteriovenous fistula, was submitted to constant monitoring of the arterial and venous fistula pressure using the digital display from the HD machine itself. The stationary bike training was carried out within a target range represented by the HR with limits set at 60-70% of the training HR.[19]

The bicycle training started with zero load, and later on speed and load were adjusted in order to maintain the HR within the previously calculated training zone. According to the best tolerance by patients vis-à-vis this exercise, incremental loads were added and the speed was increased. We recorded BP, HR and SpO_2; and we also assessed the level of perceived exertion using the Borg scale at the beginning, middle and end of the bike training. The patients were instructed to stop exercising when such symptoms occurred: headache, nausea, dizziness, severe muscle fatigue or any other debilitating muscle symptoms. All training sessions were supervised by the physical therapist.

Statistical analysis

The data collected was stored in a database created with Microsoft Excel 2003® software for a later descriptive and comparative statistical analysis of the results. We used the Statistical Package for the Social Sciences, version 16.0 (SPSS 16.0), SPSS Inc., Chicago, IL, USA. The results of the investigated variables were expressed as mean ± standard deviation, and the median value was presented when indicated. To compare the mean distances walked in the 6MWT before and after the physical therapy program, we used the paired *t*-test. We used the *t*-test to check for statistically significant differences between the domain mean values and the total scores of the SF-36 before and after the physical therapy program. For the 1RM test, HR, RR and BP we used the Wilcoxon stations test. Statistical significance was considered when $p < 0.05$. We used the Spearman coefficient to study the correlation between the SF-36 questionnaire scores, the 6MWT distance and the Borg scale, adopting a reliability index of 95% (95% CI) and $p < 0.05$.

Results

The population investigated had 22 women (40%), aged between 29 and 66 years, mean value of 43.5 years; and 34 men (60%), aged between 28 and 82 years, mean value of 56.4 years. We noticed that 42% of the patients were diagnosed as having hypertensive nephrosclerosis; 26% had diabetic nephropathy; 18% had chronic glomerulonephritis and 14% tubule-interstitial kidney disease and other disorders. Hemodialysis lasted been between 3 and 48 months, with an average of 38.2 months for women; and 4 and 60 months, with a mean of 50.9 months for men. The mean duration of hemodialysis for the total study population was 39.6 ± 36 months.

The results of the analysis of the SF-36 questionnaire domains before and after physical therapy intervention are described in Table 1. In assessing the quality of life of the patients, we observed statistically significant improvement only in the areas related to functional capacity and pain.

The bilateral quadriceps muscle strength (MS) value obtained by checking its significance by

Table 1	**Domains of the SF-36 questionnaire, before and after 16 months in the physical therapy program**		
Domains	Before	After	*p*
Functional capacity	55.34 ± 29.03	68.71 ± 26.99	0.030
Limitations by physical aspects	30.43 ± 11.00	36.92 ± 21.57	0.210
Pain	41.51 ± 21.40	51.03 ± 19.71	0.015
General health status	40.49 ± 21.33	35.29 ± 16.80	0.148
Vitality	47.91 ± 20.47	43.64 ± 15.66	0.203
Social aspects	46.71 ± 29.35	47.99 ± 28.43	0.827
Emotional aspects	24.99 ± 12.85	34.22 ± 19.76	0.229
Mental health	52.31 ± 20.93	52.71 ± 14.69	0.923

means of the Wilcoxon test, was a minimum of 3 - before the intervention; and after the intervention, this minimum value obtained was 4. The maximum values before and after therapy were, respectively, 4 and 5 ($p < 0.001$).

Before the patients underwent the physical therapy program, HR, RR and BP were taken as an average value at the beginning of the 6MWT, respectively being: 82.77 ± 15.77 bpm; 18.49 ± 2.06 ipm and 124.57 ± 11.46 mmHg. The mean values at the end of the test were 97.57 ± 16.82 bpm; 22.26 ± 2.46 ipm and 133.43 ± 15.52 mmHg. After 16 months of training, the 6MWT was applied again, and the average values for HR, RR and BP before and after the test were 82.29 ± 14.78 bpm and 93.89 ± 15.71 bpm; 17.23 ± 2.16 ipm and 19.14 ± 2.35 bpm and 124.29 ± 11.19 mmHg and 131.43 ± 13.54 mmHg. The DBP, monitored before and after the physical therapy program, both before and after the TC6M, remained at an average of 80.75 ± 2.46 mm Hg (Table 2).

The differences between the cardiac and respiratory rates (before and after the program) are statistically significant. This means a significant change in the difference between these rates in two distinct measurements. However, there was no significant blood pressure difference.

The Borg Scale scores had a mean initial value of 0.97 ± 0.98 and a median of 0.50. The final Borg Scale had a mean value of 0.43 ± 0.47 and median value equal to the initial, 0.50 ($p < 0.001$). This statistically significant difference between these scores shows that after the physical therapy program the patients were less tired, or less dyspneic to perform the longer 6MWT.

We also noticed that the average distance traveled in the 6MWT before the exercises was 545.57 ± 88.27m, with a median value equal to 545m. After physical therapy, the average distance in the 6MWT was equal to 599.94 ± 87.73 m; and the median of this variable was 612m traveled. Thus, we observe that the distance traveled by the patients after the physical therapy program increased significantly ($p < 0.001$).

To check the distribution of the SF-36 questionnaire scores before and after the program we used the Spearman correlation coefficient, to assess the relationship between scores and the distance traveled by the patient (Table 3). The increase in distance traveled, mean of 54.37m, after the physical therapy program, showed a statistically significant positive relationship at the 5% level, between the SF-36 questionnaire scores: CF and pain. There was a correlation within the 95% CI between decreases in HR and RR, associated with the reduction in the BORG scale ($p < 0.043$). However, there was no correlation between this scale and the BP ($p < 1.192$).

Table 2	**TC6M variables before and after PT**				
Variables	Mean before PT		Mean after PT		*p*
	Before the TC6M	After the TC6M	Before the TC6M	After the TC6M	
HR	82.77 ± 15.77	97.57 ± 16.82	82.29 ± 14.78	93.89 ± 15.71	0,001
RR	18.49 ± 2.06	22.26 ± 2.46	17.23 ± 2.16	19.14 ± 2.35	0,001
SBP	124.57 ± 11.46	133.43 ± 15.52	124.29 ± 11.19	131.43 ± 13.54	0,001
DBP	80.00 ± 1.9	83.00 ± 2.6	79.00 ± 3.05	81.00 ± 2.3	0,080
DP TC6M	545.57 ± 88.27		599.94 ± 87.73 0.00		0,001

PT: Physical therapy program; HR: Heart Rate; RR: Respiratory Rate; BP: Blood Pressure; DBP: Diastolic Blood Pressure; DT TC6M: Distance travelled in the six-minute walk test.

Table 3 Correlation between the distance travelled and the SF-36 quality of life questionnaire domains

Domains	Spearman coefficient	p
Functional capacity	0.820	0.020
Limitation by physical aspects	-0.163	0.349
Pain	0.684	0.013
Overall health status	-0.110	0.529
Vitality	-0.182	0.297
Social aspects	0.074	0.672
Emotional aspects	-0.121	0.490
Mental health	0.066	0.708

Discussion

The results showed that physical exercises proposed, done regularly, even during hemodialysis sessions, brought about an improvement in some parameters studied, such as reduction of HR and RR with BP stabilization, both during resistance and strength training. The significant improvement in quality of life was accompanied by an increase in the tolerance concerning the proposed exercises, reduction in pain levels and improved performance in ADL, such as walking. The 54m increase in the 6MWT after the physical therapy program shows improvement in walking and, concomitantly, in exercise capacity or other tasks that require physical strength.

Was used a stationary bicycle for cardiovascular training for 10 minutes, and weight loads according to the program proposed. Several studies[20,21] found that, after the first two hours of hemodialysis, submaximal exercise using a stationary bicycle may cause or worsen cardiovascular decompensation, such as systemic arterial hypotension. Thus, the aerobic exercise with stationary bicycle happened during the first 2.5 hours of hemodialysis. Aerobic training with the stationary bike contributed to a statistically significant reduction in HR, RR and perceived effort during this practice. The BP did not significantly increase or decrease with this workout; these findings corroborate the findings of other studies;[7,22] however, these authors found reductions in BP.

After noticing a significant effect of reducing the blood pressure, some studies[23] advocate the use of an aerobic program for 2 to 4 years. This happens because of the inaptness of the cardiovascular system of chronic kidney patients in responding to acute exercise. Thus, these adaptations are likely to be more noticeable on a chronic basis. Cardiac neuroreceptors and muscle-skeletal adaptations, just like HR changes and peripheral vasodilation, respectively, result from changes in blood volume, venous return and metabolic demand caused by the type of physical exercise.[24] These adaptations happen rather suddenly, justifying both the data found as the reduction seen after physical therapy, more specifically related to the aerobic workout, and consequently improving the cardiorespiratory capacity linked to a significant lowering in the perceived effort and dyspnoea assessed by the Borg scale.

With the significant improvement seen in muscle strength of the knee extensor muscles, there is indication that training with the exercises brought benefits in ADL that require these muscles, in addition to walking, going up and down stairs - so much present in many everyday situations, such as going in and out of busses. Together with these benefits, chronic renal patients improve their autonomy, personal independence and it provides them with greater social reintegration.[25,26] Studies have shown that physical exercise in patients during hemodialysis may improve muscle disorders, providing them with improvements in lower limb strength and better quality of life.[27-30] Some studies which published data on muscle strength assessment, around 83.3% of them, reported an increase in it (ranging from 15.5% to 82% on average) after 3 months of training. The training regimens in these studies were mild to moderate, ranging from 50% of 1RM and 5 to 85% of 3RM. These facts allow us to assume that, even at lower training intensities, muscle strength (MS) gains may occur in most individuals, which would reduce the negative impact generated by decreased physical activity in this population.[12]

As for the evaluation of quality of life, before the program, the results of the SF-36 questionnaire showed impairment in all areas analyzed. There was an improvement in total scores, in 28%, according to various studies described in the literature.[28] Increments in the significant mean values within the SF-36 questionnaire, after the program, were CF and pain, i.e., all related to the physical components. These dimensions mainly evaluate performance on ADLs at work, feeling of hopelessness, lack of energy and pain - symptoms which are directly and frequently related to the biggest complaints of chronic renal patients. The increase in the scores of these two domains of the SF-36 questionnaire after physical therapy suggests, primarily through the analysis of Spearman correlations, that physical exercise, through increased functionality (MS and other variables employed in this physical therapy program), were important to improve the perception of their physical status, as well as interaction, integration and rehabilitation of the individual in everyday social life. Our results corroborate those from several other studies that have reported only improvements in physical function,[31] which infers the improvement of QoL is mainly due to the results of the physical components worked through aerobic and anaerobic exercises during HD.[32]

Conclusion

Based on the results obtained in this study, which corroborate other studies in the literature, we noticed that physical therapy, based on an exercise program during hemodialysis, could provide significant improvements in the quality of life and physical capacity of patients with chronic renal failure.

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