Functional Capacity and Quality of Life in Patients with Chronic Kidney Disease In Pre-Dialytic Treatment and on Hemodialysis - A Cross sectional study

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Abstract

Introduction: Chronic kidney disease (CKD) infers directly in functional capacity, independence and therefore quality of life (QOL). **Objective:** To compare the physical fitness and quality of life of patients with chronic kidney disease submitted on hemodialysis (G1) and pre-dialysis treatment (G2). **Methods:** A cross-sectional study, 54 patients with CKD, 27 of the G1 group (58.15 ± 10.84 years), 27 of G2 group (62.04 ± 16.56 years). There were cardiovascular risk factors, anthropometric measurements, respiratory muscle strength was measured by the inspiratory pressure (MIP) and expiratory (MEP) maximum measured in the manometer, six-minute walk (TC6'), cardiopulmonary exercise test, sit and stand one minute test (TSL1') and the Short-Form Questionary (SF-36) to assess QOL. The patients presented disease of stage between 2 and 5. It was applied the Kolmogorov-Smirnov normality test and used the *t* (Student) test or the U (Mann Whitney) test to compare the means of quantitative variables and the chi-square Pearson test and Fisher's exact test for qualitative variables. Pearson's or Spearman's test was used to identify correlations. **Results:** No statistically significant difference was found between G1 and G2 in VO2peak (p = 0,259) in TC6' (p = 0,433) in the MIPmáx (p = 0,158) and found only in the MEPmáx (p = 0,024) to G1. The scores of the SF-36 in both groups showed a worse health status as evidenced by the low score in scores for QOL. **Conclusion:** Patients with CKD had reduced functional capacity and QOL, and hemodialysis, statistically, didn't have showed negative repercussions when compared with pre-dialysis patients.

Keywords: health evaluation; hemodialysis, home; quality of life; renal dialysis.

Introduction

The increase in chronic degenerative diseases has placed chronic kidney diseases (CKD) as one of the greatest challenges of public health, which is considered both a social and an economic problem worldwide, associated with numerous comorbidities and high public health costs.[1,2] Thus, surveillance is paramount to avoid increasing this endemic situation because the clinical expression of chronic diseases usually occurs after long exposure to risk factors and living with the silent disease yet undiagnosed.[3]

Patients with chronic kidney disease have enjoyed an increase in survival, due to the use of kidney replacement therapies.[4] The kidney replacement therapy of choice is a successful kidney transplant; however, hemodialysis and peritoneal dialysis have similar outcomes and represents the most used treatment.[5] Despite this, studies have shown the negative impact the disease and the treatment have on the cardiorespiratory and musculoskeletal systems and the very quality of life (QOL) of patients;[6-10] thus impacting their physical and mental health, [1,11] their activities,[12,13] independence, overall well-being and social interaction.[14] This causes reduced functional capacity and reduced muscle strength in these patients.[11,15-18] Several studies have shown that respiratory muscle function may be impaired in heart failure (HF),[15] in diabetics,[14,19] in chronic obstructive pulmonary disease (COPD)[16,17] and in individuals with CKD[11,18] already in regular hemodialysis.

Studies have also shown that CKD patients on hemodialysis develop physical changes,[9,20,21] and the same is observed in patients with CKD undergoing renal transplantation;[22] and those patients not yet on dialysis.[23] Thus, this study aims to compare the functional capacity and quality of life of chronic kidney failure patients on hemodialysis (G1) and pre-dialysis patients (G2).

Methods

This study was characterized as descriptive and cross-sectional, in which there were differences in the profile of CKD patients in pre-dialysis phase compared to those undergoing hemodialysis treatment. The study was designed in accordance with the Guidelines and Norms Regulating Research Involving Human Subjects, according to the National Council of Health (CNS) No. 466/11; and it approved by the Ethics Committee of the Regional University of the Northwest of Rio Grande do Sul on the advice embodied No. 187.1/2011.

The study included patients in pre-dialysis CKD and in hemodialysis, of both genders, over 18 years of age, clinically stable and with medical authorization allowing the performance of physical tests. The study excluded patients with associated chronic obstructive pulmonary disease, congestive heart failure, infectious diseases, those unable to understand and perform the test procedures, those who did not sign the consent form, and those who did not complete the assessment protocol or could not be contacted.

Assessment Protocol

The subjects' information was collected from an interview and direct examination. We collected data regarding risk factors, anthropometric measurements, respiratory muscle strength, six minutes walking test (6MWT), cardiopulmonary exercise test (CPT), muscular endurance of the lower limbs and quality of life. The patients had disease stages between 2 and 5 and we did not analyze the variables by disease stage. Upon starting the study, the participants were submitted to an assessment protocol, as described below.

Risk factors and anthropometric measures

We investigated CKD cause, risk factors for cardiovascular disease (physical inactivity, *diabetes mellitus*, smoking, alcohol consumption, hypertension, age higher than 60 years). We also measured the subjects' weight (kg), height (cm), body mass index (BMI = weight/height^2), abdominal (AC: cm) and hip (HC cm) circumferences.[24]

Respiratory muscle strength (RMS)

We used a pressure transducer (MVD-500 V.1.1 Microhard System, Globalmed, Porto Alegre, Brazil), to assess inspiratory and expiratory muscle function, determining the maximal inspiratory pressure (MIP) and maximum expiratory pressure (MEP) carried out according to the study from Dall'Ago *et al*.[15] and the expected value was calculated based on the paper by Neder *et al*.[25]

Sumaximal functional capacity (SFC)

Submaximal functional capacity evaluation was carried out through the six-minute walk test (6MWT), according to the recommendations of the American Thoracic Society (ATS),[26] in which we measured the longest distance the individual was able to cover within a six-minute walking interval and we calculated the predicted distance walked.[27]

Cardiopulmonary exercise testing

The cardiopulmonary exercise test (CPET) or maximal incremental exercise test was performed on a treadmill (Imbrasport Porto Alegre, Brazil), with a ramp protocol (initial speed of 1 km/h and end speed of 6 km/h; initial slope of 0% and 10% final slope) and the exhaled gases were analyzed every 20 seconds through a gas analyzer (Total Metabolic Analysis System, TEEM 100, Aero Sport, Ann Arbor, Michigan). Arterial blood pressure (ABP) was measured every 3 minutes with a sphygmomanometer. Heart rate (HR) was determined through the R-R interval using a 12-lead electrocardiogram. The cardiopulmonary test variables were calculated as described by Dall'Ago *et al.*[15] In short, peak VO_2 was defined as the highest value reached during the test for 20 seconds, and the peak circulatory power was calculated as the product of peak VO_2 and peak systolic pressure.[15] Oxygen consumption recovery kinetics was evaluated as the time required for 50% decrease from the peak VO_2 ($T_{1/2}$ peak VO_2) and calculated using the minimum squares mathematical model according to Dall'Ago *et al.*[15] All patients continued with the medication commonly prescribed by the doctor to perform the CPET.

Lower limbs muscular strength

We used the one-minute sitting and standing test (1'SST), in which the individual was asked to sit in a chair with his back resting on the seat, then get up without using the arms, extending the knees and then sit again with his back against the chair. The patient should stand up the most times possible within a minute.

Quality of life (QOL)

To measure QoL we used the Medical Outcomes Study 36-Item short- Form Health Survey (SF-36). This questionnaire is a generic tool used to broadly and completely assess quality of life. It consists of 36 items encompassing eight dimensions, namely: functional capacity (ten items); physical aspects (two items); emotional aspects (three items); pain (two items), general health (five items); vitality (four items); social aspects (two items); mental health (five items) and one further question comparing current health status and that of a year ago, which is extremely important for understanding the patient's disease. This instrument assesses both negative aspects (disease) as the positive aspects (wellbeing); it yields a final score from 0 to 100, where zero corresponds to the worst general health status and 100 to the best state of health.[28]

Statistical analysis

Data was processed in the SPSS statistical package (version 18.0, Chicago, IL, USA). The descriptive analysis is presented as mean ± standard deviation, relative and absolute frequency. For quantitative variables we used the Kolmogorov-Smirnov normality test and also the *t* test (Student) or the U test (Mann Whitney) to compare the means. For qualitative variables, we used the Pearson's chi-square and Fisher's exact tests. To correlate variables we used the Pearson's test or the Spearman's. A p value ≤ 0.05 was considered significant.

Results

From a total of 121 patients with CKD who underwent hemodialysis in a hemodialysis unit in the interior of Rio Grande do Sul state, 27 patients were enrolled in the study. Of the 121 patients, 15 did not complete the assessment; four were bedridden; 1 was visually impaired; 2 were hospitalized; 32 refused to participate in the study and 40 patients were out of reach; thus, 27 patients entered the study. Of the 60 patients with pre-dialysis CKD, 8 did not complete the evaluation; 3 were bedridden; 1 hospitalized; 5 refused to participate in the study and 16 patients could not be reached. Thus, the total sample comprised 54 patients with CKD, who made up two groups, G1: CKD patients undergoing hemodialysis and G2: patients in pre-dialysis CKD (Table 1).

TABLE 1 CHARACTERISTICS OF CKD PATIENTS ON HEMODIALYSIS (G1) AND PRE-DIALYSIS (G2)

	G1 (n = 27)	G2 (n = 27)	Total	*p*
Age (years)	58.15 ± 10.84	62.04 ± 16.56	60.09 ± 14	0.313¥
Gender (male/female)	19/8	17/10	36/18	0.564¢
Weight (Kg)	72.49 ± 11.72	72.01 ± 14.75	72.25 ± 13.2	0.897¥
Height (m)	1.63 ± 0.07	1.62 ± 0.09	1.62 ± 0.08	0.510£
BMI (kg.m^{-2})	27.16 ± 4.13	27.43 ± 4.56	27.29 ± 4.31	0.924£
Obesity n (%)				≤ 0.001†*
Low weight	0 (0)	16 (59.3)	16 (29.6)	-
Normal	8 (29.6)	5 (18.5)	13 (24.1)	-
Overweight	12 (44.4)	2 (7.4)	14 (25.9)	-
Obese grade I	6 (22.2)	4 (14.8)	10 (18.5)	-
Obese grade II	1 (3.8)	0 (0)	1 (1.9)	-
AC (cm)	96 ± 17.08	98.02 ± 13.58	97.03 ± 15.28	0.675£
HC (cm)	97.84 ± 7.62	100.76 ± 9.18	99.33 ± 8.5	0.213¥
RC/Q	0.97 ± 0.15	0.97 ± 0.10	0.97 ± 0.12	0.401£
CKD etiology				0.006†*
Diabetes and Hypertension	3 (11.2)	11 (40.80)	14 (25.7)	-
Hypertension	2 (7.4)	6 (22.2)	8 (14.8)	-
Unknown	10 (37.0)	0 (0)	10 (18.6)	-
Others	12 (44.4)	10 (37)	22 (40.9)	
Time in HD (months)	34.11 ± 22.90	-	34.11 ± 22.90	-
CVRF n (%)				
Inactivity	24 (88.9)	22 (81.5)	46 (85.2)	0.704†
DM	11 (40.7)	14 (51.8)	25 (46.3)	0.283†
Smoking	12 (44.4)	10 (37)	22 (40.8)	0.208†
Alcoholic	1(3.7)	1 (3.7)	2 (3.7)	1.000†
Hypertension	22 (81.5)	24 (88.9)	46 (85.2)	0.704†
Age > 60 years	13 (48.1)	16 (49.3)	29 (53.7)	0.413¢

G1: CKD patients submitted to dialysis; G2: CKD patients in pre-dialysis; DM: *Diabetes Mellitus*; CVRF: Cardiovascular risk factors; AC: Abdominal circumference; HC: Hip Circumference; W/H ratio: Waist to Hip ratio; BMI: Body Mass Index; HD: Hemodialysis; ¢ Pearson's chi-square test; † Fischer's exact test; ¥ Student-*t* test; £ Mann Whitney U test; * $p \leq 0.05$, Statistically Significant.

Age and gender characteristics were similar in both groups. Our analysis regarding the mean anthropometric, weight, height, BMI, WC and HC variables, also yielded similar values; however, when we ranked the patients according to BMI, there was a statistically significant difference between classes, with more overweight and obesity in the group submitted to hemodialysis and low weight only seen in patients who did not undergo hemodialysis (59.3%). CKD etiology was predominantly diabetes and hypertension (Table 1).

Chronic renal failure patients had changes in respiratory muscle strength in both groups, both MIP and the MEP; however, this reduction was more representative in MIP (70.23% of predicted). Comparing both groups, we noticed that the patients submitted to hemodialysis already had weak respiratory muscles (MIP ≤ 70% predicted),[13] as well as MEP, a statistically significant difference ($p = 0.024$) (Table 2). In the functional capacity analysis, we noticed that there were no significant differences in both groups, both in distance traveled as in lower limbs muscle endurance (1'SST) (Table 2).

There was no correlation between MIP and the distance covered on the six-minute walk test (r = 0.189/$p = 0.171$), sit up test (r = 0.041/$p = 0.768$),

Table 2 Respiratory muscle strength, submaximal functional capacity and lower limb muscle strength for G1 and G2 groups

	G1	G2	Total	p
IPMax (cmH_2O)	63.81 ± 34.08	75.44 ± 32.63	69.63 ± 33.57	0.158£
IPMax % of predicted	64 ± 34.7	76.45 ± 28.09	70.23 ± 31.89	0.154¥
EPmax (cmH_2O)	68.11 ± 40.40	90.41 ± 32.67	79.26 ± 38.09	0.024£*
EPmax % of predicted	64.47 ± 37.68	88.43 ± 24.07	76.45 ± 33.57	0.015£*
6MWT - dist. (m)	418.67 ± 117.3	395.63 ± 95.90	407.15 ± 106.75	0.433¥
6MWT % of predicted	80.81 ± 20.70	80.51 ± 20.27	80.66 ± 20.29	0.957¥
1'SST (no of standings)	20.67 ± 5.91	18.81 ± 6.34	19.74 ± 6.14	0.100£

G1: CKD patients submitted to hemodialysis; G2: Pre-dialysis CKD patients. IP_{max} = maximum inspiratory pressure; EP_{max} = maximum expiratory pressure; 6'WT = 6-minute walk test; 1'SST: one-minute seat and stand up test; ¥ *t*-student Test; £ Mann Whitney U test; * $p \leq 0.05$, statistically significant.

VO_2max (r = 0.197/*p* = 0.170) and duration of hemodialysis (r = -0.195/*p* = 0.329). There was a significant correlation ($p < 0.001$) between the 6MWD 'with VO_2max (Figure 1).

Figure 1. Correlation between 6'WT and peak VO_2. 6'WT: distance of the 6 minute walk test; Peak VO_2: Peak of oxygen consumption.

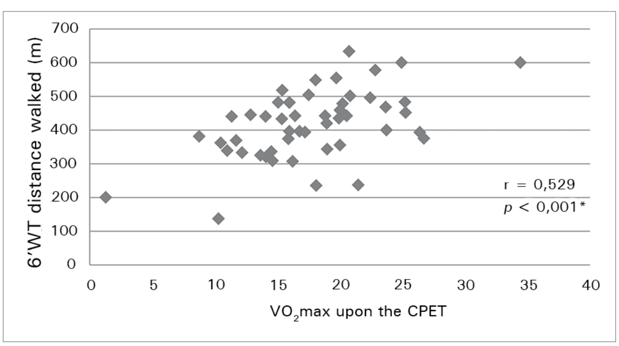

Table 3 shows the results of cardiopulmonary exercise testing between G1 and G2. In both groups we had low values at peak exercise, in the submaximal ventilatory response and in the kinetics of gas exchange recovery. However, the peak VO_2 value and the gas exchange recovery kinetics of pre-dialysis patients were higher, although not statistically significant.

The SF-36 quality of life questionnaire yielded low scores in both groups, and there were no statistically significant differences between the groups, except for the mental health dimension in G1 (Table 4).

Discussion

In this study, we noticed that CKD patients undergoing hemodialysis had inspiratory muscle weakness (IP_{max} ≤ 70% predicted). Regardless of the group, all had reduced submaximal and maximal functional capacities, demonstrated by the decrease in distance walked in the 6MWT and peak VO_2 obtained from the cardiopulmonary exercise testing, respectively.

We found a decrease in respiratory muscle strength (MIP and MEP) in both groups, but with a higher impact on the group already on hemodialysis. This result corroborates the findings from Bohannon *et al.*[29] and Kettner-Melsheimer *et al.*,[30] which confirmed 30% to 40% muscle strength reduction in patients undergoing dialysis, when compared with individuals not receiving dialysis.

The reduced functional capacity observed in this study is also described in this population by other papers.[23,31,32] Coelho *et al.*[23] demonstrated that children and adolescents with CKD undergoing conservative treatment may present significantly impaired functional capacity, respiratory musculature and nutritional status. Similarly, Jatoba *et al.*,[31] evaluated 27 patients with CKD, found significant and directly proportional impairment in ventilatory muscle capacity, with effect and

Table 3 Cardiopulmonary exercise test of CKD patients in hemodialysis (G1) and pre-dialysis (G2)

	G1 (n = 27)	G2 (n = 27)	*p*
Peak exercise			
Peak HR (bpm)	125.50 ± 31.31	135.29 ± 23.41	0.216¥
Peak ABP (mmHg)	175.43 ± 28.0	170.0 ± 23.2	0.456¥
Peak DBP (mmHg)	86.09 ± 11.57	91.85 ± 11.45	0.050£*
Peak VO_2 (L/min.)	1.21 ± 0.35	1.33 ± 0.48	0.307£
Peak VO_2 (ml/Kg/min.)	16.91 ± 4.82	18.43 ± 6.15	0.344¥
VE (L/min.)	40.87 ± 11.28	45.87 ± 11.19	0.127¥
Peak R	1.04 ± 0.08	0.99 ± 0.09	0.066¥
Peak circulatory power,			
(mmHg.ml O_2. $Kg^{-2}.min^{-1}$)	105.03 ± 32.57	124.60 ± 51.78	0.112¥
Ventilatory response			
$VE/VO_{2\ peak}$	34.96 ± 7.48	33.85 ± 8.50	0.097¥
$VCO_{2\ peak}$ (L/min.)	1.27 ± 0.36	3.40 ± 6.21	0.378£
$VE/VCO_{2\ peak}$	33.78 ± 7.12	37.07 ± 8.21	0.111£
Gas Exchange recovery			
T ½ VO_2(min)	104.20 ± 42.22	84.55 ± 26.46	0.107£
Exercise duration (min)	9.09 ± 2.75	8.91 ± 2.64	0.904£

G1: CKD patients submitted to hemodialysis; G2: Pre-dialysis CKD patients; Peak VO_2 = peak oxygen consumption; HR: Heart rate; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; VE: Ventilation; peak VCO_2: Peak carbon dioxide production; R peak = Peak respiratory exchange ratio; VE/VCO_2: Carbon dioxide and ventilation ratio; VE/VO_2: Oxygen consumption and ventilation ratio; T1/2 = Time required for a 50% drop in VO_2 after the peak; ¥ Student *t*-test; £ Mann Whitney U-test; * $p \leq 0.05$, statistically significant.

Table 4 Quality of life of ckd patients in dialysis (G1) and pre-dialysis (G2)

Domain	G1 M ± DP	G2 M ± DP	Total M ± DP	*p*
Functional Capacity	57.50 ± 24.22	46.11 ± 22.46	51.70 ± 23.82	0.082¥
Physical Aspect	37.5 ± 33.35	43.52 ± 32.96	40.57 ± 32.97	0.487£
Pain	59.48 ± 24.63	59.37 ± 25.81	59.42 ± 25.0	0.945£
General Health Status	63.52 ± 18.62	57.33 ± 22.25	60.43 ± 20.56	0.302£
Vitality	65.56 ± 20.58	57.04 ± 22.67	61.30 ± 21.87	0.135£
Social Aspects	77.74 ± 24.85	63.22 ± 32.86	68.98 ± 29.43	0.272£
Emotional Aspects	51.85 ± 41.74	51.85 ± 39.65	51.85 ± 40.32	0.993£
Mental Health	67.11 ± 20.07	53.81 ± 10.42	60.46 ± 17.20	0.003£*

G1: CKD patients submitted to hemodialysis; G2: Pre-dialysis CKD patients. M: Mean, SD: Standard Deviation; ¥ Student *t*-test; £ Mann Whitney U test; * $p \leq$.,05, statistically significant.

functional impairment in physical performance by significantly reducing the walking distance compared to the predicted values; a reduction of 38.2% in MIP and 29% in MEP compared to the predicted values. The study by Moreira *et al.*[32] reported that patients who underwent CPET obtained aerobic capacity corresponding to half of that obtained by normal subjects. Only 16% of patients would have aerobic capacity equivalent to sedentary healthy individuals. In their study, they further reinforce that low physical performance - which explains the low rates of social rehabilitation, and these hemodialysis patients would have improved their QOL if subjected to a physical rehabilitation program.

Whether in hemodialysis or not, the patients in this study had a low test time and peak VO_2 below 20 ml/kg/min, with no statistical difference between the groups. Sietsema *et al.*[33] reported that peak VO_2 values higher than 17.5 ml/min/Kg are a strong and important predictor of survival for CKD patients, demonstrating that exercise capacity assessment is essential when monitoring individuals with CKD. Within this analysis, patients who did not undergo hemodialysis have strong survival predictor, unlike those already in hemodialysis.

CKD Patients on hemodialysis had reduced functional capacity, which can hinder the performance of basic activities, leisure, work and social life, thus reducing their quality of life. In this study, both groups had impaired health status showed by low quality of life scores.[34] Hemodialysis alone did not change the worsening in quality of life scores; it is rather a possibility of life for these patients. This fact highlights the importance of adopting measures to improve the quality of life of these patients as soon as diagnosed with CKD, when hemodialysis is still not required.

The questionnaire domains that had the lowest values in both groups were functional capacity and the physical aspect. We noticed that patients who are not in hemodialysis, because of their awareness of disease progression, worsening of their disease and a possible inclusion in hemodialysis - which can change their whole lives - can explain their already poor quality of life and compromise their mental health. Even before hemodialysis, CKD is a disease that hinders physical health, often because of the associated comorbidities, anemia, etc.

Barbosa *et al.*[34] showed a significant lowering in the quality of life of CKD patients under HD, especially with regards to the physical aspect, which is consistent with the results of other Brazilian studies[35,36] using the same instrument of measurement, in which there is a predominance of better scores regarding the mental component (AS, AE and SM) and worst regarding the physical component (especially AF) in patients with CKD undergoing regular HD. It should be noted that in this study, mental health in group 1 (hemodialysis) was more impaired because it was effectively the only quality of life aspect with statistical significance between the groups.

According to Mittal *et al.*,[37] CKD impacts QOL more intensely than other chronic diseases such as heart failure, chronic obstructive pulmonary disease and rheumatoid arthritis. Note that physical aspects and functional capacity are the individual's perception of the results in relation to their QOL and these are in agreement with the findings from the physical assessment obtained by the 6MWT and cardiopulmonary exercise testing. Together with this, these patients have cardiovascular risk factors, regardless of the groups. This confirms the need to propose to these patients physical and psychological interventions as a therapeutic treatment that can reverse or ameliorate this worsening in physical and mental states in CKD. Thus, the physical therapy that works with different types of diseases, both in hospitals as in outpatient wards, may help in the treatment of these aspects in these individuals improving their physical performance.

Conclusion

Through these analyses, we noticed that in both groups there was a reduction in functional capacity and quality of life. Therefore, patients who do not require hemodialysis treatment have also shown a reduction in their physical condition and quality of life. This reinforces the need for physical rehabilitation, in which physical therapy plays a key role to reverse or ameliorate the physical condition of these patients.

It should be noted that this study is limited by its small sample size; it was carried out in a single center; the analysis did not consider CKD stage, we did not have information on the drugs used by the patients - which can have a direct impact on their functional capacity and on test results, such as beta-blockers. Therefore, a prospective study, following the same patients from their conservative treatment all the way to HD would show us the impact of the disease throughout its evolution.

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