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Physical, functional, and cardiorespiratory analysis of patients on the kidney transplant waiting list: a cross-sectional study

Análise físico funcional e cardiorrespiratória de pacientes em lista de espera para o transplante renal: estudo transversal

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RESUMO | INTRODUÇÃO: Para o tratamento da doença renal crônica os pacientes necessitam de hemodiálise ou diálise peritoneal enquanto aguardam em lista de espera pelo transplante renal. Apesar dos avanços nos procedimentos de diálise, os pacientes que fazem esse tratamento apresentam baixa capacidade física e funcional e comorbidades que influenciam no tempo de espera. **OBJETIVO:** Descrever as características físicas, antropométricas e cardiorrespiratórias de pacientes em lista de espera para o transplante renal, assim como, analisar as variáveis de acordo com o tempo em lista de espera e tempo de diagnóstico da doença. **MATERIAIS E MÉTODOS:** Estudo transversal, descritivo e analítico, submetido e aprovado pelo Comitê de Ética em Pesquisa da UNIJUÍ parecer n° 1.992.013. Foram avaliados 11 pacientes cadastrados no Hospital de Caridade de Ijuí, quanto aos dados sobre a doença renal e seu tratamento, tempo em lista de espera, fatores de risco cardiovasculares, resistência muscular de membros inferiores, força muscular respiratória e capacidade funcional submáxima. **RESULTADOS:** Foram avaliados 11 pacientes, sendo 54,5% do sexo feminino, média de idade de 51,9±11,4 anos, 45,5% tinham doença renal de origem hipertensiva, tempo de diagnóstico da doença de 84,0 (48,0-180,0) meses, 90,9% realizavam hemodiálise há uma mediana de 15,0 (8,0-41,0) meses e estavam em lista de espera há 12,0 (6,0-32,0) meses. Os fatores de risco cardiovasculares mais prevalentes foram hipertensão e sedentarismo. No teste de sentar e levantar em um minuto realizaram 17,0 (16,0-22,0) repetições, pressão inspiratória máxima de 62,0 (50,0-80,0) cmH_2O, pressão expiratória máxima de 78,0 (64,0-99,0) cmH_2O e percorreram 452,5 (416,1-503,2) metros no teste de caminhada em seis minutos. **CONCLUSÃO:** Os pacientes cadastrados em lista de espera para o transplante renal do nosso estudo apresentaram uma boa condição físico funcional e cardiorrespiratória. O tempo de diagnóstico da doença renal se correlacionou moderada e negativamente com a pressão expiratória máxima. O tempo de permanência em lista de espera não se correlacionou com a resistência de membros inferiores, força muscular respiratória e capacidade funcional submáxima.

PALAVRAS-CHAVE: Transplante de rim. Insuficiência renal crônica. Avaliação em saúde. Fisioterapia. Teste de caminhada.

ABSTRACT | INTRODUCTION: For the treatment of chronic kidney disease, patients require hemodialysis or peritoneal dialysis while being on the kidney transplant waiting list. Despite advances in dialysis procedures, patients undergoing this treatment have low physical and functional capacity and comorbidities that influence the waiting time. **OBJECTIVE:** To describe the physical, anthropometric, and cardiorespiratory characteristics of patients on the kidney transplant waiting list, as well as to analyze the variables according to the time on the waiting list and time since disease diagnosis. **MATERIALS AND METHODS:** Cross-sectional, descriptive, and analytical study, submitted and approved by the Research Ethics Committee of UNIJUÍ under the document number 1.992.013. Eleven patients registered at the Ijuí Charity Hospital were evaluated for kidney disease and its treatment, time on waiting list, cardiovascular risk factors, lower limb muscle resistance, respiratory muscle strength, and submaximal functional capacity. **RESULTS:** From the eleven patients studied: the mean age was 51.9 ± 11.4 years; 54.5% were female, 45.5% had hypertensive renal disease, the time since disease diagnosis was 84.0 (48.0-180.0) months, 90.9% underwent hemodialysis with a median of 15.0 (8.0-41.0) months, and were on the waiting list for 12.0 (6.0-32.0) months. The most prevalent cardiovascular risk factors were hypertension and sedentary lifestyle. Patients performed 17.0 (16.0-22.0) repetitions in the 1-minute sit-to-stand test and walked 452.5 (416.1-503.2) meters in the six-minute walk test. The maximal inspiratory pressure was 62.0 (50.0-80.0) cmH_2O and the maximal expiratory pressure was 78.0 (64.0-99.0) cmH_2O. **CONCLUSION:** In this study, patients enrolled in the kidney transplant waiting list presented good physical, functional, and cardiorespiratory conditions. The time since diagnosis of kidney disease was moderately and negatively correlated with maximal expiratory pressure. The time on the waiting list did not correlate with lower limb strength, respiratory muscle strength, and submaximal functional capacity.

KEYWORDS: Kidney transplantation. Chronic kidney failure. Health assessment. Physical therapy. Walking test.

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Introduction

Chronic kidney disease (CKD) is defined by the Brazilian Society of Nephrology as a structural or functional abnormality of the kidney, with or without decreased glomerular filtration[1]. It is an important public health problem, with a high mortality rate and presence of comorbidities[2]. For the treatment of advanced chronic kidney disease, patients require dialysis renal replacement therapy, such as hemodialysis and peritoneal dialysis, or kidney transplantation. Currently, there is an overall increase in the number of patients on dialysis and also a reduction in the mortality rate of these individuals[3].

In Brazil, there are 715 active dialysis care centers, where 112,004 patients undergo dialysis. Twenty percent of these dialysis care centers are located in the southern region of Brazil[3]. According to the Brazilian Registry of Transplants, 20,595 patients are currently on the kidney transplant waiting list in Brazil, of which 839 patients are enrolled in the state of Rio Grande do Sul (RS). During the first semester of 2017, 423 transplants were performed in this state, of which 403 were performed using a cadaver donor organ and 20 using a living donor organ[4].

The age factor and comorbidities are used to register patients with a lower mortality risk on the waiting list[5]. In addition, several factors are related to the waiting time for a kidney transplant. A study carried out by Machado et al.[6] in 2012 evidenced that the waiting time for transplantation was lower for patients who did not present any type of comorbidity as a cause of renal disease and also for those patients who were employed.

Despite advances in dialysis procedures, patients undergoing this treatment have low tolerance to exercise, which leads to physical deconditioning, a factor that is related to comorbidities and may also be associated with the length of time spent on the kidney transplant waiting list[7-9]. Several studies have evaluated the functional capacity of patients on dialysis[7-9], but none of them have stratified this analysis according to the time on the kidney transplant waiting list. Therefore, the objective of this study was to describe the physical, anthropometric, and cardiorespiratory characteristics of patients on the kidney transplant waiting list, as well as to analyze the variables according to the time on the kidney transplant waiting list and time since their diagnosis of chronic kidney disease.

From the data obtained in this study, we sought to emphasize the importance of physical, functional, and cardiorespiratory evaluation and the presence of the physiotherapist in the health care team of patients with chronic kidney disease. The physiotherapist is necessary in order to guide improvements in care and reinforce the need for physical intervention during the period of hemodialysis or peritoneal dialysis, and also in the pre- and post-kidney transplant period.

Materials and methods

This is a cross-sectional, descriptive, and analytical study of the institutional project entitled "Patients follow-up from the kidney transplant waiting list until after transplantation". This project was designed in accordance with the Guidelines and Norms Regulating Research Involving Human Beings according to the National Health Council Resolution 466/12, submitted and approved by the Research Ethics Committee of the Regional University of the Northwestern of Rio Grande do Sul (UNIJUÍ).

The study population consisted of patients who were on the kidney transplant waiting list at the Ijuí Charity Hospital (HCI), who were referred by nephrologist doctors of Ijuí/RS to perform the evaluations. Adult participants from both sexes were included in this study and excluded if incapable of understanding and performing the test procedures. During the study period, 24 patients were enrolled in the kidney transplant waiting list in the northwest region of the state of Rio Grande do Sul. From those, 12 patients (50%) participated in this study, since the remaining patients were receiving treatment in other hospitals in the region.

The evaluations were performed in the HCl Nephrology sector, on a previously scheduled day, which was the same day that the patients had a medical appointment with the nephrologist. The participants of this research were submitted to the evaluation protocol, as described below.

From the direct interview with patients, demographic and clinical data were collected, such as: the cause of kidney disease, time since diagnosis of the disease, presence of comorbidities, risk factors for cardiovascular diseases, type of dialysis treatment, duration of dialysis treatment, and enrollment in the waiting list.

The following anthropometric measures were evaluated: body weight in kilograms (kg); height measured in meters (m); waist circumference measured in centimeters (cm) taken at the mean distance between the last floating rib and the iliac crest. For this, a metric tape with a flexible and inextensible pattern was used, with a measurement definition of 0.1 cm. Body mass index (BMI) was calculated by the ratio of weight to height squared (kg/m^2).

The conicity index was calculated using the mathematical equation of Valdez[10] which requires knowledge of the weight, height, and waist circumference. The conicity index was calculated using the Excel spreadsheet. To determine high coronary risk, cut-off points of ≥ 1.25 for men and ≥ 1.18 for women were used based on the study by Pitanga and Lessa (2004):

$$\text{Conicity Index} = \frac{\text{waist circumference (cm)}}{0.109 \times \sqrt{\frac{\text{weight (kg)}}{\text{height (m)}}}}$$

To evaluate the muscular resistance of lower limbs, the 1-minute sit-to-stand (STS) test was used, for which the individual was instructed to sit on a chair with their back resting on the back of the chair, standing up fully without utilizing their arms, and then sitting again touching their back to the back of the chair. The individual should perform as many as possible repetitions in one minute[11].

Respiratory muscle strength was determined by measuring maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP), using the MVD-300 digital manovacuometer (Microhard System, Globalmed, Porto Alegre, Brazil). During the procedure, the subjects remained seated at rest with their trunk erect and nostrils occluded with a nasal clip to prevent air leakage. MEP was measured after the patient expired from the total lung capacity to the residual volume, with consequent maximum expiratory effort, at which time the orifice in the nozzle was occluded. While the MIP was obtained after the patient inhaled from the residual volume to the total lung capacity, generating a maximal inspiratory effort, the orifice of the mouthpiece being occluded in the same way as the MEP measurement. The highest MIP and MEP values, expressed in cmH_2O, were recorded, which was not higher than 10% of the second highest value[12]. Calculations were carried out to find the predicted values for these variables[12]. An individual is considered with diminished muscle strength when they reach a value less than or equal to 70% of the predicted value.

The submaximal functional capacity was analyzed through the six-minute walk test (6MWT), performed according to the recommendations of the American Thoracic Society[13], in which the greatest distance that the individual was able to walk in a fixed time interval of six minutes was measured. Individuals were instructed to perform the test, according to the protocol. The estimated distance walked (in meters) for the individual was calculated using the equations from Enright and Sherrill[14].

Statistical Package for Social Science - SPSS (version 18.0, Chicago, IL, USA) was used for data processing. The qualitative variables were presented by means of frequencies and percentages and the quantitative variables by mean and standard deviation (mean $\pm$ SD) or median and interquartile range, as appropriate. Spearman's correlation coefficient was used to evaluate the correlation between STS, MIP, MEP, and 6MWT and the time on the kidney transplant waiting list and time of CKD, according to the distribution of the variables. A p-value <0.05 was considered statistically significant. All tests were applied with a 95% confidence interval.

Results

Of the 12 patients enrolled on the kidney transplant waiting list and on dialysis treatment at the HCI, 11 patients were included in this study. One patient was excluded due to contact isolation during the period of data collection. The mean age was 51.9 ± 11.4 years, being 54.5% females as can be seen in Table 1.

Table 1. Clinical characterization of the sample of patients on the kidney transplant waiting list, 2017

Variables	n=11
Age (years)	51.9±11.4
Etiology of kidney disease n (%)	
Hypertensive	5 (45.5)
Polycystic disease	3 (27.3)
Glomerulonephritis	2 (18.2)
Unilateral renal agenesis	1 (9.1)
Time since diagnosis of kidney disease (months)	84.0 (48.0-180.0)
Dialytic Treatment n (%)	
Hemodialysis	10 (90.9)
Peritoneal dialysis	1 (9.1)
Dialytic treatment time (months)	15.0 (8.0-41.0)
Time on waiting list (months)	12.0 (6.0-32.0)
Cardiovascular risk factors n (%)	
Systemic arterial hypertension	10 (90.9)
Dyslipidemia	1 (9.1)
Sedentary lifestyle	8 (72.7)
Stress	4 (36.4)
Age > 60 years	3 (27.3)
Males	5 (45.5)
Obesity	2 (18.2)
Family history	4 (36.4)
Anthropometric measurements	
BMI (kg/m²) F / M	27.6±5.8 / 25.5±5.0
Waist circumference (cm) F / M	97.6±15.9 / 95.4±16.7
Conicity index F / M	1.32±0.14 / 1.31±0.12

BMI - Body Mass Index; F - Females; M - Males.

Table 2 presents the information of the physical, functional, and cardiorespiratory evaluation of patients on the kidney transplant waiting list.

Table 2. Physical, functional, and cardiorespiratory evaluation of patients on the kidney transplant waiting list, 2017

Variables	n=11
N° of repetitions in the STS test	17.0 (16.0-22.0)
MIP (cmH_2O)	62.0 (50.0-80.0)
MIP predicted (cmH_2O)	87.9 (86.0-117.0)
% of predicted MIP	73.0 (44.0-86.4)
MEP (cmH_2O)	78.0 (64.0-99.0)
MEP predicted (cmH_2O)	87.1 (84.7-116.7)
% of predicted MEP	93.0 (56.0-109.0)
Distance walked in the 6MWT (meters)	452.5 (416.1-503.2)
Distance walked predicted in the 6MWT (meters)	573.6 (532.3-593.0)
% achieved of predicted 6MWT (meters)	81.6 (71.7-87.5)

STS - 1-minute sit-to-stand test; MIP - maximal inspiratory pressure; MEP - maximal expiratory pressure; 6MWT - six-minute walk test.

The correlation of the time on the kidney transplant waiting list and the time since diagnosis of chronic kidney disease with the physical, functional, and cardiorespiratory variables was verified. A moderate negative correlation was observed between the time since diagnosis of kidney disease and the maximum expiratory pressure (r = -0.624, p-value = 0.040), as presented in Table 3.

Table 3. Correlation of time since kidney disease and time on the kidney transplant waiting list with 6MWT, MIP, MEP, and STS, 2017

Variables		D6MWT	MIP	MEP	STS
Time since diagnosis of kidney disease	r	0.091	-0.475	-0.624*	-0.119
	p-value	0.802	0.140	0.040	0.728
Time on the kidney transplant waiting list	r	-0.018	0.237	0.100	-0.586
	p-value	0.960	0.483	0.770	0.058

D6MWT - distance walked on the six-minute walk test; MIP - maximal inspiratory pressure; MEP - maximal expiratory pressure; STS - 1-minute sit-to-stand test; * - Spearman Correlation.

Discussion

The main cause of kidney disease in the studied patients enrolled in the kidney transplant waiting list was of hypertensive origin. The median time since diagnosis of kidney disease was 84.0 months, and the waiting time for the transplant was 12 months. In the physical, functional, and cardiorespiratory evaluation, the patients presented good performance in the tests reaching above 70% of their predicted values. Furthermore, a moderate negative correlation was observed between the time since diagnosis of kidney disease and the maximum expiratory pressure.

Most of the waiting list patients evaluated in our study underwent hemodialysis as renal replacement therapy, and a live donor transplant was performed during the data collection period. Our results are in agreement with previous studies, where among the renal replacement therapies the most used was hemodialysis[3]. However, kidney transplantation is the one that offers better survival and quality of life[19].

In our study, the mean time to start dialysis treatment was 27 months. A study conducted in São Paulo found a waiting time of 63 months on the waiting list, longer than the median found in our study[15]. Other studies found that hemodialysis patients who were not enrolled in the waiting list had a longer duration of renal replacement therapy[7,9,20]. Therefore, Batista et al[15] reinforced the importance of enrolling patients in the kidney transplant waiting list concomitantly with the initiation of renal replacement therapy, since dialysis time may negatively influence patients' clinical condition. According to Rigoni et al[21] the time on the waiting list is shorter for patients who undergo peritoneal dialysis.

The mean age of the patients enrolled in the waiting list of our study was similar to that found in a recent study in São Paulo[15]. In Norway, the mean age of patients on the waiting list was 71.1 years[16], and in the United States transplantation is more frequently performed with elderly patients over 65 years[17]. Such data suggest that the Brazilian population is developing early kidney disease or that the progression of the disease is occurring more rapidly in our population.

Approximately half of the patients evaluated in our study were females. In contrast, a study by Machado et al[6] included 37.7% females and Batista et al[15] included 40.4%. Hypertensive renal disease was the most frequent, corroborating with data from other studies[3,7,15]. Obesity has also been described as a cause of kidney disease due to hyperlipidemia, increased oxidative stress, increased salt intake, and

activation of the sympathetic nervous system[18]. In this study, 18.2% of the patients were classified as obese and 36.4% were overweight. Therefore, the prevalence of obesity found in this study was higher than that reported in the literature, where 37% of the patients were classified as overweight, obese, or morbidly obese[3].

Regarding cardiovascular risk factors, the most prevalent were systemic arterial hypertension and sedentary lifestyle, confirming data found in the literature[7,9]. In addition to these, high anthropometric values of body mass index, waist circumference, and conicity index are considered as cardiovascular risk factors[22]. In the evaluation of the conicity index, the cut-off points of ≥ 1.25 and ≥ 1.18 were used to determine a high coronary risk for males and females, respectively, based on a study by Pitanga and Lessa[23]. Therefore, in this study, 81.8% of the patients presented high coronary risk. Szabo et al[24] described that most patients on the waiting list are identified as low risk. According to Leford et al[25], the presence of more than three cardiovascular risk factors decreased the chance of enrollment in the waiting list by 49%.

Despite the cardiovascular risk factors, the studied patients presented a good performance in the physical, functional, and cardiorespiratory evaluation. Patients who underwent hemodialysis and were not registered in the waiting list presented lower performance in the respiratory muscle strength assessment[7,8]. Patients with chronic kidney disease on hemodialysis[7] and who have not yet started dialysis treatment[9] also presented inferior functional performance in the 6MWT. Therefore, it is suggested that these variables are associated factors as important as age and comorbidities which can also be used as criteria to register patients in the waiting list for transplantation.

Our study has potential limitations. First, the small sample size and the fact that the studied subjects are from a single care center limited the generalization of the results. Second, the lack of a control group limited the comparability of the results. Finally, the data of the physical, functional, and cardiorespiratory evaluation were analyzed from the predicted values through formulas that may not reflect the reality of the population of patients with chronic kidney failure who underwent dialysis treatment in Brazil.

Conclusion

Despite the high presence of cardiovascular risk factors and elevated coronary risk, the studied patients enrolled on the kidney transplant waiting list had good physical, functional, and cardiorespiratory conditions. The time since diagnosis of kidney disease was moderately and negatively correlated with maximal expiratory pressure. The time on the waiting list did not correlate with lower limb strength, respiratory muscle strength, and submaximal functional capacity. Thus, it is suggested that physical, functional, and cardiorespiratory variables are associated factors as important as age and comorbidities that can be used as criteria for enrolling patients in the waiting list for transplantation. Thus, the importance of the insertion of physiotherapeutic assistance for the evaluation, prevention, and physical rehabilitation of these patients is emphasized. There is a need for more studies in this area with larger sample numbers.

Authors contributions

Daniela da Silva Martins participated in the conception, design, acquisition and statistical analysis of the research data, interpretation of the results, and writing of the paper. Paula Caitano Fontela participated in the statistical analysis of the data and the writing of the paper. Maria Leocadia Bernardes do Amaral Padilha participated in the conception and writing of the paper. Eliane Roseli Winkelmann participated in the conception, design, statistical analysis of the research data, interpretation of results, writing, and logistics of the paper.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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