Original Article

Quality of life and muscle trophism of chronic kidney patients undergoing intradialytic exercise

Qualidade de vida e trofismo muscular de pacientes renais crônicos submetidos a exercício intradialítico

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ABSTRACT

Introduction: Chronic Kidney Disease is characterized by the gradual and irreversible deterioration of renal function, impairing the removal of metabolic waste. Hemodialysis emerges as an essential renal replacement therapy, filtering the blood to eliminate harmful substances (sodium, potassium, chlorides) and excess fluids. However, despite its importance, hemodialysis can lead to adverse consequences: sarcopenia, catabolism, reduced protein synthesis, decreased physical fitness and quality of life. Objective: To analyze the impact of muscle training on the quality of life and muscle strength of individuals with chronic kidney disease undergoing continuous intradialytic cycle ergometry. Methods: This is a longitudinal, prospective, randomized, and blinded cohort study conducted through a continuous exercise protocol with a cycle ergometer during hemodialysis. Forty patients were selected and divided into 2 groups (G1 continuous group and G2 control group) for 4 weeks. Results: The difference between G2 and G1 was 72.21, with a confidence interval of -12.59 to 157.00; the difference between the groups was 1098.91, with a confidence interval of 789.25 to 1408.57 and an adjusted p-value of 0.0000000 in the context of quality of life. The Pimáx showed a difference of -123.20 (CI = -149.79 to -96.61) for G1 with an adjusted p-value of 0.0000000 and the evaluation of the triceps surae, in the contracted phase, the difference was 2.50 (CI = -0.61 to 5.60, p = 0.14). Conclusions: Exercise significantly improves the quality of life and functionality of patients with chronic kidney disease.
Keywords: Kidney Failure, Chronic. Quality of Life. Renal Dialysis. Exercise. Physical Therapy Modalities. Hemodialysis Units, Hospital.

RESUMO

Introdução: A Doença Renal Crônica é caracterizada pela deterioração gradual e irreversível da função renal, prejudicando a remoção de resíduos metabólicos. A hemodiálise surge como uma terapia de substituição renal essencial, filtrando o sangue para eliminar substâncias nocivas (sódio, potássio, cloretos) e excesso de líquidos. No entanto, apesar de sua importância, a hemodiálise pode levar a consequências adversas: sarcopenia, catabolismo, redução da síntese proteica, diminuição do condicionamento físico e da qualidade de vida. Objetivo: Analisar o impacto do treinamento muscular na qualidade de vida e na força muscular de indivíduos com doença renal crônica submetidos à cicloergometria intradialítica contínua. Métodos: Trata-se de um estudo de coorte longitudinal, prospectivo, randomizado e cego, conduzido por meio de um protocolo de exercício contínuo com cicloergômetro durante a hemodiálise. Quarenta pacientes foram selecionados e divididos em 2 grupos (G1 grupo contínuo e G2 grupo controle) por 4 semanas. Resultados: A diferença entre G2 e G1 foi de 72,21, com intervalo de confiança de -12,59 a 157,00; a diferença entre os grupos foi de 1098,91, com intervalo de confiança de 789,25 a 1408,57-e p-valor ajustado de 0,0000000 no contexto da qualidade de vida. O Pimáx demonstrou diferença de -123,20 (IC = -149,79 a -96,61) para o G1 com p-valor ajustado de 0,0000000 e na avaliação do tríceps sural, na fase contraída, a diferença foi de 2,50 (IC = -0,61 a 5,60, p = 0,14). Conclusão: O exercício melhora significativamente a qualidade de vida e a funcionalidade de pacientes com doença renal crônica.
Palavras-chave: Insuficiência Renal Crônica. Qualidade de Vida; Diálise Renal. Exercício Físico. Modalidades de Fisioterapia. Unidades Hospitalares de Hemodiálise.

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INTRODUÇÃO

Chronic Kidney Disease (CKD) is characterized by the slow, progressive, and irreversible loss of kidney function, making them unable to remove metabolic waste from the bloodstream, leading to a homeostatic disorder in the body[1]. Another study[2] points out that the main diseases that alter kidney function are chronic glomerulonephritis, arterial hypertension, chronic obstructive renal processes, diabetes mellitus and hereditary diseases, which cause irreversible deterioration of the nephrons, impairing the reabsorption, filtration, and excretion of substances in the body, requiring the approach of the Renal Replacement Therapy (RRT) method, the most common being Hemodialysis (HD).

End-stage chronic kidney patients undergoing hemodialysis have a high risk of cardiovascular complications due to the additional stress generated by volume overload and pre-existing kidney conditions. These patients often develop a vicious cycle of inflammation, oxidative stress and increased cardiovascular risk, which worsens their overall prognosis[3].

Sarcopenia in patients with CKD is often associated with complications such as chronic inflammation and oxidative stress, factors that contribute to muscle loss and worsen the progression of the disease. This condition can be exacerbated by changes in protein metabolism and insulin resistance and is an important indicator of worsening prognosis in patients with CKD[4]. Sarcopenia can occur in CKD as well as in metabolic acidosis, insulin resistance and vitamin D deficiency, leading to catabolism and reduced protein synthesis. Muscular conditions such as muscle strength, muscle mass and physical performance in individuals with CKD are associated with low Quality of Life (QoL), especially in those who practice HD, due to negative impacts such as reduced mobility, risk of falls, dependence, increased hospitalization and high mortality[5].

The application of osteomyoarticular treatment or rehabilitation benefits patients undergoing and not undergoing RRT, at all stages of the disease. In a descriptive analysis of the subject[6], it was observed that when patients undergo muscular resistance programs, they end up favoring functional independence, improving the clearance of uremic toxins in the body, and contributing to the reduction of complications resulting from treatment and disease. Exercises performed during hemodialysis (intradialytic exercise) have shown significant benefits in improving physical function, cardiopulmonary capacity, and quality of life of patients. Practicing exercises during dialysis sessions can reduce the typical adverse effects of chronic kidney disease, such as loss of muscle mass and fatigue, in addition to contributing to general well-being[7].

The present research aimed to improve therapeutic strategies for patients with CKD undergoing hemodialysis, seeking to improve quality of life in addition to survival. The study aimed to evaluate the benefits of physical exercise, during the intradialytic period, on respiratory muscles, functionality, quality of life, muscle strength and diaphragmatic thickness of chronic kidney patients.

METHODS

This is a randomized, blind, prospective, longitudinal clinical trial. The research was conducted in the hemodialysis sector of the Dr. Abelardo Santos Regional Hospital, Belém – PA, Brazil. The research took place from May to August 2024. The study was approved by the Ethics and Research Committee of the University of the Amazon through opinion number 6,567,417/2023, in accordance with the standards of the National Health Council 466/2012. The project was presented in full to those who expressed interest in participating. Subsequently, the participants signed the Free and Informed Consent Form.

The sample was selected by convenience and randomized through the Randomizer® program, with a total sample size of 40 individuals divided into two groups of 20 people selected regardless of gender, color, sex, race, and social class during the hemodialysis session, according to the evaluation of the multidisciplinary team of the sector. The groups were divided into the Continuous Group (G1), which consisted of patients undergoing the exercise protocol during hemodialysis, and the Control Group (G2), which consisted of those who did not undergo the exercise protocol.

To be considered eligible, patients had to meet the following criteria: age ≥ 18 years, hemodynamically stable, heart rate > 60 bpm and < 130 bpm; systolic blood pressure > 90 mmHg < 180 mmHg; mean arterial pressure > 60 mmHg < 120 mmHg; respiratory rate > 10 breaths per minute and < 25 breaths per minute; and peripheral oxygen saturation > 88%; body temperature < 38.5°; blood glucose > 70 or < 200 mg/dl; lactate < 2 mmol/l; hemoglobin ≥ 7 g/dl; Platelets ≥ 50,000 cells/mm3; absence of peritoneostomy; not receiving proportional care; absence of deep vein thrombosis; not undergoing hemodialysis at the time of sedentary status; absence of aneurysm and absence of active gastrointestinal bleeding.

The following exclusion criteria were established: performance of surgical procedures; transfer to other hospitals to continue hemodialysis; evolutionary difficulties associated with arteriovenous fistula or dialysis catheter; diagnosis of infectious diseases of a transmissible nature; performance of kidney transplantation and patients who evolved to death.

Ultrasound Assessment Protocol for Diaphragmatic and Lower Limb Muscles

To perform the procedure, the patient was positioned in 0° in bed, and the protocol began with the to assess the muscles of the lower limbs (LL), Sonosite M-Turbo® ultrasound was used to analyze the activity of the triceps surae muscle, the rectilinear transducer was used in the sagittal plane, with the Probe Mark® directed toward the head of the research volunteer. The procedure consisted of patient prone position with the knee flexed at 20 degrees, transducer positioned 10 cm below the knee line and measurement at three points (5 cm interval) during relaxation and contraction. The parameters evaluated were muscle thickness during relaxation and contraction. The diaphragmatic thickening rate was determined by the ratio between the average thickness during inspiration and expiration. In addition, the thickness index was calculated using an equation that considers the difference between the mean thicknesses during inspiration and expiration, divided by the mean thickness during expiration and multiplied by 100.

Based on the values obtained by the evaluation, it was possible to evaluate the degree of trophism and contractility of the diaphragmatic muscles and LL in the patients participating in the study. To ensure equality of evaluations, the values of Frequency (Hz), Post Focus, No Focus, Density, Power, and Light Tone were recorded, so that they could be repeated in the final evaluation.

Respiratory Assessment

Respiratory muscle strength (Inspiratory (Pimax) and Expiratory (Pemax)) was assessed through a manovacuometry test using the InspiraMed® +-300 Analog Manovacuometer, with its average value measured in 3 attempts in the first session and in the last session, to determine the impact of the protocol on the strength gradient of this musculature.

Training Protocol

The training protocol was performed during the first two hours of each hemodialysis session, 3 times a week, for 4 weeks until the completion of the 10 sessions. Participants in the Continuous Group (G1) began the cycle ergometry protocol, with a total duration of 10 to 20 minutes in the first training session. Throughout the rehabilitation, the time was progressively increased to 30 to 40 minutes per session, with a variable rate of progression of intensity, depending on the symptoms presented by the patients and respecting their tolerance. The Control Group (G2) did not receive any approach.

Quality of Life Assessment

The Kidney Disease and Quality of Life Short-Form (KDQOL-SFTM) questionnaire was used in the initial and final assessments of the study. This instrument, validated in Brazil, comprises 80 items, including the Short Form Health Survey (SF-36) and 43 specific items on chronic kidney disease (CKD). The SF-36 assesses eight dimensions: physical capacity, physical limitations, emotional limitations, social functioning, mental health, pain, vitality, and perceptions of general health. The items related to CKD are divided into 11 dimensions, addressing symptoms, impact on daily life, burden, work, cognitive function, social interactions, sexual function, sleep, social support, encouragement from the dialysis team, and patient satisfaction. In addition, a scale of 0 to 10 assesses general health. Scores range from 0 to 100, where higher values indicate better health-related quality of life (HRQOL). The instrument also provides summary scores for physical and mental components, calculated from specific items.

Statistical Analysis

The data were double entered, organized, and processed using descriptive statistics in Excel spreadsheets (Microsoft Office® 365), determining mean and standard deviation. In the inferential analysis, after determining the normality of the data, using the parametric ANOVA test and a Tukey post-hoc criterion for intergroup comparative analysis. In all tests, we used $p \leq 0.05$ for statistical significance and a 95% confidence interval. The tests were performed using the SPSS® 24 program.

RESULTS

A total of 53 patients were selected, of which 13 were excluded due to: surgical procedures (3); developmental difficulties associated with arteriovenous fistula or catheter (2); kidney transplant (1); death (2); and patients who chose not to continue in the study for personal reasons and/or who faced difficulties in complying with the exercise and assessment protocol (5). In total, 40 volunteers were distributed into 20 participants in G1 and 20 in G2, according to randomization. After allocation into groups, evaluation processes were carried out to collect data from both groups.

For patients who were illiterate or had some alteration in visual acuity that could hinder completion of the questionnaire, support was provided through the presence of the researchers. In this context, in Table 1, we can observe the distribution of results at the end of the application of the protocol, according to each domain of the questionnaire, comparing with G2 to determine the impact of exercises on the quality of life and functionality of these patients.

Table 1. Distribution of KDQOL-SFTM dimensions in intragroup comparison

Dimensions$_1$	Continuous N = 20*1*	Control N = 20*1*	p-value*1*
Age	60 (13)	52 (13)	0.3
Emotional well-being$_2$	209 (169)	281 (71)	0.042
Pain$_2$	89 (61)	136 (64)	0.056
Generic Energy/Fatigue$_2$	64 (21)	199 (69)	<0.001
Emotional Function$_2$	44 (38)	119 (105)	0.020
Physical function$_2$	27 (35)	132 (128)	<0.001
Social Function$_2$	64 (25)	145 (51)	<0.001
Physical functioning$_2$	44 (29)	461 (325)	<0.001
Health generates$_2$	43 (17)	270 (54)	<0.001
Effects of kidney disease$_3$	62 (16)	509 (156)	<0.001
Encouragement from the dialysis team$_3$	77 (20)	182 (37)	<0.001
Cognitive function$_3$	65 (32)	141 (107)	<0.001
Sexual function$_3$	30 (47)	119 (52)	<0.001
List of symptoms/problems$_3$	70 (17)	842 (208)	<0.001
Professional role$_3$	15 (29)	25 (53)	>0.9
Quality of social interaction$_3$	58 (25)	138 (60)	<0.001
Patient satisfaction$_3$	79 (33)	74 (18)	0.041
Kidney disease burden$_3$	36 (23)	138 (110)	<0.001
Sleep$_3$	59 (21)	248 (57)	<0.001
Social Suport$_3$	67 (34)	135 (68)	<0.001
Total$_2$	375 (163)	1,474 (437)	<0.001
Total$_3$	551 (121)	2,415 (381)	<0.001

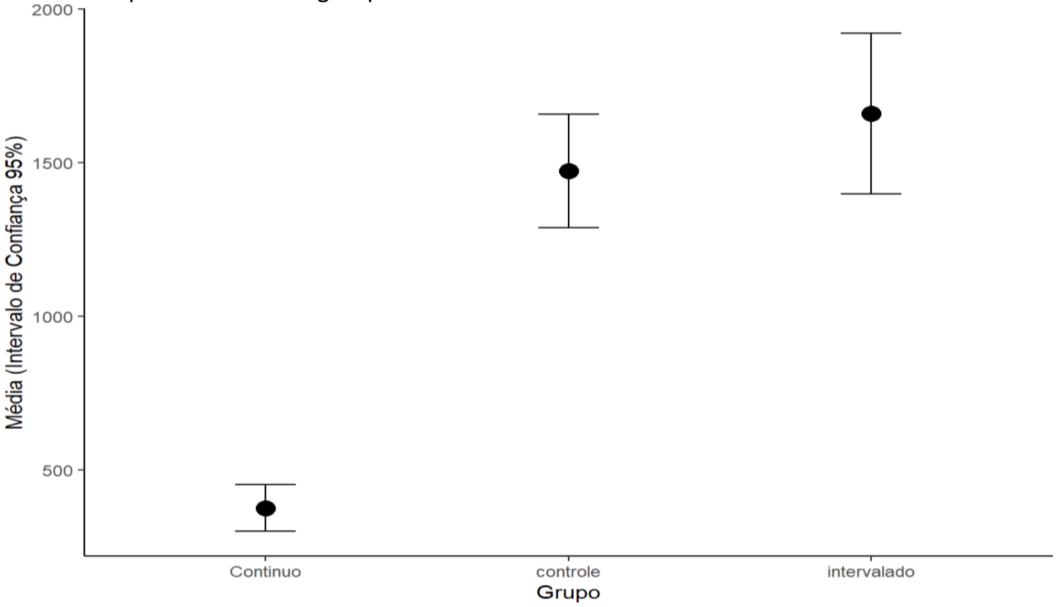
Legend: [1]Parametric test ANOVA; *2* Dimensions SF-36; *3* Dimensions QRVS.
Source: Authors (2024).

The results of the multiple comparison analysis between the groups, for each domain, indicate that the mean difference between the control group and the continuous group was 72.21, with a Confidence Interval (CI) of -12.59 to 157.00 and an adjusted p-value of 0.11, suggesting that this difference is not statistically significant. However, when analyzing the impact of exercise both in the context of general quality of life (Graph 1) and in the specific context (Graph 2) for chronic kidney disease patients, a significant impact is observed.

The difference between the control group and the continuous group was 1098.91, with a CI of 789.25 to 1408.57 and an adjusted p-value of 0.0000000, suggesting a statistically significant difference in the context of quality of life (Graph 1), as stated above. Regarding the specific aspects of chronic renal patients, graph 2 shows the distribution of the mean of the variables with intergroup analysis, with a difference of 1863.75, with a CI of 1628.43 to 2099.08 and an adjusted p-value of 0.0000000, also suggesting a statistically significant difference.

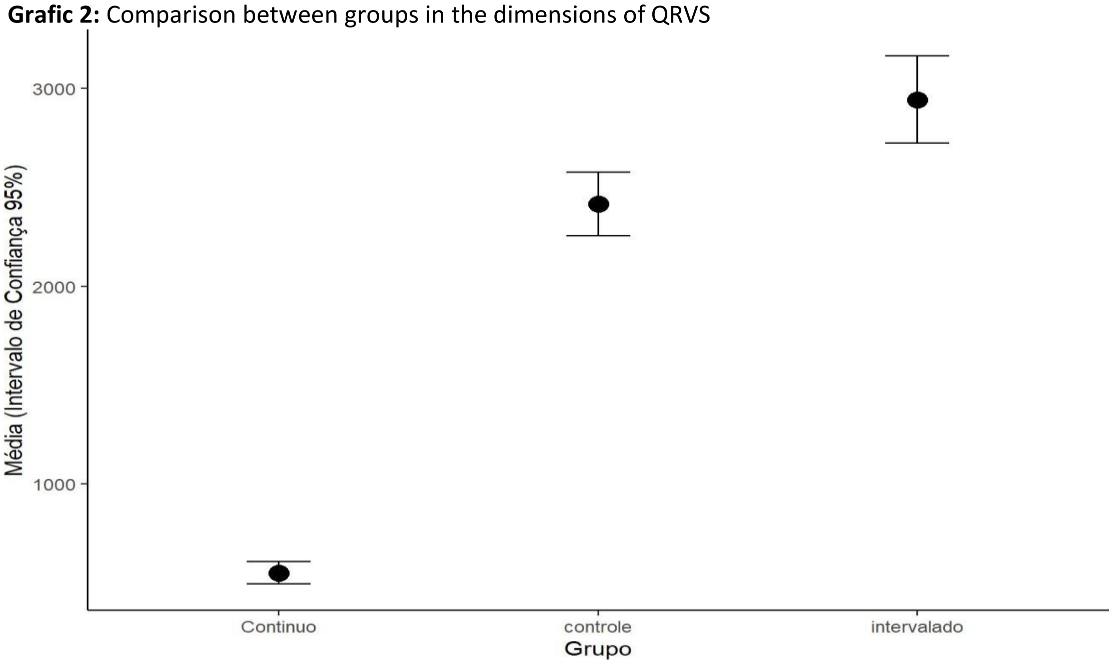
As for ventilatory mechanics, the Pimáx showed a difference between the Control group and the Continuous group of -123.20 (CI = -149.79 to -96.61) with an adjusted p-value of 0.0000000, evidencing a statistically significant difference, which demonstrates a positive effect of the exercise protocol in gaining maximum inspiratory pressure, developing greater tolerance to both exercise and daily life activities. Unlike Pemax, which was 2.93 (CI = -9.76 to 15.62), and an adjusted p-value of 0.84, where the difference was not significant, this is an important fact to be observed, given that in the case of comorbidities such as chronic obstructive pulmonary diseases, this variable may indicate a smaller influence on crisis control (Graph 3). In this context, the diaphragmatic thickness in the contracted phase, when comparing the groups, obtained a statistical value of -0.08, CI of -1.61 to 1.46 (p = 0.99), determining that the result was not statistically significant, despite the gain in inspiratory muscle strength, there was no increase in the thickness of this muscle. As well as the measurement in the relaxed phase, which reached the value of -1.21 (CI = -2.60 to 0.19, p = 0.10), in accordance with the previously mentioned assessment (Pemax) (Graph 4).

Grafic 1: Comparison between groups in the SF36 dimensions



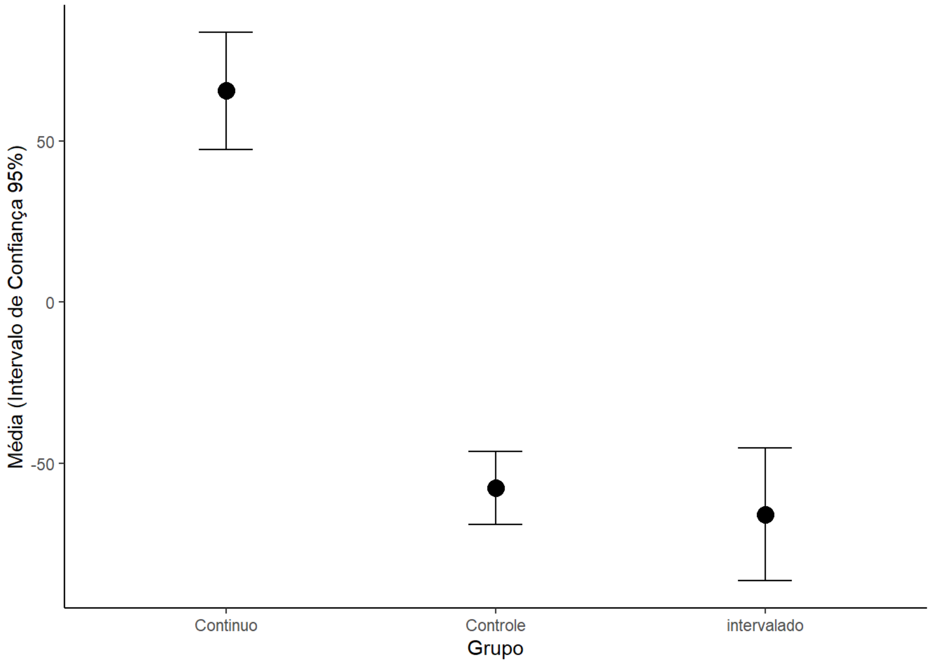
Source: Authors (2024).

Grafic 2: Comparison between groups in the dimensions of QRVS



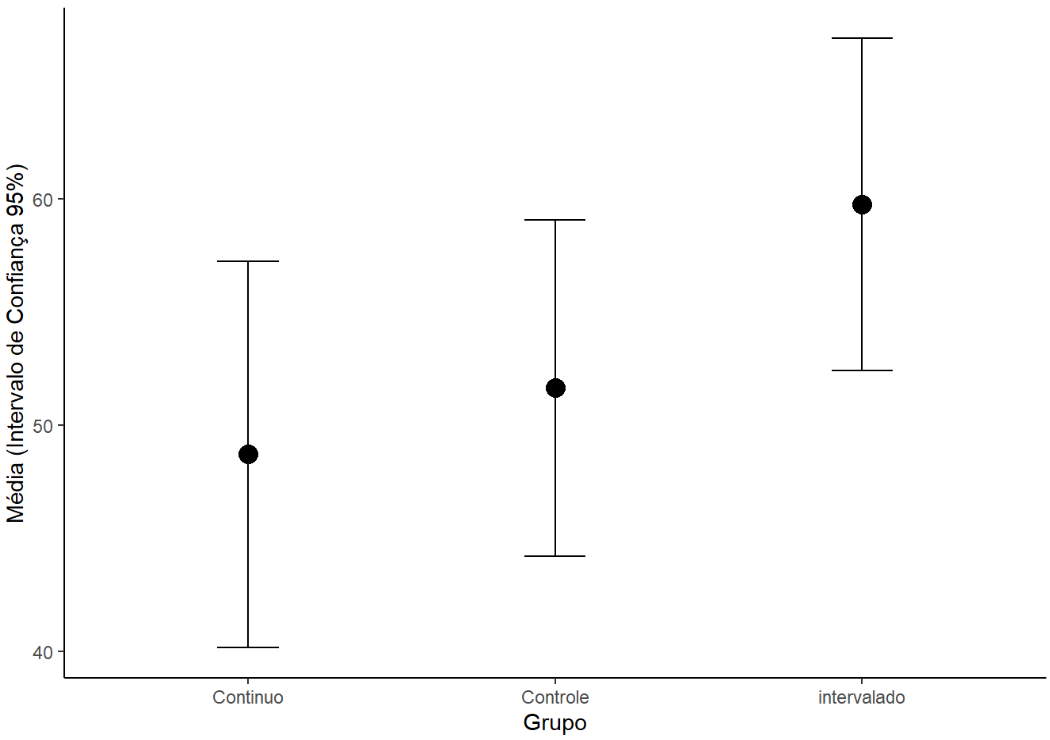
Source: Authors (2024).

Grafic 3: Comparison between groups regarding post-protocol MIP values



Source: Authors (2024).

Gráfico 4. Comparison between groups regarding post-protocol MEP values



Source: Authors (2024).

Regarding the evaluation of the triceps surae, in the contracted phase, the difference between G1 and G2 was 2.50 (CI = -0.61 to 5.60, p = 0.14), showing that the difference is not significant, as well as in the relaxed phase which was -5.92, with a CI of -15.86 to 4.03, and an adjusted p-value of 0.33 (Table 2). Determining that the protocol did not present results in muscle mass gain but presented gains in resistance to perform basic daily activities.

Table 2. Comparison of groups with final values of triceps surae ultrasound

Standards *1*	**Control N = 20***1*	**Continuous N = 20***1*	**p-value***1*
Ultra - Contracted Triceps	12.9 (3.6)	10.4 (5.7)	0.3
Ultra - Relaxed Triceps	10.4 (2.5)	16.3 (24.1)	0.10

Legend: [1]Parametric test ANOVA.
Source: Authors (2024).

DISCUSSION

The results obtained in the study consistently highlight the positive impact of the physical exercise protocol on the quality of life and functionality of patients undergoing hemodialysis when assessed by the KDQOL-SFTM scale. This tool revealed significant differences in the domains related to both general health and quality of life specific to chronic kidney disease.

The gains observed in the general domains of the questionnaire demonstrate that physical exercises provided significant improvements in aspects such as physical well-being, mental health, and functional capacity. These improvements reflect a beneficial effect of the protocol on the ability of patients to perform daily activities, promoting greater independence and quality of life.

In this sense, the study[8] reinforces these findings by evidencing the positive effects of exercises in the intradialytic period, such as improvements in physical and emotional well-being and increased daily functionality of patients, corroborating the direct impact of physical activity on the quality of life of hemodialysis patients.

Studies on the quality of life of this population reveal that the KDQOL-SFTM identified negative influences on this function in patients with chronic kidney disease, such as disease burden, physical and emotional limitations, concerns about transportation and risks, and impact on daily life[9]. Positive factors include support from the dialysis team, social interactions, and satisfactory sexual function. The findings highlight the importance of identifying these aspects to improve the quality of life of these patients, emphasizing the need for emotional support, education on disease management, and improvement in health services applied to multidisciplinarity.

Exercise practice is a proven strategy to improve the health and quality of life of kidney patients, as evidenced by recent studies. However, the implementation of effective training protocols faces significant challenges, including the lack of rigorous research that compromises the application of appropriate therapeutic methods. In this context, patients with kidney disease face multiple complications, aggravated during the COVID-19 pandemic. In view of this, a study carried out in 2023, in the state of São Paulo, highlighted the need for personalized protocols, combining physical exercises and nutritional support, to ensure quality of life, physical and emotional health of these patients[10].

The analysis of ventilatory mechanics revealed a statistically significant increase in Maximum Inspiratory Pressure (MIP), indicating an improvement in respiratory muscle strength. This finding corroborates another study that also reported the benefits in inspiratory strength in patients with CKD undergoing regular exercise protocols[11]. However, the absence of significant changes in diaphragmatic thickness, both in the contracted and relaxed phases, suggests that the performance of muscle strength and muscle thickness did not result in a significant increase.

As for peripheral muscle strength, the results indicated that the protocol did not generate significant differences in triceps surae hypertrophy, either in the contracted or relaxed phases. Despite this, participants demonstrated improvements in functional tasks, suggesting that the exercises contributed to muscular endurance. This data reinforces findings in the literature, which highlight the benefits of regular exercise on physical resistance, corroborating our study[8].

As in several studies, motor weaknesses in patients with CKD, especially in the lower limbs, have benefited significantly from rehabilitation during the dialysis process, which can guarantee a level of autonomy for the individual and consequently a better quality of life[12,13]. During the continuous application of the protocol, difficulties were observed in its execution, as some were unable to perform it due to an inadequate diet, which resulted in a lack of willingness to perform the exercises and episodes of hypoglycemia in the first hour of hemodialysis, which was a limiting factor of this study. Thus, the researchers emphasized to the patients the importance of monitoring to ensure adequate nutritional reserves of nutrients and improve adherence to the protocol. In this context, a Brazilian study[14] demonstrated more positive and beneficial results in patients who received adequate nutritional support, monitored by a specialized professional, allowing better performance in the execution of activities and greater guarantee of positive results[15,16,17,18]. Furthermore, the patients who participated in the study and needed to be in isolation from contact due to bacterial colonization, as a result of which studies have shown that patients with this profile presented greater loss of functionality[19,20]. This is a limitation found in our study and found in the literature[21,22,23,24], the way we used to change this was to apply the protocol in the time described with a specific researcher, thus avoiding the risk of cross-infection and maintaining adequate care. However, in our study, patients who were unable to continue were kept out of the study and, as soon as they were released by the multidisciplinary team, returned to the study from the initial period.

In the population studied, we observed the direct interaction of the living conditions of this patient profile actively influencing the development of the treatment, as found in a systematic review of randomized clinical trials, where motor development acquired through physical activity was fundamental at the cardiometabolic level and quality of life[25], data proven in another study[26]. The increase in sarcopenia in the CKD group becomes increasingly evident, impacting their autonomy, leisure, and social interaction. In our research, we observed a high level of this body change, since few performed activities that required effort, such as walking, cycling, climbing stairs or dancing. However, after the start of the project, this group demonstrated significant advances, including greater socialization, walking, dancing, and participation in daily activities that required effort, reducing complications that were previously frequent, as found in other studies, in which the gain in functionality was directly proportional to the patient's quality of life. Knowing that this factor is subjective, the profile of patients presented heterogeneity, being a limitation of studies in this area[27,28,29,30].

CONCLUSION

The studies highlight the importance of physical exercise during the intradialysis period for chronic kidney patients, promoting significant improvements in quality of life and functionality. Recent studies have shown significant gains in respiratory and functional capacity and quality of life8. The findings of the study corroborate those highlighted previously. Finally, it suggests the implementation of personalized physical exercise protocols, combined with nutritional support, is essential to ensure the quality of life, physical and emotional health of these patients.

It is suggested that new studies be developed in this field to provide a better quality of life for these patients, who suffer so much from the negative impacts of the disease, thus increasing survival, as well as the functional maintenance of the body.

AUTHORS' CONTRIBUTIONS

AFGS, MJDM, RFC and AL contributed substantially to the conception and design of the study, together with NSD, LFPS, MCSM, GWSS, VKSS, VRRA, COGF and SMSN with data collection, data analysis and data interpretation. AFGS, MJDM, RFC contributed to the writing of the article and AL with the critical review and final approval of the version to be published.

DATA AVAILABILITY

All data collected, analyzed and tabulated are available in this article.

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