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Original Article

Evaluation of handgrip strength during a hemodialysis session

Avaliação da força de preensão manual durante uma sessão de hemodiálise

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ABSTRACT

Objective: To analyze the behavior of the manual pressure force in patients with chronic renal insufficiency during a hemodialysis session, stratified by sex. **Method:** The manual pressure force test was applied before the hemodialysis session, after one hour of treatment, two hours, three hours and four hours, in addition to a sociodemographic and health record (applied before the hemodialysis session) in 38 patients from a Renal Clinic in the Northeast of the state of Rio Grande do Sul. The information obtained from the manual pressure force test were analyzed by histograms with representation of the mean values and standard deviation and by the Mann-Whitney and Wilcoxon test at five different times for each patient studied who were independent or connected, respectively. The confidence interval adopted was 95% ($p \leq 0.05$). **Results:** The manual pressure force in the pre hemodialysis period was significantly higher in men, when compared to women, with a significant reduction in all moments of the study for all subjects (before hemodialysis, after one hour, two hours, three hours and four hours of treatment). This reduction also occurred when the data were stratified by sex, where it is emphasized that men had higher values. **Conclusion:** These findings show that hemodialysis treatment negatively interferes in the handgrip strength of people with chronic renal insufficiency, being needed strategies to promote for increment this physical valence to assist in the treatment and day by day of the people on hemodialysis.

Keywords: muscle strength; chronic renal insufficiency; renal dialysis.

RESUMO

Objetivo: analisar o comportamento da força de preensão manual em pacientes com insuficiência renal crônica durante uma sessão de hemodiálise, estratificado por sexo. **Método:** Aplicou-se o teste de força de preensão manual antes da sessão de hemodiálise, com uma hora de tratamento, com duas horas, três horas e quatro horas, além de uma ficha sociodemográfica e de saúde (aplicada antes da sessão de hemodiálise) em 38 pacientes de uma Clínica Renal localizada no Noroeste do estado do Rio Grande do Sul. As informações obtidas dos ensaios de teste de força de preensão manual foram analisadas por histogramas com representação dos valores médios e desvio-padrão e pelo teste de Mann-Whitney e Wilcoxon em cinco diferentes momentos para cada paciente estudado que estivessem independentes ou ligados, respectivamente. O intervalo de confiança adotado foi de 95% ($p \leq 0{,}05$). **Resultados:** Evidenciou-se que a força de preensão manual no momento pré-hemodiálise foi significativamente maior nos homens, quando comparados às mulheres e que houve uma redução significativa em todos os momentos do estudo para todos os sujeitos (antes da hemodiálise, após uma hora, duas horas, três horas e quatro horas de tratamento). Esta redução também ocorreu quando os dados foram estratificados por sexo, salienta-se que os homens tiveram valores superiores em todos os momentos. **Conclusão:** Estes achados mostram que o tratamento hemodialítico interfere negativamente na força de preensão manual de pessoas com insuficiência renal crônica, sendo necessárias estratégias para incremento desta valência física para auxiliar no tratamento e no dia a dia das pessoas em hemodiálise.

Palavras-chave: força muscular; insuficiência renal crônica; hemodiálise.

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Introduction

Chronic renal failure (CRF) consists of decreased renal function. In the most advanced stages, the kidney is incapable to perform its blood filtration function, which compromises the human organism and causes severe clinical complications [1]. This disease manifests by the presence of renal lesions associated with a decrease in the Glomerular Filtration Rate (GFR) to values below 60 mL/min/1.73 m^2 for periods of three months or more [2].

The incidence and prevalence of CRF have progressively increased each year, in epidemic proportions, reaching increasingly high rates of morbidity and mortality [3]. Based on the incidence and mortality of this pathology, it can be considered a serious public health problem worldwide [4].

There are several treatments for CRF, which hemodialysis (HD) is among the most used. According to the 2016 Brazilian dialysis census, the patients' annual prevalence on hemodialysis programs in Brazil was 92,091 [3].

HD patients experience a monotonous and restricted routine, which generally causes a worsening in quality of life, functional capacity [5,6], physical conditioning, especially in maximum oxygen consumption and muscle strength [7], which can lead these patients to have a low tolerance to physical exercise, making them physically inactive [8].

CRF associated with HD can further accentuate physical disability, drastically decreasing physical fitness, exercise tolerance, and consequently muscle strength [9], reaching losses of up to 75% [10]. In this sense, the muscular system is severely affected in HD due to musculoskeletal deterioration, atrophy due to disuse, generalized muscle weakness as a result of uremic myopathy, and changes in muscle structure and function (muscle hypotrophy of type I and II fibers) [11].

Skeletal muscle mass and muscle function are negatively affected by a variance of conditions inherent in CRF and HD [12]. Thus, patients who undergo this type of treatment are commonly affected by the loss of muscle mass, weakness, and sarcopenia [13], increasing progressively according to the loss of renal function [14].

Men, although they have the same losses in muscle quantity and functionality as women, have significantly higher values of HGS than the same, regardless of age, according to systematic review studies [15,16]. There is a hypothesis that the same occurs in dialysis patients. However, HD patients generally present anemia, muscle weakness, depression, among other disorders that lead to a progressive reduction in functional capacity and physical conditioning, which may interfere with these results [17].

Although these reports are addressed in the literature, few publications assess the acute effect of an HD session on HGS, as well as whether the outcomes are the same for different sexes. Thus, the present study aimed to analyze the behavior of HGS in patients with CRF during an HD session, stratified by sex.

Methods

Type of study, population, and sample

This quantitative, descriptive, analytical, and observational study whose population was 91 patients who underwent HD at the Hospital São Vicente de Paulo/RS Renal Clinic. The selection criteria were: having HD for more than three months, having a physical condition to be part of the study (performing the five moments of the HGS test), and three weekly HD sessions lasting four hours.

After applying these criteria, patients were invited to participate in the sample of this study, totaling 38 patients. Statistically, the sampling technique used is classified as convenience sampling (not probabilistic) because the selection counted on the participation of readily available individuals at the expense of a selection by statistical criteria. Then, for a better observation of the investigated parameters, presented in the subsequent section, the sample was divided into two subgroups (men and women).

Research variables and instruments

The researched variables and their respective data collection instruments were:

- **Dependent variable:** Dynamometry to assess HGS: Patients sitting with the dominant arm extended and forearm in neutral rotation. The dynamometer's footprint was individually adjusted according to the hand's size so that the shaft closest to the dynamometer's body was positioned on the second phalanges of the index, middle, and ring fingers. The test was performed in three attempts at each point in the study. The recovery period between measurements was one minute. The best mark of the three tries was used as a measure [18]. The dynamometry was applied before the patients started to perform HD, one hour after the beginning of it, two hours, three hours, and four hours after the beginning; and,

- **Control variables:** Clinical rehabilitation record with information regarding gender, age, time on hemodialysis, participation in functional physical rehabilitation programs, and notes on all HD days.

Data collection

First, contact was made with the clinic director requesting authorization to conduct the research. Subsequently, patients were contacted at the Renal Clinic during their hemodialysis treatment time to explain the objectives and invite them to participate in the research. Patients who agreed to participate signed the Informed Consent Form (ICF). After that, the clinical rehabilitation chart of each patient was analyzed.

Subsequently, a day of data collection was scheduled, and the HGS tests were applied before HD, after one hour of HD, two, three, and four hours totaling five moments. The test lasts approximately five minutes at each time of the study (before HD, one hour, two hours, three hours, and four hours after the start of treatment), totaling 25 minutes for each patient.

The instruments were applied by Physical Education and physical therapy trainees who were previously trained by an experienced researcher.

Data analysis

The information obtained from the HGS test trials were tabulated in terms of frequency distribution and moments of the strength tests and expressed as mean and standard deviation. When necessary, histograms were drawn up with a representation of mean values and standard deviation and stratified men, women, and individuals participating in this study (sample). The Shapiro-Wilk and Chi-Square tests were used to determine whether the sample results were normal. Then, to verify the occurrence of differentiation and statistical significance for the HGS data obtained and the stratified samples in men and women, the Mann-Whitney-Wilcoxon test was applied at five different times for each patient studied who were independent or connected, respectively. The confidence interval adopted was 95% ($p \leq 0.05$) for all statistical analyzes.

Ethical aspects

This study complied with all ethical principles by Resolution 466 of 2012 of the National Health Council [19], being approved by the Ethics and Research Committee of the University of Cruz Alta under CAAE 82699917.1.0000.5322.

Results

The average age of the patients participating in the study was 53.89 ± 15.50 years and hemodialysis treatment time 63.81 ± 61.78 months. Most were male (n = 26; 68.4%) and participated in the functional physical rehabilitation program offered by the clinic (n = 29; 76.3%), which consists of practicing physical exercises in the intradialytic period.

When analyzing the data in table I and figure 1, it was observed that the HGS in the pre-HD period was significantly higher in men when compared to women. There was also a significant reduction at all times in the study for all subjects (before HD, after one hour, two hours, three hours, and four hours of treatment). This reduction also occurred when the data were stratified by sex, noting that men always had higher values.

Table I - HGS of patients with CRF during an HD session stratified by sex. Cruz Alta, Rio Grande do Sul, Brazil, 2019 (n = 39)

Variable	GHS (X ± SD)									
	Before HD	p	HD 1h	p	HD 2h	P	HD 3h	p	HD 4h	p
Sex		>0.001		>0.001		>0.001		>0.001		>0.001
Male	31.6±8.7		31.6±8.5		30.5±8.9		29.8±8.5		29.6±9.1	
Female	19.4±9.7		18.2±10.0		18.2±9.9		18.5±9.5		19.4±9.3	
Total	27.8±9.7		27.3±10.0		26.6±9.9		26.3±9.5		26.4±9.3	

HGS = handgrip strength; HD = Hemodialysis; X = mean; SD = standard deviation. P ≤ 0.05 of the Mann-Whitney-Wilcoxon test

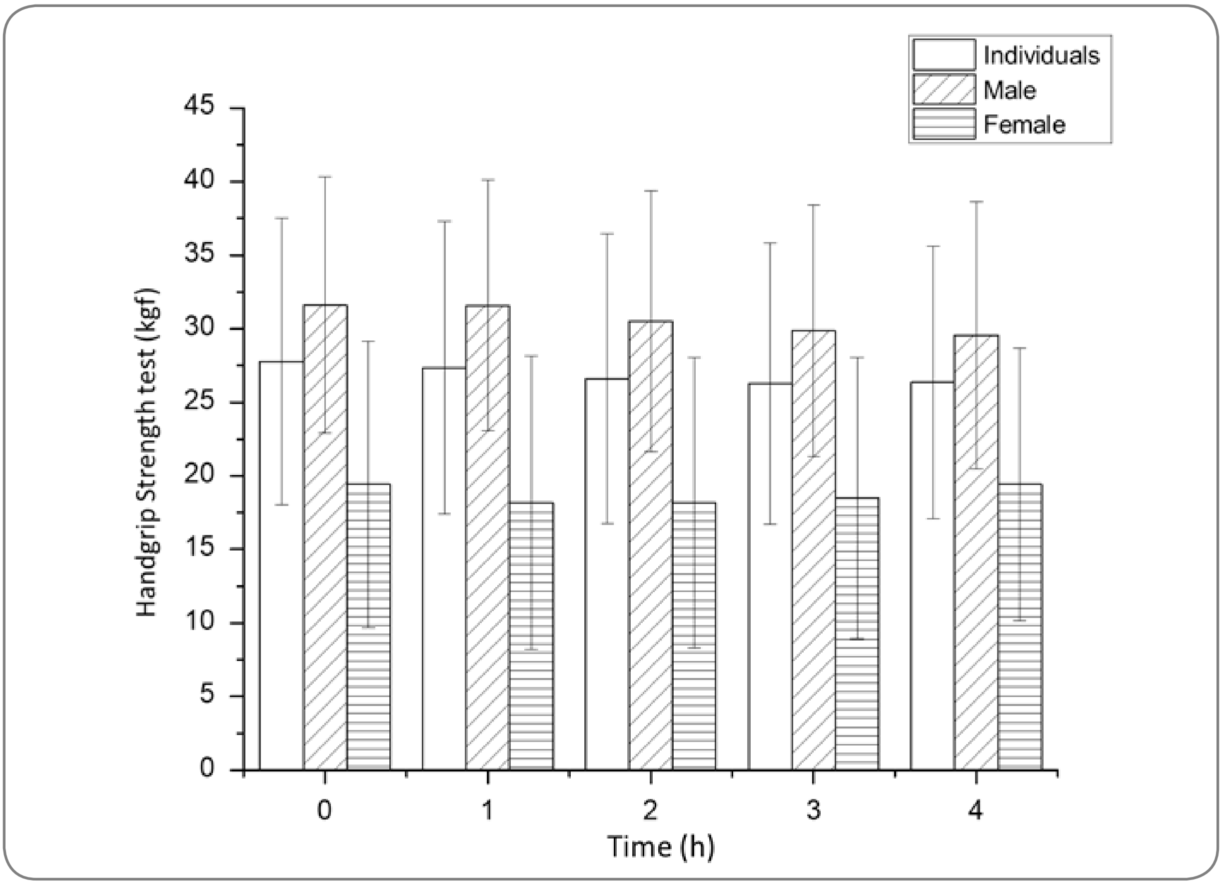

Figure 1 - Histogram of distribution and frequency of HGS data during an HD session of patients with CRF stratified by sex (male = 27; female = 12) and the total number of participating individuals (n = 39). The data are presented in terms of mean and standard deviation. Cruz Alta, Rio Grande do Sul, Brazil, 2019

When correlating the HGS of patients with the duration of the HD session, there was always a strong correlation (above 0.7), for both men and women, showing that strength decreases with treatment time regardless of gender (Table II).

Table II - HGS correlation of patients with CRF during an HD session stratified by sex. Cruz Alta, Rio Grande do Sul, Brazil, 2019 (n = 39)

HD Time	Tempo de HD				
	Before of HD Male – Fem.	1 hour of HD Male – Fem.	2 hours of HD Male – Fem.	3 hours of HD Male – Fem.	4 hours of HD Male – Fem.
Before HD					
Male – Fem.	1.00 – 1.00	0.97 – 0.92	0.93 – 0.90	0.94 – 0.81	0.90 – 0.88
1 hour of HD					
Male – Fem.	0.97 – 0.91	1.00 – 1.00	0.93 – 0.92	0.96 – 0.86	0.91 – 0.90
2 hours of HD					
Male – Fem.	0.93 – 0.90	0.93 – 0.92	1.00 – 1.00	0.94 – 0.92	0.81 – 0.93
3 hours of HD					
Male – Fem.	0.94 – 0.81	0.96 – 0.86	0.94 – 0.92	1.00 – 1.00	0.90 – 0.87
4 hours of HD		0			
Male – Fem.	0.90 – 0.88	.91 – 0.90	0.81 – 0.93	0.91 – 0.87	1.00 – 1.00

Discussion

The present study carried out an analysis of the behavior of HGS in patients with CRF during an HD session, indicating a significant loss in this variable as therapy progresses.

The negative effects of HD on HGS found in the present study were previously mentioned in a survey of 156 patients, in which a reduction in strength was found (28.6 ± 11.4 kg to 27.7 ± 11.7 kg; $p < 0.01$) after the end of the hemodialysis session [20]. However, the aforementioned authors assessed strength in two moments, pre and post-HD, unlike the present study, which evaluated it in five different moments, assessing the effect every hour of the session. Another study [21] found no difference in HGS in patients with CRF over the session course, which can be explained by the relatively small sample (n = 43).

This finding of the present study, related to the reduction of HGS every hour of the hemodialysis treatment session, occurs due to the great reduction of the muscular system that the disease and the treatment cause in the patient in question [9,10,12] taking this patient to the diagnosis of sarcopenia [13]. This reduction is due to the low level of physical activity and exercise capacity that the disease and HD impose [9,10], and due to the uremic myopathy [11] and anemia [17] resulting from CRF.

The reduction in muscle strength was also observed when men and women were analyzed separately. Besides, it was found that men have higher HGS than women at all times of the research, and this data can be explained by the fact that, even without the presence of pathologies, males have greater muscle strength due to the higher amount of muscle mass [22] considering that HGS is associated with lean body mass [20]. This is justified by the fact that men suffer the action of testosterone, while women, that of estrogen, which directly influences the cellular composition [23].

Another result presented was the inverse relationship between HD time and the reduction of HGS in patients with CRF, showing that as the months of therapy increase, they reduce the HGS scores. This relationship can be explained by the loss of muscle mass that is caused by complex mechanisms and agents, such as protein degradation, which, in turn, is mediated by the ubiquitin-proteasome system, caspase-3, insulin/IGF-1, glucocorticoid, metabolic acidosis, and signaling pathways related to sex hormones [24], angiotensin II and inflammation [25]. This corroborates the fact that the participants in this study had reduced HGS (measured before HD), both for men (31.6 ± 8.7) and for women (19.4 ± 9.7) when compared to the normative values of HGS for healthy adults, which are 42.8 and 40.9 kg for men and 25.3 and 24.0 kg for women [26].

However, alternative methods can be used to reduce or attenuate the muscle mass loss progression, including the development of new drugs seeking to prevent the mechanisms, use of nutritional supplements, and muscle resistance training [24]. In this sense, aiming to improve muscle strength and many other physical and health variables, the clinic where this study took place offers an intradialytic functional physical training program for HD patients, and of the sample in this study, most participated in this program (n = 29; 76.3%). In this context, physical exercise is recommended for patients on HD [27]. However, the implementation of intradialytic exercise programming in renal clinics is rare.

Considered as a protective factor, the practice of physical activity can mitigate the damage caused by the disease, and treatment, in addition to slowing down the progression or maintenance of renal function [28]. Some studies have evaluated different modalities of intradialytic physical exercise and point out that this practice has promoted benefits, such as a significant increase in muscle strength, improvement in all domains of quality of life [29], in functional capacity [5], in physical performance [30] and was able to prevent mortality [31]. Given the benefits, patients need to be encouraged to increase the level of physical activity [32] as a way to assist in treatment and rehabilitation [5].

As a limitation of the study, the sampling process that occurred intentionally stands out. It is suggested that a randomized study be carried out. As a positive point, we highlight the HGS collection method that occurred every hour of HD, something never done in research with this variable.

Conclusion

In this study, it became evident when analyzing the behavior of HGS in patients with CRF during an HD session that there was a significant reduction in strength at all times of the study for all subjects (before HD, after one hour, two hours, three hours and four hours of treatment) even stratified by sex when it was also found that men had higher values at all times.

These findings show that hemodialysis treatment negatively interferes with the handgrip strength of people with CRF. In this sense, strategies to promote muscle strength for HD patients should be encouraged to assist these people in the treatment and their daily lives.

Potential conflict of interest
No conflicts of interest have been reported for this article.

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Authors´s contributions
Conception and design of the research: Krug MM, Krug RR. **Data collection:** Dutra TS, Kupske JW, Keller KD, Moreira PRM, Krug RR. **Analysis and interpretation of data:** Salazar RFS, Krug RR. **Statistical analysis:** Salazar RFS. **Obtaining financing:** Krug RR L. **Writing of the manuscript:** Dutra TS, Kupske JW, Krug MM, Salazar RFS, Keller KD, Moreira PRM, Krug RR. **Critical revision of the manuscript for important intellectual content:** Krug MM, Salazar RFS, Keller KD, Moreira PRM, Krug RR.

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