



Relationship between handgrip strength and pulmonary capacity in patients on hemodialysis

Relação entre a força de preensão manual e a capacidade pulmonar de pacientes em hemodiálise

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Abstract

Introduction: Chronic kidney disease (CKD) is defined as loss of kidney function, but its progression leads to systemic changes that compromise the quality of life of patients on dialysis. As such, the decline in lung capacity in this population may be one of the factors related to reduced peripheral muscle strength. **Objective:** Assess the relationship between handgrip strength (HGS), pulmonary function and respiratory muscle strength in patients with CKD on hemodialysis. **Method:** Thirty patients with CKD were assessed in terms of anthropometric data, pulmonary function, respiratory muscle strength and HGS. **Results:** A moderate association was observed between HGS and the variables forced vital capacity ($r=0.54$; $p=0.002$), maximum voluntary ventilation ($r=0.51$; $p=0.004$) and maximum expiratory pressure ($r=0.59$; $p=0.001$), and a weak association with forced expiratory volume in 1 second (FEV1) ($r=0.46$; $p=0.009$) and maximum inspiratory pressure ($r=0.38$; $p=0.03$). Additionally, about 67% of the sample ($n=20$) exhibited some degree of restrictive ventilatory defect in the pulmonary function test. With respect to muscle strength, 40% of the

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sample (n=12) displayed below-normal handgrip strength, as well as low mean MIP and MEP. **Conclusion:** Decreased lung capacity may be related to a decline in HGS in patients with chronic kidney disease on hemodialysis. Thus, therapeutic strategies aimed at lung expansion and respiratory muscle training may contribute to facilitating and favoring rehabilitation in this population.

Keywords: Chronic Kidney Disease. Hemodialysis. Spirometry. Muscle Strength.

Resumo

Introdução: A doença renal crônica (DRC) é definida pela perda da função renal, contudo a sua progressão leva ao surgimento de alterações sistêmicas que comprometem a qualidade de vida dos pacientes em hemodiálise. Consequentemente, a redução da capacidade pulmonar nessa população pode ser um dos fatores que esteja relacionado ao declínio da força muscular periférica. **Objetivo:** Avaliar a relação entre a força de prensão manual (FPM) com a função pulmonar e a força muscular respiratória de pacientes com DRC em hemodiálise. **Método:** 30 pacientes com DRC foram avaliados quanto aos dados antropométricos, função pulmonar, força muscular respiratória e FPM. **Resultados:** Observou-se uma relação moderada da FPM com as variáveis capacidade vital forçada ($r=0,54$; $p=0,002$), ventilação voluntária máxima ($r=0,51$; $p=0,004$) e pressão expiratória máxima ($r=0,59$; $p=0,001$). Já as correlações entre a FPM com o volume expiratório forçado no primeiro segundo ($r=0,46$; $p=0,009$) e a pressão inspiratória máxima ($r=0,38$; $p=0,03$) foram fracas. Além disso, aproximadamente 67% da amostra ($n=20$) apresentou algum grau de restrição ventilatória na prova de função pulmonar. Em relação à força muscular, 40% da amostra ($n=12$) apresentou FPM abaixo do previsto de normalidade, e as médias da pressão inspiratória máxima e da pressão expiratória máxima em porcentagem também se encontraram reduzidas. **Conclusão:** A redução da capacidade pulmonar pode estar relacionada com o declínio da FPM nos pacientes com DRC em hemodiálise. Sendo assim, recursos terapêuticos visando à expansão pulmonar e o treinamento muscular respiratório podem ser estratégias para facilitar e favorecer a reabilitação dessa população.

Palavras-chave: Doença Renal Crônica. Diálise Renal. Espirometria. Força Muscular.

Introduction

Chronic kidney disease (CKD) is defined as loss of kidney function, but its progression leads to systemic changes that compromise the quality of life of patients on hemodialysis [1 - 5]. These include sarcopenia [4, 6 - 10], which leads to a decline in muscle mass and strength. Given its high prevalence and association with mortality in CKD [4, 6], recent years have seen a growing interest in its evaluation and early diagnosis. Several different measurement techniques are used in clinical practice, particularly handgrip strength (HGS) assessment, an easy low-cost method [11 - 13]. However, systems other than the muscle can also be compromised as CKD progresses.

Previous studies have demonstrated that patients with CKD experience respiratory impairments such as dyspnea, pulmonary dysfunction and reduced respiratory muscle strength [2, 3, 14, 15]. Additionally, Enia

et al. [16] reported that patients on hemodialysis with moderate to severe pulmonary edema, even when asymptomatic, showed a decline in physical function. As such, the decline in lung capacity in this population may be one of the factors related to reduced peripheral muscle strength.

Although studies have been conducted to investigate respiratory and physical function outcomes in these individuals, the relationship between lung capacity and functionality in CKD remains unclear. It is vital to elucidate this relationship because if the muscular system is affected by the patient's worsening respiratory condition, the use of therapeutic intervention aimed at improving ventilation during hemodialysis should be considered. Thus, the aim of this study was to assess the relationship between HGS, pulmonary function and respiratory muscle strength in patients with CKD on hemodialysis.

Method

The study was approved by the Research Ethics Committee of the Universidade do Estado de Santa Catarina (CAAE: 34247814.9.0000.0118). Patients undergoing hemodialysis at Associação Renal Vida in Blumenau, Santa Catarina (SC) state, Brazil, were recruited by convenience sampling and provided written informed consent.

Inclusion criteria were: 1) clinical diagnosis of CKD and undergoing hemodialysis for at least 6 months; 2) under medical supervision and not exhibiting any other acute disease; 3) no recent (3 months or less) coronary artery disease, unstable angina, severe heart arrhythmia, respiratory, orthopedic or neurological diseases; and 4) not participating in any physical activity programs in the last 6 months. Patients were excluded from the study when they were unable to perform any of the assessment tasks due to lack of understanding or cooperation.

Data were collected in one day, before the hemodialysis session. Patients were submitted to anthropometric assessment, pulmonary function testing, and respiratory muscle strength and HGS analysis.

Anthropometric assessment

Weight and height were measured with a digital balance (Actlife Balmak[®]) and stadiometer (Welmy[®]), respectively. Body mass index (BMI) was then determined and patients were classified as: underweight (<18.5Kg/m²), normal weight (18.5-24.9 Kg/m²), overweight (25-29.9 Kg/m²) and obese (=30Kg/m²) [17].

Pulmonary function test

Lung function was evaluated using a previously calibrated portable digital spirometer (EasyOne[®]; NDD), in accordance with the recommendations of the American Thoracic Society and European Respiratory Society [18]. The following variables were analyzed: forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁) and the FEV₁/FVC ratio, expressed as absolute values and percentages of predicted normal values [19]. Maximum voluntary ventilation (MVV) was also expressed in absolute values and percentages of predicted normal values [20]. Patients with FEV₁/FVC ≥ 0.7, FVC and FEV₁ ≥ 80% were deemed to have normal pulmonary function. Those who exhibited a decline in the variables studied were submitted to another assessment after inhaling a bronchodilator.

Respiratory muscle strength assessment

Respiratory muscle strength was analyzed using a digital manometer (MVD500[®]), with maneuvers performed according to the Brazilian Pulmonology and Thoracic Society [21]. The highest value obtained during maximal inspiratory (MIP) and expiratory pressure (MEP) maneuvers was considered for analysis, expressed as an absolute value and percentage of the predicted normal value [20].

HGS assessment

HGS was evaluated with a hand dynamometer (SAEHAN[®]), on the upper limb without an arterio-venous fistula. Patients were seated on a chair with no arm rests and instructed to keep their elbows flexed at their side, with the wrists in a neutral position [22]. Three measurements were taken and the highest was used for analysis. The values described by Novaes et al. were used as reference [23].

Statistical Analysis

Statistical Package for the Social Sciences software (SPSS version 20.0) was used for all analyses. Data normality was evaluated applying the Shapiro-Wilk test. The relationship between HGS and the variables pulmonary function and respiratory muscle strength were determined by Spearman's correlation coefficient. Reliability was established based on the magnitude of the coefficient of reliability described by Portney and Watkins [24]: "weak" for coefficients below 0.50, "moderate" between 0.50 and 0.75 and "good" for those above 0.75. Significance was set at p<0.05.

Results

The sample consisted of 30 patients who underwent three hemodialysis sessions a week. Most were women (56.6%) classified as overweight according to their BMI. In regard to pulmonary function, 10 participants (33.3%) presented with normal function and 20 (66.7%) some form of restrictive ventilatory defect. For HGS, 12 patients (40%) obtained below normal values. Table 1 presents the data on patient characteristics and variables.

Table 1 - Patient characteristics and variables

Anthropometric data	Mean ± SD
Gender (M/F)	13/17
Age (years)	49.47 ± 15.48
Body weight (Kg)	70.07 ± 22.76
Height (m)	1.62 ± 0.09
BMI (Kg/m ²)	26.64 ± 7.37
Pulmonary function test	Mean ± SD
FEV ₁ /FVC	0.81 ± 0.02
FVC (L)	2.55 ± 0.99
FVC (%)	71.07 ± 18.07
FEV ₁ (L)	2.07 ± 0.82
FEV ₁ (%)	67.53 ± 21.00
MVV (L)	71.94 ± 29.01
MVV (%)	53.20 ± 14.54
Muscle strength	Mean ± SD
MIP (cmH ₂ O)	74.10 ± 32.75
MIP (%)	60.20 ± 27.73
MEP (cmH ₂ O)	82.77 ± 29.30
MEP (%)	82.12 ± 27.38
HGS (Kgf)	28.18 ± 9.36
HGS (%)	114.00 ± 39.51
Laboratory tests	Mean ± SD
GFR (mL/min/1.73m ²)	5.98 ± 4.67
Urea (mg/dL)	148.50 ± 40.80
Creatinine (mg/dL)	9.91 ± 3.48
Albumin (g/dL)	3.78 ± 0.68
Calcium (mg/dL)	8.72 ± 0.50
Phosphorus (mg/dL)	5.54 ± 1.15
Iron (μg/dL)	94.10 ± 41.27
Kt/V	1.51 ± 0.40

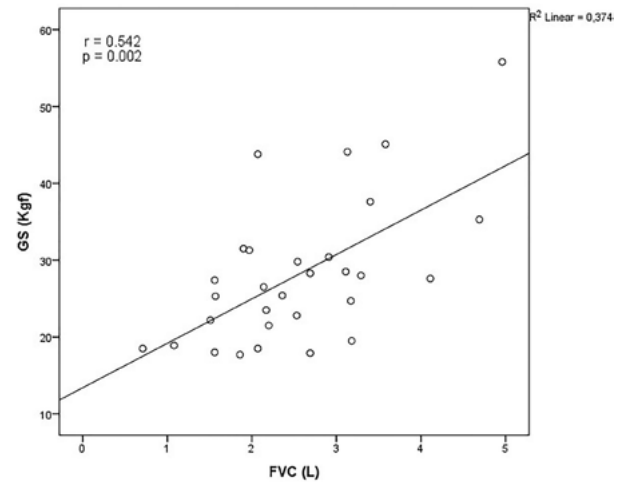
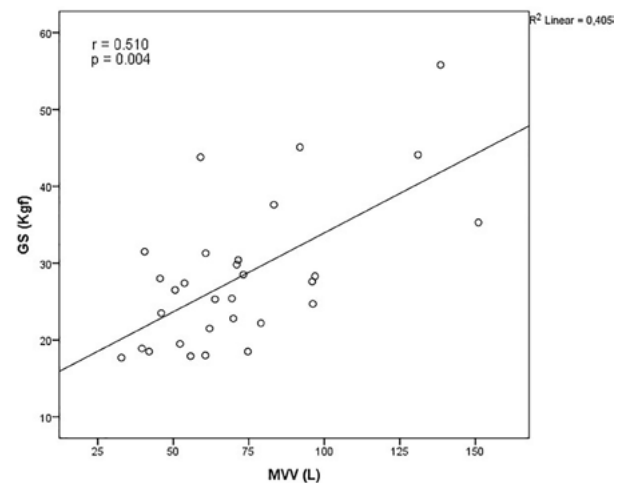
Note: M: male; F: female; BMI: body mass index; FEV₁/FVC: ratio between forced expiratory volume in 1 second and forced vital capacity; FEV₁: forced expiratory volume in 1 second; FVC: forced vital capacity; MVV: maximum voluntary ventilation; MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure; HGS: handgrip strength; GFR: glomerular filtration rate; Kt/V: Kt/V ratio; SD: standard deviation.

Analysis of the correlation between HGS and the remaining study variables shows a moderate correlation with the spirometry variables FVC and MVV (Figures 1 and 2) as well as MEP (Figure 3), and a weak correlation with FEV₁ and MIP (Table 2).

Table 2 - Correlation between HGS, FEV₁ and MIP in the study sample

Variable	r	P
FEV ₁ (L)	0.46	0.009*
MIP (cmH ₂ O)	0.38	0.03*

Note: HGS: handgrip strength; FEV₁: forced expiratory volume in 1 second; MIP: maximum inspiratory pressure; *p<0.05.

**Figure 1** - Correlation between handgrip strength (HGS) and vital forced capacity (FVC) in the study sample.**Figure 2** - Correlation between handgrip strength (HGS) and maximum voluntary ventilation (MVV) in the study sample.

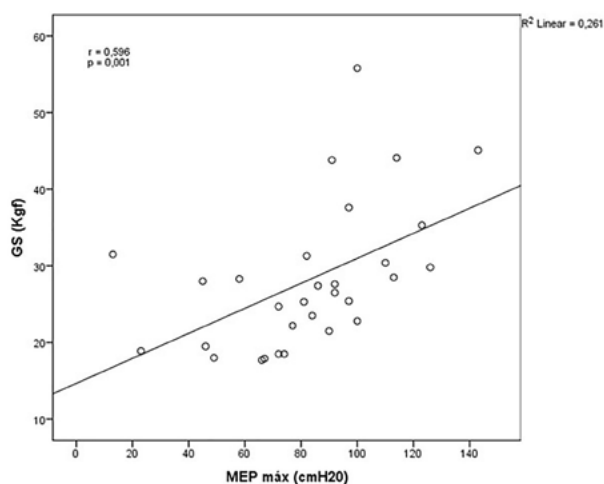


Figure 3 - Correlation between handgrip strength (HGS) and maximum expiratory pressure (MEP) in the study sample.

Discussion

The results obtained indicated that HGS was moderately correlated with FVC, MVV and MEP and weakly correlated with FEV_1 and MIP, suggesting that reduced peripheral muscle strength may be related to the decline in lung capacity in these patients. This may be due to respiratory dysfunctions caused by the progression of CKD, such as the emergence of pulmonary edema, decreased lung compliance, and reduced lung capacities and volumes [2, 3, 25 - 27]. These dysfunctions in conjunction with the effects of sarcopenia on the muscles may result in clinical symptoms such as dyspnea [15], favoring an increase in sedentary behavior in this population.

Enia et al. [16] reported that patients on hemodialysis with moderate to severe pulmonary edema, even when asymptomatic, showed a decline in physical function. As such, our findings highlight the need to pay greater attention to lung capacity in patients with CKD, since excessive fluid buildup, especially between hemodialysis sessions, associated with weak respiratory muscles appear to be contributing factors in decreased ventilatory function and may compromise muscle function.

Additionally, the mean values for spirometry variables in our sample were below predicted normal values, corroborating the findings of previous studies [3, 25, 27]. This decline seems to be related to fluid buildup between hemodialysis sessions, which reduces lung compliance, restricts lung parenchyma and obstructs

small airways, favoring a decline in lung volumes and capacities [3, 15, 25, 27]. Moreover, about 67% of patients displayed some form of restrictive ventilatory defect in the pulmonary function test, indicating the need for therapeutic intervention to improve ventilation in this population.

With respect to muscle strength, 40% of the sample ($n=12$) displayed HGS below normal values, as well as low mean MIP and MEP. In addition, mean MVV, a marker of respiratory muscle strength, was almost 50% below predicted normal values. These findings confirm those reported in previous studies [3, 25, 28, 29]. These data highlight the damage caused to the muscular system as CKD progresses, resulting in loss of muscle mass, strength and endurance. The imbalance caused by increased catabolism and a decline in anabolism, known as sarcopenia, leads to anatomical and functional changes in the peripheral muscles of these patients, favoring sedentary behavior and low exercise tolerance [3, 6, 7].

A limitation of the present study was the failure to use whole body plethysmography to provide a more comprehensive assessment of lung capacity, since this method is considered the gold standard, but we were able to satisfactorily assess lung function via spirometry. Another limitation was that bioelectrical impedance analysis was not applied in order to detect the presence of sarcopenia in this population as opposed to only reduced peripheral muscle strength. However, handgrip strength assessment is an easy low-cost method for application in clinical practice and helps guide professionals who work with these patients, even when hemodialysis clinics do not have the specific tools needed to assess all the aspects required for a sarcopenia diagnosis.

In general, our results emphasize the need for physiotherapists to pay special attention to the dysfunctions in different systems caused by the progression of CKD. Reduced lung capacity seems to be one of the factors that favors decreased peripheral muscle strength in patients on hemodialysis. As such, it is important for patients with CKD to be monitored by a physiotherapist with a view to diagnosing kinetic and functional disorders and ensuring early inclusion of respiratory and peripheral muscle training programs [30]. Additionally, further research is needed to identify the effects of therapies aimed at increasing lung capacity in patients with chronic kidney disease.

Conclusion

Decreased lung capacity may be related to a decline in HGS in patients with CKD on hemodialysis. Thus, therapeutic strategies aimed at lung expansion and respiratory muscle training may contribute to facilitating and favoring rehabilitation in this population.

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