

## Muscle thickness of the *pectoralis major* and *rectus abdominis* and level of physical activity in chronic hemodialysis patients

Espessura muscular do *pectoralis major* e do *rectus abdominis* e nível de atividade física em pacientes em hemodiálise crônica

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### ABSTRACT

**Introduction:** Patients on chronic hemodialysis tend to lose lean body mass and have sedentary behavior. **Objective:** To compare the level of physical activity and the morphology of the muscles *pectoralis major* and *rectus abdominis* of patients on hemodialysis with healthy subjects. **Methods:** We studied 17 patients and 17 healthy individuals. Muscle thickness were evaluated by ultrasound, and the level of physical activity by the International Physical Activity Questionnaire (IPAQ), long version. **Results:** The patients had lower thicknesses of the *pectoralis major* ( $5.92 \pm 0.35$  mm *vs.*  $8.35 \pm 0.62$  mm,  $p < 0.001$ ) and *rectus abdominis* ( $0.96 \pm 0.10$  mm *vs.*  $2.21 \pm 0.40$  mm,  $p < 0.001$ ) compared to healthy subjects. Patients were physically less active than healthy individuals:  $1502.55(788.19-2513.00)$  MET-minutes/week *vs.*  $2268.0(1680.0-4490,8)$  MET-minutes/week ( $p = 0.006$ ); the weekly caloric expenditure of patients was also lower:  $1384.0(480,7-2253.7)$  kcal/kg/week *vs.*  $1680.0(1677.4-4950.0)$  kcal/kg/week ( $p = 0.010$ ). The average time spent sitting per week of the patients was higher than in healthy subjects ( $394.0 \pm 33.1$  min/day *vs.*  $293.0 \pm 38.6$ ,  $p = 0.009$ ) as well as the average time spent sitting during weekend ( $460.0 \pm 40.1$  *vs.*  $201.0 \pm 10.7$ ,  $p = 0.003$ ). **Conclusion:** Chronic renal failure patients on hemodialysis have sedentary behavior and lower muscle thickness of the trunk.

**Keywords:** kidney failure, chronic; motor activity; renal dialysis.

### RESUMO

**Introdução:** Pacientes que realizam hemodiálise crônica tendem a perder massa magra e ter comportamento sedentário. **Objetivo:** Comparar o nível de atividade física e morfologia dos músculos peitoral maior e reto do abdômen de pacientes que realizam hemodiálise com indivíduos saudáveis. **Métodos:** Foram estudados 17 pacientes e 17 indivíduos saudáveis. As espessuras musculares foram avaliadas por meio de ultrassonografia, e o nível de atividade física pelo Questionário Internacional de Atividade Física versão longa (IPAQ). **Resultados:** Os pacientes apresentaram menores espessuras do peitoral maior ( $5,92 \pm 0,35$  mm *vs.*  $8,35 \pm 0,62$  mm,  $p < 0,001$ ) e de reto abdominal ( $0,96 \pm 0,10$  mm *vs.*  $2,21 \pm 0,40$  mm,  $p < 0,001$ ) comparados aos sujeitos saudáveis. Os pacientes foram fisicamente menos ativos que os indivíduos saudáveis:  $1502.55(788.19-2513.00)$  MET-minutos/semana *vs.*  $2268.0(1680.0-4490,8)$  MET-minutos/semana ( $p = 0,006$ ); o gasto calórico semanal dos pacientes também foi menor:  $1384,0(480,7-2253,7)$  kcal/kg/semana *vs.*  $1680,0(1677,4-4950,0)$  kcal/kg/semana ( $p = 0,010$ ). O tempo médio gasto sentado por semana dos pacientes foi maior que dos sujeitos saudáveis ( $394,0 \pm 33,1$  min/dia *vs.*  $293,0 \pm 38,6$ ,  $p = 0,009$ ), assim como o tempo médio gasto sentado durante o fim de semana ( $460,0 \pm 40,1$  *vs.*  $201,0 \pm 10,7$ ,  $p = 0,003$ ). **Conclusão:** Pacientes renais crônicos em hemodiálise apresentam comportamento sedentário e menores espessuras musculares do tronco.

**Palavras-chave:** atividade motora; diálise renal; insuficiência renal crônica.

## INTRODUCTION

Chronic kidney disease (CKD) is a common disease in Brazil and in the world, and because of its high prevalence is considered a public health problem.<sup>1,2</sup> The hemodialysis (HD) is recommended in the terminal stage of CKD. The HD treatment, however, is associated with decreased physical activity and is accompanied by a number of comorbidities, such as protein-energy malnutrition, reduced lean body mass and muscle strength.<sup>3-6</sup>

So often a generalized weakness state is present in these patients, the clinical condition research is required as well as the structure and function of the muscular system.<sup>7-9</sup> The most studied are the antigravity musculature of the lower limbs. This may be related to the fact that neuropathies and uremic myopathies have a higher incidence in the lower limbs in relation to the upper.<sup>10,11</sup> However, the muscles of the trunk, such as the pectoralis major, has an important role in the multiaxial shoulder joint. The atrophy in the muscles can inhibit movements such as flexion, extension, adduction and horizontal shoulder flexion preventing many activities of daily living.

The abdominal muscles have a stabilizing action of the lumbar spine, to load external loads or to maintain the posture in various positions of the activities of daily living. Furthermore, during HD patients remain about 4 hours three times a week in a lying or sitting position, which may lead to a reduction in the use state, generating atrophies and reducing the range of motion of the trunk and the upper limbs.<sup>4,12,13</sup>

However, it was not found in the literature studies evaluating the morphology of these musculature. One way to evaluate these muscles is through ultrasound that tells about the muscle thickness, which is directly associated with the amount of contractile tissue and muscle strength production capacity.<sup>4,14,15</sup> In this context, the objective of this study is to evaluate the thickness of the muscles pectoral muscles and abdominal rectus through muscle ultrasound of patients undergoing chronic hemodialysis compared to healthy subjects. Such information can assist in the organization of preventive protocols of muscle function of maintaining the trunk of these patients.

## METHODS

The sample was chosen intentionally, consisting of 17 patients with terminal CKD diagnosis on hemodialysis in Porto Alegre Clinical Hospital (HCPA), followed at the Nephrology Service and Exercise Pathophysiology Laboratory. Seventeen healthy subjects were included as a control group.

The sample size was calculated by G \* Power 3.1.3 software (Fraunhofer Universität Kiel, Germany), where the "EffectSize" adopted was 0.69, the alpha of 0.05 and power of the study to 0.80, using Student's *t* test for independent samples as statistical test for comparison of variable.<sup>16</sup> This study was approved by the Research Ethics Committee of the Porto Alegre Clinical Hospital (CAAE 36473714.1.0000.5327). All participants read and signed the consent form.

Were used as inclusion patients criteria aged above 18 years, terminal CKD treated with hemodialysis for at least three months, regardless of gender, age and severity of disease, and to provide clinically stable, without acute complications (ex., infections) in the last three months. The subjects in the control group were matched for sex, age, total body weight, height and body mass index.

The study excluded individuals who had: a) co-morbidities unrelated to the pathological process of origin; b) absolute contraindications or for holding the tests; c) difficulty in understanding the procedures proposed by researchers; d) were in a period of exacerbation of the disease, and) did not agree to participate and f) patients with neuromuscular diseases who presented motor deficits resulting from stroke (stroke), multiple sclerosis, amyotrophic lateral sclerosis or *Guillain-Barré*.

For the group of patients, the evaluations were conducted on two different days, before the beginning of the hemodialysis session. Day 1: Quiz Application on the level of physical activity (IPAQ); Day 2: Verification of muscle thickness of the pectoralis major and abdominal. The control group carried out the questionnaires and image ratings in a single day, following the same order used for patients.

## INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE LONG VERSION (IPAQ)

Among the outcome measures of the International Physical Activity Questionnaire (IPAQ), long version, were total physical activity, expressed in MET-minutes per day and minutes reported in vigorous-intensity activity, moderate-intensity activity, and hiking. Moderate intensity was assigned as 4 METs (Metabolic Equivalent of Task), vigorous intensity as 8 METs, and hiking equivalent to 3.3 METs. The metabolic equivalent/minute (MET-min) was calculated by multiplying METs per minute participation in physical activities of vigorous intensity, moderate and hiking, as the formula for MET-minutes calculation considered as follows:

- Walking MET-minutes/week = 3.3 \* hiked minutes \* days of trekking;
- Moderate MET minutes/week = 4.0 \* minutes of moderate intensity activity \* days of moderate or vigorous activities;
- Vigorous MET-minutes/week = 8.0 \* minutes of vigorous intensity activities \* day activities with vigorous intensity.

The total physical activity MET-min/week was calculated as the sum of the scores Hikin + MET-min/week moderate + vigorous. Low activity level was considered when checking to values below 600 MET-minutes/week. For moderate activity, considered 5 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum of at least 600 MET-minutes/week. And how high physical activity, considered 7 days or more of any combination of walking, moderate or vigorous intensity activities accumulating at least 3,000 MET-minutes/week.

The caloric expenditure in MET minutes/week was measured by multiplying the value of MET activity held by its weekly frequency and duration. The value obtained was multiplied by the weight and divided by 60 minutes to transform into kilocalories (kcal/min).

## EVALUATION OF MUSCLE THICKNESS

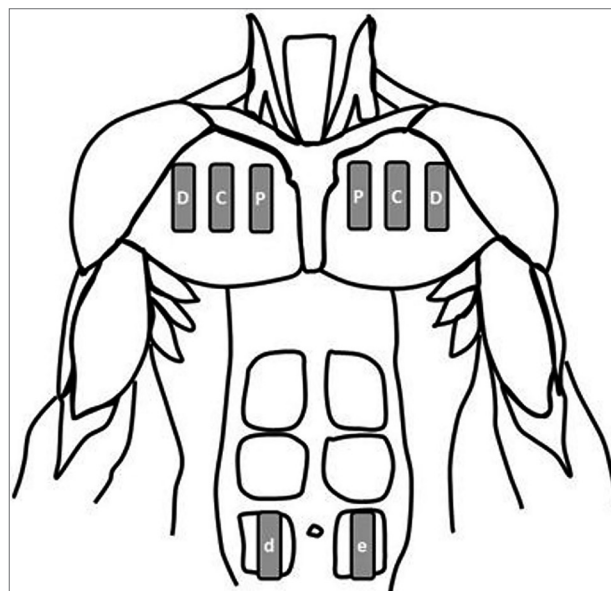
For the evaluation of transverse muscle thickness, was used an ultrasound machine and a linear array transducer B-mode ultrasonography (HD7.XE®, Philips and Neusoft Medical Systems Co., Shenyang, China)

with a frequency of 7.5 MHz. The transducer was soaked in gel water soluble transmission, promoting acoustic contact, not depress the skin surface.

To ensure that subsequent images were made in the exact anatomical location markings bony prominences were considered.<sup>17,18</sup> After demarcations, a transverse image to which it was possible to view the musculature was obtained. Thus, for evaluation of cross muscle thickness measurements were performed by ultrasound by means of an ultrasound device, considering the following regions: the upper inner edge of the aponeurosis of higher and lower abdominal and pectoral both bilateral.

For evaluation of the pectoralis major probe was positioned parallel to the sternum and perpendicular to the clavicle in the second and third rib in three points: 1) Proximal to the sternum; 2) Midpoint of the muscle belly; 3) Distal to the sternum.<sup>18</sup> For the evaluation of the abdominal muscles the probe was positioned longitudinally to the muscle, brain-caudal direction. Two images were placed, one to two centimeters to the right and one to two centimeters to the left of the umbilicus.<sup>19</sup> All images were made bilaterally (Figure 1).

**Figure 1.** Probe positioning to collect the thickness of the pectoralis major and rectus abdominis.



Gray rectangular bar equivalent to the transducer positioned along the body. Q: proximal to the sternum; C: Central to the muscle belly; D: Distal to the sternum; R: right; and L: Left.

All examinations were performed by the same examiner. To quantify the reliability of

measurements of muscle thickness (MT) was used Intra-class correlation coefficient (ICC). Six random images between groups and measured five times by the same person on different days were chosen. The values of reliability coefficients range from zero (0) to one (1) where values closer to 1 indicate higher reliability. The following categories for reliability levels were applied: greater than 0.75 = high reliability; between 0.4 and 0.75 = reasonable reliability, and lower than 0.4 = poor reliability.<sup>19</sup>

The test Shapiro-Wilk and Levene were used to verify the normality and homogeneity of data. In the descriptive analysis we used mean and standard deviation or median and interquartile range. The independent *t* test was used to compare the linkage variables (age, weight, height) and morphological variables (transverse muscle thickness) between the groups. The Mann-Whitney test was used to assess the measure of central tendency between physical activity levels between the groups. All analyzes were performed using SPSS 20.0 for Windows (Chicago, IL, USA). The level of significance was  $p < 0.05$ .

## RESULTS

The sample consisted of 17 patients with CKD, 10 men and 7 women, the same distribution occurred in the control group. There was no statistically significant difference between patients and controls with respect to age, total body weight, height and body mass index, as shown in Table 1.

**TABLE 1** DEMOGRAPHIC AND ANTHROPOMETRIC DATA OF HEMODIALYSIS PATIENTS AND HEALTHY SUBJECTS

	Patients	Control	<i>p</i>
Age (years)	54.1 ± 14.1	48.3 ± 15.2	0.33
Stature (cm)	161.3 ± 8.1	166.0 ± 12.0	0.87
Body mass (Kg)	64.2 ± 11.8	73.0 ± 20.6	0.41
BMI (kg/m <sup>2</sup> )	24.5 ± 3.1	26.4 ± 5.0	0,83

Cm: centimeters; kg: kilogram; kg/m<sup>2</sup>: kilogram per square meter; BMI = body mass index; Significance level  $p < 0,05$ .

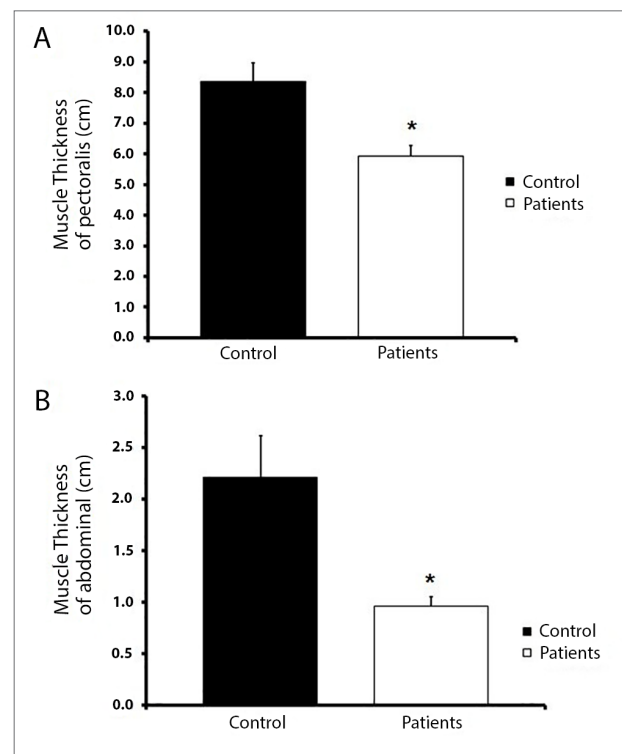
Patients were classified as moderately active: 1502.55 (788.19-2513.00) MET-minutes/week, while the control subjects were classified as highly active: 2268.0 (1680.0-4490,8) MET-minutes/week ( $p = 0.006$ ); the weekly caloric expenditure of patients was also lower: 1384.0 (480,7-2253.7)

kcal/kg/week *vs.* 1680.0 (1677.4 to 4950.0) kcal/kg/week ( $p = 0.010$ ). The weekly energy expenditure of patients was significantly lower than controls: 1384.0 (480,7-2253.7) kcal/kg/week *vs.* 1680.0 (1677.4 to 4950.0) kcal/kg/week, respectively ( $p = 0.010$ ).

The average time spent sitting week the patients were significantly higher than those of healthy subjects ( $394.0 \pm 33.1$  min/day  $293.0 \pm 38.6$ ;  $p = 0.009$ ). The same was observed in relation to the average time spent sitting during the weekend, the values were  $460.0 \pm 0.1$  for patients and  $201.0 \pm 10.7$  for the controls ( $p = 0.003$ ).

The intraclass correlation test and retest the assessment of muscle thickness of the pectoralis major was  $r = 0.971$  and the rectus abdominis of  $r = 0.984$ . Regarding muscle morphology, the groups showed significant difference in the thickness of the pectoralis major ( $p = 0.001$ ) and abdominal ( $p = 0.001$ ). Patients have a thickness average value of the pectoralis major of  $5.92 \pm 0.35$  mm and the control group an average of  $8.35 \pm 0.62$  mm. For abdominal muscle, patients have a mean value of  $0.96 \pm 0.10$  mm, whereas in the control group this value was  $2.21 \pm 0.40$  mm (Figure 2).

**Figure 2.** Muscle thickness between groups. A) muscle thickness pectoralis; B) muscle thickness of the abdominal; \*  $p < 0.001$ .



## DISCUSSION

The main finding of this study was that chronic renal failure patients on hemodialysis had lower muscle thickness of the pectoralis major and rectus abdominis. Compared to healthy subjects, patients had a lower level of physical activity, caloric expenditure and metabolic equivalent, and more time sitting in the week and the weekend.

The maintenance treatment of CKD by hemodialysis makes these patients staying for long periods of time throughout the week, a fact that is not balanced with physical activity, can promote muscle weakness, fatigue and increased hospitalization rate.<sup>13,20,21</sup> The results of the study of Medina *et al.*,<sup>23</sup> as well as the present study show that the population of chronic renal HD is insufficiently active, contributing to sedentary lifestyles and changes in muscle structure as atrophy and changes in its architecture.<sup>3</sup>

The study Sakkas *et al.*<sup>10</sup> evaluated through muscle biopsy the rectus abdominis muscle of patients who underwent peritoneal dialysis, compared to healthy subjects. The authors found muscle atrophy of the tissue sample of patients compared to control subjects. The findings of this study correlate with these data, as were observed less muscle thickness values of the rectus abdominis, although the assessment was by ultrasound and not by microscopic analysis of the tissue.

Few studies have evaluated the loss of muscle mass musculature of the trunk, such as the rectus abdominis. This muscle has an important stabilizing role of the spine during movement, moreover, it can also be affected when there is disuse and atrophy of skeletal muscles of the lower limbs.<sup>9,23</sup> Furthermore, the smallest thickness of the rectus abdominis of the patient may indicate a generalized muscular atrophy.<sup>10,11</sup>

Regarding the pectoralis major, it was also found a smaller thickness in patients in the control group. This study is the first to evaluate the muscle thickness pectoralis by ultrasound in patients with CKD who perform HD. Two other studies using muscle biopsy also showed atrophy of the deltoid muscle.<sup>24,25</sup> These findings indicate a decrease of contractile tissue in the tissue sample, predominantly of type II fibers.

The importance of evaluating the pectoralis major is in preventing problems that its atrophy may induce such as loss of accessories inspiratory musculature<sup>26</sup> strength, body posture stooped shoulders,

and difficulty in performing activities of daily living that require movements performed with upper limbs. In addition, patients with lower limb strength reduction can constantly order the pectoralis major to sit or stand up with the help of hand support due to its water main function bilaterally which assists in trunk stabilization.<sup>27</sup>

The pectoralis major assists directly movements that perform internal rotation of the arm, as is the cam function to slow shoulder extension movements, horizontal abduction and external<sup>27</sup> rotation, which can often be traced body support moves during basic activities such as bathing and bedtime. In such cases, it is important that the pectoralis major is preserved to prevent injuries such as breaks, if it is used too much force during extension and external shoulder rotation.<sup>28</sup>

It has been shown that proximal musculature of the lower limbs of kidney patients suffer more from the loss of muscle mass.<sup>29,30</sup> In advanced cases of high urea, strength reduction level of the lower limbs due to myopathies and/or polineuropathies is very high.<sup>31,32</sup> Among the mechanisms involving the loss of lean body mass are involved aspects such as the development of insulin resistance and inflammation and activation of muscle proteolysis by ubiquitin-proteasome complex.<sup>33</sup> In addition, patients with CKD have high risks in their nutritional status due to uremia, a restricted diet, low physical activity, chronic inflammation, comorbidities, and metabolic disorders. These factors affect energy expenditure and affect the body composition of these patients.<sup>34</sup>

Evidence suggests that in patients with sarcopenia CKD complex condition mediated by an imbalance between anabolism and catabolism of muscle protein.<sup>35</sup> Still, there is a gap in the literature regarding the different methods for the evaluation of muscle mass in these patients, as well as studies to perform a combination of these methods with lean mass loss markers.

In a functional kinesiological perspective, the preservation of muscle thickness of muscles such as abdominal and pectoralis becomes essential to maintain basic functions that provide functional independence. The findings of this study may help significantly in organizing interventions through physical exercises directed to the trunk, as well as the basis for further studies aimed at identifying

functional limitations of upper limb muscles, chest and abdominal wall.

As a limitation of this study, the presence and association of other lean mass conventional markers with muscle thickness parameter assessed by ultrasound has not been evaluated.

## CONCLUSION

This study showed that patients with terminal CKD treated with HD feature: 1) Lower level of physical activity; 2) Increased time spent sitting during the week and the weekend; and 3) Minor muscle thickness of the largest and rectus abdominis muscles chest.

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