

Assessment of the capacity of the Falls Efficacy Scale International in specifying the risk of falling in patients with chronic kidney disease on hemodialysis

Avaliação da capacidade da Escala Internacional de Eficácia de Quedas em discriminar risco de quedas em pacientes com doença renal crônica submetidos à hemodiálise

Evaluación de la capacidad de la Escala Internacional de Eficacia de Caídas en discriminar riesgo de caídas en pacientes con enfermedad renal crónica sometidos a hemodiálisis

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ABSTRACT | The objective of this study was to evaluate the capacity of the Falls Efficacy Scale International (FES-I), of the parathyroid hormone (PTH) serum levels, and of the length of time on hemodialysis (LTH) to discriminate falling from non-falling patients with chronic kidney disease (CKD) under hemodialysis treatment. We conducted a cross sectional study on 64 patients with an average age of 44.2±14.8 years. Anthropometric data, PTH serum level, history, and risk of falls (FES-I), LTH, and level of physical activity (International Physical Activity Questionnaire - IPAQ) were collected. We found elevated PTH serum levels in 64.1% of the patients, and 17.2% reported a history of falls in the last year. The average LTH was 50.3±37.5 months. A low level of physical activity was detected in 64.1% of the patients. There was also positive correlation between PTH and LTH ($r=0.47$, $p<0.001$). No correlation was found between the FES-I and PTH ($p<0.131$), between the FES-I and the LTH ($p<0.153$) or between the PTH (low value/normal ≤ 450 pg/mL and high value >450 pg/mL) and the risk of falling (falling and non-falling patients) ($p<0.158$). In this study, the FES-I instrument was capable of discriminating fallers from non-fallers on hemodialysis. We conclude that the FES-I showed good

performance in discerning fallers from non-fallers; however, no association was observed between falling patients with PTH serum levels and the LTH.

Keywords | parathyroid hormone; bone remodeling; renal dialysis.

RESUMO | O objetivo deste estudo foi avaliar a capacidade da Escala Internacional de Eficácia de quedas (FES-I), dos níveis séricos de paratormônio (PTH) e do tempo de tratamento hemodialítico (TTH) de discriminar pacientes com doença renal crônica (DRC) em tratamento hemodialítico caidores de não caidores. Foi realizado estudo transversal com 64 pacientes, com idade média de 44,2±14,8 anos. Foram coletados dados antropométricos, níveis séricos de PTH, histórico e risco de quedas (Escala Internacional de Eficácia de Quedas - FES-I), TTH e o nível de atividade física (Questionário Internacional de Atividade Física - IPAQ). Foram encontrados níveis séricos de PTH elevados em 64,1% dos pacientes, e 17,2% deles relataram histórico de queda no último ano. O tempo médio de TTH foi 50,3±37,5 meses. Nível de atividade física leve foi encontrado em 64,1%. Foi encontrada correlação positiva entre o PTH e o

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Presentation: Oct. 2012 - Accepted for publication: Mar. 2013 - Financing source: none - Conflict of interest: nothing to declare - Approval at the Ethics Committee n. 829/2011

TTH ($r=0,47$; $p<0,001$). Não foram encontradas correlação entre o FES-I e o PTH ($p<0,131$), entre o FES-I e o TTH ($p<0,153$) nem entre o PTH (valor baixo/normal ≤ 450 pg/mL e valor elevado >450 pg/mL) e o risco de queda (caidores e não caidores) ($p<0,158$). No estudo, o instrumento FES-I mostrou-se capaz de discriminar hemodialíticos caidores de não caidores. Concluímos que a FES-I apresentou bom desempenho de avaliação entre caidores e não caidores, no entanto não foi observada associação entre caidores com os níveis séricos do PTH e com o TTH.

Descritores | hormônio paratireóideo; remodelação óssea; diálise renal.

RESUMEN | El objetivo de este estudio fue evaluar la capacidad de la Escala Internacional de Eficacia de Caídas (FES-I), los niveles séricos de hormona paratiroidea (PTH) y el tiempo de tratamiento con hemodiálisis (TTH) para discriminar pacientes caedores de no caedores con enfermedad renal crónica (ERC) en tratamiento con hemodiálisis. Estudio transversal con 64 pacientes, con edad media de $44,2\pm 14,8$ años. Fueron recolectados

datos antropométricos, niveles séricos de PTH, historia y riesgo de caídas (Escala Internacional de Eficacia de Caídas - FES-I), TTH y el nivel de actividad física (Cuestionario Internacional de Actividad Física - IPAQ). Fueron encontrados niveles séricos de PTH elevados en 64,1% de los pacientes y 17,2% de ellos relataron una historia de caída en el último año. El tiempo medio de TTH fue $50,3\pm 37,5$ meses. El nivel de actividad física leve fue encontrado en un 64,1%. Fue encontrada una correlación positiva entre el PTH y el TTH ($r=0,47$; $p<0,001$). No fueron encontradas correlaciones entre el FES-I y el PTH ($p<0,131$), entre el FES-I y el TTH ($p<0,153$) ni entre el PTH (valor bajo/normal ≤ 450 pg/mL y valor elevado >450 pg/mL) y el riesgo de caída (caedores y no caedores) ($p<0,158$). En el estudio, el instrumento FES-I se mostró capaz de discriminar pacientes con hemodiálisis caedores de no caedores. Concluímos que FES-I presentó buen desempeño de evaluación entre caedores y no caedores, sin embargo, no fue observada asociación entre caedores con los niveles séricos de PTH y el TTH.

Palabras clave | hormona paratiroidea; remodelación ósea; diálisis renal.

INTRODUCTION

The progressive and irreversible loss of kidney functioning^{1,2} incurred by chronic kidney disease (CKD) has led to an increase in the incidence and prevalence of patients maintained in dialysis programs, and it has become a global public health issue³.

The metabolic disturbance consequential of CKD associated with dialysis may reverberate in the musculoskeletal system through alterations in parathyroid hormones (PTH), calcium, phosphorus, and calcitriol, which occur precociously from stage 3 CKD onwards^{1,4}. These alterations have a fundamental role in the physiopathology of bone diseases⁵, and are directly related to morbimortality⁶.

Studies report the association among creatinine clearance, a decrease in the serum levels of calcitriol, and vitamin D receptors in the muscle with an increase in the risk of falling⁷⁻⁹. The low levels of calcitriol associated with high levels of PTH are related to myopathy, loss of balance, the occurrence and medical history of falls¹⁰⁻¹², and due to the latter, the decline of physical functioning¹³.

Therefore, recognizing the importance of evaluating the fear of falling in patients with CKD, this study aimed at assessing the capacity of the FES-I, the serum levels of PTH, and the length of time on hemodialysis treatment (LTH) in discerning falling from non-falling patients with CKD under hemodialysis treatment. Although the assessment of the fear of falling is complex and involves physical, behavioral, and functional influences, the FES-I

is an instrument whose total score is better associated with the medical history of falls in the last year¹⁴.

The hypothesis of our study is that the FES-I applied to individuals with CKD under hemodialysis for a long period of time, and who present elevated PTH values, is capable of discerning fallers from non-fallers.

METHODOLOGY

This was a transversal study conducted at the Clinics Hospital of the Pernambuco Federal University, and at the Kidney Treatment Center from January to February 2012. The study was approved by the Pernambuco Federal University's Ethics and Research Committee (CAAE 0416.0.172.000-11), and all volunteers signed a consent form to participate in the study, in accordance with the National Health Council's Resolution 196/96.

The sample was selected sequentially and composed of 64 patients (73.40% male) in a chronic hemodialysis program three times a week, with 4-hour sessions.

The inclusion criteria were patients of both sexes, aged between 18 and 75 years, under hemodialysis treatment for at least 6 months. We excluded volunteers who presented neurological diseases that affected gait, balance or comprehension of the evaluation items; vestibular disorders; uncorrected visual deficiency; paralyzes of any etiology, and orthopedic alterations (amputations, fractures, and fail to remain in the standing position).

Anthropometric and geographical data as well as the patients' medical history of falls (frequency of falls in the previous year, and from the interview day) was collected.

International physical ability questionnaire

The level of physical activity of the individuals was evaluated by means of the International Physical Ability Questionnaire (IPAQ – version 6 – short form)¹⁵, and the information obtained was related to the frequency and duration of the activities taking into consideration the previous 7 days¹⁶. The level of activity was categorized as low, moderate, and vigorous, according to Matsudo et al.¹⁵.

Falls efficacy scale international

For the assessment of the risk of falling, we used the FES-I. In this study, falling was defined as the unintentional act of falling on the ground or onto a level lower than the patient's plane⁸. The FES-I is a questionnaire¹⁴ that contains 16 sections about different daily activities with four possibilities of answers and respective scores from one to four ("Not at all concerned" to "Extremely concerned"). The total score varies from 16 to 64 (no concern to extreme concern) related to falling during the performance of activities specified on the questionnaire¹⁴.

PTH serum levels were assessed by the chemiluminescence method (Architect – Abbott Diagnostics® brand), and through the data collected from the patient's medical chart. The reference levels for patients considered normal or with bone alterations on hemodialysis were between 100 and 450 pg/mL. However, PTH levels lower than 100 pg/mL and higher than 450 pg/mL are more closely associated with low and high bone remodeling, respectively¹⁷.

The study considered two PTH levels: low/normal ≤ 450 pg/mL, and elevated >450 pg/mL.

Statistical analysis

The results were expressed in averages, standard deviation, and frequency of the variables. For the evaluation of normality distribution, Kolmogorov-Smirnov's test was used. To compare the averages, the Student *t* test was used for independent samples (FES-I and LTH).

The Receiver Operator Characteristic (ROC) curve is a powerful tool to measure and specify problems related to the performance of the diagnosis of the risk of falling because it helps in studying the variation of sensitivity and specificity of different cut values. Therefore, the ROC curve was used in this study to evaluate the total scores of the FES-I, of the LTH and of the

PTH serum level in discerning falling from non-falling patients on hemodialysis.

The Pearson correlation to the total score of the FES-I, the LTH, the PTH serum levels, and the Pearson chi-square test was carried out to evaluate the association between PTH (categorized as low/normal and elevated serum level) and the history of falls in the last year (positive or negative).

Statistical analysis was conducted through the software SPSS, version 18.0 for Windows (SPSS, Inc. Chicago, IL), with a significance level of $p < 0.05$ for all tests.

RESULTS

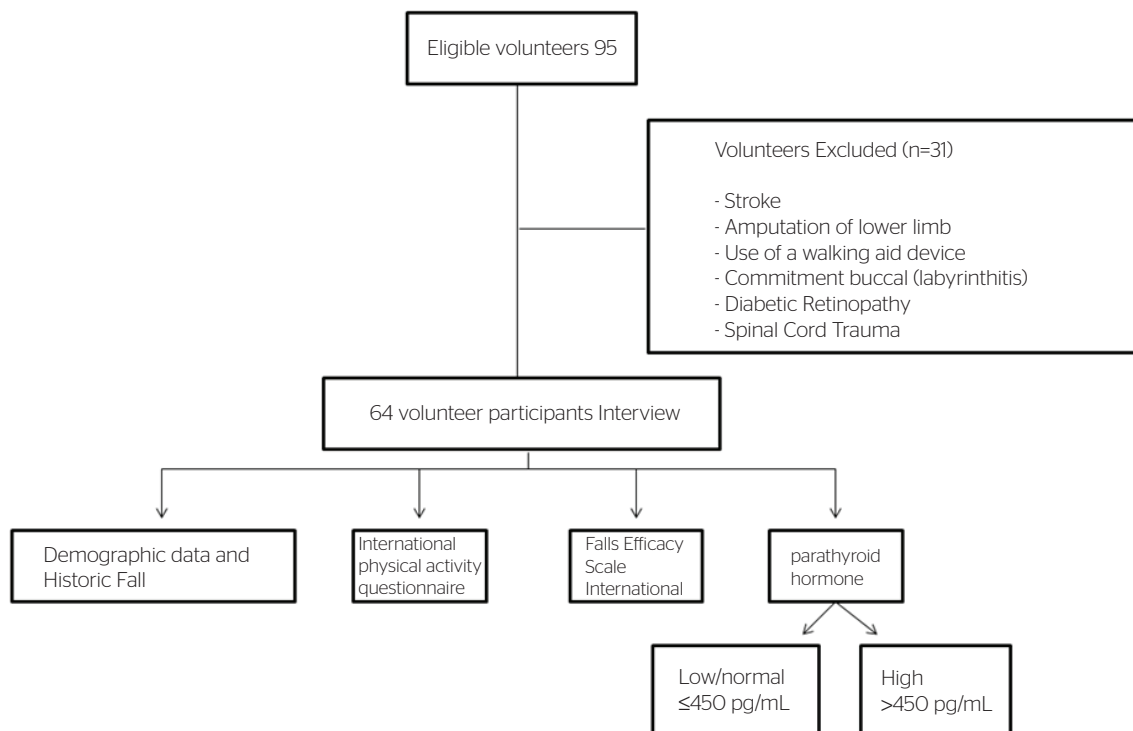
Table 1 presents the general characteristics of the sample.

At both treatment centers, of the 95 patients with CKD on hemodialysis, 64 met the inclusion criteria of the study (Figure 1).

Table 1. Sociodemographic characteristics, parathyroid hormone serum levels, history of falls, and physical activity level (IPAQ) of the sample

	n	%
Gender		
Male	47	73.4
Family income*		
Up to 1 MS	26	40.6
Over 1 MS	38	59.4
Schooling		
0 to 4 years	25	39.1
4 to 8 years	13	20.3
9 or more years	26	40.6
Marital status		
With a partner	40	62.5
Occupation		
Student	6	9.4
Active	26	40.6
Inactive	32	50
PTH serum level		
Elevated	41	64.1
History of falls in the last year		
Yes	11	17.2
Physical activity level		
Light	41	64.1
Moderate	22	34.4
Vigorous	1	1.6

*Family income shown in minimum salaries (MS); PTH: parathyroid hormone



IPAQ:International Physical activity questionnaire; FES-I: Falls Efficacy Scale International; PTH: Parathyroid hormone.

Figure 1. Fluxogram of the patients triaged for the study

Table 2. Categorization of the sample in regards to the anthropometric variables, length of time under hemodialysis treatment, parathyroid hormone serum levels, and Falls Efficacy Scale International score (average and standard deviation)

Variables	Fallers n=11	Non-fallers n=53	Min.-Max. Total	Average±SD Total
Age (years)	49.5±17.0	43.0±14.3	18.0-75.0	44.2±14.8
Body mass (kg)	63.9±19.7	61.2±12.2	35.0-98.2	61.7±13.6
Height (m)	1.6±0.0	1.6±0.1	1.3-1.8	1.6±0.09
LTH (months)	37.7±32.6	53.0±38.2	6.0-150.0	50.3±37.5
PTH (pg/mL)	580.1±429.4	826.1±699.9	31.3-3000.0	783.8±665.5
FES-I score	34.6±8.2	25.6±10.6*	16.0-56.0	27.1±10.7

LTH: length of time on hemodialysis; PTH: parathyroid hormone; FES-I: Falls Efficacy Scale International. *Student's t test for independent samples (fallers and non-fallers), p-value=0.01

The sample's categorization, along with the average length of hemodialysis treatment, PTH serum levels, and the FES-I score are described in Table 2.

With regard to the ROC curve, an area of 0.779 (p<0.004) was found, and observed that the FES-I presented good performance in discerning fallers from non-fallers. The cutting point to discern fallers from non-fallers was 23 points on the FES-I's total score, with a sensitivity of 90.9% and specificity of 47.2%. No association between falling and the PTH serum levels (p<0.420), and between falling and the LTH (p<0.366) was found (Figure 2).

The averages of the FES-I's score (27.1±10.7), their distribution, and the history of falls over the last year, are displayed on Figure 3. It was observed that the individuals who fell in the last year presented a higher score when compared to individuals that did not fall (p=0.01).

A positive correlation between PTH and LTH (r=0.47; p<0.001) was found. There was no correlation between FES-I and PTH (p<0.131), FES-I and LTH (p<0.153), and PTH (low/normal value ≤450 pg/mL, and elevated value >450 pg/mL) and the risk of falling (fallers and non-fallers) (p<0.158).

DISCUSSION

This study showed elevated PTH serum levels in more than half of the patients with CKD under hemodialysis treatment, and a positive correlation between PTH serum levels and LTH, which indicates higher PTH levels in patients who had been submitted to hemodialysis treatment for a longer period.

Falls

Literature suggests that the prevalence of falls in elderly people on hemodialysis is higher when compared to uremic individuals, and its incidence is

high¹⁸. In a study conducted with patients on hemodialysis, the researchers observed a history of falls in 47% of them, with an average of 1.60 fall per person/year, and the mortality rate directly associated with falling was 4%¹⁹.

In this study, of the 20.3% elderly people who were part of the sample, the prevalence of a history of falls in this group was 30.7% related to the adults. Although the percentage found was relatively lower than those of the aforementioned studies^{18,19}, it was still higher than the percentage in the group of adults in the sample (13.7%).

Risk of falling and the parathyroid hormone

With regard to the association between the risk of falling and the PTH levels, only the use of the FES-I in the study conducted by Boudville et al.²⁰, was found. The researchers did not observe correlation between PTH serum levels and the FES-I, but they reported a higher tendency to fall among the patients who presented low calcitriol serum levels²⁰. Exactly as it happened in our study, the non-association probably occurred because the PTH is not a direct measurement of bone tissue loss. Bone biopsy, considered the golden standard of bone disease diagnosis²¹, was not performed in the patients of this study due to the lack of a precise indication for its need, which made the analysis of the association between the discovery of bone disease and the PTH levels difficult.

Abnormal PTH levels, caused by the excessive secretion of this hormone, contribute to the development of high remodeling bone diseases, such as secondary hyperparathyroidism (SHPT)^{22,23}. The prolonged secretion of PTH results in the development of deep cavities between bone trabeculae²³, causes loss of bone mass, and elevates fracture risks²⁴, in addition to prompting an increase in the intracellular concentration of free calcium in muscle tissues^{25,26}.

Although a study by Boudville et al.²⁰, and this study did not find association between PTH levels and falling, some researchers observed that higher PTH levels are related to the latter^{27,28}, considering that bone fragility, muscle weakness, and poor postural balance are independent risk factors for the occurrence of falls and fractures²⁹. Therefore, high PTH levels associated with low vitamin D levels in individuals on hemodialysis cause a negative impact on muscle strength and functional mobility, because they cause the atrophy of muscle fibers of rapid concentration, thus predisposing the individuals to falling¹¹. The fact that no association was found suggests the necessity of studies that investigate this occurrence.

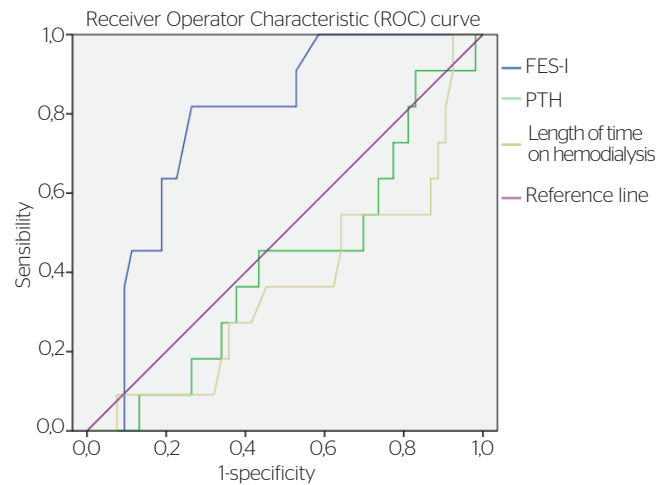


Figure 2. ROC curve of the evaluation of the Falls Efficacy Scale International (FES-I) with the history of falls, and its association with parathyroid hormone (PTH) and with the length of time under hemodialysis treatment

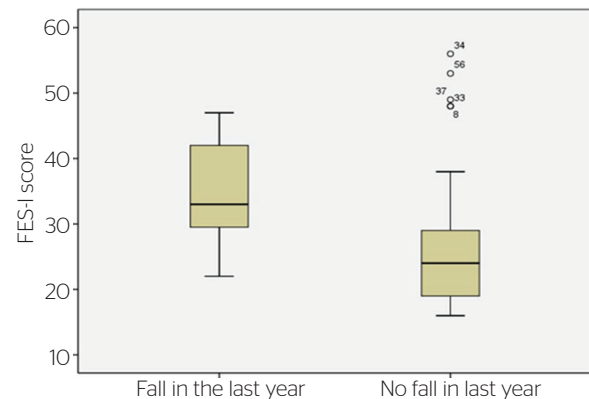


Figure 3. Distribution of the FES-I score averages, and the history of falls in the last year

Parathyroid hormone and length of time under hemodialysis treatment

In this study, we found positive correlation between PTH serum levels and the LTH. Patients with elevated PTH levels presented alterations in calcium and phosphorus metabolism as a result of the excess of PTH secretion or of the therapeutic use of vitamin D receptor activators³⁰. Generally, PTH levels become even higher as hemodialysis progresses, with the possibility of causing parathyroid hyperplasia, which then becomes a cyclical effect³¹.

The assessment of the risk of falling in individuals with CKD on hemodialysis is necessary in clinical practice, especially if these patients have been under this treatment for many years, given that the occurrence of such event causes an increase in mortality and the decrease of functional capacity.

The main limitation of this study is that bone biopsy was not done for the investigation of bone alterations, but this procedure has precise indications for stage 3 to 5D patients with CKD, who were not part of the study's sample³². Another limitation is that no other instruments were used to assess static and dynamic balance, which could be useful for the evaluation of patients with CKD on hemodialysis.

The clinical relevance of this study regards the growing concern about the occurrence of falls in individuals on hemodialysis. It is necessary to continue this study using different age ranges and LTH with the purpose of verifying a possible association between these and the occurrence of falls in patients with CKD.

The instrument used to detect such event was effective in distinguishing falling individuals from non-falling patients, and it can be used to evaluate this population's possibility of falling as well as during their follow-up when they are submitted to an exercise program with the purpose of minimizing the impact of falls.

CONCLUSION

In this study, the tool FES-I proved itself capable of discerning falling from non-falling patients on hemodialysis. The positive correlation between PTH serum levels and the length of time on hemodialysis indicated higher PTH serum levels in patients who had been under treatment for a longer period of time.

ACKNOWLEDGEMENTS

We thank Priscila Jamile Cordeiro de Souza, a scholar in the Physiotherapy program at the Pernambuco Federal University, for collaborating in the data collection for this present study.

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