

# Fall Incidence and Risk Factors in Hemodialysis Patients

## *Hemodiyaliz Hastalarında Düşme İnsidansı ve Risk Faktörleri*

### ABSTRACT

**OBJECTIVE:** The aims of this study were to assess the incidence, risk factors and complications of falls in the hemodialysis (HD) population.

**MATERIAL and METHODS:** Using a prospective study design, chronic HD patients aged  $\geq 50$  years were recruited. The baseline characteristics and laboratory markers of all study participants were recorded. Participants were followed prospectively for 12 weeks. Patients were questioned thrice weekly about fall incidents.

**RESULTS:** A total of 34 patients (mean age 69.1 year) participated in this study. 16 falls occurred in nine (26.5%) patients over 12 weeks of follow-up with an incidence rate of 1.30 falls/patient-year. By applying univariate logistic regression analysis, previous fall history (odds ratio 10.5, P-value= 0.008), high parathyroid hormone level (odds ratio 1.032, P-value= 0.016) and impaired balance (odds ratio 9.00, P-value=0.017) were identified as significant risk factors for falls.

**CONCLUSION:** We concluded that high parathyroid hormone levels might be an important predictor of falls in HD patients in addition to impaired balance and previous fall history. As such, parathyroid hormone is a crucial factor to target for future intervention strategies aimed at reducing the fall incidence in the HD population.

**KEY WORDS:** Accidental falls, Renal dialysis, Parathyroid hormone, Balance, Risk factors

### ÖZ

**AMAÇ:** Araştırmanın hedefi hemodiyaliz popülasyonunda düşmenin yüksek oranı, etkenleri ve sonuçlarının incelenmesidir.

**GEREÇ ve YÖNTEMLER:** İleriye yönelik olarak  $\geq 50$  yaşta kronik hemodiyaliz hastaları çalışmaya alındı. Temel özellikler ve laboratuvar sonuçları tüm katılımcılarda kaydedildi. Katılımcılar 12 hafta boyunca takip edildi ve düşmeyle ilgili olarak haftada üç kez sorgulandı.

**BULGULAR:** Çalışmaya toplam 34 hasta (ortalama yaş: 69,1) katıldı. Genel olarak, 12 haftalık takip boyunca 1,30 düşüş/hasta-yıl oranıyla 9 hastada (% 26.5) 16 düşüş gerçekleşti. Tek değişkenli regresyon analizi kullanılarak, önceki düşme (risk oranı 10,5, P değeri= 0,008), yüksek paratiroid hormonu düzeyi (risk oranı 1,032, P değeri= 0,016) ve denge sorunu (risk oranı 9,00, P değeri= 0.017) düşme için en temel riskler olarak saptandı.

**SONUÇ:** Hemodiyaliz hastalarında yüksek paratiroid hormonu düzeyleri denge sorunu ve önceki düşmenin yanında düşmenin öngörülmesinde en önemli faktörlerden biri olabilir. Bu nedenle paratiroid hormonu, hemodiyaliz hastalarında düşmelerin azalması yönünde gelecekteki müdahale stratejilerinde hedef alınabilecek temel bir faktördür.

**ANAHTAR SÖZCÜKLER:** Kazayla düşme, Diyaliz, Paratiroid hormonu, Denge, Risk faktörleri

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## INTRODUCTION

The prevalence and incidence of hemodialysis (HD) patients are increasing worldwide (1). HD patients have many comorbidities that have negative impact on their quality of life (2,3) and susceptible them to mortality (4). HD comorbidities include cardiovascular disease, neurological disorders, cerebrovascular disease, diabetes mellitus and peripheral vascular disease (5). Falls could also increase the likelihood of morbidity and mortality (6,7) and poorer quality of life in HD patients (8). In previous studies among elderly patients, most of the fall-related injuries were minor; however, nearly one third of all falls resulted in serious injury (9) and 10-15% of falls led to fracture (10). Furthermore, fall-related injuries among elderly people were associated with considerable economic cost (11,12), functional decline, social isolation, anxiety, depression, fear of falling (13,14) and nursing home admission (15). Risk factors of falls are thoroughly studied in the elderly population and targeted interventions have been used to reduce falls and their consequences in them (16,17). However dialysis patients have not been studied about falls in depth. Few studies have investigated the incidence rate and fall risk factors in elderly HD patients (18-20).

Common risk factors for falls in elderly HD patients include previous fall history (21), older age (22), low predialysis systolic blood pressure (23), diabetes and high number of prescribed oral drugs (24). Moreover, the hemodialysis center's physical environment such as wet floors, elevated scale and poor surroundings lighting are other important risk factors for falls in HD patients (25). Thus we conducted a prospective study in HD patients who were  $\geq 50$  years of age to determine fall incidence, risk factors and complications in our hemodialysis center.

## MATERIALS and METHODS

A prospective study was conducted between February to April 2013 in a university hemodialysis center in Iran. Patients who were older than 50 years of age on maintenance hemodialysis were approached to participate in the study. After obtaining oral consent from the participants, demographic data and potential risk factors for fall were recorded for each patient. These data included age, sex, dialysis vintage, presence of diabetes, hypertension, cerebrovascular accident, cardiovascular disease, peripheral vascular disorder, the cause of their end stage renal disease and previous fall history in the past year.

The laboratory markers were also obtained from the medical charts of participants. The last laboratory measurements before the start of the study were considered in analysis. Hemoglobin, creatinine, albumin, phosphorous, calcium and parathyroid hormone (PTH) values were included in the statistical analysis. In addition self reported impaired balance (yes or no), mobility (independent, walking aid, help of others and wheelchair) and symptoms of peripheral neuropathy (yes or no) were asked.

After the baseline evaluation, the patients were followed prospectively for 12 weeks. Patients were interviewed two or three times a week based on their frequency of hemodialysis about fall incident in order to decrease recall bias of participants.

Impaired balance was defined as a self reported increased postural sway in straight ahead gait.

In addition peripheral neuropathy was defined as a subjective report of burning pain, tingling and numbness in extremities.

A fall was also defined as an event that resulted in a person coming to rest inadvertently on the ground or other lower level (26). If a fall occurred, location of the fall (home, HD center, outside of the home), timing relative to dialysis (before dialysis, after dialysis or a day without dialysis), possible injuries (minor such as bruises, scratches or major such as admitting to emergency department), medical follow up and contributing factors were asked.

## Statistical Analysis

Data were presented as percentage for categorical variables and mean  $\pm$ SD for normally distributed continuous variables or median and interquartile for not normally distributed continuous variables. Independent t-test or Mann-Whitney test for continuous variables and fisher's exact test for categorical variables were used to compare baseline characteristics between faller and non-faller patients. Univariate logistic regression analysis was used to find significant risk factors for falls in HD population. In addition, multivariate logistic regression was performed using the Forward:LR method to determine which independent variables were predictors of falls in HD patients. Analysis were performed using SPSS (version 21). A p value of less than 0.05 was considered statistically significant.

## RESULTS

A total of 37 patients in a university hemodialysis center in Iran were approached. 36 patients agreed to participate. Two patients were excluded because of hospitalization in another medical center. Eventually 34 patients were analyzed.

Participants had a mean age of 69 years and were on dialysis for a mean of 3.9 years. The main primary causes of kidney disease were diabetes (55.9%), hypertension (32.4%) and glomerulonephritis (11.8%). All participants had completed the duration of follow up.

Participants were subjected to thrice weekly interviews over 12 weeks about falls and its consequences. During the study period, 9 of 34 patients fell. The cumulative risk of falling was 26.5% in 12 weeks. The fall incidence rate was 1.30 falls/person-year.

16 falls occurred in 9 patients. Three patients fell twice and two of patients fell three times. One of the fall occurred in dialysis center before the hemodialysis treatment and four falls occurred in the dialysis day. One fall was not considered

in the study since it was due to acute illness. Falls occurred in 6% in the dialysis center, in 56% of cases at home and in 12.5% outside the home. The locations of other falls were unknown.

Three falls in one patient occurred because of poor lighting. Five falls took place as a result of impaired balance and one fall occurred because of lightheadedness. Slippery floors were the cause of two other falls. One fall happened because of ankle torsion. The mechanisms of other falls were unknown since they could not remember the event properly. Injurious falls were common but emergency department visits occurred only in two fall incidents (12.5%). No fracture was reported in injurious falls.

Comparing fallers and non-fallers showed that fallers were more likely to be older (72.22 years versus 68.04 years). 66.67% of fallers recalled having had one or more previous falls before the study. Fallers had more balance problem than non-fallers (77.78% versus 28%). Based on laboratory data, fallers had higher phosphorous levels (2.31 mmol/L versus 1.93 mmol/L) and higher PTH levels (69.30 pmol/L versus 21 pmol/L) in their laboratory results than non-fallers. Differences in baseline

characteristics and laboratory measurements of patients who fell and those who did not fall are summarized in Tables I and II.

### **Risk Factors for Falls**

According to the univariate logistic regression analysis, history of previous fall (odds ratio: 10.5, P-value: 0.008), elevation of PTH level (odds ratio: 1.032, P-value: 0.016) and impaired balance (odds ratio: 9.00, P-value: 0.017) were statistically significant risk factors of falls with a p value of less than 0.05. The complete results are displayed in Table III.

Furthermore multivariate logistic regression results indicate the overall model fit of two predictors (previous fall history and PTH level) was statistically reliable in distinguishing between faller and non-faller patients (-2 Log Likelihood=20.66,  $\chi^2=18.63$  on 2 df,  $p<0.0001$ ). The model correctly classified 85.3 % of the cases. Regression results are presented in Table IV.

### **DISCUSSION**

In this prospective study 26.5% of patients experienced at least one fall over 12 weeks of follow up. The fall incidence

**Table I:** Baseline characteristics of fallers and non-fallers.

	<b>All participants (n=34)</b>	<b>Non-faller participants (n=25)</b>	<b>Faller participants(n=9)</b>	<b>P value</b>
Age	69.15±9.84	68.04±9.58	72.22±10.49	0.28
Older than 65 years	64.7% (22)	60%	77.78%	0.44
Male	52.19% (18)	52%	55.56%	1.00
Dialysis vintage(month)	46.91±61.01	48.84±70.41	41.55±20.84	0.22
Cause of ESRD				
Diabetes	55.9% (19)	52%	66.67%	0.64
Hypertension	32.4% (11)	32%	33.33%	
Glomerulonephritis	11.8% (4)	16%	0	
Diabetes	58.8% (20)	52%	77.78%	0.25
Hypertension	70.6% (24)	68%	77.78%	0.69
Cardiovascular disease	38.2% (13)	40%	33.34%	1.00
Cerebrovascular accident	11.8% (4)	12%	11.11%	1.00
Peripheral vascular occlusive disease	8.8% (3)	8%	11.11%	1.00
Peripheral neuropathy	64.7% (22)	56%	88.89%	0.11
Impaired balance	41.2% (14)	28%	77.78%	0.017
Mobility				
Independent	58.8% (20)	68%	33.34%	0.038
Walking aid	29.4% (10)	24%	44.44%	
Help of others	5.9% (2)	0	22.22%	
Wheelchair	5.9% (2)	8%	0	
Fall in the past year	29.4% (10)	16%	66.67%	0.009

Values expressed as mean±SD or percent (number); P-values calculated by independent t-test, Mann-Whitney test and Fishers exact test.

**ESRD:** end stage renal disease.

**Table II:** Baseline laboratory measurements of fallers and non-fallers.

	All participants (n=34)	Non-faller participants (n=25)	Faller participants (n=9)	P value
HGB(g/L)	111.53±16.81	110.68±17.55	113.89±15.27	0.63
Cr(umol/L)	678.60±188.29	643.90±151.16	774.97±251.98	0.07
Albumin( g/L)	40.00±4.40	39.76±3.86	40.67±5.85	0.6
Ca(mmol/L)	2.06±0.24	2.07±0.26	2.04±0.18	0.75
P(mmol/L)	2.03±0.49	1.93±0.35	2.31±0.70	0.34
PTH pmol/L (median (interquartile))	26.53 (42.31)	21 (16.78)	69.30 (65.75)	0.018

Values expressed as mean±SD, P-values calculated by independent t-test, Mann-Whitney.

**HGB:** Hemoglobin, **Cr:** Creatinine **Ca:** Calcium, **P:** Phosphorus, **PTH:** Parathyroid hormone.

**Table III:** Results of univariate logistic regression of probable falls risk factors.

Variable	OR(95% CI)	P value
PTH	1.032 (1.006 to 1.059)	0.016
P	5.57 (0.79-39.08)	0.08
Previous fall history	10.5 (1.82 to 60.45)	0.008
Elderly	2.33 (0.4 to 13.61)	0.35
Impaired balance	9.00 (1.49 to 54.32)	0.017
Peripheral neuropathy	6.29 (0.68 to 58.09)	0.105

**CI:** Confidence interval, **OR:** Odds ratio, **PTH:** Parathyroid hormone, **P:** Phosphorous.

rate was 1.30 falls /person-year. 55.5% of fallers fell down more than once. 22% of fallers had fall-related injuries leading to emergency department visits however they did not report a fracture.

In a one year prospective cohort study, Cook et al. found the incidence rate of 1.60 falls/person-year in HD patients who were ≥65 years of age (21) and Desmet et al. showed incidence rate of 1.18 falls/person-year in all age HD patients (24). Our incidence rate of falls seems to be between the two study above. one of its reasons could be that we followed patients who were younger (mean age 69 years) than Cook study (mean age 74.7 years).

One of the purposes of this study was to recognize probable risk factors of falls in HD population. We showed that for every 1 pmol/L elevation in PTH level, the risk of falling increased by 3%. In a HD population with the mean age of 79 years, Polinder-Bos et al. also found that for every 10 pmol/l higher PTH level, falling raised by 22% (23). The association between high serum PTH levels and falls has been showed in elderly diabetic patients, nursing home residents and elderly population in previous studies as well (27-29).

**Table IV:** Results of multivariate logistic regression of factors predictive of falling in HD patients.

Variable	OR	95% CI	P value
Previous fall history	79.67	1.865 to 3403.676	0.022
PTH	1.063	1.009 to 1.120	0.022

**OR:** Odds ratio, **CI:** Confidence interval, **PTH:** Parathyroid hormone.

In the presence of elevated PTH levels, the turnover of bone is extremely rapid therefore results in a structurally inferior woven bone that substitutes the normal lamellar bone (30). It could be because of this phenomenon that PTH level elevation can be a risk factor for fall in HD population. Many of the symptoms of hyperparathyroidism are not distinct and consist of pain in joints, spontaneous tendon rupture, susceptibility to fracture, proximal muscle weakness (31) and high turnover bone remodeling (32).

In addition we found that impaired balance was a risk factor for falls occurrence. Although we did not do a balance test, the significance of self reported difficulty in balance is important since the subjective report of the balance problem could help nurses or physicians to assess HD patients for fall risk in a short time. Exercise could improve balance and reduce falls in older people (33-36). Despite the fact that HD patients have a great rate of falling, exercise usually are not in their management of chronic kidney disease. Therefore interventions such as exercise programs might be effective ways to reduce falling.

Furthermore we found that previous fall history was significantly associated with falling as well. Previous works also reported that a history of fall was an important risk factor for fall (21,22). Recognition of patients who recall having fallen in the past could be used to evaluation of them for risk of falling. This could help to minimize the morbidity and the mortality that are associated with recurrent falls and reduce post fall anxiety syndrome and fear of falling again.



Our study also assessed environmental risk factors for falling. Poor lighting and slippery floors were the main reasons of fall accidents in our study. Heung et al. also identified environmental hazards such as low ambient lighting and slippery floors as risk factors for falls. Through educational efforts and setting modifications, they achieved a significant reduction in fall risk (25).

Limitations of our study are small sample size and the short duration of follow up however the prospective design of it helped to reduce recall bias in participants and helped to measure the timing of fall in the study.

In conclusion, we found that previous fall in the past year; self reported balance problem and increased level of PTH could be risk factors of falls in HD patients. The identification of these risk factors may help to organize exercise programs, home hazard management and managing PTH level to prevent fall incidents.

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