ACTA SCIENTIFIC MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 4 Issue 6 June 2020

Research Article

Evaluation of the Effect of the Hemodialysis Session on the Equilibrium by the Monopodal Support Test

Boughallaba N[1], Taghouti E[2] and Habib Ksouri[3]*

[1]*Centre d'Hémodialyse Nour Echiffa, Avenue Farhat Hached, Jerba-Midoun, Tunisia*

[2]*Ecole Supérieur des Sciences et des Techniques de Santé de Sousse, Sousse, Tunisia*

[3]*Service des Laboratoires, Centre National de Greffe de Moelle Osseuse, Tunis, Tunisia*

***Corresponding Author:** Habib Ksouri, Service des Laboratoires, Centre National de Greffe de Moelle Osseuse, Tunis, Tunisia.

Received: February 28, 2020

Published: May 14, 2020

Abstract

Introduction: The monopodal support test is a simple, reliable and reproducible clinical test that assesses static equilibrium and postural stability. Since chronic renal disease is an independent factor of fragility and is a source of complications, among others cardiovascular and osteoarticular ones, we propose in this work to evaluate static equilibrium and postural stability in a group of patients under regular hemodialysis to appreciate the effect of the hemodialysis session on those factors.

Patients and Methods: This is a cross-sectional descriptive study of 40 patients under regular hemodialysis in the Nour-echiffa dialysis clinic in Jerba (southern Tunisia). The data were collected from a targeted clinical examination that included demographic data and a clinical assessment including the monopodal support test. The Wilcoxon test was used for statistical calculation.

Results: The average age of our patients is 51.7 years, with a sex ratio of 1 and 90 months of hemodialysis duration mean. A clear prevalence of type 2 diabetes, glomerulopathies secondary to blood hypertension characterize the etiologies of chronic renal failure in our patients. Twenty patients reported having had falls during the previous year. Our results reveal that our patients are unstable despite their young age with an average time of monopodal support test of 18 seconds as well as a matching between the post-dialysis blood pressure decrease and the improvement of the time of this test.

Conclusion: The hemodialysis session demonstrated a positive effect on static equilibrium and postural stability. The adequacy of dialysis results in a significant normalization of blood pressure values and an increase in the time this test. Thus, this monopodal support test is a reliable, easy and practical examination that can highlight the fragility of patients under regular hemodialysis. As a result, it could be integrated into the daily activities of hemodialysis centers in order to detect and prevent serious complications due to falls.

Keywords: Hemodialysis; Monopodal Support Test; Postural Stability; Static Equilibrium

Introduction

The monopodal support test represents a simple, reliable and reproducible clinical test, which assesses static equilibrium and postural stability. This test is based on the measurement of the monopodal support time, which is considered normal if equal to or greater than 30 seconds. If it lasts less than 5 seconds, this test has a predictive value for lesional falls in the elderly and it's related to the frailty of these people [1,2].

Given that chronic renal failure represents an independent factor of frailty providing many complications, such as cardiovascular and cerebrovascular ones, we propose in this work to evaluate the static equilibrium and the postural stability in a group of patients under regular hemodialysis [3].

Our primary hypothesis is that hemodialysis sessions are a risk factor for falling because they would affect the precarious equilibrium of patients under regular hemodialysis.

Our sample includes 40 patients under regular hemodialysis, for whom we will measure the monopodal support time according to whether it is less or more than 30 seconds. In these patients we will try to assess the influence on this time (which indicates postural stability) of different parameters resulting from the effects of hemodialysis sessions/: blood pressure, weight gain, dose of dialysis evaluated by the ratio (KT/V) where T represents the duration of the dialysis session and V represents the volume of body water, time and day of hemodialysis and the ultra-filtration rate.

Patients and Methods

Patients

After having received authorizations of the medical and technical direction of the clinic as well as acceptance of the patients to participate in the work, we conducted a descriptive and analytical cross-sectional study with chronic kidney disease (CKD) patients under regular hemodialysis in the Nour-echiffa dialysis service (city of Jerba, south Tunisia). Our study was carried out over a period from February 4 to April 13, 2019.

In this work, we used a not probabilistic sampling method. We were able to recruit a total of 63 patients under regular hemodi-

alysis who met the following selection criteria: Adult autonomous patient over 18 years, under regular hemodialysis at least for three months. Among those patients, 23 were withdrawn from the study because they present exclusion criteria as mentioned in table 1.

Number of patients	Grounds for exclusion
5	Patients who find the monopodal support test difficult for them
5	Amputation of the lower limb ranging from a partial amputation of the foot to the mid-leg
3	Uncontrolled congestive heart failure
3	Advanced gonarthrosis: bilateral or unilateral
3	Parathroidectomy < 3 months
2	Femoral neck fracture (total hip replacement) and 1 tibial plateau fracture (osteosynthesis) < 6 months
2	Hospitalization for malignant tumors

Table 1: Patients exclusion criteria.

Methods

Our materials consist in a stopwatch, a blood pressure monitor, a stethoscope and a weighs person and height gauge.

Ethical considerations were well defined and respected as cited above. Confidentiality of the data obtained and the anonymity of the participants were also respected.

Among patients' data, we considered, age, gender, initial nephropathy, comorbidities, seniority of the hemodialysis and history of a fall in the past year (a fall has been defined as an involuntary change in body posture which has brought the person to a lower level [4]).

Each patient had a 4 hours hemodialysis session 3 times a week. For the purpose of this work we accomplished: blood pressure checking before, every hour during and after the hemodialysis session; time during the day of the hemodialysis session; weight and inter hemodialysis sessions weight gain ; ultrafiltration rate per hemodialysis session; hemodialysis dose (KT/V).

The monopodal support test was carried out as follows: the patient is relaxed, bare feet; standing a meter from the wall, looking straight ahead, fixing a target, upper limbs hanging along the body. For the test, the patient chooses the leg of his preference, he's instructed to keep his legs from touching and to maintain unipedal stance for as long as possible The test is stopped and considered normal if the monopodal support time reaches 30 seconds. The patients were subjected to three trials, as long as they did not reach 30 seconds in the first or second trial. The test is considered as a failure, if there's a shifting the stance foot or placing the lifted foot on the floor, or installation on the ground of the raised foot or if the participant use his arms to touch the wall.

Statistics

Wilcoxon test for paired data was used [(α = 5%); 'Confidence Interval' CI = 95%]. SPSS software (Statistical Product and Services Solutions, version 18.0, SPSS Inc, Chicago, IL, USA) was used for statistical analyses.

Results

Patients' characteristics

Patients' average age is 51.7 years (24 - 77 years), sex ratio = 1, Body Mass Index (BMI) = 25 and an average length in hemodialysis of 90 months (12 - 106 months). A clear prevalence of type 2 diabetes, glomerulopathy secondary to high blood pressure and undetermined forms characterize the main etiologies of chronic kidney failure. The average number of comorbidities per patient associated with end-stage renal disease is 2.95 (1 - 4). Cardiovascular and osteoarticular complications are due to hyperparathyroidism. The average number of drugs taken per patient is 2.67, combined in various ways, antihypertensives, insulin, antiplatelet agents. No patient was on psychotropic drugs. Twenty patients fell in the previous year, 3 of which had traumatic falls (Table 2).

Patients' characteristics		Values (averages*)
Age (years)		51.7*
Sex ratio		1
Average length in hemodialysis (months)		90*
Kidney failure etiology	Diabetes	10
	Glomerulonephritis	7
	Others[1]	6
	unknown	17
Comorbiditties	High blood pressure	20
	hyperparathyroiditis	12
	Diabetes	10
	Coronary insufficiency	7
	Hypovitaminosis D	10
	Others[2]	18
Drugs	Antihypertensive	20
	Antiplatelet agent	35
	Insulines	10
	Antianginal	7
	Anticoagulant	4
	Psychotropic	0
	Drugs	2.67*
BMI (kg/m^2)		25*
Number of falls in the previous year		20

Table 2: Patients' characteristics.

1: Polycystic kidney disease, amylosis, Systemic Lupus Erythematosus, Good-Pasture syndrome.

2: Hypothyroidism, obliterating arteriopathy of the lower limbs.

BMI: Body Mass Index.

Influence of blood pressure and hemodialysis parameters on the monopodal support test

Influence of blood pressure on the monopodal support test

The average time of the monopodal support test was strictly less than 30 seconds despite a not statistically significant slight improvement after the hemodialysis sessions.

The mean systolic and diastolic blood pressure values and the monopodal support time varied significantly after the dialysis sessions. It seems that the drop in blood pressure affects somewhat the monopodal support time in our patients.

Influence of the hemodialysis schedule on the time of the monopodal support test

Respectively, 24 and 16 patients benefit of morning and afternoon hemodialysis sessions. As mentioned in table 3, hemodialysis schedule does not appear to affect the average monopodal support time.

	Monopodal support time (seconds)		Blood Pressure (mm Hg)				Monopodal support time according to hemodialysis schedule			
		Systolic		Diastolic		Morning		Afternoon		
	Before	After	Before	After	Before	After	Before	After	Before	After
Average	18	19.19	144.2	125.5	79.6	69.33	17.38	17.72	18,91	21,10
SD	18.8	20.55	16.46	17.30	6.57	5.58	18,42	18,96	19,94	22,76
p	0.71%		0.001%		0.001%		38%		26%	

Table 3: Influence of some parameters on the monopodal support time.

SD: Standard Deviation.

Hemodialysis dose, inter-dialytic weight gain and hourly ultrafiltration

For all patients, an adequate dialysis dose > 1.2, an average inter-dialytic weight gain of 4% and an hourly ultrafiltration average of 9% of exit weight are within the limits of normal recommended by KDOQI (Kidney Disease Outcome Quality Initiation).

Distribution of patients according to monopodal support time (Table 4)

According to the results of the monopodal support test time, we divided our patients into three groups:

1. A first group (G1) includes 19 patients with an average support time strictly under 5 seconds before and after the hemodialysis sessions.
2. A second group (G2) composed of 8 patients with an average support time greater than or equal to 30 seconds before and after the hemodialysis sessions
3. A third group (G3) made up of 13 patients with an average support time between 5 and 29 seconds before and after the hemodialysis sessions.

Demographic characteristics of the groups (Table 4)

G1 group patients are the oldest one, with an average age of 58.5 years (24 - 77 years). This group is made up of very fragile patients with a high proportion of type 2 diabetes and the highest average number of comorbidities per patient equal to 3.25 (2 - 5) (principally cardiovascular and osteoarticular complications secondary to hyperparathyroidism and hypovitaminosis D). This group consumes the most drugs (average number per patient = 2.77). In their history, patients in this group had the highest fall frequency and the only traumatic falls occurred in this group.

G2 group is the youngest of the three groups, it's made up of fragile but efficient patients, with an average age of 39 years (29 - 53 years), with the highest female representation (sex- ratio = 62.5%) and the longest average length in hemodialysis of 99 months (24 - 216).

G3 group is made up of fragile patients with a male predominance (sex ratio = 46.1%) and the lowest length in hemodialysis, 73 months (12 - 192). In this group, only one patient is diabetic and 53.8% have a phosphocalcic metabolism disorder secondary to hyperparathyroidism and/or hypovitaminosis D.

Influence of blood pressure on the monopodal support test according to groups

G1 group have a statistically significant increase in systolic and diastolic blood pressure at the end of the hemodialysis session not associated with a significant improvement in the average time of monopodal support (p = 0.3), which remains still in the high-risk fall area with a post hemodialysis support time of 4.26 seconds (Table 5).

Similarly, for group G2, there was a statistically significant increase in both systolic and diastolic blood pressure at the end of hemodialysis session associated in this case with a statistically significant increase in monopodal support time. The G2 group remains effective before and after dialysis (Table 6).

For group G3, the average time for monopodal support did not vary significantly (p = 0.23), while there was a statistically significant decreased in blood pressure after the hemodialysis sessions (Table 7).

Characteristics		G1	G2	G3
Age (years)		58.5* (24 - 77)	39* (29 - 53)	49.2* (24 - 68)
Sex ratio (female/male)		9(47.36%)	5(62.5%)	6(46.1%)
Length in hemodialysis (months)		84* (12 - 92)	99* (24 - 216)	73* (12 - 192)
ERD etiology	Diabetes	7	2	1
	Glomerulopathy	2	2	2
	Other	10	4	9
Comorbidities		3.25* (2 - 5)	2.87* (2 - 4)	2.61* (1 - 4)
Diabetes		7	2	1
High Blood Pressure		8	3	4
Coronary insufficiency		4	1	2
Secondary Hyperparathyroiditis		6	2	4
Hypovitaminosis D		6	1	3
Others		9	4	5
Drugs		2.77* (+-0.99)	2.15* (+-0.83)	2.69* (+-1.31)
Number of falls		13**	3	4

Table 4: Distribution of patients according to average durations of support monopodal time.

ERD: End Renal Disease.

*: Average.

**: Including 3 traumatic falls.

	Monopodal support time (seconds)		Blood Pressure (mm Hg)			
		Systolic		Diastolic		
	Before	After	Before	After	Before	After
Average	4.05	4.26	149.12	123.68	80.7	70.1
SD	18.8	20.55	15.38	17.10	5.2	6.33
p	30.01%		0.01%		0.01%	

Table 5: Influence of average blood pressure on monopodal support time in G1.

SD: Standard Deviation.

	Monopodal support time (seconds)		Blood Pressure (mm Hg)			
		Systolic		Diastolic		
	Before	After	Before	After	Before	After
Average	51.66	56.66	139.5	121.25	81.25	69.20
SD	9.56	6.04	16.21	15.11	8.77	6.60
p	0.9%		1.25%		0.9%	

Table 6: Influence of average blood pressure on monopodal support time in G2.

SD: Standard Deviation.

	Monopodal support time (seconds)		Blood Pressure (mm Hg)			
		Systolic		Diastolic		
	Before	After	Before	After	Before	After
Average	17.60	17.89	140	130.76	77.17	68.20
SD	5.56	6.04	16.21	18.81	6.64	4.83
p	23.78%		3.46%		0.16%	

Table 7: Influence of average blood pressure on monopodal support time in G3.

SD: Standard Deviation

Influence of hemodialysis sessions on the evolution of blood pressure according to groups

Our results show a decrease in average systolic and diastolic blood pressure in the three groups during each dialysis session (1st, 2nd and 3rd session). With respect to average systolic blood pressure, the differences were statistically significant for all groups except the first two sessions of G3 (Figure 1).

Figure 1: Evolution of systolic BP in the different groups after hemodialysis sessions.

BP: Blood Pressure; G: Group; HD: Hemodialysis.

For diastolic blood pressure, the differences were also statistically significant, except for the 2nd dialysis session of G 3 (Figure 2).

Figure 2: Evolution of diastolic BP in the different groups after hemodialysis sessions.

BP: Blood Pressure; G: Group; HD: Hemodialysis.

Discussion

It is commonly accepted that the fall is perceived as a disaster that affects the elderly. The epidemiology of equilibrium disorders in Tunisia is unfortunately unknown although this disorder constitutes a common complaint in geriatrics and notably in patients under regular hemodialysis. Today, it is essential for clinicians caring for such patients to consider the risk of falling as serious as other serious complications associated with CKD. Thus, given the seriousness of the lesions that can occur, it would be interesting to integrate the monopodal support test with the standard clinical examination in such patients. Here turns out the interest of this study which aims is to assess static equilibrium and postural stability, thanks to the monopodal support test and thus bringing out the possible effect of the hemodialysis session on postural stability of such patients.

The average age of our patients was 51.7 years. This result is similar to that of Erkan., *et al*. [5] and Noto., *et al*. [6] while it does not agree with other studies [7-10] which have reported an average age greater than 72 years for patients under regular hemodialysis. These differences can be explained by the fact that we eliminated in our study all the patients with serious complications who were almost all older than 65 years. Moreover, the groups explored by other studies were mainly composed of elderly people, indeed, according to Robert's 1999 report (UK Renal Registry) [10], there is a marked increase in the number of elderly patients receiving hemodialysis in Western countries.

Our results show a gender parity (sex ratio = 1) unlike other studies [6-9] which have found a male predominance (Table 2).

In our study the average length in hemodialysis was 90 months (12 - 206 months) (Table 2), which is higher than what was reported by other studies with respectively an average of (53.7 months ± 32.9), (65.1 months ± 50.8) and (13.5 months ± 6.8). According to Plantinga., *et al.* [11] severe falls are frequent during the immediate period before the initiation of hemodialysis and also during the post-hemodialysis period at the beginning of such treatment. This frequency of fall at the initiation of hemodialysis sessions is explained in part by the fact that frequently, hemodialysis is started following a health deterioration and functional decline of patients.

Almost half of our patients (57.5%) use an average of 2.67 drugs (1 - 4 drugs) (Table 2). It is recognized that the use of more than 4 categories of drugs, especially in connection with a variety of medical conditions such as chronic nephropathy, diabetes and depression are common among fallers [9].

Twenty among our patients have experienced fall in the last year, including 3 traumatic ones (Table 2). The high incidence of falls in our series confirms other data estimating that the incidence of falls is significantly higher in patients under regular hemodialysis compared to subjects with normal renal function [9]. Cook., *et al.* [4], after having matched the age and sex of their study population (patients under regular hemodialysis) to that of studies carried out in the general population had to conclude that the incidence of falls in their population was twice as high as that of the general population. According to a prospective cohort study including patients under regular hemodialysis [3], the proportion of falls requiring medical care was 15%, 7% of patients suffered head injuries with loss of consciousness, 4% suffered fractures and 4% died from an injury caused by the fall.

With regard to the monopodal support test, our results approximate those of Bullani., *et al.* [12] who reports a monopodal support time of 15.7 ± 17 seconds before hemodialysis, in a sample made up of 11 patients aged over 70 years. All patients in this falling group

were diabetic and had peripheral neuropathy, which could partly explain this much reduced support time. In addition, Erdoganoglu., *et al.* [13] suggest an alteration of the plantar receptors patients under regular hemodialysis, which could also influence the monopodal support time.

According to Bohannon., *et al.* [14] performance on the monopodal support test is significantly correlated with age. However, despite the young age of our population, our results correspond to a performance on the monopodal test of people of advanced age groups 70 ± 19 and 89 ± 14 [14].

We noted an improvement in average arterial pressure after hemodialysis with a statistically significant gain in monopodal support time in all our patients (Table 3). In contrast, Erken., *et al.* [5] and Pollinder., *et al.* [9] noted postural instability in post-hemodialysis in the group of fallers. This fact could be explained by a drop in blood pressure less than 100 mmHg in post-hemodialysis and the old age of patients (over 74 years) in the Erken group, while taking beta-blockers inducing a drop in blood pressure below 130 mmHg before hemodialysis, could explain the results of Pollinder., *et al* [9]. Cook., *et al.* [4] have also reported a relationship between pre-hemodialysis blood pressure and the risk of falling. Relatively low blood pressure on pre-hemodialysis could by itself be a risk factor for falling, but could also be a sign of poor prognosis state. Similarly, Pollinder., *et al.* [9] have shown that a drop in mean systolic blood pressure of 5 mmHg on pre-hemodialysis corresponds to a 30% increase in the risk of falling.

Our patients received conventional hemodialysis treatment according to the recommendations of KDOQI (Kidney Outcome Quality Initiative). According to Pollinder., *et al.* [9] a better adequacy of hemodialysis allows a better elimination of uremic toxins and could improve the postural stability and equilibrium of patients with CKD. During this work, we noted a statistically significant improvement in the average time of monopodal support in post-hemodialysis in all patients and in the whole series of tests performed (Table 3). While Erken., *et al.* [5] did not notice such a change in patients who received an adequate dose of hemodialysis.

Based on the values of monopodal support time collected before and after hemodialysis seances, we divided our population into three groups. Group G1 composed of very fragile patients (Table 4) with a monopodal support time before and after hemodialysis fewer than 5 seconds. This group could correspond to the group of fallers reported by Bullani., *et al.* [12] who had a monopodal support time under 2 seconds before starting the exercise program. This group being made up of our oldest patients, with a female dominance, a percentage of diabetes of 35% and a prevalence of 63% of secondary hyperparathyroidism associated or not with a vitamin D deficiency. According to Abedi., *et al.* [15] hyperparathyroidism is a determining factor in the fall, so any increase in parathyroid hormone (PTH) of 1 pmol/l, results into an increased risk of falling of 3%. Similarly, Pollinder., *et al.* [9] have also reported that for any increase in PTH of 10 pmol/l, there is an increase in the risk of falling of 22%. Also, Sambrook., *et al.* [16] and Houston., *et al.* [17] found an association between hyperparathyroidism and falls in elderly diabetic subjects and residents of retirement homes.

For our G1 group, although there was a statistically significant difference in systolic and diastolic blood pressure after hemodialysis, the degree of significance ($p = 0.3$) was not significant in terms of increased monopodal support time after hemodialysis (Table 5).

Whereas for the G2 group made up of young high-performance subjects who have few osteoarticular and cardiovascular complications compared to the other two groups (Table 4), the statistically significant decrease in systolic and diastolic arterial tensions was associated with an equally significant increase of monopodal support time (Table 6).

The G3 group did not show a statistically significant increase in monopodal support time after hemodialysis, despite a significant decrease in blood pressure (Table 7). It should be noted that this group is made up of people who are significantly weakened by cardiovascular (46%) and osteoarticular complications (53%) due to chronic renal failure (Table 5).

When we tried to look for the separate effect of each hemodialysis session on the evolution of blood pressure among the 3 groups, we noticed that there was a statistically significant decrease in blood pressure regardless of the day of the session, group G3 presenting the least significant variations (Figure 1 and 2). While Magnard., *et al.* [18] and Erken., *et al.* [5] report a negative effect of hemodialysis session, Analan., *et al.* [19] and Farragher., *et al.* [20] consider that the disorders of equilibrium is multifactorial and that hemodialysis session is not a determining factor.

Conclusion

Despite their young ages our patients presents some problems in postural equilibrium, indeed their average monopodal support time of 17 seconds is comparable to that of an elderly population. However, we noted a positive effect of hemodialysis sessions on postural equilibrium. The adequacy of hemodialysis results in a significant normalization of blood pressure and an increase in monopodal support time, regardless of the day and time of the hemodialysis sessions.

Although the methodology and the sampling used in this study present some shortages (as low sampling, reduced duration of the study, lack of evaluation of orthostatic hypotension at the end of the hemodialysis session, difficulty to manage such fragile patients and the scarcity of comparable studies), we can preliminary conclude that monopodal support test is a reliable, easy and practical examination that highlights the fragility of hemodialysis patients independently from their chronological ages. As a result, such test could be integrated into the daily activity of hemodialysis centers

as a screening and preventive tool for serious complications due to falls.

A broad study multicentric, more prolonged in time, multidisciplinary and with instrumental examination, is suggested in order to limit the shortcomings encountered by our study.

Bibliography

1. Hurvitz EA., *et al*. "Unipedal stance testing as an indicator of fall risk among older outpatients". *Archives of Physical Medicine and Rehabilitation* 81.5 (2000): 587-591.

2. Ortega-Pérez de Villar L., *et al*. "Test-retest reliability and minimal detectable change scores for the short physical performance battery, one-legged standing test and timed up and go test in patients undergoing hemodialysis". *PLOS ONE* 13.8 (2018): e0201035.

3. Papakonstantinopoulou K., *et al*. "Risk of falls in chronic kidney disease". *Journal of Frailty, Sarcopenia and Falls* 02.02 (2017): 33-38.

4. Cook WL., *et al*. "Falls and Fall-Related Injuries in Older Dialysis Patients". *Clinical Journal of the American Society of Nephrology* 1.6 (2006):1197-1204.

5. Erken E., *et al*. "The effect of hemodialysis on balance measurements and risk of fall". *International Urology and Nephrology* 48.10 (2016): 1705-1711.

6. Noto-Kadou-Kaza B., *et al*. "Chutes chez l'hémodialysé: incidence et facteurs de risqué". *Néphrologie Thérapeutique* 11.4 (2015): 246-249.

7. Desmet C., *et al*. "Falls in hemodialysis patients: Prospective study of incidence, risk factors, and complications". *American Journal of Kidney Diseases* 45.1 (2005): 148-153.

8. Li M., *et al*. "Geriatric comorbidities, such as falls, confer an independent mortality risk to elderly dialysis patients". *Nephrology Dialysis Transplantation* 23.4 (2007): 1396-400.

9. Polinder-Bos HA., *et al*. "High fall incidence and fracture rate in elderly dialysis patients". *The Netherlands Journal of Medicine* 72.10 (2014): 7.

10. Roberts RG., *et al*. "Are elderly haemodialysis patients at risk of falls and postural hypotension?" *International Urology and Nephrology* 35.3 (2003): 415-421.

11. Plantinga LC., *et al*. "Serious Fall Injuries Before and After Initiation of Hemodialysis Among Older ESRD Patients in the United States: A Retrospective Cohort Study". *American Journal of Kidney Diseases* 70.1 (2017): 76-83.

12. Bullani R., *et al*. "Effect of Intradialytic Resistance Band Exercise on Physical Function in Patients on Maintenance Hemodialysis: A Pilot Study". *Journal of Renal Nutrition* 21.1 (2011): 61-65.

13. Erdoganoglu Y., *et al*. "Is there a relationship between plantar foot sensation and static balance, physical performance, fear of falling, and quality of life in hemodialysis patients?: Foot sensation in hemodialysis patients". *Hemodialysis International* 23.2 (2019): 273-278.

14. Bohannon RW., *et al*. "Decrease in Timed Balance Test Scores with Aging". *Physical Therapy* 64.7 (1984): 4.

15. Fatollahierad S., *et al*. "Fall Incidence and Risk Factors in Hemodialysis Patients". *Turkish Nephrology Dialysis Transplantation* 25.3 (2016): 263-268.

16. Sambrook PN., *et al*. "Serum Parathyroid Hormone Predicts Time to Fall Independent of Vitamin D Status in a Frail Elderly Population". *The Journal of Clinical Endocrinology and Metabolism* 89.4 (2004): 1572-1576.

17. Houston DK., *et al*. "Serum Parathyroid Hormone Levels Predict Falls in Older Adults with Diabetes Mellitus: PTH and falls in older adults with diabetes mellitus". *Journal of the American Geriatrics Society* 56.11 (2008): 2027-2032.

18. Magnard J., *et al*. "The effect of hemodialysis session on postural strategies in older end-stage renal disease patients: Postural sway changes in ESRD patients". *Hemodialysis International* 19.4 (2015): 553-561.

19. Analan PD and Özelsancak R. "Balance and fall risk in peritoneal dialysis patients". *Journal of Back and Musculoskeletal Rehabilitation* (2018): 1-7.

20. Farragher J., *et al*. "Equivalent Fall Risk in Elderly Patients on Hemodialysis and Peritoneal Dialysis". *Peritoneal Dialysis International* 36.1 (2016): 67-70.