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Evaluation of Frailty Levels in Hemodialysis Patients

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ABSTRACT

Introduction: This study aimed to investigate the relationship between: the etiology of chronic renal failure (CRF), hemodialysis duration, body mass index, residual renal function (RRF), ultrafiltration volume, dialysis dose value, and frailty levels by utilizing laboratory values and patient-related data from individuals undergoing hemodialysis due to CRF.

Methods: A total of 56 patients, comprising 22 females and 34 males, undergoing hemodialysis treatment due to CRF, were included in the study. Patients with active infections, hepatitis B, hepatitis C, human immunodeficiency virus, acute renal failure, or chronic liver disease were excluded. Frailty levels were assessed through a questionnaire based on the Frailty Scale and the Edmonton Frailty Scale.

Results: Frailty levels were found to be higher in patients with diabetes mellitus, cardiovascular disease (CVD), and peripheral arterial disease (PAD) compared to those without these conditions ($p=0.003$, $p=0.000$, $p=0.035$, respectively). In patients with severe anemia (hemoglobin<10), frailty levels were also higher ($p=0.024$). No significant relationship was found between the patients' age, dialysis duration (in years), calcium, phosphorus, uric acid, parathyroid hormone, RRF, and the clinical frailty index averages, ($p\geq0.05$).

Conclusion: In patients undergoing hemodialysis due to CRF. Diabetes mellitus, CVD, PAD, and anemia are factors that contribute to increased frailty. In patients receiving hemodialysis for CRF, well-conducted hemodialysis treatment can be considered effective in preventing frailty. Anemia is a treatable factor, and its management may be associated with a reduction in frailty and cardiovascular mortality.

Keywords: Chronic renal failure, hemodialysis treatment, clinical frailty index

Introduction

Chronic renal failure (CRF) is a progressiveloss of renal function that most often develops secondary to systemic diseases. It is generally seen as a consequence of conditions such as diabetes mellitus, hypertension, and glomerulonephritis, and it is characterized by deterioration of nephrons with an irreversible loss of function. A diagnosis is established when the glomerular filtration rate falls below 60 mL/minimum/1.73 m² for a duration of at least three months, accompanied by a progressive decline in renal function. CRF may also exert secondary effects on metabolism and the endocrine system. It can cause fluid retention, electrolyte disturbances (such as hyperkalemia and hyponatremia), acid-base imbalances, and the accumulation of urea and creatinine. Additionally, it can secondarily lead to various systemic complications, including anemia, hypertension, bone turnover disorders, and cardiovascular diseases (CVD). These effects exacerbate the overall condition of patients and significantly impair their quality of life. Early diagnosis is crucial for slowing the progression of CRF, enhancing patients' quality of life, and preventing potential complications. Furthermore, the treatment methods employed play a crucial role in preserving renal function and preventing further deterioration. Treatment strategies may vary depending on the patient's general condition, renal function, underlying diseases in the etiology, and individual characteristics. Timely interventions can extend survival and slow disease progression, thereby facilitating better management of the condition.

Frailty is a condition frequently observed in the elderly, though it can occur in any age group, especially in the context of chronic illnesses. CRF can impair physical capacity, thereby increasing frailty. In this context, frailty can be defined as an increased susceptibility of the body to stress, both psychologically and physiologically. Individuals with CRF may be more vulnerable to such stressors, which need to be addressed seriously, as they can complicate the treatment process (1,2). The Frail Scale is frequently used as a screening method in the assessment of frailty (3). Frailty, which progressively increases due to chronic diseases and aging, manifests with symptoms such as involuntary weight loss, weakness, fatigue, reduced physical activity, and a decline in walking speed. Malnutrition and impaired psychosocial status are also among the factors that contribute to the development of frailty. When assessing the frailty status of patients, these factors should be considered collectively, as they can lead to falls, hospitalizations, prolonged illness, and loss of independence. Therefore, early recognition of frailty symptoms and

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timely interventions are crucial for preserving and enhancing quality of life (4). As people get older, their frailty increases. Fragility becomes more prevalent in individuals over 65, and it becomes even more pronounced in those over 85. It is essential to take preventive measures in such cases (5). Another scale used to assess frailty in the geriatric population is the study of osteoporotic fractures index, which predicts the risks of falls, disability, fractures, and mortality. It can be valuable in clinical practice for identifying frailty in elderly patients who are at risk of adverse health outcomes (6). In hospitalized patients, the Edmonton Frail Scale (EFS) is more commonly used. This scale encompasses various aspects, including cognition, general health status, functionality, social support, medication use, nutrition, mood, physical performance, and incontinence (7). Compared to individuals with normal renal function, patients with CRF are significantly more prone to frailty (8,9). Frailty levels are notably higher in patients undergoing hemodialysis and are associated with increased mortality and morbidity, and exceed that of CRF patients who have not yet started dialysis (10).

Methods

Patients

This study included a total of 56 patients, comprising 22 females and 34 males. The patients included in the study were individuals who had been receiving hemodialysis treatment two or three times a week for at least three months due to end-stage renal disease. Patients with active infections, including hepatitis B virus, hepatitis C virus, human immunodeficiency virus, acute renal failure, or chronic liver disease, were excluded from the study. The clinical frailty index was assessed using the EFS in a questionnaire format, and the frailty levels of the patients were evaluated. The study was approved by the Scientific Research Ethics Committee of Kocaeli City Hospital (approval number: 2024-112, date: 26.09.2024). Consent forms were obtained from all patients.

Statistical Analysis

Data analysis was conducted using GraphPad Prism 9.5.0 and IBM SPSS Statistics for Windows, Version 25.0 (Statistical Package for the Social Sciences, IBM Corp., Armonk, NY, USA). Descriptive statistics for the patient group variables were presented as frequencies and percentages for categorical variables, and as Mean ± SD deviation or median (interquartile range) for continuous variables. The data were assessed for normality; for comparisons between two independent groups, either the Independent Samples t-test or the Mann-Whitney U test was employed, and chi-square (χ^2) analysis was used for categorical variables. A p-value of <0.05 was considered statistically significant.

Results

A total of 56 patients were included in the study, consisting of 22 females (39.3%) and 34 males (60.7%). The age range of the patients was 27 to 80 years, with a mean age of 62.26 years. Patients had been receiving hemodialysis for an average duration of 3.64 years, with a range from 1 to 11 years (Table 1).

According to the results of our study, frailty levels were higher, although not statistically significant, in patients aged 65 and older. Frailty levels were significantly higher in patients with diabetes mellitus, CVD, and peripheral arterial disease (PAD) compared to those without these conditions (p=0.003, p=0.000, and p=0.035, respectively) (Figure 1). No statistically significant relationship was found between the ultrafiltration volume (UF) in each session, residual renal function (RRF) or body mass index (BMI) (p≥0.05) (Table 2).

In patients with severe anemia [hemoglobin (Hb)<10], frailty levels were also found to be statistically significant higher (p=0.024) (Figure 2). No statistically significant relationship was found between the average clinical frailty levels and patients' age, duration of hemodialysis treatment (in years), or laboratory values, including CRP, ferritin, parathyroid hormone, serum albumin, potassium, phosphorus, calcium, uric acid and dialysis dose (Kt/V), (p≥0.05) (Table 3).

Table 1. Descriptive statistics of patient variables

Variables	Mean ± SD	Median (IQR)
Age (years)	62.73±13.06	66.00 (17.75)
HD years	3.54±2.44	3.00 (2.00)
UF (mL)	2589.95±881.46	2900.00 (1400.00)
CRP (mg/L)	21.53±45.98	6.70 (13.20)
Ferritin (ng/mL)	471.76±340.99	395.00 (310.05)
PTH (pg/mL)	482.88±401.54	377.85 (329.50)
Hb (g/dL)	10.43±1.69	10.70 (2.52)
Albumin (g/dL)	3.71±0.48	3.71 (0.54)
K (mmoL/L)	5.02±0.64	5.06 (0.91)
P (mg/dL)	4.96±1.38	5.15 (2.22)
Ca (mg/dL)	8.74±0.76	8.65 (1.20)
Uric acid (mg/dL)	5.78±1.03	5.80 (1.25)
Kt/V daugirdas	1.60±0.20	1.57 (0.36)
RRF (mL/day)	311.70±322.35	200.00 (500.00)
CFI	4.05±1.61	4.00 (2.00)
BMI (kg/m^2)	26.82±5.83	25.15 (8.96)

HD: Hemodialysis duration, UF: Ultrafiltration, CRP: C-reactive protein, PTH: Parathyroid hormone, Hb: Hemoglobin, K: Potassium, P: Phosphorus, Ca: Calcium, Kt/V: Dialysis dose, RRF: Renal residual function, CFI: Clinical frailty index, BMI: Body mass index, SD: Standard deviation, IQR: Interquartile range

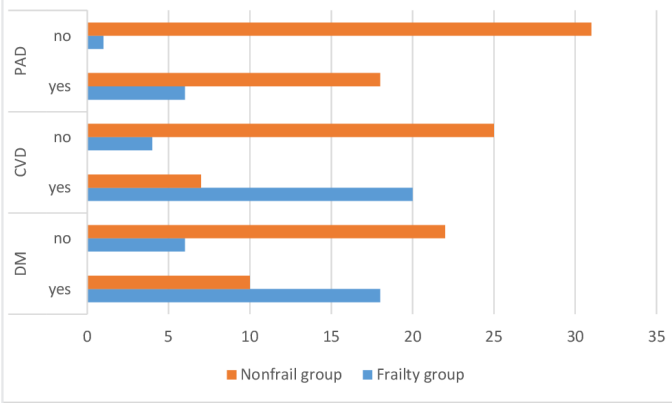

Figure 1. The relationship between frailty and DM, CVD, and PAD in hemodialysis patients

DM: Diabetes mellitus, CVD: Cardiovascular disease, PAD: Peripheral arterial disease

Discussion

This study evaluated the laboratory values and clinical data of hemodialysis patients with end-stage renal failure. In particular, the relationships of laboratory values, causes of renal failure, duration of hemodialysis, BMI, RRF, UF volume, and Kt/V values, with the patients' frailty levels were evaluated. As individuals age, their health status and functional capacities become increasingly vulnerable. They emphasize the importance of recognizing frailty in older adults and developing strategies to prevent falls (11). It has been observed that the prevalence of PAD increases after the age of 60, along with a corresponding rise in frailty levels (12). In our study, although not statistically significant, higher frailty levels were observed in patients aged 65 and older (n=33). It has been emphasized that diabetes mellitus leads to a complication such as frailty, which is associated with chronic inflammation (13). Shauyet et al. (14) reported that frailty increases the risk of hypoglycemia in elderly diabetic patients, while Meneilly et al. (15) emphasized that elderly diabetic patients are more prone to frailty. The results indicate that the presence of diabetes mellitus in the etiology of CRF is a significant factor contributing to increased frailty throughout the course of the disease. Having diabetes mellitus in the patient increases the risk of CVD, leading to a higher incidence of frailty (16). In our study, frailty levels were higher in the hemodialysis patient group with diabetes compared to those without diabetes. The incidence of CVD also increases in patients with CRF (17,18). Frailty may serve as both a consequence of CVD and a determining factor in its development and progression. This suggests that frail individuals are at risk regarding heart health and may face an increased risk of future heart disease in addition to their current health issues (19). In patients over 70 years of age who underwent percutaneous revascularization, those with frailty syndrome had a higher mortality rate compared to those without frailty (20). Yalınkılıç et al. (21) reported that frailty levels in elderly patients with heart failure were moderate. However, our study found high frailty levels in hemodialysis patients with CVD. In patients with CRF, the presence of PAD can be associated with serious outcomes, including balance disorders, falls, hospitalizations, and even death (12). According to the findings of this study, frailty levels were significantly higher in hemodialysis patients with PAD.

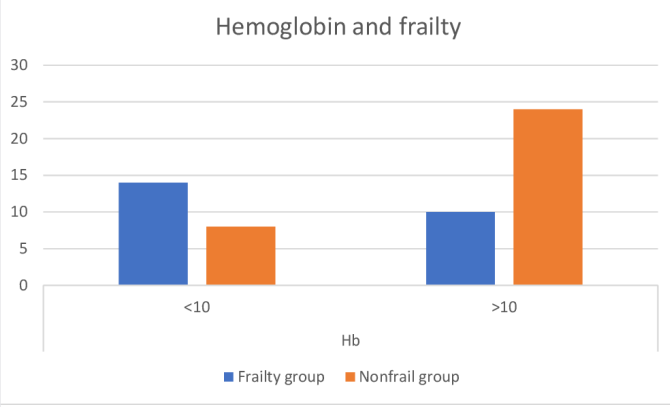

Figure 2. The relationship between hemoglobin levels and frailty in hemodialysis patients

Anemia, which manifests with symptoms such as weakness, palpitations, and fatigue, can significantly reduce an individual's daily functional capacity, adversely affecting both physical and mental performance. Anemia and frailty are two prevalent conditions in the elderly, both of which are associated with increased morbidity and mortality (22). Mutlay and Seydi (23), found, utilizing the Fried Frailty Scale, that frailty scores were significantly higher in individuals with anemia compared to other groups. This finding highlights the negative impact of anemia on overall health and its contribution to increased frailty levels. Low Hb levels in the elderly have been recognized as an independent risk factor for the development of frailty (24). Within the scope of this research, hemodialysis patients with severe anemia (Hb<10), demonstrated a statistically significant increase in frailty scores compared to those with Hb levels above 10 (12). Çelebi et al. (25) indicated that hypoalbuminemia and reduced urine output are independent risk factors for frailty.

Table 2. Relationship between clinical frailty index and variables

Clinical Frailty Index (CFI)						
		Non-frail	Frail	χ^2	SD	p
Gender	Female	13	9	0.056	1	0.813
	Male	19	15			
Etiology	DM	10	18	8.823	1	0.003
	Other	22	6			
CVD	No	25	4	18.358	1	0.000
	Yes	7	20			
PAD	No	31	18	6.306	1	0.035
	Yes	1	6			
BMI (kg/m^2)	<18.50	1	1	0.239	2	0.887
	18.80-25	14	9			
	≥25	17	14			
RRF (mL/day)	<200	12	14	1.629	1	0.202
	≥200	20	10			
UF (mL)	<2000	7	8	0.427	1	0.514
	≥2000	25	16			

DM: Diabetes mellitus, CVD: Cardiovascular disease, PAD: Peripheral arterial disease, BMI: Body mass index, RRF: Renal residual function, UF: Ultrafiltration, SD: Standard deviation

Table 3. Relationship between clinical frailty index and variables

Clinical Frailty Index (CFI)						
		Non-frail	Frail	χ^2	SD	p
Albumin (g/dL)	<3.50 ≥3.50	5 27	7 17	0.798	1	0.372
CRP (mg/L)	<5 ≥5	16 16	9 15	0.435	1	0.510
Hb (g/dL)	<10 ≥10	8 24	14 10	5.068	1	**0.024**
K (mmol/L)	<5.1 ≥5.1	19 13	12 12	0.182	1	0.670
Ca (mg/dL)	<8.5 ≥8.5	8 24	10 14	1.066	1	0.302
P (mg/dL)	<4.50 ≥4.50	11 21	11 13	0.351	1	0.554
PTH (pg/mL)	<240 ≥240	9 23	5 19	0.097	1	0.755
Ferritin (ng/mL)	<100 ≥100	1 31	1 23	0.043	1	0.835
Uric acid (mg/dL)	<6.1 ≥6.1	19 13	16 8	0.078	1	0.780
Kt/V	<1.60 ≥1.60	5 27	1 23	0.875	1	0.223

CRP: C-reactive protein, Hb: Hemoglobin, K: Potassium, Ca: Calcium, P: Phosphorus, PTH: Parathyroid hormone, Kt/V: Dialysis dose, SD: Standard deviation

However, in the present study, no significant correlation was observed among albumin levels, RRF, and frailty. Some findings in the current literature suggest that the impact of hypoalbuminemia and RRF on frailty in patients with CRF undergoing hemodialysis warrants further evaluation in larger study populations. This may be in contrast to other findings. Consequently, further research in this area is needed. No significant correlation was found between the frailty score and serum CRP levels, a result that does not support the anticipated relationship between frailty and inflammation. Similarly, no significant association was observed between the frailty score and parameters such as Kt/V or applied UF, suggesting that the effectiveness of hemodialysis treatment and UF does not negatively impact frailty. The patients' age, BMI, dialysis duration (in years), and levels of PTH, calcium, phosphorus, and uric acid were also not found to be significantly associated with frailty.

Study Limitations

The limitations of this study include the limited number of patients, the cross-sectional design, and the inclusion of patients from a specific region.

Conclusion

Patients with CKD undergoing hemodialysis are characterized by increased frailty, which can be attributed to factors such as DM, CVD, PAD, and anemia. The presence of DM in the etiology of CRF constitutes a significant factor contributing to the increased frailty observed throughout the disease progression. Moreover, the concomitant presence of cardiovascular and PAD significantly exacerbates frailty, while anemia, a common comorbidity in these patients, represents a modifiable risk factor. Correcting anemia may help reduce the heightened risk of frailty. The absence of an effect of the other evaluated parameters on frailty in patients could be due to the effectiveness of hemodialysis treatment. Long-term, consistent, and well-managed hemodialysis can result in improvements in both hemodynamic and biochemical parameters, thus reducing frailty and minimizing the detrimental effects associated with CRF. As a result, this can decrease the risk of potential complications, promote sustained overall well-being, and delay the progression of frailty. Furthermore, monitoring the frailty index and implementing appropriate preventive and corrective measures are essential for reducing cardiovascular morbidity and mortality.

Ethics

Ethics Committee Approval: The study was approved by the Scientific Research Ethics Committee of Kocaeli City Hospital (approval number: 2024-112, date: 26.09.2024).

Informed Consent: Consent forms were obtained from all patients.

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