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ORIGINAL ARTICLE

Hemodialysis Treatment Influences Postoperative Activities of Daily Living Improvement for Patients with Hip Fractures

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Objectives: The aim of this study was to investigate the influences of hemodialysis (HD) on activities of daily living (ADL) in patients with hip fracture. **Methods:** This study included 28 patients (14 HD and 14 non-HD patients) with acute hip fracture. The effects of variables such as age, sex, surgical procedure, length of hospital stay, serum albumin, C-reactive protein (CRP), number of physical therapy units, and functional independence measure (FIM) were assessed. For each factor, a two-group comparison was conducted between the HD and non-HD groups. Multiple regression analysis was used to examine the factors affecting FIM efficacy (E-FIM). **Results:** For HD patients, total and motor FIM at discharge, E-FIM, and albumin level were significantly lower than in non-HD patients. Length of hospital stay was significantly longer for HD patients. Multiple regression analysis showed that HD had a negative effect on E-FIM. **Conclusions:** The results suggest that rehabilitation for HD patients with hip fractures require intervention that not only provides standard rehabilitation but also addresses aspects of renal rehabilitation.

Key Words: hemodialysis; hip fracture; rehabilitation

INTRODUCTION

Hemodialysis (HD) patients may have various comorbidities including muscular, neurological, or bone and joint disorders caused by uremia, in addition to impaired mineral and hormonal metabolism.[1–4] These disorders potentially affect the patient's cognitive function and physical functioning such as exercise tolerance, muscle strength, and balance, leading to a decline in walking, physical activity, and other mobility functions.[4–9] The incidence of falls and fractures increases in HD patients with abnormal bone metabolism because of declining physical function.[10–12] Moreover, the incidence of hip fracture is five times higher in HD patients than in community-dwelling elderly patients.[13] Therefore, HD patients with hip fractures are often eligible for physical therapy.

In general, hip fracture is one of the major causes of patients becoming bedridden and a factor of mortality.[14] In particular, decreased mobility because of hip fracture is likely to result in a reduced level of activity, and it has been reported that decreased activities of daily living (ADL) and activity have significant impact on mortality among HD patients.[15] In fact, the mortality of HD patients following hip fracture surgery has been reported to be higher than that of non-HD patients with the same surgery.[16] Therefore, improving ADL, including walking function, is clearly an important factor for reducing mortality.

It has often been reported that HD patients do not gain muscle mass through exercise because of protein intake restrictions, chronic inflammation, and uremia.[17,18] In addition, these patients are expected to receive less rehabilitation because of the time constraints associated with HD treat-

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ment. These findings suggest that the period for improvement in the ADL of HD patients after hip fracture surgery may be prolonged because of slow improvement of muscle mass and reduced rehabilitation.

Understanding the degree of improvement in ADL may help to predict prognoses for HD patients who have undergone hip fracture surgery and to design effective rehabilitation programs for this group. However, to date, no study has reported on postoperative ADL in patients with hip fracture who are also receiving HD. The aim of this study was to investigate the influences of HD in relation to improving ADL in patients with hip fractures.

MATERIALS AND METHODS

This retrospective cohort study was conducted from April 2016 to March 2021 at the Association of EISEIKAI Medical and Healthcare Corporation Minamitama Hospital (170 beds) in Tokyo. A total of 93 patients (including 17 HD patients) who met inclusion and exclusion criteria were included in this study. Our postoperative rehabilitation protocol involves the initiation of physical therapy from the day after surgery, including standing and weight-bearing exercises on the same day.

The inclusion criteria for HD patients were as follows: 1) receiving HD three times per week and 2) started HD more than 1 month before the study began. The exclusion criteria were as follows: 1) transferred to another hospital or discharged to a nursing home, 2) neurological disorder affecting ADL, 3) difficulty walking or in need of assistance before the hip injury, and 4) an unloading period because of fracture type or procedure.

The protocol for this research project was approved by the Ethics Committee of the Association of EISEIKAI Medical and Healthcare Corporation Minamitama Hospital (No. 2020-Ack-11) in accordance with the provisions of the Declaration of Helsinki. Because this research study used medical records, written or oral consent was not obtained from research subjects. This study falls under the Ethical Guidelines for Medical and Biological Research Involving Human Subjects. Consequently, in accordance with these guidelines, opt-out materials were posted for public disclosure to give subjects or their proxies the opportunity to withdraw from the study. There were no applications to withdraw from the study after the opt-out information was presented.

Measurements

The following data were extracted from the patients' electronic medical records: age, sex, length of hospital stay, fracture types, admission serum albumin, admission C-reactive protein (CRP), and number of physical therapy units (1 unit = 20 min). Albumin and CRP were measured by standard methods as part of the routine clinical examination. The number of physical therapy units was defined as the total number of units performed during the postoperative period until discharge. Physical therapy on the day of HD was performed before or after HD treatment or both. In HD patients, the cause of renal failure and HD duration were investigated using their medical records. ADL were assessed in terms of the functional independence measure (FIM), which was examined for "motor items," "cognitive items," and "total" FIM at admission (A-FIM) and at discharge (D-FIM). FIM efficacy (E-FIM) was calculated using the following formula: E-FIM = (D-FIM − A-FIM)/ postoperative hospital stay.

Statistical Analysis

To minimize selection bias, propensity score matching was conducted in this study. We identified 17 HD patients and sought a matched cohort from 76 non-HD patients using the one-to-one nearest neighbor method. Baseline information was matched, including age, gender, fracture types, and cognitive items for A-FIM. Welch's *t*-test or χ^2 test was performed to evaluate differences in age, gender, surgical procedure, albumin, CRP, hospital stay, physical therapy units, and FIM between the HD group and the non-HD group for each study item. To investigate the factors affecting E-FIM, multiple regression analysis was conducted stepwise with E-FIM as the dependent variable and age, HD status, and physical therapy units as independent variables. SPSS Statistics for Windows Version 29.0 (IBM, Armonk, NY, USA) was used for statistical analysis. The statistically significant level of the P value reported on both sides (α) was set at 0.05.

RESULTS

After propensity matching, 14 patients were included for each of the HD and non-HD groups. The characteristics of participants are described in **Table 1**, and the cause of renal failure and HD duration are shown in **Table 2**. The median age of the subjects was 81.0 years. The most common primary disease leading to HD was diabetes mellitus in 4 patients (28.6%), and the median HD duration was 81.5 months (including one patient with unknown HD duration).

The differences between the HD group and the non-HD group in the matched cohort are shown in **Table 3**. Albumin was significantly lower in the HD group (P = 0.013), and the

Table 1. Characteristics of study population

Characteristic	All (n=28)
Age, years	81.0 (75.0–85.5)
Male, n (%)	11 (39.3)
Female, n (%)	17 (60.7)
Fracture type	
Femoral neck, n (%)	21 (75.0)
Trochanteric, n (%)	7 (25.0)
Albumin, g/dL	3.9 (3.6–4.0)
CRP, mg/dL	0.3 (0.1–1.4)

Data give as median (interquartile range) or number (percentage).

Table 2. Cause of renal failure and HD duration

Cause of renal failure	HD patients (n=14)
Diabetes mellitus, n (%)	4 (28.6)
Nephrosclerosis, n (%)	3 (21.4)
Polycystic kidney disease, n (%)	2 (14.3)
Glomerulonephritis, n (%)	1 (7.1)
Other / unknown, n (%)	4 (28.6)
HD duration, months	53.6 (30.1–113.6)

Data given as number (percentage) or median (interquartile range).

length of hospital stay was significantly longer in the HD group (P<0.001). There was no significant difference in A-FIM between the two groups in terms of "motor items," "cognitive items," or "total items." The motor items and total items for D-FIM and E-FIM were lower in the HD group than in the non-HD group (P=0.014, P=0.020, P<0.001).

The results of the multiple regression analysis are shown in **Table 4**. HD status was extracted as a significant variable as a factor affecting E-FIM (regression coefficient=−0.638, P<0.001, R^2=0.407). Age and physical therapy units were shown to have no significant effect on E-FIM.

DISCUSSION

We investigated the improvement in FIM in patients with hip fractures with and without HD. Our study showed that the total and motor items for D-FIM, E-FIM, and albumin were lower in the HD group, and the length of hospital stay was longer in this group. HD status was extracted as a significant variable as a factor affecting E-FIM. This is the first study to show the influence of HD on hip fracture.

In this study, the median age of the subjects was 81.0 years, which was close to the mean age of 82 years for Japanese patients with hip fractures in a previous study.[19] Although a study conducted by Tamaki et al.[19] reported that the propor-

Table 3. Comparison of characteristics and FIM between HD and non-HD groups

Characteristic	HD patients (n=14)	non-HD patients (n=14)	P value
Age, years	81.0 (79.0–86.5)	80.5 (75.0–85.0)	0.550
Male, %	42.9	35.7	
Female, %	57.1	64.3	0.699
Surgical formula			
Femoral neck fracture, %	64.3	85.7	
Trochanteric fracture, %	35.7	14.3	0.190
Albumin, g/dL	3.65 (3.4–3.9)	4.0 (3.9–4.2)	0.013*
CRP, mg/dL	0.4 (0.1–0.7)	0.2 (0.1–5.7)	0.179
Hospital stay, days	56.5 (46.0–80.5)	26.0 (21.5–47.0)	<0.001*
A-FIM total	58.0 (51.0–59.8)	60.0 (55.5–61.5)	0.200
A-FIM motor	24.0 (20.3–25.8)	25.0 (22.5–28.5)	0.213
A-FIM cognitive	35.0 (33.0–35.0)	35.0 (35.0–35.0)	0.653
D-FIM total	96.0 (80.3–113.3)	118.5 (113.0–121.0)	0.020*
D-FIM motor	68.5 (50.3–80.5)	84.0 (78.5–86.0)	0.014*
D-FIM cognitive	33.5 (28.5–35.0)	35.0 (35.0–35.0)	0.422
E-FIM	0.74 (0.46–1.04)	2.43 (1.33–3.27)	<0.001*
Physical therapy units, units/day	2.99 (2.68–3.18)	2.80 (2.23–3.22)	0.495

*P<0.05; data given as median (interquartile range) or as percentage.

Table 4. Examination of factors affecting E-FIM

Factor	R^2	Unadjusted hazard ratio	95% Confidence interval	P value
HD implementation or not	0.407	−0.638	−2.242 to −0.078	<0.001*
Physical therapy units per day		0.196		0.205
Age		−0.242		0.112

*P < 0.05

tion of female patients with hip fracture is generally high (approximately 79%), the proportions of male and female patients were similar in the HD group. The high proportion of male HD patients in Japan[13] and the fact that even male HD patients are prone to fractures because of abnormal bone and mineral metabolism[20] may have contributed to the higher prevalence of hip fractures among males in the HD group. As for FIM, D-FIM total and motor items and E-FIM were significantly lower in HD patients than in non-HD patients. E-FIM was influenced by the length of hospital stay and the degree of improvement in FIM. HD patients were hospitalized longer and had lower D-FIM total and motor items, which may have resulted in lower E-FIM. Previous studies have reported that HD patients are less likely to improve muscle mass with exercise,[18] which may explain the longer hospitalization period and lower improvement in total and motor items for D-FIM among HD patients. Although muscle mass data were not collected in this study, it was inferred that the lower albumin levels in HD patients indicated an influence on muscle mass improvement. Previous studies reported that the FIM at discharge and prognosis were affected in patients with low albumin,[21,22] and it is possible that albumin also affected FIM at discharge in this study. In addition, HD patients show decreased activity levels because of the need to lie down during dialysis and the fatigue that follows dialysis. Furthermore, complications of diabetes and the dialysis treatment itself contribute to delayed wound healing. These factors may have influenced the longer hospitalization period and lower improvement in total and motor items for D-FIM among HD patients. We hypothesized that the longer length of stay and lower D-FIM total and motor items in HD patients were caused by the time constraints associated with HD treatment, which reduced the number of physical therapy units performed. In this study, the number of physical therapy units per day was not significantly different between the HD and non-HD groups, suggesting that the amount of physical therapy was unlikely to have influenced the results. However, HD patients may have changed their type of exercise because of fatigue and malaise on HD days; further research is needed on this topic. Albumin was significantly lower in the HD group than in the non-HD group. HD patients tend to have lower albumin because of chronic inflammation and restricted protein intake,[3] and this may have resulted in lower albumin in HD patients with hip fractures. By contrast, the albumin levels of non-HD patients with hip fractures in this study were slightly higher than the 3.5 g/dL reported in previous studies.[23,24] The reason for the higher albumin may be that this study included patients who were able to walk independently, and there were fewer patients with cognitive decline.

The results of multiple regression analysis showed that only HD affected E-FIM negatively. In previous studies, the number of physical therapy units affected FIM at discharge.[25] However, our study showed that higher age and few physical therapy units were not related to E-FIM, and HD was the only factor affecting E-FIM. In this study, physical therapy units were not identified as a significant factor. It may be necessary to focus not only on the quantity but also on the type of rehabilitation for dialysis patients, taking into consideration factors such as dialysis days. The results suggest that HD patients with hip fracture have lower E-FIM and that it takes longer to improve D-FIM total and motor items even if they receive an equivalent number of physical therapy units as non-HD patients. HD treatment influences the improvement of ADL in patients with hip fracture, regardless of the number of physical therapy units. Therefore, in addition to general rehabilitation for hip fracture, interventions should consider aspects of comprehensive renal rehabilitation for patients undergoing HD, including nutrition, pharmacotherapy, psychological aspects, and rehabilitation interventions that are scheduled to account for HD treatment time.

Our study has several limitations. First, we were not able to determine the factors of physical function that affect motor FIM, such as muscle strength and walking function, and we were not able to examine the causal factors of low E-FIM in HD patients. Muscle strength data was not assessed in this study, so its impact is beyond the scope of prediction. Muscle strength assessment will be necessary in the future to understand any causal relationship with FIM in HD patients. Other limitations in this study included a small number of subjects, a lack of information on the type of physical therapy used, and possible selection bias in the non-dialysis patient group. This latter point should be considered given that dialysis patients are often difficult to transfer because of dialysis treatment, whereas non-dialysis patients are often transferred when prolonged ADL improvement is expected. Furthermore, in evaluating FIM, although E-FIM was used as the outcome in this study, it may have been better to evaluate the degree of improvement over the same period of time, such as 2 or 4 weeks after surgery.

CONCLUSION

We found that patients with hip fracture undergoing HD had lower albumin, lower D-FIM for total and motor items, lower E-FIM in general, and longer hospital stays than non-HD patients. In addition, only HD was extracted as a factor affecting E-FIM. This suggests that HD patients with hip fracture require intervention that not only provides standard rehabilitation but also addresses aspects of renal rehabilitation, including nutrition, intervention time, and the psychological aspects of HD treatment.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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