

Original article

Factors affecting ambulatory ability in patients aged 90 years and older following proximal femoral fractures

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Abstract

Objectives: To investigate the details of patients' status on admission and at discharge at our hospital, to compare the ambulatory group and non-ambulatory group at discharge, and to assess the factors associated with ambulatory ability at discharge in patients aged ≥ 90 years with proximal femoral fractures (PFFs).

Patients/Materials and Methods: Twenty patients admitted to our hospital for rehabilitation after surgery for a PFF were evaluated retrospectively. The rate of regaining ambulatory ability, presence of dementia, body mass index, serum albumin level, hemoglobin level, lymphocyte count, and functional independence measure (FIM) were assessed on admission and at discharge. Relationships between patients' ambulatory ability and ambulatory parameters were compared between the ambulatory and non-ambulatory groups.

Results: The rate of regaining ambulatory ability was 55% at discharge. The serum albumin level at discharge was significantly higher in the ambulatory group than that in the non-ambulatory group. More patients had dementia on admission in the non-ambulatory group than in the ambulatory group. On admission, scores for the cognitive items of the FIM ("expression" and "memory") were significantly higher in the ambulatory group than those in the non-ambulatory group.

Conclusions: The rate of ambulatory ability at discharge was 55% in those with a PFF, who were aged ≥ 90 years. The presence of dementia on admission and serum albumin level at discharge were factors related to ambulatory ability. It is very important to use a general rehabilitation protocol that takes cognitive function and nourishment into account, in addition to the physical aspect.

Key words: proximal femoral fracture, ambulation, elderly patients

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Introduction

Proximal femoral fracture (PFF) is a representative fracture of elderly people. As the Japanese society continues to age, the number of PFFs experienced by elderly people is increasing. According to a survey from the Japanese Orthopedic Association, a drastic increase in the number of patients, especially those aged > 90 years, was observed from 1998 to 2008¹. It is expected that the rate of PFFs in super-elderly people (≥ 90 years) will increase exponentially. It is therefore important to perform a targeted investigation of PFFs in super-elderly patients to determine the optimal rehabilitation protocol.

It has been reported that the survival rate after PFFs in elderly patients is related to ambulatory ability². Furthermore, factors reported to be related to ambulatory ability are age > 80 years, dementia, ambulatory ability before injury, and a contralateral hip fracture in patients aged ≥ 50 years², and prefracture ambulatory ability, American Society of Anesthesiologist rating of operative risk, and fracture type in patients aged ≥ 65 years³. However, few reports concerning PFFs in relation to ambulatory ability in individuals aged ≥ 90 years have been published. The factors related to ambulatory ability in this age group are dementia and the number of vertebral fractures⁴.

Therefore, the aims of this study were to 1) investigate patients' status on admission and at discharge at our hospital, 2) compare the ambulatory group and non-ambulatory group at discharge, and 3) assess the factors associated with ambulatory ability at discharge in patients ≥ 90 years old with a PFF.

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Table 1 Patient characteristics

Characteristics	
Age on admission (years), mean (range)	92.3 (90.0–99.0)
Sex (men:women)	2:18
Side (right:left)	11:9
Height (cm), mean \pm SD	145.0 \pm 8.2
Body weight (kg), mean \pm SD	40.0 \pm 6.2
Fracture type and surgery type, n	
Femoral neck	
Internal fixation	3
Prosthetic replacement	8
Intertrochanteric	
Intramedullary nail	9
Complication, n	
Cardiovascular disease	16
Metabolic or endocrine diseases	5
Gastrointestinal disease	4
Cerebrovascular disease	4
Respiratory disease	2
Hematologic disease	1
Osteoporotic fracture	6

SD, standard deviation.

Patients and Methods

Twenty patients admitted to our institution for rehabilitation after surgery for a PFF were evaluated retrospectively. Patients' characteristics (age, sex, height, weight, fracture side, fracture type, and complications) are summarized in Table 1. Patients were transferred to our hospital from another acute care hospital approximately 4–5 weeks postoperatively, and underwent rehabilitated joint excursion training, muscular strength training, walking exercise, and activities of daily living exercise. The complications that occurred during hospitalization at our hospital were urinary tract infections in four patients, deep vein thrombosis in one patient, arrhythmia in one patient, and delirium in one patient. No cases of implant cut-out and dislocation of the prosthetic replacement occurred.

The effects of various factors, including ambulatory ability before injury and at discharge, interval from surgery to transfer to our hospital, duration of hospitalization, presence of dementia on admission, nourishment state on admission and at discharge, place of residence at discharge, and functional independence measure (FIM) scores on admission and at discharge were evaluated.

Ambulatory ability was classified into five levels: level 1, uses a wheel chair; level 2, requires assistance from another person; level 3, holds on to something (wall or handrail); level 4, uses a walker; and level 5, performs unaided walking or uses a cane for indoor walking. We assessed ambula-

tory ability before injury and at discharge, and we placed patients with levels 3, 4, and 5 in the ambulatory group and those with levels 1 and 2 in the non-ambulatory group. Dementia was diagnosed according to the Mini-Mental State Examination (MMSE) or Hasegawa intelligence scale revised for dementia (HDS-R). A score of ≤ 23 on the MMSE and a score of ≤ 19 on the HDS-R indicated dementia. Regarding the state of nourishment, patients' body mass index (BMI), serum albumin (ALB) level, hemoglobin (Hb) level, and the total lymphocyte (Lymph) count on admission and at discharge were recorded. Regarding the FIM, we investigated self-care, sphincter control, transfers, locomotion, cognitive score, and total score on admission and at discharge, and calculated the FIM gain.

Statistical analysis

Statistical relationships between patients' ambulatory ability and the ambulatory parameters (days of hospitalization, BMI, ALB level, Hb level, Lymph count, and FIM scores) were compared between the ambulatory group and non-ambulatory group. Statistical significance was determined using Student's *t*-test. The presence of dementia and the discharge destination (e.g., the patient's home) were compared between the ambulatory group and non-ambulatory group. Statistical significance was determined using the chi-square test. A correlation coefficient was calculated between patients' ambulatory ability levels before injury and at discharge. All analyses were performed using SPSS software, version 22 (SPSS Inc., Chicago, IL, USA). A significance level of 5% was chosen for all tests ($P < 0.05$).

Results

Before injury, all patients were able to walk (level 5: 15 patients, level 4: two patients, level 3: three patients). At discharge, ambulatory ability levels were as follows: level 5, six patients; level 4, five patients; level 3, no patients; level 2, seven patients; level 1, two patients (Figure 1). At discharge, the rate of regaining ambulatory ability was 55%. The correlation coefficient of ambulatory ability level before injury and at discharge was 0.338.

Table 2 shows the details of patients' status on admission and at discharge to our hospital in the ambulatory group and non-ambulatory group. The mean duration from surgery to transfer to our hospital was 32.5 days in the ambulatory group and 36.1 days in the non-ambulatory group ($P = 0.348$). The mean hospitalization period was 71.1 days in the ambulatory group and 69.2 days in the non-ambulatory group ($P = 0.710$).

On admission, the mean BMI was 19.1 kg/m² and 19.1 kg/m² in the ambulatory group and non-ambulatory group, respectively ($P = 0.989$). The mean ALB level was higher in the

ambulatory group (3.3 g/dL) than that in the non-ambulatory group (3.0 g/dL; $P = 0.205$). The mean Hb level was 10.1 g/dL in the ambulatory group and 10.9 g/dL in the non-ambulatory group ($P = 0.060$). The mean Lymph count was $1.3 \times 10^3/\mu\text{L}$ in the ambulatory group and $1.55 \times 10^3/\mu\text{L}$ in the non-ambula-

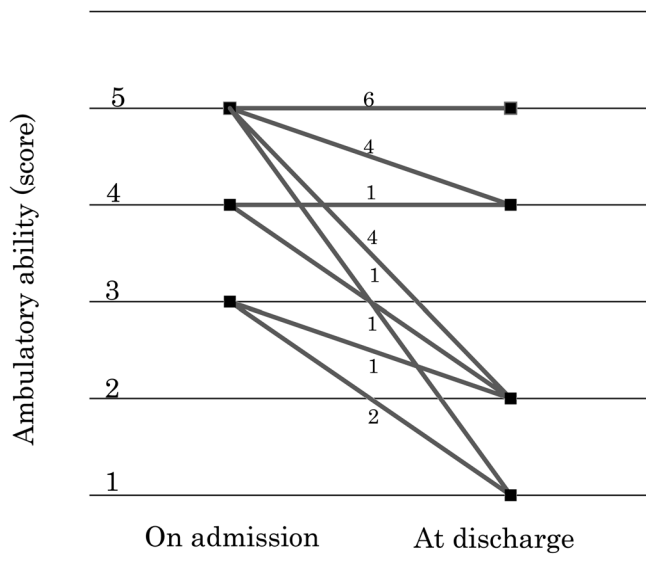


Figure 1 Ambulatory ability on admission and at discharge. Before injury, all patients were able to walk (level 5: 15 patients, level 4: two patients, level 3: three patients). At discharge, ambulatory ability levels were as follows: level 5, six patients; level 4, five patients; level 3, no patients; level 2, seven patients; level 1, two patients.

tory group ($P = 0.246$). The rate of dementia was significantly higher in the non-ambulatory group (100% [9/9 patients]) than that in the ambulatory group (54.5% [6/11 patients]; $P = 0.003$).

At discharge, BMI was 19.4 kg/m² in the ambulatory group and 19.3 kg/m² in the non-ambulatory group ($P = 0.982$). The mean ALB level was significantly higher in the ambulatory group (3.5 g/dL) than that in the non-ambulatory group (3.1 g/dL; $P = 0.013$). The mean Hb level was 10.8 g/dL in the ambulatory group and 11.2 g/dL in the non-ambulatory group ($P = 0.394$). The mean Lymph count was $1.5 (\times 10^3/\mu\text{L})$ in the ambulatory group and $1.48 (\times 10^3/\mu\text{L})$ in the non-ambulatory group ($P = 0.961$). All patients were living at home before the injury, and 16 (80%) of 20 patients were able to return home after hospitalization. All 11 patients in the ambulatory group returned home, while four of nine patients in the non-ambulatory group entered facilities ($P = 0.008$).

Table 3 shows the total score of each item of the FIM and the details of cognitive items on admission and at discharge for the two groups. On admission, the scores of the cognitive items “expression” ($P = 0.035$) and “memory” ($P = 0.042$) were significantly higher in the ambulatory group than those in the non-ambulatory group. All items of the FIM and FIM gain at discharge were significantly higher in the ambulatory group than those in the non-ambulatory group.

Discussion

In patients aged ≥ 90 years, the rate of regaining ambulatory ability after surgery for a PFF varies. MacCollum *et al.*⁵⁾ reported that only 25% of those with functional ambulatory ability preoperatively regained a similar level of

Table 2 Clinical characteristics of the ambulatory and non-ambulatory groups on admission and at discharge

Characteristic	Ambulatory group	Non-ambulatory group	<i>P</i> -value
Patients, n	11	9	
Days from surgery to transfer to our hospital, mean \pm SD	32.5 \pm 9.2	36.1 \pm 6.9	0.348
Hospitalization (d), mean \pm SD	71.7 \pm 14.7	69.2 \pm 14.4	0.71
On admission, mean \pm SD			
BMI (kg/m ²)	19.1 \pm 1.7	19.1 \pm 3.8	0.989
Alb (g/dL)	3.3 \pm 0.4	3.0 \pm 0.3	0.205
Hb (g/dL)	10.1 \pm 1.1	10.9 \pm 0.7	0.06
Lymphocytes ($\times 10^3/\mu\text{L}$)	1.30 \pm 0.42	1.55 \pm 0.48	0.246
Dementia, n	6	9	0.003*
At discharge, mean \pm SD			
BMI (kg/m ²)	19.4 \pm 2.2	19.3 \pm 3.3	0.982
Alb (g/dL)	3.5 \pm 0.3	3.1 \pm 0.2	0.013*
Hb (g/dL)	10.8 \pm 0.8	11.2 \pm 0.7	0.394
Lymphocytes ($\times 10^3/\mu\text{L}$)	1.50 \pm 0.51	1.48 \pm 0.33	0.961
Discharge to home, n	11	4	0.008*

Alb, albumin level; BMI, body mass index; Hb, hemoglobin level; SD, standard deviation. * A *P*-value < 0.05 was considered statistically significant.

Table 3 FIM on admission and at discharge in the ambulatory and non-ambulatory groups

FIM category	Ambulatory group, mean \pm SD	Non-ambulatory group, mean \pm SD	<i>P</i> -value
On admission			
Total	142.3 \pm 38.3	113.0 \pm 23.0	0.071
Self-care	28.9 \pm 9.6	23.8 \pm 5.8	0.18
Sphincter control	11.3 \pm 3.7	8.7 \pm 2.9	0.122
Transfer	11.5 \pm 9.2	9.3 \pm 3.5	0.196
Locomotion	3.6 \pm 2.2	2.0 \pm 0.6	0.092
Cognitive	28.3 \pm 7.0	20.2 \pm 5.3	0.066
Comprehension	5.5 \pm 1.5	5.0 \pm 1.2	0.407
Expression	6.8 \pm 0.6	5.6 \pm 1.3	0.035*
Social interaction	6.1 \pm 1.6	5.5 \pm 1.4	0.373
Problem solving	5.0 \pm 2.3	3.3 \pm 1.5	0.064
Memory	4.6 \pm 2.1	2.8 \pm 1.3	0.042*
At discharge			
Total	179.9 \pm 25.6	130.3 \pm 21.9	0.000*
Self-care	35.5 \pm 5.5	24.1 \pm 7.0	0.006*
Sphincter control	13.1 \pm 1.5	8.1 \pm 2.8	0.002*
Transfer	15.5 \pm 2.5	12.0 \pm 1.6	0.004*
Locomotion	9.1 \pm 2.9	4.1 \pm 3.3	0.006*
Cognitive	29.4 \pm 5.7	22.4 \pm 4.9	0.016*
Comprehension	5.8 \pm 1.2	4.9 \pm 1.3	0.118
Expression	6.8 \pm 0.6	5.5 \pm 1.2	0.017*
Social interaction	6.4 \pm 0.9	5.5 \pm 1.4	0.127
Problem solving	5.1 \pm 2.2	3.4 \pm 1.6	0.069
Memory	5.0 \pm 2.0	3.0 \pm 1.4	0.019*
FIM gain	37.6 \pm 19.6	17.3 \pm 16.1	0.024*

FIM, functional independence measure; SD, standard deviation. * A *P*-value $<$ 0.05 was considered statistically significant.

function postoperatively. Shar and colleagues⁶⁾ reported this rate as 41%, while Hagino *et al.*³⁾ reported it as 49% at discharge. Lin *et al.*⁴⁾ reported that among 96 patients, 16 (16.7%) required a walker and two (2.1%) required a cane. In the present report, the rate of regaining ambulatory ability was 55%. It is thought that the rate of regaining ambulatory ability changes according to the definition of ambulatory ability used. Additionally, our facility is a rehabilitation hospital, so patients with femoral fractures are transferred from another acute care hospital within 4–5 weeks postoperatively to our hospital. The mean length of hospitalization at our institution was approximately 70 days. The total rehabilitation period was approximately 90 days at the acute care hospital and our institution. The Japanese Orthopedic Association reported that the mean hospital stay in Japan for patients with a PFF was approximately 40.7 days in 2008⁹⁾. In the present study, the length of hospitalization was longer than that at other Japanese hospitals. This finding shows that even in super-elderly patients (\geq 90 years), it is possible to increase the rate of regaining ambulatory ability by providing sufficient rehabilitation. Ishida *et al.*⁷⁾ reported the long-

term functional outcomes of 74 patients aged \geq 90 years with a PFF. They reported that patients' ambulatory ability at discharge decreased compared to that before injury, and that ambulatory ability decreased during the first year after discharge but reached a plateau thereafter. It is necessary to evaluate ambulatory ability after discharge and to examine the method of maintaining ambulatory ability.

Factors related to the recovery of ambulatory ability after surgery for a PFF are age, sex, the presence of dementia, prefracture ambulatory ability, American Society of Anesthesiologist rating of operative risk, fracture type, a contralateral PFF, and the number vertebral fractures^{2, 7, 8)}. In the present study, the factors related to ambulatory ability were the presence of dementia on admission and ALB level at discharge. In the present study, the cognitive FIM items "expression" and "memory" on admission were significantly higher in the ambulatory group than those in the non-ambulatory group, which adds evidence that the presence of dementia on admission is related to ambulatory ability. This is the first report that dementia according to the MMSE or HDS-R, FIM score, and ALB level at discharge are related

to ambulatory ability in those with a PFF who are aged \geq 90 years. Kyo and colleagues⁹⁾ and Yoshii *et al.*¹⁰⁾ have also reported that the severity of dementia is strongly correlated with the level of functional activity and ambulatory ability. Patients with severe dementia have reduced motivation for rehabilitation and are unable to understand instructions. Thus, it is difficult for them to continue rehabilitation. Furthermore, because patients with dementia have a high risk of falling, a wheel chair is recommended to ensure their safe transport. It is thought that these are the reasons why patients with dementia are unable to regain their ambulatory ability. In elderly patients with PFFs, it is necessary to control both physical condition and mental state.

In the present report, ALB level at discharge was associated with ambulatory ability at discharge. Koval *et al.*¹¹⁾ reported that abnormal ALB level (3.5 g/dL) and Lymph count (1500 /mL) on admission are associated with the length of hospitalization, mortality, and recovery of the prefracture level of independence in basic activities of daily living. Hagiwara and Ibayashi¹²⁾ reported that FIM gain and FIM efficacy were significant and ambulatory ability at discharge was better after the intervention of a nutrition support team (NST) in patients with a PFF who were aged $>$ 90 years. In the present study, the ALB level in the ambulatory group improved at discharge compared to that on admission. It is thought that the early diagnosis of malnutrition, early intervention of a NST, and periodical monitoring are important for helping elderly patients to regain ambulatory ability and function in activities of daily living. The present study also showed that dementia was an inhibitor of ambulation. In addition, the ALB level was related to mortality¹¹⁻¹³⁾ and ambulatory ability.

Most of our patients (80%) were able to return home after hospitalization. All 11 patients in the ambulatory group returned home. The FIM score and FIM gain at discharge were higher in the ambulatory group than those in the non-ambulatory group. Therefore, it was thought that the rate of discharge to home was higher in the ambulatory group than that in the non-ambulatory group.

This study has several limitations. Only 20 super-elderly (\geq 90 years) patients with femoral fractures were evaluated retrospectively. A prospective evaluation of a large number of these patients with PFFs is needed. Additionally, we evaluated the ambulatory ability of patients at discharge, and a future study with a long-term follow-up after discharge is necessary.

Conclusions

The rate of regaining ambulatory ability at discharge was 55% in super-elderly patients (\geq 90 years) with a PFF. The presence of dementia on admission and serum ALB level at discharge were factors related to ambulatory ability.

A general rehabilitation protocol, which considers cognitive function and nourishment alongside the physical aspect, should be used in this patient group.

Conflict of interest: There are no conflicts of interest to declare.

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