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

Ryoko Takeuchi¹, Hirotaka Mutsuzaki¹, Yukiyo Shimizu², Yuki Mataki¹, Kayo Tokeji¹, and Yasuyoshi Wadano³

¹ Department of Orthopedic Surgery, Ibaraki Prefectural University of Health Sciences, Japan
² Department of Rehabilitation Medicine, University of Tsukuba, Japan
³ Department of Rehabilitation Medicine, Ibaraki Prefectural University of Health Sciences, Japan

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

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 2008. 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 ability. 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 years, and prefracture ambulatory ability, American Society of Anesthesiologist rating of operative risk, and fracture type in patients aged ≥ 65 years. 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 fractures.

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.
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, and 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 ambulatory 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

| Characteristics | Mean ± SD (Range) |
|-----------------|------------------|
| Fracture type   |                  |
| 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.
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 \( 1.3 \times 10^3/\mu L \) in the ambulatory group and \( 1.55 \times 10^3/\mu L \) in the non-ambulatory 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/m\(^2\) in the ambulatory group and 19.3 kg/m\(^2\) 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 \( 1.5 \times 10^3/\mu L \) in the ambulatory group and \( 1.48 \times 10^3/\mu L \) 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 \( \geq 90 \) 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

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

| Characteristic                  | Ambulatory group | Non-ambulatory group | \( P \)-value |
|--------------------------------|------------------|----------------------|--------------|
| Patients, n                     | 11               | 9                    |              |
| Days from surgery to transfer to our hospital, mean ± SD | 32.5 ± 9.2        | 36.1 ± 6.9           | 0.348        |
| Hospitalization (d), mean ± SD  | 71.7 ± 14.7      | 69.2 ± 14.4          | 0.71         |
| On admission, mean ± SD         |                  |                      |              |
| BMI (kg/m\(^2\))                | 19.1 ± 1.7       | 19.1 ± 3.8           | 0.989        |
| Alb (g/dL)                      | 3.3 ± 0.4        | 3.0 ± 0.3            | 0.205        |
| Hb (g/dL)                       | 10.1 ± 1.1       | 10.9 ± 0.7           | 0.06         |
| Lymphocytes (\( \times 10^3/\mu L \)) | 1.30 ± 0.42      | 1.55 ± 0.48          | 0.246        |
| Dementia, n                     | 6                | 9                    | 0.003*       |
| At discharge, mean ± SD         |                  |                      |              |
| BMI (kg/m\(^2\))                | 19.4 ± 2.2       | 19.3 ± 3.3           | 0.982        |
| Alb (g/dL)                      | 3.5 ± 0.3        | 3.1 ± 0.2            | 0.013*       |
| Hb (g/dL)                       | 10.8 ± 0.8       | 11.2 ± 0.7           | 0.394        |
| Lymphocytes (\( \times 10^3/\mu L \)) | 1.50 ± 0.51      | 1.48 ± 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.
function postoperatively. Shar and colleagues reported this rate as 41%, while Hagino et al. reported it as 49% at discharge. Lin et al. 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 2008. 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 (≥ 90 years), it is possible to increase the rate of regaining ambulatory ability by providing sufficient rehabilitation. Ishida et al. reported the long-term functional outcomes of 74 patients aged ≥ 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. 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

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

FIM, functional independence measure; SD, standard deviation. * A P-value < 0.05 was considered statistically significant.
to ambulatory ability in those with a PPF who are aged ≥ 90 years. Kyo and colleagues\textsuperscript{9} and Yoshii et al.\textsuperscript{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.\textsuperscript{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 Ibayashi\textsuperscript{12} reported that FIM gain and FIM efficacy level was related to mortality. Patients with dementia are unable to regain their ambulatory ability. In addition, the ALB level in the ambulatory group improved at discharge compared to that on admission. It is thought that 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 (≥ 90 years) with a PPF. 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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