Effect of types of proximal femoral fractures on physical function such as lower limb function and Activities of Daily Living

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ABSTRACT. Objectives: This study aimed to assess physical function such as lower limb function and Activities of Daily Living after surgery for proximal femoral fractures (unstable medial femoral neck fracture and trochanteric fracture). Methods: This study enrolled 68 patients with proximal femoral fractures. Isometric knee extension strength (IKES), the Japanese Orthopedic Association (JOA) hip score, and the number of days required to develop straight leg raising, transfer, and T-cane-assisted gait abilities to become independent were assessed. Patients were classified based on the types of proximal femoral fractures, namely unstable medial femoral neck fracture (bipolar hip arthroplasty [BHA] group), stable trochanteric fracture (S group), and unstable trochanteric fracture (US group). Results: IKES and the JOA hip score were significantly better in the BHA group than in the S and US groups. IKES and the JOA hip score were significantly worse in the US group than in the BHA and S groups. Both transfer and T-cane-assisted gait abilities of patients in the BHA and S groups were indifferent. However, all physical functions were significantly worse in the US group. Conclusions: Our study results suggested that physical therapists plan the different rehabilitation program for the patients with proximal femoral fractures who were classified into three types, namely unstable medial femoral neck fracture, stable trochanteric fracture, and unstable trochanteric fracture, instead of two types.

Key words: Proximal Femoral Fractures, Surgical Approach, Lower Limb Function, Activities of Daily Living (ADL), Physical Function


Proximal femoral fractures are one of the most devastating injuries among the elderly individuals. Loss of gait ability and quality of life after proximal femoral fracture are more severe among majority of the patients3–5. Furthermore, the inability to walk after hospital discharge and presence of delirium are independent predictors of 1-year mortality. In addition, the possibility of not recovering gait ability at hospital discharge and 1-year mortality after proximal femoral fracture were higher among older patients who had severe cognitive impairment, lower functional level before injury, and those who experienced postoperative delirium and pressure ulcers3,5. Therefore, early recovery of gait ability is crucial for the patients.

Proximal femoral fractures are divided into two fracture types: medial femoral neck fracture and trochanteric fracture. Researchers have previously reported that the clinical prognosis of medial femoral neck fracture was con-
siderably better than that of trochanteric fracture\(^{57}\). According to Evans classification, trochanteric fractures were divided into the stable and unstable types\(^{57}\). The short-term clinical results of individuals with stable type were better than those with unstable type for gait ability\(^{57}\). Therefore, considering these reports, it is important to subdivide proximal femoral fractures into the three-fracture type. However, no studies have reported physical function such as lower limb function and Activities of Daily Living in the three-fracture type of the proximal femoral fracture. We hypothesized that physical function such as lower limb function and Activities of Daily Living decrease in the following order: medial femoral neck fracture, stable type of trochanteric fracture, and unstable type of trochanteric fracture. This study aimed to assess physical function such as lower limb function and Activities of Daily Living after surgery for proximal femoral fractures (unstable medial femoral neck fracture and trochanteric fracture).

**Material and Methods**

1. **Patients**

   This study recruited 382 patients who experienced proximal femoral fractures from March 2016 to February 2019. The inclusion criteria were independent gait ability with or without T-cane-assistance before the fracture. And the period of hospitalization for the patients was for more than 4 weeks. The exclusion criteria were presence of dementia (Mini Mental State Examination score: <23) and a history of cerebrovascular or osteoarthritis disorder that caused gait disorder. In this study, the period of hospitalization for the patients with proximal femoral fractures who underwent intramedullary nail fixation (hanson pin or cannulated cancellous screw) was within two weeks. Therefore, they were excluded in this study. In total, 68 patients with proximal femoral fractures who underwent bipolar hip arthroplasty (BHA; BHA group) or intramedullary nail fixation (gamma locking nail; gamma group) met the inclusion criteria and were enrolled in this study. After surgery, all the patients were divided based on the surgery type. The BHA group comprised 34 patients and the gamma group comprised 34 patients. Moreover, the gamma group patients were divided into the stable type (S group; 21 patients) and the unstable type (US group; 13 patients)\(^{19}\). This study was approved by the institutional review board and conformed to the Declaration of Helsinki. All the procedures in this study were approved by the Ethics Committee of the Heisei Memorial Hospital (H15-1). No infection was observed in the hip during the entire postoperative course.

   All the patients followed the same postoperative rehabilitation protocol and they did not drop out for this protocol. They were instructed to increase the range of hip motion starting the day after the surgery and to bear as much weight as they could tolerate starting the day after the treatment.

2. **Assessment of outcome**

   Relevant descriptive characteristics such as age, height, weight, and body mass index (BMI) were extracted from the medical records of the patients. We evaluated isometric knee extension strength (IKES) and the Japanese Orthopedic Association (JOA) hip score at 1, 2, 3, and 4 weeks after the surgery and discharge.

   IKES was measured using a hand-held dynamometer (μ-tas F-1, ANIMA Corp., Japan) with patients in a seated position and the knee flexed at a 90° angle, as described previously\(^{10}\). Patients were instructed to gradually increase the intensity of knee extension against the dynamometer for approximately 2 seconds, avoiding an explosive contraction, and to maintain their maximal force output for approximately 3 seconds. Two measurements were obtained and the maximum values were used for analysis. Furthermore, the laterality (affected side per non-affected side) was calculated.

   Medical doctor, nurse, and physical therapist evaluated the number of days required to develop straight leg raising (SLR), transfer, and T-cane-assisted gait abilities to become independent. The independent criteria were more than 6 points on Functional Independence Measure.

3. **Statistical analyses**

   IKES and the JOA hip score were analyzed using two-way analysis of variance (ANOVA) with repeated measurements to evaluate the fracture types and assessment time points (after 1, 2, 3, and 4 weeks of surgery and discharge).

   The number of days required to develop SLR, transfer, and T-cane-assisted gait abilities by each group were compared using one-way ANOVA with repeated measures. Bonferroni corrections were applied to account for multiple comparisons. The significance level for all analyses was set at 5%. SPSS version 18.0J for Windows (SPSS, Chicago, IL, USA) was used for analysis.

**Results**

Characteristics of patients of all the three groups are summarized in Table 1. No significant differences were noted in the mean age, height, weight, and BMI of patients of all the three groups.

The two-way ANOVA for both IKES and the JOA hip score showed a significant main effect of fracture types (p < 0.001), their interaction (p < 0.01), and the assessment timepoint (p < 0.001). According to Post hoc analyses, the BHA group had significantly better IKES (after 1, 2, 3, and 4 weeks of surgery) and JOA hip score (after 2, 3, and 4 weeks of surgery and discharge) compared with the S group. In addition, significantly better IKES (after 1, 2, 3, and 4 weeks of surgery and discharge) and JOA hip score
Discussion

This study revealed the differences in physical function such as lower limb function and Activities of Daily Living after surgery by types of proximal femoral fractures, namely unstable medial femoral neck fracture and stable and unstable trochanteric fractures. Clinical prognosis was significantly worse in the US group. Therefore, considering the clinical prognosis, proximal femoral fractures should be subdivided into three types.

IKES was significantly higher after 1, 2, 3, and 4 weeks of surgery in the BHA group than in the S and US groups. However, at discharge, no differences were noted in IKES between the BHA and S groups. IKES was significantly worse in the US group at all assessment time points. Previously, researchers have reported that patients with trochanteric fracture experience a large of amount of bleeding\textsuperscript{11,12}\textsuperscript{11,12}. Furthermore, patients in the US group have been reported to experience more bleeding than those in the S group\textsuperscript{12,13}\textsuperscript{12,13}. Thus, increased amount of bleeding resulted in swelling or edema in the thigh that in turn increased the internal pressure in the thigh, causing muscle weakness and limiting knee extension. In addition, the gamma locking nail invaded the vastus lateralis and knee extension is asso-

Data expressed as means ± standard deviations.

Table 2. The Results of chronological data and two-way ANOVA (IKES and JOA hip score)

<table>
<thead>
<tr>
<th></th>
<th>1 week</th>
<th>2 weeks</th>
<th>3 weeks</th>
<th>4 weeks</th>
<th>discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>IKES (kgf/kgf) a)</td>
<td>0.64±0.14 **</td>
<td>0.69±0.16 **</td>
<td>0.52±0.14 **</td>
<td>0.45±0.10 **</td>
<td>0.35±0.08 **</td>
</tr>
<tr>
<td>BHA group</td>
<td></td>
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<tr>
<td>S group</td>
<td>0.54±0.10 **</td>
<td>0.59±0.10 **</td>
<td>0.40±0.07 **</td>
<td>0.36±0.08 **</td>
<td>0.35±0.08 **</td>
</tr>
<tr>
<td>US group</td>
<td></td>
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<tr>
<td>JOA hip score (points b)</td>
<td>36.6±12.70 ***</td>
<td>40.7±14.58 ***</td>
<td>36.5±7.45 **</td>
<td>36.0±14.19 **</td>
<td>38.6±14.19 **</td>
</tr>
<tr>
<td>BHA group</td>
<td></td>
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<tr>
<td>S group</td>
<td>3.0±0.31 **</td>
<td>3.5±0.88 **</td>
<td>3.4±0.02 **</td>
<td>3.4±0.02 **</td>
<td>3.4±0.02 **</td>
</tr>
<tr>
<td>US group</td>
<td></td>
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To become independent, the BHA, S, and US groups required 3.3 ± 1.8, 6.0 ± 4.7, and 17.1 ± 6.2 days, respectively, to develop SLR ability; 4.1 ± 1.7, 4.4 ± 2.3, and 8.0 ± 4.7 days, respectively, to develop transfer ability; and 19.5 ± 9.4, 23.2 ± 5.6, and 38.6 ± 10.8 days, respectively, to develop T-cane-assisted gait ability. The BHA group required significantly less number of days to develop SLR ability than both the S and US groups. The BHA and S groups required the same number of days to develop both transfer and T-cane-assisted gait abilities. However, all physical functions were significantly worse in the US group. The results are summarized in Figure 1, 2, and 3.
Clinical result of three types of proximal femoral fractures

Figure 1. The number of days for SLR to become independent
BHA group was significantly better than S group and US group.
S group was significantly better than US group. *Significant
level at p < 0.05. **Significant level at p < 0.001.

Figure 2. The number of days for transfer to become independent
US group was significantly worse than BHA and S group. There
was no difference between BHA group and S group. ***Signifi-
cant level at p < 0.001.

Figure 3. The number of days for T-cane gait to become in-
dependent
US group was significantly worse than BHA and S group. There
was no difference between BHA group and S group. ***Signifi-
cant level at p < 0.001.

associated with this muscle weakness. Hence, IKES was signifi-
cantly higher and the number of days required to develop
SLR ability to become independent were significantly
lesser in the BHA group than in the S and US groups.

The JOA hip scores of the BHA group was higher than
those of the S and US groups. There was no difference be-
tween S group and US group. The JOA hip score com-
prised pain, range of motion (ROM), gait ability, and ac-
tivities of daily living (ADL) ability. Researchers have pre-
viously reported that the trochanteric fracture often caused
periosteal pain, especially pain due to weight-bearing in the
acute phase\cite{15,16}. Few studies have reported about the post-
operative passage for ROM after proximal femoral frac-
tures. There was considerable amount of bleeding after the
trochanteric fracture\cite{11,12}. The swelling or edema with bleed-
ing is caused by the loss of soft tissue flexibility, resulting
in lower ROM after trochanteric fracture. Considering ADL
ability, the number of days required to develop SLR, trans-
fer and gait abilities were significantly lesser in the BHA
group than in the S and US groups. SLR ability is associ-
ated with getting out of bed. The earlier the patients get out
of bed, the earlier they can become independent. In addi-
tion, SLR ability is associated with transfer ability. The pa-
tients of the US group experienced periosteal pain as well
as weight-bearing pain. Therefore, due to pain and SLR in-
ability, the US group required a long time to become inde-
pendent as compared with the BHA and S groups. Further-
more, the transfer ability of US group was significantly
worse than the BHA and S groups. And gait ability after
proximal femoral fracture is associated with IKES\cite{18,19}.

Past researchers reported gait ability was most impaired in
the US group\cite{9,17}. Therefore, the number of days to develop
T-cane-assisted gait abilities to become independent was
significantly worse in the US group than in the BHA and S
groups. However, there was no differences between BHA
and S groups. Therefore, we will assess to evaluate other
muscle strength (for example, gluteus medius, gluteus
maximus and so on) in the future. For all these reasons, the
JOA hip scores of the BHA group was higher than those of
the S and US groups. However, there was no difference in
the JOA hip scores of the S and US groups.

This study had some limitations. First, this study en-
rolled only 20% of all the patients with proximal femoral
fracture because the level of inclusion criteria was high.
Second, we did not evaluate the hip muscle strength. SLR
ability is associated with iliopsoas muscle strength. The
surgical invasion caused weakness in gluteus medius and maximus, the muscles associated with gait ability. In the future, we will change the inclusion criteria regarding dementia, recruit more patients and examine the other outcomes such as hip muscle strength. In addition, we intend to assess the relationship between the three types of fractures and physical function.

**Conclusion**

Our study results suggested that physical therapists plan the different rehabilitation program for the patients with proximal femoral fractures who were classified into three types, namely unstable medial femoral neck fracture, stable trochanteric fracture, and unstable trochanteric fracture, instead of two types.

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