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Timely Surgical Intervention for Hip Fractures is Essential to Reinstate Ambulatory Function on Discharge: Propensity Score Matching

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Background: Timely surgical intervention for hip fractures extends postoperative survival and alleviates potential complications. However, the extent to which individuals can restore their mobility after undergoing hip fracture surgery remains unclear. We aimed to investigate the effect of timely surgical management, defined as intervention within 48 hours of injury, on postoperative ambulatory function in patients with hip fractures.

Methods: We included 320 patients who underwent bipolar hemiarthroplasty for hip fractures at our institution between April 2017 and March 2023. Patients were divided into 2 groups based on the postinjury timing of the surgical intervention: the "early group" (within 48 hours) and the "delay group" (after 48 hours). We applied propensity score matching to address confounders in this retrospective observational study.

Results: The early and delay groups each comprised 127 patients. We assessed the Functional Independence Measure (FIM) (walking/wheelchair) score on discharge. For preinjury Functional Ambulation Category (FAC) 3, there was a notable contrast between the early (FIM: 3.44) and delay groups (FIM: 2.31) ($p = 0.005$). Similarly, regarding the Gross Muscle Test (GMT) (unaffected side) score on discharge, there was a significant between-group difference at FAC 3 (early group, GMT score = 3.56; delay group, GMT score = 3.18 [$p = 0.01$]). Except for FAC 3, there were no significant between-group differences in either FIM or GMT scores for the other categories. Multiple regression analysis revealed that the regression coefficient for the FIM (locomotion) score on the "time from injury to surgery" was -0.28 ($p = 0.03$).

Conclusions: Patients who underwent surgery at >48 hours after sustaining an injury faced increased difficulties in achieving postoperative ambulatory function, especially if their mobility had been compromised before the injury, as indicated by a low preinjury FAC score. Disparities in the restoration of ambulatory function were associated with muscle weakness.

continued

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The authors declare that they have no competing interests.

This study was approved by the Research Ethics Committee of Sendai Medical Association Hospital (approval number: 5-010). Our local ethics committee approved this study, and all data were collected according to the ethical standards of the Institutional and National Research Committee and the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Informed consent was obtained in the form of opt-out on the website. Patients who refused to participate were excluded. Relevant guidelines and regulations were implemented for all the methods.

The research information was notified as an opt-out and disclosed on a website to ensure that the participants had the opportunity to refuse.

The data sets used and analyzed in the current study are available from the corresponding author upon reasonable request.

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Introduction

Hip fractures in older individuals can lead to extended immobility and assistance needs, which affect the overall quality of life and pose a substantial financial burden on health systems and societies[1-3]. The timing of surgery is a crucial factor influencing survival outcomes. International guidelines recommend timely surgical interventions for hip fractures within 24 to 48 hours after injury[4-6].

Patients undergoing surgery within 48 hours after injury have a 20% diminished risk of mortality in the subsequent 12 months[7]. Recent reports have indicated that timely surgery for hip fractures and discharge can yield favorable outcomes, with reduced postoperative complications, such as pulmonary embolism and pneumonia[8-13]. In addition, empirical evidence suggests that timely surgery, preferably within 48 hours, is pivotal for mitigating mortality and morbidity in patients with hip fractures[14-16].

Although Japanese guidelines advocate for prompt surgery, Hagino et al.[17] showed that, on average, people in Japan wait 4.5 days for surgery, which is a significant deviation from the recommended time frame. Surgical intervention within 48 hours of injury requires collaboration among orthopaedic surgeons, ward staff, operating room staff, and anesthesiologists. Institutions included in the Japan Trauma Data Bank are major emergency medical establishments with capabilities similar to those of Level I trauma centers in the United States and major trauma centers in the United Kingdom[18]. Compared with Europe and the United States, Japan has fewer specialized trauma care centers. In addition, emergency hospitals in Japan do not provide medical care on weekends, holidays, or other nonoperational days.

Another reason for delays in surgery can be patient-related factors. According to the National Institute for Health and Care Excellence clinical guidelines, immediate treatment is recommended for patients with anemia, anticoagulation, volume depletion, electrolyte imbalance, uncontrolled diabetes, uncontrolled heart failure, acute cardiac arrhythmia or ischemia, acute chest infection, or exacerbation of chronic chest disease[6].

In general, guidelines recommend continuing aspirin during the perioperative period, discontinuing antiplatelet agents other than aspirin, and switching to anticoagulants with shorter withdrawal periods[19]. Concerns regarding the discontinuation of antithrombotic drugs include the risk of embolic complications, increased medical costs because of prolonged hospital stays, and higher postoperative mortality rates[13]. However, recent reports have indicated that continuing antithrombotic medications does not increase the risk of bleeding complications or mortality when surgery is performed early for hip fractures[20].

At our hospital, anticoagulants are not discontinued, and surgery is performed under the guidance of the anesthesiologist. Consequently, in our setting, the use of anticoagulants does not affect the timing of surgery.

The repercussions of postfracture immobility may extend beyond concerns regarding mortality, which places a significant financial burden on patient care. Consequently, mitigating postfracture ambulatory challenges has become a crucial focus point among caregivers of patients with hip fractures[21]. However, there has been limited research on the impact of early surgery on regaining preinjury ambulatory function and facilitating patient discharge. Furthermore, the influence of the time spent waiting for surgery on ambulatory function improvement remains unclear.

There are various types of hip fractures, and including patients who underwent different surgeries can introduce bias and complicate the assessment of ambulatory function. To address this, patients who had open reduction and internal fixation (ORIF) for femoral trochanteric fractures or intra-articular ORIF for femoral neck fractures were excluded from this study. As a result, only patients who underwent bipolar hemiarthroplasty for femoral neck fractures were included.

In this study, we aimed to investigate the effect of timely surgical management, defined as intervention within 48 hours of injury, on postoperative ambulatory function in patients with hip fractures.

Materials and Methods

Participants

The retrospective observational study included 418 patients who underwent bipolar hemiarthroplasty for femoral neck fractures at Sendai Medical Association Hospital, Kagoshima, Japan, between April 2017 and March 2023. A total of 627 patients who underwent ORIF for femoral trochanteric fractures and 28 patients who had intra-articular ORIF for femoral neck fractures were excluded from the study.

We excluded 13 patients with multiple fractures during their hospital stay and 6 patients transferred to other departments during treatment. In addition, 6 patients with older fractures and 3 patients without postoperative radiography images were excluded.

We also excluded 16 patients who underwent bipolar hemiarthroplasty for femoral trochanteric fractures due to rehabilitation challenges from disruption of the abduction mechanism. 16 patients who underwent surgical techniques other than the anterolateral supine approach, 5 patients with COVID-19, and 2 patients who died during hospitalization were also excluded.

Furthermore, 31 cases where surgery was delayed due to patient-related issues were excluded. Table I presents the reasons for these delays and the corresponding proportions of patients in the delay group.

Consequently, the study included 320 patients, divided into 2 groups based on the timing of surgery after the injury: the early group (surgery within 48 hours, n = 186) and the delay group (surgery after 48 hours, n = 134). Although the date of injury was available from medical records, the exact time was not always documented. Therefore, the early group was defined as those who underwent surgery within 2 days of the injury, with the date of injury designated as day 0.

Workflow

The authors used patients' medical records to evaluate the age-adjusted Charlson Comorbidity Index (ACCI), the American Society of Anesthesiologists Physical Status Classification System (ASA-PS), the revised Hasegawa Dementia Scale (HDS-R), and the Functional Ambulation Category (FAC). At discharge, physical therapists assessed the patients using the Functional Independence Measure (FIM), the Gross Muscle Test (GMT), and HDS-R. The FIM measurements were taken a few days before discharge from the recovery-phase rehabilitation ward by a physical therapist. Notably, FIM scores were not measured during outpatient follow-up in this series.

Outcomes

Preinjury ambulatory function was assessed using the FAC, which categorizes ambulatory function into 6 distinct levels[22]. Table II presents the FAC scores. In this study, FAC 3 was defined as a "low preinjury FAC score" and FAC 2 as a "very low preinjury FAC score."

Details regarding patients' preinjury ambulatory function were documented in the medical records, with information obtained from hospital or facility records, and interviews with the patient or their family. An independent examiner then determined the patients' preinjury FAC based on the information contained in the medical records.

The FIM, which assesses instrumental activities of daily living, was developed by Granger et al. in 1983[23]. The FIM comprises 18 assessment items covering motor and cognitive domains, each evaluated on a 7-point scale ranging from 1 to 7. Table III presents the FIM scores for the "Locomotion: walking/wheelchair" domain.

TABLE I Reasons for Delay and the Corresponding Proportion of Patients in the Delay Group

Reason	No. of patients
Hospital-side issues	
The day of the week (nonoperational days) or consultations beyond regular hours, % (n)	78.78 (130)
Operating room availability, % (n)	2.42 (4)
Patient-side issues	
Community-acquired pneumonia, % (n)	3.03 (5)
Delayed hospital visits, % (n)	3.03 (5)
Aspiration pneumonia, % (n)	1.81 (3)
Other, % (n)	10.90 (18)

Variables

The ACCI is a framework that considers the age and chronic health conditions of an individual[24]. This index is commonly used to predict long-term outcomes in patients with cancer[25] and to evaluate the risk of postoperative complications following orthopaedic surgery[26]. We calculated the ACCI by referencing the patient's medical records.

The ASA-PS is used to assess and communicate pre-anesthesia medical comorbidities in a patient[27]. This tool helps predict perioperative risks. An anesthesiologist performed a preoperative evaluation of the patients using the ASA-PS.

The HDS-R is an improved tool for evaluating suspected dementia and cognitive decline[28]. A physical therapist administered the HDS-R to patients with a history of dementia or those who developed delirium during hospitalization. In this study, patients whose delirium persisted throughout hospitalization were categorized as having dementia.

Femoral neck fractures were categorized according to the Garden[29] and Pauwels[30] classifications. Detailed visualization of these fractures was achieved using 3-dimensional computed tomography.

Muscle strength in the unaffected side of the lower extremities was evaluated using the GMT, which is graded on a 6-point scale according to the manual muscle test criteria. A physical therapist administered the GMT to patients on admission and discharge.

Rehabilitation Protocol

All patients were transferred from the acute ward to the recovery-phase rehabilitation ward, where they received ongoing rehabilitation. In both wards, physical therapists guided patients. Rehabilitation continued until the patient was discharged from the recovery-phase rehabilitation ward.

Statistical Analyses

Propensity score matching (PSM), a statistical method widely used in clinical studies, is recommended for managing factors that may result in biased findings[31]. One approach involves setting a caliper width equivalent to 0.2 of the standard deviation (SD) of the logit of the propensity scores[32]. We selected variables that influenced group allocation and outcomes to address potential confounding factors adequately. These factors included age, body mass index (BMI), ACCI, ASA-PS, and "time from surgery to discharge," with a caliper set at 0.2. As a result, we enrolled 127 patients per group, totaling 254 patients. Figure 1 presents the study flowchart.

Between-group comparisons of demographic characteristics were performed using the Student *t*-test and Fisher exact test. Continuous and categorical variables are expressed as means ± SDs and proportions, respectively.

Multiple regression analyses were conducted to identify factors associated with the FIM (locomotion) score at discharge

TABLE II Functional Ambulation Category*

Category	Description	Definition
0	Nonfunctional ambulation	The patient cannot ambulate, ambulates only in parallel bars or requires supervision or physical assistance from more than one person to ambulate safely outside of parallel bars
1	Ambulator-Dependent for Physical Assistance–Level II	The patient requires manual contact of no more than one person during ambulation on level surfaces to prevent falling. Manual contacts are continuous and necessary to support body weight, maintain balance, and assist coordination
2	Ambulator-Dependent for Physical Assistance–Level I	The patient requires manual contact of no more than one person during ambulation on level surfaces to prevent falling. Manual contact consists of continuous or intermittent light touch to assist balance or coordination
3	Ambulator-Dependent for Supervision	The patient can physically ambulate on level surfaces without manual contact from another person but requires standby guarding from no more than one person for safety due to poor judgment, questionable cardiac status, or the need for verbal cuing to complete the task
4	Ambulator-Independent Level Surfaces Only	The patient can ambulate independently on level surfaces but requires supervision or physical assistance to negotiate stairs, inclines, or nonlevel surfaces
5	Ambulator-Independent	The patient can ambulate independently on both level and nonlevel surfaces, including stairs and inclines

*This study determined that an FAC score of 3 corresponds to a "low preinjury FAC score," and an FAC score of 2 corresponds to a "very low preinjury FAC score." FAC = Functional Ambulation Category.

after PSM. The FIM (locomotion) score was used as the response variable, whereas age, sex, BMI, ACCI, ASA-PS, dementia, preinjury FAC, and "time from injury to surgery" served as explanatory variables.

All comparisons were conducted using 2-tailed tests, with the threshold for statistical significance being set at $p < 0.05$. Odds ratios, 95% confidence intervals, and corresponding p-values were calculated using standard formulas. Statistical analyses were conducted using JMP Pro version 17.0.0 (SAS Institute).

Sample Size

The sample size was determined through a priori analysis using G*Power version 3.1.9.6 (Franz Faul; Kiel University). The analytical framework used the Student *t*-test, with the goodness-of-fit parameters being established at $\alpha = 0.05$, $1 - \beta = 0.8$, and an effect size of 0.5[33]. As a result, we determined that the minimum sample size required for this study was 64 patients per group, amounting to a total of 128 patients.

Results

Table I presents the factors contributing to surgical delays and the corresponding number of affected patients. The most significant hindrance to prompt surgery was hospital-related issues, with nonoperational days or consultations beyond regular hours being the most prevalent factors, accounting for 78.78% of the cases. In addition, challenges

TABLE III Functional Independence Measure Score; Locomotion: Walking/Wheelchair

Level	Description	Definition
1	Total assistance	The patient contributes <25% of the effort or does not walk ≥15 m
2	Maximal assistance	The patient provides <50% of the locomotion effort to walk ≥15 m
3	Moderate assistance	The patient provides >50% of the locomotion effort to walk ≥50 m (The helper takes some weight, but the patient still carries more than the helper)
4	Minimal contact assistance	The patient provides ≥75% of the locomotion effort to walk ≥50 m (no weight-bearing by the helper or leaning onto the helper)
5	Supervision or setup	The patient receives supervision (stand-by, cueing/coaxing) or setup (e.g., another person applies orthosis/prosthesis) to walk ≥50 m
6	Modified independence	The patient walks a minimum of 50 m but uses an adaptive device, such as a brace, prosthesis, or walking aid, or there are considerations for time or safety
7	Complete independence	The patient walks ≥50 m without assistive devices independently and safely

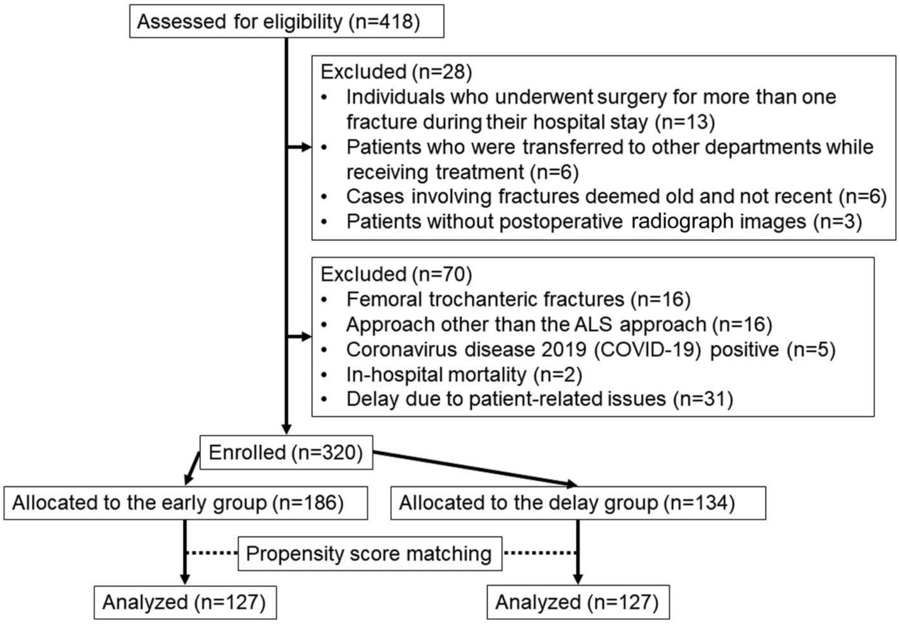

Fig. 1
Flow diagram of participant enrollment in the study.

related to operating room availability contributed to 2.42% of the delay cases.

Patient-related reasons for the delay that could have affected outcomes were also identified. For example, patients with community-acquired pneumonia or aspiration pneumonia experienced delays in surgery, which could affect functional recovery. Consequently, all cases where surgery was delayed due to patient-related issues were excluded from the study.

Table IV provides an overview of the baseline characteristics. PSM, including all 5 variables listed in Table IV, was used to ensure comparability between the groups. Initially, there was a difference of approximately 3 days in the "time from surgery to discharge" between the 2 groups, which was not statistically significant (p = 0.051). However, this difference was reduced to within 1 day following PSM (p = 0.67).

Table V presents the demographic characteristics of the 2 cohorts following PSM. There were no significant between-group differences. There was no statistical difference in the preinjury FAC scores between the early and delay groups.

Table VI presents the FIM scores at discharge from the preinjury FAC in both groups following PSM. There were significant between-group differences in preinjury FAC 3 at the supervised walking level. Specifically, the FIM (walk/wheelchair) scores were 3.44 in the early group and 2.31 in the delay group (p = 0.005). The "time from surgery to discharge" was 31.6 days for the early group and 32.3 days for the delay group (Table IV). The FIM (walk/wheelchair) scores were assessed a few days before discharge.

Table VII presents the GMT (unaffected side) score from the preinjury FAC in both groups following PSM. In the subset

TABLE IV Comparisons of Baseline Characteristics Between the Early and Delay Groups

	The Entire Population			Propensity Score Matched the Population		
Response Variable	Early Group	Delay Group	p	Early Group	Delay Group	p
No. of patients	186	134		127	127	
Age, yrs, mean ± SD	85.26 ± 7.74	83.80 ± 8.14	0.10	84.40 ± 7.62	84.37 ± 7.50	0.96
BMI, kg/m^2, mean ± SD	20.26 ± 3.49	20.65 ± 3.54	0.32	20.65 ± 3.36	20.61 ± 3.48	0.93
ACCI, score, mean ± SD	6.43 ± 1.61	6.54 ± 1.62	0.53	6.46 ± 1.58	6.50 ± 1.56	0.84
ASA-PS, score, mean ± SD	2.13 ± 0.39	2.19 ± 0.48	0.26	2.15 ± 0.40	2.18 ± 0.46	0.56
Time from surgery to discharge, d, mean ± SD	35.37 ± 15.37	32.10 ± 13.84	0.051	31.63 ± 13.70	32.35 ± 13.67	0.67

ACCI = age-adjusted Charlson Comorbidity Index, ASA-PS = American Society of Anesthesiologists Physical Status, BMI = body mass index, and SD = standard deviation.

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TABLE V Comparison of Response Variables Between the Early and Delay Groups Following Propensity Score Matching

	Following Propensity Score Matching			
Response Variable	Total	Early Group	Delay Group	p
No. of patients	254	127	127	
Time from injury to surgery, d, mean ± SD		1.42 ± 0.61	3.71 ± 0.86	<0.001*
Sex, n		Male 26; Female 101	Male 32; Female 95	0.45
Dementia (+), % (n)	57.48 (146)	31.10 (79)	26.38 (67)	0.16
Femoral neck fracture				
Garden 3, % (n)	22.83 (58)	11.42 (29)	11.42 (29)	0.79
Garden 4, % (n)	69.69 (177)	34.25 (87)	35.43 (90)	0.79
Pauwels 3, % (n)	7.48 (19)	4.33 (11)	3.15 (8)	0.79
Operative time, min, mean ± SD		83.70 ± 27.24	85.62 ± 24.82	0.55
Blood loss, mL, mean ± SD		156.92 ± 95.60	155.78 ± 88.80	0.92
Subsidence (+), % (n)	15.75 (40)	8.27 (21)	7.48 (19)	0.86
Intraoperative fracture (+), % (n)	5.12 (13)	2.76 (7)	2.36 (6)	1.00
Dislocation (+), % (n)	0.39 (1)	0.39 (1)	0.00 (0)	1.00
Preinjury FAC				
0, % (n)	3.94 (10)	1.97 (5)	1.97 (5)	0.99
1, % (n)	0.00 (0)	0.00 (0)	0.00 (0)	
2, % (n)	5.51 (14)	2.76 (7)	2.76 (7)	0.99
3, % (n)	18.50 (47)	9.84 (25)	8.66 (22)	0.99
4, % (n)	50.79 (129)	25.20 (64)	25.59 (65)	0.99
5, % (n)	21.26 (54)	10.24 (26)	11.02 (28)	0.99

*Statistically significant ($p < 0.05$). FAC = Functional Ambulation Category; Garden, Garden classification; Pauwels, Pauwels classification, and SD = standard deviation.

of patients with a preinjury FAC 3, the GMT score at discharge significantly differed between the early group (3.56) and the delay group (3.18) ($p = 0.01$). The GMT scores were assessed a few days before discharge.

Table VIII presents multiple regression analyses of factors associated with the FIM (locomotion) score at discharge following PSM. Age, dementia, preinjury FAC, and "time from injury to surgery" were identified as factors influencing the FIM scores.

Discussion

This study investigated the impact of timely surgical intervention, defined as surgery performed within 48 hours of injury, on postoperative ambulatory function in patients with hip fractures. Patients with compromised preoperative ambulatory function, as indicated by a low preinjury FAC score, experienced worse ambulatory outcomes on discharge if surgery was delayed beyond 48 hours after the injury. Similarly, these patients showed signs of muscle weakness. Our findings emphasized the importance of surgery within 48 hours following injury to maintain ambulatory function.

Surgery delays exceeding 48 hours have been associated with poor early functional outcomes following hip fracture surgery[34]. Various factors, including prefracture functional mobility, cognitive impairment, and incongruence with expectations, contribute to an increased risk of diminished ambulatory function in patients with hip fractures[35]. Our findings demonstrated that individuals with impaired ambulatory function before injury, as indicated by a low preinjury FAC score, exhibited reduced postoperative ambulatory function following surgery delays of >48 hours.

At an FAC score of 3 points, a patient can walk independently on level ground but requires proximal monitoring by one person for safety. By contrast, an FAC score of 2 indicates that the patient needs assistance to prevent falls while walking on level ground. Our observations revealed that surgical delays significantly affected ambulatory function on discharge in patients with low ambulatory function (FAC score of 3). However, for patients with very low ambulatory function (FAC score of 2), the timing of surgery did not have a noticeable impact. In summary, surgical delays adversely affect patients with an FAC score of 3 but do not significantly affect those with an FAC score of 2.

Knee extension muscle strength has been reported to correlate with ambulatory function in patients with hip fractures[36,37]. In this study, among patients with a preinjury FAC score of 3, the GMT score at discharge significantly differed

TABLE VI Comparison of the FIM Score at Discharge From the Pre-injury FAC Between the Early and Delay Groups Following Propensity Score Matching

Response Variable	Following Propensity Score Matching		
	Early Group	Delay Group	p
Preinjury FAC	FIM (walking/wheelchair) score		
0, score, mean ± SD	1.00 ± 0.00	1.00 ± 0.00	
2, score, mean ± SD	2.00 ± 0.57	2.14 ± 0.89	0.72
3, score, mean ± SD	3.44 ± 1.44	2.31 ± 1.12	0.005*
4, score, mean ± SD	3.76 ± 1.64	3.70 ± 1.72	0.84
5, score, mean ± SD	6.00 ± 0.74	6.14 ± 0.75	0.48
Preinjury FAC	FIM (stairs) score		
0, score, mean ± SD	1.00 ± 0.00	1.00 ± 0.00	
2, score, mean ± SD	1.00 ± 0.00	1.00 ± 0.00	
3, score, mean ± SD	1.48 ± 1.15	1.04 ± 0.21	0.09
4, score, mean ± SD	2.34 ± 1.92	2.27 ± 1.96	0.84
5, score, mean ± SD	4.61 ± 2.13	4.50 ± 1.79	0.83
Preinjury FAC	FIM (locomotion) score		
0, score, mean ± SD	2.00 ± 0.00	2.00 ± 0.00	
2, score, mean ± SD	3.00 ± 0.57	3.14 ± 0.89	0.72
3, score, mean ± SD	4.92 ± 2.27	3.36 ± 1.21	0.006*
4, score, mean ± SD	6.10 ± 3.19	5.98 ± 3.38	0.83
5, score, mean ± SD	10.61 ± 2.62	10.64 ± 2.18	0.96

*Statistically significant ($p < 0.05$). FAC = Functional Ambulation Category, FIM = Functional Independence Measure, and SD = standard deviation.

TABLE VII Comparison of the GMT (Unaffected Side) Score From the Preinjury FAC Between the Early and Delay Groups Following Propensity Score Matching

Response Variable	Following Propensity Score Matching		
	Early Group	Delay Group	p
Preinjury FAC	GMT (unaffected side) score at admission		
0, score, mean ± SD	2.60 ± 0.54	2.60 ± 0.54	1.00
2, score, mean ± SD	3.28 ± 0.48	3.00 ± 0.57	0.33
3, score, mean ± SD	3.32 ± 0.55	3.27 ± 0.55	0.77
4, score, mean ± SD	3.43 ± 0.55	3.38 ± 0.60	0.60
5, score, mean ± SD	3.69 ± 0.61	3.75 ± 0.51	0.71
Preinjury FAC	GMT (unaffected side) score at discharge		
0, score, mean ± SD	2.60 ± 0.54	2.60 ± 0.54	1.00
2, score, mean ± SD	3.28 ± 0.48	2.85 ± 0.69	0.20
3, score, mean ± SD	3.56 ± 0.50	3.18 ± 0.50	0.01*
4, score, mean ± SD	3.60 ± 0.58	3.56 ± 0.52	0.68
5, score, mean ± SD	3.84 ± 0.46	3.92 ± 0.37	0.47

*Statistically significant ($p < 0.05$). FAC = Functional Ambulation Category, GMT = Gross Muscle Test, and SD = standard deviation.

TABLE VIII Multiple Regression Analysis of Factors Associated With the FIM (Locomotion) Score at Discharge Following Propensity Score Matching

	Following Propensity Score Matching			
	Response Variable			
	FIM (Locomotion) Score			
Explanatory Variable	Regression Coefficient	95% CI	Standard Coefficient	p
Age, yrs	−0.05	−0.10 to −0.005	−0.11	0.03*
Sex, female	−0.12	−0.53 to 0.29	−0.02	0.56
BMI, kg/m^2	0.01	−0.09 to 0.11	0.01	0.82
ACCI, score	−0.16	−0.41 to 0.09	−0.06	0.21
ASA-PS, score	−0.76	−1.58 to 0.05	−0.09	0.06
Dementia, (−)	0.81	0.40 to 1.22	0.21	<0.001*
Preinjury FAC, score	1.48	1.13 to 1.84	0.44	<0.001*
Time from injury to surgery, d	−0.28	−0.53 to −0.02	−0.10	0.03*
Adjusted R-square	0.44			

*Statistically significant (p < 0.05). ACCI = age-adjusted Charlson Comorbidity Index, ASA-PS = American Society of Anesthesiologists Physical Status, BMI = body mass index, CI = confidence interval, FAC = Functional Ambulation Category, and FIM = Functional Independence Measure.

between the early group (3.56) and the delay group (3.18) (p = 0.01). Although this difference in GMT is minor and has limited clinical significance, it may be related to knee extension muscle strength variations. A decreased gross muscle strength might be associated with reduced knee extension strength, potentially contributing to diminished ambulatory function. We hypothesize that this muscle weakness could lead to reduced ambulatory function.

The standardized coefficients remained consistent when "age" increased by 1 year and "time from injury to surgery" increased by 1 day, highlighting the significance of surgery delay. There was a difference of approximately 3 days in the "time from surgery to discharge" between the early and delayed surgery groups. Constraints within the medical insurance system may limit the possibility of extending hospital stays, even if surgery is delayed. This factor is crucial to consider, as decreased ambulatory function at discharge often necessitates increased assistance.

Previous studies have combined femoral trochanteric and femoral neck fractures, complicating the assessment of functional outcomes. Femoral trochanteric fractures disrupt the abduction mechanism, potentially influencing rehabilitation outcomes. In addition, varying surgical procedures, such as ORIF and bipolar hemiarthroplasty, further complicate comparisons. This study is distinctive in its exclusive focus on bipolar hemiarthroplasty for femoral neck fractures, allowing for a precise evaluation of the impact of timely surgical intervention.

A limitation of this study is that Japanese acute care hospitals, which treat patients with hip fractures, may have similar functions to those of acute care hospitals in other countries, geriatric rehabilitation centers, and nursing homes[38]. This similarity in functional characteristics could limit the generalizability of the findings to different healthcare settings with varying operational practices and resource availability.

In conclusion, our findings demonstrated that patients who undergo surgery beyond 48 hours postinjury, especially those with compromised preinjury ambulatory function, indicated by a low preinjury FAC score, may experience significantly impaired postoperative ambulatory function recovery due to muscle weakness during the waiting period. Early surgery was effective only in patients with a preinjury FAC score of 3, corresponding to a "low preinjury FAC score." It did not show similar effectiveness in patients with a preinjury FAC score of 2, corresponding to a "very low preinjury FAC score." ■

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