

Surgery within Two Days of Admission Reduces Complications and Mortality of Patients with Trochanteric Femur Fractures: A Japanese DPC Study

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An early surgery for older adult patients with hip fractures is recommended to avoid perioperative complications in existing clinical guidelines. Few studies have analyzed only transtrochanteric fractures. The purpose of this study was to assess whether surgery within two days of admission reduces the incidence of pneumonia, deep vein thrombosis, pulmonary embolism, pressure ulcers, and mortality during hospitalization in patients with older adult transtrochanteric femur fractures. In this retrospective study, we used the Japanese National Administrative DPC (Diagnosis Procedure Combination) database that covers April 2016 to March 2022. Transtrochanteric femur fracture was included in patients aged 65 years or older who underwent surgery. The perioperative complications with pneumonia, deep vein thrombosis, pulmonary embolism, pressure ulcers, and mortality during hospitalization were assessed after propensity score matching, focusing on surgeries conducted within two days of admission. After one-to-one propensity score matching for age, sex, and comorbidity, we identified 79,649 pairs of patients who underwent surgery either within two days or after the third day of admission. Surgery delayed beyond two days was independently associated with increased pneumonia, pulmonary embolism, pressure ulcers, and mortality during hospitalization with risk ratios of 1.335 (95% CI: 1.256-1.418, p < 0.0001), 1.287 (95% CI: 1.225-1.351, p < 0.0001), 1.229 (95% CI: 1.094-1.380, p < 0.0001), and 1.063 (95% CI: 0.978-1.155, p = 0.0035), respectively. Surgery within two days of admission for transtrochanteric femur fracture effectively prevents perioperative complications and reduces mortality during hospitalization.

Keywords: diagnosis procedure combination; early surgery pneumonia; pulmonary embolism; trochanteric femur fracture

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Introduction

Elderly people frequently suffer from hip fractures, such as femoral neck and intertrochanteric fractures, that are associated with increased morbidity and mortality (Braithwaite et al. 2003; Bukata et al. 2011; Orimo et al. 2016). Osteoporosis-related hip fractures are a major global health hazard. As the population ages in Japan, the number of proximal femur fractures is increasing (Orimo et al. 2016; Takusari et al. 2021), 13 million individuals have osteoporosis (Tamaki et al. 2019), and 250,000 patients are thought to suffer hip fractures (Yamamoto et al. 2024). While the incidence of fragility fractures increases steeply after age 65 (Burge et al. 2007), the perioperative complications also increase over time in patients with hip fractures. The 30-day mortality rate is reported to be 4.0-5.4% (Giannoulis et al. 2016).

In the past, there have been many studies reported on

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timely surgeries for proximal femur fractures, which relate to the risk of perioperative complications (Khan et al. 2009; Fu et al. 2017; Sasabuchi et al. 2018; Yamamoto et al. 2022), morbidity and mortality (Kitamura et al. 1998; Novack et al. 2007; Shiga et al. 2008; Rosso et al. 2016; Pincus et al. 2017). The American Academy of Orthopaedic Surgeons guidelines recommend that patients with hip fractures should undergo surgery within 48 h of admission (Brox et al. 2015), the reason being surgical delay beyond 48 h is associated with worse outcomes (Shiga et al. 2008, Brox et al. 2015, Rosso et al. 2016); A meta-analysis and meta-regression of 35 studies including more than 190,000 patients found that preventing surgical delay beyond 48 h was associated with significant life prolongation and decubitus reduction (Moja et al. 2012). Based on these findings, Fragility Fracture Network-Japan recommends surgery as early as possible (Yamamoto et al. 2024). Nevertheless, no extensive research has indicated if surgery performed during 48 h lowers problems like pneumonia, deep vein thrombosis (DVT), pulmonary embolism (PE), pressure ulcers, and mortality during hospitalization in Japanese patients, and the benefit of early surgery remains still up for debate. Most reports consider the fractures of the trochanteric and neck together as pre-operative complications and mortality (Burge et al. 2007; Shiga et al. 2008; Khan et al. 2009; Giannoulis et al. 2016; Rosso et al. 2016; Pincus et al. 2017; Sasabuchi et al. 2018; Yamamoto et al. 2022), however, the treatment strategies for the femoral neck fracture and transtrochanteric fracture are different because the prognosis and variations in treatment methods are various. Most transtrochanteric fractures are treated by reduction and internal correction (Madsen et al. 1998), and displaced femoral neck fractures are commonly treated with prosthetics.

Studies using the Diagnosis Procedure Combination (DPC) database for Japanese hip fracture cases have previously reported the impact of dementia (Tomioka et al. 2020), the results of a study on the length of hospital stay (Mine et al. 2020), comparison of bipolar hemiarthroplasty vs. total hip replacement for femoral neck fractures (Mori et al. 2024a), and a complication and mortality including all proximal femur fractures (Sasabuchi et al. 2018; Mori et al. 2024b). However, the effect of early surgery only for transtrochanteric femur fractures has not yet been studied. Therefore, this study aimed to evaluate whether surgery performed within two days of admission for transtrochanteric femur fractures was associated with hospital-acquired pulmonary, DVT, PE, pressure ulcers, and mortality during hospitalization continuation.

Materials and Methods

Study design

This retrospective study was conducted using the DPC database with the ethical standards of the Declaration of Helsinki and approved by the Tokyo Medical and Dental University (approval number: M2000-788). The Japanese

National Administrative DPC reimbursement system database was examined retrospectively (Matsuda 2016). Surgical treatment was performed on a database of 500,844 proximal femur fracture cases between April 2016 and March 2022. The following studies included patients treated for hip fractures from approximately 1100 hospitals throughout Japan; the data represented actual clinical practices nationwide. For the investigation of transtrochanteric femur fractures in the elderly, the inclusion criteria were set to 1) the DPC code was S7210 (Transtrochanteric fracture, closed) with diseases requiring the most medical resources, 2) aged 65 years and over, and 3) treated surgically. Patients were selected from a registry that included the following three categories: 1) principal diagnosis, 2) principal reason for admission, and 3) the disease that required the most medical resources. Finally, the study included 220,278 trochanteric femur fractures. Among those, 79,664 cases (36.2%) were treated surgically within two days of admission (Early group), and 140,614 cases (63.8%) were treated after the third day of admission (Delayed group). The surgery within two days of admission was defined as the surgery on the day of admission, the next day, and 2nd day after admission. Baseline demographic data, including age, sex, comorbidities, rehabilitation, and osteoporosis treatment, was shown in Table 1.

Data selection

A one-to-one propensity score (PS) matching between surgical cases within two days of admission and those after the third day of admission was performed. Covariates used for confounding adjustment included age, sex, and comorbidities, including hypertension, dementia, ischemic heart disease, cerebrovascular disease, chronic renal dysfunction, chronic lung disease, and diabetes. C-statistics were used to assess the discriminatory powers of the models. PS estimates were used to perform nearest-neighbor matching without replacement, with the PS estimates being used as the calipers; the caliper was set to 0.2 times the standard deviation of the PS estimate. This resulted in matched pairs and the establishment of PS-matched control and treatment groups.

Statistical analyses

All data are expressed as mean \pm standard deviation. Student t-tests were performed for normally distributed variables and variables that were not normally distributed based on the Shapiro-Wilk test to compare variables between the Early and Delayed groups, respectively. Significant differences between the two groups were examined using the χ^2 test for each clinical parameter for the early surgery during two days and the delayed surgery group. The χ^2 test was used for delayed surgery and the occurrence of hospital-acquired pneumonia, DVT, PE, pressure ulcers, and mortality during hospitalization. The association between age, sex, comorbidities, general anesthesia, early surgery, early rehabilitation during three days, pneu-

	Table	e 1. Characteristics	of patients after p	ropensity score matching.			
	Early group	Delayed group	p-value	Early group (matched)	Delayed group (matched)	SMD	
u	79,664	140,614		79,649	79,649		
Age	86.6 ± 7.1	86.2 ± 7.1	< 0.0001 *	86.6 ± 7.1	86.5 ± 7.1	0.0040	
Sex							
Male	15,242 (19.1%)	28,655 (20.4%)	< 0.0001	15,237 (19.1%)	15,238 (19.1%)	0.0000	
Female	64,422 (80.9%)	11,959 (79.6%)		64,412 (8.9%)	64,411 (8.9%)		
Comorbidities							
Hypertension	30,182 (37.9%)	57,416 (40.8%)	< 0.0001	30,178 (37.9%)	30,205(37.8%)	0.0007	
Dementia	18,483 (23.2%)	33,340 (23.7%)	0.0068	18,482 (23.2%)	18,406 (23.1%)	0.0023	
Diabetes	13,095 (16.4%)	26,646 (19.0%)	< 0.0001	13,088 (16.4%)	13,109~(16.5%)	0.0007	
Cerebrovascular disease	7,275 (9.1%)	15,347 (10.9%)	< 0.0001	7,271 (9.1%)	7,264(9.1%)	0.0003	
Ischemic heart disease	5,799 (7.3%)	12,402 (8.8%)	< 0.0001	5,792 (7.3%)	5,779 (7.3%)	0.0023	
Chronic renal dysfunction	3,494 (4.4%)	9,664 (5.5%)	< 0.0001	3,488 (4.4%)	3,476 (4.4%)	0.0007	
Chronic lung disease	983 (1.2%)	2,019 (1.4%)	< 0.0001	981 (1.2%)	902 (1.1%)	0.0092	
						χ^2 statics	<i>p</i> -value
Rehabilitation							
Rehabilitation within 3 days of admission	63,786 (80.1%)	46,818 (33.3%)	< 0.0001	63,772 (80.1%)	26,263 (33.0%)	37,557	< 0.0001
Rehabilitation after 3days of admission	15,878 (19.9%)	93,796 (66.7%)		15,877 (19.9%)	53,386~(67.0%)		
Osteoporosis treatment							
Daily bisphosphonates	203 (0.25%)	358 (0.25%)	1.0000	203 (0.3%)	2,010(0.3%)	0.116	0.7676
Weekly bisphosphonates	6,208 (7.8%)	10,135 (7.2%)	< 0.0001	6,207 (7.8%)	5,790 (7.3%)	7.839	< 0.0001
Monthly bisphosphonates (oral)	2,382 (3.0%)	3,531 (2.5%)	< 0.0001	2,382 (3.0%)	2,037 (2.6%)	13.87	< 0.0001
Monthly bisphosphonates (iv)	572 (0.7%)	1,040(0.7%)	0.5849	572 (0.7%)	597~(0.8%)	0.269	0.4811
Yearly bisphosphonates (iv)	101 (0.13%)	222 (0.16%)	0.0723	101 (0.1%)	127 (0.2%)	1.488	0.0973
Daily teriparatide	709 (0.9%)	1,857~(1.3%)	< 0.0001	708 (0.9%)	1,064(1.3%)	36.41	< 0.0001
Weekly teriparatide	401 (0.5%)	$1,088\ (0.8\%)$	< 0.0001	401 (0.5%)	632~(0.8%)	26.22	< 0.0001
Biweekly teriparatide	159 (0.2%)	236 (0.2%)	0.0936	159 (0.2%)	138 (0.2%)	0.7444	0.2454
Denosumab	387 (0.5%)	445 (0.3%)	< 0.0001	386 (0.5%)	250(0.3%)	14.71	< 0.0001
Eldecalcitol	8,333 (10.5%)	12,897 (9.2%)	< 0.0001	8,332 (10.5%)	7,418 (9.3%)	29.44	< 0.0001
Alfacalcidol	9,277 (11.7%)	15,779 (11.2%)	0.0027	9,274 (11.6%)	8,832 (11.1%)	6.087	0.0005
SERM	1,245 (1.5%)	2,026 (1.4%)	0.0241	1,245 (1.6%)	1,190(1.5%)	0.631	0.2701
A as is shown as mean + standard deviati	D_{-3} and P_{-3} and P_{-3}	01 are considered s	ionificant by the	Student-t test and w2 test SM	manne etondord mann diffar	moon ii ione	c intrasse_

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means standard mean difference; 1V means intrave-Age is shown as mean \pm standard deviation; P-values of < 0.001 are considered significant by the Student-t test and χ^2 test; SMD nous injection; SERM means selective estrogen receptor modulator. *Student-t test monia, DVT, PE, pressure ulcers, and mortality during hospitalization were examined using multivariate logistic regression analysis. All statistical tests were two-tailed; p-values < 0.001 were considered significant. All analyses were performed using JMP version 17 (SAS, Cary, NC, USA).

Result

After PS matching according to age, sex, and comorbidities, there were 79,649 and 79,649 cases of surgery within two days of admission and after the third day of admission, respectively. A flow chart of the present study is shown in Fig. 1. The characteristics of the surgical cases performed within two days of admission and after the third day of admission are shown in Table 1. The C statistic was 0.711. Standardized mean differences were < 0.1 for all parameters. Approximately 64% of the patients were rehabilitated during three days of admission, although it was impossible to determine whether the rehabilitation was preor postoperative. Osteoporosis is often treated with bisphosphonates and an active form of vitamin D, and the overall osteoporosis treatment rate was 28.3%.

The associations between surgery within two days of admission and the development of pneumonia, DVT, PE, pressure ulcers, and mortality during hospitalization are shown in Table 2. For transtrochanteric femur fractures, the risk of developing pneumonia, DVT, PE, pressure ulcers, and mortality during hospitalization increased to 1.335 (95% CI: 1.256-1.418), 0.911 (95% CI: 0.771-1.077), 1.287 (95% CI: 1.225-1.351), 1.229 (95% CI: 1.094-1.380), and 1.063 (95% CI: 0.978-1.155) respectively, when surgery

was performed after the third day of admission. Significant associations were found between hospital-acquired pneumonia, PE development, and pressure ulcers.

The results of the multivariate logistic analysis of the association between pneumonia and surgery within two days of admission, comorbidities, and rehabilitation during three days for each variable are presented in Table 3. For pneumonia in transtrochanteric fracture patients, male sex: 3.142 (95% CI: 2.945-3.351); surgery after the third day of admission: 1.381 (95% CI: 1.290-1.478); chronic lung disease: 2.141 (95% CI: 1.802-2.544); dementia: 1.600 (95% CI: 1.234-1.475) were significant risk factors. In contrast, general anesthesia was not associated with the apparent risk of pneumonia.

The outcomes of the multivariate logistic analysis for assessing risk factors for DVT are shown in Table 4. For DVT in transtrochanteric fracture patients, only a hypertension odds ratio of 1.429 (95% CI: 1.207-1.693) was shown to be a significant risk. The risk factor for DVT was, however, not significant after the third day of admission. The findings related to early rehabilitation presented a paradoxical trend.

The results from the multivariate logistic regression analysis aimed at identifying risk factors for PE are presented in Table 5. In the context of transtrochanteric fracture, female sex with a risk ratio of 1.299 (95% CI: 1.212-1.393); undergoing surgery after the third day of admission 1.365 (95% CI: 1.292-1.442); hypertension 1.467 (95% CI: 1.396-1.541); and dementia 1.146 (95% CI: 1.084-1.212) were identified as significant risk factors. On the other hand, early rehabilitation did not show a distinct association



Fig. 1 A flow chart of the present study.

Complication	Total (n)	Odds Ratio (95% CI)	$\chi 2$ statics	<i>p</i> -value
Hospital-acquired pneumonia	4,567	1.335 (1.256 - 1.418)	87.39	< 0.0001
DVT	560	0.911 (0.771 - 1.077)	1.188	0.2758
PE	6,847	1.287 (1.225 - 1.351)	102.8	< 0.0001
Pressure ulcers	1,159	1.229 (1.094 - 1.380)	12.07	< 0.0001
Mortality during hospitalization	2,386	1.063 (0.978 - 1.155)	2.067	0.0035

Table 2. Association between occurrence of pneumonia, deep vein thrombosis, and pulmonary embolism and surgey after the third day of admission.

P-values of < 0.001 are considered significant by the $\chi 2$ test

DVT means deep vein thrombosis; PE means pulmonary embolism; CI means confidence interval.

Table 3.	Multivariate	logistic ana	lysis of	risk	factors 1	for I	Hospita	l-acquired	pneumonia
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Variable	Odds Ratio (95% CI)	χ2 statics	<i>p</i> -value
Age	1.045 (1.040 - 1.050)	365.7	< 0.0001
Male	3.142 (2.945 - 3.351)	1,091	< 0.0001
Surgery after the third day of admission	1.381 (1.290 - 1.478)	86.85	< 0.0001
General Anesthesia	0.965 (0.908 - 1.025)	1.307	0.253
Hypertension	1.068 (1.005 - 1.136)	4.411	0.0357
Diabetes	1.009 (0.929 - 1.095)	0.042	0.8371
Cerebrovascular disease	1.349 (1.234 - 1.475)	50.28	< 0.0001
Chronic renal dysfunction	0.974 (0.847 - 1.122)	0.132	0.7168
Ischemic heart disease	1.033 (0.926 - 0.153)	0.339	0.5601
Dementia	1.600 (1.501 - 1.706)	195.6	< 0.0001
Chronic lung disease	2.141 (1.802 - 2.544)	62.48	< 0.0001
Rehabilitation after 4 days	1.022 (0.955 - 1.093)	0.389	0.5328

P-values of < 0.001 are considered significant by the $\chi 2$ test; CI means confidence interval.

Table 4. Multi	variate logistic and	lysis of risk factors f	for deep vein thrombos	sis.
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Variable	Odds Ratio (95% CI)	χ2 statics	<i>p</i> -value
Age	1.017 (1.004 - 1.030)	6.977	0.0083
Male	1.065 (0.854 - 1.327)	0.307	0.5794
Surgery after the third day of admission	1.247 (1.036 - 1.501)	5.385	0.0203
General Anesthesia	1.062 (0.896 - 1.258)	0.475	0.4907
Hypertension	1.429 (1.207 - 1.693)	16.97	< 0.0001
Diabetes	1.013 (0.809 - 1.269)	0.013	0.9088
Cerebrovascular disease	0.987 (0.788 - 1.236)	0.019	0.8909
Chronic renal dysfunction	0.616 (0.374 - 1.015)	4.215	0.0401
Ischemic heart disease	1.688 (1.309 - 2.178)	14.42	0.0001
Dementia	0.992 (0.815 - 1.206)	0.007	0.9328
Chronic lung disease	1.334 (0.686 - 2.595)	0.661	0.4162
Rehabilitation after 4 days	0.571 (0.468 - 0.695)	31.95	0.0403

P-values of < 0.001 are considered significant by the $\chi 2$ test; CI means confidence interval.

with a reduced risk of PE.

Pressure ulcer occurrence was also investigated, and results from the multivariate logistic regression analysis are shown in Table 6. For pressure ulcers, male sex: 1.437 (95% CI: 1.248-1.653) and diabetes 1.399 (95% CI: 1.156-1.551) were significant risk factors. The surgery after the third day of admission was not a significant factor.

The outcomes from the multivariate logistic regression

analysis aimed at identifying risk factors for mortality during hospitalization are described in Table 7, male sex: 2.743 (95% CI: 2.509-3.000), surgery after the third day of admission 1.287 (95% CI: 1.173-1.441); chronic lung disease 1.997 (95% CI: 1.565-2.549); chronic renal dysfunction 2.200 (95% CI: 1.908-2.536) were demonstrated as significant risk factors. As for early rehabilitation, the results are paradoxical.

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Variable	Odds Ratio (95% CI)	$\chi 2$ statics	<i>p</i> -value
Age	0.995 (0.992 - 0.999)	6.61	0.0101
Female	1.299 (1.212 - 1.393)	57.22	< 0.0001
Surgery after the third day of admission	1.365 (1.292 - 1.442)	122.8	< 0.0001
General Anesthesia	0.991 (0.902 - 1.121)	87.3	< 0.0001
Hypertension	1.467 (1.396 - 1.541)	227.7	< 0.0001
Diabetes	0.938 (0.877 - 1.003)	3.515	0.0608
Cerebrovascular disease	0.837 (0.766 - 0.915)	16.08	< 0.0001
Chronic renal dysfunction	0.826 (0.725 - 0.941)	8.726	0.0031
Ischemic heart disease	0.980 (0.893 - 1.076)	0.182	0.6693
Dementia	1.146 (1.084 - 1.212)	22.49	< 0.0001
Chronic lung disease	1.038 (0.825 - 1.306)	0.012	0.75
Rehabilitation after 4 days	0.878 (0.831 - 0.927)	21.52	< 0.0001

Table 5. Multivariate logistic analysis of risk factors for pulmonary embolism.

P-values of ${<}\,0.001$ are considered significant by the $\chi 2$ test; CI means confidence interval.

Table 6. Multivariate logistic analysis of risk factors for pressure ulcers during h	hospitalization
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Variable	Odds Ratio (95% CI)	χ2 statics	<i>p</i> -value
Age	1.026 (1.017 - 1.035)	32.52	< 0.0001
Male	1.437 (1.248 - 1.653)	25.52	< 0.0001
Surgery after the third day of admission	1.180 (1.033 - 1.348)	5.96	0.0146
General Anesthesia	0.962 (0.855 - 1.082)	0.413	0.5204
Hypertension	0.831 (0.735 - 0.941)	8.588	0.0034
Diabetes	1.339 (1.156 - 1.551)	15.24	< 0.0001
Cerebrovascular disease	0.956 (0.779 - 1.174)	0.185	0.6674
Chronic renal dysfunction	1.536 (1.213 - 1.944)	12.71	0.0004
Ischemic heart disease	1.123 (0.909 - 1.388)	1.157	0.2820
Dementia	1.278 (1.122 - 1.457)	13.54	0.0002
Chronic lung disease	1.010 (0.604 - 1.690)	0.001	0.9700
Rehabilitation after 4 days	1.140 (1.000 - 1.300)	3.822	0.0506

P-values of < 0.001 are considered significant by the $\chi 2$ test; CI means confidence interval.

Table 7. Wallivariate logistic analysis of fisk factors for mortanty during hospitalization	Table 7.	Multivariate	logistic ana	lysis of risk	factors	for mortality	during	hospitalization.
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Variable	Odds Ratio (95% CI)	χ2 statics	<i>p</i> -value
Age	1.075 (1.068 - 1.082)	494.2	< 0.0001
Male	2.743 (2.509 - 3.000)	440.5	< 0.0001
Surgery after the third day of admission	1.287 (1.173 - 1.411)	28.51	< 0.0001
General Anesthesia	0.937 (0.863 - 1.018)	2.351	0.1252
Hypertension	0.756 (0.692 - 0.826)	39.76	< 0.0001
Diabetes	1.121 (1.003 - 1.253)	3.956	0.0467
Cerebrovascular disease	1.141 (0.998 - 1.304)	3.615	0.0572
Chronic renal dysfunction	2.200 (1.908 - 2.536)	97.93	< 0.0001
Ischemic heart disease	1.046 (0.901 - 1.216)	0.348	0.5551
Dementia	1.075 (0.978 - 1.182)	2.239	0.1345
Chronic lung disease	1.997 (1.565 - 2.549)	25.76	< 0.0001
Rehabilitation after 4 days	0.815 (0.743 - 0.895)	18.6	< 0.0001

P-values of < 0.001 are considered significant by the $\chi 2$ test; CI means confidence interval.

Discussion

In the present large-scale database study of femoral transtrochanteric fractures, surgery performed within two days of admission was associated with the occurrence of sequelae of pneumonia, PE, pressure ulcers, and mortality during hospitalization in older adult Japanese patients. The findings revealed that surgery performed after the third day of admission led to a 1.335-fold increased risk of pneumonia, 1.287-fold increased risk of PE, 1.229-fold increased risk of press ulcer, and 1.063-fold increased risk of mortality during hospitalization in a multivariate analysis in a population adjusted for confounding factors, indicating the important role of surgery within two days of admission in patient outcomes in a Japanese older adult population.

In the present study, we investigated early surgery for femoral transtrochanteric fractures. Previous studies on the impact of early surgery for patients with overall hip fractures on mortality and pneumonia have been inconclusive. The majority of transtrochanteric fractures will heal when proper osteosynthesis is executed, and a satisfactory bone union is anticipated (Halonen et al. 2022; Yamamoto et al. 2022), with the incidence of pseudarthrosis and nonunion being 0.5 to 2.9% (Baumgaertner et al. 1998; Madsen et al. 1998). The collapse of the femoral head induced by traumatic osteonecrosis is low, with a reported rate of 0.3-1.2%(Bartonicek et al. 2007). Previous studies have shown conflicting results on the impact of early surgery on hospitalacquired pneumonia (Bredahl et al. 1992; Parker and Pryor 1992; Smektala et al. 2008; Holt et al. 2010; Sasabuchi et al. 2018), pressure ulcers (Yamamoto et al. 2022), and mortality (Shiga et al. 2008; Simunovic et al. 2010; Moja et al. 2012; Sasabuchi et al. 2018). The studies included in these meta-analyses were observational and used regression analysis; confounding factors may affect results. Some studies have suggested that the main reason for delaying surgery in patients with hip fractures is the existence of comorbidities (Grimes et al. 2002; Holt et al. 2010). The present study addressed confounding factors such as comorbidities by applying propensity score matching early surgery for transtrochanteric fractures, which can reduce pneumonia, PE, pressure ulcers, and hospital mortality.

The perioperative complication rate was reported to be 6.9%-19% (Lawrence et al. 2002; Sathiyakumar et al. 2015; Sheehan et al. 2017), lung and heart disease are common. They may become severe enough to affect life prognosis (Lawrence et al. 2002). Acute renal failure is reported to be a common complication of surgery in elderly patients who sustain a fracture of the hip; 12.7% developed renal damage five days after surgery (Pedersen et al. 2016). The previous study reported that surgery within two days of admission for elderly patients with hip fractures, compared with surgery performed later, is significantly associated with a lower proportion of patients developing hospital-acquired pneumonia and pressure ulcers (Yamamoto et al. 2022). In the present study data of multivariate logistic analysis of

risk factors for mortality during hospitalization, we show that the comorbidity of chronic renal dysfunction and chronic pulmonary disease are risk factors compared to cardiac and brain disease. Early surgery is necessary; care must also be taken to manage complications. The DVT or PE onset rate was reported to be 0.7-1.2% (Sathiyakumar et al. 2015; Sheehan et al. 2017); early surgery within two days of admission reduced the risk of PE and pressure ulcers but was not an apparent factor for DVT in the present study.

Early rehabilitation can lead to weaning in older adult patients with hip fractures. Effective prevention of pneumonia, DVT, PE, and hospitalization mortality are essential in practice but have not been demonstrated in large-scale database studies. To prevent pneumonia, the benefits of respiratory rehabilitation and oral care have been reported (Chiang et al. 2013; Geerds et al. 2022). Anticoagulation, including low-molecular-weight heparin, is crucial for preventing DVT and PE (Falck-Ytter et al. 2012; Barrera et al. 2013; Forster and Stewart 2016). Additionally, comprehensive evaluations have shown that the advantages of medication outweigh those of alternative physical interventions (Barrera et al. 2013). The present study did not establish the effectiveness of early rehabilitation in preventing PE, DVT, pressure ulcers, and pneumonia. Anticoagulant use is a substantial independent factor, especially when it comes to the prevention of pulmonary emboli and deep vein thrombosis. Unfortunately, this study did not examine the use of anticoagulants; therefore, we could not clarify the usefulness of rehabilitation. However, we considered the surgery results within two days of hospital admission, as they showed a preventive effect on pneumonia, DVT, PE, pressure ulcers, and mortality during hospitalization.

The present study has several limitations. First, the study population included patients with hip fractures treated only in acute-care hospitals reporting to the DPC data system. This did not include patients admitted to non-DPC reporting beds, which account for 30% of all general hospital beds or those who have never been treated in an acute care hospital (Tomioka et al. 2020). Second, the time between injury and surgery was not investigated. Although the surgical procedure should be considered within 48 h of the injury, this study considered the surgical procedure within two days of admission. Third, we could not examine the anticoagulant treatment status and rehabilitation details. Therefore, further large-scale studies based on patient data are warranted. To examine pneumonia, DVT, PE, pressure ulcers, and mortality during hospitalization in patients with hip fractures in more detail, the denominators of all older adult patients with hip fractures in the community and the details of treatment in acute care hospitals need to be examined. Fourth, the main reason why the operation date was decided was unclear. It was also unclear when the perioperative complication occurred, the date of admission, and the date and time of surgery, which are available but not the time. These data could not be obtained from the DPC data system. Fifth, this study was based on the DPC data; the comorbidities that were not enrolled might not be able to pick it up.

In a large DPC-based study in Japan, surgery within two days of admission for elderly patients with transtrochanteric femur fractures is associated with a significant decrease in complications such as pneumonia, PE, pressure ulcers, and mortality during hospitalization. These results support current guidelines, which recommend early surgery for elderly patients with hip fractures.

Author Contributions

All authors are responsible for the work described in this paper. H.T., K.T., Y.M., K.F., and T.A. conceived, designed, and planned the study. H.T. and Y.M. analyzed the data. H.T., K.T., Y.M., K.F., and T.A. interpreted the data. All the authors contributed to the critical review and approved the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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