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ORIGINAL ARTICLE

Predictors of Prognosis for Elderly Patients with Poststroke Hemiplegia Experiencing Hip Fractures

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Abstract Hip fracture is an important cause of mortality and disability in elderly patients, particularly in those with poststroke hemiplegia, but little information is available regarding differences of general characteristics between patients with and without hemiplegia who experience hip fractures, factors predicting recovery of prefracture ambulatory status, and mortality of patients with poststroke hemiplegia with hip fractures. We retrospectively reviewed 1379 consecutive prospectively followed patients with hip fractures treated from January 2000 to May 2006. Of the 1379 patients, 101 (7.3%) had poststroke hemiplegia. All patients were followed a minimum of 1 year if they survived more than a year or until death if they died within a year after surgery (mean, 19.5 months; range, 4–49 months). According to the American Society of Anesthesiologists (ASA) rating, the patients with hemiplegia were sicker than patients without hemiplegia, more likely to have three or more comorbidities, lower cognitive ability, weaker prefracture ambulatory status, more days of hospitalization, and higher mortality rate. Gender, ASA rating, number of comorbidities, and prefracture ambulatory status predicted mortality of hip fractures in elderly patients with poststroke hemiplegia, and the ASA rating, number of comorbidities, and cognitive ability predicted recovery of prefracture ambulatory status for these patients.

Level of Evidence: Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

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Introduction

The proportion of elderly people is increasing in most countries. Sweden has one of the largest proportions of elderly people in the world; 18% are older than 65 years, and by 2010, this figure will have increased to approximately 26% [16]. From 2001 to 2020, China similarly is faced with rapid aging of the population, increasing by 3.28% per year [41]. By 2020, the aging population (at least 60 years of age) will increase to approximately 17.17% [41]. Hip fracture often occurs in the elderly population, and the number of patients with hip fractures is increasing correspondingly with the sustained increase in the elderly population [26], such as in the United States [6, 31] and Asia [23, 25].

Stroke also is a substantial cause of morbidity in the elderly. As with hip fractures, stroke incidence increases with increasing age. In China, the morbidity rate of stroke is 640 per one million and the mortality rate is 66 per one million. Every 40 to 45 seconds, someone in the United States has a stroke [11]. One-fourth of initial stroke survivors have a second stroke within 5 years [21]. Patients who have a stroke are vulnerable for osteoporotic fractures and falls. Increased fracture risk is a recognized complication after a stroke, particularly in patients who have hemiplegia after the stroke [32]. Patients who have had strokes have as much as a fourfold increased risk of hip fracture [36] because of a high incidence of falls [35, 42] and loss of bone mass on the paretic side [14, 37]. In a study of 363,447 patients who had strokes, 4528 patients had hip fractures, 2.0% had fractures by 1 year, and 10.6% had fractures by 10 years [7].

Various factors (eg, age [9, 38], gender [10, 13, 38], ASA rating [9, 17], dementia [4], and type of fracture [28, 29]) reportedly affect ambulatory status and mortality of elderly patients with hip fractures, but little is known of any differences in general characteristics between patients with and without hemiplegia who had hip fractures, factors predicting recovery of prefracture ambulatory status, and mortality of patients with hemiplegia after stroke who experienced hip fractures.

Therefore, the purpose of our study was fourfold: (1) to compare the general characteristics of patients with and without hemiplegia who experienced hip fractures; (2) to identify predictors of mortality of patients with hemiplegia who experienced hip fractures; (3) to identify predictors of recovery of prefracture ambulatory status of patients with hemiplegia who experienced hip fractures; and (4) to identify the relative frequency of fractures in the affected and unaffected sides of patients with hemiplegia.

Materials and Methods

We retrospectively reviewed the medical records of 1505 prospectively followed patients with hip fractures treated between January 2000 and May 2006. Patients were identified at the time of admission and were prospectively followed up. Information regarding prefracture ambulatory status was collected at the time of admission by patient or family member interview. We included patients (1) at least 65 years old with a nonpathologic femoral neck or intertrochanteric hip fracture and having surgical treatment; (2) with followup of at least 1 year after surgery if patients survived more than a year or until death if patients died within a year after surgery; and (3) who survived the perioperative period. We excluded patients who had prior surgery on the same hip or previous ipsilateral hip fracture. Of the 1505 patients, 126 (109 without hemiplegia and 17 with hemiplegia) were excluded by these criteria leaving 1379 patients. Of the 126 patients excluded, 68 were lost to followup, either because we failed to contact patients or the patients refused to be interviewed. Of these 68 patients, 25 dropped out within 6 months after surgery and 43 dropped out between 6 and 12 months after surgery. One hundred one of the 1379 patients (7.3%) had hemiplegia of a lower extremity before hip fracture and 1278 did not have hemiplegia. In the group of 101 patients with hemiplegia, 76 survived at least 1 year. The mean age of all 1278 patients without hemiplegia was 76.4 ± 7.1 years (range, 65–99 years) at the time of injury, and that of the 101 patients with hemiplegia was 76.2 ± 5.8 years (range, 65–89 years) (Table 1). The minimum followup was 4 months (mean, 19.5 months; range, 4–49 months).

From the medical records, we abstracted data on fracture type, surgery type, patient's general health status, severity of health problems at the time of admission, cognitive ability on admission, and days of hospitalization. For patients with poststroke hemiplegia, we recorded whether the fracture occurred on the hemiparetic or on the nonhemiplegic side. Followup information regarding ambulatory status was obtained by clinical or telephone interview. The date of death for patients who died was ascertained from the physician or a relative of the patient.

The patient's general health status was defined by the number of preoperative comorbidities, including hypertension, stroke, ischemic heart disease, diabetes mellitus, congestive heart failure, cardiac arrhythmias, renal disease, cancer, chronic obstructive pulmonary disease, and the need for ongoing anticoagulation therapy. These comorbidities were chosen as being most important based on our experience and those reported in the literature [10, 44]. A previous study suggests patients with zero, one, or two comorbidities had similar outcomes [1]. Therefore, for this analysis, patients were categorized as having two or fewer or three or more comorbidities.

The ASA rating scale was used to assess the role of the severity of health problems at the time of admission. The categories are: I, normal, healthy; II, mild systemic disease; III, severe systemic disease, not incapacitating; IV, severe incapacitating systemic condition, constant threat to life; and V, moribund patient. There were no patients in Category V in this study. For purposes of statistical analysis, ASA ratings were collapsed into two categories: I or II and III or IV. This approach was used previously [10, 24, 39].

Cognitive ability was rated according to Hasegawa's Intelligence Scale revised for dementia [15, 30]. A score of 20 or less was considered dementia and a score of 21 or greater was considered nondementia. Dementia was categorized in four levels: 3 = nondementia (score of 21 or greater), 2 = slight dementia (score of 15–20), 1 = moderate dementia (score of 10–14), and 0 = severe dementia (score of 0–9) [15, 17, 30].

All patients were treated with a similar postoperative physiotherapy protocol by a skilled physiatrist. We used a Pelma vein pump (Labtek Medical Co, Dalian City, China) to prevent thrombosis and edema as soon as the operation was completed. Patients began isometric contraction of the quadriceps femoris muscle, active movement, and passive activity of the knee and ankle on the first postoperative day. In 2 to 3 days, they were taken to the rehabilitation unit to

Table 1. General characteristics of the patient groups

Characteristic	Nonhemiplegia	Hemiplegia	Statistical test	p Value
Number of patients	1278	101		
Age (years; mean ± SD)	76.4 ± 7.1	76.2 ± 5.8	Unpaired two-tailed Student's t test	0.799
Gender			Chi square test	0.234
Male	456 (35.7%)	42 (41.6%)		
Female	822 (63.3%)	59 (58.4%)		
ASA rating			Chi square test	0.021
I or II	480 (37.6%)	26 (25.7%)		
III or IV	798 (62.4%)	75 (74.3%)		
Number of preoperative comorbidities			Chi square test	0.004
0–2	863 (67.5%)	54 (53.5%)		
≥ 3	415 (32.5%)	47 (46.5%)		
Type of fracture			Chi square test	0.693
Femoral neck fracture	594 (46.5%)	49 (48.5%)		
Intertrochanteric fracture	684 (53.5%)	52 (51.5%)		
Surgery type			Chi square test	0.928
Prosthesis	512 (40.1%)	40 (39.6%)		
Internal fixation	766 (59.9%)	61 (60.4%)		
Prefracture ambulatory status			Chi square test	< 0.001
Community ambulators	913 (71.4%)	54 (53.5%)		
Home ambulator	357 (27.9%)	32 (31.7%)		
Nonfunctional ambulators	8 (0.7%)	15 (14.8%)		
Cognitive ability			Chi square test	< 0.001
0	11 (0.9%)	4 (4.0%)		
1	92 (7.2%)	16 (15.8%)		
2	180 (14.1%)	36 (35.6%)		
3	995 (77.8%)	45 (44.6%)		
Days of hospitalization (mean rank)	668.38	963.59	Mann-Whitney U test	< 0.001
1-year survival status			Chi square test	< 0.001
Survival	1140 (89.2%)	76 (75.2%)		
Mortality	138 (10.8%)	25 (24.8%)		

SD = standard deviation; ASA = American Society of Anesthesiologists.

begin ambulation using parallel bars. Patients were allowed partial weightbearing on the fractured extremity as tolerated. As soon as they felt secure using the parallel bars, patients were encouraged to use a walker or crutches, depending on their abilities before fracture. When patients felt secure using a walker or crutches, they received gait training. The average lengths of hospitalization were 25 days and 31 days in patients without hemiplegia and with hemiplegia, respectively. After discharge, patients received training in a rehabilitation hospital or outpatient rehabilitation clinic and gradually were allowed full weightbearing using a walker, crutches, or cane, or without assistance. Duration of supervised rehabilitation was 6 months.

We dichotomized postfracture ambulatory status as a return to the prefracture level or a decrease in at least one level of function [39]. Prefracture and postfracture ambulation levels were classified based on standard definitions of community, home, and nonfunctional ambulators [22, 39]. For purposes of a more detailed analysis, these categories were further subdivided (Table 2) [22, 39].

We compared the general characteristics of the patients with hip fractures with poststroke hemiplegia of the lower extremity with a population without hemiplegia, and investigated predictors of recovery of prefracture ambulatory status and mortality at 1 year followup of elderly patients with poststroke hemiplegia who had a hip fracture. Confounding variables included age, gender, ASA rating, number of preoperative comorbidities, type of fracture, prefracture ambulatory status, cognitive ability, and side of fracture. For continuous variables, we determined the mean ± standard deviation. We performed

Table 2. Categories of ambulatory status

Category	Definition
Community ambulators	Independent community ambulator
	Community ambulator with cane
	Community ambulator with walker or crutches
Home ambulators	Independent household ambulator
	Household ambulator with cane
	Household ambulator with walker or crutches
Nonfunctional ambulator	Confined to bed
	Limited to bed-to-chair transfers with assistance

exploratory analyses to determine differences in the categorical variables (gender, ASA rating, number of preoperative comorbidities, type of fracture, surgery type, prefracture ambulatory status, cognitive ability, 1-year survival status) using contingency table methods (chi square) and differences in continuous variables (age, days of hospitalization) using unpaired two-tailed Student's test or nonparametric test (Mann-Whitney U test) between patients with and without hemiplegia. We similarly compared the same variables between patients who survived and those who died, and between patients who recovered and those who did not recover prefracture ambulatory status; a p value of 0.05 or less was considered significant. To determine the simultaneous effect of potential confounding variables on dependent variables (mortality, recovery of prefracture ambulatory status), a multiple logistic regression was performed for variables with a $p < 0.05$ in the preliminary analysis. The data were analyzed using SPSS® Version 16.0 (SPSS Inc, Chicago, IL).

Results

The two groups did not differ in gender ratio, age, type of fracture, or surgery type (prosthetic replacement or internal fixation) (Table 1). The patients with hemiplegia were sicker ($p = 0.021$) than the patients without hemiplegia according to the ASA rating of preoperative risk, and the former were more likely to have an ASA rating of Category III or IV. Furthermore, there was a difference in the number of preoperative comorbidities between the groups. The patients with hemiplegia were more likely ($p = 0.004$) to have three or more comorbidities than the patients without hemiplegia. Prefracture ambulatory status was inferior ($p < 0.001$) in the patients with hemiplegia compared with the patients without hemiplegia, and patients without hemiplegia were more likely to be community ambulators. Patients with hemiplegia were more likely ($p < 0.001$) to have lower cognitive ability, and they had longer ($p < 0.001$) mean days of hospitalization (mean rank, 963.59) than patients without hemiplegia (mean rank, 668.38). The mortality rate was higher ($p < 0.001$) in patients with hemiplegia than in patients without hemiplegia, with 25 (24.8%) patients with and 138 (10.8%) patients without hemiplegia dying within 1 year of hip fracture.

In the preliminary analysis, age ($p = 0.677$), type of fracture ($p = 0.388$), and side of fracture ($p = 1.00$) were similar between the patients who survived and those who died; however, male gender ($p < 0.001$), higher ASA rating ($p < 0.001$), more number of preoperative comorbidities ($p = 0.001$), weaker prefracture ambulatory status ($p < 0.001$), and lower cognitive ability ($p = 0.04$) were more likely in patients who died within a year after surgery than in patients who survived (Table 3). In the multiple logistic regression analysis, gender ($p = 0.012$), ASA rating ($p = 0.01$), number of preoperative comorbidities ($p = 0.03$), and prefracture ambulatory status ($p < 0.001$) predicted mortality of elderly patients with poststroke hemiplegia who experienced hip fractures (Table 4).

To assess return to prefracture ambulatory status, we excluded three of the 76 patients with hemiplegia who were nonfunctional ambulators before experiencing hip fracture, and of the remaining 73 patients, 50 (68.5%) returned to their prefracture ambulatory status, and 23 did not return to their prefracture ambulatory status (Table 5). Of these 23 patients, 15 had decreases of one ambulatory level from their prefracture level, seven had decreases of two ambulatory levels, and one had a decrease of three ambulatory levels. In the preliminary analysis, age ($p = 0.133$), type of fracture ($p = 0.16$), prefracture ambulatory status ($p = 0.531$), and side of fracture ($p = 0.306$) were similar between the patients who recovered and those who did not recover prefracture ambulatory status. In the multiple logistic regression analysis, ASA rating ($p = 0.005$), number of preoperative comorbidities ($p = 0.021$), and cognitive ability ($p = 0.006$) predicted recovery of prefracture ambulatory status in elderly patients with poststroke hemiplegia who experienced hip fractures (Table 6).

Eighty-nine hip fractures (88.1%) occurred in patients with hemiplegia and 12 (11.9%) occurred in patients without hemiplegia (Table 3).

Discussion

The proportion of elderly people is increasing worldwide. Hip fractures and strokes often occur in the elderly population and their rates increase with increased age. Patients who have strokes are vulnerable for osteoporotic fractures. Increased fracture risk is a recognized complication after

Table 3. Comparison of patients' characteristics 1 year after surgery

Characteristic	Survived	Died	Statistical test	p Value
Number of patients	76	25		
Age (years; mean ± SD)	76.4 ± 5.1	75.7 ± 7.6	Unpaired two-tailed Student's t test	0.677
Gender			Chi square test	< 0.001
Male	22 (28.9%)	20 (80.0%)		
Female	54 (71.1%)	5 (20.0%)		
ASA rating			Chi square test	< 0.001
II	24 (31.6%)	2 (8.0%)		
III	38 (50.0%)	6 (24.0%)		
IV	14 (18.4%)	17 (68.0%)		
Number of preoperative comorbidities			Chi square test	0.001
≤ 2	48 (63.2%)	6 (24.0%)		
≥ 3	28 (36.8%)	19 (76.0%)		
Type of fracture			Chi square test	0.388
Femoral neck fracture	35 (46.1%)	14 (56.0%)		
Intertrochanteric fracture	41 (53.9%)	11 (44.0%)		
Prefracture ambulatory status			Chi square test	< 0.001
Community ambulators	47 (61.8%)	7 (28.0%)		
House ambulators	26 (34.3%)	6 (24.0%)		
Nonfunctional ambulators	3 (3.9%)	12 (48.0%)		
Cognitive ability			Chi square test	0.04
0 or 1*	11 (14.5%)	9 (36.0%)		
2	27 (35.5%)	9 (36.0%)		
3	38 (50.0%)	7 (28.0%)		
Side of fracture			Chi square test	1.00
Hemiplegic side	67 (88.2%)	22 (88.0%)		
Nonhemiplegic side	9 (11.8%)	3 (12.0%)		

* No patient with severe dementia survived at 1 year followup; for purposes of statistical analysis, severe dementia and moderate dementia were combined into one category; SD = standard deviation; ASA = American Society of Anesthesiologists.

Table 4. Predictors of 1-year mortality in the hemiplegic group

Factor	p Value	Odds ratio	95% confidence interval
Gender	0.012	0.150	0.034–0.661
ASA rating	0.010	5.901	1.525–22.843
Number of preoperative comorbidities	0.030	6.651	1.197–36.938
Prefracture ambulatory status	0.000	0.093	0.029–0.299
Cognitive ability	0.564	1.293	0.540–3.100
Constant	0.392	0.082	

ASA = American Society of Anesthesiologists.

stroke [2, 7, 20], particularly with strokes with resulting hemiplegia [32], but factors predicting recovery of prefracture ambulatory status and mortality for patients with poststroke hemiplegia who experienced hip fractures are not reported, and little information is known regarding differences of general characteristics between patients with or without hemiplegia who have hip fractures. Our purpose was fourfold: (1) to compare the general characteristics of patients with and without hemiplegia who experienced hip fractures; (2) to identify predictors of mortality of patients with hemiplegia who experienced hip fractures; (3) to identify predictors of recovery of prefracture ambulatory status of patients with hemiplegia who experienced hip fractures; and (4) to identify the relative frequency of fractures in the affected and unaffected sides of patients with hemiplegia.

This study has some limitations. The sample size of patients with hemiplegia was relatively small. We lacked information about other factors, such as economic and social factors, that might influence return of function. Also, we did not classify or stage patients who had a stroke. The severity is an important influence on mortality and recovery of function. Hip fracture during an earlier period of stroke rehabilitation results in a more negative influence

Table 5. Characteristics of recovery status of hemiplegic patients who survived to 1 year

Characteristic	Recovery of prefracture ambulatory status	No recovery of prefracture ambulatory status	Statistical test	p Value
Number of patients	50	23		
Age (years; mean ± SD)	75.9 ± 5.4	78.0 ± 4.3	Unpaired two-tailed Student's t test	0.113
Gender			Chi square test	0.005
Male	10 (20.0%)	12 (52.2%)		
Female	40 (80.0%)	11 (47.8%)		
ASA rating			Chi square test	< 0.001
II	21 (42.0%)	3 (13.0%)		
III	28 (56.0%)	7 (30.4%)		
IV	1 (2.0%)	13 (56.6%)		
Number of preoperative comorbidities			Chi square test	< 0.001
≤ 2	40 (80.0%)	6 (26.1%)		
≥ 3	10 (20.0%)	17 (73.9%)		
Type of fracture			Chi square test	0.16
Femoral neck fracture	23 (46.0%)	9 (39.1%)		
Intertrochanteric fracture	27 (54.0%)	14 (60.9%)		
Prefracture ambulatory status			Chi square test	0.531
House ambulators	19 (38.0.0%)	7 (30.4%)		
Community ambulators	31 (62.0%)	16 (69.6%)		
Cognitive ability			Chi square test	< 0.001
1	1 (2.0%)	7 (30.4%)		
2	14 (28.0%)	13 (56.6%)		
3	35 (70.0%)	3 (13.0%)		
Side of fracture			Chi square test	0.306
Hemiplegic side	42 (84.0%)	22 (95.7%)		
Nonhemiplegic side	8 (16.0%)	1 (4.3%)		

SD = standard deviation; ASA = American Society of Anesthesiologists.

Table 6. Predictors of 1-year recovery of ambulatory status

Factor	p Value	Odds ratio	95% confidence interval
Gender	0.302	2.321	0.469–11.498
ASA rating	0.005	0.184	0.057–0.598
Number of preoperative comorbidities	0.021	0.155	0.032–0.756
Cognitive ability	0.006	7.325	1.759–30.496
Constant	0.258	15.130	

ASA = American Society of Anesthesiologists.

because the fracture disturbs rehabilitation training, and earlier-period rehabilitation training is more crucial. We did not consider type of surgery as a variable because type of surgery and type of fracture are almost collinear variables [17].

We found patients who had a previous stroke represented 7.3% of all patients, which is similar to a reported percentage [43] (Table 7). Patients who have had a stroke have an increased risk for an osteoporotic hip fracture [36] because of a high frequency of falls [35, 42] and loss of bone mass on the paretic side [14, 18, 19, 33, 37]. Most fractures that occur after a stroke are on the paretic side [3, 34, 43] and are caused by accidental falls [12, 33]. We found 88.1% of hip fractures after strokes occurred on the hemiparetic side. We also found patients with hemiplegia were sicker than patients without hemiplegia according to the ASA rating and more likely to have three or more comorbidities, lower cognitive ability, and weaker walking ability. The aforementioned reasons led to a higher mortality rate in patients with hemiplegia. The patients with hemiplegia also had longer mean days of hospitalization, which is in accordance with previous studies [8, 43] (Table 7).

Similar to the study of Clague et al. [4], we observed no association between age and mortality, but another study [38] concluded otherwise (Table 8). This might have been attributable to exclusion of people younger than 65 years and the relatively short followup in our study. We found

Table 7. Literature summary

Study	Year	Results
Chiu et al. [3]	1992	Of 1430 patients with hip fractures, 146 (10.2%) had previous cerebrovascular accidents; the fracture was on the hemiplegic side in 82% of patients
Di Monaco et al. [8]	2003	Activity ability was significantly less in the patients with stroke than in the control subjects; lower cognitive ability was negatively associated with activity ability
Youm et al. [43]	2000	Of 862 patients with hip fractures, 63 (7.3%) had a history of cerebrovascular accident; the fracture was on the hemiplegic side in 46 (86.8%) of the 53 patients with hemiplegia; patients who had a history of cerebrovascular accident were more likely to have an ASA rating of III or IV, have three or more comorbidities, be a home ambulator, and have a higher average length of hospital stay (28.5 days) than those who did not have a prior cerebrovascular accident (22.4 days); when controlling for prefracture level of function, there were no differences in the rate of functional recovery between the two groups of patients
Current study	2008	Patients with poststroke hip fracture represented 7.3% of all patients; 88.1% of hip fractures after a stroke occurred on the hemiparetic side; the patients with hemiplegia were sicker than those without hemiplegia according to the ASA rating of preoperative risk and more likely to have three or more comorbidities, lower cognitive ability, and weaker walking ability than patients without hemiplegia; patients with hemiplegia had longer days of hospitalization and higher mortality rate at 1 year followup (for patients with hemiplegia who experienced hip fractures)

ASA = American Society of Anesthesiologists.

Table 8. Literature summary of factors affecting mortality

Study	Year	Negative factors
Clague et al. [4]	2002	Dementia, cardiovascular complications, pulmonary complications, ASA grade
Cornwall et al. [5]	2004	Poor preinjury function, intertrochanteric fracture
Elliott et al. [9]	2003	Increasing age, male gender, longer preoperative delay, ASA rating score, lower mental test score, lower activity ability
Endo et al. [10]	2005	Male gender
Gdalevich et al. [13]	2004	Male gender, mental deterioration, postoperative mobility, severity of preexisting diseases, general postoperative complications
Ishida et al. [17]	2005	Preoperative ASA rating score, walking ability, intracapsular fracture, number of prevalent vertebral fractures on admission
Marottoli et al. [28]	1994	More comorbidities, degree of dementia on admission, intracapsular fracture
Michel et al. [29]	2002	Extracapsular fracture
Schrøder et al. [38]	1993	Mortality increased with age, male gender
Current study	2008	Male gender, ASA rating, more preoperative comorbidities, weaker prefracture ambulatory status (for patients with hemiplegia who experienced hip fractures)

ASA = American Society of Anesthesiologists.

the type and side of fractures did not affect mortality, although other studies suggested intracapsular [28] or extracapsular fractures [29] increased mortality. Gender, ASA rating, number of comorbidities, prefracture ambulatory status, and cognitive ability showed an effect on mortality in the preliminary analysis, but cognitive ability disappeared in multivariate logistic regression. There are several possible explanations; first, dementia negatively influences health. Second, presumably dementia is entangled with prefracture ambulatory status and/or comorbidities because dementia is related to prefracture ambulatory status and is one of the comorbidities. Male patients were more likely to have more severe medical comorbidities than women and had a greater likelihood of having more severe complications develop after surgery [10]. Obviously, ASA rating and number of comorbidities influence mortality. Prefracture ambulatory status reflects status of physical agility and cardiorespiratory function. Therefore, male gender, three or more comorbidities, Category III or IV ASA rating, and weaker prefracture ambulatory status predicted mortality. Similar results have been reported for patients without hemiplegia who have hip fractures [5, 9, 10, 13, 40].

In our preliminary analysis, age, type of fracture, prefracture ambulatory status, and side of fracture did not have an effect on recovery of prefracture ambulatory status. Ishida et al. [17] also reported age did not predict recovery of prefracture ambulatory status after surgery. Other

Table 9. Literature summary of factors affecting recovery of ambulatory status

Study	Year	Negative factors
Cornwall et al. [5]	2004	Patient age, preinjury functional independence measure scores
Ishida et al. [17]	2005	Dementia, the number of prevalent vertebral fractures
Kitamura et al. [22]	1998	Dementia
Koval et al. [24]	1998	Age 85 years or older, living alone before sustaining a fracture, one or more comorbidities
Shyu et al. [40]	2004	More concomitant diseases, longer hospital stay
Current study	2008	ASA rating, number of preoperative comorbidities, cognitive ability on admission (for patients with hemiplegia who experienced hip fractures)

ASA = American Society of Anesthesiologists.

studies [17, 24] reported fracture type did not predict recovery of prefracture ambulatory status. Youm et al. [43] showed the functional recovery of elderly patients with a prior stroke who experience a hip fracture was similar to that of patients without a prior stroke when controlling for prefracture level of function. We found 68.5% of patients with hemiplegia who were surviving at the 1-year followup and were not nonfunctional ambulators before the fracture returned to their prefracture ambulatory status, which is similar to the result reported by Kitamura et al. [22]. In the preliminary analysis, we found gender, ASA rating, number of comorbidities, and cognitive ability influenced recovery of prefracture ambulatory status, however, gender disappeared in the multivariate logistic regression, which is consistent with the results of other studies [17, 24] (Table 9). A possible explanation is that gender is entangled with the ASA rating because men were more likely to have a higher ASA rating for operative risk [10]. Patients with three or more comorbidities [40] or Category III or IV ASA rating generally possess inferior physical capacity, and consequently, their rehabilitation training is limited. Several studies have shown dementia decreases the likelihood of recovery of prefracture ambulatory status [17, 22, 27], a finding our study confirms. Because patients with severe dementia have poor motivation and are unable to follow instructions, it is difficult for them to complete the rehabilitation schedule [22, 27]. Therefore, patients with three or more comorbidities, Category III or IV ASA rating, or moderate to severe dementia were less likely to regain their prefracture ambulatory status.

Our data indicate gender, ASA rating, number of comorbidities, and prefracture ambulatory status are predictors of mortality in elderly patients with poststroke hemiplegia who experience a hip fracture, whereas ASA rating, number of comorbidities, and cognitive ability are factors associated with recovery of prefracture ambulatory status for these patients. These predictors are helpful for us to judge prognosis and curative effect for these patients in clinical practice. In addition, because the mortality rate is higher in patients when compared with patients without hemiplegia, prevention of hip fractures is even more important for patients who have had a stroke. Treatment of osteoporosis and avoiding falls are essential for patients with poststroke hemiplegia.

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References

1. Aharonoff GB, Koval KJ, Skovron ML, Zuckerman JD. Hip fractures in the elderly: predictors of one year mortality. *J Orthop Trauma.* 1997;11:162–165.
2. Bast BA, Greenwald BD. Preventing hip fracture after stroke. *Top Stroke Rehabil.* 2007;14:67–79.
3. Chiu KY, Pun WK, Luk KD, Chow SP. A prospective study on hip fractures in patients with previous cerebrovascular accidents. *Injury.* 1992;23:297–299.
4. Clague JE, Craddock E, Andrew G, Horan MA, Pendleton N. Predictors of outcome following hip fracture: admission time predicts length of stay and in-hospital mortality. *Injury.* 2002;33:1–6.
5. Cornwall R, Gilbert MS, Koval KJ, Strauss E, Siu AL. Functional outcomes and mortality vary among different types of hip fractures: a function of patient characteristics. *Clin Orthop Relat Res.* 2004;425:64–71.
6. Cummings SR, Rubin SM, Black D. The future of hip fractures in the United States: numbers, costs, and potential effects of postmenopausal estrogen. *Clin Orthop Relat Res.* 1990;252:163–166.
7. Dennis MS, Lo KM, McDowall M, West T. Fractures after stroke: frequency, types, and associations. *Stroke.* 2002;33:728–734.
8. Di Monaco M, Vallero F, Di Monaco R, Mautino F, Cavanna A. Functional recovery and length of stay after hip fracture in patients with neurologic impairment. *Am J Phys Med Rehabil.* 2003;82:143–148; quiz 149–151, 157.
9. Elliott J, Beringer T, Kee F, Marsh D, Willis C, Stevenson M. Predicting survival after treatment for fracture of the proximal femur and the effect of delays to surgery. *J Clin Epidemiol.* 2003;56:788–795.
10. Endo Y, Aharonoff GB, Zuckerman JD, Egol KA, Koval KJ. Gender differences in patients with hip fracture: a greater risk of morbidity and mortality in men. *J Orthop Trauma.* 2005;19:29–35.
11. Fisher M. Stroke and TIA: epidemiology, risk factors, and the need for early intervention. *Am J Manag Care.* 2008;14(suppl 2):S204-S211.

12. Forster A, Young J. Incidence and consequences of falls due to stroke: a systematic inquiry. *BMJ.* 1995;311:83–86.
13. Gdalevich M, Cohen D, Yosef D, Tauber C. Morbidity and mortality after hip fracture: the impact of operative delay. *Arch Orthop Trauma Surg.* 2004;124:334–340.
14. Hamdy RC, Moore SW, Cancellaro VA, Harvill LM. Long-term effects of strokes on bone mass. *Am J Phys Med Rehabil.* 1995; 74:351–356.
15. Imai Y, Hasegawa K. The revised Hasegawa's dementia scale (HDS-R): evaluation of its usefulness as a screening test for dementia. *Hong Kong Coll Psychiatr.* 1994;4:20–24.
16. Ingemarsson AH, Frändin K, Mellström D, Möller M. Walking ability and activity level after hip fracture in the elderly: a follow-up. *J Rehabil Med.* 2003;35:76–83.
17. Ishida Y, Kawai S, Taguchi T. Factors affecting ambulatory status and survival of patients 90 years and older with hip fractures. *Clin Orthop Relat Res.* 2005;436:208–215.
18. Jørgensen L, Crabtree NJ, Reeve J, Jacobsen BK. Ambulatory level and asymmetrical weight bearing after stroke affects bone loss in the upper and lower part of the femoral neck differently: bone adaptation after decreased mechanical loading. *Bone.* 2000;27:701–707.
19. Jørgensen L, Jacobsen BK, Wilsgaard T, Magnus JH. Walking after stroke: does it matter? Changes in bone mineral density within the first 12 months after stroke: a longitudinal study. *Osteoporos Int.* 2000;11:381–387.
20. Kanis J, Oden A, Johnell O. Acute and long-term increase in fracture risk after hospitalization for stroke. *Stroke.* 2001;32:702–706.
21. Kelly BM, Pangilinan PH Jr, Rodriguez GM. The stroke rehabilitation paradigm. *Phys Med Rehabil Clin N Am.* 2007;18:631–650.
22. Kitamura S, Hasegawa Y, Suzuki S, Sasaki R, Iwata H. Functional outcome after hip fracture in Japan. *Clin Orthop Relat Res.* 1998;348:29–36.
23. Koh LK, Saw SM, Lee JJ, Leong KH, Lee J. Hip fracture incidence rates in Singapore 1991–1998. *Osteoporos Int.* 2001;12: 311–318.
24. Koval KJ, Skovron ML, Aharonoff GB, Zuckerman JD. Predictors of functional recovery after hip fracture in the elderly. *Clin Orthop Relat Res.* 1998;348:22–28.
25. Lau EM, Cooper C. The epidemiology of osteoporosis: the oriental perspective in a world context. *Clin Orthop Relat Res.* 1996;323:65–74.
26. Lin PC, Chang SY. Functional recovery among elderly people one year after hip fracture surgery. *J Nurs Res.* 2004;12:72–82.
27. Lyons AR. Clinical outcomes and treatment of hip fractures. *Am J Med.* 1997;103:51S-63S; discussion 63S-64S.
28. Marottoli RA, Berkman LF, Leo-Summers L, Cooney LM Jr. Predictors of mortality and institutionalization after hip fracture: the New Haven EPESE cohort. Established Populations for Epidemiologic Studies of the Elderly. *Am J Public Health.* 1994; 84:1807–1812.
29. Michel JP, Klopfenstein C, Hoffmeyer P, Stern R, Grab B. Hip fracture surgery: is the pre-operative American Society of Anesthesiologists (ASA) score a predictor of functional outcome? *Aging Clin Exp Res.* 2002;14:389–394.
30. Minematsu A. The frequency of family visits influences the behavioral and psychological symptoms of dementia (BPSD) of aged people with dementia in a nursing home. *J Phys Ther Sci.* 2006;18:123–126.
31. Morris AH, Zuckerman JD. National Consensus Conference on Improving the Continuum of Care for Patients with Hip Fracture. *J Bone Joint Surg Am.* 2002;84:670–674.
32. Myint PK, Poole KE, Warburton EA. Hip fractures after stroke and their prevention. *QJM.* 2007;100:539–545.
33. Nevitt MC, Cummings SR. Type of fall and risk of hip and wrist fractures: the study of osteoporotic fractures. *J Am Geriatr Soc.* 1993;41:1226–1234.
34. Poole KE, Reeve J, Warburton EA. Falls, fractures, and osteoporosis after stroke: time to think about protection? *Stroke.* 2002;33:1432–1436.
35. Ramnemark A, Nilsson M, Borssén B, Gustafson Y. Stroke, a major and increasing risk factor for femoral neck fracture. *Stroke.* 2000;31:1572–1577.
36. Ramnemark A, Nyberg L, Borssén B, Olsson T, Gustafson Y. Fractures after stroke. *Osteoporos Int.* 1998;8:92–95.
37. Ramnemark A, Nyberg L, Lorentzon R, Englund U, Gustafson Y. Progressive hemiosteoporosis on the paretic side and increased bone mineral density in the nonparetic arm the first year after severe stroke. *Osteoporos Int.* 1999;9:269–275.
38. Schrøder HM, Erlandsen M. Age and sex as determinants of mortality after hip fracture: 3,895 patients followed for 2.5–18.5 years. *J Orthop Trauma.* 1993;7:525–531.
39. Shah MR, Aharonoff GB, Wolinsky P, Zuckerman JD, Koval KJ. Outcome after hip fracture in individuals ninety years of age and older. *J Orthop Trauma.* 2001;15:34–39.
40. Shyu YI, Chen MC, Liang J, Wu CC, Su JY. Predictors of functional recovery for hip fractured elders during 12 months following hospital discharge: a prospective study on a Taiwanese sample. *Osteoporos Int.* 2004;15:475–482.
41. The National Working Committee Office on Aging. Report of prediction study on China's population aging trends. Available at: http://www.cnca.org.cn/default/iroot1000610000/4028e47d16ec2fd901171963a2690382.html. Accessed December 27, 2007.
42. Tutuarima JA, van der Meulen JH, de Haan RJ, van Straten A, Limburg M. Risk factors for falls of hospitalized stroke patients. *Stroke.* 1997;28:297–301.
43. Youm T, Aharonoff G, Zuckerman JD, Koval KJ. Effect of previous cerebrovascular accident on outcome after hip fracture. *J Orthop Trauma.* 2000;14:329–334.
44. Zuckerman JD, Skovron ML, Koval KJ. Postoperative complications and mortality associated with operative delay in older patients who have a fracture of the hip. *J Bone Joint Surg Am.* 1995;77:1551–1556.