Original Article

# The timing of surgery and mortality in elderly hip fractures

## A retrospective, multicenteric cohort study

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## Abstract

**Background:** Early surgery is recommended for elderly hip fracture patients, but some studies show no clear advantage. The benefits of early surgery may differ according to the medical environment in different countries. The purpose of this study was to identify the potential benefits of early surgery in elderly hip fracture patients by evaluating the effect of timing of surgery on mortality.

**Materials and Methods:** A retrospective study was conducted at multiple centers on hip fracture patients aged over 65 years. The primary outcome was 1 year mortality and the secondary outcomes were 30-day/6-month mortality and complications during admission. The effect of time to surgery on mortality was analyzed using a Cox proportional-hazards model.

**Results:** Among the 874 patients, 162 (18.5%) received surgery within 3 days and their 1-year mortality rate was 9.9%. However, the 1-year mortality rate for the delayed surgery group was 12.5%. After adjustment for potential confounders, the 1-year mortality rates in patients who received surgery in 3-7 days (Hazard ratio = 1.0; 95% confidence interval [CI]: 0.7-1.6) and over 7 days (hazard ratio = 1.3; 95% CI: 0.9-1.8) were not significantly different. In addition, the time to surgery did not have a significant effect on 30-day mortality, 60-day mortality or complications arising during hospitalization.

**Conclusions:** The time to surgery did not affect short and long term mortality or the in hospital complication rate in elderly hip fracture patients. We recommend concentrating more on optimizing the condition of patients early with sufficient medical treatment rather than being bound by absolute timing of surgery.


**Key words:** Hip fracture, morbidity, mortality, hip surgery
**MeSH terms:** Hip fractures, morbidity, mortality, orthopedic surgery

## Introduction

Hip fractures are a major cause of mortality and morbidity in the elderly population and the 1-year mortality rate is approximately 10-20%.[1] So the hip fracture in elderly is an important issue from the perspective of society and health. Of the factors that affect mortality, early surgery (within 1 to 3 days from admission) has shown favorable outcomes in many studies.[2-6] However, some studies have not shown a clear advantage of early surgery.[7-12] Therefore, it is not certain that all medical environments in different countries will show favorable outcomes. In addition, Asian countries lack large scale studies on this subject. The purpose of this study was to identify the potential benefits of early surgery in elderly hip fracture patients at multiple centers in Korea by evaluating the effect of timing of surgery on mortality.

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## Materials and Methods

1388 consecutive patients older than 65 years, admitted to three urban teaching hospitals with a diagnosis of traumatic hip fracture between January 2002 and December 2009 constituted this retrospective study. These hospitals were selected because they were willing to allow a review of their medical records. The exclusion criteria included: Patients with multiple fractures, previous hip fracture history, subtrochanteric-type of fracture, injury occurred more than 48 h before hospitalization, patients who received conservative treatment, patients unable to walk before injury and missing data. Before proceeding to hip fracture surgery, clinicians at all three hospitals evaluated

the patient's active medical problems and solved them by consulting specialists. After the surgery, all patients underwent gait training as soon as possible.

Data was collected in a retrospective manner from medical record review by three researchers in each hospital and by using the same study protocol. In each hospital, the Institutional Review Board approved the study protocol. Upon admission to the ward, sex, age, height, weight and year of admission were recorded, as were smoking habits, body mass index, insurance status, general health status, hip fracture type, type of surgical procedure, postoperative complications and walking ability at discharge.

The following major comorbid conditions at admission were recorded: Hypertensive disease (International Classification of Diseases-10 Code: I10-I15), diabetes (E10-E14), chronic ischemic heart disease (I20, I23-I25), heart failure (I50), chronic lower respiratory disease (J40-J47), chronic kidney disease (N17-N19), dementia or Alzheimer's disease (F00-F03, G30) and malignancy (any C code). These conditions were recorded for patients who needed medical attention for these at the time of hospitalization.

We used two composite indicators of physical condition: The Charlson comorbidity index (CCI)[13] and the American Society of Anesthesiologists (ASA) physical classification system.[14]

Socioeconomic status was sorted into insurance and medical aid groups according to the type of insurance coverage held by the patient. Smoking habits were recorded as smoker or non smoker (never and ever smoker who ceased smoking over 1 year). The operative techniques were classified as internal fixation (by screw or nail) or replacement (hemiarthroplasty, total arthroplasty). The time to surgery and the duration of admission were recorded. Complications encountered in hospital were also recorded. Walking ability at discharge was graded using the simplified Kitamura's classification: Can walk (grade I-III) versus cannot walk (grade IV-V).[15]

We have defined 'time to surgery' as the length of time from occurrence of fracture to surgery and based on this, early surgery as 'surgery less than 3 days', which has been referred to as the criterion of early surgery in existing studies. The delayed-surgery group was subdivided into two groups: Surgery between 3 and 7 days and surgery after 7 days. The time to surgery was reported in 24-h intervals. The surgeries were scheduled by the medical staff after the medical condition of the patients was assessed. The patient data was recorded separately if the surgery was delayed for other reasons. Without any separate record, it was assumed that the surgery was delayed because of medical conditions.

The primary outcome was 1-year mortality after the fracture. National death data between January 1, 2002 and December 31, 2011 were used to confirm death and the date of death.[16] The entire study group was followed for 2-10 years after surgery.

We evaluated mortality at 30 days and 6 months after the fracture and we also evaluated the in hospital complication rate after surgery. The morbidity was evaluated in all patients after admissions, the in-hospital complications that were considered to occur at a relatively high rate and to affect mortality were selected. These complications included: Bed-sores, pneumonia, thromboembolism, pulmonary congestion and acute renal failure. Pneumonia patients were identified by documentation in medical charts, diagnosis by culture or radiography and the presence of antibiotic use in the medical records. A bed-sore was defined by newly developed lesions occurring during the hospital stay, with documentation in the medical chart. Pulmonary thromboembolism was defined by a positive result on a pulmonary angiogram. Pulmonary congestion was defined by a diagnosis made by chest X-ray and subsequent treatment.

### Statistical analysis

SPSS win 17.0K for windows (SPSS Inc., Illinois, USA) was used for all statistical analyses. The Chi-squared test or Fisher exact test was used for nominal variables. A linear-by-linear association was used to analyze trends of ranking variables. Student's *t*-test or the Wilcoxon rank sum test was used for continuous variables.

To identify factors significantly associated with mortality after hip fracture surgery, we used a Cox proportional hazards model. CCI, ASA class, comorbid condition, year of admission, admitted to which hospital, sex and age were included in the model. Other confounding variables included cases that occurred in at least 5% of the patients whose expected value was over five in the contingency table and that showed statistical significance on univariate analysis ($P < 0.05$). By these methods, relationships between operative delay, mortality and the trend of results over time were studied. We used logistic regression analysis to analyze in hospital complications.

## Results

This study reviewed data from 1388 hip fracture patients over 65 years of age. Of these there was insufficient data of one patient, 117 had nonsurgical treatment, 19 were injured more than 48 h before admission, 33 had a subtrochanteric type of fracture, 58 had a previous fracture history and 286 had multiple fractures other than hip; these patients were thus excluded. As a result, 874 patients were analyzed. The average age of the patients was 77.1 years (range:

**Table 1: Clinical details of patients**

| Characteristics | Number (%) | | |
|---|---|---|---|
| | Total (*n*=874) | Surgery ≤3 days (*n*=162) | Surgery >3 days (*n*=712) |
| From admission to surgery (day) | | | |
| 0-3 | 162 (18.5) | 162 (100) | NA |
| >3-7 | 240 (27.5) | NA | 240 (33.7) |
| >7 | 472 (54.0) | NA | 472 (66.3) |
| Sex | | | |
| Female | 676 (77.3) | 126 (77.8) | 486 (68.3) |
| Age (years) | | | |
| 65-74 | 331 (37.9) | 71 (43.8) | 260 (36.5) |
| 75-84 | 399 (45.7) | 67 (41.4) | 332 (46.6) |
| ≥85 | 144 (16.4) | 24 (14.8) | 120 (16.9) |
| Fracture type | | | |
| Neck | 413 (47.3) | 77 (47.5) | 336 (47.2) |
| Intertrochanter | 461 (52.7) | 85 (52.5) | 376 (52.8) |
| Insurance | | | |
| NHI | 822 (94.1) | 154 (95.1) | 668 (93.8) |
| Medical aid | 52 (5.9) | 8 (4.9) | 44 (6.2) |
| Current smoker | 107 (12.2) | 21 (12.9) | 86 (12.1) |
| BMI (kg/m$^2$) | | | |
| >23 | 295 (33.8) | 56 (34.6) | 239 (33.6) |
| 18.5-23 | 439 (49.9) | 80 (49.4) | 359 (50.4) |
| <23 | 140 (16.0) | 26 (16.0) | 114 (16.0) |
| Surgery type | | | |
| Fixation | 329 (37.6) | 69 (42.6) | 260 (36.5) |
| Replacement | 545 (62.4) | 93 (57.4) | 452 (63.5) |
| No. of comorbid chronic diseases | | | |
| 0 | 164 (18.8) | 41 (25.3) | 123 (17.3) |
| 1 or 2 | 608 (69.6) | 108 (66.7) | 500 (70.2) |
| ≥3 | 102 (11.6) | 13 (8.0) | 89 (12.5) |
| Active medical problems | | | |
| Heart failure | 38 (4.3) | 3 (1.1) | 35 (4.9) |
| IHD | 59 (6.8) | 8 (3.0) | 51 (7.2) |
| Dementia | 82 (9.4) | 10 (6.2) | 72 (10.1) |
| Chronic kidney disease | 35 (4.0) | 5 (3.1) | 30 (4.2) |
| Diabetes mellitus | 264 (30.2) | 49 (30.2) | 215 (30.3) |
| Hypertension | 532 (60.9) | 89 (54.9) | 443 (62.2) |
| COPD | 103 (11.8) | 11 (6.8) | 92 (12.9) |
| Malignancy | 33 (3.8) | 6 (3.7) | 27 (3.8) |
| CCI | | | |
| 0 | 391 (44.7) | 89 (54.9) | 302 (42.4) |
| 1 | 328 (37.5) | 52 (32.1) | 276 (38.8) |
| 2 or more | 155 (17.7) | 21 (13.0) | 134 (18.8) |
| ASA class | | | |
| 1 or 2 | 421 (48.2) | 91 (56.2) | 50 (46.3) |
| 3 | 435 (49.8) | 70 (43.2) | 365 (51.3) |
| 4 | 18 (2.0) | 1 (0.6) | 17 (2.4) |
| Walking ability during admission | | | |
| Can walk | 304 (34.8) | 68 (42.0) | 236 (33.1) |
| Cannot walk | 570 (65.2) | 94 (58.0) | 476 (66.9) |
| Year of admission | | | |
| 2002-2005 | 290 (33.2) | 39 (24.1) | 251 (35.3) |
| 2006-2009 | 584 (66.8) | 123 (75.9) | 561 (64.7) |
| Duration of hospital stay (days) (median, IQR) | 24 (20-34) | 20 (17-30) | 25 (21-35) |
| Survival time (days) (median, IQR) | 643 (213-1337) | 643 (202-1337) | 588 (231-1303) |
| Mortality after fracture | | | |
| Within 1 month | 12 (1.4) | 1 (0.6) | 11 (1.5) |
| Within 6 months | 66 (7.6) | 8 (4.9) | 58 (8.1) |
| Within 1 year | 105 (12.0) | 16 (9.9) | 89 (12.5) |

ASA=American Society of Anesthesiologists, CCI=Charlson comorbidity index, IQR=Interquartile range, NHI=National health insurance, BMI=Body mass index, IHD=Ischemic heart disease, COPD=Chronic obstructive pulmonary disease

65-95 years) and 676 of 874 (77.3%) were females. Of the 874 patients, 162 (18.5%) had surgery within 3 days of hospitalization and 472 (54%) had surgery at least 7 days after admission. In comparison with the delayed surgery group, the early surgery group had fewer comorbid chronic conditions, showed better physical status according to ASA class, had shorter periods of hospitalization and had more cases in which patients recovered their ambulatory ability during their hospitalization. However, the median survival time in the early surgery group was 643 days (interquartile range 202-1337), which was not significantly longer than the median survival time of 588 days (interquartile range 231-1303) in the delayed-surgery group. For the entire cohort of 874 subjects, the 1-month, 6-month, and 1-year mortalities were 1.4%, 7.6%, and 12%, respectively. The early surgery group showed a lower mortality rate than the delayed surgery group, but it was not significant [Table 1]. There were no nonmedical causes of delays to surgery.

On an unadjusted bivariate analysis, the timing of surgery, sex, age, current smoking, body mass index, operation type, CCI, some of the comorbid conditions, recovery of walking ability, physical condition indicators and some of the complications were associated with 1-year mortality. Mortality hazard ratio of the 712 patients who did not receive surgery within 3 days after the fracture injury increased in relation to the elapsed time with an unadjusted mortality rate of 1.2 (95% confidence interval [CI]: 0.8-1.2) in patients who had surgery within 3 to 7 days after the injury and 1.6 (95% CI: 1.1-2.1) in patients who had surgery at least 7 days after admission. However, in an adjusted analysis the timing of surgery did not have a significant effect on the 1-year mortality [Table 2 and Figure 1].

**Table 2: Association between time to surgery and mortality**

| From fracture to surgery (day) | Hazard ratio (95% CI) | | | | | |
|---|---|---|---|---|---|---|
| | 1-month mortality | | 6-month mortality | | 1-year mortality | |
| | Unadjusted | Adjusted | Unadjusted | Adjusted | Unadjusted | Adjusted |
| 0-3 | 1 | | 1 | | 1 | 1 |
| >3-7 | 1.2 (0.8-1.8) | 1.1 (0.8-1.7) | 1.2 (0.8-1.8) | 1.1 (0.7-1.6) | 1.2 (0.8-1.7) | 1.0 (0.7-1.6) |
| >7 | 1.5 (1.1-2.2) | 1.3 (0.9-1.8) | 1.6 (1.1-2.2) | 1.3 (0.9-1.9) | 1.6 (1.1-2.2) | 1.3 (0.9-1.8) |

CI=Confidence interval

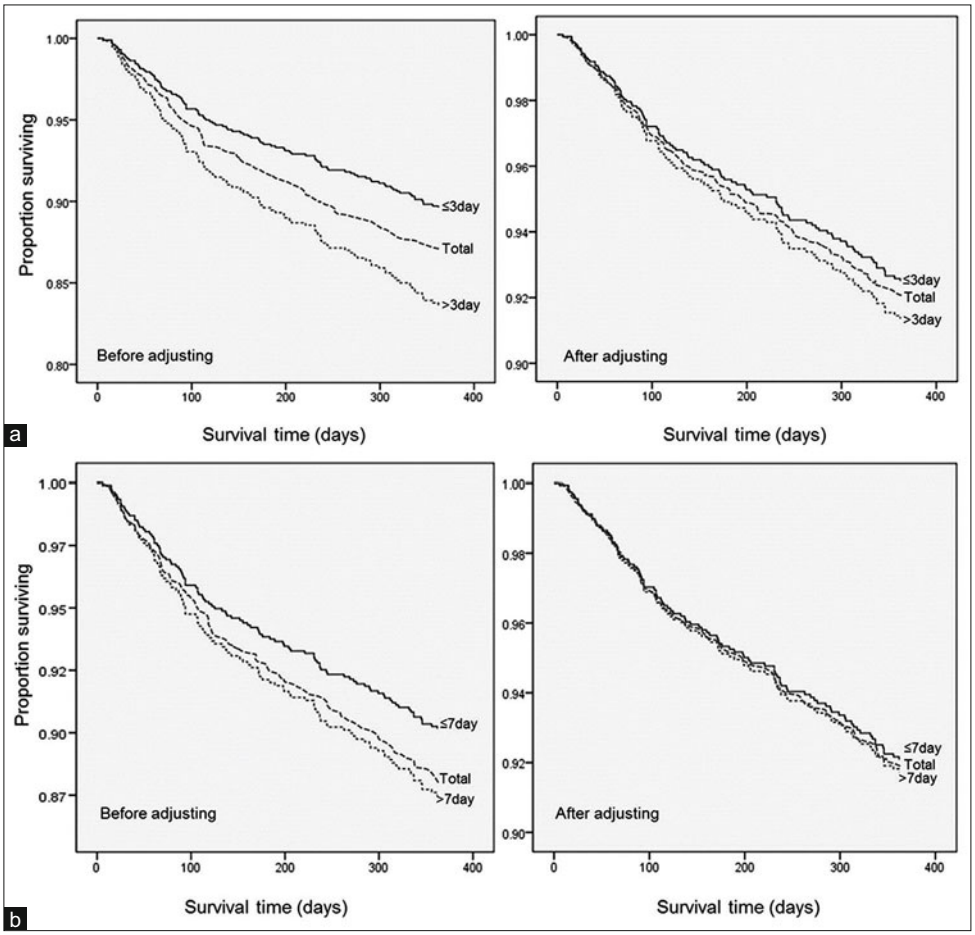


**Figure 1:** Adjusted long term survival of elderly hip fracture patients according to time from admission to surgery. (a) Comparison of survival between surgery within 3 days and surgery after 3 days. (b) Comparison between surgery within 7 days and surgery after 7 days. The survival plots show that time to surgery did not significantly relate to survival

In patients who had surgery after 7 days, the unadjusted 30-day and 6-month mortality hazard ratios were significantly increased, with ratios of 1.5 (95% CI: 1.1-2.2) and 1.6 (95% CI: 1.1-2.2), respectively. In patients who had surgery 3-7 days after admission, the 30-day and 6-month mortality rates were not significantly higher than those of the early-surgery group. After adjustment, the timing of surgery was no longer significantly associated with 30-day and 6-month mortality [Table 2]. The relative risk of major complications that occurred at a relatively high rate in the delayed-surgery group was not significantly higher compared with that in the early-surgery group [Table 3].

## Discussion

Several previous studies on the timing of hip fracture surgery have generally shown that early surgery within 2-3 days is associated with high long term survival and a low complication rate.[2,3,6,8,17-19] However, several studies have also shown that early surgery and prognosis are not related.[7-11,17] In the present study, the rate of early surgery within 3 days of hospitalization was 18.5%, which was relatively lower than the early-surgery rate of nearly 40% in England or other European or North American countries.[2] In addition, 54% of the patients received surgery after at least 7 days of hospitalization,

**Table 3: Association between surgery timing and development of complications during admission**

| Complications | Number (%) | | Adjusted relative risk (95% CI) |
|---|---|---|---|
| | Surgery ≤3 days (*n*=162) | Surgery >3 days (*n*=712) | |
| Delirium | 25 (15.4) | 86 (13.5) | 0.82 (0.51-1.33) |
| Pulmonary congestion | 11 (6.8) | 36 (5.1) | 0.73 (0.36-1.47) |
| Pulmonary embolism | 6 (3.7) | 40 (5.6) | 1.38 (0.40-4.72) |
| Bed sore | 6 (3.7) | 43 (6.0) | 1.67 (0.70-4.00) |
| Electrolyte imbalance | 6 (3.7) | 41 (5.8) | 1.56 (0.54-4.51) |
| Pneumonia | 5 (3.1) | 45 (6.3) | 2.12 (0.83-5.42) |
| Acute renal failure | 5 (3.1) | 19 (2.7) | 0.86 (0.32-2.34) |

CI=Confidence interval

which was different from the results of other previous studies. However, the 1 year mortality rate was 9.9% in the early surgery group and 12.5% in the delayed surgery group, which was similar to or lower than, the mortality rate reported in previous studies. In addition, the results of this study show that the time to surgery did not have a significant effect on short term or long term mortality and complications, probably because the major reason for the delay of surgery was an active medical problem.[8,10,20-25] In this study, the rate of poor physical status was high in the delayed-surgery group, which may account for the high mortality and complication rate in this group. However, in elderly patients, 1 week of bed rest resulted in muscle weakness and a 1/3 decrease in strength, and it increased the rate of complications such as pulmonary embolism. Furthermore, it is true that with the passage of time after injury the morbidity does increase in the elderly, which ultimately may be the cause of morbidity. Therefore, even if adequate medical care can ameliorate the disadvantages associated with delayed surgery, the necessity of preparing the patient for surgery as soon as possible is clear.[19] However, rather than recommending a universal timing for surgery, the condition and medical environment of each patient should be considered in deciding the timing of surgery. Thus, the results of this study suggest that the importance of reducing the absolute number of unacceptable delays outweighs the importance of advancing the date of the surgery.

The limitations in this study include the following: First, the study was not a randomized trial and therefore, cannot cover all aspects of mortality and other factors related to complications. However, this limitation is considered to be minimal because many variables have been collected from the medical records. Second, when data was gathered from medical records, missing, or incorrect data may have been used. Furthermore, there were no separate data records for reasons for delay in surgery. Therefore, data may be missing. Additionally, methods of medical treatments, physical condition of the patients and surgery skills may vary by year and by hospital. However, we added year and hospital to the analysis model. Third, the operative technique was simply classified into two groups (internal fixation and replacement) to increase the statistical power for analyzing these small sized sample groups. Currently however, various operative techniques are used for hip fracture and each of these techniques can have its own mortality or morbidity. This is a potential drawback of this study.

Finally, this study did not evaluate the functional capacity of the patients, e.g. patient activity changes between the fracture and long term followup, recurrence after discharge resulting in nonunion, residential district of the patients and treatment for osteoporosis. These variables should be included in a future prospective study. Additionally, the data may lack accuracy because all data was gathered from charts and the possibility that the cause of death could be nonmedical too cannot be ruled out. Moreover, although variables that seem to affect mortality were addressed, only variables with relatively high prevalence were included in the multivariate analysis. Therefore, the results may be different if larger studies are undertaken.

The time to surgery was not significantly related to short or long term mortality or to an increase in the in hospital complication rate. However, these findings do not devalue the standard teaching in which the elderly patient, whenever fit for anesthesia, should be operated on as early as possible basis in view of the comorbid conditions. We recommend concentrating more on optimizing the condition of patients early with sufficient medical treatment rather than being bound by the absolute timing of surgery.

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