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Hip Fracture Surgery Between 24–48 Hours Is a Risk Factor for One-Year Mortality in Elderly Patients

Pumsak Thamviriyarak, MD

Department of Orthopedics, Yasothon Hospital, Yasothon, Thailand

Purpose: This study compared one-year survival rates between elderly patients who underwent hip fracture surgery within 24 hours versus those between 24–48 hours, and assessed factors influencing survival.
Methods: This retrospective cohort study included elderly patients who underwent hip fracture surgery at Yasothon Hospital between June 1, 2019, and January 31, 2023. Patients were followed up until their final life status, as determined on January 31, 2024. In total, 212 patients were included, with 106 each undergoing surgery within 24 hours and between 24–48 hours. Statistical analyses were performed using the log-rank test and Cox regression.
Results: A total of 36 patients (16.98%) died during the one-year follow-up period, with most deaths occurring in the 24–48-hour surgery group (27 patients, 25.47%). The mortality rates at 3 months, 6 months, and 1 year were 5.19%, 3.30%, and 8.49%, respectively. Significant mortality predictors included: age (adjusted HR = 1.06, 95% CI = 1.01–1.12); ASA class 3 (adjusted HR = 8.17, 95% CI = 1.03–64.79); general anesthesia (adjusted HR = 3.10, 95% CI = 1.46–6.57); complications (adjusted HR = 2.16, 95% CI = 1.02–4.56); and surgery performed after 24 hours (adjusted HR = 3.88, 95% CI = 1.67–9.02).
Conclusions: Hip fracture surgery performed after 24 hours significantly increases the mortality risk in elderly patients. General anesthesia and postoperative complications are the key factors affecting survival. These findings emphasize the importance of surgery within 24 hours to reduce both mortality and complications in elderly patients.

Keywords: Hip fractures, Mortality, time to treatment

The hip bone is a vital component of the skeletal system; it supports body weight and enables movement. It also acts as a reservoir for essential minerals such as calcium [1]. Hip fractures are among the most common causes of emergency orthopedic surgery in the elderly and often require long-term care [2]. Despite advancements in medical treatment, mortality rates following hip fracture surgery remain high. Research shows that 10% of patients die within 30 days post-surgery, whereas 8–36% die within one year [3]. The global incidence of hip fractures is increasing, particularly among individuals aged ≥65 years. Many countries report 10–15 cases per 1,000 people annually, with women experiencing a 2–3 times higher prevalence because of their increased risk of osteoporosis [4].

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Correspondence to: Pumsak Thamviriyarak, MD
Department of Orthopedics, Yasothon Hospital, Yasothon, Thailand
E-mail: adepo99@hotmail.com

In the United States, approximately 280,000 hip fractures occur per year, with projections suggesting an increase to 500,000 cases annually by 2040 (5). In Thailand, the number of hip fractures is expected to reach 34,246 cases by 2025 and 56,443 cases by 2050 (6). Falls are the primary cause of hip fractures in the elderly; they are often associated with osteoporosis, sarcopenia, and impaired balance (7,8). Patients with hip fractures typically experience intense pain and cannot bear weight, resulting in a loss of independence and an increased risk of complications such as pneumonia, pressure ulcers, and sepsis (9). These increasing numbers underscore the urgent need for improved treatment and management strategies to reduce the burden of hip fractures and their associated complications in the elderly.

Surgical intervention is the gold standard treatment for hip fractures. For medically stable patients, surgery within 48 hours is recommended to reduce complications such as infections, venous thromboembolism, and prolonged immobility (10,11). Postoperative rehabilitation, including physical therapy and structured exercise programs, is essential to restore muscle strength, flexibility, and overall quality of life (12,13). Several studies state that early surgical intervention (within 24–48 hours) significantly improves survival rates. The National Institute for Health and Care Excellence (NICE) in the United Kingdom recommends surgery within 48 hours (14,15), although other studies state that surgery within 24 hours yields even better outcomes (16). Earlier studies have demonstrated that surgery delayed beyond 48 hours increases the risk of mortality (10,11).

Although numerous international studies have demonstrated improved outcomes with early surgery, the applicability of these findings to the Thai population remains uncertain. Differences in healthcare systems, hospital resources, surgical access, and patient characteristics may influence the treatment outcomes. Therefore, local evidence is essential to validating international recommendations within the Thai context. Generating Thai-specific data will support evidence-based national clinical guidelines and help optimize the care of elderly patients with hip fractures.

In the context of clinical practice in Thailand, limited data exist regarding survival rates among elderly patients with hip fractures, highlighting the need for further research. This study aimed to compare one-year survival rates in elderly patients who underwent hip fracture surgery within 24 hours and those who underwent surgery between 24–48 hours at Yasothon hospital. Additionally, this study aimed to analyze the factors influencing survival, providing essential data for improving clinical guidelines and enhancing the standard of care for elderly patients with hip fractures in Thailand.

METHODS

Study Design

A retrospective cohort study was conducted using medical records at Yasothon Hospital.

Study Population

This study included elderly patients who underwent hip fracture surgery at Yasothon Hospital between June 1, 2019, and January 31, 2023. All patients were followed up until January 31, 2024, to assess their one-year survival status, and no data beyond one year were collected. Hip fractures were defined as low-energy fractures involving the proximal femur, specifically femoral neck, intertrochanteric, and subtrochanteric fractures, confirmed through radiography: x-rays or computed tomography (CT).

At Yasothon Hospital, Thailand, surgical techniques were selected based on fracture type. Non-displaced femoral neck fractures were primarily treated with multiple screws fixation. Displaced femoral neck fractures were typically managed using cementless bipolar hemiarthroplasty, Austin Moore hemiarthroplasty for limited activity levels, and total hip replacement for preexisting hip pathologies, such as osteonecrosis or severe osteoarthritis of the hip. Intertrochanteric fractures were typically managed using proximal femoral nailing (PFN) for unstable fractures or dynamic hip screw fixation for stable fractures. Subtrochanteric fractures were treated using long PFN. The attending orthopedic surgeon chose the technique according to standard orthopedic management.

The timing of surgery (within 24 hours vs. 24–48 hours) was determined using a combination of clinical and logistical factors. Patients with stable vital signs who completed the preoperative assessments typically underwent surgery within 24 hours. Delays beyond 24 hours were usually due to comorbidities requiring further medical clearance, limited availability of operating rooms, or scheduling conflicts.

Sample Size Calculation

The sample size was calculated based on a previous study by Suttaphakti et al. [17], which reported a one-year survival rate of 95.5% for patients operated on within 72 hours and 83.8% for those operated on after 72 hours. The proportions in group 1 (p_1) and group 2 (p_2) were 0.950 and 0.830, respectively, with a ratio (r) of 1.00. The significance level (α) was set at 0.05, with Z (0.975) = 1.96, and the power (1-β) was 80%, corresponding to Z (0.800) = 0.84. The following equation was used to determine an approximate the sample size:

$$n_1 = \left[\frac{z_{1-\frac{\alpha}{2}} \sqrt{\bar{p}\bar{q}\left(1+\frac{1}{r}\right)} + z_{1-\beta}\sqrt{p_1 q_1 + \frac{p_2 q_2}{r}}}{\Delta} \right]^2$$

$$\Delta = p_1 - p_2, \quad \bar{p} = \frac{p_1 + p_2 r}{1+r}, \quad r = \frac{n_2}{n_1}$$

$$q_1 = 1 - p_1, \quad q_2 = 1 - p_2, \quad \bar{q} = 1 - \bar{p}$$

$$m_1 = \frac{n_1}{4}\left(1 + \sqrt{1 + \frac{2(r+1)}{n_1 r |p_2 - p_1|}}\right)^2$$

The estimated sample size was 212 patients, with 106 patients who underwent surgery within 24 hours and 106 patients who underwent surgery between 24–48 hours. At a total sample size of 212 patients (106 patients per group), the calculated power was 81.6% at a significance level of α = 0.05. This confirmed that the study had adequate power to detect a statistically significant intergroup differences. During the study period, more patients than the estimated sample size met the eligibility criteria. Therefore, we used simple random sampling based on medical records to select 212 patients, aligning with the calculated sample size for statistical power.

Inclusion and Exclusion Criteria

The inclusion criteria for the study were: patients aged ≥60 years, with radiographically confirmed hip fractures (via x-rays or CT scan), who underwent surgical treatment. The exclusion criteria were: a history of hip surgery (periprosthetic fracture), multiple fractures, head trauma, high-energy trauma, pathologic fractures, and surgery performed >48 hours after hospital admission. Pathologic fractures were defined as fractures caused by malignancy (primary or metastatic bone tumors) or metabolic bone diseases. Osteoporotic fragility fractures resulting from low-energy trauma (e.g., falls from standing height) were not considered pathological and were included in this study. Patients with high-energy trauma such as traffic accidents or falls from heights were excluded.

Definitions

Low-energy trauma refers to injuries resulting from minimal force, and is typically observed in elderly patients with osteoporosis. In this study, low-energy trauma was defined as a fall from standing height or less, such as tripping or slipping while walking.

High-energy trauma involves substantial external forces and is typically associated with traffic accidents, falls from significant heights, or direct impact injuries. These mechanisms often result in complex fractures and were therefore excluded from this study.

Pathological bone refers to bone that is structurally weakened due to underlying diseases, such as primary bone tumors, metastatic bone disease, or metabolic bone disorders. Fractures in these bones are considered pathological fractures. However, osteoporotic fractures from low-energy trauma were not considered pathological for exclusion purposes in this study.

Multiple fractures were defined as more than one fracture site occurring simultaneously during the same traumatic event (e.g., hip fracture plus wrist fracture from the same fall). Patients with a history of fractures at different times were not excluded unless the prior fracture involved the hip and had undergone surgery.

Death from causes unrelated to hip fracture was defined as death clearly attributable to non-fracture-related causes such as advanced malignancy, cerebrovascular accident, myocardial infarction, or end-stage organ failure, based on medical records or the national death registry. These patients were censored for the survival analyses.

Patient Follow-up

The study subjects were followed up from the time of the hip fracture surgery until 365 days postoperatively. Patients who were lost to follow-up or died from causes unrelated to hip fractures were considered censored cases. Mortality status and the cause of death were verified using data obtained from the National Civil Registry database.

Material

Data were retrospectively collected from electronic medical records and inpatient department (IPD) charts at Yasothon Hospital from June 1, 2019, to January 31, 2023. The parameters collected included demographic data (age, sex, body mass index), fracture type, ASA classification, type of anesthesia, surgical technique, operative time, estimated blood loss, postoperative opioid use (oral morphine equivalents [OME]), complication types, and mortality status at 3, 6, and 12 months. Mortality data were cross-referenced and verified using the National Civil Registry Database as of January 31, 2024.

Research Ethics

This study was approved by the Human Research Ethics Committee of Yasothon Hospital under the approval document number YST-2024-20, issued on June 4, 2024.

Statistical Analysis

Descriptive statistics were used to present normally distributed data as mean ± standard deviation (SD), whereas non-normally distributed data were reported as median and interquartile range (IQR). For inferential statistics, the chi-square test or Fisher's exact test was used to compare categorical variables. The Kaplan-Meier method was used to analyze overall survival and disease-free survival, and the results are presented as a Kaplan-Meier survival curve. The log-rank test was used to compare survival distributions between groups. Cox regression analysis was performed to estimate both crude and adjusted hazard ratios (HR), along with 95% confidence intervals (CI). Statistical significance was set at $p < 0.05$.

RESULTS

Of the 212 patients included in the study, 36 (16.98%) died by the one-year follow-up. Among the 36 patients who died during the one-year follow-up period, 27 deaths (25.47% of all participants) occurred in the group that underwent surgery between 24–48 hours, while 9 deaths (8.49%) occurred in the group that underwent surgery within 24 hours. In comparison, the group that underwent surgery within 24 hours had a significantly lower mortality rate (2.81%). Mortality rates were evaluated at three postoperative time points: 3 months (11 patients, 5.19%), 6 months (7 patients, 3.30%), and 1 year (18, 8.49%) (Table 1). The results of the log-rank test, which indicated a statistically significant difference in survival rates between the two groups ($p = 0.0011$), are shown in Figure 1.

Patients who underwent surgery within 24 hours were significantly older than those in the 24–48-hour group ($p = 0.011$) and had a higher proportion of intertrochanteric fractures ($p = 0.002$). The delayed surgery group had a significantly longer operation time and greater estimated blood loss ($p = 0.009$ and $p = 0.025$, respectively). Additionally, this group received higher opioid doses, as reflected by greater morphine consumption, cumulative postoperative OME, and average OME per hospital day (all $p < 0.05$). However, there were no statistically significant differences in postoperative complications, including anemia, urinary tract infection, pneumonia, or delirium, between the two groups (Table 2).

Table 1 Comparison of one-year survival rates following hip fracture surgery performed within 24 hours and between 24–48 hours (n = 212).

Mortality	Deaths (n, %)		p-value
	Surgery within 24 hours	**Surgery between 24–48 hours**	
3 months	3 (2.83)	8 (7.55)	0.122[a]
6 months	0 (0.97)	7 (6.60)	0.035[b]
1 year	6 (5.66)	12 (11.32)	0.139[a]

*p-values were calculated using the [a]chi-square test and [b]Fisher's exact test.

Table 2 General characteristics of the patients in the study, stratified according to time to surgery.

Variables	Surgery within 24 hours (n=106)	Surgery between 24–48 hours (n=106)	Total (n=212)	p-value
Sex (n, %)				1.000[a]
Male	33 (31.13)	33 (31.13)	66 (31.13)	
Female	73 (68.87)	73 (68.87)	146 (68.87)	
Age, years (Mean ± SD)	77.14 ± 7.72	74.44 ± 7.60	75.79 ± 7.76	0.011[b]
BMI, kg/m^2 (Mean ± SD)	22.45 ± 3.45	22.36 ± 3.48	22.41 ± 3.46	0.865[b]
Underweight (< 18.50) (n, %)	11 (10.38)	12 (11.32)	23 (10.85)	0.784[a]
Normal (18.50–22.99) (n, %)	49 (46.23)	53 (50.00)	102 (48.11)	
Overweight (≥ 23.00) (n, %)	46 (43.40)	41 (38.68)	87 (41.04)	
Fracture type (n, %)				0.002[a]
Neck of femur	26 (24.53)	47 (44.34)	73 (34.43)	
Intertrochanteric fracture	80 (75.47)	59 (55.66)	139 (65.57)	
ASA class (n, %)				0.563[c]
1	2 (1.89)	0 (0.00)	2 (0.94)	
2	24 (22.64)	26 (24.53)	50 (23.58)	
3	80 (75.47)	80 (75.47)	160 (75.47)	
Preoperative opioid use (n, %)				0.054[a]
No	57 (53.77)	43 (40.57)	100 (47.17)	
Yes	49 (46.23)	63 (59.43)	112 (52.83)	
Surgical fixation/treatment (n, %)				<0.001[c]
Multiple screws fixation	2 (1.89)	3 (2.83)	5 (2.36)	
Bipolar hemiarthroplasty	10 (9.43)	37 (34.91)	47 (22.17)	
Proximal femoral nailing	80 (75.47)	60 (56.60)	140 (66.04)	
Total hip replacement	0 (0.00)	1 (0.94)	1 (0.47)	
Austin Moore hemiarthroplasty	14 (13.21)	5 (4.72)	19 (8.96)	
Operative time, Min	48.76 ± 21.95	57.42 ± 26.39	53.09 ± 24.60	
(Mean ± SD) Median (Q1, Q3)	42.5 (32.0, 60.0)	50.0 (35.0, 70.0)	48.5 (35.0, 66.0)	0.009[d]
Estimate blood loss, ml	76.13 ± 44.56	103.21 ± 87.94	89.67 ± 70.86	
(Mean ± SD), Median (Q1, Q3)	50.0 (50.0, 100.0)	100.0 (50.0, 100.0)	100.0 (50.0, 100.0)	0.025[d]

Table 2 General characteristics of the patients in the study, stratified according to time to surgery. (Cont.)

Variables	Surgery within 24 hours (n=106)	Surgery between 24–48 hours (n=106)	Total (n=212)	p-value
Anesthesia type (n, %)				0.237[a]
Spinal Block	94 (88.68)	88 (83.02)	182 (85.85)	
General Anesthesia	12 (11.32)	18 (16.98)	30 (14.15)	
Morphine, mg (n=186)	15.84 ± 13.38	23.12 ± 17.65	19.36 ± 15.97	
(Mean ± SD) Median (Q1, Q3)	12.0 (8.0, 24.0)	18.0 (11.0, 30.0)	15.0 (8.0, 26.0)	0.001[d]
Tramadol, mg (n=28)	4.50 ± 1.41	6.33 ± 5.69	5.70 ± 4.69	
(Mean ± SD), Median (Q1, Q3)	5.0 (5.0, 5.0)	5.0 (1.0, 15.0)	5.0 (1.0, 5.0)	0.914[d]
Fentanyl, mcg (n=22)	11.82 ± 21.33	4.50 ± 3.24	8.33 ± 15.69	
(Mean ± SD), Median (Q1, Q3)	5.0 (3.0, 8.0)	5.0 (1.0, 8.0)	5.0 (1.0, 8.0)	0.495[d]
Total length of stay, hours	169.85 ± 86.39	194.51 ± 107.82	182.18 ± 98.24	
(Mean ± SD), Median (Q1, Q3)	146.5 (120.0, 190.0)	167.0 (142.0, 209.0)	163.0 (133.5, 197.0)	0.013[d]
Total oral morphine equivalents (n=194) (Mean ± SD), Median (Q1, Q3)	46.53 ± 39.99 36.0 (18.0, 69.0)	72.66 ± 53.79 54.0 (37.5, 94.5)	59.39 ± 48.95 45.0 (27.0, 75.0)	<0.001[d]
Cumulative post-operative OME (n=193) (Mean ± SD), Median (Q1, Q3)	40.61 ± 38.53 30.0 (12.0, 48.0)	61.03 ± 47.51 45.0 (30.0, 81.0)	50.60 ± 44.24 36.0 (24.0, 69.0)	<0.001[d]
Average OME per hospital day (n=194) (Mean ± SD), Median (Q1, Q3)	7.86 ± 5.49 6.63 (4.0, 11.25)	10.08 ± 7.38 7.61 (4.8, 13.56)	8.95 ± 6.57 7.29 (4.5, 12.0)	0.049[d]
Preoperative pain score	3.01 ± 1.01	2.91 ± 1.05	2.96 ± 1.03	
(Mean ± SD), Median (Q1, Q3)	3.0 (2.0, 3.0)	3.0 (2.0, 3.0)	3.0 (2.0, 3.0)	0.386[d]
Postoperative pain score	1.40 ± 0.95	1.34 ± 0.92	1.37 ± 0.94	
(Mean ± SD), Median (Q1, Q3)	2.0 (1.0, 2.0)	1.0 (1.0, 2.0)	2.0 (1.0, 2.0)	0.590[d]
Complication (n, %)				0.674[a]
No	65 (61.32)	62 (58.49)	127 (59.91)	
Yes	41 (38.68)	44 (41.51)	85 (40.09)	
Anemia	36 (33.96)	32 (30.19)	68 (32.08)	0.556[a]
Sepsis/Septic	1 (0.94)	2 (1.89)	3 (1.42)	0.561[c]
Pneumonia	4 (3.77)	2 (1.89)	6 (2.83)	0.407[c]
UTI	1 (0.94)	5 (4.72)	6 (2.83)	0.098[c]
Heart Failure	1 (0.94)	4 (3.77)	5 (2.36)	0.175[c]
Delirium	0 (0.00)	1 (0.94)	1 (0.47)	0.316[c]

*p-values were calculated using [a]chi-square test, [b]independent t-test, [c]Fisher's exact test, and [d]Mann–Whitney U test.

* OME= Oral Morphine Equivalent, ASA= American Society of Anesthesiologists

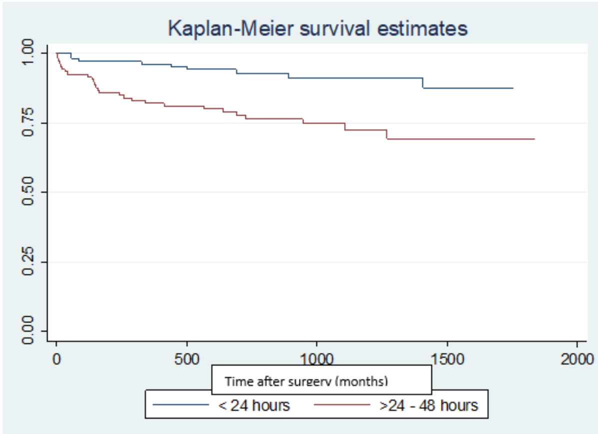

Fig. 1 Kaplan–Meier survival curves comparing cumulative survival between patients undergoing hip fracture surgery within 24 hours and those between 24–48 hours.

X-axis: Time after surgery (months); Y-axis: Cumulative survival probability.
Log-rank test: p = 0.0011

A total of 36 patients (16.98%) died within one year of surgery. The mean age of non-survivors was significantly higher than that of survivors ($p = 0.004$, and all non-survivors were classified as ASA Class 3 ($p = 0.001$). The non-survivor group also had a significantly higher proportion of patients receiving general anesthesia ($p < 0.001$), longer hospital stay ($p = 0.001$), and higher total oral morphine equivalent consumption ($p = 0.047$). Additionally, postoperative complications, particularly pneumonia ($p = 0.013$), heart failure ($p = 0.003$), and delirium ($p < 0.001$), were more frequent in this group. The results are summarized in Table 3.

Table 3 General characteristics of the patients in the study (n=212).

Variables	**Survivors (n = 176)**	**Death (n=36)**	**Total (n=212)**	**p-value**
Sex (n, %)				0.429[a]
Male	53 (30.11)	13 (36.11)	66 (31.13)	
Female	123 (69.89)	23 (63.89)	146 (68.87)	
Age, years (Mean ± SD)	75.11±7.75	79.14±6.99	75.79±7.76	0.004[b]
BMI, kg/m² (Mean ± SD)	22.40±3.30	22.45±4.19	22.41±3.46	0.903[b]
Underweight (< 18.50) (n, %)	19 (10.80)	4 (11.11)	23 (10.85)	0.955[a]
Normal (18.50–22.99) (n, %)	86 (48.86)	16 (44.44)	102 (48.11)	
Overweight (≥ 23.00) (n, %)	71 (40.34)	16 (44.44)	87 (41.04)	
Fracture type (n, %)				0.581[a]
Neck of femur	59 (33.52)	14 (38.89)	73 (34.43)	
Intertrochanteric fracture	117 (66.48)	22 (61.11)	139 (65.57)	
American Society of Anesthesiologists Physical Status Classification (ASA class) (n, %)				0.001[c]
1	2 (1.14)	0 (0.00)	2 (0.94)	
2	50 (28.41)	0 (0.00)	50 (23.58)	
3	124 (70.45)	36 (100.00)	160 (75.47)	
Preoperative opioid use (n, %)				0.922[a]
No	83 (47.16)	17 (47.22)	100 (47.17)	
Yes	93 (52.84)	19 (52.78)	112 (52.83)	
Surgical fixation/treatment (n, %)				0.586[c]
Multiple screws fixation	4 (2.27)	1 (2.78)	5 (2.36)	
Bipolar hemiarthroplasty	40 (22.73)	7 (19.44)	47 (22.17)	
Proximal femoral nailing	118 (67.05)	22 (61.11)	140 (66.04)	

Table 3 General characteristics of the patients in the study (n=212). (Cont.)

Variables	Survivors (n = 176)	Death (n=36)	Total (n=212)	p-value
Total hip replacement	1 (0.57)	0 (0.00)	1 (0.47)	
Austin Moore hemiarthroplasty	13 (7.39)	6 (16.67)	19 (8.96)	
Operative time, Min	53.47±24.33	51.22±26.14	53.09±24.60	0.474[d]
(Mean ± SD), Median (Q1, Q3)	50 (35, 65)	40 (33.5, 68.5)	48.5 (35, 66)	
Estimate blood loss, ml	87.24±70.58	101.53±72.00	89.67±70.86	0.200[d]
(Mean ± SD), Median (Q1, Q3)	90 (50, 100)	100 (50, 100)	100 (50, 100)	
Anesthesia type (n, %)				<0.001[a]
Spinal Block	157 (89.20)	25 (69.44)	182 (85.85)	
General Anesthesia	19 (10.80)	11 (30.56)	30 (14.15)	
Morphine, mg (n=186)	17.27±15.65	21.09±18.49	17.93±16.19	0.070[d]
(Mean ± SD) Median (Q1, Q3)	14 (8, 24)	20 (12, 33)	15 (8, 26)	
Tramadol, mg (n=28)	8.46±27.27	25.93±50.71	12.60±34.83	0.767[d]
(Mean ± SD) Median (Q1, Q3)	5 (5, 5)	1 (1, 15)	5 (1, 5)	
Fentanyl, mcg (n=22)	5.72±19.88	15.39±33.92	8.03±24.18	0.596[d]
(Mean ± SD), Median (Q1, Q3)	5 (3, 8)	4 (1, 8)	5 (1, 8)	
Total length of stay, hours	172.23±81.18	230.81±149.35	182.18±98.24	0.001[d]
(Mean ± SD), Median (Q1, Q3)	159.5 (133.5,191)	182 (134, 268)	163 (133.5, 197)	
Total oral morphine equivalents (n=194)	53.46±47.66	71.23±55.65	56.50±49.42	0.047[d]
(Mean ± SD), Median (Q1, Q3)	45 (24, 72)	60 (42, 87)	45 (27, 75)	
Cumulative post-operative OME (n=193)	43.86±41.97	59.23±54.28	46.55±44.60	0.057[d]
(Mean ± SD), Median (Q1, Q3)	36 (24, 63)	39 (30, 85.5)	36 (24, 69)	
Average Oral Morphine Equivalent (OME) per	8.42±6.64	8.97±7.01	8.52±6.69	0.613[d]
hospital day (n=194) (Mean ± SD), Median (Q1, Q3)	7.2 (4.5, 12.0)	8.0 (5.25, 10.8.0)	7.29 (4.5, 12.0)	
Preoperative pain score (Mean ± SD),	2.97±1.00	2.92±1.16	2.96±1.03	0.794[d]
Median (Q1, Q3)	3 (2, 3)	3 (2, 3)	3 (2, 3)	
Postoperative pain score (Mean ± SD)	1.38±0.91	1.31±1.06	1.37±0.94	0.662[d]
Median (Q1, Q3)	2 (1, 2)	1 (0, 2)	2 (1, 2)	
Complication (n, %)				0.025[a]
No	112 (63.64)	15 (41.67)	127 (59.91)	
Yes	64 (36.36)	21 (58.33)	85 (40.09)	
Anemia	54 (30.68)	14 (38.89)	68 (32.08)	0.467[a]
Sepsis/Septic	2 (1.14)	1 (2.78)	3 (1.42)	0.317[c]
Pneumonia	3 (1.70)	3 (8.33)	6 (2.83)	0.013[c]
Urinary Tract Infection (UTI)	6 (3.41)	0 (0.00)	6 (2.83)	0.297[c]
Heart Failure	2 (1.14)	3 (8.33)	5 (2.36)	0.003[c]
Delirium	0 (0.00)	1 (2.78)	1 (0.47)	<0.001[c]

*p-values were calculated using [a]chi-square test, [b]independent t-test, [c]Fisher’s exact test, and [d]Mann–Whitney U test.

Multivariate Cox regression analysis was conducted to determine the risk factors of mortality in elderly patients undergoing hip fracture surgery with a one-year follow-up period. The analysis revealed that older age, ASA Class 3 classification, use of general anesthesia, postoperative complications, and surgery delayed beyond 24 hours were significantly associated with increased mortality risk (Table 4). The findings showed that for every one-year increase in age, the risk of mortality increased by 6% (adjusted HR = 1.06, 95% CI: 1.01–1.12, p = 0.027). Patients classified as ASA Class 3 had an 8.17 times higher risk of mortality (95% CI: 1.03–64.79, p = 0.047). The use of general anesthesia was associated with a 3.10-fold higher mortality risk (95% CI: 1.46–6.57, p = 0.003). Patients who developed postoperative complications had a 2.16-fold higher risk of mortality (95% CI: 1.02–4.56, p = 0.044). patients who underwent surgery after 24 hours had a 3.88-fold higher mortality risk (95% CI: 1.67–9.02, p = 0.002).

Table 4 Risk factors associated with mortality in the study.

Variables	**Univariate Cox regression**		**Multivariate Cox regression**	
	Crude HR (95% CI)	**p-value**	**Adjusted HR (95% CI)**	**p-value**
Age	1.07 (1.02–1.11)	0.004	1.06 (1.01–1.12)	0.027
ASA class (3)	13.59 (1.86–99.21)	0.010	8.17 (1.03–64.79)	0.047
General anesthesia	3.28 (1.61–6.67)	0.001	3.10 (1.46–6.57)	0.003
Total length of stay	1.00 (1.00–1.01)	0.001	1.00 (0.99–1.00)	0.347
Total oral morphine equivalents	1.01 (1.00–1.01)	0.047	1.01 (1.00–1.01)	0.092
Complication	2.11 (1.08–4.09)	0.028	2.16 (1.02–4.56)	0.044
Surgery after 24 hours	3.29 (1.55–6.99)	0.002	3.88 (1.67–9.02)	0.002

DISCUSSION

Hip fractures in the elderly significantly affect quality of life, functional independence, and survival [2]. Surgical intervention is essential, with early surgery (within 24 hours) linked to reduced mortality, faster mobilization, shorter hospital stays, and fewer complications [16, 18]. However, the survival outcomes between early and delayed surgeries are still debated. Our study shows that delayed surgery (24–48 hours) substantially increases mortality risk, with general anesthesia and postoperative complications as key factors.

The one-year mortality rate in our study was consistent with that of previous research: 16.6% and 19.9% [19, 20]. Klestil et al.'s meta-analysis of 46 studies also supports the benefit of early surgery, showing a significant reduction in 30-day (RR = 0.86, 95% CI: 0.82–0.91) and one-year mortality [16]. Seckel et al. demonstrated that surgery within 24 hours decreased mortality in patients older than 90 years from 15.2% to 4.2% [21], and Welford et al. found that it reduced 30-day mortality from 14% to 8.6% [22]. Our findings further confirm that timely surgical intervention enhances recovery and survival outcomes.

We found that delayed surgery increased mortality risk 3.88-fold (adjusted HR = 3.88; 95% CI: 1.67–9.02), consistent with Lieten et al.'s findings [23]. Delays also increased the risk of perioperative cardiac complications (p = 0.010), pneumonia (p < 0.001), and overall mortality (OR = 2.634, p < 0.001), highlighting the importance of early surgery. This supports the NICE and American Academy of Orthopaedic Surgeons guidelines advocating surgery within 24–48 hours [24]. Advanced age was an independent predictor of mortality, increasing death risk by 6% per year (adjusted HR = 1.06; 95% CI: 1.01–1.12), consistent with the outcomes reported by Morri et al. [19] and Luo et al. [25]. General anesthesia raised the mortality risk 3.10-fold (adjusted HR = 3.10; 95% CI: 1.46–6.57), similar to reports by Qiu et al. [26] and Desai et al. [27]. This is likely due to hemodynamic instability, cognitive dysfunction, and other complications [28]. Although our findings showed a significantly increased mortality risk in patients who underwent surgery after 24 hours, this association should be interpreted with caution. In our study, the timing of surgery was influenced by both clinical and logistical factors. Patients who were medically stable typically underwent surgery within 24 hours, whereas delays beyond 24 hours were often due to comorbidities requiring further medical optimization or operating room constraints. These nonrandom factors could have introduced a selection bias. However, as shown in Table 4, we performed a multivariate Cox regression analysis after adjusting for key confounders, including age, ASA class, anesthesia type, length of stay, morphine use, complications, and surgical timing. This finding strengthens the validity of our conclusion that surgical delay beyond 24 hours is independently associated with increased mortality.

Patients classified as ASA Class 3 had an 8.17-fold increased mortality risk (adjusted HR = 8.17; 95% CI: 1.03–64.79), consistent with Luo et al. [25], reflecting the impact of severe comorbidities on perioperative stability and recovery. Our finding that postoperative complications doubled mortality risk (adjusted HR = 2.16; 95% CI: 1.02–4.56), is in line with the outcomes reported by Choi et al., who analyzed 1,363 hip fracture patients [29]. The most common complications contributing to increased mortality include hospital-acquired pneumonia, pulmonary embolism, deep vein thrombosis, and cardiovascular events [30]. These results underscore the critical role of careful perioperative management in mitigating the increased mortality risk associated with severe comorbidities and postoperative complications in elderly patients with hip fractures.

The findings of this study should be interpreted considering its retrospective design and reliance on electronic medical records from a single institution, which may limit the generalizability of the results to other settings with different treatment protocols, resources, and patient populations. Nevertheless, we recommend that future studies utilize a prospective cohort approach to improve data accuracy and explore long-term outcomes, such as mobility, pain, and quality of life post-surgery. Further research should investigate the role of nutritional status, frailty, and rehabilitation strategies in optimizing perioperative care and refining the guidelines for elderly patients with hip fractures.

CONCLUSIONS

In addition to its retrospective design and single-center setting, this study has several limitations. First, different fracture types were treated using different surgical techniques (e.g., multiple screws, hemiarthroplasty, and PFN), which may have introduced bias. We did not directly compare outcomes across fracture patterns or surgical methods. As a result, it is possible that differences in the surgical approach, rather than in surgical timing alone, contributed to the observed differences in mortality. Although we adjusted for several key confounders in the multivariate analysis, residual confounding factors related to fracture severity and surgical complexity may still exist.

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