Turkish Journal of Geriatrics
DOI: 10.31086/tjgeri.2022.304
2022; 25(3): 452-464

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Received : Jul 27, 2022
Accepted : Sep 20, 2022

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RESEARCH

EVALUATION OF FACTORS AFFECTING MORTALITY IN GERIATRIC HIP FRACTURE SURGERY: A RETROSPECTIVE STUDY

Abstract

Introduction: The primary aim of this study is to evaluate the effect of anesthesia methods on in-hospital, 30-day, and six-month mortality following geriatric hip fracture surgery. The secondary aim is to evaluate the effect of preoperative comorbidities on mortality.

Method: This retrospective study included patients aged ≥75 years who had undergone femoral neck fracture surgery.

Results: The data of 135 patients were analyzed. The postoperative stay in the intensive care unit of patients who were given general anesthesia ($p < 0.05$) was significantly longer. In the comparisons made according to survival, the exitus cases were found to have higher rates of renal disease and dementia. The variables found to be significantly different in the paired comparisons and determined to be a risk factor as a result of logistic regression analysis were applied with an receiver operating characteristic analysis, as a result of which a cutoff value of 6 in the modified Charlson comorbidity index score was found to be statistically significant area under curve = 0.727, $p < 0.001$, 95% CI: 0.644–0.800). The cutoff value for preoperative hemoglobin was determined to be 11.4 (Area under curve = 0.643, $p = 0.005$, 95% confidence interval: 0.556–0.723).

Conclusions: Ensuring the preoperative waiting time does not exceed 48 hours, optimizing the medical and hemodynamic status with a multidisciplinary approach, and determining the anesthesia method according to the clinical characteristics of each patient may contribute to reducing mortality rates.

Keywords: Hip Fractures; Geriatrics; Anesthesia; Mortality.

INTRODUCTION

As the population of the elderly grows worldwide, the incidence of surgical interventions for elderly individuals has also increased, the most common of which has been reported to be orthopedic operations. Hip fractures occur in approximately 1.6 million people per year worldwide, and it is estimated that this number could reach 6 million by 2050 (1). Despite efforts made to improve perioperative care, complications and mortality rates following geriatric hip fracture surgery continue to be a problem throughout the world. It is thought that hip fractures due to osteoporosis and osteopenia may increase in more elderly patients due to longer and more active lives. (2).

Patients with hip fractures generally constitute a population of people of advanced ages with multiple comorbidities and a high fragility index; therefore, these are the patients with the highest morbidity and mortality incidence in the orthopedic operating theatre. Previous studies have reported a one-year mortality rate after hip fractures between 14% and 37% (3). Factors, such as advanced age, gender, and multiple comorbidities, have an effect on mortality that cannot be changed, whereas preoperative waiting time, fluid electrolyte imbalance, nutritional status, a high serum creatinine level, and a low hemoglobin level are modifiable factors. The anesthesia method applied to patients undergoing operations is also among the modifiable factors that can have an effect on mortality. Many studies in the literature have investigated the effect of anesthesia methods on postoperative complications and mortality in this patient group, but to date, no anesthesia method has been shown to be superior to others (4).

In this study, the effect of the anesthesia type on mortality was investigated in patients aged ≥75 years, who were operated on to treat their hip fractures. The primary aim of this study is to evaluate the effect of the anesthesia selected for these advanced-age patients on in-hospital, 30-day, and six-month mortality. The secondary aim of this study is to evaluate the effect of other factors on mortality.

METHOD

Study design

The Ethics Committee of Ankara City Hospital granted approval for this study. The electronics record system of the hospital was retrospectively examined for the information of patients aged ≥75 years, who presented at the Emergency Department and were admitted for surgery because of a femoral neck fracture between February 2019 and May 2021. The identified patients were contacted by telephone so that their postoperative health status could be recorded. Patients were excluded from the study if they had a femur fracture in the middle or distal section, pathological fracture, bilateral femur fracture, or concomitant multiple trauma, or if they were admitted for further surgery for revision or a recurrent fracture.

All patients were evaluated with respect to their age, gender, comorbidities, American Society of Anesthesiologists (ASA) score, operation type, anesthesia type, preoperative modified Charlson comorbidity index (mCCI) score, preoperative hemoglobin level, preoperative waiting time (days between the point of hospital admission and surgery), postoperative stay in the Intensive Care Unit (ICU), postoperative length of stay in the hospital, postoperative complications, in-hospital mortality, and mortality of discharged patients in the first 30 days and first six months.

Statistical Analyses

The data obtained for the study were analyzed statistically using SPSS vn. 25.0 (IBM Corpn., Armonk, NY, USA) and MedCalc 15.8 (MedCalc Software Bvba, Ostend, Belgium) statistical programs. InIn addition to the descriptive statistical methods for data evaluation (stated as the number, percentage, mean, standard deviation, median, and minimum–maximum values), the Chi-square test was conducted to compare the qualitative data. The conformity of the data to normal distribution was assessed with the Kolmogorov–Smirnov test, skewness and kurtosis, and visual graphic methods (histogram, Q-Q plot, stem-and-leaf plots. the evaluation of the quantitative data showing normal distribution, an independent samples t-test was conducted. To determine the differentiation ability of the variables, the receiver operating characteristic (ROC) curve analysis was performed, and to determine the risk ratio, binary logistic regression analysis was performed. In the survival analyses, the Kaplan-Meier, logrank, Breslow, and Tarone-Ware tests were performed. A value of $p < 0.05$ was accepted as statistically significant.

Power Analysis

The power analysis was performed using the G*Power 3.1.9.7 (Franz Faul, Universität Kiel, Germany) software and, based on the mCCI score, determined a power of 98% with $n_1 = 95$, $n_2 = 40$, $\alpha = 0.05$, and effect size (d) = 0.8.

RESULTS

From the hospital records system, a total of 151 patients were identified who were aged ≥75 years and were admitted to the hospital for surgery because of a femoral neck fracture between February 2019 and May 2021. A total of 16 patients were excluded from the study: three cases with femoral shaft fracture, five with distal femur fracture, one with revision surgery, three with multiple trauma, two with incomplete hospital data, and finally, two cases with unknown survival status after discharge (as they could not be contacted). Thus, the data of 135 patients were analyzed, comprising 65.2% females and 34.8% males with a mean age of 85.0 ± 5.6 years. The ASA scores were determined to be I–II in 24.4% of the patients and III–IV in 75.6% (Table 1).

In the comparisons made according to the anesthesia type, the postoperative length of stay in the ICU was found to be statistically significantly longer in the patient group who were administered general anesthesia ($p < 0.05$). No statistically significant difference was determined between the anesthesia types with respect to any other variables.

In the comparisons made according to their survival, the exitus cases were found to have higher rates of renal disease and dementia (specifically, Alzheimer's disease), higher ASA and mCCI scores, a lower preoperative hemoglobin value, higher rates of postoperative complications, and a longer postoperative stay in the ICU ($p < 0.05$) (Table 2).

The results of the correlation analysis showed a correlation between survival–mortality and the following:

- mCCI value; r = 0.364
- Postoperative length of stay in the ICU; r = 0.333
- Preoperative hemoglobin level; r = –0.226
- Renal disease; r = 0.364
- Dementia (Alzheimer's disease); r = 0.249
- ASA score; r = 0.256
- Postoperative complications; r = 0.286

All these correlations were determined to be statistically significant ($p < 0.05$).

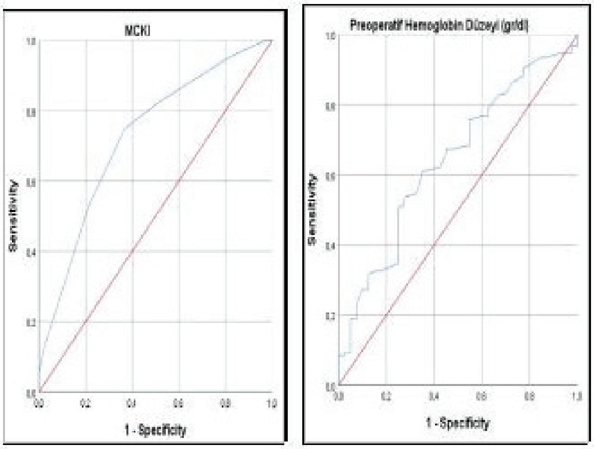
The variables for which a difference was found in the paired comparisons between survival and mortality—renal disease, dementia (Alzheimer's disease), ASA score, mCCI score, preoperative hemoglobin value, postoperative complications, and postoperative stay in the ICU—were included in the regression model using the backward stepwise method. Further, the model was terminated in the fifth step. The dependent variable (survival–mortality) explained approximately 32% of this model (Nagelkerke $R^2 = 0.317$). According to this model, there was a statistically significant correlation between the survival–mortality status and mCCI and the preoperative hemoglobin level ($p < 0.05$). The exitus status was approximately 3.5-fold higher in patients with dementia (Alzheimer's disease) compared to those without, approximately 1.7-fold higher in patients with a higher mCCI value, and approximately 1.4-fold higher in those with a low preoperative hemoglobin value (Table 3).

ROC analyzes of risk factors provided logistic regression analysis :

- The cutoff value for the mCCI value was found to be 6 (Area under curve = 0.727, $p < 0.001$, 95% confidence interval (CI): 0.644–0.800).
- The cutoff value for the preoperative hemoglobin level was found to be 11.4 (Area under curve = 0.643, $p = 0.005$, 95% CI: 0.556–0.723) (Figure 1).

In the comparisons made according to mortality, a statistically significant difference was determined in gender, renal disease, mCCI, and length of stay in the ICU, according to the mortality status ($p < 0.05$). Post-hoc tests were applied to determine from which group or groups the difference originated. Exitus within the first six months was determined at a higher rate in females, while in-hospital exitus was higher in males, and the rate of renal disease was lower in patients who were exitus within the postoperative first 30 days. The mCCI value was higher in patients who were exitus in the hospital than in those who were exitus within the postoperative first 30 days. The postoperative length of stay in the ICU was higher in patients who were exitus in the hospital (Table 4).

Figure 1. ROC Analysis



DISCUSSION

The results of this study showed that regional anesthesia was applied at a high rate (83.7%) to patients aged ≥75 years, who were operated on for hip fracture, but no significant relationship was observed between the anesthesia method and their mortality. Postoperative mortality was determined to be significantly increased in patients with preoperative kidney dysfunction or failure and in patients diagnosed with dementia. The study results also showed that a high preoperative mCCI score and low hemoglobin value were risk factors for mortality. In patients with a postoperative outcome of mortality, there was a significant increase in the postoperative length of stay in the ICU and the frequency of complications.

In a prospective, single-center study by Huette et al., no relationship was found between the anesthesia type and mortality in a one-year follow-up period of 309 patients operated on for hip fracture (5). Waesberghe et al. reviewed 23 studies in a meta-analysis and reported that the anesthesia type did not affect 30-day mortality but significantly decreased in-hospital mortality and the length of stay in hospital (6). O'Donnell et al. conducted a meta-analysis of the data collected from 15 large observational studies and reported no difference between the two anesthesia techniques with respect to 30-day mortality (7). In contrast, some studies have predicted that neuraxial anesthesia could prolong survival compared to general anesthesia. Ahn et al. compared national data on patients who had undergone hip surgery and found that regional anesthesia provided a better outcome than general anesthesia with respect to 30-day mortality in elderly patients (8). In a comprehensive cohort study in

Table 1. Demographic Data of the Patients (mean±SD, min-max; n, %)

		n mean ± SD	% Median (Min-Max)
Gender *	female	88	65.2
	male	47	34.8
Age (years)**		85.0 ± 5.6	85.0 (75.0 – 99.0)
ASA*	I-II	33	24.4
	III-IV	102	75.6

*: n / %, **: Mean ± Standard Deviation / Median (Min-Max)

Table 2. Comparisons according to survival

		Survival		P
		Survived (n=95)	**Exitus (n=40)**	
Gender	Female	64 (67.4%)	24 (60.0%)	0.533 [a]
	Male	31 (32.6%)	16 (40.0%)	
Age (years)		84.3 ± 5.3	86.4 ± 6.2	0.053 [b]
Comorbidities	Absent	14 (14.7%)	1 (2.5%)	**0.040** [a]
	Present	81 (85.3%)	39 (97.5%)	
	HT	*56 (58.9%)*	*28 (70.0%)*	*0.310* [a]
	DM	*28 (29.5%)*	*11 (27.5%)*	*0.982* [a]
	CAD-CHF	*28 (29.5%)*	*18 (45.0%)*	*0.124* [a]
	Arrhythmia	*14 (14.7%)*	*5 (12.5%)*	*0.944* [a]
	COPD	*22 (23.2%)*	*10 (25.0%)*	*0.993* [a]
	Renal disease	*9 (9.5%)*	*13 (32.5%)*	***0.002*** [a]
	Malignancy	*6 (6.3%)*	*3 (7.5%)*	*0.724* [a]
	Dementia-Alzheimer	*16 (16.8%)*	*16 (40.0%)*	***0.008*** [a]
	CVE	*10 (10.5%)*	*8 (20.0%)*	*0.230* [a]
	Parkinson	*6 (6.3%)*	*2 (5.0%)*	*1.000* [a]
Operation type	Arthroplasty	53 (55.8%)	26 (65.0%)	0.423 [a]
	Screw- plate	42 (44.2%)	14 (35.0%)	

ASA	I-II	30 (31.6%)	3 (7.5%)	**0.006** [a]
	III-IV	65 (68.4%)	37 (92.5%)	
Anesthesia type	Regional	81 (85.3%)	32 (80.0%)	0.616 [a]
	General	14 (14.7%)	8 (20.0%)	
mCCI		6.0 ± 1.7	7.6 ± 1.9	**0.000** [b]
	≤4	*18 (18.9%)*	*2 (5.0%)*	**0.001** [a]
	5-7	*57 (60.0%)*	*17 (42.5%)*	
	≥8	*20 (21.1%)*	*21 (52.5%)*	
Preoperative Waiting Time (days)		2.6 ± 1.9	2.8 ± 1.8	0.536 [b]
	1 day	*31 (32.6%)*	*7 (17.5%)*	0.203 [a]
	2 days	*27 (28.4%)*	*14 (35.0%)*	
	≥3 days	*37 (38.9%)*	*19 (47.5%)*	
Postoperative stay in ICU (days)		0.7 ± 2.5	3.4 ± 6.9	**0.021** [b]
Postoperative stay in hospital (days)		5.3 ± 5.9	6.3 ± 6.8	0.377 [b]
Preoperative Hemoglobin level (gr/dl)		11.6 ± 1.9	10.7 ± 1.6	**0.011** [b]
	Normal	*50 (52.6%)*	*10 (25.0%)*	**0.006** [a]
	Anemic	*45 (47.4%)*	*30 (75.0%)*	
Postoperative complications	Absent	71 (74.7%)	18 (45.0%)	**0.002** [a]
	Present	24 (25.3%)	22 (55.0%)	
	Pulmonary Complications	*4 (16.7%)*	*3 (13.6%)*	--
	Cardiac Complications	*4 (16.7%)*	*1 (4.5%)*	
	Renal Complications	*9 (37.5%)*	*13 (59.1%)*	
	Neurological Complications	*2 (8.3%)*	*0 (0.0%)*	
	Infectious Complications	*0 (0.0%)*	*2 (9.1%)*	
	Delirium	*5 (20.8%)*	*3 (13.6%)*	

a: Chi-Square Test (n (%)), b: Independent Samples t Test (Mean ± SD), ICU: Intensive care unıt. mCCI: (modified Charlson Comorbidity Index). ASA (American Society of Anesthesiologists). HT: Hypertension, DM: Diabetes Mellitus, COPD: Chronic Obstructive Pulmonary Disease, CAD, CHF: coronary artery disease/ congestive heart failure, CVE: cerebrovascular event.

Table 3. Evaluations with Logistic Regression Analysis

Risk Factor	B	Odds	95% CI	Wald	P*
Dementia-Alzheimer	1.255	3.507	1.40 – 8.78	7.181	**0.007**
mCCI	0.509	1.664	1.30 – 2.14	15.934	**0.000**
Preoperative Hemoglobin level (gr/dl)	-0.317	1.372	1.08 – 1.75	6.543	**0.011**
Constant	-1.163				

*: Binary Logistic Regression Test, Nagelkerke R^2 = 0,317, Hosmer and Lemeshow Test = 0,631, Variable(s) removed on: Step 2: Comorbidities Step 3: Renal Disease, Step 4: ASA, Step 5: Postoperative stay in ICU

Table 4. Comparisons according to Mortality

		Mortality			P
		In-hospital Exitus (n=15)	Exitus within 30 days of postoperative discharge (n=11)	Exitus within 30 days-6 months of postoperative discharge (n=14)	
Gender	Female	6 (40.0%)	6 (54.5%)	12 (85.7%)	**0.039** [a]
	Male	9 (60.0%)	5 (45.5%)	2 (14.3%)	
Age (years)		86.5 ± 6.2	85.7 ± 6.6	86.8 ± 6.3	0.913 [b]
Comorbidities	Absent	0 (0.0%)	1 (9.1%)	0 (0.0%)	0.259 [a]
	Present	15 (100.0%)	10 (90.9%)	14 (100.0%)	
	HT	*11 (73.3%)*	*6 (54.5%)*	*11 (78.6%)*	*0.402* [a]
	DM	*5 (33.3%)*	*3 (27.3%)*	*3 (21.4%)*	*0.773* [a]
	CAD-CHF	*7 (46.7%)*	*5 (45.5%)*	*6 (42.9%)*	*0.978* [a]
	Arrhythmia	*3 (20.0%)*	*0 (0.0%)*	*2 (14.3%)*	*0.304* [a]
	COPD	*4 (26.7%)*	*2 (18.2%)*	*4 (28.6%)*	*0.823* [a]
	Renal disease	*7 (46.7%)*	*0 (0.0%)*	*6 (42.9%)*	***0.025*** [a]
	Malignancy	*3 (20.0%)*	*0 (0.0%)*	*0 (0.0%)*	*0.067* [a]
	Dementia-Alzheimer	*7 (46.7%)*	*4 (36.4%)*	*5 (35.7%)*	*0.800* [a]
	CVE	*3 (20.0%)*	*1 (9.1%)*	*4 (28.6%)*	*0.482* [a]
	Parkinson	*1 (6.7%)*	*0 (0.0%)*	*1 (7.1%)*	*0.670* [a]

Operation type	Artroplasty	12 (80.0%)	7 (63.6%)	7 (50.0%)	0.237 [a]
	Screw-plate	3 (20.0%)	4 (36.4%)	7 (50.0%)	
ASA	I-II	0 (0.0%)	2 (18.25)	1 (7.1%)	0.220 [a]
	III-IV	15 (100.0%)	9 (81.8%)	13 (92.9%)	
Anesthesia Type	Regional	11 (73.3%)	8 (72.7%)	13 (92.9%)	0.328 [a]
	General	4 (26.7%)	3 (27.3%)	1 (7.1%)	
mCCI		8.5 ± 1.7	6.4 ± 1.8	7.6 ± 1.8	**0.018** [b]
	≤4	*0 (0.0%)*	*1 (9.1%)*	*1 (7.1%)*	--
	5-7	*4 (26.7%)*	*7 (63.6%)*	*6 (42.9%)*	
	≥8	*11 (73.3%)*	*3 (27.3%)*	*7 (50.0%)*	
Preoperative Waiting time (days)		2.7 ± 1.8	2.8 ± 1.2	3.0 ± 2.3	0.888 [b]
	1 day	*4 (26.7%)*	*1 (9.1%)*	*2 (14.3%)*	0.740 [a]
	2 days	*4 (26.7%)*	*4 (36.4%)*	*6 (42.9%)*	
	≥3 days	*7 (46.7%)*	*6 (54.5%)*	*6 (42.9%)*	
Postoperative stay in ICU (days)		7.2 ± 10.1	1.2 ± 2.0	1.1 ± 2.2	**0.025** [b]
Postoperative stay in hospital (days)		8.1 ± 9.8	5.5 ± 4.8	5.0 ± 3.1	0.427 [b]
Preoperative Hemoglobin level (gr/dl)		10.8 ± 1.6	10.4 ± 1.9	10.8 ± 1.6	0.743 [b]
	Normal	*2 (13.3%)*	*3 (27.3%)*	*5 (35.7%)*	0.372 [a]
	Anemic	*13 (86.7%)*	*8 (72.7%)*	*9 (64.3%)*	
Postoperative Complications	Absent	5 (33.3%)	5 (45.5%)	8 (57.1%)	0.436
	Present	10 (66.7%)	6 (54.5%)	6 (42.9%)	
	Renal	*6 (60.0%)*	*4 (66.7%)*	*3 (50.0%)*	--
	Pulmonary	*2 (20.0%)*	*1 (16.7%)*	*0 (0.0%)*	
	Delirium	*0 (0.0%)*	*0 (0.0%)*	*3 (50.0%)*	
	Infectious	*2 (20.0%)*	*0 (0.0%)*	*0 (0.0%)*	
	Cardiac	*0 (0.0%)*	*1 (16.7%)*	*0 (0.0%)*	

a: Chi-Square Test (n (%)), b: Independent Samples t Test (Mean ± SD), mCCI: (modified Charlson Comorbidity Index). ASA (American Society of Anesthesiologists). HT: Hypertension, DM: Diabetes Mellitus, COPD: Chronic Obstructive Pulmonary Disease, CAD, CHF: coronary artery disease/ congestive heart failure, CVE: cerebrovascular event

Canada, there was reported to be an increase in 30-day survival by 20–25% of hospitals with the use of neuraxial anesthesia in hip fracture operations (9). Peterson et al. compared regional anesthesia with general anesthesia in a population-based cohort study of patients aged >70 years and reported an 18% decrease in 30-day mortality with regional anesthesia (10). In a retrospective study by Desai et al., the in-hospital mortality rate was found to be higher in patients administered general anesthesia and in those transferred from regional anesthesia to general anesthesia. However, after the discharge of these cases from the hospital, no significant difference was determined between the two anesthesia types with respect to mortality rates. Previous research has concluded that both anesthesia methods can be used in these patients. However, the most important point is that the method selected is appropriate to the clinical characteristics of the patient, and it is recommended that this should be administered carefully by experienced anesthetists.

It has been reported that when general anesthesia is selected, rapid fluctuations in intraoperative arterial pressure can be prevented by administering titred anesthetic agents at low doses. When spinal anesthesia is selected, intraoperative hypotension has been seen less with a reduced volume (<10mg) of intrathecal 0.5% hyperbaric bupivacaine. Previous studies have shown that the application of the fascia iliaca nerve block and the femoral nerve block together under ultrasonography guidance reduced anesthetic doses in patients administered with general anesthesia. It has also been reported that positioning during spinal anesthesia application facilitates and allows the use of low-dose local anesthetics.

Previous studies have shown that age is closely related to mortality in hip fracture surgery. In a retrospective study, Endo et al. showed that the strongest factors increasing in-hospital mortality after hip fracture surgery were age, gender, congestive heart failure, kidney failure, and fluid electrolyte imbalance, and of these, advanced age (especially >85 years), congestive heart failure, weight loss, and fluid electrolyte imbalance were reported to be stronger markers of mortality than other risk factors (11). It is the aim of the current study to create a more homogenous population by including geriatric patients aged ≥75 years. The mean age at which hip fractures were seen in this age range was determined to be 84–85 years in this study. The in-hospital mortality rate in the current study was found to be 37.5%, and this high rate was thought to be on account of the study including patients of advanced age.

Chronic renal disease has been reported to be a risk factor for fragility fractures. Moreover, in elderly patients presenting at the hospital with hip fractures, frequently seen findings have been reported to be severe fluid deficiency and associated fluid electrolyte imbalance and elevated urea–creatinine, even without any underlying kidney disease. In patients who are not treated preoperatively, this can result in acute renal failure. Among the current study's patients identified in the hospital's computerized system as having acute or chronic renal failure or renal dysfunction, regardless of their preoperative blood biochemistry tests, the in-hospital mortality rate was observed to be significantly increased. In a case-control study conducted by Chiang et al. to determine the risk of in-hospital mortality after hip fracture surgery, the data of 841 patients were compared, and there was determined to be a significant correlation between renal dysfunction and in-hospital mortality (12).

Systematic planning of the postoperative care of patients with hip fractures should be started preoperatively. It has been recommended that by rapidly transferring elderly patients presenting with hip fractures to a separate ICU, treatment can be provided promptly by a primary care team, including an ICU specialist, a thoracic disease specialist, and a cardiologist (13).

Patients with dementia are generally less active and have poor self-care capabilities, which can increase postoperative complications, such as surgical site infections, urinary tract infections, and respiratory complications (14). In a recent meta-analysis of 18 studies, one-year mortality was found to be 39% in patients with dementia (15). In the current study, no significant correlation was observed between dementia and in-hospital and 30-day mortality, but the rate of dementia in patients with the outcome of mortality in the total postoperative six-month period was high (40.0%). In the current study, a diagnosis of dementia (Alzheimer's disease) was present in 23.7% of the patients. In the logistic regression evaluation, mortality was determined to be approximately 3.5-fold more in patients with a preoperative diagnosis of dementia (Alzheimer's disease) compared to those without (ß: 1.255, Odds: 3.507, 95% CI: 1.40–8.78, Wald: 7.181, p: 0.007). Patients aged >70 years presenting at the hospital with hip fractures were evaluated in a population-based cohort study by Peterson et al., and the postoperative 30-day mortality among them was determined to have a 1.5-fold increase in patients with a diagnosis of dementia compared to those without (HR = 1.50 [95% CI 1.31–1.72]) (16).

The most serious form of hip fractures, which could potentially diminish patients' quality of life and lead to being a great cost burden to society, are osteoporotic fractures. Generally, the Charlson comorbidity index (CCI) is related to increased mortality among patients with fragility fractures. Osteoporosis has been determined at a more advanced level in elderly patients with a higher CCI, but the time to surgery and the length of stay in the hospital have not been found to be significantly longer (17). The age-adjusted mCCI has been used to predict mortality in hip-fracture patients and has also been strongly associated with fragility. Studies have reported that mCCI of ≥6 in an elderly patient with a femur fracture is associated with a high complication risk and mortality rate (18). These patients have poor bone quality, and it is well known that they often have osteoporosis. Furthermore, osteoporotic fractures are fragility fractures, which occur as a result of low-energy mechanical forces or forces at a level lower than that which would create a normal fracture. With logistic regression modeling in the current study, the mCCI calculated preoperatively was found to be a risk factor for mortality at a moderate level, and patients with a high mCCI value were determined to be exitus at a rate approximately 1.7-fold higher than those with lower mCCI values. In the ROC analysis, the cutoff value for mCCI values was found to be 6 (Area under curve= 0.727, p < 0.001, 95% CI: 0.644–0.800). Wang et al. conducted a similar study and found a positive correlation between complications and an mCCI value of ≥6 with staged logistic regression modeling (OR: 4.27, p = 0.02) (19).

One of the findings in the current study is that a significant correlation was determined between a low preoperative hemoglobin level and mortality. The preoperative hemoglobin level was found to be a risk factor as a result of logistic regression analysis, and in the ROC analysis, the cutoff value was determined to be 11.4 (Area under curve = 0.643, p = 0.005, 95% CI: 0.556–0.723). In a retrospective study by Nia et al. of geriatric patients operated on for proximal hip fracture, anemia (Hgb <12) was determined to be an independent risk factor for mortality (20). Yombi et al. also found significantly higher rates of short-, medium-, and long-term mortality after hip fracture surgery in patients with a preoperative hemoglobin level of <12 (21). Some factors, such as age, gender, fracture type, hereditary predisposition, and comorbidities, which affect mortality in patients with hip fracture, cannot be changed, while there are also modifiable factors, such as physical health, nutritional status, high serum creatinine level, and low hemoglobin level. Although the hemoglobin level is a potentially modifiable factor, there remains uncertainty about the benefit of blood transfusion in patients with preoperative anemia, which is associated with increasing blood transfusions, healthcare costs, morbidity, and mortality. In patients hospitalized because of hip fracture, it has been reported that by increasing the erythrocyte production and oxygen carrying capacity, the optimization of anemia with preoperative erythropoietin (EPO) and intravenous iron treatment reduces transfusion rates and complications associated with transfusions. In a recent systematic meta-analysis that reviewed 12 clinical studies, it was seen that preoperative intravenous iron treatment in patients undergoing orthopedic surgery reduced the rate of perioperative blood transfusion by 31%, shortened the length of stay in the hospital by 1.6 days, and reduced the postoperative infection rate by 33%, but it had no effect on mortality (22).

The waiting time for surgery of the patients in the current study who presented with hip fracture was seen to be similar in both patients who survived and who were exitus. In a multicenter, prospective analysis by Orosz et al., there was found to be no significant effect of waiting time on mortality, but the presence of comorbidities were determined to increase mortality (23). Leer-Salvesen et al. determined that a preoperative delay of more than 48 hours significantly increased early mortality in an observational study of geriatric patients operated on for hip fractures. It has been emphasized that the preoperative waiting time should not exceed 48 hours to optimize medical and hemodynamic statuses (24). Klestil et al. analyzed 28 prospective studies in a meta-analysis and reported that there was a 20% lower risk of one-year mortality in patients operated on within 48 hours (25). In the current study, the waiting times for surviving and exitus patients were calculated as 2.6 and 2.8 days, respectively, with no significant difference determined between the groups. In both groups, the waiting time exceeded 48 hours.

Age is one of the most important factors affecting mortality in patients operated on for hip fractures. The aim was to standardize the age factor in this study by only including patients aged ≥75 years. In this respect, this study is the first to be conducted on advanced-age hip-fracture patients. However, this condition meant that the study was completed with a low number of patients, which can be considered a limitation of the study. There is a need for further multi-center, similar studies with greater numbers of patients. Another limitation of the study is that, as the data were retrospectively collected from the computer database, it was not possible to evaluate the preoperative level of fragility of the patients and the intraoperative hemodynamic status, which can play a role in mortality.

In conclusion, preoperative classification with a routine determination of a risk score can be of guidance for the clinicians of patients of advanced age undergoing surgery to treat hip fracture. The modifiable factors include not exceeding the preoperative waiting time of 48 hours, optimizing the medical and hemodynamic status with a multidisciplinary approach and selecting the anesthesia method according to the clinical characteristics of each patient. Care given to these factors could contribute to reducing mortality rates.

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