

# Age-stratified mortality after hip fracture surgery: A retrospective cohort study comparing hemiarthroplasty and osteosynthesis

✉ Murat Gök,<sup>1</sup> ✉ Tuna Koçoğlu,<sup>2</sup> ✉ Fatih Işık,<sup>1</sup> ✉ Ali Bozdemir,<sup>3</sup> ✉ Onur Çetin,<sup>4</sup> ✉ Cemil Kayalı<sup>5</sup>

<sup>1</sup>Department of Orthopedics and Traumatology, University of Health Sciences, Balıkesir Atatürk City Hospital, Balıkesir-Türkiye

<sup>2</sup>Department of Orthopedics and Traumatology, İstanbul Medipol University, Pendik Hospital, İstanbul-Türkiye

<sup>3</sup>Department of Orthopedics and Traumatology, Bursa Karacabey State Hospital, Bursa-Türkiye

<sup>4</sup>Department of Orthopedics and Traumatology, İstanbul Medipol University, Çamlıca Hospital, İstanbul-Türkiye

<sup>5</sup>Department of Orthopedics and Traumatology, University of Health Sciences, İzmir Faculty of Medicine, İzmir-Türkiye

## ABSTRACT

**BACKGROUND:** Hip fractures are a major public health problem associated with substantial mortality and morbidity, particularly among older adults. More than 90% of hip fractures occur in individuals aged 50 years and older, and the incidence increases with age because of osteoporosis and declining bone quality. This study aimed to examine the association between surgical treatment method and short- and long-term mortality after hip fracture, with an emphasis on age-stratified outcomes.

**METHODS:** This retrospective cohort study included patients aged 65 years and older who underwent surgery for hip fracture at a tertiary care center. Age and time to surgery were analyzed as continuous variables, whereas sex, surgical method, comorbidities, and follow-up status were analyzed as categorical variables. Baseline characteristics were compared between surgical treatment groups using the independent samples t-test or Mann–Whitney U test for continuous variables and the chi-square test for categorical variables, as appropriate. Cumulative mortality at predefined time points was assessed descriptively, and overall survival was evaluated using Kaplan–Meier survival analysis with comparisons performed using the log-rank test.

**RESULTS:** A total of 885 patients met the inclusion criteria; 509 patients (57.5%) underwent hemiarthroplasty and 376 patients (42.5%) underwent osteosynthesis. There was no significant difference in one-year cumulative mortality between the groups ( $p=0.984$ ). At five years, cumulative mortality was higher in the hemiarthroplasty group than in the osteosynthesis group (68.1% vs. 58.5%,  $p=0.003$ ). Among patients with a Charlson Comorbidity Index  $\leq 5$ , five-year cumulative mortality was also higher following hemiarthroplasty (61.1% vs. 50.1%,  $p=0.010$ ). Kaplan–Meier analysis demonstrated significant differences in overall survival between the surgical treatment groups.

**CONCLUSION:** Higher long-term mortality following hemiarthroplasty was more evident among younger elderly patients and those with a lower comorbidity burden, whereas differences were less pronounced in older patients or those with greater comorbidity.

**Keywords:** Arthroplasty; hip fracture; mortality; osteosynthesis.

## INTRODUCTION

Hip fractures are a major public health concern associated with high rates of mortality and morbidity, and their incidence

continues to increase with rising life expectancy. Worldwide, approximately 1.6 million individuals sustain a hip fracture each year, and this number is projected to exceed 7 million in the coming decades.<sup>[1]</sup> Owing to the substantial mortality,

Cite this article as: Gök M, Koçoğlu T, Işık F, Bozdemir A, Çetin O, Kayalı C. Age-stratified mortality after hip fracture surgery: a retrospective cohort study comparing hemiarthroplasty and osteosynthesis. *Ulus Travma Acil Cerrahi Derg* 2026;32:735-744.

Address for correspondence: Murat Gök

Department of Orthopedics and Traumatology, University of Health Sciences, Balıkesir Atatürk City Hospital, Balıkesir, Türkiye

E-mail: dr.muratgok@yahoo.com

*Ulus Travma Acil Cerrahi Derg* 2026;32(6):735-744 DOI: 10.14744/tjtes.2026.38852

Submitted: 21.01.2026 Revised: 24.03.2026 Accepted: 29.03.2026 Published: 03.06.2026

OPEN ACCESS This is an open access article under the CC BY-NC license (<http://creativecommons.org/licenses/by-nc/4.0/>).



morbidity, and disability associated with hip fractures, these injuries pose a considerable burden on healthcare systems and society. Previous studies have reported mortality rates of 6%–11% within the first month and 14%–36% within the first year after hip fracture, while many survivors experience a loss of functional capacity. In addition to the suffering experienced by patients, hip fractures create caregiving challenges and impose social burdens on family members and caregivers.<sup>[2,3]</sup> Furthermore, studies have demonstrated that hip fractures continue to affect mortality for up to 10 years after surgery.<sup>[4]</sup> Therefore, optimal management of patients with hip fractures is of critical importance from a public health perspective.

More than 90% of hip fractures occur in individuals aged 50 years and older. The incidence rises progressively with age because of osteoporosis and deterioration in bone quality. As life expectancy continues to increase, the incidence of hip fractures is expected to rise substantially, creating additional challenges for healthcare systems.<sup>[5]</sup>

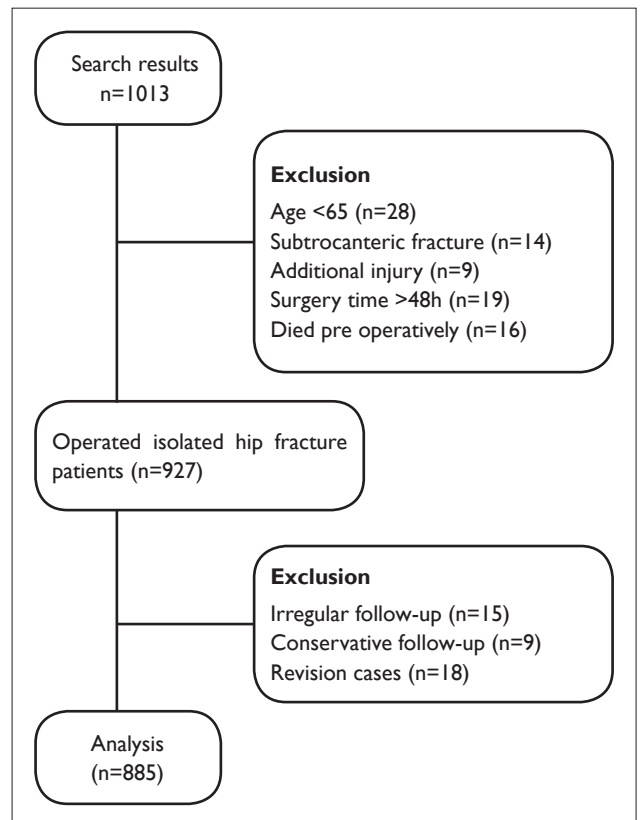
Surgical treatment is the standard of care for hip fractures, with the primary options being arthroplasty or osteosynthesis. Although both techniques are well established, selecting the most appropriate treatment approach can be complex. Existing literature suggests that treatment decisions are influenced by multiple factors, including fracture pattern, bone quality, preinjury functional status, and overall patient frailty. However, despite the widespread use of these techniques, the comparative effects of hemiarthroplasty and osteosynthesis on mortality remain controversial. Previous studies have reported conflicting findings, often limited by heterogeneous patient populations, variable follow-up durations, or inadequate adjustment for comorbidities and baseline functional status. Consequently, uncertainty remains regarding which surgical strategy provides a survival advantage in elderly patients with hip fractures.<sup>[6]</sup>

Given these gaps in the literature, a clearer understanding of short- and long-term mortality outcomes associated with different surgical approaches is needed. This retrospective cohort study aimed to compare short- and long-term mortality in patients aged 65 years and older with hip fractures treated with either hemiarthroplasty or osteosynthesis. Improved understanding of these outcomes may help guide surgical decision-making and optimize patient care.

## MATERIALS AND METHODS

This study was designed as a retrospective observational cohort study. Patients aged 65 years and older who were treated for hip fractures at a tertiary referral center between 2013 and 2018 were evaluated. Eligible patients had sustained fractures resulting from low-energy trauma, defined as a simple fall from standing height, and underwent surgical intervention within 48 hours of injury.

Patients were excluded if they were younger than 65 years; had subtrochanteric fractures; presented with additional trau-



**Figure 1.** Flowchart of patient inclusions and exclusion criteria.

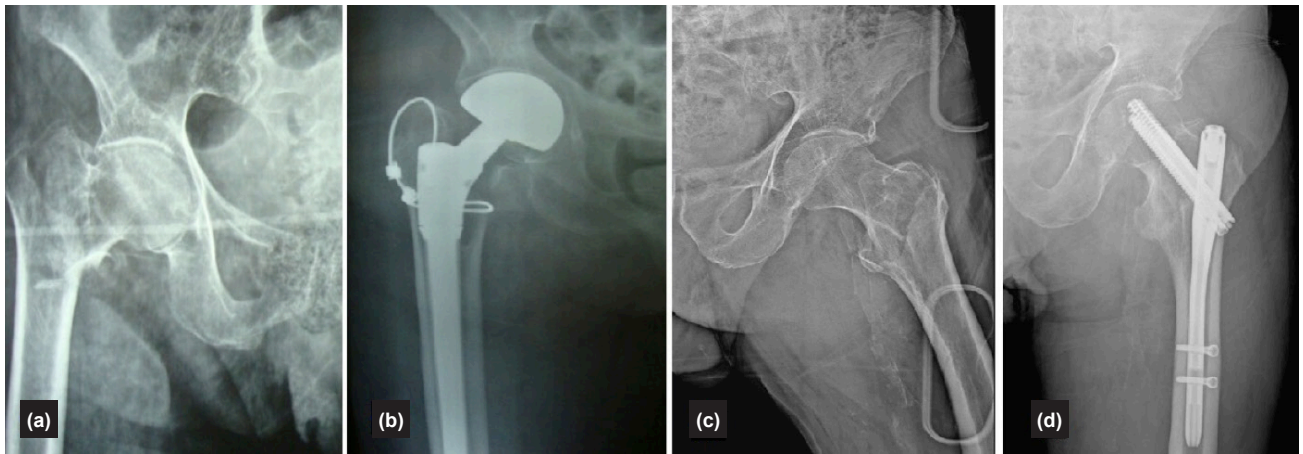
matic injuries; had incomplete or irregular follow-up; were managed nonoperatively; underwent revision procedures; died before surgery; or could not undergo surgical treatment within the first 48 hours after fracture occurrence (Fig. 1).

All patients were initially evaluated in the emergency department. Following a detailed medical history and radiological assessment, treatment planning was performed after consultation with the relevant specialties regarding patient comorbidities.

Patients underwent surgical treatment with a proximal femoral nail (PFN), dynamic hip screw (DHS), osteosynthesis with cancellous screws, or hemiarthroplasty (Fig. 2). The choice of surgical procedure was based on fracture type, fracture location, degree of displacement, patient age, general medical condition, and pre-fracture activity level. All procedures were performed under regional or general anesthesia. Prophylactic antibiotics consisting of a first-generation cephalosporin were administered before surgical incision in all patients.

In patients with intertrochanteric femoral fractures, proximal femoral nailing was preferred in most cases, whereas hemiarthroplasty was favored in comminuted fractures and in patients with severe osteoporosis who were considered at high risk for implant failure following osteosynthesis. Proximal femoral nailing was performed on a traction table under fluoroscopic guidance in all cases.

Hemiarthroplasty was performed in selected patients with



**Figure 2.** Representative preoperative and postoperative radiographs of hip fracture treatments. **(a)** Preoperative radiograph of a displaced femoral neck fracture. **(b)** Postoperative radiograph following hemiarthroplasty. **(c)** Preoperative radiograph of an intertrochanteric femoral fracture. **(d)** Postoperative radiograph after osteosynthesis with a proximal femoral nail.

intertrochanteric femoral fractures. The greater trochanter was fixed with a cerclage cable when necessary.<sup>[7]</sup> In all patient groups, mobilization was initiated on the first postoperative day in patients whose general condition permitted and as early as possible in those whose condition did not permit immediate mobilization. Patients ambulated with crutches or walkers and were allowed weight-bearing as tolerated. Antibiotic prophylaxis was continued for 24 hours postoperatively in all patients. Additionally, all patients received deep vein thrombosis prophylaxis with low-molecular-weight heparin for three months after surgery.

Patient demographics and clinical characteristics, including age, sex, surgical method, time from fracture onset to surgery, preoperative and postoperative comorbidities, American Society of Anesthesiologists (ASA) score, outpatient follow-up data, and time of death for deceased patients, were retrospectively obtained from the hospital electronic medical records system. Subgroup analyses were performed according to age and Charlson Comorbidity Index (CCI) categories to evaluate the consistency of observed associations across different risk strata. Age was dichotomized as  $\leq 75$  years and  $> 75$  years according to the World Health Organization report, while CCI was categorized as low risk ( $\leq 5$ ) and high risk ( $> 5$ ) based on estimated five-year life expectancy.<sup>[8,9]</sup> Charlson Comorbidity Index scores at initial presentation were calculated by considering both age and comorbidities. Medical records, including hospitalization reports, outpatient clinic notes, medication histories, and physician-recorded diagnostic codes, were reviewed in detail. To evaluate both short-term and mid- to long-term outcomes, mortality was assessed at one-year, three-year, and five-year follow-up intervals. Mortality rates at these time points and their relationship with surgical method were analyzed according to age groups and comorbidity status. Fractures were additionally classified as stable or unstable according to the Evans classification, and subgroup analyses were conducted to assess

mortality outcomes based on fracture stability and surgical method.

### Statistical Analysis

The distribution of continuous variables was assessed using the Kolmogorov–Smirnov test. Variables with a normal distribution were expressed as mean  $\pm$  standard deviation and analyzed using the independent samples t-test. Variables that did not meet the assumption of normality were presented as median and interquartile range and compared using the Kruskal–Wallis test. Categorical variables were reported as frequencies and percentages, and comparisons between groups were performed using the chi-square test or Fisher’s exact test, as appropriate.

Survival outcomes were evaluated using Kaplan–Meier survival analysis, and comparisons between groups were performed using the log-rank test. To control for Type I error inflation resulting from multiple comparisons in analyses of baseline and clinical variables, adjusted p-values were calculated using the Benjamini–Hochberg false discovery rate (FDR) method. Both unadjusted and adjusted p-values were reported. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA).

This study was approved by the Izmir Bozyaka Training and Research Hospital Local Clinical Research Ethics Committee (21.06.2023, decision no: 2023/88). Data collection was conducted in accordance with the principles of the Declaration of Helsinki and the regulations of the ethics committee.

## RESULTS

A total of 1,013 patients underwent surgery for hip fracture during the study period. Of these, 885 patients met the inclusion criteria, while 128 patients were excluded according to the predefined exclusion criteria. Among the included patients, 287 (32.4%) were male and 598 (67.6%) were female.

Age was normally distributed, with a mean age of  $79.3 \pm 8.6$  years. Intertrochanteric femoral fractures were identified in 601 patients (67.9%), whereas femoral neck fractures were present in 284 patients (32.1%). Hemiarthroplasty was performed in 509 patients (57.5%), and osteosynthesis was performed in 376 patients (42.5%) (Table 1).

Preoperative characteristics were compared between patients who underwent osteosynthesis and those who underwent hemiarthroplasty. No significant differences were observed between the groups with respect to age, ASA classification, or CCI scores. The mean age was  $78.89 \pm 9.23$  years in the osteosynthesis group and  $79.6 \pm 8.76$  years in the hemiarthroplasty group ( $p=0.244$ ). The mean ASA score was  $2.49 \pm 0.88$  in patients treated with osteosynthesis and  $2.47 \pm 0.91$  in those treated with hemiarthroplasty, with no statistically sig-

nificant difference between the groups ( $p=0.694$ ). Similarly, CCI scores were comparable between groups, with a mean value of  $4.96 \pm 1.44$  in both groups ( $p=0.216$ ).

### Mortality Outcomes

At one year of follow-up, 97 of 376 patients (25.7%) in the osteosynthesis group and 131 of 509 patients (25.7%) in the hemiarthroplasty group had died. No statistically significant difference in one-year mortality was observed between the groups ( $p=0.984$ ) (Table 2).

At three years, cumulative mortality was 52.6% (198/376) in the osteosynthesis group and 60.5% (308/509) in the hemiarthroplasty group ( $p=0.023$ ). However, after adjustment for multiple comparisons using the Benjamini–Hochberg FDR method, this difference did not remain statistically significant

**Table 1.** Baseline characteristics of patients undergoing osteosynthesis or hemiarthroplasty

| Variable                             | Total (n=885) | Osteosynthesis (n=376) | Hemiarthroplasty (n=509) | p     |
|--------------------------------------|---------------|------------------------|--------------------------|-------|
| Age, years (mean±SD)                 | 79.3±8.6      | 78.9±9.2               | 79.6±8.8                 | 0.244 |
| Age category, n (%)                  |               |                        |                          |       |
| ≤75 years                            | 266 (30.0)    | 143 (38.0)             | 123 (24.2)               | 0.121 |
| >75 years                            | 619 (70.0)    | 233 (62.0)             | 386 (75.8)               |       |
| Sex, n (%)                           |               |                        |                          | 0.586 |
| Female                               | 598 (67.6)    | 249 (66.2)             | 349 (68.6)               |       |
| Male                                 | 287 (32.4)    | 127 (33.8)             | 160 (31.4)               |       |
| ASA score (mean±SD)                  | 2.48±0.90     | 2.49±0.88              | 2.47±0.91                | 0.694 |
| Charlson Comorbidity Index (mean±SD) | 4.96±1.44     | 4.96±1.44              | 4.96±1.44                | 0.216 |
| CCI category, n (%)                  |               |                        |                          |       |
| ≤5                                   | 574 (64.8)    | 255 (67.8)             | 319 (62.7)               |       |
| >5                                   | 311 (35.2)    | 121 (32.2)             | 190 (37.3)               |       |

\*Charlson Comorbidity Index; \*American Society of Anesthesiologists. Continuous variables were compared using the independent samples t-test. Categorical variables were compared using the chi-square test. SD: Standard deviation; CCI: Charlson Comorbidity Index.

**Table 2.** Comparison of one-year mortality between osteosynthesis and hemiarthroplasty groups

| Group, n              | One-year mortality |                  |              |                  |       |       |
|-----------------------|--------------------|------------------|--------------|------------------|-------|-------|
|                       | Osteosynthesis     |                  | Arthroplasty |                  | p     | FDR   |
|                       | Total, n           | Mortality, n (%) | Total, n     | Mortality, n (%) |       |       |
| Overall (n=885)       | 376                | 97 (25.7%)       | 509          | 131 (25.7%)      | 0.984 | 0.994 |
| Age ≤75 years (n=266) | 143                | 17 (11.8%)       | 123          | 23 (18.6%)       | 0.121 | 0.227 |
| Age >75 years (n=619) | 233                | 80 (34.3%)       | 386          | 108 (27.9%)      | 0.105 | 0.225 |
| CCI* ≤5 (n=574)       | 255                | 48 (18.8%)       | 319          | 66 (20.6%)       | 0.578 | 0.730 |
| CCI >5 (n=311)        | 121                | 49 (40.4%)       | 190          | 65 (34.2%)       | 0.279 | 0.465 |

CCI: Charlson Comorbidity Index.

**Table 3.** Comparison of three-year mortality between osteosynthesis and hemiarthroplasty groups

| Group, n              | Three-year mortality |                  |              |                  |       |       |
|-----------------------|----------------------|------------------|--------------|------------------|-------|-------|
|                       | Osteosynthesis       |                  | Arthroplasty |                  | p     | FDR   |
|                       | Total, n             | Mortality, n (%) | Total, n     | Mortality, n (%) |       |       |
| Overall (n=885)       | 376                  | 198 (52.6%)      | 509          | 308 (60.5%)      | 0.020 | 0.057 |
| Age ≤75 years (n=266) | 143                  | 42 (29.3%)       | 123          | 59 (47.9%)       | 0.002 | 0.015 |
| Age >75 years (n=619) | 233                  | 156 (66.9%)      | 386          | 249 (64.5%)      | 0.535 | 0.730 |
| CCI* ≤5 (n=574)       | 255                  | 109 (42.7%)      | 319          | 171 (53.6%)      | 0.010 | 0.037 |
| CCI >5 (n=311)        | 121                  | 89 (73.5%)       | 190          | 137 (72.1%)      | 0.780 | 0.900 |

CCI: Charlson Comorbidity Index.

**Table 4.** Comparison of five-year mortality between osteosynthesis and hemiarthroplasty groups

| Group, n              | Five-year mortality |                  |              |                  |       |       |
|-----------------------|---------------------|------------------|--------------|------------------|-------|-------|
|                       | Osteosynthesis      |                  | Arthroplasty |                  | p     | FDR   |
|                       | Total, n            | Mortality, n (%) | Total, n     | Mortality, n (%) |       |       |
| Overall (n=885)       | 376                 | 220 (58.5%)      | 509          | 347 (68.1%)      | 0.003 | 0.015 |
| Age ≤75 years (n=266) | 143                 | 52 (36.3%)       | 123          | 70 (56.9%)       | 0.001 | 0.015 |
| Age >75 years (n=619) | 233                 | 168 (72.1%)      | 386          | 277 (71.7%)      | 0.927 | 0.994 |
| CCI* ≤5 (n=574)       | 255                 | 128 (50.1%)      | 319          | 195 (61.1%)      | 0.01  | 0.037 |
| CCI >5 (n=311)        | 121                 | 92 (76.0%)       | 190          | 152 (80.0%)      | 0.480 | 0.720 |

CCI: Charlson Comorbidity Index; FDR: False discovery rate.

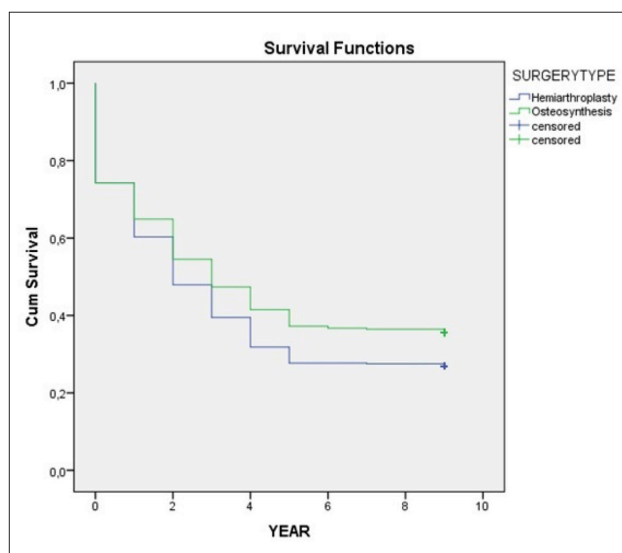
at the predefined threshold (FDR-adjusted  $p=0.057$ ) (Table 3).

At five years, cumulative mortality was higher in the hemiarthroplasty group (68.1%; 347/509) than in the osteosynthesis group (58.5%; 220/376) ( $p=0.003$ ). This difference remained statistically significant after FDR adjustment (FDR-adjusted  $p=0.015$ ) (Table 4).

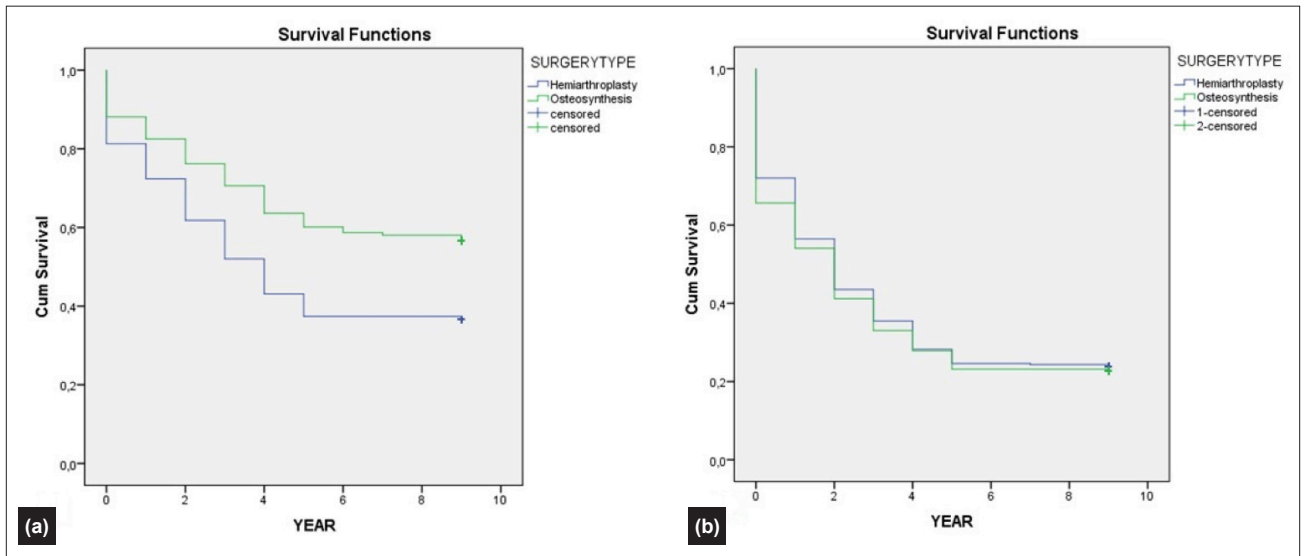
Overall survival was evaluated using Kaplan–Meier survival analysis. Comparison of survival curves across the entire follow-up period demonstrated a significant difference between the surgical method groups (log-rank  $p=0.013$ ) (Figure 3).

#### Age-Stratified Analyses

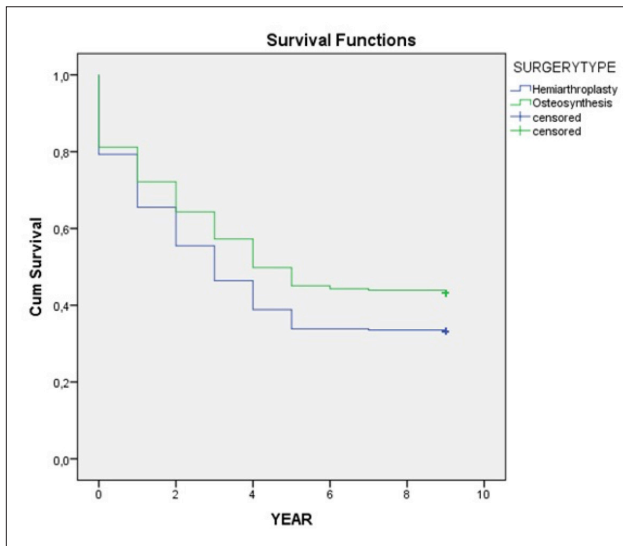
Patients were stratified into two age groups ( $\leq 75$  years and  $> 75$  years).<sup>[6]</sup> Among patients aged  $\leq 75$  years ( $n=266$ ), cumulative mortality at one year was 11.8% in the osteosynthesis group and 18.6% in the hemiarthroplasty group ( $p=0.121$ ). At three years, cumulative mortality was higher in the hemiarthroplasty group than in the osteosynthesis group (47.9% vs. 29.3%,  $p=0.002$ ). At five years, cumulative mortality remained higher in the hemiarthroplasty group (56.9% vs. 36.3%,  $p=0.001$ ). Among patients older than 75 years ( $n=619$ ), cumulative mortality rates at one, three, and five years were

**Figure 3.** Kaplan–Meier survival curves comparing hemiarthroplasty and osteosynthesis over a five-year follow-up period.

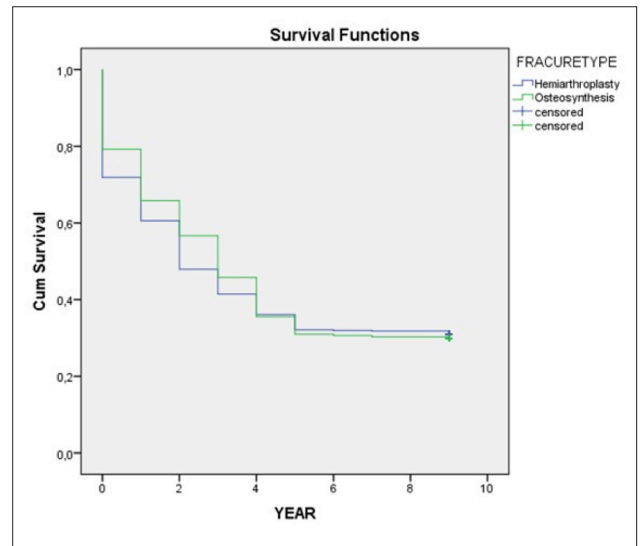
similar between the osteosynthesis and hemiarthroplasty groups (34.3% vs. 27.9%,  $p=0.105$ ; 66.9% vs. 64.5%,  $p=0.543$ ;



**Figure 4.** Kaplan–Meier survival curves stratified according to age group. (a) Patients aged ≤75 years. (b) Patients aged >75 years.



**Figure 5.** Kaplan–Meier survival curves stratified according to Charlson Comorbidity Index (CCI) ≤5.



**Figure 6.** Kaplan–Meier survival curves stratified according to Charlson Comorbidity Index (CCI) >5.

and 72.1% vs. 71.7%,  $p=0.927$ , respectively). Kaplan–Meier survival analysis demonstrated a significant difference in overall survival between surgical methods among patients aged ≤75 years (log-rank  $p=0.010$ ), whereas no significant difference was observed in patients aged >75 years (log-rank  $p=0.535$ ) (Fig. 4).

### CCI-Stratified Analyses

Patients were also stratified according to estimated five-year life expectancy based on the Charlson Comorbidity Index (CCI ≤5 vs. >5).<sup>[9]</sup> Among patients with CCI ≤5 ( $n=574$ ), no significant difference between surgical methods was observed in one-year mortality ( $p=0.578$ ). However, cumulative mor-

tality at both three years ( $p=0.012$ ) and five years ( $p=0.010$ ) was higher in the hemiarthroplasty group. Kaplan–Meier analysis also demonstrated a significant difference in overall survival between treatment groups (log-rank  $p=0.017$ ) (Fig. 5).

Among patients with CCI >5 ( $n=311$ ), cumulative mortality rates at one, three, and five years were similar between the osteosynthesis and hemiarthroplasty groups, with no statistically significant differences ( $p=0.279$ ,  $p=0.443$ , and  $p=0.480$ , respectively). Survival analysis likewise demonstrated comparable outcomes between the two treatment modalities, as Kaplan–Meier curves showed no significant separation (log-rank  $p=0.844$ ) (Fig. 6).

**Table 5.** Mortality outcomes stratified by surgical method and fracture stability

| Group                              | n   | One-year mortality | p     | Three-year mortality | p     | Five-year mortality | p     |
|------------------------------------|-----|--------------------|-------|----------------------|-------|---------------------|-------|
| Osteosynthesis + stable fracture   | 239 | 59 (24.6%)         | 0.541 | 125 (52.3%)          | 0.854 | 138 (57.7%)         | 0.745 |
| Osteosynthesis + unstable fracture | 137 | 38 (27.7%)         |       | 73 (53.2%)           |       | 82 (59.8%)          |       |
| Arthroplasty + stable fracture     | 217 | 57 (26.2%)         | 0.102 | 134 (61.7%)          | 0.621 | 151 (69.5%)         | 0.443 |
| Arthroplasty + unstable fracture   | 292 | 74 (25.3%)         |       | 174 (59.5%)          |       | 196 (67.1%)         |       |
| Total stable fractures             | 456 | 116 (25.4%)        | 0.399 | 259 (56.7%)          | 0.815 | 289 (63.3%)         | 0.779 |
| Total unstable fractures           | 429 | 112 (26.1%)        |       | 247 (57.5%)          |       | 278 (64.8%)         |       |

### Fracture Type–Stratified Analysis

A total of 456 patients (51.5%) had stable fractures, whereas 429 patients (48.5%) had unstable fractures. Within the osteosynthesis group, no significant difference in mortality was observed between stable and unstable fractures. Five-year mortality rates were 57.7% in patients with stable fractures and 59.8% in those with unstable fractures ( $p=0.745$ ). Similarly, among patients treated with hemiarthroplasty, mortality rates did not differ significantly according to fracture stability. Five-year mortality was 69.5% in stable fractures and 67.1% in unstable fractures ( $p=0.443$ ) (Table 5).

Among patients with stable fractures, one-year mortality rates were comparable between the osteosynthesis and hemiarthroplasty groups ( $p=0.411$ ). However, at three and five years, mortality rates were significantly higher in the hemiarthroplasty group than in the osteosynthesis group (61.7% vs. 52.3%,  $p=0.04$ ; and 69.5% vs. 57.7%,  $p=0.008$ , respectively).

Among patients with unstable fractures, one-year mortality rates were also similar between treatment groups. At three years, the difference in mortality between hemiarthroplasty and osteosynthesis did not reach statistical significance (59.5% vs. 53.2%,  $p=0.218$ ). However, at five years, mortality was significantly higher in the hemiarthroplasty group (67.1% vs. 59.8%,  $p=0.04$ ).

### Multivariable Survival Analysis

In unadjusted Cox proportional hazards analysis, hemiarthroplasty was associated with a higher risk of mortality compared with osteosynthesis (hazard ratio [HR]=1.213, 95% confidence interval [CI]: 1.031–1.427;  $p=0.019$ ). After adjustment for age, sex, Charlson Comorbidity Index, ASA score, and fracture type, this association was attenuated and no longer statistically significant (adjusted HR=1.112, 95% CI: 0.913–1.337;  $p=0.19$ ).

In age-stratified Cox proportional hazards analyses, models were adjusted for sex, Charlson Comorbidity Index, ASA score, and fracture type, without including age as a covariate. In the  $\leq 75$ -year age group, patients treated with hemiarthro-

plasty demonstrated a significantly higher mortality risk than those managed with osteosynthesis (adjusted HR=1.757, 95% CI: 1.131–2.730;  $p=0.012$ ). In contrast, no significant association between surgical method and mortality was observed among patients aged  $>75$  years (adjusted HR=1.032, 95% CI: 0.837–1.272;  $p=0.768$ ).

## DISCUSSION

This study provides important data regarding the relationship between surgical treatment choice and mortality in elderly patients with hip fractures, a condition that represents a major public health problem. Our findings suggest that the type of surgical treatment may influence mortality, particularly in patients younger than 75 years and in those with fewer comorbidities. The relatively large sample size and minimum follow-up duration of five years strengthen the value of the findings. Nevertheless, the retrospective design and single-center nature of the study should be considered limitations.

Hip fracture is a significant public health issue that predominantly affects the elderly population and is associated with substantial morbidity, mortality, and healthcare costs.<sup>[10]</sup> Recent evidence suggests that hip fracture rates may have stabilized or even declined, possibly reflecting improvements in osteoporosis management. In a large population-based study from the United States covering the years 2002–2015, Lewiecki et al.<sup>[11]</sup> reported stabilization in hip fracture incidence between 2012 and 2015. However, increasing global life expectancy continues to raise concerns regarding the worldwide burden of hip fractures. Previous studies have shown that hip fractures occur 2–8 times more frequently in women than in men.<sup>[12]</sup> Consistent with these reports, most patients in our cohort were female (67.6%).

The primary goal in the treatment of hip fractures is early mobilization while minimizing mortality and morbidity. Therefore, surgical treatment is generally preferred whenever the patient's overall condition permits.<sup>[13–16]</sup> The optimal timing of surgery has not been clearly established in the current literature, and no clear consensus exists regarding whether acceptable surgical delay should be limited to 24, 48, or 72

hours, or even longer. Some studies have associated early surgery with lower mortality and morbidity, whereas others suggest that delaying surgery until adequate clinical stabilization may reduce complications.<sup>[2,17-21]</sup> Because operative timing itself may influence mortality outcomes, our study included only patients who underwent surgery within 48 hours of fracture occurrence, and the effect of surgical delay on mortality was not specifically evaluated.

Several studies have compared osteosynthesis and hemiarthroplasty in the treatment of fractures.<sup>[22,23]</sup> Osteosynthesis has been associated with reduced blood loss, shorter operative time, lower transfusion requirements, and fewer wound-related complications.<sup>[24]</sup> However, fixation failure is more common after osteosynthesis than after arthroplasty. From a cost perspective, osteosynthesis may be less expensive during the initial hospitalization but can become more costly over time because of revision procedures.<sup>[25]</sup> According to Frihagen et al.,<sup>[26]</sup> hospital length of stay did not differ significantly between osteosynthesis and hemiarthroplasty groups.

Although previous studies have investigated postoperative mortality and morbidity following arthroplasty and osteosynthesis, findings have remained inconsistent. Jensen et al.<sup>[27]</sup> compared osteosynthesis with cannulated screw with hemiarthroplasty and reported lower mortality following osteosynthesis, whereas surgical site infections and medical complications were more common after arthroplasty. Similarly, Parker et al.<sup>[23]</sup> suggested that osteosynthesis caused less surgical trauma than arthroplasty in patients with displaced intracapsular hip fractures, particularly among older individuals and those with lower functional status.

Davison et al.<sup>[28]</sup> reported higher one-year mortality following arthroplasty compared with osteosynthesis. However, other studies have found no significant difference in mortality between osteosynthesis and arthroplasty.<sup>[29,30]</sup> In our study, when all patients were evaluated regardless of age, the surgical method did not affect one-year mortality. However, three-year and five-year mortality rates were significantly higher among patients who underwent hemiarthroplasty.

Jiang et al.<sup>[9]</sup> demonstrated that a Charlson Comorbidity Index greater than 5 was associated with reduced five-year life expectancy and increased mortality in patients older than 65 years with hip fractures. In our cohort, when patients were stratified into CCI  $\leq 5$  and CCI  $> 5$  groups, three-year and five-year mortality rates were significantly higher in patients with better estimated five-year life expectancy who underwent hemiarthroplasty, whereas no significant differences were observed among patients with poorer estimated life expectancy.

Similarly, in patients younger than 75 years, three-year and five-year mortality rates were higher in the hemiarthroplasty group. The absence of a significant difference in older patients may be related to their limited overall survival time. Additionally, in the  $\leq 75$ -year subgroup, the increased mortality observed after hemiarthroplasty may partly reflect selection-

related factors, as hemiarthroplasty was more frequently chosen for comminuted fractures or markedly poor bone quality. Furthermore, hemiarthroplasty is a more invasive procedure that involves greater soft-tissue dissection and blood loss, potentially resulting in increased perioperative physiological stress. In contrast, osteosynthesis preserves native bone and may facilitate earlier and more physiological mobilization, potentially reducing postoperative complications. These combined clinical and procedural differences may help explain the increased mortality risk observed in this younger subgroup.

## CONCLUSION

In this retrospective cohort study, differences in one-, three-, and five-year mortality were observed between hemiarthroplasty and osteosynthesis, with the association varying according to age and comorbidity subgroups. Although hemiarthroplasty was associated with higher long-term mortality in patients younger than 75 years and in those with a lower comorbidity burden, the two procedures demonstrated comparable outcomes in older patients and in those with greater comorbidity burden. These findings should be interpreted cautiously because of the retrospective design of the study and the potential for residual confounding and selection bias. Further prospective studies are needed to clarify the long-term impact of surgical treatment choice in the management of hip fractures.

**Ethics Committee Approval:** This study was approved by the Izmir Bozyaka Training and Research Hospital Local Clinical Research Ethics Committee (Date: 21.06.2023, Decision No: 2023/88). Data collection was conducted in accordance with the principles of the Declaration of Helsinki and the regulations

**Peer-review:** Externally peer-reviewed.

**Authorship Contributions:** Concept: M.G., T.K., F.I., A.B., O.C., C.K.; Design: M.G., T.K., F.I., A.B., O.C., C.K.; Data collection and/or processing: M.G., T.K., F.I., A.B., O.C., C.K.; Analysis and/or interpretation: M.G., T.K., F.I., A.B., O.C., C.K.; Writing: M.G., T.K., F.I., A.B., O.C., C.K.; Critical review: M.G., T.K., F.I., A.B., O.C., C.K.

**Informed Consent:** Retrospective study.

**Conflict of Interest:** The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Financial Disclosure:** The author declared that this study has received no financial support.

## REFERENCES

1. Bäcker HC, Wu CH, Maniglio M, Wittekindt S, Hardt S, Perka C. Epidemiology of proximal femoral fractures. *J Clin Orthop Trauma* 2021;12:161–5. [[CrossRef](#)]
2. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? *J Bone Joint Surg Am* 2005;87:483–9. [[CrossRef](#)]

3. Neuburger J, Currie C, Wakeman R, Tsang C, Plant F, De Stavola B, et al. The impact of a national clinician-led audit initiative on care and mortality after hip fracture in England: an external evaluation using time trends in non-audit data. *Med Care* 2015;53:686–91. [\[CrossRef\]](#)
4. von Friesendorff M, McGuigan FE, Wizert A, Rogmark C, Holmberg AH, Woolf AD, et al. Hip fracture, mortality risk, and cause of death over two decades. *Osteoporos Int* 2016;27:2945–53. [\[CrossRef\]](#)
5. Mittal R, Banerjee S. Proximal femoral fractures: Principles of management and review of literature. *J Clin Orthop Trauma* 2012;3:15-23. [\[CrossRef\]](#)
6. Palm H. Hip fracture: the choice of surgery. In: Falaschi P, Marsh D, editors. *Orthogeriatrics: the management of older patients with fragility fractures*. 2nd ed. Cham (CH): Springer; 2021. p. 125–41. [\[CrossRef\]](#)
7. Ozan F, Koyuncu S, Pekedis M, Altay T, Yıldız H, Tokar G. Greater trochanteric fixation using a cable system for partial hip arthroplasty: a clinical and finite element analysis. *Biomed Res Int* 2014;2014:931537. [\[CrossRef\]](#)
8. World Health Organization. *World report on ageing and health*. 2015: World Health Organization. Available at: [\[CrossRef\]](#)
9. Jiang L, Chou ACC, Nadkarni N, Ng CEQ, Chong YS, Howe TS, et al. Charlson comorbidity index predicts 5-year survivorship of surgically treated hip fracture patients. *Geriatr Orthop Surg Rehabil* 2018;9:2151459318806442. [\[CrossRef\]](#)
10. Roberts KC, Brox WT, Jevsevar DS, Sevarino K. Management of hip fractures in the elderly. *J Am Acad Orthop Surg* 2015;23:131–7. [\[Cross-Ref\]](#)
11. Lewiecki EM, Wright NC, Curtis JR, Siris E, Gagel RF, Saag KG, et al. Hip fracture trends in the United States, 2002 to 2015. *Osteoporos Int* 2018;29:717–22. [\[CrossRef\]](#)
12. Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: Worldwide geographic variation. *Indian J Orthop* 2011;45:15-22. [\[CrossRef\]](#)
13. Hu F, Jiang C, Shen J, Tang P, Wang Y. Preoperative predictors for mortality following hip fracture surgery: a systematic review and meta-analysis. *Injury* 2012;43:676–85. [\[CrossRef\]](#)
14. Handoll HH, Parker MJ. Conservative versus operative treatment for hip fractures in adults. *Cochrane Database Syst Rev* 2008;2008:CD000337. [\[CrossRef\]](#)
15. Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. *Osteoporos Int* 2004;15:897–902. [\[CrossRef\]](#)
16. Peeters CM, Visser E, Van de Ree CL, Gosens T, Den Oudsten BL, De Vries J. Quality of life after hip fracture in the elderly: A systematic literature review. *Injury* 2016;47:1369–82. [\[CrossRef\]](#)
17. Simunovic N, Devereaux PJ, Sprague S, Guyatt GH, Schemitsch E, Debeer J, et al. Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. *CMAJ* 2010;182:1609–16. [\[CrossRef\]](#)
18. Lefaivre KA, Macadam SA, Davidson DJ, Gandhi R, Chan H, Broekhuysen HM. Length of stay, mortality, morbidity and delay to surgery in hip fractures. *J Bone Joint Surg Br* 2009;91:922–7. [\[CrossRef\]](#)
19. Sheehan KJ, Sobolev B, Guy P. Mortality by timing of hip fracture surgery: factors and relationships at play. *J Bone Joint Surg Am* 2017;99:e106. [\[CrossRef\]](#)
20. Grimes JP, Gregory PM, Noveck H, Butler MS, Carson JL. The effects of time-to-surgery on mortality and morbidity in patients following hip fracture. *Am J Med* 2002;112:702–9. [\[CrossRef\]](#)
21. Casaletto JA, Gatt R. Post-operative mortality related to waiting time for hip fracture surgery. *Injury* 2004;35:114–20. [\[CrossRef\]](#)
22. Ridha M, Al-Jabri T, Stelzhammer T, Shah Z, Oragui E, Giannoudis PV. Osteosynthesis, hemiarthroplasty, total hip arthroplasty in hip fractures: All I need to know. *Injury* 2024;55:111377. [\[CrossRef\]](#)
23. Parker MJ, Khan RJ, Crawford J, Pryor GA. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures in the elderly. A randomised trial of 455 patients. *J Bone Joint Surg Br* 2002;84:1150–5. [\[CrossRef\]](#)
24. Parker MJ, Gurusamy K. Internal fixation versus arthroplasty for intracapsular proximal femoral fractures in adults. *Cochrane Database Syst Rev* 2006;2006:CD001708. [\[CrossRef\]](#)
25. Keating JF, Grant A, Masson M, Scott NW, Forbes JF. Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients. *J Bone Joint Surg Am* 2006;88:249–60. [\[CrossRef\]](#)
26. Frihagen F, Nordsletten L, Madsen JE. Hemiarthroplasty or internal fixation for intracapsular displaced femoral neck fractures: randomised controlled trial. *BMJ* 2007;335:1251–4. [\[CrossRef\]](#)
27. Jensen J, Rasmussen T, Christensen S, Holm-Møller S, Lauritzen J. Internal fixation or prosthetic replacement in fresh femoral neck fractures. *Acta Orthop Scand* 1984;55:712.
28. Davison JN, Calder SJ, Anderson GH, Ward G, Jagger C, Harper WM, et al. Treatment for displaced intracapsular fracture of the proximal femur. A prospective, randomised trial in patients aged 65 to 79 years. *J Bone Joint Surg Br* 2001;83:206–12. [\[CrossRef\]](#)
29. Johansson T, Jacobsson SA, Ivarsson I, Knutsson A, Wahlström O. Internal fixation versus total hip arthroplasty in the treatment of displaced femoral neck fractures: a prospective randomized study of 100 hips. *Acta Orthop Scand* 2000;71:597–602. [\[CrossRef\]](#)
30. Karaman Ö, Özkazanlı G, Orak MM, Mutlu S, Mutlu H, Çalıřkan G, et al. Factors affecting postoperative mortality in patients older than 65 years undergoing surgery for hip fracture. *Ulus Travma Acil Cerrahi Derg* 2015;21:44–50. [\[CrossRef\]](#)

## ORİJİNAL ÇALIŞMA - ÖZ

**Kalça kırığı cerrahisi sonrası yaşa göre mortalitenin değerlendirilmesi: Hemiartroplasti ve osteosentezin karşılaştırıldığı retrospektif bir kohort çalışması**

**AMAÇ:** Kalça kırıkları, özellikle ileri yaşlı bireylerde yüksek mortalite ve morbidite ile ilişkili önemli bir halk sağlığı sorunudur. Kalça kırıklarının %90'ından fazlası 50 yaş ve üzerindeki bireylerde görülmekte olup, osteoporoz ve kemik kalitesindeki bozulmaya bağlı olarak insidans yaşla birlikte artmaktadır. Bu çalışmanın amacı, kalça kırığı sonrası uygulanan cerrahi tedavi yöntemleri ile kısa ve uzun dönem mortalite arasındaki ilişkiyi, yaşa göre alt grup analizlerine odaklanarak incelemektir.

**GEREÇ VE YÖNTEM:** Bu retrospektif kohort çalışmasına, üçüncü basamak bir sağlık merkezinde kalça kırığı nedeniyle cerrahi tedavi uygulanan 65 yaş ve üzerindeki hastalar dâhil edildi. Yaş ve cerrahiye kadar geçen süre sürekli değişkenler olarak; cinsiyet, cerrahi yöntem, komorbiditeler ve takip durumu kategorik değişkenler olarak analiz edildi. Başlangıç özellikleri, cerrahi yöntem grupları arasında sürekli değişkenler için bağımsız örneklem t testi veya Mann–Whitney U testi, kategorik değişkenler için ise ki-kare testi kullanılarak karşılaştırıldı. Önceden belirlenmiş zaman noktalarındaki kümülatif mortalite tanımlayıcı olarak değerlendirildi; genel sağkalım ise Kaplan–Meier sağkalım analizi ile incelendi ve gruplar log-rank testi kullanılarak karşılaştırıldı.

**BULGULAR:** Toplam 885 hasta çalışma kriterlerini karşıladı; bunların 509'u (%57.5) hemiarthroplasti, 376'sı (%42.5) ise osteosentez ile tedavi edilmişti. Gruplar arasında 1 yıllık kümülatif mortalite açısından anlamlı fark saptanmadı ( $p=0.984$ ). Beş yıllık takipte ise hemiarthroplasti grubunda kümülatif mortalite, osteosentez grubuna kıyasla daha yüksekti (%68.1 ve %58.5;  $p=0.003$ ). Charlson Komorbidite İndeksi  $\leq 5$  olan hastalarda da 5 yıllık kümülatif mortalite, hemiarthroplasti sonrası daha yüksek bulundu (%61.1 vs %50.1;  $p=0.010$ ). Kaplan–Meier analizine göre genel sağkalım, cerrahi yöntem grupları arasında farklılık göstermekteydi.

**SONUÇ:** Hemiartroplasti sonrası uzun dönem mortalitenin daha yüksek olması, özellikle daha genç hastalarda ve komorbidite yükü daha düşük olan bireylerde belirgin; ileri yaşlı veya daha fazla komorbiditesi olan hastalarda cerrahi yöntemler arasındaki fark daha sınırlı bulunmuştur.

**Anahtar sözcükler:** Artroplasti; kalça kırığı; mortalite; osteosentez.

Ulus Travma Acil Cerrahi Derg 2026;32(6):735-744 DOI: 10.14744/tjtes.2026.38852