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Association between electrolyte imbalance and mortality in older adults with hip fracture

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Abstract

Hip fractures in the elderly are associated with high mortality rates. This study aimed to evaluate whether hyponatremia, hypernatremia, hypokalemia, and hyperkalemia are associated with 90-day postoperative mortality after hip fracture surgery. We retrospectively analyzed data from 388 patients who underwent surgery for hip fracture between January 1, 2020, and July 1, 2025, and were included in the study. Patient age, gender, American Society of Anesthesiologists (ASA) grade, fracture type, time from hospital admission to surgery, length of hospital stay, and sodium and potassium levels during hospitalization were recorded. Hyponatremia (p=0.02), hypernatremia (p=0.04), hypokalemia (p=0.03), and hyperkalemia (p=0.04) were found to be associated with 90-day mortality after hip fracture. This association persisted even after adjusting for age, sex, ASA, fracture type, time from hospital admission to surgery, and length of hospital stay. Hyponatremia, hypernatremia, hypokalemia, and hyperkalemia are common preoperative and postoperative findings in elderly patients undergoing hip fracture surgery and have been shown to be associated with mortality within 90 days postoperatively.

Keywords: Electrolyte imbalance, hip fracture, mortality, potassium, sodium

Introduction

Hip fractures, which are common in the geriatric population, often lead to functional impairment and reduced quality of life [1]. Moreover, hip fractures represent a major public health concern due to their association with considerable morbidity and mortality [2]. The reported 1-yr mortality ratio after hip fracture varies between 15% and 25% [3]. Many patients with hip fractures present with multiple geriatric conditions, such as malnutrition and cognitive impairment, which predispose them to the development of complications, all of which result in rised mortality [4].

Age-related physiological changes, along with existing comorbidities, predispose patients with hip fractures to perioperative electrolyte disturbances [5]. Electrolyte imbalance is among the most frequent perioperative complications, with hyponatremia being the most common [6-8]. Other electrolyte abnormalities—hypernatremia, hypokalemia, and hyperkalemia—also occur, albeit less frequently [9-11].

Identifying factors that influence postoperative mortality and morbidity is essential for developing optimal preoperative and postoperative management strategies. The impact of numerous demographic data and patient medical information on mortality following hip fracture has been investigated in the literature [2,12,13]. Uncorrected preoperative electrolyte imbalances can delay surgery, increase mortality, and result in serious cardiovascular and cerebrovascular complications [14].

Although studies exist showing that hyponatremia and hypernatremia increase mortality in elderly hip fracture patients, the effect of hypokalemia and hyperkalemia on mortality is unclear. This study aimed to evaluate factors that may be associated with the high mortality rate observed after hip

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fractures and to determine the relationship between electrolyte imbalance and 90-day postoperative mortality. Our hypothesis is that sodium and potassium imbalances are associated with increased mortality in elderly hip fracture patients.

Material and Methods

In this study, 402 patients diagnosed with hip fracture and who underwent surgery between January 1, 2020, and July 1, 2025, were retrospectively evaluated. Since laboratory results from the first day of hospitalization were unavailable for 14 patients, 388 patients were included in the study. This study was approved by the Aksaray University Health Sciences Scientific Research Ethics Committee with decision number 120 in 2025. The presented article does not contain any information identifying the patients.

Patients over 65 years of age who underwent surgery due to hip fracture were included in the study. Patients with conservative treatment, revision surgery, multiple trauma, pathological fractures, and a history of malignancy were excluded.

For each patient, data on age, gender, American Society of Anesthesiologists (ASA) grade, hip fracture type, time from hospital admission to surgery, time from discharge to hospitalization, and laboratory test results were obtained from the hospital's digital archive system. The fracture types included femoral neck, pertrochanteric, and subtrochanteric femur fractures. It was observed that patients with intertochanteric and subtrochanteric femoral fractures underwent intramedullary nailing following closed reduction. Partial hemiarthroplasty was observed in patients who underwent surgery for femoral neck fractures.

Serum sodium and potassium levels were recorded from laboratory tests at the time of initial hospital admission to assess electrolyte imbalance. A serum sodium value below 135 mmol/L is defined as hyponatremia, a value above 145 mmol/L is defined as hypernatremia; a serum potassium value below 3.5 mmol/L is defined as hypokalemia, and a value above 5.3 mmol/L is defined as hyperkalemia [15].

When evaluating 90-day mortality, the day of surgery was considered day zero. Apart from the patients who died, no patients were dropped from follow-up. Information on whether the patients died and their dates of death were obtained from the Death Notification System of the Ministry of Health.

Statistical analysis was performed using IBM SPSS (Statistical Package for Social Sciences for Windows ver. 26, IBM Corp, Armonk, NY). Differences between continuous variables were tested using unpaired t-tests. Differences in the distribution of categorical variables (baseline characteristics and crude mortality rates) were tested using Fisher's exact test. Hazard ratios were calculated using Cox proportional hazards models with all-cause mortality as the endpoint with adjustment for age, sex, ASA grade, fracture type, delay from admission to surgery and lenght of stay at hospital. A calculated p value of less than 0.05 was considered statistically significant.

Results

Of the 388 patients evaluated, 266 were females, and 122 were males, with a mean age of 77. 6 yr. Preoperative assessment showed that 26 patients were classified as ASA I, 52 as ASA II, 206 as ASA III, and 104 as ASA IV. Among these patients, 126 underwent surgery for femoral neck fractures, 254 for pertrochanteric fractures, and eight for subtrochanteric femur fractures. The mean time from hospital admission to surgery was 1.9 days, and the mean time from discharge to hospitalization was 4.2 days. The mean follow-up duration was 31.1 months.

When patients were evaluated according to serum sodium concentration, 235 were found to be normonatremic, 141 were hyponatremic, and 12 were hypernatremic. No marked differences were observed among the sodium groups regarding age, gender, ASA grade, hip fracture type, time from hospital admission to surgery, time from discharge to hospitalization, or mean follow-up duration. However, 90-day mortality was higher in the hyponatremia and hypernatremia groups compared to the group with normal sodium levels (Table 1).

Unadjusted 90-day mortality were higher in hyponatremic and hypernatremic patients compared to normonatremic patients (Table 2). After adjusting for age, sex, ASA grade, and fracture type, hyponatremia (HR=1.88 [1.55–2.24], p = 0.04) and hypernatremia (HR=1.88 [1.51–2.08], p = 0.04) were found to be associated with 90-day mortality (Table 2). Similarly, after adjusting for age, sex, ASA grade, fracture type, time from hospital admission to surgery, and length of hospital stay, 90-day mortality was found to be associated with hyponatremia (HR=1.57 [1.12–1.98], p = 0.04) and hypernatremia (HR=1.58 [1.17–1.91], p = 0.04) (Table 2).

When patients were evaluated according to serum potassium concentration, 261 were found to be normokalemic, 102 were hypokalemic, and 25 were hyperkalemic. No marked differences were observed among the potassium groups regarding age, gender, ASA grade, hip fracture type, time from hospital admission to surgery, time from discharge to hospitalization, or mean follow-up duration. However, 90-day mortality was higher in the hypokalemic and hyperkalemic groups compared to the group with normal potassium levels (Table 3).

Unadjusted 90-day mortality were higher in hypokalemic and hyperkalemic patients compared to normokalemic patients (Table 4). After adjusting for age, sex, ASA grade, and fracture type, hypokalemia (HR=1.84 [1.65–2.18], p = 0.03) and hyperkalemia (HR=1.81 [1.41–1.99], p = 0.04) were found to be associated with 90-day mortality (Table 4). Similarly, after adjusting for age, sex, ASA grade, fracture type, time from hospital admission to surgery, and length of hospital stay, 90-day mortality was found to be associated with hypokalemia (HR=1.59 [1.01–1.82], p = 0.04) and hyperkalemia (HR=1.61 [1.21–1.97], p = 0.04) (Table 4).

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Table 1. Distribution of patients and 90-day mortality according to serum sodium concentration

Variables	Normonatremia (N=235)	Hyponatremia (N=141)	p	Hypernatremia (N=12)	p
Age, years	78.2 ± 9.6	76.5 ± 8.3	0.58	79.8 ± 10.1	0.514
Sex, f/m	160/75	98/43	0.389	8/4	0.601
ASA, 1/2/3/4	17/33/117/68	8/17/81/35	0.801	1/2/8/1	0.699
Fracture type, femoral neck fracture/ pertrochanteric fracture/ subtrochanteric fracture	78/152/5	45/94/2	0.196	3/8/1	0.344
Delay from admission to surgery, days	1.92 ± 0.4	1.89 ± 0.3	0.772	1.83 ± 0.2	0.12
Lenght of stay at hospital, days	4.3 ± 2.1	4.1 ± 2.7	0.21	4.1 ± 2.2	0.286
Follow up time, months	30.6 ± 5.4	32.1 ± 4.6	0.194	31.5 ± 4.4	0.39
Mortality, in first 90 days	45 (19.1%)	37 (26.2%)	0.02	4 (33.3%)	0.04

Data are presented as mean ± standard deviation or number (percentage). ASA: American Society of Anesthesiologists; p values represent comparisons between normonatremia and other groups. A p value <0.05 was considered statistically significant.

Table 2. 90-day mortality according to admission levels of sodium—crude and adjusted hazard ratios

Serum sodium status	Deaths, N (%)	Hazard ratio HR [95% CI]			
		Unadjusted	Adjusted for sex and age	Adjusted for sex, age, ASA and fracture type	Adjusted for sex, age, ASA, fracture type, delay from admission to surgery, lenght of stay at hospital
Normonatremia	45 (19.1)	1 [reference]	1 [reference]	1 [reference]	1 [reference]
Hyponatremia	37 (26.2)	1.71 [1.28–2.09] p=0.02	1.86 [1.48–2.21] p=0.03	1.88 [1.55–2.24] p=0.04	1.57 [1.12–1.98] p=0.04
Hypernatremia	4 (33.3)	1.72 [1.21–1.83] p=0.04	1.79 [1.39–2.17] p=0.04	1.88 [1.51–2.08] p=0.04	1.58 [1.17–1.91] p=0.04

CI: confidence interval; ASA: American Society of Anesthesiologists.

Table 3. Distribution of patients and 90-day mortality according to serum potassium concentration

Variables	Normokalemia (N=261)	Hypokalemia (N=102)	p	Hyperkalemia (N=25)	p
Age, years	76.7 ± 11.2	79.9 ± 10.3	0.164	77.8 ± 9.3	0.385
Sex, f/m	178/83	71/31	0.48	17/8	0.666
ASA, 1/2/3/4	17/30/119/95	7/17/72/6	0.496	2/5/15/3	0.702
Fracture type, femoral neck fracture/ pertrochanteric fracture/ subtrochanteric fracture	82/149/6	39/86/1	0.38	5/19/1	0.432
Delay from admission to surgery, days	1.93 ± 0.2	1.86 ± 0.3	0.704	1.84 ± 0.3	0.398
Lenght of stay at hospital, days	4.1 ± 1.9	4.4 ± 2.1	0.542	4.4 ± 2.2	0.68
Follow up time, months	30.7 ± 4.8	32.2 ± 5.2	0.212	31.8 ± 4.4	0.322
Mortality, in first 90 days	51 (19.5%)	26 (25.4%)	0.03	9 (36.0%)	0.04

Data are presented as mean ± standard deviation or number (percentage). ASA: American Society of Anesthesiologists; p values represent comparisons between normokalemia and other groups. A p value <0.05 was considered statistically significant.

Table 4. 90-day mortality according to admission levels of potassium—crude and adjusted hazard ratios

Serum sodium status	Deaths, N (%)	Hazard ratio HR [95% CI]			
		Unadjusted	Adjusted for sex and age	Adjusted for sex, age, ASA and fracture type	Adjusted for sex, age, ASA, fracture type, delay from admission to surgery, lenght of stay at hospital
Normonatremia	51 (19.5)	1 [reference]	1 [reference]	1 [reference]	1 [reference]
Hyponatremia	26 (25.4)	1.78 [1.42–2.07] p=0.03	1.91 [1.66–2.34] p=0.03	1.84 [1.65–2.18] p=0.03	1.59 [1.01–1.82] p=0.04
Hypernatremia	9 (36.0)	1.69 [1.19–1.99] p=0.04	1.85 [1.43–2.13] p=0.04	1.81 [1.41–1.99] p=0.04	1.61 [1.21–1.97] p=0.04

CI: confidence interval; ASA: American Society of Anesthesiologists.

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Discussion

Electrolyte imbalance in elderly patients is influenced by multiple predisposing factors, and hip fractures further exacerbate this condition. Several studies have reported that mortality rates may increase in the presence of abnormal serum sodium or potassium concentrations [16]. Sodium and potassium imbalances typically result from disturbances in body water homeostasis. The primary cause of hypernatremia in elderly individuals is dehydration, whereas sodium overload and impaired renal excretion are less common causes. In contrast, hyponatremia is generally associated with reduced sodium intake resulting from nutritional deficiencies in this population [17]. The relationship between potassium imbalance and mortality is largely attributed to arrhythmogenic complications resulting from altered potassium imbalances [18].

Few studies have examined the impact of sodium and potassium levels on mortality in patients undergoing hip fracture surgery. Previous research has shown that patients with hyponatremia and hip fractures experience more frequent perioperative complications and higher mortality rates than patients with normonatremia [19]. A large Danish case series reported markedly higher 30-day mortality in patients with hypernatremia compared with those with normal sodium concentrations and noted that 1.7% of patients hospitalized for hip fractures had hypernatremia [20]. The mortality findings of our study are consistent with the findings in the literature for hyponatremia ($p=0.02$) and hypernatremia ($p=0.04$). This association persisted even after adjusting for age, gender, ASA grade, fracture type, time from hospital admission to surgery, and length of hospital stay. Moreover, the 3% prevalence of hypernatremia at presentation in our cohort exceeded the 1.7% reported in previous studies, which may be attributable to differences in nutritional patterns among the study populations.

Lewis et al. [16] reported that patients with hyperkalemia at presentation had higher mortality . Similarly, Pepin et al. [18] found that hypokalemia and hyperkalemia increased 30-day mortality. Arora et al. [21] also demonstrated that potassium imbalances were predictive of mortality and adverse cardiovascular events. Consistent with these findings, our study found that the presence of hypokalemia ($p = 0.03$) and hyperkalemia ($p = 0.04$) was associated with 90-day mortality. This association persisted even after adjusting for age, sex, ASA grade, fracture type, time from hospital admission to surgery, and length of hospital stay.

A major strength of our study is that it is the first to comprehensively assess sodium and potassium levels in older patients undergoing hip fracture surgery and to evaluate the association between hyponatremia, hypernatremia, hypokalemia, hyperkalemia, and mortality.

Our study has some limitations; firstly, the study design is retrospective and single-center. Due to the lack of access to certain data from the hospital database, it is unknown which patients received blood transfusions before and after surgery and which treatments were applied for electrolyte imbalances. Furthermore, there is a lack of information regarding patients' comorbidities, particularly renal failure, and the use of medications that could cause electrolyte imbalance. Finally, reliable data on causes of death are not available.

In the future, we believe that larger case series, which eliminate limitations such as information on the disease and medications used, and information on treatments applied before and after surgery, especially during discharge, and which evaluate less common electrolyte imbalances such as calcium and magnesium together, will enrich the literature on this subject.

Conclusion

Hyponatremia, hypernatremia, hypokalemia, and hyperkalemia are common preoperative and postoperative findings in elderly patients undergoing hip fracture surgery and have been shown to be associated with mortality in the 90-day postoperative period. Therefore, we recommend that electrolyte imbalances be carefully assessed and managed as an integral component of orthogeriatric care.

Ethical Approval
Approved by the Aksaray University Health Sciences Scientific Research Ethics Committee (No: 2025/120, Date: 03 July 2025).

Patient Consent
Informed consent was waived due to the retrospective design.

Conflict of Interest
The authors declare no conflict of interest.

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