ORIGINAL ARTICLE

Hyperchloremia at hospital admission for hip fractures is associated with increased morbidity and mortality rates

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ABSTRACT

BACKGROUND: Hip fractures in the elderly represent a major public health concern due to their high incidence, associated morbidity and mortality, and rising healthcare costs. This study investigates the impact of initial serum chloride levels, measured upon emergency department admission, on hospital length of stay, revision surgeries, and in-hospital mortality in elderly patients with hip fractures.

METHODS: Between August 2022 and August 2023, a total of 204 patients over 65 years of age diagnosed with hip fractures in the emergency department were included in the study. Patients were categorized into two groups based on their initial serum chloride levels: normochloremic (96-108 mEq/L) and hyperchloremic (>115 mEq/L). Length of hospital stay and postoperative complications were compared between the groups.

RESULTS: The mean chloride level was 102.1 mEq/L in the normochloremic group and 121.3 mEq/L in the hyperchloremic group. The average hospital length of stay was 9.9 days in the normochloremic group and 15.5 days in the hyperchloremic group, a statistically significant difference (p=0.009). Mortality and revision surgery rates did not show statistically significant differences between the groups. However, all six patients who died during the study had serum chloride levels above 115 mEq/L at admission.

CONCLUSION: This study demonstrates that elevated serum chloride levels at admission are associated with prolonged hospital stays and increased morbidity in elderly patients with hip fractures. While hyperchloremia may not directly predict mortality or the need for revision surgery, it may serve as a prognostic marker for extended hospitalization, indicating a higher risk in this vulnerable population.

Keywords: Chloride; elderly patients; hip fracture; hyperchloremia; morbidity; prolonged hospital stay.

INTRODUCTION

Hip fractures in the elderly represent a significant public health concern, not only due to their high incidence but also because of the substantial morbidity, mortality, and healthcare costs associated with these injuries.[1] As life expectancy increases globally, the prevalence of hip fractures continues to rise, making them a critical area of focus in both orthopedic and geriatric care. The perioperative management of hip fracture patients is complex and multifaceted, requiring careful assessment of both clinical and biochemical parameters to minimize complications and optimize recovery. Moreover, patients may experience complications such as delirium, acute kidney injury, and acute lung injury following a hip fracture, further em-

Cite this article as: Gürbüz S, Ocak O, Kır MÇ, Karslıoğlu B, Akı S. Hyperchloremia at hospital admission for hip fractures is associated with increased morbidity and mortality rates. Ulus Travma Acil Cerrahi Derg 2025;31:465-471.

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Ulus Travma Acil Cerrahi Derg 2025;31(5):465-471 DOI: 10.14744/tjtes.2025.33779

Submitted: 22.10.2024 Revised: 19.01.2025 Accepted: 19.02.2025 Published: 05.05.2025

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phasizing the importance of this condition as a public health issue.[2]

Among various biochemical markers, electrolyte imbalances have gained increasing attention for their potential impact on clinical outcomes in surgical patients. Chloride, a key extracellular anion, plays an essential role in maintaining osmotic balance, acid-base homeostasis, and proper cell function. Despite its physiological importance, chloride has traditionally been overlooked in favor of electrolytes such as sodium and potassium. However, emerging evidence suggests that hyperchloremia may be associated with adverse outcomes in critically ill and postoperative patients.[3] In surgical settings, hyperchloremia has been associated with impaired renal function, heightened inflammatory responses, and an increased incidence of acidosis, all of which may delay recovery and elevate the risk of complications.

In the context of hip fractures, elderly patients are particularly susceptible to the adverse effects of electrolyte imbalances due to pre-existing comorbidities and overall physiological frailty. Following a fracture, patients often experience dehydration and constipation, making micturition and defecation more difficult. To minimize pain, they tend to avoid movement; however, using the toilet inevitably involves mobilizing the fractured area, which causes significant discomfort. The perioperative period for hip fracture repair is often marked by substantial fluid shifts, blood loss, and the administration of intravenous fluids. As such, close monitoring of electrolyte levels, including chloride, is essential. Several studies have reported an association between hyperchloremia and poorer outcomes, including prolonged hospital stays, increased postoperative complications, and higher mortality rates across various patient populations.[4-6] However, there is a notable gap in the literature specifically examining the role of serum chloride levels in elderly patients with hip fractures.

This study aims to fill this gap by investigating the relationship between initial serum chloride levels at the time of emergency department admission and critical clinical outcomes, including length of hospital stay, revision surgeries, and in-hospital mortality, in elderly patients with hip fractures. By exploring these associations, this study seeks to determine whether serum chloride levels could serve as a reliable biomarker for risk stratification, thereby enabling more tailored and proactive perioperative management strategies for this high-risk population.

MATERIALS AND METHODS

Between August 2022 and August 2023, 216 patients admitted to the emergency department due to a fall and diagnosed with a proximal femoral fracture were considered for inclusion in this retrospective study. Ethics approval was obtained Prof. Dr. Cemil Tascioglu City Hospital ethics committee (23/09/2024,192). Eight patients under the age of 65 were excluded from the study. Additionally, two patients who were discharged from the hospital upon their own request at admission, and two who declined to give informed consent for the use of their data, were also excluded. A total of 204 patients were included in the final analysis. Informed consent was obtained from each patient prior to inclusion in the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

As part of the admission protocol, blood tests were performed for each patient to prepare them for surgery. This blood panel included the measurement of blood chloride levels. According to the hospital laboratory system, normal blood chloride values range between 96-108 mmol/L. Each patient was retrospectively followed until discharge from the hospital, either due to death or completion of treatment. All 204 patients diagnosed with proximal femoral fractures were classified according to the AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) system as 31A1.2, 31A1.3, 31A2, 31B1, 31B2, 31B3, 31C1, or 31C2 and were included in the study.

Preoperatively, all patients underwent a comprehensive evaluation by the anesthesia team to assess perioperative risk and optimize their medical condition for surgery. As part of the standard protocol, anticoagulant therapy was initiated for all patients, and mechanical prophylaxis measures, including compression stockings and air mattresses, were implemented to reduce the risk of thromboembolic events and pressure ulcers. Each patient's current medication regimen and comorbidities were thoroughly reviewed, and necessary consultations with relevant specialties were conducted to ensure multidisciplinary care. Surgical treatment consisted of either hip hemiarthroplasty (HHA) or proximal femoral nail (PFN).

Postoperatively, all patients were enrolled in a structured pulmonary rehabilitation program, which included Triflo breathing exercises to improve pulmonary function and reduce the risk of postoperative respiratory complications.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 22 software for Windows (IBM Corp., NY, USA), employing non-parametric tests due to the non-normal distribution of variables. Statistical significance was set at $p<0.05$. The chi-square test was used to assess statistical significance for complications, such as mortality and revision surgery, between the two groups.

RESULTS

Patients were categorized based on their initial chloride levels: normal (96-108 mEq/L) and hyperchloremic (>115 mEq/L). They were evaluated for hospital length of stay and complication rates. Patients were divided into two groups: those with normal chloride levels and those with hyperchloremia. Those with chloride levels between 109-114 mEq/L were not

assigned to either group but were still included in the overall analysis to assess the relationship between initial serum chloride levels and hospital length of stay. A t-test was used to analyze continuous variables, while the chi-square test was applied to categorical variables. Of the total patients, 138 had fractures on the left side, and the remainder had fractures on the right side. No patients with bilateral hip fractures were included in the study. The average age of the patients was 68.2 years.

There were 144 patients in the normochloremic group and 40 patients in the hyperchloremic group. The average blood chloride level at hospital admission was 102.1 mEq/L in the normochloremic group and 121.3 mEq/L in the hyperchloremic group. The remaining 20 patients were not included in either group, as their chloride levels did not meet the criteria for classification as hyperchloremic or normochloremic based on the defined laboratory parameters. However, as previously mentioned, these patients were still included in the study for the calculation of overall mean chloride levels and average hospital length of stay.

In this study, specific demographic and clinical parameters were compared between the hyperchloremic and normochloremic groups, and differences in postoperative outcomes were evaluated. According to the data, the mean age in the hyperchloremic group was 72.1 years (range: 68-86 years), while in the normochloremic group it was 68.1 years (range: 65-86 years) (Table 1).

Regarding gender distribution, the proportions of male and female patients were similar in both groups. The hyperchloremic group included 18 male and 22 female patients, while the normochloremic group consisted of 66 male and 78 female patients ($p>0.05$).

A statistically significant difference was observed between the groups in terms of postoperative hospital length of stay ($p<0.05$). However, no statistically significant difference was found between the two groups concerning anesthesia risk classification based on the American Society of Anesthesiologists (ASA) scores. Nevertheless, patients in the ASA 3 and ASA 4 risk categories were more frequently observed in the hyperchloremic group (ASA 3: 23 patients, ASA 4: 10 patients). In contrast, the majority of patients in the normochloremic group had a lower risk profile (ASA 2: 64 patients, ASA 3: 75 patients).

When evaluating mortality rates, all reported deaths occurred exclusively in the hyperchloremic group, with a total of six deaths. Chi-square test analysis indicated that this difference was statistically significant ($p<0.05$), suggesting that hyperchloremic patients had a higher perioperative mortality risk compared to normochloremic patients. Regarding blood transfusion rates, no statistically significant difference was observed between the normochloremic group (88.2%) and the hyperchloremic group (97.5%). However, proportionally, pa-

Table 1. Patient demographics

Total Number of Patients (n=204)	Hyperchloremic Group (n=40)	Normochloremic Group (n=144)
Age	72.1 (68-86)	68.1 (65-86)
Gender		
Male	18	66
Female	22	78
Fracture Side		
Right	10	56
Left	30	108
Postoperative Hospital Stay (days)	15.5 (2-35)	10 (1-21)
Anesthesia Risk		
ASA 2	7	64
ASA 3	23	75
ASA 4	10	5
In-Hospital Mortality	6	-
Blood Transfusion	39	127
Diabetes Mellitus	18	64
Hypertension	29	84
COPD	4	23
Diuretic Use	18	46

Table 2. Comparative evaluation between groups

	Normochloremic Group (96-108 mEq/L)	Hyperchloremic Group (>115 mEq/L)	Statistical Significance
Number of Patients	144	40	-
Average Blood Chloride Level	102.1	121.3	p=1.0
Average Length of Hospital Stay (days)	9.9	15.5	p=0.009*
Complication Count	3	9	p=0.006*

tients in the hyperchloremic group exhibited a greater need for blood transfusion. Additionally, while the differences in the prevalence of diabetes mellitus and hypertension in the hyperchloremic group were not statistically significant, these conditions were more commonly observed in that group. Conversely, chronic obstructive pulmonary disease (COPD) did not show a statistically significant difference between the groups; however, it was proportionally more prevalent in the normochloremic group. Diuretic use was more common in the hyperchloremic group (45%), but statistical analysis did not reveal a significant difference between the groups (p=0.178).

Surgeries in this study included all revision procedures, such as those required for infections, mechanical complications, and implant failures. Specifically, four patients underwent revision surgery due to early infections, and two patients required revision for hip dislocation. Fisher's exact test was used to analyze both mortality and revision surgery rates. Neither outcome showed a statistically significant difference between the normochloremic and hyperchloremic groups (p>0.05).

The average hospital length of stay for patients in the normochloremic group was 9.9 days, compared to 15.5 days in the hyperchloremic group. As the Shapiro-Wilk normality test indicated that data from both Group 1 (chloride level 96-108) and Group 2 (chloride level >115) were not normally distributed, the Mann-Whitney U test was used. This analysis revealed a statistically significant difference (p=0.009) in hospital length of stay between the two groups (Table 2).



Figure 1. Initial blood chloride level LOHS relation.

All patients underwent either PFN or HHA procedures. A total of 98 PFN surgeries and 106 HHA surgeries were performed (112 patients had pertrochanteric fractures, while 92 had collum femoris fractures). The average hospital stay was 16.2 days for patients who underwent HHA and 10.1 days for those who underwent PFN. Comparative analysis showed that hospital stay was significantly longer in the HHA group. The mean serum chloride level was 106.5 in patients who underwent PFN and 104.7 in those who underwent HHA. Age differences between the two groups may also have contributed to this finding, as the average age in the PFN group was 67.3 years, while it was 71.2 years in the HHA group.

An analysis of all 204 patients was conducted to evaluate the relationship between serum chloride levels and hospital length of stay. According to the results of the Pearson correlation test, the Pearson correlation coefficient was found to be 0.49, with a p-value of 0.013. These findings indicate a moderate positive correlation between initial serum chloride levels and the duration of hospitalization, demonstrating statistical significance (p<0.05). This suggests that higher initial blood chloride levels are associated with longer hospital stays (Fig. 1).

DISCUSSION

The purpose of this study was to investigate the association between initial blood chloride levels upon emergency department admission and key clinical outcomes in elderly patients with hip fractures, specifically hospital length of stay, mortality, and complications such as revision surgeries. The primary objective was to determine whether elevated serum chloride levels could serve as a biomarker to predict prolonged hospitalization and adverse outcomes in this high-risk population.

Electrolyte disturbances, particularly hyperchloremia, have gained increasing attention in recent years for their potential impact on recovery in critically ill and postoperative patients. Although often overshadowed by other electrolytes

such as sodium and potassium, chloride plays a crucial role in maintaining osmotic balance and acid-base homeostasis. Briscoe et al.[7] found in a recent study that trauma patients with blood hyperchloremia (>115) were associated with adverse effects such as impaired renal function, acidosis, and heightened inflammatory responses, all of which may prolong hospital stays and worsen clinical outcomes. These risks are especially pronounced in elderly patients, who are more susceptible to dehydration, fluid imbalances, and other physiological stressors following a hip fracture. While the current study does not investigate the duration of hyperchloremia, recent research has explored the impact of prolonged hyperchloremia and its relationship with morbidity in patients with traumatic brain injury.[8] Another study examining prognostic factors in traumatic brain injury investigated electrolyte imbalances and found no association between serum calcium or sodium levels and morbidity. However, it demonstrated that hyperchloremia was associated with lower Glasgow Coma Scale scores, which correlate with increased morbidity and mortality.[9]

The results indicated a significant difference in the length of hospital stay between patients with normal chloride levels and those with hyperchloremia. Patients with elevated chloride levels at admission experienced a significantly longer hospital stay, with a statistically significant difference (p=0.009). This finding aligns with existing research suggesting that hyperchloremia can exacerbate postoperative complications, leading to delayed recovery and prolonged hospitalization.[10,11]

Despite the significant association between hyperchloremia and length of stay, no statistically significant difference was found in mortality or the need for revision surgery between the two groups. Notably, all six patients who died during the study had chloride levels above 115 mEq/L; however, this finding did not reach statistical significance in our analysis. This suggests that while hyperchloremia may not directly predict mortality or surgical complications, it is a strong indicator of prolonged hospitalization, which can contribute to an overall increase in healthcare burden and patient morbidity.

Our findings highlight the importance of routinely monitoring serum chloride levels in elderly patients with hip fractures, particularly during the perioperative period. Significant fluid shifts, blood loss, inadequate fluid intake, poor nutrition, and intravenous fluid administration during this time make these patients especially vulnerable to electrolyte disturbances.[12] Early identification of hyperchloremia allows clinicians to take proactive steps to manage fluid and electrolyte imbalances, potentially reducing their impact on recovery. Hyperchloremia is also commonly associated with renal complications, particularly acute kidney injury.[13]

The physiological mechanisms underlying the association between hyperchloremia and prolonged hospital stays are multifactorial. Elevated chloride levels may contribute to metabolic acidosis, which in turn can impair renal function and trigger inflammatory responses. Hyperchloremic acidosis has recently been linked to multi-organ failure.[14,15] These conditions can slow the body's ability to heal postoperatively, resulting in extended hospitalization. Additionally, patients with elevated chloride levels may experience more postoperative complications, such as acute kidney injury or respiratory distress, which can further delay recovery. A recent study showed that, in critically ill patients, close monitoring of serum chloride levels is necessary.[16]

Interestingly, while hyperchloremia was significantly associated with longer hospital stays, it did not predict higher mortality rates or the need for revision surgery in our cohort. This finding may suggest that, although hyperchloremia reflects a more severe postoperative course, it is not necessarily a marker of life-threatening complications. Hyperchloremia has been hypothesized to cause renal hypoperfusion and acute kidney injury through its vasoconstrictive effect on renal vascular smooth muscle.[6] Rather, it may serve as a useful indicator of the overall burden of illness and recovery time in elderly patients, who often experience prolonged hospitalizations. Despite the growing body of evidence highlighting the hazards of elevated serum chloride levels, Huet et al.[17] demonstrated in their study that while a hypertonic NaCl load induced hyperchloremia in trauma patients, it did not result in detectable kidney damage. On the other hand, even in pediatric patients with major trauma, hyperchloremia within the first 48 hours of admission has been associated with increased 28-day mortality rates.[5,18]

Among the six deceased patients in our study, two underwent a proximal femoral nailing procedure, while the remaining four underwent cemented hip hemiarthroplasty. HHA is generally associated with higher morbidity and mortality rates compared to PFN. These findings are consistent with previous research.[19] In our study, revision surgeries were predominantly performed in patients who had undergone HHA, highlighting the increased complexity of this procedure in elderly patients. Prior studies have demonstrated that PFN is a safer option for managing hip fractures (particularly extracapsular fractures) in older adults.[20,21] Based on our findings, we recommend prioritizing PFN in hyperchloremic patients, especially in cases of extracapsular fractures, as this approach may help reduce early morbidity rates.

Diuretic use, diabetes mellitus, hypertension, and COPD did not show statistically significant differences between the groups in this study. Therefore, no definitive conclusions can be drawn regarding the impact of these factors on blood chloride levels, hospital length of stay, morbidity, or mortality.

The limitations of our study should also be acknowledged. First, the relatively small sample size and single-center design may limit the generalizability of our findings. The retrospective nature of the study is another limitation. Additionally, while we observed a significant relationship between hyper-

chloremia and hospital length of stay, our study only briefly explored potential interventions to mitigate this risk. Future research should investigate whether targeted management of chloride levels during the perioperative period can reduce hospitalization time and improve overall outcomes in this vulnerable population.

CONCLUSION

This study demonstrates that elevated blood chloride levels at the time of hospital admission are significantly associated with longer hospital stays in elderly patients with hip fractures. While hyperchloremia did not predict mortality or revision surgery rates in our retrospective cohort, it serves as a valuable biomarker for identifying patients at risk of prolonged hospitalization. Early recognition and management of hyperchloremia may help healthcare providers improve patient outcomes and reduce the burden of extended hospital stays in this high-risk group.

Ethics Committee Approval: This study was approved by the İstanbul Prof Dr. Cemil Taşçıoğlu City Hospital Ethics Committee (Date: 24.09.2024, Decision No: 23/09/2024,192).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: S.G., M.Ç.K.; Design: S.G.; Supervision: B.K.; Resource: O.O., S.A.; Materials: O.O., S.A., S.G.; Data collection and/or processing: O.O., S.G., Analysis and/or interpretation: S.G., M.Ç.K., B.K.; Literature review: S.G.; Writing: S.G.; Critical review: B.K.

Conflict of Interest: None declared.

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

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ORİJİNAL ÇALIŞMA - *ÖZ*

Kalça kırıklarında erken dönem hiperkloreminin morbidite ve mortalite artışı üzerine etkisinin değerlendirilmesi

AMAÇ: Yaşlı bireylerde kalça kırıkları, yüksek insidansları, ilişkili morbidite ve mortalite oranları ile artan sağlık maliyetleri nedeniyle önemli bir halk sağlığı sorunu oluşturmaktadır. Bu çalışma, acil servise başvuru sırasında ölçülen başlangıçtaki serum klorür seviyelerinin hastanede kalış süresi, revizyon cerrahileri ve hastane içi mortalite üzerindeki etkisini araştırmaktadır.

GEREÇ VE YÖNTEM: Ağustos 2022 ile Ağustos 2023 tarihleri arasında acil serviste kalça kırığı tanısı konulan 65 yaş üstü toplam 204 hasta çalışmaya dahil edildi. Hastalar, başlangıçtaki serum klorür seviyelerine göre iki gruba ayrılmıştır: normokloremik (96–108 mEq/L) ve hiperkloremik (>115 mEq/L). Hastanede kalış süresi ve postoperatif komplikasyonlar bu gruplar arasında karşılaştırılmıştır.

BULGULAR: Ortalama klorür seviyesi normokloremik grupta 102.1 mEq/L, hiperkloremik grupta ise 121.3 mEq/L olarak bulunmuştur. Ortalama hastanede kalış süresi normokloremik grupta 9.9 gün, hiperkloremik grupta ise 15.5 gün olup, istatistiksel olarak anlamlı bir fark tespit edilmiştir (p=0.009). Mortalite ve revizyon cerrahisi oranları açısından gruplar arasında istatistiksel olarak anlamlı bir fark gözlenmemiştir. Ancak, çalışma süresince hayatını kaybeden altı hastanın tamamının başvuru sırasında serum klorür seviyelerinin 115 mEq/L'nin üzerinde olduğu belirlenmiştir.

SONUÇ: Bu çalışma, hastaneye yatış sırasında yüksek serum klorür seviyelerinin yaşlı kalça kırığı hastalarında uzamış hastane yatış süresi ve artmış morbidite ile ilişkili olduğunu göstermektedir. Hiperkloremi doğrudan mortaliteyi veya revizyon cerrahisi ihtiyacını öngörmeyebilir; ancak uzamış hastanede yatış için prognostik bir belirteç olarak değerlendirilerek, bu yüksek riskli hasta grubunda önemli bir risk faktörü oluşturabilir.

Anahtar sözcükler: Klor; yaşlı hastalar; kalça kırığı; hiperkloremi; morbidite; uzamış hastane yatışı.

Ulus Travma Acil Cerrahi Derg 2025;31(5):465-471 DOI: 10.14744/tjtes.2025.33779