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ORIGINAL ARTICLE

The effect of blood parameters measured in the emergency department on 30-day mortality in patients with proximal femur fractures: A retrospective analysis

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Abstract

Proximal femur fractures (PFF) are a common and significant health problem in the elderly population, often leading to morbidity and mortality. This study aims to investigate the association between hematological and biochemical parameters measured at admission and 30-day mortality by retrospectively evaluating patients diagnosed with PFF in the emergency department. This retrospective study includes 344 patients over the age of 65 who admitted to the Emergency Medicine Department of Afyonkarahisar Health Science University Faculty of Medicine Hospital and were diagnosed with PFF between January 1st, 2018, and July 1st, 2023. The patients' demographic characteristics, PFF-related features, and their hematological and biochemical parameters at presentation, were recorded. Specific parameters were proportionally analyzed in accordance with relevant literature. The relationship between these findings and 30-day mortality was evaluated. Of the included patients, 59.6% were female, with a mean age of 81.88 ± 7.76 years. The 30-day mortality rate was 7%. A significant difference was observed in the mortality group regarding ICU admission history, length of hospital stays, glucose/potassium ratio, WBC, neutrophil, hemoglobin, and RDW levels. According to ROC analysis, the AUC for hemoglobin was 0.641 (95% CI: 0.589–0.690), with a cutoff value of <12.8, yielding a sensitivity of 87.5% and specificity of 36.0% (p=0.01). For RDW, the AUC was 0.721 (95% CI: 0.672–0.767), with a cutoff value of >16.2, resulting in a sensitivity of 54.2% and specificity of 86.7% (p=0.001). Hemoglobin, red cell distribution width, and glucose/potassium ratio levels in the emergency department are associated with 30-day mortality in patients diagnosed with PFF. Evaluating these parameters in clinical practice may aid in the early identification of high-risk patients and facilitate the planning of appropriate treatment strategies. Future research should validate these findings through larger-scale studies.

Keywords Proximal femur fracture, glucose/potassium ratio, hemoglobin, RDW, 30-day mortality

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Introduction

Proximal femur fractures (PFF) represent a significant health concern, particularly prevalent in the elderly population, and are a major cause of morbidity and mortality. These fractures typically result from high-energy trauma in younger individuals, while in older adults, they are primarily associated with low-energy trauma [1]. Osteoporosis is a leading cause of hip fractures in the elderly, with approximately 70% of these fractures occurring in women [2]. Around 18% of women and 6% of men are diagnosed with a hip fracture at some point in their lives [3]. Globally, the mortality rate associated with hip fractures is approximately 7% [4]. According to estimates by the World Health Organization, the elderly population is projected to reach 1.2 billion by 2025 and 2 billion by 2050 [5]. This demographic shift indicates that PFFs will become an increasingly critical public health issue.

Emergency departments serve as crucial points for the initial diagnosis and assessment of hip fractures. Rapid and accurate diagnosis is essential for effective treatment and patient comfort [6]. Surgical intervention is the primary approach to managing these fractures, encompassing reduction, fixation, and arthroplasty [7]. Prolonged hospital stays and the need for subsequent home care services create a medical and socioeconomic burden [3].

Various biomarkers have been investigated to predict mortality and morbidity in PFF cases. Serum glucose is an easily obtainable and cost-effective parameter, with significant associations between elevated glucose levels and post-traumatic mortality [8,9]. However, the prognostic value of the glucose/potassium ratio in hip fractures has yet to be thoroughly studied. Parameters such as low hemoglobin [10], albumin levels [11,12], elevated C-reactive protein [13], neutrophil/lymphocyte ratio [14], and platelet/lymphocyte ratio [15] have demonstrated prognostic value in various clinical contexts. Nevertheless, more research is needed on the specific role of these parameters in PFF cases.

This study aims to retrospectively evaluate patients with PFF who presented to the emergency department and to investigate the relationship between routinely assessed hematological and biochemical parameters—and specific ratios of these parameters (*e.g.*, glucose/potassium, neutrophil/lymphocyte, platelet/lymphocyte, monocyte/lymphocyte ratios) - and 30-day (short-term) mortality. A distinctive aspect of this study is its focus on examining the prognostic value of the glucose/potassium ratio. Ultimately, this research seeks to contribute to more effective management of the growing PFF burden in emergency settings and to identify potential risk factors in an aging population.

Materials and Methods

Ethical approval for this study was obtained from the Ethics Committee Afyonkarahisar Health Sciences University on April 19, 2024, with protocol number 2024/2. This retrospective study examined patients diagnosed with proximal femur fractures (PFF) who admitted to the Emergency Medicine Department of Afyonkarahisar Health Sciences University Faculty of Medicine Hospital. The study included 344 patients aged 65 and older who visited the hospital between January 1, 2018, and July 1, 2023 and were diagnosed with PFF according to the International Classification of Diseases-10 (ICD-10). Inclusion criteria were being over 65, having an isolated traumatic femur fracture, presence of a femur fracture record in the hospital system, and accessible post-discharge patient information. Exclusion criteria included being under 65, missing information in the hospital system, a history of hematologic disease or malignancy, signs of acute infection, multiple traumas, inaccessible post-discharge data, and a diagnosis of Diabetes Mellitus or chronic kidney failure.

Patient characteristics (*e.g.*, gender, age, medical history, medication use, side of the fracture, and fracture type), length of hospital stay, intensive care unit (ICU) admissions, ICU stay duration, and one-year mortality status were recorded in a data collection form. Hematologic and biochemical parameters collected at the time of emergency admission - hemoglobin, leukocytes, neutrophils, lymphocytes, monocytes, platelets, RDW (red cell distribution width),

glucose, potassium, CRP (C-reactive protein), albumin, and total protein - were documented. Additionally, ratios such as neutrophil-to-lymphocyte (NLR), monocyte-to-lymphocyte (MLR), platelet-to-lymphocyte (PLR), and CRP-to-albumin (CAR) were calculated and included in the data form. These parameters were analyzed for their association with 30-day mortality. The glucose-to-potassium ratio was also calculated and evaluated for its relation to mortality within the first 30 days.

Mortality data were obtained from the Ministry of Health's death notification system and through follow-up calls to patients' registered contact numbers. Additional necessary data were retrieved from the hospital's automation system (Nucleus v9.40.69 and Interpacs imaging application) and recorded in the data collection form.

Statistical analyses were conducted using SPSS 27 for Windows. Distributions of nominal and ordinal variables were assessed via frequency analysis, while continuous data were reported as mean ± SD or patient count (%). Non-normally distributed variables were described using median and interquartile range (IQR). The normality of distribution was assessed using analytical methods (*Kolmogorov-Smirnov/ Shapiro-Wilk* tests). Student's *t*-test and paired *t*-test were applied to normally distributed continuous variables, while the *Mann-Whitney U* and *Wilcoxon* tests were used for non-normally distributed variables. Categorical data were analyzed using *Pearson's* chi-square test. ROC analysis was employed to determine thresholds for hemoglobin, RDW, and glucose/potassium ratio values concerning 30-day mortality and to evaluate their performance parameters (specificity and sensitivity). All analyses were performed with a 95% confidence interval, and a *p*-value of less than 0.05 was considered statistically significant. Following the statistical analyses, data were processed and tabulated using Microsoft Excel.

Results

A total of 344 patients were included in the

Table 1. The basic and clinical characteristics of the patients.

Sex, n (%)	
Male	139(40.4)
Female	205(59.6)
Mean age (Mean ± SD)	81.88±7.76
Age group, n (%)	
65-74	25 (7.3)
75-84	113 (32.8)
85 and over	206 (59.9)
Fractured Side, n (%)	
Right	183 (53.2)
Left	161 (46.8)
Fracture Type, n (%)	
Intracapsular	88 (25.6)
Extracapsular	256 (74.4)
Hospital length of stay, median (IQR)*	7 (5-9)
Hospitalization History at ICU, n (%)	
Yes	56 (16.3)
No	288 (83.7)
Hospitalization at ICU (days) (IQR)*	5 (3-16)

ICU: Intensive Care Unit IQR: Interquartile Range

Table 2. Mortality status of the patients.

Mortality Status	Number of Patients, n (%)
Mortality within One Year	37 (10.8)
Early Phase (First 30 Days) Mortality	24 (7)
Late Phase (30 Days to 1 Year) Mortality	13 (3.8)
Survivors at One Year	307 (89.2)
Day of Mortality, Median (IQR)	24 (8-86.5)

IQR: Interquartile range

Table 3. Comparison of basic and clinical parameters between mortality and non-mortality groups.

Parameter	Non-Mortality	30 Day Mortality	*p*-value
Sex, n (%)			0.064
Male	125 (39.1)	14 (58.3)	
Female	195 (60.9)	10 (41.7)	
Age	81.82±7.83	82.67±6.94	0.613
Fracture type, n (%)			0.418
Intracapsular	81 (25.3)	7 (29.2)	
Extracapsular	239 (74.7)	17 (70.8)	
ICU History, n (%)			<0.001
Yes	37 (11.6)	19 (79.2)	
No	283 (88.4)	5 (20.8)	
Hospitalization duration	8.82±12.22	12.17±8.34	0.008
ICU duration	17.03±30.75	9.75±8.05	0.482
Glucose	155.13±54.2	176.89±73.73	0.104
Potassium	4.62±0.61	4.35±0.63	0.039
Glucose/potassium	33.90±11.34	40.92±16.09	0.005
WBC	11.48±4.24	9.19±4.61	0.002
Neutrophil	9.51±4.19	7.44±4.34	0.002
Lymphocyte	1.17±0.6	1.02±0.54	0.177
Monocyte	0.68±0.25	0.64±0.30	0.242
Hemoglobin	12.09±1.91	10.92±2.04	0.004
RDW	14±2.38	16.32±2.8	0.022
Platelet	226.43±82.32	220.04±86.69	0.231
CRP	20.56±41.93	17.67±26.38	0.202
Albumin	3.6±0.47	3.46±0.66	0.317
NLR	10.58±8.32	9.12±7.11	0.251
PLR	238.47±151.74	287.12±199.5	0.544
MLR	0.72±0.52	0.77±0.55	0.956
CAR	3.19±8.57	1.99±2.43	0.122

ICU: Intensive Care Unit, RDW: Red Cell Distribution Width, NLR: Neutrophil to Lymphocyte Ratio

PLR: Platelet to Lymphocyte Ratio, MLR: Monocyte to Lymphocyte Ratio, CRP: C-reactive Protein CAR: CRP to Albumin Ratio

study. Of these, 205 (59.6%) were female, and 139 (40.4%) were male. The mean age was determined to be 81.88±7.76 years, with the majority of patients (59.9%) aged 85 years or older. Regarding fracture type, 74.4% of the patients had extracapsular fractures. The median length of hospital stay was 7 days (IQR: 5-9). A history of admission to the intensive care unit (ICU) was present in 16.3% of patients, with a median ICU stay of 5 days (IQR: 3-16) (Table 1).

In terms of mortality, 10.8% of the patients (37 patients) died within one year. Among these, 7% (24 patients) passed away within the first 30 days, while 3.8% (13 patients) died between 30 days and one year. The median time to death for deceased patients was 24 days (IQR: 8-86.5) (Table 2).

Comparing patient groups who died within the first 30 days to other patients, statistically significant differences were observed in ICU admission history (p<0.001), length of hospital stay (p=0.008), glucose/potassium ratio (p=0.005), white blood cell count (WBC, p=0.002), neutrophil count (p=0.002), hemoglobin level (p=0.004), and red cell distribution width (RDW, p=0.022). Among those who died, the ICU admission rate was higher (79.2%), the hospital stay was more extended (12.17±8.34 days), and the glucose/potassium ratio was elevated (40.92±16.09). Additionally, in this group, hemoglobin levels were lower (10.92±2.04 g/dL), and RDW values were higher (16.32±2.80) (Table 3).

According to ROC analysis, the area under the curve (AUC) for RDW was 0.721 (95% CI: 0.672–0.767) with a cutoff value of >16.2, yielding a sensitivity of 54.2% and specificity of 86.73% (p=0.001). For hemoglobin, the AUC was 0.641 (95% CI: 0.589–0.690), with a cutoff value of <12.8, resulting in a sensitivity of 87.5% and specificity of 36% (p=0.01) (Table 4).

Discussion

Proximal femur fractures (PFF) are a common occurrence, particularly among elderly patients presenting with low-energy trauma. With the increasing aging population, the prevalence of these fractures has risen, making them significant contributors to mortality and morbidity worldwide.

This study aimed to retrospectively analyze the fundamental and clinical characteristics of elderly patients with PFF and evaluate the impact of hematological and biochemical parameters measured in the emergency department on 30-day mortality. We included 344 patients, of whom 59.6% were female and 40.4% were male. Matos et al. reported that 65.5% of 119 patients with hip fractures were women, while Belmont et al. demonstrated that 62% of 44,419 hip fracture cases were female [4,16]. Osteoporosis is a major risk factor for fractures. In women, a decrease in bone mineral density is observed with menopause. The risk of fractures in women is higher than in men due to lower muscle mass and osteoporosis [17]. The distribution of patients by sex in our study aligns with findings from the literature.

Table 4. Performance parameters of hemoglobin and RDW as a predictor of 30-day mortality.

Performance parameters	Hemoglobin	RDW
Cutoff value	<12.8	>16.2
Sensitivity	87.5	54.2
Specificity	36	86.7
AUC	0.641	0.721
95% CI for AUC	0.589 - 0.69	0.672 -0.767
p	**0.01***	**0.001***

AUC: Area Under the Receiver Operating Characteristic Curve

RDW: Red Cell Distribution Width

CI: Confidence Interval

*p<0.05

The mean age of the patients was 81.88 ± 7.76 years, comparable to the ages reported by Zhang et al. (77.12 ± 5.88) and Dubljanin et al. (77.6 years) [18,19]. It has been reported that the risk of PFF increases with age due to factors such as worsening osteoporosis, decreased physical activity, and comorbidities [20]. The fact that the majority of our patients (59.9%) were aged 85 years and older supports this observation.

Regarding fracture type, our study demonstrated that extracapsular fractures (74.4%) were more prevalent than intracapsular fractures (25.6%) [21]. This finding is consistent with the study by Morita et al. Similarly, Guerra et al. reported that extracapsular fractures were more common (61.8%) [22].

The median hospital stay was 7 days (interquartile range: 5-9), shorter than reported in other studies. Matos et al. reported an average length of stay of 20 days, while Astur et al. and Eschbach et al. reported 10.65 days and 13.5 days, respectively [4,23,24]. This difference may be attributed to recent improvements in the quality of healthcare services and the implementation of more effective treatment protocols.

In our study, it was demonstrated that 10.8% of patients diagnosed with PFF in the emergency department died within one year, with a substantial proportion (7.1%) of patients passing away within the first 30 days (short-term).

Similar studies reported short-term mortality rates as 5% by Ariza-Vega et al. and 8.7% by Tarazona-Santabalbina et al. [25,26]. Moran et al. examined 2,660 patients with hip fractures and determined the short-term mortality rate to be 9% and the one-year mortality rate to be 30% [27]. Differences in mortality rates may depend on the methodologies employed in the studies and the levels of healthcare system development in different countries.

Mortality rates are high among patients with PFF. Epidemiological characteristics and hematological and biochemical parameters potentially associated with short-term mortality were examined. A history of intensive care unit admission, length of hospital stays, leukocyte count, neutrophil count, hemoglobin levels, red cell distribution width (RDW), and glucose/potassium ratios were all shown to correlate with short-term mortality. In this study, we specifically investigated the role of hemoglobin and RDW levels and the glucose/potassium ratio in predicting short-term mortality.

An analysis of the relationship between hemoglobin levels and early mortality indicated a significant association between low hemoglobin and increased mortality. Julian Karres et al. demonstrated that low hemoglobin levels increased the risk of 30-day mortality following a hip fracture [28]. Zhang et al. identified an association between low hemoglobin levels and mortality in a study of 2589 patients [29]. Receiver operating characteristic (ROC) analysis indicated an area under the curve (AUC) of 0.641 for hemoglobin levels in predicting 30-day mortality (p=0.01), with the most discriminative hemoglobin threshold being <12.8 g/dL (sensitivity: 87.5%, specificity: 36.0%). Additionally, some studies relate mortality to preoperative and postoperative transfusion complications. Anemia is a common problem among the elderly and is a significant contributor to the poor prognosis of PFFs. Therefore, preventive healthcare services aimed at osteoporosis management and identifying the etiologies of anemia, followed by appropriate interventions, may effectively reduce the incidence of proximal femur fractures and associated mortality.

RDW (Red Cell Distribution Width) describes the red blood cell volume variability [30]. Our study found a statistically significant relationship between RDW levels and 30-day mortality. The ROC curve analysis identified a cutoff value of RDW>16.2 for predicting 30-day mortality (p=0.001, AUC=0.721, sensitivity: 54.2%, specificity: 86.7%). In the literature, RDW is a reliable indicator of disease severity and mortality prediction in conditions such as pneumonia, heart failure, renal failure, and acute pancreatitis [31,32]. Elevated RDW is considered an unfavorable prognostic factor. Two studies in the literature, like ours, have also found an association between high RDW levels and 30-day mortality in patients with PFF [33,34]. It has been demonstrated that RDW values increase with oxidative stress and inflammation. A meta-

analysis suggested that elevated RDW levels at presentation and thereafter may correlate with both short- and long-term mortality in PFF patients [35]. In clinical practice, alongside factors such as age, patient history, fracture type, and hemoglobin levels, RDW can also be utilized as a critical determinant for patient management in PFF cases.

Several studies have investigated the relationship between serum glucose/potassium (Glu/K) ratios and mortality in different clinical scenarios. The Glu/K ratio is obtained by comparing the levels of glucose and potassium, which are routinely measured biochemical parameters in all patients presenting to the emergency department without additional burdens on healthcare staff. Due to the sympathetic activity increased by trauma, the release of catecholamines is expected to raise serum Glu/K ratios, potentially influencing patient prognosis. Previous studies have examined Glu/K ratios in patients with blunt abdominal trauma, acute intracerebral hemorrhage, and severe traumatic brain injury, finding associations particularly with early mortality [36,37]. While various studies have explored hyperglycemia and hypoglycemia concerning hip fractures, ours is the first to investigate the relationship between Glu/K ratios and mortality in patients presenting with PFF. In our cohort, patients who experienced early mortality (within the first 30 days) had higher glucose/potassium ratios at presentation. This suggests that elevated Glu/K ratios at presentation may be associated with early mortality in patients with PFF. Correcting hyperglycemia and potassium disturbances at presentation could represent a novel strategy to improve the prognosis of patients with PFF.

Our study specifically examined the relationship between hemoglobin, RDW, and glucose/potassium ratios and short-term mortality. Our findings indicate that these parameters are associated with mortality. These results suggest that routine evaluation of these parameters in the emergency department may play a significant role in the early detection and treatment planning for high-risk patients.

The strengths of our study include its large patient cohort and the comprehensive examination of the association between routinely measured hematological and biochemical parameters and short-term mortality. Additionally, focusing on the relatively new glucose/potassium ratio parameter concerning short-term mortality enhances the study's uniqueness. However, the study's retrospective design presents limitations in establishing causality, and its execution at a single center may restrict the generalizability of the findings. Potential confounding factors, such as chronic diseases within the study population, may not have been fully controlled. Future research should validate these findings in multiple centers with larger patient groups.

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Conflict of interest

The authors declare no conflict of interest.

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