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Prognostic Value of CCI and HALP Score in Geriatric Femur Fractures: One-Year Emergency Department Experience

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Abstract

Objective: The objective of this study was to assess and contrast the predictive accuracy of the Charlson Comorbidity Index (CCI) and HALP (Hemoglobin-Albumin-Lymphocyte-Platelet) score in predicting short-term (30-day) and long-term (1-year) mortality in elderly individuals presenting to the emergency department with proximal femur fractures.

Methods: This retrospective cohort study comprised 122 patients aged 65 years and older who had radiologically verified femoral neck or intertrochanteric fractures, who underwent surgical treatment between January 2023 and December 2023. Data regarding demographics, clinical features, and laboratory results were retrieved from electronic medical systems. The primary outcomes were short-term (30-day) and long-term (1-year) mortality. Statistical analyses were performed to assess associations between mortality and CCI, HALP, and other clinical variables.

Results: The mortality rates of 30 day and 1-year were 9.8% and 29.5%. One-year mortality showed a strong correlation with increased age ($p<0.001$) and lower serum albumin levels ($p=0.030$). The HALP score was lower in deceased patients, however, this difference did not reach statistical significance ($p=0.244$). No significant association was observed between CCI and mortality at either 30-days or 1-year. ICU admission and prolonged hospital stay were strongly correlated with elevated 30-day mortality rates ($p<0.001$ and $p=0.003$, respectively).

Conclusion: Advanced age and hypoalbuminemia were independently associated with increased 1-year mortality. While HALP and CCI scores showed numerical differences between survivors and non-survivors, only albumin reached statistical significance. ICU admission and extended hospitalization were significant predictors of short-term mortality. These findings highlight the need for multidimensional assessment tools combining clinical, nutritional, and inflammatory parameters to improve outcome prediction in elderly femur fracture patients.

Keywords: Geriatrics, HALP score, CCI, Mortality

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Geriatrik Femur Kırıklarında CCI ve HALP Skorunun Prognostik Değeri: Bir Yıllık Acil Servis Tecrübesi

Öz

Amaç: Bu çalışmada, acil servise proksimal femur kırığı ile başvuran geriyatrik hastalarda Charlson Komorbidite İndeksi (CCI) ve HALP (Hemoglobin, Albümin, Lenfosit, Trombosit) skorunun 30 günlük ve 1 yıllık mortaliteyi öngörmedeki prognostik değerinin değerlendirilmesi amaçlandı.

Yöntemler: Retrospektif kohort tasarımla yürütülen bu çalışmaya, Ocak 2023–Aralık 2023 tarihleri arasında cerrahi tedavi uygulanmış, radyolojik olarak doğrulanmış femur boyun veya intertrokanterik kırığı olan 65 yaş üstü 122 hasta dâhil edildi. Demografik, klinik ve laboratuvar verileri elektronik kayıt sisteminden elde edildi. Birincil sonuçlar 30 günlük ve 1 yıllık mortaliteydi. CCI, HALP ve diğer klinik değişkenlerle mortalite arasındaki ilişkiler analiz edildi.

Bulgular: 30 günlük mortalite %9.8, 1 yıllık mortalite %29.5 olarak saptandı. 1 yıllık mortalite; ileri yaş ($p<0.001$) ve düşük serum albümin düzeyleriyle ($p=0.030$) anlamlı şekilde ilişkiliydi. Ölen hastalarda HALP skoru daha düşük bulunmasına rağmen, bu fark istatistiksel olarak anlamlı değildi($p=0,244$). CCI skoru ile mortalite arasında anlamlı bir ilişki gözlenmedi. Yoğun bakım ihtiyacı ve uzun hastanede kalış süresi 30 günlük mortalite ile anlamlı ilişki gösterdi (sırasıyla $p<0.001$ ve $p=0.003$).

Sonuç: İleri yaş ve hipoalbüminemi, 1 yıllık mortalite açısından bağımsız risk faktörleri olarak saptandı. HALP ve CCI skorları sayısal farklılık gösterse de yalnızca albümin düzeyi anlamlıydı. Yoğun bakım gereksinimi ve uzamış hastane yatışı erken dönem mortalite ile ilişkilendirildi. Bu bulgular, geriyatrik femur kırığı hastalarında prognozun daha doğru belirlenmesi için klinik, beslenme ve inflamasyon parametrelerini birleştiren çok boyutlu değerlendirme araçlarına ihtiyaç olduğunu göstermektedir.

Anahtar kelimeler: Geriatri, HALP skoru, CCI, Mortalite.

INTRODUCTION

Femoral fractures in the geriatric population represent a significant clinical concern due to their high rates of mortality and morbidity. As the global elderly population increases, the incidence of such fractures is also rising; one-year mortality rates range between 20% and 30%, hospital stays are prolonged, and healthcare costs are escalating[1]. Therefore, the use of early, practical, and reliable prognostic indicators is of great importance, particularly in the emergency department setting, to guide appropriate patient management.

The Charlson Comorbidity Index (CCI) is one of the most frequently utilized scoring systems in such clinical scenarios. The Charlton Comorbidity Index consists of 19 comorbid conditions as shown in Table 1[3]. A prospective cohort study conducted in 2024 reported a c-statistic value of 0.74 for the CCI in predicting one-year mortality, underscoring the clinical relevance of this index[4].

Table I: Charlson Comorbidity Index

Conditions	Assigned weights for each condition
Myocardial Infarction	1
Congestive Heart Failure	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Dementia	1
Chronic pulmonary disease	1
Connective tissue disease	1
Ulcer disease	1
Mild liver disease	1
Diabetes	1
Hemiplegia	2
Moderate or severe renal disease	2
Diabetes with end organ damage	2
Any tumor without metastasis	2
Leukemia	2
Lymphoma	2
Moderate or severe liver disease	3
Metastatic solid tumor	6
Acquired Immune Deficiency Syndrome (AIDS)	6

However, scoring systems based solely on comorbidities may fall short in capturing the nutritional and inflammatory responses that follow trauma. Consequently, new-generation biomarker-based scores have gained prominence. The HALP score calculated using hemoglobin, albumin, lymphocyte, and platelet levels is a simple yet powerful indicator that reflects both nutritional status and systemic inflammation[5]. Initially developed in oncology and cardiovascular contexts, the HALP score has recently attracted attention for its prognostic potential in trauma patients.

In a retrospective study published in 2023, the HALP score was identified as a significant predictor of both early and late mortality among geriatric trauma patients admitted to the emergency department[6]. Additionally, a cohort study conducted in China with 1707 participants demonstrated a robust link between HALP scores and 90-day mortality in femoral fracture patients, indicating that higher HALP values were significantly correlated with decreased risk of death within the follow-up period[7].

However, studies directly comparing the HALP score and CCI particularly in geriatric populations presenting to the emergency department are still scarce in the literature. To bridge this knowledge gap, the current study investigated and compared the effectiveness of the CCI and HALP scores in predicting one-year mortality among elderly patients admitted to the emergency department with femoral fractures.

The study pursues three main goals: facilitating early risk assessment, offering objective metrics to guide clinical decisions, and enhancing care quality by identifying high-risk elderly patients for more effective resource distribution. Through this approach, we aim to equip clinicians with a practical evaluation tool and support a more individualized management strategy for geriatric patients.

METHODS

Study Design and Setting

This retrospective cohort study was carried out in the emergency department of a tertiary university hospital from January to December 2023. The study population comprised patients aged 65 years and older who were admitted with radiologically verified proximal femoral fractures.

Inclusion and Exclusion Criteria

Patients were included if they:

- Were 65 years of age or older

- Had a confirmed diagnosis of femoral neck or intertrochanteric fracture,

- Underwent surgical intervention,

- Had complete medical records including laboratory parameters within 24 hours of admission.

Patients were excluded if they:

- Had pathological fractures,

- Were lost to follow-up within the 1-year period,

- Had a history of hematologic or active inflammatory disorders.

Data Collection

Relevant data were retrieved from the hospital's electronic health records system. Information collected included demographic details (such as age and sex), clinical parameters (including fracture classification, ICU admission status, length of hospital stay, and pre-injury mobility level), as well as laboratory findings (hemoglobin levels, albuminlevels, lymphocyte count, and platelet count). The HALP score was computed using the formula:

HALP = Hemoglobin level(g/L) × Albumin level(g/L) × Lymphocyte count (/L) ÷ Platelet count (/L).

The Charlson Comorbidity Index (CCI) was determined using the conventional method based on 17 predefined comorbid conditions, as described in established literature[3].

Outcomes

The main endpoints of the study were:

• 30-day mortality, referring to deaths occurring within 30 days after hospital admission.

• 1-year mortality, defined as any death taking place within one year (365 days) from the initial admission date.

Statistical Analysis

All statistical analyses were conducted using SPSS software (version XX; IBM Corp., Armonk, NY, USA). Categorical variables were analyzed using the chi-square test and are presented as number (%). Continuous variables were analyzed using the Student's t-test and are presented as mean ± standard deviation (SD). A p value < 0.05 was considered statistically significant.

RESULTS

The study included 122 elderly individuals diagnosed with proximal femoral fractures. The average age was 79.7 ± 7.8 years, ranging from 65 to 99, and the majority of participants (58.2%) were female. The mean hemoglobin concentration measured 12.28 ± 1.9 g/dL, and the average serum albumin level was 36.5 ± 3.6 g/L. The median lymphocyte count was 1.32 ± 0.7 $\times 10^9$/L, and the mean platelet count was 237 ± 70 $\times 10^9$/L. The mean HALP score was 26 ± 16, and 59% of the patients had HALP scores ≤26.8. The distribution of fracture types was nearly equal, with 50.8% having trochanteric and 49.2% having neck fractures.

The mean Charlson Comorbidity Index (CCI) was 2.35 ± 2.28. Most patients (83.6%) were ambulatory prior to their falls. During the hospital course, 9.8% of patients required admission to the intensive care unit (ICU), where the average duration of stay was 6.5 ± 2.1 days. The overall mean hospitalization period was 4.48 ± 3 days, and 15.6% of patients remained hospitalized for more than 7 days. In 48.4% of the cases, the interval between injury and surgical intervention exceeded two days.

The in-hospital, 30-day, and 1-year mortality rates were 5.7%, 9.8%, and 29.5%, respectively.

30-Day Mortality

Patients who died within 30 days tended to be older than those who survived (83.3 ± 7.7 vs. 79.3 ± 7.8 years), although this difference was not statistically significant (p=0.097). No significant differences were observed between the groups in terms of gender distribution (p=0.221), hemoglobin levels (p=0.864), albumin levels (p=0.110), lymphocyte count (p=0.154), platelet count (p=0.396), or HALP scores (p=0.422). Likewise, comorbidity burden assessed by CCI (p=0.715), fracture classification (p=0.202), and time elapsed from injury to surgery (p=0.905) showed no significant association with 30-day mortality.

However, ICU admission was significantly associated with higher 30-day mortality (50% vs. 5.5%, p<0.001). Patients who died within 30 days had significantly longer hospital stays (11.15 ± 8.1 vs. 4.82 ± 3.7 days, p=0.003) and ICU stays (9.3 ± 4.9 vs. 0.81 ± 3.7 days, p=0.001). Hospitalization exceeding 7 days was also significantly associated with 30-day mortality (26.3% vs. 6.8%, p=0.009).

1-Year Mortality

One-year mortality showed a significant correlation with advanced age (83.75 ± 7.6 versus 78.1 ± 7.2 years, p<0.001) and reduced serum albumin levels (35.4 ± 4.0 compared to 37.05 ± 3.4 g/L, p=0.030). Although the HALP scores were lower on average in patients who died (24.1 ± 14 versus 27.8 ± 16), this difference did not reach statistical significance (p=0.244). No meaningful relationships were observed between one-year mortality and variables such as gender (p=0.238), hemoglobin (p=0.312), lymphocyte count (p=0.126), platelet count (p=0.388), or CCI (p=0.216)

ICU admission was significantly more common among those who died within one year (58.3% vs. 41.7%, p=0.021), and these patients had longer ICU stays (1.06 ± 2.42 vs. 0.40 ± 1.9 days, p=0.037). There was no significant difference in total hospital stay duration (p=0.137) or time to surgery (p=0.532). Pre-fall mobility status was not significantly associated with mortality at one year (p=0.312), though a trend toward higher

mortality among previously mobile patients was observed (31.4% vs. 20%).

DISCUSSION

In this retrospective cohort study, we investigated the prognostic value of the Charlson Comorbidity Index (CCI) and HALP score in predicting 30-day and 1-year mortality among geriatric patients admitted to the emergency department with femoral fractures. Our findings underscore the continued importance of advanced age and hypoalbuminemia as independent predictors of long-term mortality. Moreover, although the HALP score numerically trended lower in non-survivors, it did not reach statistical significance, suggesting that it may have limited discriminatory power as a sole biomarker in this specific patient population. Taken together, our findings highlight that while certain well-established clinical and laboratory parameters retained their prognostic significance, composite scoring systems did not uniformly demonstrate predictive value in this specific geriatric fracture cohort. This underscores the importance of interpreting both statistically significant and non-significant results within the clinical and demographic context of the study population, rather than as isolated metrics.

Our study revealed a 1-year mortality rate of 29.5%, which aligns with previously reported ranges of 20–30% in elderly hip fracture patients[8]. Advanced age was consistently associated with both 30-day and 1-year mortality, with a statistically significant difference observed at the 1-year endpoint. This is consistent with the literature, wherein age remains one of the most robust predictors of post-fracture outcomes, partly due to its cumulative association with frailty, reduced physiological reserves, and increased prevalence of multimorbidity[9] (Table II).

Table II: Clinical and Demographic Characteristics

		Min-Max			**Mean.±SD/n-%**		
Age		65	-	99	79.7	±	7.8
Gender	Female				71		58.2%
	Male				51		41.8%
Hemoglobin (g/dL)		8	-	17	12.28	±	1.9
Albümin (g/L)		23	-	44	36.5	±	3.6
Lymphocyte count (/L)		0.1	-	6	1.32	±	0.7
Platelet count (/L)		109	-	558	237	±	70
HALP Score		2		88	26	±	16
HALP Score	≤26.8				72		59%
	>26.8				50		41%
Trochanteric fracture					62		50.8%
Neck fracture					60		49.2%
CCI		0	-	8	2.35	±	2.28
Pre-fall situation	Mobil				102		83.6%
	Inmobil				20		16.4%
Hospitalization area	ICU				12		9.8%
	Non-ICU				110		90.2%
Length of ICU stay (day)		3	-	15	6.5	±	2.1
Length of hospital stay (day)		1	-	20	4.48	±	3
Length of hospital stay (day)	≤7				103		84.4%
	>7				19		15.6%
Injury to-surgery time (day)	≤2				63		51.6%
	>2				59		48.4%
Mortality	In hospital				7		5.7%
	30 day				12		9.8%
	1 year				36		29.5%

Continuous variables were compared using the Student's t-test. Categorical variables were compared using the chi-square test

Abbreviations: SD, standard deviation; CCI, Charlson Comorbidity Index; HALP, hemoglobin–albumin–lymphocyte–platelet score; ICU, intensive care unit.

Although the CCI has been widely validated in orthopedic trauma settings[10], our study did not find a statistically significant difference between survivors and non-survivors at either 30 days or 1 year. This may be due to the relatively low CCI scores across the cohort and the sample size, which may have limited the statistical power to detect small differences. In contrast, other studies have shown CCI to be a strong predictor of long-term mortality in elderly patients with hip fractures[11]. It should also be noted that the prognostic performance of the CCI may vary depending on study design, population heterogeneity, and outcome timeframe. While some studies have demonstrated strong associations between higher CCI scores and long-term mortality[11], others have reported diminished predictive value in cohorts with relatively homogeneous comorbidity burdens or limited score dispersion. Therefore, our findings do not negate the clinical relevance of CCI but suggest that its utility may be context-dependent and potentially enhanced when combined with functional or laboratory-based parameters (Table III, Table IV).

Table III: Factors Affecting 30-Day Mortality

		Alive (n=110)(90.2%)			**Dead (n=12)(9.8%)**			**P value**
		Mean± SD /n-%			**Mean± SD /n-%**			
Age		79.3	±	7.8	83.3	±	7.76.6	0.097
Gender	Female	66		93%	5		7%	0.221
	Male	44		86.3%	7		13.7%	
Hemoglobin		12.3	±	1.8	12.1	±	2.7	0.864
Albumin		36.7	±	3.5	35.0	±	4.1	0.110
Lymphocyte		1.36	±	0.7	1.02	±	0.4	0.154
Platelet		239	±	64	221	±	113	0.396
HALP Score		27.1	±	16	23.1	±	12	0.422
HALP Score	≤26.8	65		90.3%	7		9.7%	0.960
	>26.8	45		90%	5		10%	
CCI		2.33	±	2.26	2.58	±	2.57	0.715
Trochanteric Fracture		58		93.5%	4		6.5%	0.202
Neck Fracture		52		86.7%	8		13.3%	
Injury to surgery Time (day)	≤2	57		90.5%	6		9.5%	0.905
	>2	53		89.8%	6		10.2%	
Pre-fall situation	Immobil	18		90.0%	2		10.0%	0.979
	Mobil	92		90.2%	10		9.8%	
Length of hospital stay		4.82	±	3.7	11.15	±	8.1	**0.003**
Length of hospital stay	≤7 Gün	96		93.2%	7		6.8%	**0.009**
	>7 Gün	14		73.7%	5		26.3%	
ICU stay		6		50%	6		50%	**0.000**
Non-ICU stay		104		94.5%	6		5.5%	
Length of ICU stay		0.81	±	3.7	9.3	±	4.9	**0.001**

Continuous variables were compared using the Student's t-test. Categorical variables were compared using the chi-square test

Abbreviations: SD, standard deviation; CCI, Charlson Comorbidity Index; HALP, hemoglobin–albumin–lymphocyte–platelet score; ICU, intensive care unit.

Table IV: Factors Affecting 1year Mortality

		Alive (n=86)			Dead (n=36)			P value
		Mean±sd/n-%			Mean±sd/n-%			
Age		78.1	±	7.2	83.75	±	7.6	**0.000**
Gender	Female	53		74.6%	18		25.4%	0.238
	Male	33		64.7%	18		35.3%	
Hemoglobin		12.4	±	1.9	12.0	±	2.1	0.312
Albumin		37.05	±	3.4	35.4	±	4	**0.030**
Lymphocyte		1.39	±	0.8	1.16	±	0.5	0.126
Platelet		241	±	64	229	±	84	0.388
HALP Score		27.8	±	16	24.1	±	14	0.244
HALP Score	≤26.8	48		66.7%	24		33.3%	0.266
	>26.8	38		76%	12		24%	
CCI		2.19	±	2.17	2.75	±	2.52	0.216
Trochanteric Fracture		44		71%	18		29%	0.907
Neck Fracture		42		70%	18		30%	
Injury to surgery Time (day)	≤2	46		73%	17		27%	0.532
	>2	40		67.8%	19		32.2%	
Pre-fall situation	Immobil	16		80%	4		20%	0.312
	Mobil	70		68.6%	32		31.4%	
Length of hospital stay		4.38	±	3.1	4.69	±	2.5	0.137
Length of hospital stay	≤7 Gün	75		72.8%	28		27.2%	0.190
	>7 Gün	11		57.9%	8		42.1%	
ICU stay		5		41.7%	7		58.3%	**0.021**
Non-ICU stay		81		73.6%	29		26.4%	
Length of ICU stay		0.40	±	1.9	1.06	±	2.42	**0.037**

Continuous variables were compared using the Student's t-test. Categorical variables were compared using the chi-square test

Abbreviations: SD, standard deviation; CCI, Charlson Comorbidity Index; HALP, hemoglobin–albumin–lymphocyte–platelet score; ICU, intensive care unit.

Serum albumin levels were significantly lower in patients who died within one year, supporting its role as a sensitive marker of both nutritional and inflammatory status. Hypoalbuminemia has been previously linked to poor outcomes in hip fracture patients and is believed to reflect systemic vulnerability to surgical and postoperative stressors[12]. The divergent prognostic performances of serum albumin and the HALP score in our cohort further emphasize the potential value of single, robust biomarkers over composite indices in elderly populations. Serum albumin, as a long-established and routinely available parameter, may more directly reflect chronic malnutrition and inflammatory status, which are critical determinants of long-term survival in geriatric patients.

The HALP score, an integrative index reflecting hematologic, nutritional, and immunological status, was not significantly associated with short or long-term mortality in our cohort, although a trend toward lower scores in deceased patients was observed. While previous studies have suggested the utility of HALP in trauma and oncology populations[13,14], our findings suggest that its prognostic value in elderly fracture patients may be less pronounced or require larger sample sizes for validation. The lack of statistical significance observed for the HALP score may be attributable to several factors. First, the HALP

score was originally developed and validated primarily in oncology and mixed trauma populations, where systemic inflammatory burden and hematologic variability are more pronounced[13,14]. In contrast, geriatric femoral fracture patients often exhibit chronically altered baseline nutritional and inflammatory profiles, potentially attenuating the discriminatory capacity of composite indices. Additionally, age-related immunosenescence and sarcopenia may blunt variations in HALP components, thereby limiting its prognostic sensitivity in this setting.

ICU admission emerged as a consistent and strong predictor of both 30-day and 1-year mortality. This finding likely reflects the severity of complications or comorbidities necessitating critical care and is in agreement with prior studies showing increased mortality associated with ICU requirement following orthopedic trauma[15].

Interestingly, longer ICU and hospital stays were associated with increased 30-day mortality, but not 1-year mortality. This finding may reflect the immediate postoperative and perioperative complications contributing to early deaths, while long-term survival may depend more on baseline functional and nutritional status. (Table III, Table IV). From a clinical perspective, these findings suggest that advanced age, hypoalbuminemia, and ICU requirement remain more reliable indicators of mortality risk than composite scoring systems alone in geriatric femoral fracture patients. Future prospective studies with larger sample sizes and inclusion of functional and frailty indices may help clarify the role of integrative scores such as HALP in this vulnerable population.

LIMITATIONS

There are several limitations to this study. Firstly, its retrospective nature restricts the ability to establish causal relationships. Secondly, the sample size—especially the number of mortality events—may have reduced the statistical power to detect certain associations. Thirdly, we did not include other novel inflammatory and nutritional biomarkers, such as the Systemic Immune-Inflammation Index (SII), calculated from neutrophil, lymphocyte, and platelet counts, or the Prognostic Nutritional Index (PNI), which is derived from serum albumin levels and lymphocyte counts and reflects nutritional and immune status. Lastly, since the research was conducted at a single tertiary care center, the applicability of the results to other settings may be limited.

CONCLUSION

The conclusion section of the article has been shortened as follows: In conclusion, advanced age and low serum albumin levels were associated with increased 1-year mortality in elderly patients with femoral fractures. ICU admission and prolonged hospitalization were related to early mortality, whereas the HALP score and CCI showed limited prognostic value in this cohort.

Ethical Approval: The study was approved by the Ethics Committee for Noninterventional Studies on June 18, 2024, with decision number 230.

Conflict of Interest: The authors declared no conflicts of interest.

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