ORIGINAL ARTICLE

Can C-reactive protein-based biomarkers be used as predictive of 30-day mortality in elderly hip fractures? A retrospective study

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ABSTRACT

BACKGROUND: C-reactive protein-to-lymphocyte ratio (CLR), C-reactive protein/albumin (CRP/ALB), and CRP are prognostic factors for outcome and survival in oncology and digestive surgery. CLR has not been studied for the prediction of mortality in hip fracture. The aim of this study is to investigate whether there is an association between pre-operative CLR, CRP/ALB, and CRP levels in patients with hip fracture and patient survival.

METHODS: The medical reports of the patients who underwent surgery with a diagnosis of hip fracture in our hospital between January 2016 and December 2019 were retrospectively reviewed. The patients were divided into two groups (Group E: Those who died within 1 month and Group S: Those who died after the 1st month or those who survived). A total of 19 parameters, namely, included " blood parameters including hemoglobin, C-reactive protein, albumin, lymphocytes, neutrophils, monocytes, platelets, PLR, NLR, LMR, CLR CRP/ALB ratios, gender, American Society of Anesthesiologists, Charlson Comorbidity Index, delirium, infections, repeated surgeries, and type of anesthesia were evaluated preoperatively and on the post-operative 2nd and 5th days and 1 month.

RESULTS: A total of 165 patients with the mean age of 83.09±8.52 years who met the inclusion criteria were studied. The pre-operative means of CRP, neutrophil count, CLR ratio, and CRP/ALB ratio were statistically significantly higher in Group E than in Group S (p=0.016, p=0.023, p=0.035, and p=0.044, respectively). The univariate regression analysis showed that age, pre-operative Hb level, CRP, and CRP/ALB ratio were significant predictors of the 1-month mortality (ß=−0.335, p=0.049; ß=0.411, p=0.028; ß=3.632, p=0.007; and ß=−3.280, p=0.008; respectively). When we performed the ROC curve analysis, the CRP/ALB ratio had the highest AUC, with the highest sensitivity and specificity. The cutoff value of CRP/ALB ratio was found to be 12.42.

CONCLUSION: We found that the pre-operative CRP/ALB ratio is an important parameter for predicting the first 30-day mortality in elderly patients with intertrochanteric femur fractures. For this reason, we recommend that CRP and albumin be checked in preparation for routine pre-operative anesthesia.

Keywords: Albumin; CLR; C-reactive protein; lymphocyte; motality.

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INTRODUCTION

Hip fractures are injuries that are common in the elderly causing morbidity and mortality.[1] The majority of deaths from hip fractures are due to post-operative complications.[2] There are various studies in the literature that examine the association between pre-operative risk factors and mortality in elderly patients undergoing surgery.[3] Inflammatory changes caused by hip trauma and surgery may affect the survival of patients undergoing surgery for hip fracture.[4]

Post-operative lymphopenia is an important finding that indicates a high risk of complications in elderly patients.[5] Lymphopenia that develops after surgical trauma and becomes permanent after surgery is associated with high mortality.[6] Pre-operative lymphopenia is associated with a higher incidence of post-operative complications such as cardiac, infectious, and renal failure.[7] In the general population, lymphopenia is also associated with an increased risk of hospitalization for infection.[7]

The level of albumin in serum is considered an indicator of nutritional status. Albumin that is a negatively charged substance synthesized by the liver is an acute-phase reactant.[7] There are studies in the literature showing that pre-operative low albumin level (ALB) increases mortality.[8,9] Serum C-reactive protein (CRP), synthesized by the liver, is a positive acute-phase reactant.[10] It is a powerful marker of systemic inflammation and a good indicator of vascular events that may develop.[11] CRP has been shown to be closely associated with trauma, inflammation, and bacterial infections.[12]

The ratio of C-reactive protein-to-lymphocyte ratio (CLR) is a new indicator of inflammatory status.[13] It is simply calculated based on the ratio of CRP to lymphocytes. CLR has recently been defined in some studies as a new parameter to determine the prognosis of malignancy.[13] In patients with malignancies, both elevated CRP and decreased peripheral blood lymphocyte count have been associated with poor prognosis.[13] Although CLR is used as an inflammatory parameter in various fields of medicine, to our knowledge, there is no literature evaluating its ability to predict mortality in hip fractures. There is no consensus on the relationship between high CRP and low albumin blood levels and the CRP/ALB ratio and mortality in hip fractures. The aim of this study is to investigate whether there is an association between pre-operative CLR, CRP/ALB, and CRP levels in patients with hip fractures and patient survival.

MATERIALS AND METHODS

We designed the study as a retrospective cohort study after receiving approval from the local ethics committee (21-KAEK-218). The study evaluated the patients diagnosed with an unstable fracture in the pertrochanteric region (AO31A2) according to the AO/OTA classification system and operated on with a short proximal femoral nail at a single center (Faculty of Medicine, Gaziosmanpasa University) between January 2016 and December 2019.

The data of the patients were obtained from the pre-operative anesthesia records and patient medical records using the electronic patient record system (Enlil Hospital Information Management System, Version V2.19.46 20191118) and the PACS software (Sectra Workstation Ids7, Version 21.2.11.6289; ©2019 Sectra Ab). The mortality data were taken from the national population management system.

Inclusion criteria are patients over the age of 60 years old with a diagnosis of acute hip fracture resulted from low-energy trauma (<7 days) who underwent internal fixation in closed reduction (CRIF). Patients with bilateral hip fractures, fractures extending to the subtrochanteric region or femoral shaft, pathological and multiple fractures with multi-trauma, cirrhosis, cancer patients undergoing chemotherapy treatment, and those with missing data and severe cognitive impairment were excluded from the study.

The patients were divided into two groups (E: Death in 1 month and S: Death after 1 month or survivors). The patient's comorbidities were collected. We recorded the patients' demographic data (including the date of death if occurred, gender, and age), American Society of Anesthesiologists (ASA) score, type of anesthesia (combined spinal epidural: CSE, general anesthesia: GA, and spinal anesthesia: SA), Charlson Comorbidity Index (CCI), requirement of intensive care unit (ICU), delirium, hemoglobin (Hb) level, time of entry into the operating room (day), necessitating blood transfusion, length of hospital stay (day), post-operative length of ICU stay, infection, reoperations, and blood biochemical and hematological parameters. The time to surgery was calculated as the time from the fracture to the patient's entry into the anesthesia room. The ASA score, which is a subjective measure of the patient's pre-operative physical condition, was graded from 1 to 5.

All blood samples were processed in a blood analyzer used in our laboratory for the determination of the complete blood cell counts (CBCs) and biochemical analyses. We evaluated the Hb, C-reactive protein (CRP), ALB, lymphocyte (Lym), neutrophil (Neu), monocyte (Mono), platelet (Plt), mean CRP value, CRP/Lym, CRP/ALB, Neu/Lym Plt/Lym, Lym/Mono on the admission, and post-operative 2nd and 5th days and 1 month.

All patients were operated on in the supine position, without the use of a traction table, by the same surgical team. The patients who participated in the study continued to take the medications they were prescribed for their comorbidities. In addition, subcutaneous enoxaparin sodium and anti-embolic stockings were administered daily for prophylaxis of deep vein thrombosis after surgery. The patients were followed up monthly for the first 3 months, then at 6 months and 1 year. Follow-up was defined as the time between hospitalization and date of death or last follow-up (January 1, 2021).

Statistical Analysis

The normality was assessed using one-sample Kolmogorov–Smirnov test for each variable. The quantitative data are presented as means and standard deviation, and the qualitative data as frequency and percentage. The qualitative data analyses were carried out using Chi-square test. Independent samples t-test was used to compare the laboratory values of the groups with normal distribution, and Mann-Whitney U test was performed for the variables with abnormal distribution. Intragroup comparison was made by repeated measures ANOVA test. A linear regression analysis was conducted for possible predictors on 1 month mortality. ROC curve analysis was employed to assess the sensitivity and specificity of the possible predictors. A logistic regression analysis was carried out for possible predictors on 1 month mortality. All statistical analyses were conducted using the Statistical Package for the Social Sciences Inc., Chicago, IL, version 20.0 software. The statistical significance for all analyses was set at $p<0.05$.

RESULTS

A total of 165 cases were enrolled in this study, where 95 (57.6%) of those were female. The mean age of the patients was 83.09±8.52. The demographic characteristics of the groups are presented in Table 1. The mean age of the patients in Group E was significantly higher than that of Group S ($p<0.05$; Table 1). The ICU admission in Group E was found to be more frequent compared to Group S ($p=0.002$; Table 1). The comparison of CBC and biochemical analyses of the groups is displayed in Table 2. The pre-operative means of CRP value, neutrophil count, CRP/lymphocyte value, and CRP/ALB were found higher in Group E than in Group S ($p=0.016$, $p=0.023$, $p=0.035$, and $p=0.044$, respectively; Table 2). The post-operative Hb, post-operative 5th day albumin, and post-operative 1st month Hb values were higher in Group S than in Group E ($p=0.047$, $p=0.013$, and $p=0.013$, respectively; Table 2). In Group E, the post-operative 5th day CRP, post-operative neutrophil count, post-operative Neu/Lym value, and post-operative Lym/Mono value were significantly different when compared to the pre-operative values ($p=0.012$, $p=0.002$, $p=0.034$, and $p=0.028$, respectively; Table 2). In Group S, the post-operative CRP value, post-operative 5th day CRP value, post-operative Hb value, post-operative 5th day Hb value, post-operative 1st month Hb value, post-operative lymphocyte count, post-operative neutrophil count, post-operative 5th day neutrophil count, post-operative 1st month neutrophil count, post-operative monocyte count, post-operative 1st month monocyte count, post-operative 5th day platelet count, post-operative 1st month platelet count, post-operative CRP/Lym ratio, post-operative 5th day CRP/Lym ratio, post-operative Neu/Lym ratio, post-operative 1st month Neu/Lym ratio, post-operative Plt/Lym ratio, post-operative 5th day Plt/Lym ratio, post-operative 1st month Plt/Lym ratio, post-operative Lym/Mono ratio, post-operative 1st month Lym/Mono ratio, and post-operative CRP/ALB ratio were significantly changed compared to the pre-operative values ($p<0.05$, $p<0.05$, $p<0.05$, $p<0.05$, $p=0.009$, $p<0.05$, $p=0.006$, $p=0.012$, $p<0.05$, $p=0.024$, $p<0.05$, $p=0.002$, $p<0.05$, $p<0.05$, $p=0.018$, $p<0.05$, $p=0.014$, $p=0.004$, $p=0.004$, $p=0.002$, $p<0.05$, $p=0.049$, and $p=0.044$, respectively; Table 2). The univariate regression analysis revealed that age, pre-operative Hb level, pre-operative CRP value, and pre-operative CRP/ALB ratio were significant predictors for 1 month

Table 1. Demographic and clinical characteristics of the patients

	Group E	Group S	p
	n (%)	n (%)	
Gender (Female)			
Female	19 (63.3)	76 (56.3)	0.481[a]
Male	11 (36.7)	59 (43.7)	
ASA (II/III/IV)			
II	–	8 (5.9)	–
III	17 (56.7)	103 (76.3)	
IV	13 (43.3)	24 (17.8)	
CCI (0/1/2/3/4/5)			
0	3 (10)	20 (14.8)	–
1	10 (33.3)	49 (36.3)	
2	12 (40)	39 (28.9)	
3	3 (10)	19 (14.1)	
4	1 (3.3)	6 (4.4)	
5	1 (3.3)	2 (1.5)	
Type of anesthesia			
CSE	–	8 (6)	–
SA	18 (60)	65 (48.9)	
GA	12 (40)	60 (45.1)	
IC admission			
Admitted	26 (86.7)	75 (55.6)	0.002*
Delirium			
Present	1 (3.3)	11 (8.1)	0.696[b]
Infection			
Present	–	2 (1.5)	>0.05[b]
Re-operation			
Present	1 (3.3)	9 (6.7)	0.691[b]
	Mean±SD	Mean±SD	
Age (years)	89±6.32	81.77±8.41	<0.05c*
Hospital stay (days)	9.96±4.89	8.66±8.55	0.423[c]

E: Death in one month; S: Death after one month or survivors; CCI: Charlson Comorbidity Index; ASA: American Society of Anesthesiologists Score; IC: Intensive care; CSE: Combined spinal-epidural anesthesia; SA: Spinal anesthesia; GA: General anesthesia; SD: Standard deviation. *P<0.05. [a]Chi-square test. [b]Fisher's exact test. [c]Student t test.

Table 2. The comparison of CBC and biochemical analyses

	Group E (n=30)	Group S (n=135)	p
Preop-Hb	10.86±1.71	11.46±1.6	0.069[a]
Preop-CRP	75.43±65.44	42.05±61.11	0.016a[*]
Preop-Alb	3.17±0.45	3.45±0.45	0.078[a]
Preop-Lym	1.14±0.59	1.45±1.14	0.151[a]
Preop-Neu	9.6±5.19	7.88±3.3	0.023a[*]
Preop-Mono	0.76±0.36	1.19±5.19	0.645[a]
Preop-Plt	203.333±60.17	226.95±83.51	0.145[a]
Preop-CRP/Lym	79.14±82.15	43.2284.25	0.035a[*]
Preop-Neu/Lym	10.21±6.62	8.27±9.01	0.270[a]
Preop-Plt/Lym	211.28±91.89	211.7±153.29	0.989[a]
Preop-Lym/Mono	1.87±1.42	2.06±1.41	0.518[a]
Preop-CRP/Alb	32.16±21.98	15.66±23.43	0.044[a*]
Postop-Hb	9.37±1.37	9.98±1.54	0.047[a*]
Postop-CRP	168.06±97.1	153.3±93.29	0.487[a]
Postop-Alb	2.77±0.41	2.97±0.44	0.139[a]
Postop-Lym	1.09±0.97	1.14±1.01	0.793[a]
Postop-Neu	10.3±5.35	8.7±4.8	0.110[a]
Postop-Mono	0.78±.05	0.88±0.45	0.276[a]
Postop-Plt	200.76±71.12	218.26±80.43	0.274[a]
Postop-CRP/Lym	269.31±308.09	179.52±145.13	0.168[b]
Postop-Neu/Lym	12.87±8.37	9.45±5.87	0.041[b]
Postop-Plt/Lym	276.42±215.14	236.82±132.51	0.340[b]
Postop-Lym/Mono	1.79±1.29	1.71±3.09	0.888[a]
Postop-CRP/Alb	72.29±38.78	55.73±37.84	0.176[a]
Postop 5th day-Hb	9.06±1.26	9.64±1.39	0.087[a]
Postop 5th day-CRP	148.48±98.96	111.81±82.53	0.126[a]
Postop 5th day-Alb	2.48±0.62	2.9±0.51	0.013[a*]
Postop 5th day-Lym	1.11±0.65	3.69±22.43	0.602[a]
Postop 5th day-Neu	8.02±5.51	6.41±2.55	0.204[b]
Postop 5th day-Mono	0.89±1.49	0.7±0.31	0.578[b]
Postop 5th day-Plt	229.57±88.57	252.47±88.02	0.289[a]
Postop 5th day-CRP/Lym	330.21±711.9	104.78±86.34	0.211[b]
Postop 5th day-Neu/Lym	10.01±9	6.23±4.4	0.074[b]
Postop 5th day-Plt/Lym	297.2±214.21	236.24±127.97	0.223[b]
Postop 5th day-Lym/Mono	2.17±1.38	4.76±24.07	0.624[a]
Postop 5th day-CRP/Alb	76.43±87	39.58±27.41	0.117[b]
Postop 1 month-Hb	8.53±1.43	10.89±2.02	0.013[a*]
Postop 1 month-CRP	110.4±61.72	48.27±70.34	0.063[a]
Postop 1 month-Alb	2.58±0.32	3.31±0.7	0.052[a]
Postop 1 month-Lym	0.91±0.64	1.59±1.16	0.200[a]
Postop 1 month-Neu	12.62±9.44	5.22±1.88	0.155[b]
Postop 1 month-Mono	0.5±0.08	0.59±0.24	0.421[a]
Postop 1 month-Plt	329.6±200.86	289.47±111.61	0.472[a]
Postop 1 month-CRP/Lym	231.93±214.61	44.79±87.88	0.123[b]
Postop 1 month-Neu/Lym	25.52±31.91	4.55±3.34	0.216[b]
Postop 1 month-Plt/Lym	694.07±794.99	247.54±173.39	0.278[b]
Postop 1 month-Lym/Mono	1.97±1.69	3.75±5.87	0.506[a]
Postop 1 month-CRP/Alb	53.26±15.87	21.78±36.87	0.106[a]

E: Death in one month; S: Death after one month or survivors; Hb: Hemoglobin; CRP: C-reactive protein; Alb: Albumin; Lym: Lymphocyte; Neu: Neutrophil; Mono: Monocyte; Plt: Platelet. [*]P<0.05. [a]Independent samples t test. [b]Mann-Whitney U test.

Table 3. Univariate analysis of predictors

	Beta	t	p
Age	-0.335	-2.047	0.049*
Gender	0.229	1.606	0.118
Preop-Hb	0.411	2.304	0.028*
Preop-CRP	3.632	2.868	0.007*
Preop-Alb	0.026	0.157	0.876
Preop-Lym	-0.583	-1.438	0.160
Preop-Neu	-0.829	-1.988	0.055
Preop-Mono	0.215	0.895	0.378
Preop-Plt	0.492	1.645	0.110
Preop-CRP/Lym	-0.537	-1.597	0.120
Preop-Neu/Lym	0.526	1.034	0.309
Preop-Plt/Lym	-0.854	-1.968	0.058
Preop-Lym/Mono	-0.112	-0.408	0.686
Preop-CRP/Alb	-3.280	-2.830	0.008*

E: Death in one month; S: Death after one month or survivors; Hb: Hemoglobin; CRP: C-reactive protein; Alb: Albumin; Lym: Lymphocyte; Neu: Neutrophil; Mono: Monocyte; Plt: Platelet. This model explains 54.6% of the variance. The dependent variable was mortality.

mortality [ß=−0.335, p=0.049; ß=0.411, p=0.028; ß=3.632, p=0.007; and ß=−3.280, p=0.008; respectively; Table 3). The ROC curve analysis for the CRP/ALB ratio showed an AUC of 0.727 with a cutoff value of 12.42 providing a sensitivity of 81.8% and a specificity of 69.4% (Table 4; Fig. 1). The 30-day mortality increased by 1.32 times when the pre-operative CRP to albumin ratio increased one unit (Table 5).

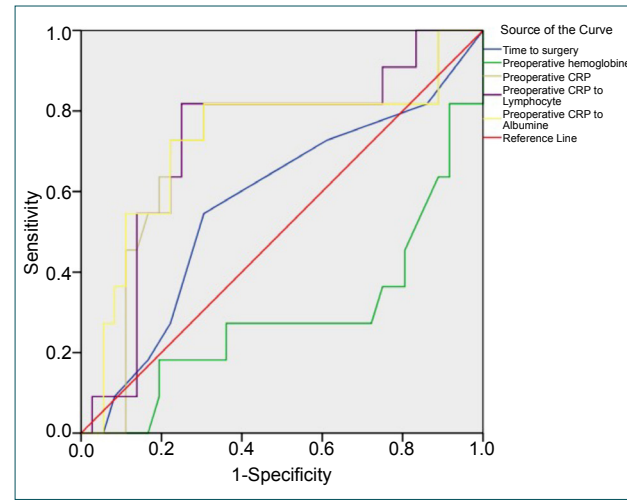

Figure 1. ROC curve for CRP/ALB ratio

DISCUSSION

Most hip fracture patients are known to be malnourished.[14] Total lymphocyte count and albumin are considered nutritional markers.[15] Pain, anesthesia, and surgery are important stress factors in elderly hip fracture patients. A high CRP

Table 4. ROC curve results and sensitivity, specificity, positive–negative predictive values

Variables	Cut-off	AUC	Sensitivity	Specifity	PPV	NPV	p
Time to surgery	≥4	0.6398	0.4667	0.7778	0.3182	0.8678	0.008
Preoperative Hemoglobine	≤10.3	0.6168	0.5	0.7926	0.3488	0.877	<0.001
Preoperative CRP	≥36	0.6574	0.6667	0.6296	0.2857	0.8947	0.004
Preoperative CRP to Lymphocyte	≥50	0.6865	0.6333	0.7704	0.38	0.9043	<0.001
Preoperative CRP to Albumine	≥12.42	0.7273	0.8182	0.6944	0.45	0.9259	0.028

AUC: Area under curve; PPV: Positive predictive value; NPV: Negative predictive value; CRP: C-reactive protein; Alb: Albumin; AUC: Area under curve; PPV: Positive predictive value; NPV: Negative predictive value.

Table 5. Multivariate logistic regression for 30 day mortality

Variables	Univariate				Multivariate			
	p	Odds Ratio	95% CI for Odds Ratio		p	Odds Ratio	95% CI for Odds Ratio	
			Lower	Upper			Lower	Upper
Preoperative CRP to albumine	0.044	1.026	0.999	1.055	0.042	1.327	0.986	1.787
Preoperative CRP	0.016	1.007	1.001	1.012	0.097	0.912	0.817	1.017
Preoperative CRP to lymphocyte	0.035	1.004	1.000	1.008	0.398	1.005	0.993	1.017

CRP: C-reactive protein; CI: Confidence interval.

level is associated with the severity of post-traumatic stress.[16] Therefore, we hypothesized that an elevated CLR level resulting from an increase in CRP level and/or a decrease in lymphocyte count and albumin levels may contribute to poor prognosis in elderly patients with hip fractures. The present study shows that the patients who died within the first 30 days after surgery had higher pre-operative CRP, CLR, and CRP/ALB ratios compared to surviving patients. Among all ratios, the CRP/ALB ratio was found to perform better in predicting mortality. The CRP/ALB ratio, a new prognostic marker associated with inflammation, can be easily calculated by dividing serum CRP level by serum albumin level. Our study showed that combining these parameters into a single index is a more effective for predicting inflammation than CRP or albumin alone, due to the contrasting aspects of each marker.

It is well known that inflammation plays a major role in mortality.[4] Although the relationship between mortality and many parameters in patients with hip fractures has been investigated, to our knowledge, the effect of pre-operative CLR ratio on mortality prediction is unknown. CLR is a simple inflammatory marker that is easily calculated by dividing CRP by lymphocyte count. CLR has recently been used to predict inflammation in COVID-19, digestive surgery, and oncology.[17,18] It has been shown that low lymphocyte count is an important risk factor for the development of post-operative sepsis and mortality.[19] In reviewing the literature, we could not find any study in which CLR, an inflammatory marker, has been used to predict mortality in patients with hip fracture. We think that this could be due to the fact that CRP is not routinely measured in preparation for anesthesia. In our study, there was no statistically significant difference between Group S and Group E in terms of PLR, NLR, and MLR ratios. However, a statistically significant difference was detected between these groups in terms of pre-operative CLR.

The mortality rate in the early phase is considerably high in patients with hip fractures.[20] In addition to the studies demonstrating an increased risk of mortality after hip fractures, there are numerous studies investigating survival and the prognostic factors that influence it.[21] Age, functional status of the patient before surgery, comorbid factors, and ASA scores have been reported to be associated with mortality.[22] However, most of these predictive factors are not correctable. Very few factors, such as anemia, can be corrected before surgery.[23] Anemia is common in geriatric patients with hip fractures. It may be caused by blood loss associated with hip fracture or by concomitant chronic diseases. Anemia-related morbidity and mortality may be due to hypoperfusion, increased cardiac demands, and transfusion-related complications.[24] The results of our study show that elderly patients with hip fracture who had a Hb level of 10.3 (g/dL) or less at the time of admission had a higher mortality rate in the first 30 days.

It has been found that malnutrition rates increase in elderly patients with hip fractures. Bohl et al.[25] determined the threshold value for ALB as 3.50 g/dL in their study to predict 1-year mortality, hospitalizations, and complications from ALB. In addition, they compared patients with normal albumin levels and those with hypoalbuminemia and detected that the mortality rate was higher in patients with hypoalbuminemia.

Harrison et al.[26] investigated the effect of pre-operative hypoalbuminemia on 1-year mortality and reported that the mean pre-operative ALB was 2.95 g/dL in patients who died while 3.28 g/dL in surviving patients. In our study, the albumin values measured on the post-operative 5th day rather than the pre-operative albumin values were statistically significantly lower in the patients who died within the first 30 days. The mean albumin value on the post-operative 5th day was 2.9±0.51 mg/dL in Group S while 2.48±0.62 mg/dL in Group E.

In recent studies in the literature, inflammation in the body, which is considered one of the main causes of death in elderly patients, and many parameters that are triggered by this inflammation or indicative of events that trigger inflammation have been investigated.[27,28] PLR,[6] NLR,[29] interleukin-6,[30] CRP,[31] prognostic nutritional index (PNI), and CRP/PNI ratio[32] have been used to predict mortality associated with hip fracture. In addition, several studies are in progress to determine the parameters that can predict mortality with high level of accuracy in elderly hip fracture patients. CRP is a non-specific systemic marker of inflammation. It has been stated in the literature that a high serum CRP level is an independent indicator of mortality in coronary artery disease, atherosclerosis, and strokes.[33,34] The reports in the literature regarding the relationship between hip fracture and CRP levels are controversial. Beloosesky et al.[35] found no association between pre-operative and post-operative CRP levels and 6-month mortality in geriatric patients undergoing hip fracture surgery. Niessen et al.,[36] in their retrospective study of patients with hip fractures, found no association between CRP level measured before surgery or at hospitalization and in-hospital mortality. Kim et al.[31] showed that a high pre-operative CRP level (>10.0 mg/dL) was associated with 1-year mortality after hip fracture surgery in the elderly. Fakler et al.[37] reported that the effect of pre-operative CRP on mortality is significant in patients with femoral neck fracture. In our study, we detected that high pre-operative CRP (>34.5 µmg/dL) was associated with mortality in the first 30 days after hip fracture surgery in the elderly. We determined that the pre-operative CRP level was significantly higher in the patients who died compared to those who survived. Our results suggest that CRP is a risk factor for mortality in the first 30 days after hip fracture surgery in elderly patients. We think that the severity of systemic inflammation associated with hip injury may affect mortality.

Low lymphocyte count has been shown to be an important risk factor for the development of post-operative sepsis and mortality. In this study, we aimed to investigate the efficacy of

CRP when used in conjunction with lymphocytes or albumin as a key inflammatory marker.

Patients with hip fractures are also likely to have more co-morbidities. Anesthesia preparations for surgery usually take a long time. Some studies have found that more than 2 or 3 days between admission to the emergency department and surgery were directly related to mortality.[38] For this reason, preparations for hip fracture surgery usually start with an emergency room application. The patient's blood count and CBC are routinely checked. However, CRP and ALB are not routinely evaluated. In our study, we found that the pre-operative CRP/ALB ratio in patients with hip fractures had a higher sensitivity and specificity than Hb in predicting the first 30-day mortality, as well as the AUC value. Therefore, we recommend that CRP and albumin be checked in preparation for routine pre-operative anesthesia.

The limitations of our study are that it was a single-center retrospective study and additional large-scale clinical cohorts are needed to confirm these findings.

Conclusion

We found that the pre-operative CRP/ALB ratio is an important parameter for predicting the first 30-day mortality in elderly patients with intertrochanteric femur fractures. For this reason, we recommend that CRP and albumin be checked in preparation for routine pre-operative anesthesia.

Ethics Committee Approval: This study was approved by the Gaziosmanpaşa University Faculty of Medicine Clinical Research Ethics Committee (Date: 21.10.2021, Decision No: 21-KAEK-218).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Yaşlı kalça kırıklarında 30 günlük mortaliteyi öngörmek için C-reaktif protein bazlı biyobelirteçler kullanılabilir mi?: Geriye dönük bir çalışma

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AMAÇ: CLR, CRP/ALB ve CRP, onkoloji ve cerrahide cerrahi sonuç sonuç ve sağkalım için prognostik faktör olarak tanımlanmıştır. CLR kalça kırığı hastalarında mortalitenin öngörüp öngöremeyecegi hakkında çalışılmamıştır. Bu çalışmanın amacı, kalça kırığı olan hastalarda ameliyat öncesi CLR, CRP/Alb ve CRP düzeyleri ile hasta sağkalımı arasında bir ilişki olup olmadığını araştırmaktır.

GEREÇ VE YÖNTEM: Ocak 2016–Aralık 2019 tarihleri arasında hastanemizde kalça kırığı tanısı ile ameliyat edilen hastaların verileri geriye dönük olarak incelendi. Hastalar iki gruba ayrıldı (E grubu: bir ay içinde ölenler, S grubu: ilk aydan sonra ölenler veya hayatta kalanlar). Cinsiyet, ASA, CCI, deliryum, enfeksiyonlar, tekrarlanan ameliyatlar ve anestezi tipi gibi klinik parametreler incelendi. Ayrıca hemoglobin, C-reaktif protein, albümin, lenfositler, nötrofiller, monositler, trombositler, PLR, NLR, LMR, CLR ve CRP/Alb oranlarını içeren kan parametreleri ameliyat öncesi ve ameliyat sonrası ikinci, beşinci gün ve bir ayda değerlendirildi.

BULGULAR: Çalışmaya alınma kriterlerini karşılayan yaş ortalaması 83.09±8.52 yıl olan toplam 165 hasta incelendi. C-RP, nötrofil sayısı, CLR oranı ve CRP/Alb oranının ameliyat öncesi ortalamaları grup E'de grup S'ye göre istatistiksel olarak anlamlı derecede yüksekti (sırasıyla, p=0.016, p=0.023, p=0.035 ve p=0.044). Tek değişkenli regresyon analizi, yaş, ameliyat öncesi Hb seviyesi, C-RP ve CRP/Alb oranının bir aylık mortalitenin anlamlı öngörücüleri olduğunu gösterdi (sırasıyla, ß=-0.335, p=0.049; ß=0.411, p=0.028; ß=3.632, p=0,007; ß=-3,280, p=0.008). ROC eğrisi analizini yaptığımızda, CRP/Alb oranı, en yüksek duyarlılık ve özgüllük ile en yüksek AUC'ye sahipti. CRP/Alb oranının kestirim değeri 12.15 olarak bulundu.

TARTIŞMA: Kalça kırığı olan yaşlı hastalarda ameliyat öncesi CRP/Alb oranının ilk 30 günlük mortaliteyi öngörmede önemli bir parametre olduğunu bulduk. Bu nedenle rutin ameliyat öncesi anesteziye hazırlıkta CRP ve albumin kontrolü yapılmasını öneriyoruz.

Anahtar sözcükler: Albumin; CLR; C-reaktif protein; lenfosit; mortalite.

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