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Investigation of the relationship between inflammatory markers and grade of disease in patients with acute ischemic stroke with partial anterior circulation infarct

Sadettin Ersoy[1], **Canan Akünal Türel**[1], **Ömer Çetin**[2]

[1]*Department of Neurology, Faculty of Medicine, Bolu Abant İzzet Baysal University, Bolu, Türkiye*
[2]*Department of Emergency Medicine, Faculty of Medicine, Bolu Abant İzzet Baysal University, Bolu, Türkiye*

Abstract

Objectives: The aim of this study was to investigate the relationship between National Institutes of Health Stroke Scale scores and Glasgow coma scores of patients with partial anterior ischemic stroke and laboratory results, particularly serum CRP, albumin, platelet and other complete blood count data, and prognosis.

Methods: In this retrospective study 226 of patients with partial anterior circulation infarction who were admitted to the Bolu Abant İzzet Baysal University Neurology Clinic between January 2021 and 2022 with the diagnosis of acute ischemic stroke and hospitalized within the first 24 hours were investigated. The demographic data, stroke etiology and risk factors, National Institutes of Health Stroke Scale, Glasgow coma scores, complete blood count, certain inflammatory markers and biochemical parameters, length of hospital stay and mortality rates were examined. And the relationship between inflammatory markers and grade of disease was evaluated statistically.

Results: The patients with moderate Glasgow coma score had a lower lymphocyte level, severe patients had higher PCT level and moderate patients had higher CRP level among others. Patients with moderate GCS had higher CRP/ALB values than those with mild. Patients with moderate and moderate-severe National Institutes of Health Stroke Scale had higher RBC and HGB levels than the patients with mild. Moderate-severe patients had lower albumin levels.

Conclusion: CRP-albumin ratio, serum platelet and serum albumin levels may have prognostic value in acute partial anterior ischemic stroke patients.

Keywords: albumin; CRP-albumin ratio; HDL-uric acid ratio; stroke

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Introduction

Acute ischemic stroke (AIS) ranks first among the emergent neurological diseases and stroke is the second most common cause of death after acute cardiac diseases worldwide.[1] With the aging of the human population, the importance of stroke continues to increase day by day since it is a significant cause of mortality, morbidity and economic burden in advanced age.[2]

Low HDL cholesterol levels are associated with impaired metabolic status and cerebrovascular risk.[3] Uric acid is a product of purine metabolism, and high serum levels are associated with impaired metabolic states and increased cerebrovascular risk.[4] C-reactive protein (CRP) is an acute phase protein produced by the activation of cytokines secondary to ischemia, infection, trauma and other inflammatory conditions.[5] Again, low serum albumin levels were found to be associated with poor prognosis and mortality.[6,7] The combination of these two metabolic parameters was thought to be a good predictor of stroke risk.[8] The use of simple parameters measured in serum is important in terms of prognosis and evaluation of recurrent stroke risk factors of patients, since they are both cost-effective and easy to use.[2,9,10] For these reasons, we aimed to investigate the relationship between degree of the disease and inflammatory markers in stroke patients with acute partial anterior circulation infarction.

Materials and Methods

Medical files of 226 of patients (105 females, 121 males) aged between 41–97 (median: 75, IQR: 65–83) with partial anterior circulation infarction who were admitted to the Bolu Abant İzzet Baysal University Neurology Clinic between January 2021 and 2022 with the diagnosis of acute ischemic stroke and hospitalized within the first 24 hours were investigated retrospectively. The demographic data, stroke etiology and risk factors, National Institute of Health Stroke Scale (NIHHS), Glasgow coma score (GCS), modified ranking scale (mRS) at the time of admission to the hospital, complete blood count parameters, CRP, albumin (alb), uric acid, HDL, AST, CRP/albumin, HDL/uric acid values, length of hospital stay and mortality rates were examined. Patients were grouped under 3 categories according to their GCS as severe (3–8), moderate (9–12) and mild (13–15). According to the GCS; 131 were mild, 81 were moderate, and 14 were severe. The patients were further grouped under 5 according to their NIHSS as asymptomatic (0), mild (1–4), moderate (5–15), moderate-severe (16–20) and severe (21–42). According to the NIHSS, 60 were mild, 141 were moderate, 22 were moderate-severe, and 3 were severe. There were no asymptomatic patients. Those who had previously been diagnosed with cancer and those with other neurological diseases were not included in the study.

Continuous data were compared using Student's t-test, Mann-Whitney U test or Kruskal-Wallis test and categorical data were compared using Pearson's chi-squared test or Fisher's exact test. In order to determine the factors affecting mortality and length of stay, multiple logistic regression (forward Wald method) and multiple linear regression analyses were applied. Parameters with a simple analysis result of $p<0.20$ were included in the multiple model. Log-transform was applied on length of stay to the normality of the residual's assumption. SPSS (Version 23.0, IBM Corp., Armonk, NY, USA) was used for the analyses. Significance level was determined as $p<0.05$.

Results

Among the other diseases accompanying the stroke, the most common comorbid factor was hypertension (51.77%) (**Table 1**).

The patients with moderate and severe GCS had a higher mRS of 3 and above than those with mild ($p<0.001$). The patients with moderate GCS a lower lymphocyte (LYM) level, severe patients had higher PCT level and moderate patients had higher CRP level among others ($p=0.049$, $p=0.029$ and $p=0.001$, respectively). Patients with moderate GCS had higher CRP/ALB values than those with mild ($p=0.001$). Patients with GCS severe stayed in hospital for a shorter time than other GCS groups ($p<0.001$) (**Table 2**).

Patients with moderate, moderate-severe and severe NIHSS had a higher mRS of 3 and above than mild ones ($p<0.001$). Patients with moderate and moderate-severe NIHSS had higher RBC and HGB levels than the patients with mild NIHSS ($p<0.001$ and $p=0.008$, respectively). Moderate-severe patients had lower albumin levels ($p=0.010$). It was observed that the AST level was higher in patients with moderate than those with mild ($p=0.022$). As the NIHSS scores increased, the patients stayed in the hospital longer ($p<0.001$) (**Table 3**).

Mortality rate was lower in patients with mild GCS and higher in patients with severe ($p<0.001$). Mortality rate was higher in patients with mRS of 3 and above ($p=0.016$). PLT, MONO, PCT, albumin levels were found to be higher and MCV levels were lower in patients who died ($p=0.003$, $p= 0.007$, $p=0.006$, $p=0.010$ and $p=0.047$, respectively) (**Table 4**).

The mortality risk was found to be 21.05 (95% CI: 5.4–82.04) times higher in patients with GCS severe ($p<0.001$). It was concluded that a one-unit increase in MONO caused a 3.72 (95% CI: 1.1–12.6) fold increase in mortality risk ($p=0.035$). In the mortality estimation model, the overall accuracy rate was 91.2%, sensitivity 20%, specificity 98.1%. The factors affecting the length of stay in the hospital were determined as GCS (mild group), NIHSS (Moderate and Moderate-Severe), LYM, NEU and RDW. The coefficients shared in **Table 5** was determined for log-transformed hospitalization time. After applying the back transformation; it was determined that the hospitalization times increased

Table 1
Characteristics of the patients.

	n	%
Additional disease		
Hypertension	117	51.77
Diabetes	69.0	30.53
Hyperlipidemia	18	7.96
Coronary disease	52	23.01
MI/stroke	45	19.91
Atrial fibrilation	71	31.42
Chronic kidney disease	6	2.65
Pulmonary hypertension	1	0.44
Smoking history	31	13.72
Modified ranking scale score		
<3	78	35
≥3	148	65

Table 2
Comparison of data according to Glascow coma score.

	Mild (n=131)	Moderate (n=81)	Severe (n=14)	p-value
Age (year)	76.5 (58.25–80.75)	73 (64–83.5)	75 (66–82)	0.929
Sex (female)	5 (35.71)	46 (56.79)	54 (41.22)	0.062
Hypertension	8 (57.14)	38 (46.91)	71 (54.2)	0.539
Diabetes	5 (35.71)	23 (28.4)	41 (31.3)	0.824
Hyperlipidemia	1 (7.14)	6 (7.41)	11 (8.4)	0.960
Coronary disease	3 (21.43)	22 (27.16)	27 (20.61)	0.540
MI/stroke	2 (14.29)	14 (17.28)	29 (22.14)	0.596
Atrial fibrilation	3 (21.43)	31 (38.27)	37 (28.24)	0.220
Chronic kidney disease	1 (7.14)	1 (1.23)	4 (3.05)	0.283†
Pulmonary hypertension	1 (7.14)	0 (0)	0 (0)	-
Smoking	1 (7.14)	8 (9.88)	22 (16.79)	0.277
mRS				
<3	73 (55.73)[a]	5 (6.17)[b]	0 (0)[b]	<0.001
≥3	58 (44.27)[b]	76 (93.83)[a]	14 (100)[a]	
WBC	8.74 (6.81–10.9)	8.96 (7.19–11.7)	10.02 (8.83–11.87)	0.158
RBC*	4.7±0.63	4.47±0.74	4.69±0.69	0.053
HGB*	13.49±1.73	12.94±2.46	12.9±2.56	0.145
PLT	229 (192–276)	233 (195.5–284)	266.5 (211.25–398.75)	0.087
MCV	88.2 (84.8–91.9)	88.2 (84.4–91.3)	86.05 (81.83–90.33)	0.328
RDW	13.9 (12.9–15.8)	13.8 (12.9–15.7)	13.75 (12.68–17.05)	0.997
LYM	1.71 (1.25–2.21)[a]	1.5 (0.94–2.06)[b]	1.74 (1.1–2.68)a,b	0.049
MONO	0.59 (0.47–0.84)	0.63 (0.5–0.79)	0.77 (0.53–0.93)	0.313
NEU	5.81 (3.94–7.8)	6.65 (4.61–8.84)	6.71 (5.27–10.23)	0.109
BASO	0.05 (0.03–0.07)	0.05 (0.02–0.06)	0.05 (0.03–0.06)	0.532
EOS	0.11 (0.04–0.21)	0.08 (0.03–0.18)	0.07 (0.05–0.14)	0.244
PDW	13.7 (11.5–17.2)	12.9 (11.25–16.2)	11.4 (10.83–13.93)	0.134
MPV	10.2 (9.1–11.1)	10.4 (9.55–11.2)	10.05 (9.47–10.33)	0.487
PCT	0.22 (0.18–0.27)[b]	0.25 (0.19–0.3)[a,b]	0.26 (0.21–0.39)[a]	0.029
CRP	4.3 (0.7–11)[b]	10.3 (2.35–43.7)[a]	7.6 (0.58–14.5)[a,b]	0.001
Albumin	40 (37.2–42.8)	38.8 (34.5–42.6)	40 (32.08–43.63)	0.116
Uric acid	5.4 (4.5–6.4)	5.3 (4.5–6.75)	6.2 (5.2–7.05)	0.338
HDL	43 (37–51.4)	43.1 (36.95–49.1)	43.5 (37.68–53.88)	0.919
AST	21 (17–25)	22 (17–32)	20 (17.5–25.75)	0.341
CRP/albumin	1.17 (0.16–3)[b]	2.59 (0.57–11.45)[a]	2.13 (0.17–3.84)[a,b]	0.001
HDL/uric acid	7.95 (6.55–10.7)	8.13 (5.83–10.91)	7.45 (5.66–10.81)	0.824
Hospital stay	8 (4.5–15.5)[a]	6 (4–12)[a]	4 (2–7)[b]	<0.001

Continuous data were summarized as median (IQR, 25th–75th percentile) and analyzed with Kruskal-Wallis test (post-hoc Dunn test). Qualitative data were summarized by frequency and percentage and analyzed using Pearson's chi-squared test (post-hoc adj. Bonferroni method). *Data were summarized as mean±sd (one-way ANOVA). †Fisher's exact test. [a,b]According to the results of the post-hoc tests, different letters indicate a significant difference between the groups, p<0.05.

approximately 24.85% and 97% in NIHSS moderate and moderate-severe group, and 25% decreased in GCS moderate group, respectively. A 1-unit increase in LYM and RDW values resulted in an approximately 25% and 4.6% decrease in the length of hospital stay, and a 1-unit increase in neu value resulted in 9.7% increase in the length of hospital stay (**Table 5**).

Discussion

The main target of our study was to determine the relationship between inflammatory markers and grade of disease in patients with acute ischemic stroke with partial anterior circulation infarct. According to the results of our study, CRP-albumin ratios and HDL-uric acid ratios did not have a statistically significant relationship with

Table 3
Comparison of data according to National Institute of Health Stroke Scale (NIHHS) stroke score.

	Mild (n=60)	Moderate (n=141)	Moderate-Severe (n=22)	Severe† (n=3)	p-value
Age (year)	74.5 (65.25–81.75)	74 (64.5–82)	81.5 (67–86.25)	59 (47–79)	0.573
Sex (female)	22 (36.67)	72 (51.06)	11 (50)	0 (0)	0.100
Hypertension	32 (53.33)	75 (53.19)	10 (45.45)	0 (0)	0.349
Diabetes	14 (23.33)	49 (34.75)	5 (22.73)	1 (33.33)	0.309
Hyperlipidemia	4 (6.67)	12 (8.51)	1 (4.55)	1 (33.33)	0.381
Coronary disease	16 (26.67)	31 (21.99)	5 (22.73)	0 (0)	0.791
MI/stroke	11 (18.33)	30 (21.28)	4 (18.18)	0 (0)	0.951
Atrial fibrilation	17 (28.33)	45 (31.91)	9 (40.91)	0 (0)	0.555
Chronic kidney disease	0 (0)	5 (3.55)	1 (4.55)	0 (0)	0.319
Pulmonary hypertension	0 (0)	0 (0)	1 (4.55)	0 (0)	-
Smoking	6 (10)	24 (17.02)	1 (4.55)	0 (0)	0.334
mRS					
<3	51 (85)[a]	24 (17.02)[b]	3 (13.64)[b]	0 (0)[b]	<0.001
≥3	9 (15)[b]	117 (82.98)[a]	19 (86.36)[a]	3 (100)[a]	
WBC	8.78 (6.76–10.6)	8.86 (6.93–10.99)	9.74 (7.31–12.07)	9.26 (9.14–14.25)	0.386
RBC*	4.83 (4.45–5.25)[a]	4.51 (4.07–5.02)[b]	4.41 (4.05–4.75)[b]	5.3±0.64	<0.001
HGB*	13.8 (12.8–15.08)[a]	12.8 (11.6–14.6)[b]	12.65 (11.88–14.2)[b]	15.27±2.1	0.008
PLT	238 (196–278.75)	231 (193–284)	234 (206.25–279)	319 (197–544)	0.929
MCV	88.35 (84.7–91.88)	88.1 (84.5–91.3)	89.4 (84.9–93.65)	86.1 (81.1–88.1)	0.620
RDW	13.85 (12.9–15.7)	14.1 (12.85–15.8)	14.05 (12.9–15.85)	12.7 (11.5–12.8)	0.850
LYM	1.86 (1.22–2.45)	1.67 (1.16–2.15)	1.58 (1.05–1.8)	1.43 (1.11–1.66)	0.172
MONO	0.6 (0.48–0.88)	0.62 (0.49–0.79)	0.58 (0.45–0.82)	0.67 (0.46–0.98)	0.793
NEU	5.54 (3.9–7.42)	6.05 (4.44–8.5)	7.1 (5.09–10.61)	6.68 (6.24–12.62)	0.153
BASO	0.05 (0.03–0.08)	0.05 (0.03–0.06)	0.04 (0.02–0.05)	0.05 (0.02–0.06)	0.074
EOS	0.11 (0.04–0.24)	0.1 (0.04–0.18)	0.06 (0.01–0.15)	0.15 (0.01–0.51)	0.164
PDW	13.55 (11.33–17.3)	13 (11.35–16.75)	13.65 (10.85–17.68)	11.2 (10.2–11.6)	0.606
MPV	10.15 (8.45–10.7)	10.3 (9.5–11.2)	10.15 (9.35–10.83)	10.2 (9.7–10.3)	0.216
PCT	0.22 (0.18–0.28)	0.24 (0.19–0.3)	0.25 (0.19–0.28)	0.33 (0.2–0.53)	0.450
CRP	4.25 (1–11.23)	5.8 (1.3–17.65)	9.2 (2.75–45.3)	20.8 (1.8–43.5)	0.095
Albumin	40.2 (38–43)[a]	39.1 (36–42.7)[a]	36 (31.5–40.45)[b]	39 (29–45)	0.010
Uric acid	5.6 (4.63–6.88)	5.3 (4.5–6.4)	5.7 (4.33–7.53)	6.4 (2.5–7.6)	0.162
HDL	43 (37.18–52.68)	43 (37–49.95)	42.6 (38.05–48.5)	38.3 (23.6–47.2)	0.966
AST	19.5 (16–24)[b]	22 (18–31)[a]	21.5 (18.5–25.75)[a,b]	23 (19–37)	0.022
CRP/albumin	1.07 (0.25–2.94)	1.4 (0.32–4.73)	2.49 (0.7–15.2)	5.33 (0.4–15)	0.072
HDL/uric acid	7.29 (6.11–10.52)	8.14 (6.43–10.85)	8.09 (5.58–10.95)	7.38 (5.04–9.44)	0.398
Hospital stay	3 (2–6)[a]	5 (3–9)[b]	10 (6–18.25)[c]	11 (2–0)	<0.001

Continuous data were summarized as median (IQR, 25th–75th percentile) and analyzed with Kruskal-Wallis test (post-hoc Dunn test). Qualitative data were summarized by frequency and percentage and analyzed using Fisher's exact test (post-hoc adj. Bonferroni method). *Data were summarized as mean±sd (one-way ANOVA). †Continuous data could not be compared due to insufficient number of observations. [a,b,c]According to the results of the post-hoc tests, different letters indicate a significant difference between the groups, p<0.05.

NIHSS and mortality. However, the CRP-albumin ratio had a significant relationship only between the mild and moderate GCS groups. It was previously shown that CAR ratio may be a predictor of mortality in ischemic stroke patients.[11] Although it was mentioned that CAR ratio would be a better predictor than only serum albumin and serum CRP levels alone. Our study revealed that only albumin ratio was correlated with NIHSS and thus can be suggested as a better predictor than CAR ratio. PCT, which is one of the complete blood count parameters, draws attention because it is associated with both the NIHSS and the mortality rate. The limitation

Table 4
Comparison of data with mortality.

	Survived (n=206)	Dead (n=20)	p-value
Age (year)	75 (65–83)	75.5 (64.75–82.75)	0.974
Sex (female)	94 (45.63)	11 (55)	0.423
Hypertension	109 (52.91)	8 (40)	0.270
Diabetes	60 (29.13)	9 (45)	0.141
Hyperlipidemia	18 (8.74)	0 (0)	0.380†
Coronary disease	47 (22.82)	5 (25)	0.785
MI/stroke	40 (19.42)	5 (25)	0.560
Atrial fibrilation	64 (31.07)	7 (35)	0.718
Chronic kidney disease	5 (2.43)	1 (5)	0.430†
Pulmonary hypertension	0 (0)	1 (5)	-
Smoking	30 (14.56)	1 (5)	0.324†
GCS			
Mild	125 (60.68)[a]	6 (30)b	<0.001
Moderate	74 (35.92)[a]	7 (35)a	
Severe	7 (3.4)[b]	7 (35)a	
NIHSS			
Mild	58 (28.16)	2 (10)	0.090**
Moderate	127 (61.65)	14 (70)	
Moderate-severe	19 (9.22)	3 (15)	
Severe	2 (0.97)	1 (5)	
mRS			
<3	76 (36.89)	2 (10)	0.016
≥3	130 (63.11)	18 (90)	
WBC	8.83 (6.97–10.95)	9.85 (8.47–18.04)	0.057
RBC*	4.62±0.69	4.61±0.58	0.942
HGB*	13.33±2.07	12.49±2.07	0.086
PLT	228 (192–278)	276.5 (242.25–580)	0.003
MCV	88.15 (84.78–91.83)	85.6 (79.5–93.6)	0.047
RDW	13.8 (12.88–15.63)	14.95 (12.83–22.4)	0.268
LYM	1.63 (1.15–2.15)	1.74 (1.26–3.93)	0.316
MONO	0.6 (0.47–0.8)	0.8 (0.62–1.58)	0.007
NEU	5.96 (4.44–8.36)	7.59 (4.59–12.96)	0.180
BASO	0.05 (0.03–0.06)	0.05 (0.02–0.14)	0.997
EOS	0.1 (0.04–0.18)	0.07 (0.04–0.59)	0.497
PDW	13.1 (11.3–17.1)	12.25 (10.93–18.2)	0.132
MPV	10.2 (9.35–11)	10.2 (9.5–11.9)	0.957
PCT	0.23 (0.18–0.28)	0.3 (0.21–0.45)	0.006
CRP	5.4 (1.38–15.63)	11.9 (4.3–110.1)	0.084
Albumin	40 (36.45–43)	36.25 (32.7–46)	0.010
Uric acid	5.4 (4.5–6.6)	5.15 (4.43–40)	0.707
HDL	43 (37–51.4)	41.15 (36.33–63)	0.329
AST	21.5 (17–26)	21.5 (16.5–124)	0.747
CRP/albumin	1.3 (0.33–4.27)	3.18 (1.13–32.38)	0.074
HDL/uric acid	8.03 (6.08–10.72)	7.57 (6.43–17.41)	0.759

Continuous data were summarized as median (IQR, 25th–75th percentile) and analyzed with Mann-Whitney U test. Qualitative data were summarized by frequency and percentage and analyzed using Pearson's chi-squared test (post-hoc adj. Bonferroni method). *Data were summarized as mean±sd and analyzed by Student's t-test. †Fisher's exact test.

Table 5
Multiple regression analyzes for mortality, multiple linear regression analyzes for length of hospital stay (LOS).

		Mortality			Ln(LOS)		
		Odds	Odds 95% CI	p-value	β(se)	Std. β	p-value
GCS	Mild	(Ref.)			-0.29 (0.11)	-0.18	0.008
	Moderate	2.22	0.7–7.1	0.177	-	-	-
	Severe	21.05	5.4–82.04	<0.001	-	-	-
NIHSS	Mild	-	-	-	-	-	-
	Moderate	-	-	-	0.22 (0.11)	0.14	0.055
	Moderate-severe	-	-	-	0.68 (0.2)	0.25	0.001
	Severe	-	-	-	-	-	-
LYM					-0.1 (0.06)	-0.11	0.070
NEU					0.06 (0.01)	0.23	0.000
MONO		3.72	1.1–12.6	0.035			
RDW		-	-	-	-0.05 (0.02)	-0.14	0.016
Model summary		Nagelkerke R^2= 0.22; ACC: 91.2%, SE: 20%, SP: 98.1%			Adjusted R^2: 0.22; Model: F=11.85, p<0.001		

ACC: accuracy; **β(se):** model coefficent (standart error); **Ln(LOS):** logarithmic transformation of length of stay; **SE:** sensitivity; **SP:** specificity.

of our study was low number of severe cases included to our study. We suggest this condition should be evaluated in more details in studies with higher number of severe cases. The decrease in albumin level in some chronic diseases and the fact that it is affected by conditions such as malnutrition may limit its use in such patients. Due to insufficient data, we could not exclude patients with malnutrition in our study. Although, since the prognosis of patients with malnutrition would be worse after stroke, it may not have adversely affected our results.

The results of study showed that serum CRP-value did not correlate with NIHSS. It did only show statistically significant difference in patients with moderate and mild GCS scores, similar to previous studies. In a previous study, CRP-value at admission was not found to be associated with prognosis, while serum CRP-values during follow-up were found to be associated with prognosis.[12] In another study, it was shown that the serum platelet value of the patient may be related to the prognosis in ischemic stroke.[13] In our study, we found that mortality rates were correlated with high serum platelet levels. Serum MONO and MCV levels were also correlated with mortality. As a result of our findings, we thought that CAR, serum albumin, PCT, PLT, MONO and MCV levels could be predictors that can be evaluated while regulating the treatment of patients. We found that neutrophil-lymphocyte ratio, HDL-uric acid ratio, and lymphocyte-monocyte ratios, which are frequently studied in other diseases recently, were not correlated with GCS and NIHSS.

In conclusion, since these parameters are easily accessible and cost-effective, it is important to guide the prognosis and it will be beneficial to studies conducted in larger case series.

Conclusion

In conclusion, since these parameters are easily accessible and cost-effective, it is important to guide the prognosis and it will be beneficial to studies conducted in larger case series.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

SE: project development, data analysis, drafting the article; CAT: data collection, data analysis, drafting the article, revising it critically for important intellectual content; ÖÇ: data collection, data analysis, drafting the article. All authors approved the final of the version to be published, agree to be accountable for all aspects of the work if questions arise related to its accuracy or integrity.

Ethics Approval

The study was approved by Ethical Committee of Bolu Abant İzzet Baysal University (No:2022-300).

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References

1. Güven HH, Çilliler AE, Sarikaya SA, Köker C, Çomoğlu SS. The etiologic and prognostic importance of high leukocyte and neutrophil counts in acute ischemic stroke. Journal of Neurological Sciences (Turkish) 2010;27:311–8.
2. Guven H, Çilliler AE, Koker C, Sarikaya SA, Comoglu SS. Association of serum calcium levels with clinical severity of acute ischemic stroke. Acta Neurol Belg 2011;111:45–9.
3. Dehghan A, van Hoek M, Sijbrands EJ, Hofman A, Witteman JCM. High serum uric acid as a novel risk factor for type 2 diabetes. Diabetes Care 2008;31:361–2.
4. Guerreiro S, Ponceau A, Toulorge D, Martin E, Alvarez-Fischer D, Hirsch EC, Michel PP. Protection of midbrain dopaminergic neurons by the end-product of purine metabolism uric acid: potentiation by low-level depolarization. J Neurochem 2009;109:1118–28.
5. Thijs LG, Hack CE. Time course of cytokine levels in sepsis. Intensiv Care Med 1995;21 Suppl 2:S258–63.
6. Artero A, Zaragoza R, Camarena JJ, Sancho S, Gonzalez R, Nogueira JM. Prognostic factors of mortality in patients with community-acquired bloodstream infection with severe sepsis and septic shock. J Crit Care 2010;25:276–81.
7. Goldwasser P, Feldman J. Association of serum albumin and mortality risk. J Clin Epidemiol 1997;50:693–703.
8. Demirel ME. The correlation of c-reactive protein/albumin, Mii-1 and Mii-2 indexes with hospitalization and mortality in Stanford type A aortic dissection. Medical Records 2022;4:361–6.
9. Demirel ME. Acute coronary syndromes and diagnostic methods. Medical Research and Innovations 2019;3:1–8.
10. Mert I, Cetinkaya A, Gurler M, Turel CA, Celik H, Torun IE, Turel I. Anti-inflammatory potential of liraglutide, a glucagon-like peptide-1 receptor agonist, in rats with peripheral acute inflammation. Inflammopharmacology 2022;30:1–13.
11. Kocatürk M, Kocatürk Ö. Assessment of relationship between C-reactive protein to albumin ratio and 90-day mortality in patients with acute ischaemic stroke. Neurol Neurochir Pol 2019;53:205–11.
12. Rocco A, Ringleb PA, Grittner U, Nolte CH, Schneider A, Nagel S. Follow-up C-reactive protein level is more strongly associated with outcome in stroke patients than admission levels. Neurol Sci 2015; 36:2235–41.
13. Yang M, Pan Y, Li z, Yan H, Zhao X, Liu L, Meng X, Wang Y, Wang Y. Platelet count predicts adverse clinical outcomes after ischemic stroke or TIA: subgroup analysis of CNSR II. Frontiers in Neurology 2019;10:370.

ORCID ID:
S. Ersoy 0000-0003-0837-8756;
C. Akünal Türel 0000-0001-8791-235X;
Ö. Çetin 0000-0003-3588-2077

Correspondence to: Sadettin Ersoy, MD
Department of Neurology, Faculty of Medicine,
Bolu Abant İzzet Baysal University, Bolu, Türkiye
Phone: +90 505 931 67 54
e-mail: ersoysadettin@gmail.com

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