Uric Acid-to-Albumin Ratio: A Novel Marker for the Extent of Coronary Artery Disease in Patients with Non-ST-Elevated Myocardial Infarction

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Keywords

Uric acid · Albumin · Uric acid-to-albumin ratio · Coronary artery disease · Syntax score

Abstract

Objective: This research aimed to investigate the predictive value of the uric acid-to-serum albumin ratio (UAR) in establishing the severity and extent of coronary artery disease (CAD) with non-ST segment elevation myocardial infarction (NSTEMI) patients. **Methods:** A total of 402 patients (mean age 63.5 ± 11.6 years) were included in this retrospectively designed study. We compared Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery Scores (SS) between low (≤ 22) and intermediate-high (> 22) groups. The UAR, the neutrophil-to-lymphocyte ratio (NLR), and the C-reactive protein-to-albumin ratio (CAR) were evaluated and compared. **Results:** SS > 22 were observed in 30.8% ($n = 124$) of the patients, and their UAR, NLR, and CAR were significantly higher. Three separate multivariate analysis models performed as the outcome of a reliable correlation between UAR, NLR, CAR, and consequently UAR (OR = 2.08; 95% CI 1.21–3.58; $p = 0.008$) and CAR (OR = 3.33; 95%

CI 1.85–5.9; $p < 0.001$) reached significance but NLR (OR = 1.26; 95% CI 0.86–1.84; $p = 0.20$) clinically trended significance (not statistically). Model performance comparisons demonstrated that UAR is a better predictor regarding likelihood ratios (UAR, 60.95; NLR, 57.8; and CAR, 59.0). **Conclusion:** As a novel inflammatory marker, UAR independently predicted better outcomes than CAR and might be used reliably in prediction of the extent of CAD in NSTEMI patients.

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Introduction

Acute coronary syndrome (ACS) refers to a spectrum of clinical presentations including ST segment elevation myocardial infarction, non-ST segment elevation myocardial infarction (NSTEMI), and unstable angina [1]. The main pathophysiological mechanisms of ACS and NSTEMI are coronary atherosclerotic plaque rupture, vasospasm, and consequent platelet adhesion, aggregation, and secondary thrombosis [2]. The Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (Syntax) Score (SS) is a comprehensive ana-

tomic scoring system obtained at the diagnostic coronary angiography to determine the complexity and extent of coronary artery disease (CAD) [3].

Serum albumin (SA), well known and the most important protein of human serum, has many significant physiological functions [4]. An increased inflammatory response has been associated with decreased synthesis and increased catabolism of SA [5]. Lower SA levels may increase blood viscosity and disrupt endothelial functions [6, 7]. Additionally, SA is an important inhibitor of platelet activation and aggregation and an important mediator of platelet-induced coronary artery stenosis [8, 9]. Serum uric acid (UA), the end product of purine metabolism, increases the risk of atherosclerosis and contributes to both the occurrence and the prognosis of CAD at high levels [10]. UA is shown to be one of the mediators of endothelial dysfunction, inflammation, and vascular disease [11]. Hyperuricemia is connected to the higher burden of coronary atherosclerosis [12].

SA and UA production and excretion could be affected by many factors [13, 14], this makes it difficult to use both parameters as individual markers of ACS. Therefore, we aimed to measure the predictive value of the ratio of these 2 important ACS severity-associated laboratory parameters as the uric acid-to-albumin ratio (UAR). To our best knowledge, no data exist regarding the association between UAR and the severity of CAD in NSTEMI patients. A comparison with the C-reactive protein-to-albumin ratio (CAR) and the neutrophil-to-lymphocyte ratio (NLR) was also performed.

Patients and Methods

Study Population

We reviewed the medical records of consecutive patients from January 2018 to December 2019 who were admitted to the Department of Cardiology, Kosuyolu Training and Research Hospital, University of Health Sciences in Istanbul, Turkey. Patients diagnosed with NSTEMI and who had undergone a coronary angiography were included in our study. Based on hospital records, patient baseline clinical and demographic characteristics including diabetes mellitus (DM), hypertension (HT), dyslipidemia, smoking, and history of CAD were obtained. Medications used at admission were noted for the possibility of any effect on uric acid or serum albumin levels. None of the patients had gout or thyroid disease or were on uric acid-lowering therapy.

The medical records of 543 patients were reviewed retrospectively and analyzed using our database. Patients with a history of CAD treated with percutaneous coronary intervention or coronary artery bypass grafting ($n = 52$), end-stage renal disease or receiving hemodialysis ($n = 21$), active malignancy ($n = 8$), active infection ($n = 10$), any rheumatic and connective tissue disorder

($n = 5$), no significant CAD or other evident causes of coronary pain such as significant myocardial bridging or diffuse coronary spasm during angiography ($n = 38$), and any missing information ($n = 7$) were excluded from the study. Finally, 402 patients were enrolled into the study.

The diagnosis of ACS was made by employing the diagnostic criteria for ACS from the American College of Cardiology/American Heart Association guidelines, noticing symptoms, electrocardiography findings, and other accessory examinations. Presentation with acute chest pain or an overwhelming shortness of breath with the absence of persistent ST elevation is suggestive of non-ST-elevated ACS (except in patients with a true posterior myocardial infarction). Non-ST-elevated ACS can be further subdivided based on cardiac biomarkers of necrosis such as cardiac troponin. If cardiac biomarkers are elevated and the clinical findings are appropriate, the patient is considered to have NSTEMI; otherwise, the patient is deemed to have unstable angina pectoris [15]. All of the patients were treated in adherence with the current guidelines [16]. Coronary angiography for NSTEMI was performed <24 h after admission according to our institute protocol.

Laboratory Measurements

The blood samples were drawn from the antecubital vein immediately upon hospital admission, before any heparin therapy or reperfusion procedure. Complete blood cell counts including total white blood cells (WBC), hemoglobin, neutrophils, platelets, lymphocytes, and monocytes were measured with an auto analyzer. Plasma levels of fasting blood glucose, creatinine, troponin I, total cholesterol, triglycerides, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol were measured for all of the patients using an automated chemistry analyzer. Serum uric acid and albumin levels were measured using a Roche Diagnostics Cobas 8000 c502 analyzer (Roche Holding AG, Basel, Switzerland). The normal range was 3.5–7.2 mg/L for uric acid and 35–52 g/L for serum albumin. Characteristic data were collected during hospitalization. The clinical presentation including the heart rate and the Killip class was assessed on admission by the attending physician. The medical history related to cardiovascular risk factors (HT, DM, previous ischemic heart disease, and smoking status) was noted.

The UAR was calculated as the ratio of serum uric acid (mg/dL) to serum albumin (g/L). The NLR was calculated by dividing the neutrophil count by the lymphocyte count, and the CAR was calculated by dividing the serum C-reactive protein (CRP) level by the serum albumin level [17]. The creatinine clearance was calculated using the Cockcroft-Gault equation. The left ventricular ejection fraction (LVEF) was obtained using a modified Simpson method in the apical 4-chamber and 2-chamber views in both end-diastole and end-systole.

Angiographic Analyses

Coronary angiograms were recorded to digital media for quantitative analysis (Infiniti Healthcare Co., Phillipsburg, NJ, USA). Coronary angiograms were analyzed by 2 experienced interventional cardiologists who were blinded to the patients' clinical data. The anatomic severity of the coronary stenosis was quantitatively evaluated with the anatomical Syntax score (SS) by using a version downloaded from <http://www.syntaxscore.com>. The study population was divided into the following 2 groups according to CAD severity using the SS: low (≤ 22) and intermediate-high (> 22).

Table 1. Baseline demographics of the study population by SS

	All (n = 402)	SS ≤22 (n = 278)	SS >22 (n = 124)	p value
Clinical characteristics				
Males	296 (73.6)	196 (70.5)	100 (80.6)	0.13
Age, years	63.5±11.6	62.7±11.8	65.3±10.9	0.14
BMI	28.1±4.24	28.2±4.37	28.1±3.95	0.88
Hypertension	236 (58.7)	148 (53.2)	88 (71)	0.02
DM	150 (37.3)	96 (34.5)	54 (43.5)	0.22
Smoking	150 (37.3)	106 (38.1)	44 (35.5)	0.72
CAD history	160 (39.8)	116 (41.7)	44 (35.5)	0.42
LVEF	51.3±11	54.4±10	44.4±9.96	<0.001
SBP, mm Hg	127±17.2	127±17.8	127±15.8	0.95
Current medication at admission				
Aspirin	199 (49.5)	138 (49.6)	61 (49.1)	0.83
β-blocker	187 (46.5)	130 (46.8)	57 (45.9)	0.51
ACE inhibitor	169 (42)	116 (41.7)	53 (42.7)	0.53
ARB	22 (5.5)	15 (5.4)	7 (5.6)	0.45
Calcium channel blocker	67 (24.1)	25 (9.0)	42 (33.9)	0.02
Loop diuretics	7 (1.7)	5 (1.8)	2 (0.8)	0.57
Thiazide diuretics	136 (33.8)	93 (33.4)	43 (34.6)	0.45
MRA	9 (2.2)	6 (2.2)	3 (2.4)	0.81
Statin	128 (31.8)	87 (31.3)	41 (33.1)	0.31

Values are presented as numbers (%) or means ± SD. ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; MRA, mineralocorticoid receptor antagonist; SBP, systolic blood pressure.

Statistical Analysis

All statistical analyses were performed using the “rms,” “Hmisc,” and “ggplot” packages with R version 3.4.1 (R Project, Vienna, Austria). Continuous variables were expressed as means ± SD or, in the case of a nonnormal distribution, as median 25th to 75th percentiles (IQR). Categorical variables were shown as percentages and numbers, and the χ^2 test was used to compare groups. The Kolmogorov-Smirnov test was performed to assess whether the variables were normally distributed. The Student *t* test or the Mann-Whitney U test was performed to compare continuous variables between groups based on whether they were normally distributed or not. The Pearson coefficient was used to describe the degree of correlation of parameters among each other and with the SS. The Lin statistic (concordance correlation coefficient; CCC) was used to analyze the interoperator agreement for image analysis. A sample of 50 individual endovascular interventions was assessed, and the interobserver agreement was calculated. Agreement was considered to be poor if the CCC was <0.90, moderate if the CCC was 0.90–0.95, substantial if the CCC was 0.95–0.99, and excellent if the CCC was >0.99 [18].

Independent predictor variables were chosen according to the results of previous studies [17, 19, 20] and the stepwise backward univariate analysis of the present study. The association between SS ≤22 or >22 taken as a dichotomous response variable and the predictor variables was evaluated using multivariable logistic regression models. Only variables with a *p* value <0.05 in the univariate analysis were incorporated into the multivariate logistic regression analysis. To determine the independent predictors of an intermediate-high SS, a multivariable logistic regression analysis

was performed using variables in the univariate logistic regression analysis. After finding a reliable correlation between UAR, CAR, and NLR, we constituted 3 separate models that included the UAR (model 1), the NLR (model 2) and the CAR (model 3) separately. The relative importance of each predictor in the models was estimated with a partial χ^2 value for each predictor divided by the model's total χ^2 , which estimates the independent contribution of the predictor to the variance of the outcome. The performance of the model was measured using *R*², Akaike information criteria (AIC), Bayesian information criteria (BIC), and the C index. Three separate models were compared via the assessment of fit (likelihood ratio χ^2), quality (AIC and BIC), predictive accuracy (*R*²), and discrimination (C index). The independent contribution of the predictors to the variance of outcome was estimated. In this regard, the relative importance of each predictor in the model (UAR, CAR, and NLR) was estimated with a partial χ^2 value for each predictor. The UAR was further examined via a receiver operating characteristic (ROC) curve to determine the optimal cutoff according to the Youden index. *p* < 0.05 was considered statistically significant for all statistical analyses.

Results

A total of 402 patients (mean age 63.5 ± 11.6 years) were included in this study. Their baseline clinical characteristics, such as age, BMI, cardiovascular risk factors,

Table 2. Laboratory parameters and angiographic characteristics of the study population by SS

	All (<i>n</i> = 402)	SS ≤22 (<i>n</i> = 278)	SS >22 (<i>n</i> = 124)	<i>p</i> value
Laboratory parameters				
Creatinine, mg/dL	0.88±0.24	0.86±0.24	0.9±0.23	0.35
CrCl, %	83.4±17.9	83.4±18.4	83.6±16.9	0.94
LDL-C, mg/dL	122±32	121±32.6	124±30.5	0.46
Uric acid, mg/dL	5.79±1.31	5.6±1.3	6.21±1.25	0.02
Albumin, g/L	35.3±3.68	36.3±3.74	33.6±2.75	<0.001
CRP, mg/dL	3.4 (3.11–9.0)	3.11 (3.05–4.43)	10.1 (4.5–16.11)	<0.01
Neutrophils, <i>n</i> × 10 ³ /μL	6.5±1.8	6.1±1.9	7.4±0.9	<0.01
Lymphocytes, <i>n</i> × 10 ³ /μL	2.1±0.9	2.2±0.9	2.0±0.8	0.27
Platelets, <i>n</i> × 10 ³ /μL	232±56	232±57.6	231±52.7	0.87
Thyroid-stimulating hormone, mIU/L	2.59±0.81	2.63±0.84	2.50±0.99	0.33
UAR	0.165±0.04	0.15±0.04	0.18±0.004	<0.001
CAR	0.09 (0.08–0.24)	0.08 (0.07–0.12)	0.27 (0.12–0.33)	<0.01
NLR	3.76±2.24	3.48±2.29	4.35±2.03	<0.01
PLR	0.132±0.07	0.13±0.08	0.13±0.06	0.64
Angiographic characteristics, <i>n</i> (%)				
LMCA disease	19 (4.7)	2 (0.7)	17 (13.7)	<0.001
Three-vessel disease	33 (8.2)	9 (3.2)	24 (19.3)	<0.001
Bifurcation	48 (11.9)	13 (4.7)	35 (28.2)	<0.001
Chronic total occlusion	48 (11.9)	13 (4.7)	35 (28.2)	<0.001
Lesion length >20 mm	56 (13.9)	17 (6.1)	39 (31.4)	<0.001
Severe tortuosity	38 (9.4)	16 (5.8)	22 (17.7)	<0.001
Thrombus	58 (14.4)	29 (10.4)	29 (23.4)	<0.001
SS	11±6.23	8.15±5.4	27±4.53	<0.001

Values are presented as means ± SD or medians (IQR). CrCl, creatinine clearance; LDL-C, low density lipoprotein cholesterol; LMCA, left main coronary artery.

Table 3. Univariate and multivariate logistic regression analysis models

Variable	Univariate			Multivariate								
				model 1 (UAR)			model 2 (NLR)			model 3 (CAR)		
	OR	95% CI	<i>p</i> value	OR	95% CI	<i>p</i> value	OR	95% CI	<i>p</i> value	OR	95% CI	<i>p</i> value
Age (55–71 years)	1.59	1.04–2.42	0.03	1.55	0.85–2.85	0.15	1.53	0.84–2.80	0.16	1.51	0.82–2.78	0.18
Creatinine (0.74–1.03 mg/dL)	2.28	1.46–3.53	0.002	1.04	0.55–1.96	0.89	1.46	0.76–2.82	0.25	1.33	0.70–2.52	0.38
HT	2.15	1.14–4.04	0.02	1.69	0.76–3.76	0.20	2.30	1.01–5.24	0.04	2.21	0.92–5.32	0.07
DM	2.72	1.48–5.03	0.001	1.26	0.56–2.83	0.57	0.44	0.19–1.05	0.07	0.67	0.27–1.63	0.38
LVEF (45–65)	0.15	0.07–0.30	<0.001	0.20	0.09–0.42	<0.001	0.12	0.06–0.26	<0.001	0.18	0.08–0.38	<0.001
UAR (0.135–0.188)	0.68	1.95–4.80	<0.001	2.08	1.21–3.58	0.008						
NLR	3.06	1.08–2.05	0.01				1.26	0.86–1.84	0.20			
CAR (0.08–0.15)	1.49	2.74–7.60	<0.01							3.33	1.85–5.9	<0.001

and current medication at admission, are listed in Table 1. Patients with an intermediate-high SS (>22) had lower LVEF values and a longer history of HT diseases ($p < 0.001$ and $p = 0.02$, respectively). There were no significant differences between groups according to thiazide and loop diuretics ($p = 0.45$ and $p = 0.57$).

Table 2 shows the detailed laboratory parameters and angiographic characteristics. There was substantial interobserver agreement on analysis of the images (CCC = 0.96; 95% CI 0.93–0.98). Thyroid-stimulating hormone levels were not significant between groups ($p = 0.33$). According to admission laboratory results, the serum UA

Fig. 1. Adjusted χ^2 analysis for the inflammatory markers UAR, NLR, and CAR.

level ($p = 0.002$), the serum CRP level ($p < 0.01$), and the serum neutrophil count ($p < 0.01$) were higher in the intermediate-high SS group, but the serum albumin level was lower ($p < 0.001$). Compared to patients in the low SS group, patients in the intermediate-high SS group also had significantly higher UAR ($p < 0.001$), CAR ($p < 0.01$), and NLR ($p < 0.01$), but PLR did not reach statistical significance ($p = 0.64$).

The univariate logistic regression outcome variable SS was used to determine whether there was any relationship between physiological and clinical plausible variables. Only variables with a p value < 0.05 were shown (Table 3). Table 3 shows 3 separate models performed as a consequence of reliable correlations between UAR, NLR, and CAR. The model 1 multivariate analysis demonstrated that a higher UAR (OR = 2.08; 95% CI 1.21–3.58; $p = 0.008$) and a lower LVEF (OR = 0.20; 95% CI 0.09–0.42; $p < 0.0001$) were statistically significant with increasing SS values, while the other variables were not. The model 2 multivariate analysis revealed that having HT (OR = 2.30; 95% CI 1.01–5.24; $p = 0.04$) and a lower LVEF (OR = 0.12; 95% CI 0.06–0.26; $p < 0.001$) were the only variables statistically significant with increasing SS; while NLR (OR = 1.26; 95% CI 0.86–1.84; $p = 0.20$) had a clinically significant trend, statistically it did not reach significance. The model 3 multivariate analysis revealed that a higher CAR (OR = 3.33; 95% CI 1.85–5.9; $p < 0.001$) and a lower LVEF (OR = 0.18; 95% CI 0.08–0.38; $p < 0.001$) were statistically significant with increasing SS, while the other variables were not.

To compare the performances of our 3 separate multivariate analysis predictive models for intermediate-high SS, we conducted model performance comparisons (Table 4). The AIC and BIC values of UAR model were low-

Table 4. Model performance comparisons

	R^2	Likelihood ratio	AIC	BIC	C index
UAR model	0.365	60.95	201.2	215.3	0.86
NLR model	0.345	57.8	211.2	237.6	0.82
CAR model	0.355	59.0	202.3	228.7	0.85

er, and the R^2 and C index values of UAR model were higher, than those of NLR model and CAR model (R^2 : 0.365, 0.345, and 0.355, and C index: 0.860, 0.820, and 0.850, respectively). The likelihood ratios of UAR were higher than those of NLR and CAR (60.95, 57.8, and 59, respectively).

The adjusted χ^2 value for UAR was higher than those for NLR and CAR (adjusted χ^2 : 8.7, 1.5, 3.7, respectively) as shown in Figure 1. Partial effect plots of the UAR in model 1, the NLR in model 2, and the CAR in model 3 are presented in Figure 2, and by adjusting the age, creatinine, HT, DM, and LVEF log odds of effect the plot showed that UAR has the steeper slope than NLR and CAR. ROC analysis (Fig. 3) predicted >0.183 as the optimal cutoff value (58.4% sensitivity, 81.6% specificity, and area under the curve = 0.742).

Discussion

The main findings are as follows: (1) elevated UAR and higher CAR are significantly associated with CAD severity as indicated by the SS in patients with NSTEMI; (2)

Fig. 2. Partial effect plot of UAR, NLR, and CAR.

Fig. 3. ROC curves of UAR for prediction of intermediate-high SS. AUC = 0.742. $p < 0.001$.

UAR is a superior marker to CAR for prediction of CAD extent and severity in patients with NSTEMI; (3) NLR had a clinically significant trend but could not reach statistically significant values compared to UAR and CAR.

Epidemiological evidence suggests that hyperuricemia and cardiovascular disease are highly related [21]; increased UA levels are a statistically significant and independent predictor of cardiovascular disease and cardio-

vascular mortality [22]. In a recent study the serum UA level was related to the severity of CAD and it was an independent predictor of a high SS [12]. However, the causal mechanisms linking elevated UA levels to cardiovascular disease are still not fully clear. Uric acid can crystallize and form monosodium urate crystals in various tissues, initiating local inflammatory responses. Mechanistic activities involving uric acid crystals have been reported to be intimately involved in patients with CAD [23]. Human atherosclerotic plaque contains a significant amount of UA, and high serum UA – via purine metabolism – may promote thrombus formation [24, 25]. Additionally, UA can trigger oxidative stress and induce inflammation, vasoconstriction, and endothelial dysfunction [26]. As observed in patients with hyperuricemia, each of the above factors is known to play an important role in the advancement of atherosclerosis and may potentially involve progression of CAD. Epidemiological studies have revealed that low SA levels are associated with the development of CAD and the all-cause mortality risk [27]. There is also substantial evidence that decreased SA concentrations may be the cause of atherosclerosis development and progression [28]. The potential pathophysiological mechanism of hypoalbuminemia in CAD may be primarily related to its decreased anti-inflammatory, antioxidant, and anti-platelet aggregation activity leading to increased blood viscosity, oxidative stress, decreased endothelial function, and an increase in an important mediator of platelet-derived coronary artery narrowing [14].

In the last decade, research has reflected a growing interest in the direct deleterious effect of the synergistic im-

pact of UA on other cardiovascular risk factors and CAD [19, 29]. Furthermore, previous studies have shown that SA has much more complex functions beyond being a transporter and low concentrations are linked to the emergence of CAD and its severity [20, 30]. Despite all of the scientific work that has been done, UA and SA separately are not included in any risk profiles. There are possible reasons for this controversy. Primarily, UA levels are affected by a multitude of different factors, including renal excretion, the dietary intake of various foods, and the rate of uric acid cell turnover [13]. Additionally abnormally high levels of UA are often associated with gout, insulin resistance, DM, metabolic syndrome, HT, and chronic renal disease [12]. SA synthesis is increased by amino acids intake, insulin, and a low colloid osmotic pressure. Factors that decrease synthesis include a high colloid osmotic pressure, inflammation, malnutrition, diabetes, liver disease, and infections, and the mechanisms of its degradation are poorly understood [14]. Common conditions in ill patients, such as malnutrition, infections, inflammation, congestive heart failure, and renal diseases, can affect the levels of UA and SA [31]; they might be involved in different phases of vascular damage [12]. As a result of this knowledge, we decided to assay UAR to increase each variable's separate predictive value and compare them to other previously proven inflammatory markers of CAD, CAR, and NLR.

There is considerable evidence that high circulating platelet counts and WBC counts including neutrophils, lymphocytes, and monocytes are associated with major adverse cardiovascular outcomes [32]. Especially in patients with an acute presentation, NLR has been proposed to be more accurate and stable than the total WBC count, although the total WBC count has been found to be associated with the presence, severity, and extent of coronary atherosclerosis and with increased mortality and worse outcomes after acute myocardial infarction. Newly, a meta-analysis study with a total of 7,017 CAD cases suggested NLR as a useful tool for predicting severe stenosis in CAD [33]. As a result, a higher NLR represents a higher level of inflammation, and this may explain why NLR was found to be related to CAD extent and severity. In our research NLR had clinically higher values between intermediate-high SS and low SS groups but did not reach prognostic performance regarding UAR and CAR parameters.

As an acute-phase reactant, increased CRP levels in patients with stable CAD and ACS have been discovered to be independently associated with the extent of CAD and recurrent cardiovascular events [34]. CRP has a role in all phases of atherosclerosis by directly influencing

processes such as complement activation, endothelial damage, vascular cell activation, apoptosis, and thrombosis. In a study published in 2019, CAR was found to be independently correlated for risk stratification in patients with ACS [35]. A more recently published study compared the predictive values of CAR and other inflammatory markers such as NLR and PLR; CAR exhibited a better predictive performance for intermediate-high SS than did NLR, but PLR failed to predict the extent of CAD [17]. Our current research demonstrates the same conclusion, resulting in a better likelihood ratio of CAR than NLR; however, UAR was a better predictor of CAD extent than CAR and it proved to be a better inflammatory marker.

There is no study published to date comparing the predictive value of UAR and other inflammatory markers such as NLR and CAR. Consequently, this research is the first to evaluate the value of UAR in predicting the CAD extent versus NLR and CAR. Although CAR independently predicted CAD severity, UAR exhibited better independent predictive performance for intermediate-high SS compared to CAR. Additionally, all of our study patients had NSTEMI, and there were no acute ST-segment elevation myocardial infarctions. A recent study comparing the timing of invasive strategy at NSTEMI reported no improvement in clinical outcomes [36]. As a result of this, LVEF was found to be an independent predictor of CAD extent and severity and not a consequence of a delayed detected coronary progress, as indicated in previous studies [37].

However, this study has some limitations. First, this study is based on a retrospective design, it has a relatively small sample size, and it relied on a single-center experience. Second, coronary artery severity was only evaluated by visual coronary angiograms based on luminal stenosis and we did not include additional information about the quantitative assessment of coronary artery atherosclerosis. Third, this study did not include patients with a history of coronary artery bypass grafting, percutaneous coronary intervention, and end-stage renal disease receiving hemodialysis. Fourth, we measured UA and SA levels only at admission, and the alterations that would be observed by serial measurements may superimpose a predictive value. Fifth, as we recorded only small volume and event rate values, the data obtained did not allow us to evaluate the prognostic value of UAR on adverse cardiovascular outcomes.

This study showed that decreased a LVEF, a higher UAR value, and an elevated CAR value are independent predictors of CAD severity. We also observed that the predictive accuracy of UAR for CAD severity was better than that of CAR.

Conclusion

UAR has a significant association with SS and may be a potentially readily available, easily measurable, and inexpensive parameter for determining the severity and extent of CAD. It may be a part of the cardiovascular examination to identify individuals with NSTEMI at high risk for advanced CAD who may need a more aggressive therapeutic approach and closer clinical follow-up. However, to evaluate the predictive and prognostic value of UAR in NSTEMI patients, large-scale and prospective studies are still required.

Statement of Ethics

This study was approved by the Kartal Kosuyolu High Specialty and Research Hospital Ethical Committee and the Research Review Committee of the Department of Cardiology (approval No. 2020/14/402; Istanbul, Turkey). All of the patients provided written informed consent.

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Conflict of Interest Statement

The authors declare that they have no conflict of interests.

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Author Contributions

E.Ö.Ç. and İ.A.İ.: conception and design of this study. E.B., M.Ç., M.K., K.E., and E.İ.: data collection. E.Ö.Ç., and A.K.: analysis and interpretation of data. E.Ö.Ç. and E.B.: drafting of this paper. E.Ö.Ç. and A.K.: revision and editing. E.Ö.Ç. and İ.A.İ.: supervision.

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