Eskisehir Medical Journal
Eskişehir Tıp Dergisi

Eskisehir Med J. 2023; 4(supp): 188-194
doi: 10.48176/esmj. 2023.131

Araştırma Makalesi / Original Article

SYSTEMIC IMMUNE-INFLAMMATION INDEX IS A PREDICTOR OF LEFT VENTRICULAR THROMBUS FORMATION FOLLOWING ANTERIOR MYOCARDIAL INFARCTION

SİSTEMİK İMMÜN-ENFLAMASYON İNDEKSİ, ANTERİOR MİYOKARD ENFARKTÜSÜNÜ TAKİBEN SOL VENTRİKÜL TROMBÜS OLUŞUMUNUN BİR GÖSTERGESİ

AHMET LÜTFÜ SERTDEMİR[1] MUSTAFA DURAN[2] AHMET TAHA ŞAHİN[1] ABDULLAH İÇLİ[1] MUSTAFA ÇELİK[1] SEFA TATAR[1] YAKUP ALSANCAK[1]

[1]Necmettin Erbakan University, Faculty of Medicine, Department of Cardiology, Konya, Turkey
[2]Konya City Hospital, Department of Cardiology, Konya, Turkey

ÖZET

Giriş: Anterior ST yükselmeli miyokard infarktüsünü (STEMI) takiben sol ventrikül trombüsü (SVT) oluşumu ciddi bir komplikasyondur ve artmış kardiyovasküler morbidite ve mortalite riski ile ilişkilidir. Son zamanlarda tanıtılan sistemik immün-enflamasyon indeksi (SII), çeşitli kardiyovasküler durumlardaki olumsuz olayların güvenilir bir göstergesidir. Burada, primer perkütan koroner girişim (PKG) sonrası anterior STEMI hastalarında SII'nin SVT oluşumunu öngörmedeki rolünü araştırmayı amaçladık.

Yöntemler: Primer PKG sonrası SVT gelişen 124 anterior STEMI hastasının ve primer PKG sonrası SVT oluşmayan yaş ve cinsiyet uyumlu 124 anterior STEMI hastasının tıbbi kayıtları analiz edildi. Her grup için hasta demografik özellikleri, komorbiditeler, laboratuvar parametreleri, EKG ve ekokardiyografik bulgular analiz edildi. SII, aşağıdaki formül kullanılarak ölçüldü: SII= toplam periferik trombosit sayısı x nötrofil/lenfosit oranı.

Bulgular: Çalışmamıza göre, azalmış sol ventrikül ejeksiyon fraksiyonu ve artmış SII, anterior STEMI sonrası SVT oluşumunun bağımsız belirteçleri olarak belirlendi. SII indeksi cut-off değerinin SVT oluşumunu öngörmede belirlenmesi için ROC eğrisi çizildi ve en iyi cut-off değeri 676,27 olarak belirlendi (AUC:0,778, 95% CI:0,699-0,858, p<0,001). Bu cut-off değerinin üzerinde %66,1 sensitivite ve %74,2 spesifite ile SVT oluşumu tahmin edilebildi.

Sonuç: SII, primer PKG sonrası anterior STEMI hastalarında SVT oluşumunun bağımsız bir göstergesi olabilir.

Anahtar Kelimeler: Sol ventrikül trombüsü, ST yükselmeli miyokard enfarktüsü, sistemik immün-inflamasyon indeksi.

ABSTRACT

Introduction: Left ventricular thrombus (LVT) formation following anterior ST-elevation myocardial infarction (STEMI), is a serious complication and is associated with an increased risk of cardiovascular morbidity and mortality. Recently introduced the systemic immune-inflammation index (SII) is a reliable indicator of adverse events in various cardiovascular conditions. Herein, we aimed to explore the role of SII in the prediction of LVT formation in anterior STEMI patients following primary percutaneous coronary intervention (PCI).

Methods: Medical records of 124 anterior STEMI patients who developed LVT following primary PCI and 124 age and sex-matched anterior STEMI patients without formation of LVT following primary PCI were analyzed. For each group, patient demographics, comorbidities, laboratory parameters, ECG and echocardiographic findings were analyzed. The SII was measured using the following formula: SII= total peripheral platelets count x neutrophil/lymphocyte ratio.

Results: According to our study, reduced left ventricular ejection fraction and increased SII were identified as independent predictors of LVT formation following anterior STEMI. To determine the SII index cut-off value for predicting LVT formation, the ROC curve was drawn and the best cut-off value was determined as 676.27 (AUC:0.778, 95% CI:0.699-0.858, p<0.001). Above this cut-off value, LVT formation could be predicted with a sensitivity of 66.1% and a specificity of 74.2%.

Conclusion: SII is may be used as an independent predictor of LVT formation for anterior STEMI patients following primary PCI.

Keywords: Left ventricular thrombus, ST-elevation myocardial infarction, systemic immune-inflammation index.

Corresponding Author: Ahmet Taha Şahin
E-mail: tahasahin94@gmail.com
ORCID: 0000-0002-2928-1059
Received Date: 29.05.2023 **Accepted Date:** 20.06.2023

Cite as: Sertdemir AL, Duran M, Sahin AT, et al. Systemic immune-inflammation index is a predictor of left ventricular thrombus formation following anterior myocardial infarction. Eskisehir Med J. 2023; 4(supp): 188-194. doi: 10.48176/esmj.2023.131.

INTRODUCTION

Left ventricular thrombus (LVT) formation following ST-elevation myocardial infarction (STEMI), is a serious complication and is associated with an increased risk of cardiovascular morbidity and mortality (1-3). Although the incidence of LVT has decreased dramatically since the introduction of primary percutaneous coronary intervention (PCI) and aggressive antiplatelet therapy, it still occurs in the range of 2.9% to 15% (4). According to currently available data, anterior STEMI, involvement of the anterior and/or apical segments, development of Left Ventricle (LV) akinesis or dyskinesis (irrespective of the vascular territory affected), reduced ejection fraction, severe diastolic dysfunction, and large infarct size are major determinants of LVT (5-7). Yet there is a paucity of data not only for early prediction of LVT formation but also for identifying high-risk patients who are more likely to develop LVT following STEMI.

The systemic immune-inflammation index (SII) has been established for the evaluation of patients' inflammatory status and is strongly associated with adverse cardiovascular events (8-10). This index was reported to be more accurate than other biomarkers in terms of determining inflammatory and hypercoagulable states (11,12). However, no relevant research has investigated the association between the SII and the development of LVT in high-risk STEMI patients treated with primary PCI. Therefore, this study aimed to explore the role of SII in the prediction of LVT formation in anterior STEMI patients following primary PCI.

METHODS

Study population

Participants in this study were retrospectively recruited from the medical records of 124 anterior STEMI patients who developed LVT following primary PCI between January 2015 and December 2021. 4810 STEMI patients were screened, and approximately 1820 of these patients had anterior Myocardial Infarction (MI). 124 randomly matched age- and sex-matched anterior STEMI patients without LVT following primary PCI were also enrolled retrospectively as a control group. The diagnosis of STEMI was defined based on symptoms suggestive of myocardial ischemia, electrocardiographic (ECG) findings, and rise and fall of cardiac troponin levels above the 99th percentile upper reference limit (13). Demographic and clinical risk factors of the study population and the indication for the coronary intervention were retrospectively analyzed. Exclusion criteria were prior MI, malignancy, non-ischemic cardiomyopathy, hematological disorders, connective tissue disorders, severe valve disease, presence of active infection, corticosteroid use, use of anticoagulants, and non-steroidal anti-inflammatory drugs. Patients whose final diagnosis was other than anterior STEMI or patients who underwent rescue or facilitated PCI were also excluded from the study. Study protocol was approved by the local ethics committee of our hospital (2022/3967:11040, 19.09.2022).

Data collection

The patient demographics, comorbidities, laboratory parameters, ECG, and echocardiographic findings were extracted from patient records and the hospital database. A comprehensive metabolic panel was conducted to measure full blood count, liver and kidney functions, and lipid concentrations. Blood specimens were collected from the antecubital vein on hospital admission. All metabolic panel measurements were performed using an auto-analyzer (Roche Diagnostic Modular Systems, Tokyo, Japan). The SII was measured using the following formula: SII= total peripheral platelets count x neutrophil/lymphocyte ratio (14).

All patients underwent comprehensive transthoracic echocardiographic examination within seven days following STEMI using a GE Vingmed Vivid 5 echocardiography device (GE Vingmed Ultrasound, Horten, Norway). During an echo exam, parasternal long-axis, short-axis, and apical 4-chamber and 2-chamber views were obtained and evaluated using M-mode, 2-D, continuous-wave Doppler, pulse wave Doppler, and tissue Doppler methods. LVT was defined as the presence of an echo-dense mass with well-defined borders distinct from the endocardium seen in the left ventricular cavity on a transthoracic echocardiogram (15). All measurements were performed by an experienced cardiologist who was blinded to patient data.

Coronary angiography

The angiographic records were retrospectively analyzed at a core lab using CAASV software (version 5.7, Pie Medical Imaging, Maastricht, the Netherland). Patients with symptoms ≤12 hours in duration as well as patients presenting with continuing ischemic symptoms lasting 12 to 24 hours from onset of symptoms underwent primary PCI. All coronary interventions were performed under systemic heparinization for maintaining an activated clotting time of >250 s when a glycoprotein IIb/IIIa inhibitor was not used. The catheter balloons and stents used during the procedure, access site, and procedural technique were left at the operator's discretion. Adjunctive pharmacotherapies including, dual antiplatelet therapies, beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, and lipid-lowering therapies were prescribed according to evidence-based guidelines. Patients who were diagnosed with LVT received triple anticoagulation therapy including acetylsalicylic acid, clopidogrel, and warfarin (with a target international normalized range of 2-3).

Statistical Analysis

Statistical analysis was performed using SPSS software version 20.0 for Windows (IBM Corp., Armonk, USA). Data are expressed as mean ± standard deviation (SD) for normal distribution and as median (minimum-maximum) for variables which are not normally distributed. The Kolmogorov-Smirnov and Shapiro–Wilk test was used to check the distribution of continuous variables. The $\chi 2$ test

Table 1. Comparison of baseline characteristics of the study population (n=248).

Parameters	Left ventricular thrombus – (n=124)	Left ventricular thrombus + (n=124)	p value
Age (years)	65±11.16	67.26±12.01	0.280*
Gender: Female, n(%)	28(22.6)	14(11.3)	0.150**
Hypertension, n(%)	76(61.3)	72(58.1)	0.351**
Diabetes Mellitus, n(%)	50(40.3)	44(35.5)	0.453**
Stroke, n(%)	26(21.0)	16(12.9)	0.228**
Liver disease, n(%)	6(4.8)	10(8.1)	0.718**
Bleeding history, n(%)	2(1.6)	6(4.8)	0.620**
Chronic kidney disease, n(%)	6(4.8)	8(6.5)	1.000**
ECG Parameters			
Rhythm, n(%) Sinus rhythm Atrial fibrillation Other	 108(87.1) 16(12.9) 0(0)	 110(88.7) 12(9.7) 2(1.6)	0.511**
Heart rate, /min	73(51-120)	76(50-136)	0.298*
QRS Duration, ms	80(66-170)	89.50(65-180)	0.072*
Bundle branch block -Left -Right	 14(11.3) 4(3.2)	 22(17.7) 16(12.9)	0.073*
QT Duration, ms	378.11±37.25	382.36±37.14	0.551*
Echocardiography Parameters			
LVEF, %	33(20-40)	30(20-40)	0.011*
LVEDD, mm	52.90±7.43	55.40±8.81	0.090*
LVESD, mm	37.14±8.43	39.61±10.60	0.265*
Left atrial diameter, mm	40.97±5.77	41.54±8.22	0.655*
SPAP, mmHg	30(22-71)	30(20-97)	0.952*
Laboratory Parameters			
Creatinine, mg/dL	1.00(0.6-6.96)	1.13(0.69-4.89)	0.088***
GFR, ml/min	73.80±29.27	68.74±27.27	0.423***
Sodium, mmol/L	139(132-154)	139(123-143)	0.716***
Potassium, mmol/L	4.58±0.46	4.68±0.57	0.297***
LDL, mg/dL	92.07±36.35	95.75±39.61	0.610***
HDL, mg/dL	38.48±11.28	38.82±12.90	0.880***
TG, mg/dL	120(41-609)	118.50(56-505)	0.655***
Hb, g/dL	13.77±2.13	12.84±2.47	0.026***
WBC, x103/μL	7.98(3.70-15.80)	9.39(4.40-25)	0.005***
Platelets, x103/μL	218(72-440)	363.5(92-814)	0.002***
Neutrophils, x103/μL	4.5(1.6-11.50)	6.25(3.6-22.20)	<0.001***
Lymphocytes, x103/μL	2.30(0.8-5.3)	1.98(0.4-12.40	0.125***
SII	495.24(81.60-1635)	790.67(356-14530)	<0.001*

GFR, glomerular filtration rate; Hb, hemoglobin; HDL, high density lipoprotein; LDL,low density lipoprotein; LVEDD, left ventricular end diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end systolic diameter; SII, systemic immune-inflammation index; SPAP, systolic pulmonary artery pressure; TG, triglycerides; WBC, White blood cell; ECG: Electrocardiogram

*: Pearson Chi-square test

**: Mann Whitney U test

***: Student's T test

and Fisher's exact test were used to evaluate categorical variables. The student's t-test was used for variables complying with a normal distribution and the variables were presented as mean ± SD. The comparison of intergroup continuous variables complying without normal distribution was analyzed using Mann-Whitney U-test. The effect of multiple variables on LVT formation was analyzed by univariate regression analysis. In these analyses, variables with unadjusted $p<0.05$ were considered as potential covariates and were included in multivariate regression analyses. The area under the receiver operating characteristic (ROC) curves (AUCs) was used to assess the predictive value of the SII for LVT formation following anterior STEMI.

RESULTS

After the exclusion of ineligible subjects, 124 patients with LVT and 124 patients without LVT were enrolled. Of the total patients, 83.1% of them were male and the median age was 66.1±11.8 years. The comparison of baseline clinical risk factors, ECG, echocardiographic, and laboratory findings of both groups are shown in Table 1. Both groups had similar clinical risk factors, ECG, and echocardiographic findings. However, the calculated LV ejection fraction (LVEF) was significantly lower in patients with LVT compared with patients without LVT [30 (20-40) vs 33 (20-40) %, $p<0.05$].

Regarding baseline laboratory values, serum white blood cell count [9.39(4.40-25) vs. 7.98(3.70-15.80) 103/μL, $p<0.05$], serum neutrophil count [6.25(3.6-22.20) vs. 4.5(1.6-11.50) 103/μL, $p<0.05$)], and serum platelet count [363.5(92-814) vs. 218(72-440) 103/μL, $p<0.05$) were significantly higher in patients with LVT compared with patients without LVT. On the other hand, serum hemoglobin level (12.84±2.47 vs. 13.77±2.13 g/dL, $p<0.05$) was significantly lower in patients with LVT compared with patients without LVT. With respect to SII scores, patients with LVT had significantly higher levels of SII scores compared with patients without LVT [790.67(356-14530) vs. 495.24(81.60-1635), $p<0.01$].

Table 2. Univariate and multivariate regression analyses.

Parameters	Univariate Regression Analyse			Multivariate Regression Analyse		
	Exp(B)	95% CI for Exp(B)	p value	Exp(B)	95% CI for Exp(B)	p value
Gender: Female	0.436	0.163-1.170	0.099	-	-	-
QRS Duration, ms	1.015	0.998-1.032	0.084	-	-	-
Bundle branch block	2.098	1.084-4.063	0.028*	1.642	0.725-3.720	0.235*
LVEF, %	0.907	0.841-0.979	0.012*	0.910	0.831-0.997	0.042*
LVEDD, mm	1.039	0.994-1.087	0.093	-	-	-
Creatinine, mg/dL	1.185	0.717-1.965	0.551	-	-	-
Hb, g/dL	0.836	0.711-0.982	0.029*	0.857	0.696-1.057	0.149*
WBC, $x10^3/\mu L$	1.232	1.062-1.429	0.006*	0.784	0.357-1.719	0.543*
Platelets, $x10^3/\mu L$	1.006	1.002-1.010	0.002*	1.004	0.999-1.009	0.132*
Neutrophils, $x10^3/\mu L$	1.417	1.153-1.741	0.001*	1.035	0.824-1.301	0.767*
Lymphocytes, $x10^3/\mu L$	0.907	0.682-1.207	0.503	-	-	-
SII	1.003	1.001-1.004	<0.001*	1.002	1.001-1.004	0.001*

Hb, hemoglobin; LVEDD, left ventricular end diastolic diameter; LVEF, left ventricular ejection fraction;; SII, systemic immune-inflammation index;, WBC, White blood cell; CI: Confidence Interval
*:Mann Whitney U test

To identify the independent predictors of LVT formation, a multivariable logistic regression analysis was performed by using variables that showed statistically significant associations with univariate analysis. After adjusting for confounding factors; reduced left ventricular ejection fraction (LVEF) and SII score were identified as independent predictors of LVT formation following anterior STEMI (Table 2). To determine the SII index cut-off value for predicting LVT formation, the ROC curve was drawn and the best cut-off value was determined as 676.27 (AUC:0.778, 95% CI:0.699-0.858, p<0.001), (Figure 1). Above this cut-off value, LVT formation could be detected with a sensitivity of 66.1% and a specificity of 74.2%.

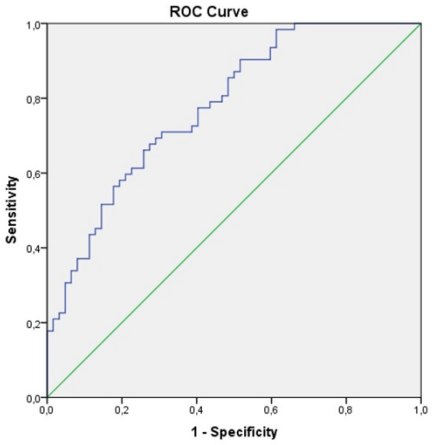

Figure 1. ROC Curve. Sensitivity of SII≥676.27 for the presence of left ventricular thrombus 66.1% specificity 74.2% (AUC:0.778, 95% CI:0.699-0.858, p<0.001)

DISCUSSION

In this study, we evaluated the predictive role of the SII on LVT formation in anterior STEMI patients following primary PCI and found that the SII was an independent predictor of LVT formation. To the best of our knowledge, this is the first study in the literature that evaluates the relationship between SII and LVT formation in anterior STEMI patients.

It has been well established that MI contributes to the development of blood stasis, endothelial injury, and a prothrombotic state (16). In addition, MI provokes a strong inflammatory response which intensifies hypercoagulability (17). Since LVT formation is most commonly seen in the setting of a hypercoagulable and inflammatory state, this phenomenon is frequently observed among post-MI survivors, especially patients with a prior history of anterior STEMI [18]. According to a previous study, the cumulative incidence of LVT detected by two-dimensional echocardiography in patients with anterior STEMI was reported to be 9.1% (4). Yet, in contemporary cardiac magnetic resonance studies, the rate of LVT reaches up to 24% among patients presenting with anterior STEMI (18). Similar to previous reports these studies revealed that involvement of the anterior and/or apical segments, development of apical aneurysm/akinesia, reduced ejection

fraction, and large infarct size were major risk factors for LVT formation (4,19). In our study, reduced LVEF and higher SII were identified as independent predictors of LVT formation. Regarding the strong relationship between the increased blood viscosity and inflammatory response associated with MI and the formation of LVT, it is not surprising the reach such an outcome.

Since various studies confirmed the strong relationship between inflammation severity and adverse cardiovascular events, several blood indices including neutrophil to lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte to high-density lipoprotein cholesterol (HDL-C) ratio have been proposed for clinical practice (20-23). In this context, a novel biomarker named SII that combines these indices has been introduced to clinical practice. Findings from previous studies revealed that SII had a better predictive value in terms of determining the inflammatory status of the patient and the development of poor outcomes in multiple cardiac conditions such as chronic heart failure, coronary artery disease, severe aortic stenosis, and acute coronary syndrome (24-26). The basis of thrombosis can be linked to Virchow's triad, which includes injury to the vessel walls, a hypercoagulable state and stasis. Recognised predisposing risk factors for thrombosis are known to include inflammation and infection. SII, it combined the platelet, neutrophil and lymphocyte count, reflecting the inflammation and thrombosis. Therefore, SII was more stable and representative, compared with these factors above (27,28). Yet none of these studies investigated the prognostic value of SII for predicting LVT. Considering the complex interplay between inflammatory response and LVT, we used SII as a predictor of LVT and observed a statistically significant relationship between the higher SII and the formation of LVT.

Indeed, the relationship between inflammation severity and the development of LVT is a well-known phenomenon. Underlying mechanisms are increased expression of proinflammatory cytokines and platelet deposition triggered by monocytes and macrophages that are located in the necrotic myocardium (29). Infiltrating neutrophils induced platelet-activating factor (PAF) is also responsible for thrombus formation in the necrotic myocardium (30). Since there is a direct link between inflammation and thrombosis, the greater the inflammatory response, the higher incidence of LVT formation following MI (31). According to a study conducted by Shacham et al. anterior STEMI patients with a higher level of peak serum C-reactive protein (CRP) concentration had significantly higher rates of LVT compared to those with a lower level of peak serum CRP concentration (32). Regarding these data, we can postulate that higher levels of SII not only predict inflammation severity but also predicts the probability of LVT formation following STEMI.

Limitation

There are some limitations of our study. First, this is a single-center retrospective study with a limited number of patients. Second, owing to a lack of continuous measurement of blood tests in this study, SII were measured at a one-time point, and fluctuation of SII was not considered. Follow-up monitoring may provide additional predictive value. Third, we did not compare the measurements of the SII with other inflammatory markers.

CONCLUSION

This study showed that the SII is an independent predictor of LVT formation for anterior STEMI pa-tients following primary PCI. To improve our ability to predict LVT formation following primary PCI, this index is a simple, cheap, and non-invasive prognostic tool that can be used during pre-procedural evaluation.

Ethics Committee Approval: Study protocol was approved by Necmettin Erbakan University ethics committee (2022/3967:11040, 19.09.2022).

Informed Consent: The study was conducted retrospectively.

Authorship Contributions: ALS: Design, conception, writing; MD, conception, analysis; Aİ: supervision, writing and reviewing, YA: analysis, literature review; MÇ: supervision, literature review; ATŞ: data collection, reviewing, ST: data collection, reviewing. All authors read and approved the final manuscript.

Conflict Of Interest: The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report.

Financial Disclosure: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

REFERENCES

1. Solheim S, Seljeflot I, Lunde K, et al. Frequency of left ventricular thrombus in patients with anterior wall acute myocardial infarction treated with percutaneous coronary intervention and dual antiplatelet therapy. Am J Cardiol. 2010;106:1197-200.

2. Gianstefani S, Douiri A, Delithanasis I, et al. Incidence and predictors of early left ventricular thrombus after ST-elevation myocardial infarction in the contemporary era of primary percutaneous coronary intervention. Am J Cardiol. 2014;113:1111-6.

3. Leow AST, Sia CH, Tan BYQ, et al. Characterisation of acute ischemic stroke in patients with left ventricular thrombi

after myocardial infarction. J Thromb Thrombolysis. 2019;48:158–66.

4. Robinson AA, Jain A, Gentry M, McNamara RL. Left ventricular thrombi after STEMI in the primary PCI era: a systematic review and meta-analysis. Int J Cardiol. 2016;221:554–59.

5. Garber AM, Mentz RJ, Al-Khalidi HR, et al. Clinical predictors and outcomes of patients with left ventricular thrombus following ST-segment elevation myocardial infarction. J Thromb Thrombolysis. 2016;41:365-73.

6. Driesman A, Hyder O, Lang C, Stockwell P, Poppas A, Abbot JD. Incidence and Predictors of Left Ventricular Thrombus After Primary Percutaneous Coronary Intervention for Anterior ST-Segment Elevation Myocardial Infarction. Clin Cardiol. 2015;38:590-7.

7. Gokdeniz T, Boyaci F, Hatem E, et al. SYNTAX score predicts the left ventricle thrombus development in patients undergoing primary percutaneous coronary intervention for first anterior myocardial infarction. Clin Appl Thromb Hemost. 2014;20:698-705.

8. Huang J, Zhang Q, Wang R, et al. Systemic immune-inflammatory index predicts clinical outcomes for elderly patients with acute myocardial infarction receiving percutaneous coronary intervention. Med. Sci. Monit. 2019;25:9690–701.

9. Seo M, Yamada T, Morita T, et al. Prognostic value of systemic immune-inflammation index in patients with chronic heart failure. Eur Heart J. 2018;39:ehy564.P589.

10. Yang YL, Wu CH, Hsu PF, et al. Systemic immune-inflammation index (SII) predicted clinical outcome in patients with coronary artery disease. Eur J Clin Invest. 2020;50:e13230.

11. Chen L, Pandey S, Shen R, Xu Y, Zhang Q. Increased Systemic Immune-Inflammation Index Is Associated With Delayed Cerebral Ischemia in Aneurysmal Subarachnoid Hemorrhage Patients. Front Neurol. 2021;12:745175.

12. Gok M, Kurtul A. A novel marker for predicting severity of acute pulmonary embolism: systemic immuneinflammation index. Scand Cardiovasc J. 2021;55:91-6.

13. Ibanez B, James S, Agewall S, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: the Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39:119-77.

14. Hu B, Yang XR, Xu Y, et al. Systemic immune-inflammation index predicts prognosis of patients after curative resection for hepatocellular carcinoma. Clin Cancer Res. 2014;20:6212-22.

15. Saric M, Armour AC, Arnaout MS, et al. Guidelines for the use of echocardiography in the evaluation of a cardiac source of embolism. J Am Soc Echocardiogr. 2016;29:1-42.

16. Delewi R, Zijlstra F, Piek JJ. Left ventricular thrombus formation after acute myocardial infarction. 2012;98:1743-9.

17. Neumann FJ, Ott I, Gawaz M, Richardt G, Holzapfel H, Jochum M, Schömig A. Cardiac release of cytokines and inflammatory responses in acute myocardial infarction. Circulation. 1995;92:748-55.

18. Pöss J, Desch S, Eitel C, de Waha S, Thiele H, Eitel I. Left Ventricular Thrombus Formation After ST-Segment-Elevation Myocardial Infarction: Insights From a Cardiac Magnetic Resonance Multicenter Study. Circ Cardiovasc Imaging. 2015;8:e003417.

19. Phan J, Nguyen T, French J, et al. Incidence and predictors of left ventricular thrombus formation following acute ST-segment elevation myocardial infarction: a serial cardiac MRI study. Int J Cardiol Heart Vasc. 2019;24:100395.

20. Arbel Y, Finkelstein A, Halkin A, et al. Neutrophil/lymphocyte ratio is related to the severity of coronary artery disease and clinical outcome in patients undergoing angiography. Atherosclerosis. 2012;225:456-60.

21. Adamstein NH, MacFadyen JG, Rose LM, et al. The neutrophil-lymphocyte ratio and incident atherosclerotic events: analyses from five contemporary randomized trials. Eur Heart J. 2021;42:896–903.

22. Kurtul A, Murat SN, Yarlioglues M, et al. Association of platelet-to-lymphocyte ratio with severity and complexity of coronary artery disease in patients with acute coronary syndromes. Am J Cardiol. 2014;114:972-78.

23. Ma X, Han K, Yang L, et al. Adjustment of the GRACE risk score by monocyte to high-density lipoprotein ratio improves prediction of adverse cardiovascular outcomes in patients with acute coronary syndrome undergoing percutaneous coronary intervention. Front Cardiovasc Med. 2022;8:755806.

24. Candemir M, Kiziltunc E, Nurkoç S, Sahinarslan A. Relationship Between Systemic Immune-Inflammation Index (SII) and the Severity of Stable Coronary Artery Disease. Angiology. 2021;72:575–81.

25. Tosu AR, Kalyoncuoglu M, Biter HB, et al. Prognostic Value of Systemic Immune-Inflammation Index for Major Adverse Cardiac Events and Mortality in Severe Aortic Stenosis Patients after TAVI. Medicina (Kaunas). 2021;57:588.

26. Han K, Shi D, Yang L, et al. Prognostic value of systemic inflammatory response index in patients with acute coronary syndrome undergoing percutaneous coronary intervention. Ann Med. 2022;54:1667-77.

27. Siddiqi SA, Nishat S, Kanwar D, et al. Cerebral venous sinus thrombosis: association with primary varicella zoster virus infection. J Stroke Cerebrovasc Dis 2012;21:917.e1–917.e4.

28. İdil Soylu A, Arıkan Cortcu S, Uzunkaya F, et al. The correlation of the platelet-to-lymphocyte ratio with the severity of stenosis and stroke in patients with carotid arterial disease. Vascular 2017;25:299–306.

29. Kerr R, Stirling D, Ludlam CA. Interleukin 6 and haemostasis. Br J Haematol. 2001;115:3–12.

30. Anzai T, Yoshikawa T, Asakura Y, et al. Preinfarction angına as a major predictor of left ventricular function and long-term prognosis after a first Q wave myocardial infarction. J Am Coll Cardiol. 1995;26:319–27.

31. Anzai T, Yoshikawa T, Kaneko H, et al. Association between serum C-reactive protein elevation and left ventricular thrombus formation after first anterior myocardial infarction. Chest. 2004; 125:384-9.

32. Shacham Y, Leshem-Rubinow E, Ben Assa E, et al. Comparison of C-reactive protein and fibrinogen levels in patients having anterior wall ST-Segment elevation myocardial infarction with versus without left ventricular thrombus (from a primary percutaneous coronary intervention cohort). Am J Cardiol. 2013;112:57-60.