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Association between SYNTAX score-II and no-reflow in patients with acute anterior ST-segment elevation myocardial infarction

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SOUHRN

Kontext a cíle: „No-reflow" fenomén spojený s úmrtím na kardiovaskulární onemocnění představuje závažnou komplikaci perkutánní koronární intervence. Pokud jsou známy klinické a angiografické parametry pacienta, skóre SYNTAX II (SS-II) predikuje mortalitu pacientů s akutním koronárním syndromem (AKS). Cílem této studie je zjistit vztah mezi „no-reflow" fenoménem a SS-II.
Pacienti a metody: Do studie bylo zařazeno 255 po osobě následujících pacientů (210 [82,3 %] mužů, průměrný věk 55 [18–90] let) s akutním infarktem myokardu přední stěny s elevacemi úseku ST (anterior ST-segment elevation myocardial infarction, STEMI), u nichž byla provedena primární perkutánní koronární intervence. Pacienti byli rozděleni do dvou skupin; jedné s „no-reflow" fenoménem a druhé s obnoveným průtokem krve („reflow"). Zaznamenávaly se demografické parametry, komorbidity i biochemické parametry a byly vypočteny hodnoty skóre SYNTAX I (SS-I) i SS-II pacientů.
Výsledky: Skupina „no-reflow" byla starší. Hypertenze byla přítomna častěji ve skupině „no-reflow" než ve skupině s obnovením průtoku krve (p = 0,007). U pacientů s „no-reflow" byly naměřeny vyšší hodnoty troponinu (jak při příjmu, tak maximální), TIMI frame count, hodnoty SS-I a SS-II byly statisticky významně vyšší u pacientů s „no-reflow". V logistické regresní analýze byla hodnota SS-II (poměr šancí [odds ratio, OR] 1,096; 95% interval spolehlivosti [confidence interval, CI] 1,058–1,135; p < 0,001) nezávisle spojena s „no-reflow" fenoménem. V analýze křivky ROC predikovala mezní hodnota ≥ 24,85 přítomnost „no-reflow" fenoménu se senzitivitou 75,9 % a specificitou 59,2 % (AUC 0,721 [0,637–0,805], 95% CI; p < 0,001).
Závěr: U pacientů se STEMI, zvláště s akutním infarktem myokardu přední stěny, je hodnota SS-II nezávisle spojena s „no-reflow" fenoménem jako fatální a častou komplikací AKS.

Keywords:
Coronary artery disease
No-reflow phenomenon
Smoking
SYNTAX score-II

ABSTRACT

Background and objectives: The no-reflow phenomenon associated with cardiovascular mortality is one of the serious complications of percutaneous coronary intervention. Also, having both clinical and angiographic parameters, SYNTAX score-II (SS-II) predicts mortality in patients with acute coronary syndrome (ACS). The aim of this study is to investigate the association of the no-reflow phenomenon with SS-II.
Subjects and methods: 255 consecutive participants (210 [82.3%] male, median age; 55 [18–90] with acute anterior ST-segment elevation myocardial infarction (STEMI) undergoing primary percutaneous coronary intervention were enrolled in the study. Patients were divided into two groups as follows: those with no-reflow and those with reflow. Demographic features, comorbidities, biochemical parameters were recorded. SYNTAX score-I (SS-I), and SS-II of the patients were calculated.
Results: No-reflow group was older. Hypertension was more frequent in the no-reflow group than that of the re-flow group (p = 0.007). Troponin levels (both on admission and peak), TIMI frame count, SS-I, and SS-II were significantly higher in patients with no-reflow. In logistic regression analysis, SS-II (odds ratio [OR]: 1.096, 95% confidence interval [CI]: 1.058–1.135; p< 0.001) was independently associated with the no-reflow phenomenon. A cut-off value of ≥ 24.85 predicted no-reflow, with 75.9% sensitivity and 59.2% specificity (AUC: 0.721 [0.637–0.805], 95% CI, p< 0.001) in ROC curve analysis.
Conclusion: In STEMI patients, particularly acute anterior MI, SS-II is independently associated with the no-reflow phenomenon, which is a fatal and frequent complication of ACS.

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Introduction

Coronary heart disease is still one of the leading causes of death throughout the world.[1] Considering the clinical results, primary percutaneous coronary intervention (PPCI) is the best option in the treatment of ST-segment elevation myocardial infarction (STEMI).[2] The no-reflow phenomenon is a common complication of PPCI, which is characterized by myocardial perfusion impairment without any visible proof of vascular occlusion.[3,4] Besides, there is a growing body of evidence revealing that several mechanisms, such as endothelial dysfunction, reperfusion, ischemia-related injury, distal thromboembolism, and microvascular arterial spasm, play a role in the pathophysiology of this phenomenon.[5,6] Impaired myocardial perfusion occurring in this phenomenon is also associated with a poor prognosis.[7]

In STEMI patients, various scores, among which the SYNTAX score is well-known, are used to determine the severity of cardiovascular disease and to predict complications. The SYNTAX score calculated on coronary angiography not only demonstrate the extent of coronary artery disease but also gives us information about the outcome.[8] Given the limitations of the SYNTAX score, such as the clinical characteristics of individuals, the SYNTAX score-II (SS-II) was developed to better predict mortality in patients with complex lesions.[9] Therefore, in order to compensate for this deficiency, SS-II is calculated by taking into account age, gender, left ventricular ejection fraction (LVEF), creatinine clearance, chronic obstructive pulmonary disease (COPD), and peripheral vascular disease, together with the SYNTAX score I (SS-I). In this way, the SS-II can be used as a more effective and customized tool in the management of complex coronary artery disease.[10] In addition, high SS-II predicts major cardiac events, target vessel revascularization, recurrent myocardial infarction.[11,12]

The present study aims to examine the relationship between SS-II and the no-reflow phenomenon in patients with acute anterior myocardial infarction.

Methods

Study population and design

In our single-center study with a retrospective cohort design, 255 consecutive patients with acute anterior myocardial infarction who met the following inclusion criteria: a) being a participant aged ≥18 years, b) were hospitalized within 12 hours from the onset of symptoms, c) underwent PPCI, were enrolled in the study. Patients with prior coronary artery bypass grafting, stent thrombosis, chronic liver failure, cardiogenic shock, an active infection, or cancer were excluded from the study. We divided the participants into two groups as follows: with the no-reflow group and without the no-reflow group.

The study protocol and identification of risk factors

The ST-segment elevation is considered suggestive of ongoing coronary artery acute occlusion in the following cases: at least two contiguous leads with ST-segment elevation ≥2.5 mm in men < 40 years, ≥2 mm in men ≥40 years, or >1.5 mm in women in leads V_2–V_3 and/or ≥1mm in the other leads (in the absence of left ventricular [LV] hypertrophy or left bundle branch block [LBBB]).[13] Patients receiving antihypertensive therapy or those with arterial blood pressure measurement ≥ 140/90 mmHg in at least two different measurements were considered hypertensive.[14] The diagnosis of hyperlipidemia was made according to the European Society of Cardiology (ESC) guidelines on dyslipidaemias in patients receiving lipid-lowering therapy or those with a high blood level of lipid.[15] Of individuals in the study, those with a known diagnosis of diabetes mellitus (DM) (including those using oral anti-diabetic or insulin before), with fasting glucose ≥126 mg/dl or postprandial glucose ≥ 200 mg/dl, or with HbA_{1c} 6.5% were defined as DM.[16]

Blood sampling

Hemogram, lipid profile, kidney and liver function tests, and high sensitivity cardiac troponin T (hs-cTnT) (on admission and peak level) were obtained from all patients included in the study via venous blood samples taken before the procedure. Plasma triglyceride,low-density lipoprotein (LDL), high-density lipoprotein (HDL), glucose, uric acid, and creatinine concentrations were measured with an automated chemistry analyzer (Abbott Aero set, Minnesota, USA) using commercial kits (Abbott). Creatine kinase MB (CK-MB) activity was measured with an assay that used 2 monoclonal antibodies (CK-MB STAT) on an Elecsys 2010 analyzer (Roche Diagnostics, Basel, Switzerland) by electrochemiluminescence immunoassay. Plasma N-terminal pro-brain natriuretic peptide (NT-proBNP) was measured by electrochemiluminescence (Roche Diagnostics, Basel, Switzerland). e-GFR was calculated according to the Modification of Diet in Renal Disease (MDRD) formula. All data were recorded.

Coronary angiography procedure

Coronary angiography was performed for all patients using 7 French catheters through the femoral approach. Angiographic images were evaluated by an independent invasive cardiologist who was blinded to the data of the patients included in the study. Clopidogrel (600 mg loading, 75 mg maintenance dose), acetylsalicylic acid (300 mg), and unfractionated heparin (70–100 IU/kg bolus, 30–50 IU/kg maintenance in prolonged procedures) were administered to the patients during angiography. The diagnosis of the no-reflow phenomenon was defined as a flow of TIMI II or less without the presence of dissection, mechanical obstruction, significant residual stenosis, or other plausible causes.[17] TIMI frame count was assessed by a quantitative method previously defined by Gibson.[18] Unless there were any specific contraindications, treatment of acute myocardial infarction such as dual antiplatelet, statin, beta-blocker, and angiotensin receptor blocker or angiotensin-converting enzyme inhibitor were administered to the patients after angiography.

Syntax score-II and its parameters

SS-II was calculated based on the data obtained from pre-intervention angiographic images using an online calculator (http://syntaxscore.com). Age, gender, and other demographic characteristics of the patients

were also recorded. LVEF was calculated according to Simpson's method. COPD is a common, preventable, and treatable disease, which is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases and influenced by host factors including abnormal lung development. We practiced approaches under current recommendations in the diagnosis and treatment of COPD while calculating the SS-II.[19] The diagnosis of peripheral artery disease was made according to the 2017 ESC peripheral artery disease guidelines.[20]

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 20.0 (SPSS Inc., Chicago, IL, USA). The normality distribution of continuous variables was tested with an analytical (Kolmogorov–Smirnov test) method and visual methods (histograms and probability plots). Continuous variables are expressed as mean ± standard deviation or median (minimum–maximum) as appropriate, whereas categorical variables are expressed as number (n) and percentage (%). Chi-square or Fisher exact test was used for comparison of categorical data. Student t-test or Mann–Whitney U test was used to compare continuous variables between the two groups as appropriate. Spearman correlation analysis was used to investigate the association between SS-II and possible parameters. Receiver operating characteristic (ROC) curve analysis was used to determine the predictive value of the independent predictor. The optimal cut-off value was calculated using the youden-index. Multivariate logistic regression analysis identified clinical predictors of no-reflow. Confounders with a p-value < 0.10 in the univariate analysis were included in the forward conditional multivariate logistic regression analysis. A two-tailed p-value of ≤ 0.05 was considered statistically significant.

Results

In our retrospective study, 255 participants with acute anterior myocardial infarction who underwent PPCI were consecutively included in the study (210 [82.3%] male, median age 55 [18–90]. Median age was higher in patients with no-reflow (60 [33.0–90.0]) than in the group without no-reflow (53 [18.0–85.0] [p = 0.009]). Culprit lesions on angiography were as follows; LAD in 244 participants (95.7%), followed by diagonals in 10 (3.9%), and RCA in 1 (0.04%), due to wrapping RCA around the apex. The most common comorbidity in the overall population of the study was smoking (69.4%) followed by family history (44.3%), hypertension (HT) (36%), DM (21.1%), hyperlipidemia (HLP) (15.6%). Eld and HT were significantly higher in the no-reflow group (p = 0.001, p = 0.007, respectively). NT-proBNP, troponin levels on admission, and peak troponin levels were significantly higher in the no-reflow group. Detailed demographic characteristics, comorbidities, laboratory findings, echocardiography, and angiography results of the patients are shown in Table 1.

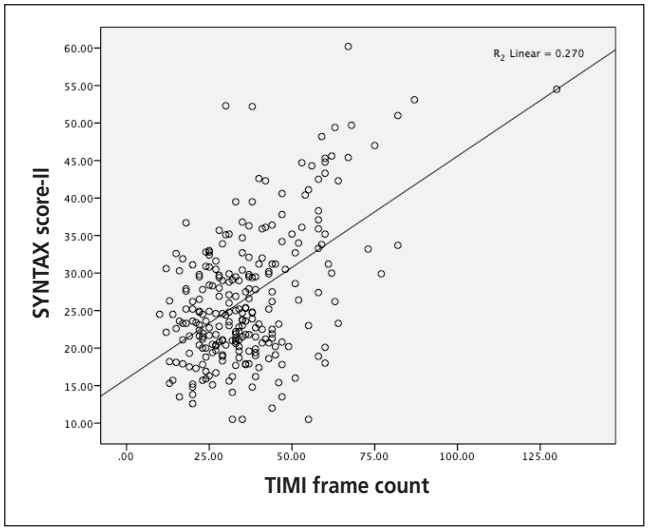
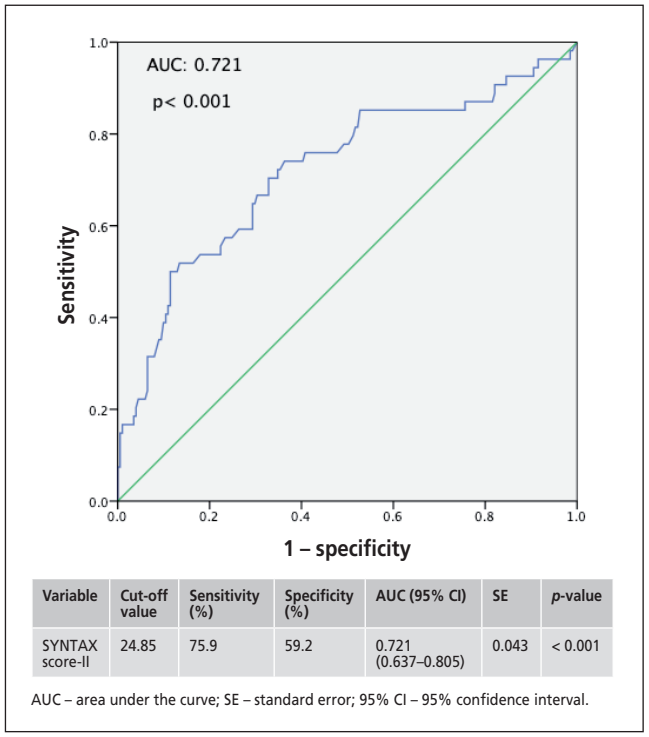


Fig. 1 – Scatter plot diagram of the relationship of TFC with SS-II.



Variable	Cut-off value	Sensitivity (%)	Specificity (%)	AUC (95% CI)	SE	*p*-value
SYNTAX score-II	24.85	75.9	59.2	0.721 (0.637–0.805)	0.043	< 0.001

AUC – area under the curve; SE – standard error; 95% CI – 95% confidence interval.

Fig. 2 – Receiver operating characteristic (ROC) curve of SYNTAX score-II for the diagnosis of the no-reflow phenomenon.

There was no significant difference in terms of LVEF between the two groups (p = 0.10). TIMI frame count, SS-I, and SS-II were also significantly higher in the no-reflow group. Parameters that may be associated with SS-II are shown in Table 2. TIMI frame count, which is a quantitative method of assessing coronary artery flow, was significantly correlated with SS-II (p< 0.001) (Fig.1). Although the frequency of current smoker was higher in the reflow group than that of the no-reflow group (75.1% vs 48.1%, p< 0.001), smoking showed a protective effect on the no-reflow phenomenon in the univari-

Table 1 – Comparison of baseline characteristics of the patients with STEMI

Variable	No-reflow group (n = 54)	Reflow group (n = 201)	All (n = 255)	*p*-value
Demographic and clinical features				
Age (year)	60.0 (33.0–90.0)	53.0 (18.0–85.0)	55.0 (18.0–90.0)	**0.001**
Gender (male), n (%)	38 (70.3)	172 (85.5)	210 (82.3)	**0.009**
BMI (kg/m^2)	26.7 (19.0–36.5)	26.9 (11.6–44.2)	26.8 (11.6–44.2)	0.805
Current smoker, n (%)	26 (48.1)	151 (75.1)	177 (69.4)	**< 0.001**
Ejection fraction (%)	42.3±7.5	44.1±6.8	43.7±7.0	0.101
Comorbidities				
DM, n (%)	14 (25.9)	40 (19.9)	54 (21.1)	0.336
HT, n (%)	28 (51.9)	64 (31.8)	92 (36.0)	**0.007**
CAD, n (%)	2 (3.7)	11 (5.5)	13 (5.0)	1.000
HLP, n (%)	7 (13.0)	33 (16.4)	40 (15.6)	0.535
Family history, n (%)	23 (42.6)	90 (44.8)	113 (44.3)	0.774
PAD, n (%)	10 (18.5)	19 (9.5)	29 (11.4)	**0.062**
COPD, n (%)	12 (22.2)	28 (13.9)	40 (15.7)	0.137
Laboratory findings				
LDL (mg/dL)	131.0 (53.0–207.0)	129.0 (50.0–298.0)	133.5 (50.0–298.0)	0.857
HDL (mg/dL)	42.0 (23.0–74.0)	38.0 (17.0–86.0)	40.4(17.0–86.0)	**0.006**
Triglyceride (mg/dL)	105.0 (39.0–732.0)	126.0 (29.0–1296.0)	161.7 (29.0–1296.0)	0.277
Creatinine (mg/dL)	0.9 (0.4–8.2)	0.8 (0.3–2.3)	0.9 (0.3–8.2)	0.261
Uric acid (mg/dL)	5.2 (2.6–9.8)	5.3 (1.7–10.2)	5.4 (1.7–10.2)	0.789
GFR (ml/min/1.73 m^2)	100.4 (8.5–232.4)	115.6 (42.9–245.6)	112.4 (8.5–245.6)	**0.022**
CK-MB, on admission (U/L)	11.8 (0.7–300.0)	7.4 (0.3–300.0)	49.5 (0.3–300.0)	0.052
Troponin T, on admission (µg/L)	351.0 (3.0–10000.0)	104.2 (3.0–10000.0)	134.2 (3.0–10000)	**0.019**
Troponin T, peak (g/L)	6247.0 (271.4–10000.0)	4362.0 (28.9.0–10000.0)	5191.1 (28.9–10000)	**0.036**
NT-proBNP (pg/mL)	488.3 (18.7–9083.0)	139.6 (4.5–17200.0)	770.4 (4.5–17200.0)	**< 0.001**
Angiographic findings				
TIMI frame count	60.0 (26.0–130.0)	31.0 (10.0–49.0)	37.7 (10.0–130.0)	**< 0.001**
SYNTAX score-I	19.8±6.4	17.1±5.7	17.7±6.0	**0.008**
SYNTAX score-II	29.9 (10.5–60.2)	24.5 (10.5–52.2)	27.0 (10.5–60.2)	**< 0.001**

Data are presented as number and percentages (%), mean ± standard deviation or median (minimum–maximum); *p*-value was calculated using the Independent Samples t-test or the Mann–Whitney U-test for continuous variables and the Chi-Square test or the Fisher's exact test for categorical variables as appropriate; *p*-value < 0.05 was considered significant.
BMI – body mass index; CAD – coronary artery disease; CK-MB – creatine kinase myocardial band; COPD – chronic obstructive pulmonary disease; DM – diabetes mellitus; HDL – high-density lipoprotein; HLP – hyperlipidemia; HT – hypertension; GFR – glomerular filtration rate; LDL – low-density lipoprotein; NT-proBNP – N-terminal pro-brain natriuretic peptide; PAD – pulmonary artery disease.

Table 2 – Parameters significantly correlated with SYNTAX score-II

	r*	*p*
SYNTAX score-I	0.454	**< 0.001**
Body mass index, kg/m^2	–0.022	0.723
Low-density lipoprotein, mg/dL	–0.102	0.106
High-density lipoprotein, mg/dL	0.256	**< 0.001**
NT-proBNP, pg/mL	0.425	**< 0.001**
Troponin T, on admission, g/L	0.234	**< 0.001**
Troponin T, peak, g/L	0.349	**< 0.001**
TIMI frame count	0.359	**< 0.001**

*Spearman correlation. NT-proBNP – N-terminal pro-brain natriuretic peptide.

ate regression analysis (OR = 0.307, 95% CI: 0.165–0.573, *p*< 0.001). This effect, however, got lost after adjusting for confounding factors. A forward conditional multivariate logistic regression analysis was performed to determine predictors of no-reflow phenomenon in patients who underwent PPCI. SS-II (OR = 1.096, 95% CI: 1.058–1.135, *p*< 0.001) predicted the no-reflow phenomenon in the regression analysis (Table 3). ROC curve analysis was carried out to determine the possible cut-off value of SS-II for predicting the no-reflow phenomenon. A cut-off value of higher than 24.85 predicted no-reflow phenomenon, with 75.9 % sensitivity and 59.2 % specificity (AUC: 0.721 [0.637–0.805], 95% CI, *p*< 0.001) (Fig. 2).

Table 3 – Independent risk factors for no-reflow phenomenon

Variable	Univariate analysis		Multivariate analysis	
	OR (95 % CI)	*p*-value	OR (95 % CI)	*p*-value
DM	1.409 (0.699–2.838)	0.337	–	–
Current smoker	0.307 (0.165–0.573)	**< 0.001**	–	–
HT	2.305 (1.252–4.246)	**0.007**	–	–
HDL, mg/dL	1.033 (1.006–1.061)	**0.017**	–	–
NT-proBNP, pg/mL	1.000 (1.000–1.001)	**0.007**	–	–
Peak troponin T, g/L	1.000 (1.000–1.000)	**0.036**	–	–
SS-II	1.070 (1.035–1.105)	**< 0.001**	1.096 (1.058–1.135)	**< 0.001**

p-value < 0.05 was considered significant. Nagelkerke R2: 0.172, *p*< 0.001.
DM – diabetes mellitus; HT – hypertension; HDL – high-density lipoprotein; NT-proBNP – N-terminal pro-brain natriuretic peptide; SS-II – SYNTAX score-II.

Discussion

In the present study, the association of SS-II with no-reflow phenomenon was evaluated in patients with acute anterior myocardial infarction undergoing PPCI, and SS-II was demonstrated as a good predictor of no-reflow.

Current studies have demonstrated the relationship between anatomical SS (SS-I) and the no-reflow phenomenon.[21,22] The no-reflow phenomenon, which is a serious complication occurring after PPCI, is associated with poor prognosis.[23] In the literature, the incidence of no-reflow in acute myocardial infarction patients ranges from 2.3% to 32.8%.[21,24] Various mechanisms, distal embolism arising from intracoronary thrombus is one of the most prominent, play a role in the pathophysiology of the no-reflow phenomenon.[25] Also; inflammation,[26] platelet activation,[27] coronary microvascular spasm, and reperfusion injury[28] also can be presented as other causes of this phenomenon. The no-reflow phenomenon is more common in patients with "high SS-I" indicating the severity of coronary artery disease. This is thought to be caused by the fact that diffuse coronary artery disease is related to impaired microcirculation resistance, which affects epicardial blood flow.[29]

In the SYNTAX study: advanced age, female gender, COPD, renal failure and low LVEF, and peripheral artery disease were associated with mortality.[30] SS-II is calculated by adding certain clinical data to SS-I, which is the anatomical scoring obtained from angiographic images. Farooq et al. demonstrated the SS-II score was found to be more successful than SS-I in predicting 4-year mortality in patients with complex coronary artery disease.[9] In a study carried out by Askin et al. 126 STEMI patients who underwent PPCI, 44 of whom developed no-reflow phenomenon, were included in the study, and SS-II was significantly higher in the no-reflow group. SS-II and incomplete ST resolution strongly predicted the development of major cardiac events (MACE) in this study.[31] When compared with the present study, we included patients with acute anterior MI, a subgroup of STEMI, in our study and did not calculate the MACE index, but demonstrated that high SS-II with a higher number of patients than Askin et al. strongly predicted no-reflow phenomenon. In a study on STEMI patients conducted by Yesin et al.;[32] a total of 193 patients, including 42 patients with no-reflow, were enrolled. The study showed SS-II and LVEF were more effective and successful than SS-I in predicting no-reflow. Although we found no relationship between LVEF and no-reflow, we showed that SS-II predicted no-reflow, in line with his study.

An independent relationship of age with no-reflow has been demonstrated in some studies.[21,33] Diffuse coronary atherosclerosis, vascular calcification, distal embolization, and microcirculatory disorders, which increase in frequency with aging, play a role in the development of no-reflow. These pathophysiologies that contribute to the development of the no-reflow phenomenon could be, to a certain extent, attributed to neurohumoral and autonomic changes associated with aging and impaired collateral circulation.[34] In a study conducted by Liang et al.,[35] similar to our study, the no-reflow group was older than without the no-reflow group and there was an independent relationship between age and no-reflow.-

Conflicting results are available on the association of smoking with no-reflow. In the study carried out by Arbel et al., a strong relationship was found between smoking and the no-reflow phenomenon.[36] Otherwise, in the studies conducted by Hong et al.[37] and Shemirani et al.,[38] no significant relationship was found between no-reflow and smoking. Another study showed postprocedural thrombolysis in myocardial infarction (TIMI) flow grade, and TIMI frame were better in smokers.[39] In addition, Pepa et al. detected less no-reflow phenomenon in the smoker subgroup among STEMI patients undergoing PPCI.[40] Several investigators also demonstrated that smokers had higher reperfusion rates than non-smokers after fibrinolytic treatment.[39] These results may attribute to certain features of smokers such as healthier coronary artery risk profile, smaller plaque burden, and less extensive atherosclerotic disease.[41,42] In our study, the fact that the smoker group was younger than the non-smoker group may promote this mentioned physiopathology (appendix).

Appendix – Comparison of risk factors of the patients			
	Smoker (n = 177)	**Non-smoker (n = 78)**	***p*-value**
Age (year)	52.0 (18.0–80.0)	63.0 (34.0–90.0)	**< 0.001**
Gender (male), n (%)	140 (79.1)	43 (55.1)	**< 0.001**
DM, n (%)	31 (17.5)	23 (29.5)	**0.031**
HT, n (%)	53 (29.9)	39 (50.0)	**0.002**
CAD, n (%)	10 (5.6)	3 (3.8)	0.760
HLP, n (%)	26 (14.7)	14 (17.9)	0.510
PAD, n (%)	21 (17.5)	8 (11.5)	0.709
COPD, n (%)	31 (11.9)	9 (10.3)	0.227

CAD – coronary artery disease; COPD – chronic obstructive pulmonary disease; DM – diabetes mellitus; HLP – hyperlipidemia; HT – hypertension; PAD – pulmonary artery disease.

In summary; we consider that clinical data in SS-II may not only demonstrate coronary artery severity but also predict the no-reflow phenomenon, increasing susceptibility to coronary distal embolisms, thrombosis, and microvascular circulatory disorders. We, therefore, tried to reveal the relationship between SS-II and the no-reflow phenomenon based on this possible physiopathology.

Limitations

The main limitation of our study is a retrospective design, which may be a possible cause of bias. Second limitation: small sample size. Also, the fact that other components of the acute coronary syndrome were not included in the study and that STEMI was limited to only one subgroup, acute anterior myocardial infarction, prevent the generalizability of the results.

Conclusion

In the present study, we showed that SS-II, which is used to predict the complexity of coronary artery disease and prognosis, has also compelling evidence in predicting the no-reflow phenomenon, which is a notable and frequent complication of acute myocardial infarction. Multi-center, more comprehensive, and prospective studies are required to further clarify this relationship and underlying physiopathology.

Conflict of interest

The authors declare that they have no conflict of interest and no financial disclosures.

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