The Relationship Between PRECISE-DAPT Score and Spontaneous Reperfusion of Infarct-Related Artery in Patients with ST-Segment Elevation Myocardial Infarction

ST Segment Elevasyonlu Myokart Enfarktüsü Tanısı Alan Hastalarda PRECISE-DAPT Skoru ile Enfarkt-ilişkili Arterdeki Spontan Reperfüzyon Arasındaki İlişki

ABSTRACT

Objective: Spontaneous reperfusion (SR) presence and a low PREdicting bleeding Complications In patients undergoing Stent implantation and subsEquent Dual Anti Platelet Therapy (PRECISE-DAPT) score in patients with acute coronary syndrome have been associated with favorable clinical outcomes. This study aimed to investigate the relationship between SR and this score.

Methods: The study included 436 patients with ST-segment elevation myocardial infarction (STEMI) who underwent primary percutaneous coronary intervention (PCI). Thrombolysis in myocardial infarction (TIMI) III blood flow presence in the infarct-related artery (IRA) before primary percutaneous coronary intervention (PCI) was defined as SR. Patients were categorized into two groups based on the presence (n = 49) or absence (n = 387) of SR. The PRECISE-DAPT score was computed for each patient using the web-based calculator.

Results: The group with SR had a lower frequency of hyperlipidemia and a higher ejection fraction (EF) at admission. Conversely, the group without SR presented with higher values of glucose, troponin, creatine kinase-myocardial band (CK-MB), and PRECISE-DAPT score. The no-reflow phenomenon and elevated SYNergy between PCI with TAXUS and Cardiac Surgery (SYNTAX-I) scores were higher in the group without SR than in the one with SR. Multivariate regression analysis indicated that a high PRECISE-DAPT score was an independent predictor of the absence of SR (odds ratio: 0.96, *P* = 0.04).

Conclusion: The PRECISE-DAPT score is an independent predictor of the presence of spontaneous reperfusion in patients who experienced STEMI.

Keywords: PRECISE-DAPT score, spontaneous reperfusion, ST-segment elevation myocardial infarction, SYNTAX score, TIMI flow

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ÖZET

Amaç: Akut koroner sendrom tanısı alan hastalarda spontan reperfüzyonun (SR) varlığı ve düşük PREdicting bleeding Complications In patients undergoing Stent implantation and subsEquent Dual Anti Platelet Therapy (PRECISE-DAPT) skorunun iyi klinik sonuçlarla ilişkili olduğu gösterilmiştir. Bu çalışmada SR ile bu skor arasındaki ilişkinin araştırılması amaçlandı.

Yöntem: Bu çalışmaya ST yükselmeli myokart enfarktüsü (STYME) geçiren ve birincil perkütan koroner girişim (PKG) ile tedavi edilen 436 hasta dahil edildi. Birincil PKG yapılmadan önce infarkt ilişkili arterde TIMI III kan akımının olması SR olarak tanımlanmıştır. Hastalar SR olup olmamasına göre iki gruba ayrıldı. Hastaların PRECISE-DAPT skorları web tabanlı hesaplayıcı kullanarak hesaplandı.

Bulgular: SR olan grupta hiperlipidemi oranı düşük iken başvurudaki ejeksiyon fraksiyonu anlamlı olarak yüksek bulundu. Glukoz, troponin ve kreatinin kinaz myokardiyal band (CK-MB) değerleri ve PRECISE-DAPT skoru SR olmayan grupta anlamlı olarak yüksekti. No-reflow fenomeni sıklığı ve SYNTAX-I skoru SR olmayan grupta anlamlı olarak daha yüksek izlendi. Çok değişkenli regresyon analizinde yüksek PRECISE-DAPT skorunun SR yokluğu için bağımsız bir belirteç olduğu saptandı (odds ratio: 0,96, *P* = 0,04).

Sonuç: STYME geçiren hastalarda PRECISE-DAPT skoru SR yokluğu için bağımsız bir belirteçtir.

Anahtar Kelimeler: PRECISE-DAPT skoru, spontan reperfüzyon, ST yükselmeli myokart enfarktüsü, SYNTAX skoru, TIMI akımı

Turk Kardiyol Dern Ars 2023;51(8):537–542

Şeker et al. PRECISE–DAPT Score and Spontaneous Reperfusion

Restoration of early coronary blood flow in the infarct–related artery (IRA) for patients with ST-segment elevation myocardial infarction (STEMI) improves ventricular performance and reduces mortality.[1,2] The thrombolysis in myocardial infarction (TIMI) flow grading is a scoring method used to assess coronary blood flow. For patients with STEMI, the primary survival goal is achieving TIMI III flow after percutaneous coronary intervention (PCI). The primary determinant of TIMI III flow after PCI, correlating with favorable clinical outcomes, is the patency of the infarct-related artery before PCI. Spontaneous reperfusion (SR) is defined as the presence of TIMI III blood flow in the IRA before primary PCI. This phenomenon is associated with positive outcomes after percutaneous interventions and during short–term follow-ups.[3] SR incidence in the IRA is reported in up to 30% of patients.[3] Early administration of glycoprotein IIb/IIIa inhibitors before undergoing primary PCI has been linked to an increased SR incidence (approximately 40% in various studies).[4] Several factors, such as oxidative stress, diabetes mellitus, severity of coronary artery disease, thrombus burden, smoking, and age may influence the SR incidence.[5-9]

The PREdicting bleeding Complications In patients undergoing Stent implantation and subsEquent Dual Anti Platelet Therapy (PRECISE-DAPT) score was primarily devised to predict bleeding risks in patients in dual antiplatelet therapy after PCI.[10] The PRECISE-DAPT score's clinical components include age, white blood cell count, hemoglobin level, creatinine clearance, and bleeding history. Beyond estimating bleeding risks, recent studies indicate that this score also forecasts in-hospital and long-term mortality, contrast-related nephropathy, the no-reflow phenomenon, and arrhythmia onset in patients with acute coronary syndrome.[10-15] In this study, our objective was to investigate the relationship between SR and the PRECISE-DAPT score in STEMI patients.

Materials and Methods

Patient Group

A total of 436 consecutive patients, admitted to our hospital with a STEMI diagnosis and treated with primary PCI, were included in this observational and retrospective study. STEMI patients were diagnosed according to the current "universal definition of myocardial infarction" guideline.[16] We excluded patients with active infections, hematological or oncological diseases, severe liver failure, chronic renal failure requiring dialysis, inflammatory diseases, and those previously on anticoagulants and P2Y12 receptor inhibitors. The study design received approval from the Ethics Committee of Health Sciences University, Adana Training and Research Hospital (Approval Number: 1885-103, Date: 07.04.2022), and the research adhered to the Declaration of Helsinki.

All invasive procedures performed on the patients followed the current STEMI guidelines.[17] We recorded basal characteristics such as age, gender, smoking status, hypertension (HT), and diabetes mellitus (DM). Laboratory values and angiographic images were sourced from the hospital database. Peripheral venous blood samples were drawn from the antecubital vein upon admission. Blood counts were assessed using an autoanalyzer (Sysmex K-1000, Block Scientific, USA) within 5 minutes of sampling. We measured plasma levels of triglyceride, low-density lipoprotein, high-density lipoprotein, glucose, uric acid, and creatinine using an automated chemistry analyzer (Abbott Aeroset, USA) and commercially available kits (Abbott, USA). Creatinine clearance was determined using the Cockcroft and Gault equation. We calculated the PRECISE-DAPT score for each patient via a web-based calculator. Based on the TIMI flow prior to the PCI procedure, patients were divided into two groups: those with TIMI 0, I, and II flow were classified as the non-SR group, while those with TIMI III flow were placed in the SR group.

Coronary Angiography

All study participants underwent coronary angiography either through the femoral or radial approach using the Judkins technique. Prior to the coronary angiography, unless contraindicated, each patient received 300 mg of acetylsalicylic acid, a loading dose of the P2Y12 inhibitor (Ticagrelor), and a standard dose of unfractionated heparin (70-100 U/kg). All coronary angiographic images were stored digitally for subsequent quantitative analysis. TIMI flow grading, TIMI myocardial perfusion grading (TMPG), and coronary angiographies were evaluated by two cardiologists blinded to the patient details. If there was a disagreement, a third cardiologist was consulted. A final consensus was achieved after all three cardiologists agreed. The TIMI flow grade before PCI was determined and recorded separately for each patient. The no-reflow phenomenon was characterized as a TIMI flow of II or below at least 10 minutes after PCI or a TMPG grade of 0 or I, despite TIMI III flow, in the absence of coronary artery spasm and dissection. The SYNergy between PCI with TAXUS and Cardiac Surgery (SYNTAX) score was computed using an online calculator, factoring in various criteria like coronary artery diameters of at least 1.5 mm or greater, stenosis of 50% or more, total occlusion, bifurcation, lesion length, distal vascular bed, thrombus, and calcification. Spontaneous reperfusion was described as the presence of TIMI III blood flow in the IRA before the PCI procedure.

Statistical Analysis

The statistical analysis was conducted using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. SPSS Inc., Chicago, Illinois, United States). The distribution of normality was assessed using the Kolmogorov–Smirnov test. Continuous variables are presented as mean ± standard deviation, and

ABBREVIATIONS

CI	Confidence Interval
CK–MB	Creatine Kinase–Myocardial Band
DM	Diabetes Mellitus
EF	Ejection Fraction
HT	Hypertension
IRA	Infarct-Related Artery
PCI	Percutaneous Coronary Intervention
PRECISE-DAPT	PREdicting bleeding Complications In patients undergoing Stent implantation and subsEquent Dual Anti Platelet Therapy
SR	Spontaneous Reperfusion
STEMI	ST-Segment Elevation Myocardial Infarction
SYNTAX	The SYNergy between PCI with TAXUS and Cardiac Surgery
TIMI	Thrombolysis in Myocardial Infarction
TMPG	Myocardial Perfusion Grading

Şeker et al. PRECISE-DAPT Score and Spontaneous Reperfusion

Turk Kardiyol Dern Ars 2023;51(8):537–542

categorical variables are summarized as frequencies. Differences between the two groups, based on continuous variables, were determined using the independent samples t-test or the Mann–Whitney U test. Categorical variables were compared using the χ^2 test. Logistic regression analysis was employed to identify the effect of potential prognostic factors on non-SR. Independent predictors were identified by including significant risk factors in the logistic regression model. Parameters with a p-value <0.25 in the univariable analysis were considered for the multivariable analysis. A P-value of <0.05 was considered statistically significant.

Results

The baseline characteristics and laboratory findings of the SR and non-SR groups are presented in Table 1. In the non-SR group, the prevalence of hyperlipidemia was found to be high, and the ejection fraction (EF) upon admission was lower. The glucose, creatine kinase-myocardial band (CK-MB), and troponin levels were found to be higher in the non-SR group compared to the SR group. The angiographic and procedural characteristics of the patients from both groups are depicted in Table 2. The no-reflow phenomenon and a high SYNTAX score were observed more frequently in the non-SR group.

Differences in findings and risk factors between the groups were assessed using logistic regression analysis. According to the univariate analysis, hyperlipidemia, EF upon admission, glucose, triglyceride, CK-MB, and troponin levels, as well as the PRECISE-DAPT score, were identified as determinants of spontaneous reperfusion. Following the multivariate regression analysis, high triglyceride and troponin levels, along with a high PRECISE-DAPT score, were pinpointed as independent predictors of the absence of spontaneous reperfusion (for PRECISE-DAPT score, odds ratio: 0.96, $P = 0.04$). Independent markers for spontaneous reperfusion are outlined in Table 3.

Discussion

In our study, we demonstrated that IRA patency before primary PCI is independently linked to the PRECISE-DAPT score in patients with STEMI. Furthermore, a significant correlation between troponin and triglyceride levels with spontaneous reperfusion was observed. To the best of our knowledge, this is the first study in the literature highlighting the relationship between the PRECISE-DAPT score and spontaneous reperfusion in patients who have experienced STEMI.

The PRECISE-DAPT score is a new, easily applicable score that determined the optimal duration of dual anti-platelet therapy after a PCI procedure.[18] Furthermore, recent studies indicate that this score not only predicts the risk of bleeding but is also associated with complications such as arrhythmias, the no-reflow phenomenon, a high thrombus burden, the presence of multi-vessel disease, in-hospital mortality, and contrast-related nephropathy.[10-15] Parameters included in the PRECISE-DAPT score are age, bleeding history, hemoglobin level, white blood cell count, and creatinine clearance. When we individually evaluated the relationship of these parameters with spontaneous reperfusion, both older age and a higher white blood cell count were observed in patients without spontaneous reperfusion. In a study by Ando et al.[19], it was observed that the number of patients with TIMI III flow before the procedure was fewer in the group with contrast-related nephropathy, which indirectly related to creatinine clearance, although this was not statistically significant. Given that the PRECISE-DAPT score encompasses all these parameters, we posit that it can more strongly predict spontaneous reperfusion.

In a study by Cura et al.[20], it was demonstrated that having TIMI II or III flow upon a patient's admission, before the procedure, is one of the most important predictors of TIMI III flow after the PCI procedure. In another study, the PRECISE-DAPT score was found to be higher in the group with the no-reflow phenomenon.[14] Similarly, in our study, which included a larger patient cohort, we confirmed that the no-reflow phenomenon indicates post-PCI flow, and that SR serves as an indicator of pre-PCI flow. Additionally, the PRECISE-DAPT score was found to be higher in the patient group with a high thrombus burden, determined before stenting or ballooning.[21] Moreover, in Wang et al.'s[6] study, the thrombus burden was found to be higher in patients without SR, suggesting that the PRECISE-DAPT score may be associated with spontaneous reperfusion, as demonstrated in our study.

Spontaneous reperfusion is defined as the presence of TIMI III flow in the infarct-related artery before revascularization in patients with STEMI. Studies have shown that patients with SR exhibit a lower troponin value, a smaller myocardial infarction area, and better clinical outcomes compared to those without SR.[22,23] Wang et al.[6] elucidated the relationship between the troponin value and spontaneous reperfusion, and similarly, in our study, the troponin value was found to be lower in the patient group with spontaneous reperfusion. Therefore, these findings underscore that the infarct area will be smaller and post-myocardial infarction complications will be fewer in patients with SR.

In conclusion, a high PRECISE-DAPT score in patients with STEMI may indicate the absence of spontaneous reperfusion, which correlates with favorable clinical outcomes. A risk score like PRECISE-DAPT, which incurs no additional cost and can be easily calculated, could prove clinically advantageous. A high calculated score may identify patients at risk for complications and in-hospital mortality after STEMI. In light of the aforementioned findings, high-risk patients should be treated more intensively and monitored more closely to reduce both mortality and morbidity.

Limitations

The primary limitations of our study include its retrospective design and the small patient sample. Additionally, being a single-center study poses another limitation. While patients with consecutive STEMI were included in the study, we recognize the potential for selection bias. Another limitation is our reliance on a purely visual method to determine the presence or absence of SR. Therefore, using more advanced imaging techniques to assess SR may yield more reliable results. Furthermore, although our findings align with previous studies evaluating post-PCI flow characteristics, the results should be validated by larger, multi-center studies with more patients and a focus on pre-PCI flow characteristics.

Table 1. Baseline Characteristics and Laboratory Findings of the Patients

Variables	Spontaneous reperfusion group (n = 49)	Non–spontaneous reperfusion group (n = 387)	P
Baseline Characteristics			
Age (years)	55.4 ± 8.8	56.2 ± 11.0	0.643
Gender, (male), n (%)	44 (89.8)	306 (79.1)	0.075
BMI (kg/m^2)	26.7 (19.1–38.1)	26.5 (17.9–52.9)	0.704
Heart Rate (bpm)	76 (50–120)	78 (20–134)	0.476
SBP (mmHg)	130 (78–240)	125 (65–224)	0.608
DBP (mmHg)	79 (49–125)	78 (33–134)	0.971
HT, n (%)	20 (40.8)	148 (38.2)	0.727
DM, n (%)	8 (16.3)	96 (24.8)	0.189
HPL, n (%)	4 (8.2)	86 (22.2)	**0.022**
Current smoker, n (%)	36 (73.5)	275 (71.1)	0.725
Previous CAD, n (%)	2 (4.1)	7 (1.8)	0.268
Family history of CAD, n (%)	21 (42.9)	202 (52.2)	0.218
LV EF at admission (%)	53 (33–67)	51 (25–68)	**0.033**
Laboratory Findings			
Hemoglobin (g/dL)	14.0 (7.8–17.2)	13.9 (7.8–18.0)	0.705
Leukocyte count, X 10^3/uL	11.2 (4.9–23.4)	11.9 (4.4–37.4)	0.155
Platelet count, X 10^3/uL	211 (102–393)	214 (112–1084)	0.541
Glucose (mg/dL)	118 (72–355)	137 (59–615)	**0.004**
eGFR (mL/min per 1.73 m^2)	111.8 (49.6–141.0)	96.3 (22.0–140.0)	0.261
Uric acid (mg/dL)	4.9 (2.3–7.3)	5.4 (2.6–10.9)	0.145
Triglyceride (mg/dL)	78 (21–318)	99 (26–617)	0.054
Total cholesterol (mg/dL)	184.1 ± 43.7	190.9 ± 41.8	0.290
HDL cholesterol (mg/dL)	39 (19 –59)	39 (15–74)	0.669
LDL cholesterol (mg/dL)	123 (45–193)	128 (53–298)	0.553
Troponin T (pg/mL)	663.8 (4.1–10000.0)	1013.0 (4.7–10000.0)	**<0.001**
CK-MB (ng/ml)	16.0 (1.0–300.0)	48.0 (1.0–320.0)	**0.002**
Risk scores			
PRECISE-DAPT score	10 (3–46)	14 (3–50)	**0.001**
Killip Class, n (%)			
I	45 (91.8)	376 (97.2)	0.207
II	3 (6.1)	8 (2.1)	
III	1 (2.0)	2 (0.5)	
IV	0 (0.0)	1 (0.3)	
Medications			
Aspirin, n (%)	10 (20.4)	73 (18.9)	0.784
ACE-I/ARB use, n (%)	21 (42.9)	144 (37.2)	0.691
CC blocker use, n (%)	3 (6.1)	9 (2.3)	0.452
Beta-blocker use, n (%)	22 (44.9)	189 (48.8)	0.911
Statin use, n (%)	14 (28.6)	92 (23.8)	0.439

Data are presented as number (percentage), mean ± standard deviation or median (minimum–maximum).
ACE–I, Angiotensin-converting enzyme inhibitor; ARB, Angiotensin receptor blocker; BMI, Body mass index; CAD, Coronary artery disease; CC, Calcium channel; CK–MB, Creatine kinase–Myocardial band; DBP, Diastolic blood pressure; DM, Diabetes mellitus; eGFR, estimated glomerular filtration rate; HDL, High–density lipoprotein; HPL, Hyperlipidemia; HT, Hypertension; LDL, Low–density lipoprotein; LVEF, Left ventricular ejection fraction; PRECISE–DAPT, Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Antiplatelet Therapy; SBP, Systolic blood pressure; STEMI, ST-Elevation Myocardial Infarction.

Şeker et al. PRECISE-DAPT Score and Spontaneous Reperfusion

Turk Kardiyol Dern Ars 2023;51(8):537–542

Table 2. Angiographic and Procedural Characteristics of the Patients

Variables	Spontaneous reperfusion group (n = 49)	Non-spontaneous reperfusion group (n = 387)	P
Clinical presentation, n (%)			0.548
Acute inferior STEMI	14 (28.6)	95 (24.5)	
Acute posterior STEMI	1 (2.0)	8 (2.1)	
Acute infero-posterior STEMI	5 (10.2)	83 (21.4)	
Acute lateral STEMI	1 (2.0)	7 (1.8)	
Acute anterior STEMI	27 (55.1)	180 (46.5)	
Acute infero-lateral STEMI	1 (2.0)	14 (3.6)	
Mean door-to-balloon interval (min)	25.6±12.7	24.0±7.7	0.816
GP IIIb/IIa inhibitor use, n (%)	10 (20.4)	124 (32.0)	0.096
In-hospital mortality, n (%)	0 (0.0)	5 (1.3)	0.424
Arrhythmic complications, n (%)	7 (14.3)	61 (15.8)	0.924
Atrial fibrillation	2 (4.1)	17 (4.4)	
Ventricular tachycardia	3 (6.1)	26 (6.7)	
Ventricular fibrillation	1 (2.0)	9 (2.3)	
Heart block	1 (2.0)	7 (1.8)	
Junctional rhythm	0 (0.0)	10 (2.6)	
Acute stent thrombosis, n (%)	0 (0.0)	11 (2.8)	0.232
Acute stroke, n (%)	0 (0.0)	2 (0.5)	0.614
Culprit vessel, n (%)			0.471
Left main coronary artery	0 (0.0)	2 (0.5)	
Left anterior descending artery	26 (53.1)	182 (47.0)	
Left circumflex artery	7 (14.3)	43 (11.1)	
Right coronary artery	13 (26.5)	147 (38.0)	
Diagonal branch	2 (4.1)	4 (1.0)	
Obtuse marginal branch	1 (2.0)	8 (2.1)	
Intermediate artery	0 (0.0)	1 (0.3)	
No-reflow, n (%)	2 (4.1)	69 (17.8)	**0.014**
SYNTAX score I	8 (2-22)	14 (2-29)	**<0.001**

Data are presented as number and (percentage), mean ± standard deviation. STEMI, ST-Elevation Myocardial Infarction; SYNTAX, Synergy Between PCI With TAXUS ™ and Cardiac Surgery

Table 3. Univariate and Multivariate Analyses of Spontaneous Reperfusion

Variables	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Gender, (male), n (%)	2.329 (0.895-6.065)	0.083	–	–
HPL, n (%)	0.311 (0.109-0.889)	**0.029**	0.349 (0.120-1.016)	0.053
LVEF at admission (%)	1.036 (1.000-1.073)	**0.047**	–	–
Glucose (mg/dL)	0.995 (0.990-0.999)	**0.026**	–	–
Triglyceride (mg/dL)	0.996 (0.992-0.999)	**0.048**	0.995 (0.991-0.999)	**0.025**
Troponin T (pg/mL)	1.000 (1.000-1.000)	**0.006**	1.000 (1.000-1.000)	**0.005**
CK-MB (ng/ml)	0.995 (0.991-0.998)	**0.021**	–	**–**
PRECISE-DAPT score	0.956 (0.918-0.994)	**0.026**	0.958 (0.920-0.998)	**0.040**

P value < 0.05 was considered significant. CK-MB, Creatine kinase-Myocardial band; HPL, Hyperlipidemia; LVEF, Left ventricular ejection fraction; OR, Odds ratio; PRECISE-DAPT, Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Antiplatelet Therapy.

Conclusion

In our study, we demonstrated that the PRECISE–DAPT score is independently associated with SR in STEMI cases after primary PCI.

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