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Research Article

Factors affecting adequate myocardial perfusion in patients with acute st-elevation myocardial infarction with successful epicardial flow

Başarılı epikardal akım sağlanan akut st elevasyonlu miyokardiyal enfarktüslü hastalarda yeterli miyokardiyal perfüzyonu etkileyen faktörler

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Abstract

Aim: The aim of this study was to evaluate and compare multifarious parameters between complete and incomplete ST-segment resolution (STR) patients groups and to identify associates of STR in patients with acute ST-segment elevation myocardial infarction (STEMI) after successful primary percutaneous coronary intervention (pPCI).

Material and Methods: 888 consecutive patients were divided into two groups according to the STR <70% and ≥70% 60-90 min after pPCI. The cardiovascular risk factors and various angiographic parameters were assessed and compared between the groups.

Results: There were 346 patients with incomplete STR and 542 patients with complete STR. In multivariable regression analysis, culprit lesion (Left Anterior Descending artery) (Odd's Ratio (OR)=1.768; p=0.048), door-to-wire crossing time (OR=0.993; p=0.033), total procedure time (OR=0.994; p=<0.001) and glycoprotein 2b/3a inhibitor use (OR=2.135; p=0.013) were found to be independent risk factors for complete STR. The Area Under Curve of door-to-wiring and total procedure time for STR prediction was 0.668, 0.831, the cut-off value was 58, 52 min, and the sensitivity and specificity were 63.9%, 70.8%, and 63.1%, 76.8%.

Conclusion: Even if the successful flow is achieved at the end of pPCI, keeping the procedure time as short as possible and using glycoprotein 2b/3a are the factors that can increase perfusion at the myocyte level.

Keywords: ST-elevation myocardial infarction, TIMI-3 flow, ST elevation resolution, electrocardiography

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Öz

Amaç: Bu çalışmanın amacı, başarılı primer perkütan koroner girişimden (pPKG) sonra akut ST segment yükselmeli miyokard enfarktüslü (STEMI) hastalarda tam ve yetersiz ST segment rezolüsyonlu (STR) hasta grupları arasında çok yönlü parametreleri değerlendirmek ve karşılaştırmak ve STR ile ilişkili ilişkileri belirlemektir.

Gereç ve Yöntemler: 888 hasta çalışmaya dahil edildi, hastalar pPKG'den 60-90. Dakikada çekilen elektrokardiyografide STR <%70 ve ≥%70 olmak üzere iki gruba ayrıldı. Kardiyovasküler risk faktörleri ve çeşitli anjiyografik parametreler değerlendirildi ve gruplar arasında karşılaştırıldı.

Bulgular: Yetersiz STR'li 346 hasta ve tam STR'li 542 hasta vardı. Çok değişkenli regresyon analizinde sorumlu lezyonun LAD olması (OR=1.768; p=0,048), kapı-tel geçiş süresi (OR=0.993; p=0,033), toplam işlem süresi (OR=0.994; p=<0,001) ve glikoprotein 2b/3a inhibitörü kullanımı (OR=2,135; p=0,013) tam STR için bağımsız risk faktörleri olarak bulundu. Kapı-tel ve toplam işlem süresinin eğri altında kalan alanı 0.668, 0.831, cut-off değeri 58, 52 dakika ve duyarlılık ve özgüllük %63,9, %70,8 ve %63,1, %76,8 olarak belirlendi.

Sonuç: pPKG sonunda başarılı akım sağlansa bile işlem süresinin mümkün olduğunca kısa tutulması ve glikoprotein 2b/3a kullanılması miyosit düzeyinde perfüzyonu artırabilen faktörler olarak bulundu.

Anahtar Kelimeler: ST elevasyonlu miyokard enfarktüsü, TIMI-3 akım, ST elevasyon rezolüsyonu, elektrokardiyografi

Introduction

Over the past years, great endeavors have been made to improve the outcome of patients with acute ST-elevation myocardial infarction (STEMI). In STEMI, primary percutaneous coronary intervention (pPCI) is the cornerstone of therapy that reduces hospital mortality and long-term mortality.1 Rapid recanalization of infarct-related artery (IRA) with pPCI is associated with better cardiac performance and lower mortality.2 The success of pPCI can be established electrocardiographically (ECG) by measuring ST-segment resolution (STR) after the procedure and angiographically by evaluating Thrombolysis in Myocardial Infarction (TIMI) flow.3 Although revascularization therapy provides complete epicardial blood flow recovery in most STEMI patients sometimes its beneficial effects are not sufficient. Because epicardial blood flow does not necessarily mean adequate perfusion at the myocyte level, STR is considered a surrogate for reperfusion of cardiac myocytes4 because it reflects the physiology of the cardiac cells.5 Complete STR is defined by a drop ≥70% of the ST-segment elevation recorded after PCI.6

In studies on STR, some patients in the incomplete STR group consisted of patients with post-PCI TIMI flow 0-2. The prognosis is affected due to this situation and worse in this group, as expected, due to more procedural complications and comorbidities.5,7-9 There was a need for re-evaluation on this subject due to reasons such as expanded medical treatment options, shortening of the time to reach pPCI, new procedural techniques, and the quality of the materials used. Additionally, considering that these studies were performed in the first-generation drug-eluting stent (DES) and bare-metal stent (BMS) era, STR predictors in patients with the successful epicardial flow at the end of the procedure arouse curiosity. Our study aimed to evaluate and compare clinical parameters between complete STR and incomplete STR patients' groups in post-PCI normal epicardial flow and to identify clinical associates and their impact on STR.

Material and Methods

Study population

A total of 888 consecutive patients with acute STEMI who underwent PPCI from December 1, 2017, to August 31, 2020, were enrolled in the study in a high-volume tertial-level hospital. The necessary patient information was collected from files from the hospital archive. The inclusion criteria have collaborated diagnosis of STEMI 10 (typical chest pain lasting for more than 20 min and ST-segment elevation of ≥2 mm in men or ≥1.5 mm in women in V2-V3 leads and ≥1 mm in at least other two contiguous leads); symptoms of less than 12 h duration and persistent ST-segment elevation; eligibility for pPCI. The exclusion criteria were thrombolytic therapy; symptom onset more than 12 h; absence or doubtable culprit lesion; culprit lesion not crossable with guidewire; history of coronary artery disease; history of previous MI; paced rhythm; left bundle branch block and post-PCI TIMI flow <3.

Dual antiplatelet therapy (300 mg acetylsalicylic acid (ASA)+ 600 mg clopidogrel/180 mg ticagrelor) was given to all the patients, and they were anticoagulated with heparin infusion following the indication.

This study aimed to compare demographic and procedure-related characteristics of patients with and without complete ST-segment resolution after performing pPCI and to identify the variables associated with incomplet ST resolution. Cardiovascular disease risk factors (age, arterial hypertension, diabetes mellitus, dyslipidemia, smoking), sex, and door-to-wiring time were assessed and compared between complete and incomplete STR groups.

Electrocardiographic evaluation

The electrocardiographic analysis followed the prevalent normative guidelines, considering complete an ST-segment resolution ≥ 70%. 11 Technically adequate 12-lead ECGs before and 60-90 min after pPCI was finished were registered using a speed of 25 mm/s and amplitude of 10 mm/mV. ST-segment resolution in ECG was assessed based on ST-segment regression percentage on 60-90th minute ECG, and 70% and above ST resolution was concluded as successful reperfusion. The elevation of the ST segment was measured at the J point in mm. The arithmetic mean of ST-segment elevation was calculated for anterior STEMI from V1-V6 leads and inferior STEMI from II, III, and aVF leads.

Angiographic evaluation

Coronary angiography was routinely performed through the femoral and radial approach using Judkins catheters (Philips DCI-SX Integris Monoplane system). pPCI was applied to the culprit's vessel in all patients. Patients who underwent pPCI were treated with direct stenting if possible; otherwise, stent implantation was done after balloon angioplasty. Angiograms were recorded at 15 frames/s. The calculated value was doubled to reach the standardized 30 frames/second. The TIMI flow grade was assessed previously at the TIMI Angiographic Core Laboratory.12 Frame counts were determined by the method described previously by Gibson et al13 Left anterior descending artery (LAD) measurements were divided by 1.7 and used as corrected TIMI frame count (TFC). TFC of those with an before the procedure TFG >0 was calculated. The GpIIb-IIIa inhibitor [tirofiban (Aggrastat) 12.5 mg/50 mL; DSM Pharmaceuticals, Greenville, North Carolina] was applied as recommended by ad-hoc guidelines according to the operator's decision based on the coronary angiography result. The total processing time was obtained by calculating the time between the first cine recording and the last recording, which is the time after the removal of the guidewire and no no-reflow detected after that. Door-wiring time was calculated as the time between the patient's admission to the emergency department and the time the wire passed through the lesion angiographically. The American College of Cardiology (ACC) and the American Heart Association (AHA) classification was used to evaluate the morphology of coronary stenotic lesions.14

The study was conducted in accordance with the protocol, the Declaration of Helsinki revised in 2013, and applicable local requirements. İnformed consent was not obnained from the patients because of retrospective nature.

Statistical analysis

Statistical analyses were performed using SPSS software for Windows 20 (IBM SPSS Inc., Chicago, IL). The distributional properties of the variables were assessed using the Shapiro–Wilk test. Student t-test was used to analyze the normally distributed variables expressed as mean ± standard deviation. Mann–Whitney U test was used for non-normally distributed variables expressed as median (interquartile range). The parameters that may be clinically related to STR were first evaluated by univariable regression analysis. Then, a multivariable regression analysis including the variables with a p-value ≤0.05 at univariate analysis was performed. A receiver operating characteristic (ROC) curve was generated, and the area under the curve (AUC) was calculated to assess diagnostic value. ROC curve plots the true-positive rate (sensitivity) against the false-positive rate (1- specificity) for all possible cut-off values (Youden's index). AUC and %CI for variables in the ROC analysis are indicated as 1- for easier understanding. P values 2-sided <0.05 were considered statistically significant.

Results

Eight hundred eighty-eight patients were divided into two groups according to STR ≥70% (542, 61.0%) or STR <70% (346, 39.0%). The mean age (57.1 ±12.2 vs. 60.1 ± 12.9; p =0.037), heart rate (77.5 ±16.3vs. 76.6 ± 15.8; p=0.611), loading dose of ticagrelor (66.8% vs. 67.6%; p=0.795) and Diabetes mellitus (DM) (28.0% vs. 26.6%; p = 0.757) were higher in patients STR ≥70% compared to <70%. Body-mass index (BMI), (27.3 ± 4.1 vs. 28.1 ± 4.5; p=0.02), rates of HT (232 (42.8%) vs. 178 (51.4%); p=0.067) and interventricle septum (IVS), mm (1.07 ± 0.14 vs. 1.23 ± 0.20; p= <0.001) was higher in STR <70% group. Table 1 summarizes the patients' baseline characteristics.

Table 1. Baseline characteristics of the patients.				
	All patients n = 888	STR > 70% n = 542	STR < 70% n = 346	P value
Age, mean ± SD	58.1 ± 12.5	57.1 ±12.2	60.1 ± 12.9	0.037
Gender (Male), n(%)	666 (75.0%)	400 (73.8%)	266 (76.9%)	0.465
Smoking, n (%)	514 (57.9%)	326 (60.1%)	188 (54.3%)	0.191
BMI (kg/m^2), mean ± SD	27.2 ±4.4	27.3 ± 4.1	28.1 ± 4.5	0.020
Loading P2Y12 therapy (Ticagrelor)	596 (67.1%)	362 (66.8%)	234 (67.6%)	0.795
Previous ASA exposure, n(%)	73 (8.2%)	49 (9.0%)	24 (6.9%)	0.057
WBC (109/L) , mean ± SD	7.96±2.13	8.18±2.91	7.73±1.27	0.142
Neutrophil (K/ul), median (IQR)	5.2 (3.6-7.5)	5.3 (3.7-7.3)	5.1 (3.6-7.5)	0.097
Hemoglobin (g/dL), mean ± SD	14.9 (13.4-16.1)	14.6 ± 2.0	14.6 ± 1.8	0.958
Platelet (K/ul), median (IQR)	253 (210-298)	257 (214-300)	251 (208-291)	0.466
Creatinine (mg/dL), median (IQR)	1.02 (0.91-1.18)	1.03 (0.92-1.18)	1.01 (0.90-1.19)	0.282
Sodium (mmol/L), median (IQR)	137 (136-138)	137 (135-138)	137 (135-139)	0.398
Potassium (mmol/L), median (IQR)	4.02 (3.75-4.31)	4.04 (3.80-4.29)	4.01 (3.75-4.34)	0.474
Troponin (ng/mL), median (IQR)	25.2 (6.8-75.2)	23.2 (6.5-66.3)	28.7 (7.1-93.8)	0.204
LDL (mg/dL), mean ± SD	131 ± 34.7	131.4 ± 34.9	131.7 ±33.1	0.781
HbA1c, mean ± SD	6.8 ± 1.9	6.7 ± 1.7	6.9 ± 2.1	0.147
TSH (mIU/L), mean ± SD	1.70 ±2.55	1.80 ± 3.14	1.56 ± 1.23	0.456
Glucose (mg/dL), median (IQR)	126 (103-165)	125 (103-160)	131 (101-176)	0.281
ALT (U/L), median (IQR)	40 (23-78)	43 (24-82)	37 (23-76)	0.956
Heart rate (bpm), mean ± SD	77.4 ± 16.4	77.5 ±16.3	76.6 ± 15.8	0.611
Diabetes Mellitus, n(%)	244 (27.5%)	152 (28%)	92 (26.6%)	0.757
Hypertension, n(%)	410 (46.2%)	232 (42.8%)	178 (51.4%)	0.067
COPD, n(%)	106 (11.9%)	56 (11.4%)	50 (14.4%)	0.585
LVEF (%), mean ± SD	45.4 ± 9.0	46.1 ± 8.1	44.4 ± 8.9	0.047
IVS (cm), mean ± SD	1.15 ± 0.19	1.07 ± 0.14	1.23 ± 0.20	<0.001
SBP (mmHg), median (IQR)	130 (112-149)	130 (111-147)	130 (114-150)	0.326
DBP (mmHg), median (IQR)	80 (70-90)	79.5 (71-89)	80 (70-90)	0.542
The data without normal distribution is presented as median (interquartile range-IQR). COPD: Chronic obstructive pulmonary disease ALT: Alanine Transaminase IVS: Interventricular-septum ASA: Acetylsalicylic acid				

Compared with patients with STR <70%, those with complete STR were wider stent diameter (3 (2.25-4.5) vs. 3 (2.0-4.0); p = 0.022), more use of glycoprotein 2b/3a (231 (42.6%) vs. 101 (29.2%); p = <0.001), shorter duration of the door-to-wiring time (51 (20-216) vs. 66 (16-197); p= <0.001) and total procedure time (40 (18-90) vs. 56 (29-118); p = <0.001), were less likely to have an anterior myocardial infarction (206 (38.0%) vs. 172 (49.7%); p =0.005). Initial TIMI flow grade, TIMI frame count, and final TIMI frame count did not significantly differ between the two groups (0.877, 0.732, and 0.799, respectively). There were no significant differences between the two groups in regard to the number of stents, stent length, post-dilatation, thrombus aspiration, and stent type. Angiographic parameters are shown in Table 2.

In the univariate analysis, increase in age (OR=0.983; p=0.038), BMI (OR=0.942; p=0.021), culprit lesion (LAD) (OR=1.258; p<0,001), stent diameter (OR=1.323; p=0.023), IVS diameter (OR=0.522 ; p<0,001), door-to-wire crossing time (OR=0.998; p=<0.001), total process time (OR=0.996; p=<0.001), glycoprotein 2b/3a inhibitor use (OR=1.803; p=<0.001) and LVEF (OR=1.016; p=0.048) were determined as possible risk factors for STR ≥%70. In the multivariable regression model, in which possible risk factors were included culprit lesion (LAD) (OR=1.768; p=0.048), door-to-wire crossing time (OR=0.993; p=0.033), total process time (OR=0.994; p=<0.001) and glycoprotein 2b/3a inhibitor use (OR=2.135; p=0.013) levels were found to be independent risk factors for complete STR. (-2 Log-Likelihood: 302,681 Nagelkerke R2:0.55) (Table-3)

Table 2. Angiographic characteristics of patients				
	All patients n =888	STR > 70% n = 542	STR < 70% n = 346	P value
Culprit lesion location, n(%)				
Left anterior desending	378 (42.6%)	206 (38.0%)	172 (49.7%)	0.005
Left circumflex	140 (15.9%)	88 (16.2%)	52 (15.0%)	
Right coronary artery	344 (38.7%)	236 (43.5%)	108 (31.2%)	
Diagonal	20 (2.3%)	10 (1.8%)	10 (2.9%)	
Other	6 (0.7%)	2 (0.4%)	4 (1.2%)	
Characteristics of lesion				
Type A	472 (53.1%)	313 (57.7%)	159 (45.9%)	0.003
Type B	283 (31.8%)	167 (30.8%)	116 (33.5%)	
Type C	133 (14.9%)	62 (11.4%)	71 (20.5%)	
No stent, n(%)	54 (6.1%)	40 (7.4%)	14 (4.0%)	0.189
1, n(%)	636 (71.6%)	386 (71.2%)	250 (72.3%)	
2, n(%)	168 (18.9%)	98 (18.1%)	70 (20.2%)	
3+, n(%)	30 (3.4%)	18 (3.3%)	12 (3.5%)	
Stent diamater, median (min-max)	3 (2.0-4.5)	3 (2.25-4.5)	3 (2.0-4.0)	0.022
Stent length, median (min-max)	24 (8-104)	24 (8-82)	25 (12-104)	0.065
Post-dilatation, n(%)	320 (36.0%)	194 (35.8%)	126 (36.4%)	0.850
Manual thrombus aspiration, n (%)	88 (9.9%)	58 (10.7%)	30 (8.7%)	0.323
Glycoprotein IIb/IIIa inhibitor, n (%)	332 (37.4%)	231 (42.6%)	101 (29.2%)	<0.001
Initial TIMI flow grade, n(%)				
0	564 (63.5%)	342 (63.1%)	222 (64.2%)	0.877
1	78 (8.8%)	48 (8.9%)	30 (%8.7)	
2	160 (18.0%)	106 (19.6%)	54 (15.6%)	
3	86 (9.7%)	46 (8.5%)	40 (11.6%)	
Stent type				
Paclitaxel-eluting	129 (15.5%)	74 (13.8%)	55 (18.1%)	0.062
Zotaralimus-eluting	705 (84.5%)	433 (86.2%)	272 (81.9%)	
Access site, n(%)				
Radial artery, n(%)	73 (8.2%)	46 (8.4%)	27 (7.8%)	0.168
Femoral artery, n(%)	815 (91.8%)	498 (91.6%)	317 (92.2%)	
Symptom to wire crossing time (minutes), median (IQR)	125(103-165)	121(103-160)	130(104-168)	<0.001
Door-to-wire crossing time (minutes), median (min-max)	56 (16-216)	51 (20-216)	66 (16-197)	<0.001
Total processing time (minutes), median (min-max)	48 (18-118)	40 (18-90)	56 (29-118)	<0.001
Initial TIMI frame count, median (min-max)	42 (18-96)	43 (18-90)	39 (20-96)	0.732
Final TIMI frame count, median (min-max)	26 (14-79)	26 (14-79)	26 (14-49)	0.799
The data without normal distribution is presented as median (interquartile range-IQR). TIMI = Thrombolysis in Myocardial Infarction				

Table 3. Univariate and multivariate analysis for prediction of STR				
Variables	Univariate analysis		Multivariate analysis	
	OR (95 CI%)	P value	OR (95% CI)	P value
Age	0.983 (0.961-0.998)	0.038	0.984 (0.960-1.011)	0.138
Body-Mass Index	0.942 (0.902-0.997)	0.021	0.987 (0.921-1.054)	0.728
Interventricle septum diamater	0.522 (0.022-0.854)	<0.001	0.140 (0.022-1.101)	0.062
Culprit lesion (for LAD)	1.258 (1.221-1.279)	<0.001	1.768 (1.007-3.106)	0.048
Stent diamater	1.323 (1.041-1.691)	0.023	1.363 (0.814-2.260)	0.237
Door-to-wire crossing time	0.998 (0.997-0.999)	<0.001	0.993 (0.987-0.997)	0.033
Total procedure time	0.996 (0.992-0.999)	<0.001	0.994 (0.990-0.999)	<0.001
Glikoprotein 2b/3a inhibitor use	1.803 (1.352-2.406)	<0.001	2.135 (1.170-3.894)	0.013
Left Ventricle Ejection Fraction	1.016 (1.002-1.035)	0.048	1.003 (0.975-1.042)	0.635

We used ROC analysis to examine the ability of door-to-wiring and total procedure time to discriminate STR. The AUC of door-to-wiring time for STR prediction was 0.668 (95% CI = 0.632-0.704; p < 0.001), the cut-off value was 58 min, the sensitivity and specificity were 63.9%, and 63.1%. The AUC values were 0.831 (95% CI = 0.804-0.859; p < 0.001), the sensitivity and specificity were 70.8% and 76.8% for total procedure time, and the cutoff value was 52 min. (Figure-1)

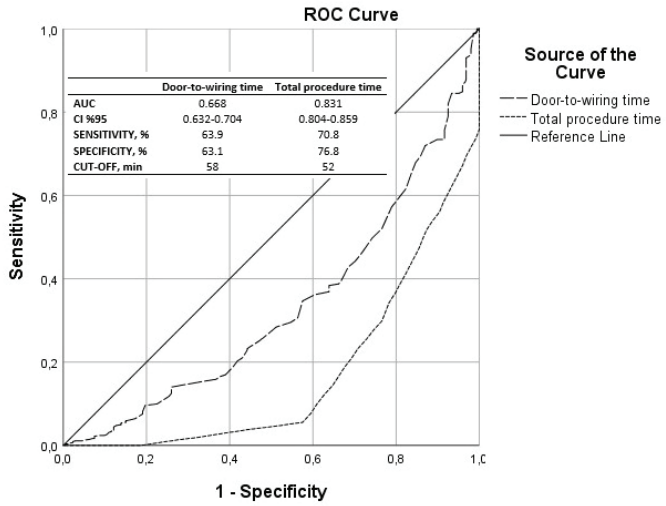

Figure 1. ROC analysis examines the door-to-wiring ability and total procedure time to discriminate STR. AUC: area under the curve, CI: confidence interval

Discussion

In this study, we tried to determine the factors affecting the ST-elevation resolution after successful revascularization. As far as we know, this is the first study on this subject. As a result of this study, we determined that short door-wiring time, short procedure time, use of glycoprotein 2b/3a in the procedure, and culprit lesion location (LAD) were predictors for STR.

The fact that the end-of-procedure flow has not been fully provided, as expected, is a more important reason than other factors because it will affect the myocardial blood supply. This study was planned because the main issue is determining the factors affecting the STR despite the successful flow. Measuring STR after pPCI is one of the most convenient methods of assessing microvascular injury. Microvascular damage can be structural due to myocardium necrosis or functional due to increased restriction of the microvascular region, edema, endothelial dysfunction, or obstruction with platelets or neutrophils. 15 Also, the PCI itself can cause microvascular obstruction with plaque debris or thrombus particles.16 The development of drugs and treatment regimens that can improve blood flow before PCI is crucial to reducing microvascular injury in STEMI patients.5 Early restorations of coronary blood flow are gained by the dissolution of clots, which can be promoted by drugs such as aspirin, other adenosine diphosphate receptor inhibitors (ADP), and heparin. Especially, new generation anti-aggregates play an active role due to more potent platelet inhibition. However, ticagrelor do not affect STR at the end of the pPCI, as in the subgroup analysis of the PLATO study.17 Probably because the onset effect of the ticagrelor is between 30 minutes and 2 hours, the procedure often ends until the effect begins. However, ticagrelor's long-term effects are likely superior to clopidogrel, especially in patients with TFG <3. Previous studies have provided evidence of the beneficial effect of GP IIb/IIIa inhibition in acute coronary syndromes.18,19 In the Platelet Receptor Inhibition for Ischemic Syndrome Management in Patients Limited by Unstable Signs and Symptoms (PRISM-PLUS) trial, tirofiban was shown to reduce intracoronary thrombus.20 These studies demonstrate that GP IIb/IIIa inhibition is valuable in maintaining microvascular perfusion and associated with ST-segment resolution.

One of the results in the study in patients with anterior MI had lower STR compared with non. The likely mechanism is that the affected area is more extensive in patients with anterior MI. This finding is concordant with other studies.6,15

The prevalence of hypertension was a prominent finding in STR <70% of patients. Parallel to this finding, the thickness of the IVS was more remarkable. Additionally, IVS was also an independent prognostic factor for an incomplete STR. These results support the possibility that microvascular dysfunction is common in patients with hypertension and that ST-segment recovery is less measured in hypertensive patients with left ventricular hypertrophy. 5

Optical coherence tomography detected a smaller thrombus volume in the culprit lesion in patients with the acute coronary syndrome who took aspirin before their first presentation compared to those who did not use aspirin before.21 In addition to the effects of secondary prevention, antiplatelet therapy may improve coronary reperfusion and clinical outcomes.22 In our study, the rate of aspirin users before the procedure was higher in the complete STR group, but it did not reach statistical significance.

Lesion complexity is one of the most critical determinants of procedural success and survival in patients undergoing pPCI.23 In particular, the type of vessel (according to the criteria of

lesion length, calcification, tortuosity, angled segments, and major side branches to be protected) expressed as a type C lesion according to the ACC lesion classification system causes the intensive use of pre dilatation and post-dilation, the need for extra support material and the possibility of bifurcation of the procedure and prolongation of the procedure time. It is one of the most important parameters affecting adequate flow at epicardial and myocardial levels since the risk of developing no-reflow during the procedure is high in patients with vessels with this feature. In our study group, the most remarkable proportional difference between the groups was observed in patients with type C lesions.

Over the years, stent technology has come a long way. Significant advantages have been achieved with new-generation DESs. Late and very late stent micro and macro thrombosis (ST) is more common in BMS compared to first-generation DES. Also, this stent group is associated with incomplete strut reendothelialization, polymer-induced chronic inflammation, hypersensitivity reaction, stent malapposition, and accelerated neoatherosclerosis.24,25 The probability of successful myocardial blood supply at the end of the procedure increases due to more potent antiaggregant therapies, shorter transportation times to PCI centers, and increased operator experience in the new generation stents era. Stent length and multiple stent treatments may not be as related to damage to the microvascular area as before due to the factors mentioned.

Early intervention and the use of potent agents are closely associated with STR. The most critical point of the study is that the shorter duration of the PCI time provides more effective angiographic and electrocardiographic results. This data should be supplemented with symptom-balloon time. Durmaz et al. found that even if no reflow developed, a short ischemic time was significantly associated with its reversibility.26 The prolongation of the procedure may be associated with complications, complex intervention during the process, or the desire to achieve the best angiographic image. Sometimes the effort to search for the best can result in problems because of deceleration of the heparin effect due to prolonged processing time, endothelial damage and microthrombuses due to further material transport, and excessive post-dilatation. According to an interesting study on this subject, an increase in peak cardiac troponin levels was detected when balloon occlusion in the coronary arteries lasted for 30 seconds or more, and thus cardiac ischemia was detected.27. Moreover, Reidar Winter et al. showed that catheter and balloon induced ischemia using automated frame-to-frame tracking of gray-scale speckle pattern and subsequent 2D quantification of myocardial motions.28 Our findings support keeping the procedure time short in patients with acute MI unless strictly necessary. According to SINCERE database results, procedure time is one of the important parameters in terms of long-term prognosis.29

Our study has some limitations. Firstly this study was designed as a retrospective. It is a study investigating the short-term effects of the factors affecting STR and does not show long-term results. Myocardial blush grade calculation was not made. There are also possibly operator-related factors affecting STR, but they could not be categorized.

Conclusion

Even if TIMI-3 flow is achieved in patients after PCI, it is important to keep the procedure time as short as possible and increase the use of glycoprotein 2b/3a to ensure adequate perfusion at the myocardial level.

Conflict of interest

All authors declare that they do not have any conflicts of interest.

Disclosure Statement

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