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Residual SYNTAX score can predict short- and long-term outcomes in patients with STEMI

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Klíčová slova:
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Reziduální SYNTAX skóre

SOUHRN

Cíle: Prognostická hodnota reziduálního SYNTAX skóre (rSS) byla popsána u různých pacientských populací, tato jeho hodnota však nebyla zjišťována u pacientů s infarktem myokardu s elevacemi úseku ST (STEMI) léčených primární perkutánní koronární intervencí (PCI).
Metody: Do studie bylo zařazeno celkem 208 pacientů splňujících kritéria vhodnosti k zařazení. Kompletní revaskularizace (CR) byla definována jako rSS = 0 a inkompletní revaskularizace (IR) jako rSS s hodnotou ≥ 1.
Výsledky: Z našeho vzorku pacientů jich bylo 78 (33,3 %) zařazeno do skupiny CR a 130 (67,7 %) do skupiny IR. Jeden pacient (1,3 %) ve skupině CR a osm pacientů (6,2 %) ve skupině IR zemřelo do 30 dnů od zařazení ($p < 0,01$). Incidence trombózy stentu, recidivy infarktu myokardu (IM) a revaskularizace cílové léze (target lesion revascularisation, TLR) byla v obou skupinách podobná. Během sledování (o průměrné délce 28,8 ± 7,1 měsíce) zemřeli dva pacienti (2,6 %) ze skupiny CR a deset pacientů (7,7 %) ze skupiny IR ($p > 0,05$). Incidence recidivy IM (18,5 % vs. 7,7 %; $p < 0,01$) a závažných nežádoucích kardiovaskulárních příhod (major adverse cardiovascular events, MACE) (24,6 % vs. 7,7 %; $p < 0,01$) byla statisticky významně vyšší ve skupině IR.
Závěr: Parametr rSS jako nepřímý ukazatel nekompletní revaskularizace nezávisle koreloval s incidencí recidivy IM a MACE po STEMI.

Keywords:
Incomplete revascularisation
Primary percutaneous coronary intervention
Residual SYNTAX score
ST-elevation myocardial infarction

ABSTRACT

Objectives: The prognostic value of residual SYNTAX score (rSS) has been observed in different patient groups. However, its prognostic value has not been compared in patients with ST segment elevation myocardial infarction (STEMI) treated with primary percutaneous coronary intervention (PCI).
Methods: A total of 208 patients meeting the eligibility criteria were included in the study. Complete revascularisation (CR) was defined as rSS = 0 and incomplete revascularisation (IR) was defined as rSS ≥ 1.
Results: Among the sample, 78 patients (33.3%) were included in the CR group and 130 patients (67.7%) in the IR group. One patient (1.3%) in the CR group and 8 patients (6.2%) in the IR group died by day 30 ($p < 0.01$). The incidence of stent thrombosis, recurrent myocardial infarction (MI) and target lesion revascularisation (TLR) was similar between the two groups. During follow-up (mean 28.8 ± 7.1 months), 2 patients (2.6%) from the CR group and 10 (7.7%) patients from the IR group died ($p > 0.05$). The incidence of recurrent MI (18.5% vs. 7.7%; $p < 0.01$) and major adverse cardiovascular events (MACE) (24.6% vs. 7.7%; $p < 0.01$) were significantly higher in the IR group.
Conclusion: rSS, which is an indirect marker of incomplete revascularisation, was independently correlated with recurrent MI and MACE after STEMI.

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Introduction

Despite significant improvements in the diagnosis and treatment of ST segment elevation myocardial infarction (STEMI), it continues to be the most important public health problem especially in developing countries. With the development and widespread adoption of primary angioplasty (PCI), major advancements have been made in the management of acute myocardial infarction [1]. However, incomplete revascularisation (IR) is a major problem that may lead to worse outcomes after PCI [2–4]. IR has no universally accepted definition. Post-PCI residual coronary stenosis severity, extent and nature may have different effects on outcomes. The SYNergy between PCI with TAXUS and Cardiac Surgery (SYNTAX) scoring system may show the severity of the coronary anatomy before revascularisation based on a quantitative and reproducible measurement [5–9]. Different scoring systems have been created with a combination of clinical variables and angiographic, electrocardiographic and demographic data [10]. In patients undergoing PCI with a diagnosis of STEMI, these scoring systems have been reported to predict outcomes. Our study aimed to investigate the relation between residual Syntax score (rSS) and short- and long-term outcomes in STEMI patients treated with primary PCI.

Material and methods

Patients who were diagnosed with STEMI between April 2011 and October 2014 at Sakarya University Education and Research Hospital were retrospectively recruited to the study.

Inclusion criteria were ST elevation ≥1 mm in ≥2 adjacent leads or new onset of left bundle branch block on electrocardiography (ECG), onset of chest pain <12 h and/or patients with chest pain or ongoing symptoms despite 12–24 h period of time, and patients who underwent emergency coronary angiography with primary PCI. Patients with previous coronary artery bypass graft (CABG) surgery or proposed to undergo urgent CABG after primary PCI, with cardiogenic shock and with failed thrombolytic therapy and applied rescue PCI were excluded from the study.

The study protocol was approved by the local ethics committee.

Evaluation of the patient data

Clinical risk factors, such as age, sex, diabetes mellitus (DM), hypertension (HT), hypercholesterolemia, current smoking, history of myocardial infarction (MI) and history of PCI were evaluated. History of out-hospital cardiac arrest, Killip classification, arrival pulse rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), height, weight, body mass index and creatinine clearance (CrCL) values were processed. CrCL was calculated from the Cockcroft–Gault formula.

Definitions

HT was defined as resting SBP or DBP of at least 140/90 mmHg or the presence of diagnosed disease by clinician. DM was defined as the use of antidiabetic drugs and fasting blood glucose level > 126mg/dl. Renal failure was defined as creatinine clearance <60 ml/min according to the Cockcroft–Gault formula. Multivessel disease was defined as the presence of more than 50% stenosis on two or three major epicardial coronary arteries. Acute stent thrombosis was defined as the abrupt onset of cardiac symptoms with elevated cardiac biomarker levels or ECG evidence of myocardial injury after stent deployment in the first 24 h accompanied by angiographic evidence of a flow-limiting thrombus 5 mm adjacent to a previously placed stent. Cardiac death was defined as unexplained sudden death or death due to acute MI, heart failure and cardiac arrhythmias. Cardiogenic shock was defined as the presence of symptoms of hypoperfusion associated with marked and resistant hypotension (SBP < 80 mmHg) for longer than 30 min because of left ventricular dysfunction, right ventricular infarction, or mechanical complications. Reinfarction was defined as rising serum CK-MB enzyme levels more than twice the upper limit of the normal and re-elevation of ST segment on ECG.

Target lesion revascularisation (TLR) was defined as the revascularisation of the stented segment or within the 5 mm margins proximal or distal to the stent by either repeat PCI or CABG.

Follow-up information was obtained through a review of hospital records and telephone contact with the patient or the patient's relatives. All subsequent hospital admissions (for angina, recurrent infarction and additional intervention) during follow-ups were recorded. TLR not related to thrombosis-related events were assumed to be 'restenosis related'. Major adverse cardiac events (MACE) were defined as cardiovascular mortality, reinfarction and TLR (percutaneous or surgical). CR was defined as a successful operation in whole major epicardial coronary artery lesions (provided that stenosis ≥50% and diameter ≥2.5 mm) with PCI during hospitalisation and in the first four weeks.

Angiographic parameters and definitions

Coronary angiography was performed using the standard Judkins technique via the femoral artery on catheter laboratory of Sakarya University Education and Research Hospital Cardiology Department. Coronary angiography and PCI was performed by 4 experienced interventional cardiologists (>75 cases per year). All patients were given 300 mg chewable acetylsalicylic acid and 600 mg loading dose of clopidogrel before procedure. The degree of occlusion on IRA was evaluated according to the TIMI classification. After identifying coronary anatomy, heparin 100 U/kg was given. For each procedure success was defined as TIMI grade 3 flow or residual stenosis less than 20% on IRA. During the process, stent usage, selection of stent type, stent diameter/length, predilatation or postdilatation implementation, use of suction catheter and tirofiban were left to the discretion of the operator. Lesion characteristics on IRA or other epicardial coronary arteries that could affect the success rate, such as serious calcification, chronic total occlusion, bifurcation/trifurcation, ostial lesion, lesion length > 20 mm, presence of thrombus, aneurysm and ectasia, were evaluated. For STEMI patients with multivessel disease who underwent primary PCI of the IRA, we adopted a conservative approach to the remaining coronary arteries. We used optimal me-

dical therapy after primary PCI and performed staged PCI to the other significant coronary lesions only if there were symptoms or evidence of ischaemia in the provocative tests.

Evaluation of SYNTAX score (SXscore) and angiographic parameters

SXscore was employed to all coronary lesions with a diameter stenosis greater than 50% in vessels larger than 1.5 mm according to a full description elsewhere. The total SXscore was identified by calculating each lesion [9]. With a coefficient and in consideration of the morphological characteristics of each lesion, SXscore was determined using software that calculates the scores separately (SXscore calculator v2.02, www.syntaxscore.com). In this study, the baseline SXscore (bSS) was calculated by two experienced interventional cardiologists unaware of the patients' clinical outcomes and therapeutic applications using the sum of each lesion separately. In the original SYNTAX study, STEMI patients were among the exclusion criteria. Therefore, no score calculation method was adopted for these patients. Therefore, in calculating the bSS, the total occlusion of IRA was classified as obstructed less than 3 months and included in the algorithm. In calculating the rSS, 5 points were assigned for unsuccessful PCI (TIMI 0 flow after the procedure). Complete revascularization group included patients with rSS = 0 and incomplete revascularization (IR) group included patients with rSS $\geq$ 1 after primary and staged PCI.

The rSS was calculated after the completion of all elective PCI procedures.

Outcomes

Short-term outcomes were defined as development of cardiac mortality, reinfarction, urgent target vessel revascularisation and acute-subacute stent thrombosis.

Long-term outcomes were defined as late stent thrombosis, recurrent MI (RE-MI), TLR and death.

Death, RE-MI and TLR were accepted as MACE.

Statistical analysis

All data are presented as mean ± SD for variables with normal distribution or median (interquantile range) for variables with a non-normal distribution. Categorical variables are reported as numbers and percentages. Continuous variables were checked for the normal distribution assumption using Kolmogorov–Smirnov statistics. Categorical variables were tested by Pearson's χ^2 test and Fisher's exact test. The differences between patients and control subjects were evaluated using the Mann–Whitney U test or Student's t test when appropriate. The independent predictors of mortality and MACE were investigated by binary logistic regression analysis. Forward stepwise multivariable regression models using parameters with $p < 0.10$ were created. *P*-values were two sided, and values <0.05 were considered statistically significant. All statistical studies were conducted using Statistical Package for Social Sciences software (SPSS 20.0 for Windows, SPSS Inc., Chicago, Illinois).

Results

A total of 208 patients with STEMI undergoing primary PCI were included in our study.

Clinical and demographic characteristics

Seventy-eight (37.5%) patients were included in the CR group and 130 (62.5%) patients in the IR group. The number of male patients was 163 (78.4%). The mean age was 53.96 ± 11.43 in the CR group and 62.18 ± 12.05 in the IR group. Table 1 lists the demographic, clinical and laboratory characteristics of the patients in the study groups.

Angiographic and procedural characteristics

Before the procedure, TIMI flow 0/1 was observed in 168 (80.8%) patients. After the procedure, TIMI 3 flow was achieved in 187 (89.9%) patients. The bSS average was 15.47 ± 6.76, and the rSS average was 4.07 ± 5.31. Table 2 presents the angiographic and procedural characteristics of the patients in the study group.

Short- and long-term outcomes

During the 30-day period, 8 patients from the IR and 1 patient from the CR group died ($p < 0.01$). The rates of stent thrombosis, reinfarction and TLR were not different between the groups. The mean follow-up duration was 28.8 ± 7.1 months in the study. During follow-up, 10 patients from the IR and 2 patients from the CR group died ($p = 0.11$). The incidence of recurrent MI and MACE was significantly higher in the IR group than in the CR group. The incidence of late stent thrombosis and TLR was not different between the two groups ($p = 0.60$ and 0.35, respectively) (Table 3).

Predictors of mortality and MACE were investigated with univariable and multivariable logistic regression analyses. In the multivariable analysis, age (OR 1.06, 95% CI 1.02–1.11, $p < 0.01$), bSS (OR 1.10, 95% CI 1.02–1.21, $p < 0.01$), rSS (OR 1.11, 95% CI 1.03–1.19, $p < 0.01$) and rSS >1 vs. rSS = 0 (OR 4.12, 95% CI 1.15–14.12, $p < 0.01$) were correlated with mortality in the study population. Moreover, in the multivariable analysis, bSS, rSS and rSS $\geq$ 1 vs. rSS = 0 were found to be significantly correlated with MACE in the model adjusted for age (Table 4).

Discussion

The main findings of this study are as follows: (1) short-term mortality rate is high when complete revascularisation fails, and (2) long-term MACE is high in patients with rSS $\geq$ 1. As a sign of incomplete revascularisation, rSS $\geq$ 1 group is correlated with severe forms of CAD estimated by the total number of stenotic segments and SXscores.

Patient-oriented risk scoring systems have been used in patients presenting with STEMI. Most of these systems were prepared considering the data of patients' clinical and laboratory variables, Killip classification and electrocardiographic ST-segment changes. Many of them were developed prior to the introduction of the primary PCI for the treatment of STEMI. As a result, although different levels of risk scoring methods are available for predicting the effect of mortality, they have limitations because of the lack of an assessment of any angiographic lesion characteristics. SXscore is an angiographic scoring system that gives the correct decisions to facilitate revascularisation, and it predicts mortality and morbidity in long- and short-term follow-up. The SYNTAX study excluded pati-

ents with STEMI, and thus it has no calculation method for these patients. However, in a study of 807 patients with STEMI, Garg et al. [11] adapted the Syntax scores, which were divided into low, medium and high groups. A Syntax score > 16 was presented as a high-risk group with a one-year follow-up, and the rates of mortality, re-infarction, MACE and stent thrombosis were shown to be significantly high. Kul and colleagues reported that the high Syntax score (> 21.75) of 646 STEMI patients undergoing primary PCI, in-hospital MACE and cardiovascular mortality was significantly higher than that of the low-scoring group [12].

The rSS definition was first used by Genereux et al. [13] on 2686 moderate- to high-risk acute coronary syndrome patients managed with early invasive strategy. To determine the extent and complexity of residual coronary stenosis after PCI, rSS was calculated as a marker of incomplete revascularisation. For all rSS risk groups, the outcomes were significantly higher than those of complete revascularisation. Unlike those of this study, our patients are whole on STEMI diagnosis. Moreover, in a large cohort study of symptomatic ischemic heart disease patients who underwent PCI with new generation DES, Xu et al. [14] found that ischemia-driven target vessel failure was significantly high in the high bSS and rSS groups.

Similar to our study, Magro and colleagues [9] calculated the Syntax score prior to the procedure and after passing the culprit lesion with wire in a study conducted on 736 STEMI patients. In terms of MACE, the primary outcomes were significantly high in the high Syntax score group mostly related to the initial Syntax score.

In the current literature, many studies have compared CR and IR after PCI. However, no definite results were found on the prognostic significance of CR. This outcome can be attributed to the retrospective infrastructure of the studies, lack of consensus on the definition of CR and statistically significant differences in patient populations. In patients with multivessel disease, operators will have to decide on the revascularisation of either all the hemodynamically significant lesions or only the symptom-related lesion. Operators can choose IR because of the presence of serious medical problems, one or more chronic

Table 1 – Demographic, clinical and laboratory findings in study groups.

	Total (n = 208)	rSS = 0 (n = 78)	rSS ≥ 1 (n = 130)	*p*
Age (year)	59.1 ± 12.4	53.96 ± 11.43	62.18 ± 12.05	<0.01
Gender (%) Male Female	 163 (78.4) 45 (21.6)	 68 (87.1) 10 (12.9)	 95 (73.1) 35 (26.9)	0.02
Height (cm)	170.8 ± 6.9	173 ± 6.38	168.57 ± 7	<0.01
Weight (kg)	77.5 ± 10.7	78.51 ± 10.44	77.04 ± 10.97	0.34
BMI (kg/m²)	26.5 ± 2.9	26.14 ± 2.65	26.74 ± 3.12	0.16
Heart rate (beat/min)	77.9 ± 15.4	77.77 ± 14.44	78.10 ± 16	0.88
Systolic BP (mmHg)	121.41 ± 21.8	120.03 ± 19.86	122.25 ± 23	0.48
Diastolic BP (mmHg)	75.38 ± 13.61	75.31 ± 12.51	75.43 ± 14.26	0.95
Killip class 2–3, n (%)	50 (24)	14 (17)	36 (27)	0.27
Left ventricular EF (%)	43.40 ± 8.22	43.65 ± 8.66	43.25 ± 7.97	0.73
Hypertension, n (%)	105 (50.5)	26 (33.3)	79 (60.8)	<0.01
Diabetes mellitus, n (%)	60 (28.8)	14 (17.9)	46 (35.3)	0.07
Hyperlipidemia, n (%)	43 (20.7)	15 (19.2)	28 (21.5)	0.69
Current smoking, n (%)	116 (55.8)	49 (62.8)	67 (51.5)	0.11
Previous MI, n (%)	11 (5.3)	4 (5.1)	7 (5.4)	0.93
Previous PCI, n (%)	17 (8.2)	5 (6.4)	12(9.2)	0.47
MI localization Anterior, n (%) Inferior, n (%) Lateral, n (%)	 102 (49) 100 (48.1) 6 (2.9)	 46 (59) 29 (37.3) 3 (3.8)	 56 (43.1) 71 (54.6) 3 (2.3)	0.06
Creatinine (mg/dl)	0.96 ± 0.29	0.91 ± 0.18	0.99 ± 0.33	0.04
LDL-cholesterol (mg/dl)	129.1 ± 44.8	131.4 ± 38.3	127.82 ± 48.4	0.58
Triglyceride (mg/dl)	146.6 ± 119.3	146.4 ± 132.5	146.7 ± 111.2	0.99
HDL-cholesterol (mg/dl)	41.64 ± 29.54	40.7 ± 8.3	42.1 ± 27	0.66
Creatinin clearance (ml/dk/1.73 m²)	90.76 ± 26.53	97.87 ± 22.98	86.43 ± 27.68	<0.01
Peak CK-MB (U/l)	254.6 ± 230.6	235.2 ± 189.7	266.2 ± 252	0.35
Admission troponin I (ng/ml)	5.18 ± 11.49	5.4 ± 11.3	4.9 ± 11.6	0.76
Hemoglobin (g/dl)	13.89 ± 1.63	14.21 ± 1.30	13.71 ± 1.78	0.31
Hematocrit (%)	41.45 ± 5.11	42.07 ± 4.79	41.07 ± 5.28	0.17

Parametric variables are reported in mean ± SD or median (interquantile range); categorical variables are reported in number (percentage).
BMI – body mass index; BP – blood pressure; EF – ejection fraction; MI – myocardial infarction; PCI – percutaneous coronary intervention.

Table 2 – Angiographic and procedural characteristics of the patients in the study groups.

	Total (n = 208)	rSS = 0 (n = 78)	rSS ≥ 1 (n = 130)	*p*
Infarct related artery				
LAD, n (%)	102 (49)	45 (57.6)	57 (43.8)	0.18
RCA, n (%)	88 (42.3)	28 (35.8)	60 (46.1)	
CX, n (%)	18 (8.7)	5 (6.4)	13 (10)	
Number of diseased vessels				
1-vessel, n (%)	87 (41.8)	73 (93.6)	14 (10.8)	<0.01
2-vessel, n (%)	66 (31.7)	4 (5.1)	62 (47.7)	
3-vessel, n (%)	55 (26.5)	1 (13)	54 (41.5)	
Total lesion count	2.38 ± 1.52	1.15 ± 0.45	3.12 ± 1.46	<0.01
Stent length (mm)	22.66 ± 5.86	22.74 ± 6.95	22.58 ± 6.89	0.87
Stent diameter (mm)	3.34 ± 0.3	3.71 ± 0.4	3.12 ± 0.4	0.20
Total stent count	1.20 ± 0.4	1.15 ± 0.4	1.23 ± 0.5	0.28
Drug eluted stent, n (%)	39 (18.8)	13 (16.7)	26 (20)	0.55
TIMI baseline 0/1, n (%)	168 (80.8)	60 (76.9)	108 (83)	0.40
TIMI final 3, n (%)	187 (89.9)	71 (91)	116 (89.2)	0.924
Tirofiban usage, n (%)	83 (39.9)	32 (41)	51 (39.2)	0.798
Predilatation, n (%)	134 (64.4)	52 (66.7)	82 (63.1)	0.601
Postdilatation, n (%)	14 (6.7)	5 (6.4)	9 (6.9)	0.886
Thrombus aspiration, n (%)	13 (6.3)	5 (6.4)	8 (6.2)	0.941
Baseline SYNTAX Score (bSS)	15.47 ± 6.76	12.79 ± 6.01	17.07 ± 6.69	<0.01
Residual SYNTAX Score (rSS)	4.07 ± 5.31	0	6.51 ± 5.40	<0.01
Reperfusion time (min)	324 ± 197	319 ± 201	327 ± 195	0.76
Door-balloon time (min)	44.81 ± 14.07	43.40 ± 13.73	45.65 ± 14.25	0.26
Lesion length > 20 mm	62 (29.8)	22 (28.2)	40 (30.8)	0.69
Chronic total occlusion, n (%)	17 (8.1)	0	17 (13.1)	<0.01
Bifurcation lesion, n (%)	9 (4.3)	3 (3.8)	6 (4.6)	0.79
Osteal lesion, n (%)	10 (4.8)	0	10 (7.7)	<0.01
Thrombus, n (%)	60 (28.8)	27 (34.6)	33 (25.4)	0.15
Ectasia, n (%)	2 (1)	0	2 (1.5)	0.27
Calcification, n (%)	26(12.5)	2 (2.6)	24 (18.5)	<0.01

Parametric variables are reported in mean ± SD or median (interquantile range); categorical variables are reported in number (percentage).
Cx – circumflex artery; LAD – left anterior descending artery; RCA – right coronary artery.

Table 3 – Comparison of incidence of adverse cardiovascular events at 30 days and on follow-up.

	Total (n = 208)	rSS = 0 (n = 78)	rSS ≥ 1 (n = 130)	*p*
Clinical outcomes at 30 days				
Stent thrombosis, n (%)	7 (3.3)	2 (2.5)	5 (3.8)	0.61
Recurrent myocardial infarction, n (%)	14 (6.7)	3 (3.8)	11 (8.5)	0.19
Target lesion revascularization, n (%)	8 (3.8)	2 (2.5)	6 (4.6)	0.45
Death, n (%)	9 (6.2)	1 (1.3)	8(6.2)	<0.01
Major adverse cardiac events, n (%)	21 (10)	4 (5.1)	17 (13.1)	0.06
Clinical outcomes on follow up				
Late stent thrombosis, n (%)	10 (4.8)	3 (3.8)	7 (5.4)	0.60
Recurrent myocardial infarction, n (%)	36 (17.3)	6 (7.8)	24 (18.5)	<0.01
Target lesion revascularization, n (%)	12 (5.7)	3 (3.8)	9 (6.9)	0.35
Death, n (%)	12 (9.1)	2 (2.6)	10 (7.7)	0.11
Major adverse cardiac events, n (%)	38 (26.3)	8 (10.1)	32 (25)	<0.01

Death, recurrent myocardial infarction, and target lesion revascularization are accepted as major adverse cardiac events.

Table 4 – Univariate and multivariate logistic regression analysis for the major adverse cardiovascular events (MACE) in study population.

Variables	Unadjusted OR (95% CI)	*p*	Adjusted OR* (95% CI)	*p*
Age	1.02 (0.99–1.05)	0.06	1.02 (0.98–1.07)	0.31
Male sex	0.73 (0.34–1.55)	0.42	–	–
Hypertension	1.12 (0.62–2.11)	0.71	–	–
Diabetes mellitus	1.81 (0.67–4.88)	0.24	–	–
Current smoking	0.72 (0.29–1.77)	0.47	–	–
Previous MI	0.88 (0.12–6.68)	0.89	–	–
LVEF	0.97 (0.91–1.03)	0.31	–	–
Reperfusion time	1.001 (0.99–1.003)	0.52	–	–
Hemoglobin	0.72 (0.48–1.15)	0.18	–	–
Peak CK-MB	1.001 (0.99–1.003)	0.32	–	–
Creatinine	1.10 (0.21–5.66)	0.90	–	–
Predilatation	1.22 (0.48–3.52)	0.68	–	–
TIMI final III flow	0.41 (0.13–1.24)	0.12	–	–
Tirofiban usage	0.96 (0.34–2.02)	0.94	–	–
bSS*	1.08 (1.03–1.13)	< 0.01	1.07 (1.03–1.12)	< 0.01
rSS*	1.07 (1.03–1.12)	<0.01	1.05 (1.02–1.09)	0.02
RSS > 1 vs. RSS = 0*	3.37 (1.64–6.79)	< 0.01	3.11 (1.46–6.39)	< 0.01

These parameters were analyzed separately in multivariate model.
* Variables with *p* values < 0.10 in univariate analyses were included in multivariate regression analysis.

total occlusion and left ventricular dysfunction. However, the AHA guideline does not recommend the intervention of non-culprit lesions unless hemodynamic instability is present [15].

In a meta-analysis of nine studies comparing IR and CR, Aggarwal et al. [16] reported a statistically significant low incidence in the IR group in terms of mortality, non-fatal MI and CABG procedure requirements with an average follow-up of 29 months, but the repeated procedures were not different.

The management of non-infarct-related lesions in hemodynamically stable patients with STEMI has been a controversial topic in recent years. The prospective, randomised PRAMI (Preventive Angioplasty in Acute Myocardial Infarction) and CVLPRIT (Complete Versus Lesion-Only Primary PCI Trial) trials showed a significant benefit with complete revascularisation compared with PCI of only the culprit lesion with a significant improvement in a composite endpoint [17,18]. The ongoing COMPLETE (Complete vs. Culprit-only Revascularization to Treat Multi-vessel Disease After Primary PCI for STEMI) trial, which aims to enrol 3900 patients, is conducted to detect differences in cardiovascular death or MI. Moreover, in a meta-analysis of seven randomised trials with 1303 patients, Kowalewski et al. [19] reported that complete revascularisation at the time of primary PCI reduced MACE driven mainly by a reduction in recurrent MI at a median follow-up of 12 months .

In this study, we performed only primary PCI on infarct-related artery during the procedure in accordance with the recommendations. Residual lesions such as chronic total occlusions or a variety of reasons (i.e., tortuosity, calcification, aneurysm, ostial, left main coronary artery and bifurcation), which could be at risk because of invasive intervention, were left for bypass surgery. Stage PCI was planned in accordance with the provocative tests on the remaining patients with residual lesions suitable for revascularisation.

We excluded patients with cardiogenic shock, history of bypass and critical left main coronary artery stenosis, which can be considered relatively high risk. The basal average SXscore of our patients were low. Moreover, 22 patients had TIMI 3 flow in an infarct-related artery in the initial angiographies. The first application in the emergency room until the process of transferring to the catheter laboratory, as soon as the diagnosis perched, clopidogrel loading doses and aspirin and heparin treatment were applied to all patients. We obtained a high rate of spontaneous reperfusion because of the late application of some patients and early effective first-line therapies. Therefore, no significant difference was found between the groups in terms of short-term outcomes except death. The results of incomplete revascularisation were not apparent within 30 days with similar rates of MACE in the two groups. However, in the mean of the three-year follow-up, MACE and reinfarction rates were significantly high in the IR group.

Limitations

This work is a retrospective, observational and single-centre study with a limited number of patients and thus has the inherent limitations of a retrospective design. The success of the intervention was evaluated with post-PCI TIMI flow grades but not with a myocardial blush grade or ST-segment resolution.

Conclusions

In STEMI patients, the residual SYNTAX score, which is an indirect marker of incomplete revascularisation, was correlated with short- and long-term adverse outcomes.

The development of different risk scoring methods is useful to evaluate the combination of clinical, angiographic and laboratory data. More extensive randomised controlled trials are needed to demonstrate long- and short--term mortality on this issue.

Conflict of interest
The authors declare that they have no conflict of interest.

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None.

Ethical statement
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent
Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

References

[1] E.C. Keeley, J.A. Boura, C.L. Grines, Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials, Lancet 361 (2003) 13–20.
[2] E.L. Hannan, C. Wu, G. Walford, et al., Incomplete revascularization in the era of drug-eluting stents: impact on adverse outcomes, JACC: Cardiovascular Interventions 2 (2009) 17–25.
[3] Y.H. Kim, D.W. Park, J.Y. Lee, et al., Impact of angiographic complete revascularization after drug-eluting stent implantation or coronary artery bypass graft surgery for multivessel coronary artery disease, Circulation 123 (2011) 2373–2381.
[4] E.L. Hannan, M. Racz, D.R. Holmes, et al., Impact of completeness of percutaneous coronary intervention revascularization on long-term outcomes in the stent era, Circulation 113 (2006) 2406–2412.
[5] T. Palmerini, P. Genereux, A. Caixeta, et al., Prognostic value of the SYNTAX score in patients with acute coronary syndromes undergoing percutaneous coronary intervention: analysis from the ACUITY (Acute Catheterization and Urgent Intervention Triage StrategY) trial, Journal of the American College of Cardiology 57 (2011) 2389–2397.
[6] M.J. Van den Brand, B.J. Rensing, M.A. Morel, et al., The effect of completeness of revascularization on event-free survival at one year in the ARTS trial, Journal of the American College of Cardiology 39 (2002) 559–564.
[7] G. Sianos, M. Morel, A. Kappetein, et al., The SYNTAX score: an angiographic tool grading the complexity of coronary artery disease, EuroIntervention 1 (2005) 219–227.
[8] C. Girasis, S. Garg, L. Raber, et al., SYNTAX score and clinical syntaxscore as predictors of very long-term clinical outcomes in patients undergoing percutaneous coronary interventions: a substudy of SIRolimus-eluting stent compared with pacliTAXel-eluting stent for coronary revascularization (SIRTAX) trial, European Heart Journal 32 (2011) 3115–3127.
[9] M. Magro, S. Nauta, C. Simsek, et al., Value of the SYNTAX score in patients treated by primary percutaneous coronary intervention for acute ST-elevation myocardial infarction: the MI SYNTAXscore study, American Heart Journal 161 (2011) 771–781.
[10] E. Lev, R. Kornowski, H. Vaknin, et al., Comparison of the predictive value of four different risk scores for outcomes of patients with ST elevation acute myocardial infarction undergoing primary percutaneous coronary intervention, American Journal of Cardiology 102 (2008) 6–11.
[11] S. Garg, G. Sarno, P.W. Serruys, et al., Prediction of 1-year clinical outcomes using the SYNTAX score in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous intervention, JACC: Cardiovascular Interventions 4 (2011) 66–75.
[12] S. Kul, O. Akgul, H. Uyarel, et al., High SYNTAX score predicts worse in-hospital clinical outcomes in patients undergoing primary angioplasty for acute myocardial infarction, Coronary Artery Disease 23 (2012) 542–548.
[13] P. Genereux, T. Palmerini, A. Caixeta, et al., Quantification and impact of untreated coronary artery disease after percutaneous coronary intervention: the residual SYNTAX (Synergy Between PCI with Taxus and Cardiac Surgery) score, Journal of the American College of Cardiology 59 (2012) 2165–2174.
[14] B. Xu, Y.J. Yang, Y.L. Han, et al., Validation of residual SYNTAX score with second-generation drug-eluting stents: one year results from the prospective multicenter SEEDS study, EuroIntervention 10 (2014) 65–73.
[15] G.N. Levine, E.R. Bates, J.C. Blankenship, et al., 2015 ACC/ AHA/SCAI focused update on primary percutaneous coronary intervention for patients with ST-elevation myocardial infarction: an update of the 2011 ACCF/AHA/ SCAI guideline for percutaneous coronary intervention and the 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction, Journal of the American College of Cardiology 67 (2016) 1235–1250.
[16] V. Aggarwal, S. Rajpathak, M. Singh, et al., Clinical outcomes based on completeness of revascularisation in patients undergoing percutaneous coronary intervention: a meta-analysis of multivessel coronary artery disease studies, EuroIntervention 7 (2012) 1095–1102.
[17] D.S. Wald, J.K. Morris, N.J. Wald, et al., Randomized trial of preventive angioplasty in myocardial infarction, New England Journal of Medicine 369 (2013) 1115–1123.
[18] A.H. Gershlick, J.N. Khan, D.J. Kelly, et al., Randomized trial of complete versus lesion only revascularization in patients undergoing primary percutaneous coronary intervention for STEMI and multivessel disease: the CvLPRIT trial, Journal of the American College of Cardiology 65 (2015) 963–972.
[19] M. Kowalewski, V. Schulze, S. Berti, et al., Complete revascularisation in ST-elevation myocardial infarction and multivessel disease: meta-analysis of randomized controlled trials, Heart 101 (2015) 1309–1317.