Coronary Anatomy and Reperfusion Success in Acute Myocardial Infarction with ST Segment Elevation

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Introduction: Multivessel disease has a major impact on reperfusion in acute myocardial infarction with ST segment elevation (STEMI), as well as on patients' prognostic after primary percutaneous coronary intervention (PCI). Concurrently with the invasive treatment, a precise description of the coronary anatomy is obtained. However, there is only one scoring system based just on anatomy to appreciate the prognosis after PCI – the SYNTAX score (SXS) – and it was recently validated for STEMI cases. The relationship between the SXS and myocardial reperfusion has not been studied till now.

Material and methods: A retrospective study was performed including cases admitted with STEMI between 01 January 2010–31 January 2011. The SXSs were calculated. As a surrogate for reperfusion, ST segment resolution after angioplasty was measured and compared between the low, medium and high SXS tertiles. Total in-hospital mortality was also evaluated as a function of the SXS score.

Results: Eighty-four patients were enrolled in the study. The groups with low, medium and high values of SXS were homogenous with regard to: age, sex, presence of arterial hypertension, diabetes, smoking, ischemic period, pre- and postprocedural thrombolysis in myocardial infarction (TIMI) flow. However, mean ejection fraction was significantly lower in medium or high SXS tertiles ($p < 0.05$). Medium and high values of SXS were significantly associated with poor ST segment resolution, as well as a higher in-hospital mortality ($p < 0.05$).

Conclusion: Complex coronary anatomy has a negative influence on the short-term prognosis of STEMI, possibly partially by poor reperfusion, in spite of achieving a good epicardial flow.

Keywords: SYNTAX score, STEMI, PCI, reperfusion

Introduction

The most efficient treatment of acute myocardial infarction with ST-segment elevation (STEMI) is immediate percutaneous coronary intervention (PCI). Successful reperfusion is the key of good long-term clinical prognosis, however, even when the patency of the epicardial vessel is restored, there could be a subsequent adverse evolution of the disease with a significant mortality rate [1,2]. A good alternative to appreciate the success of the reperfusion therapy is the evaluation of the ST segment resolution; this was shown to correlate well with mortality and reinfarction, independent of target vessel patency [3].

Multivessel disease has a major (negative) impact on reperfusion, as well as on patients' prognostic after primary PCI [2,4]. At the time of the invasive treatment, a precise description of the coronary anatomy is obtained. However, there is only one dedicated anatomy-based scoring system to appreciate the prognosis after PCI: the SYNTAX score [5,6] (SXS), and it was recently validated for STEMI cases [7]. The score characterizes thoroughly the complexity of the coronary anatomy; this feature could provide more information about the predictors of successful reperfusion than simple categorization of patients in single- or multivessel disease groups. The relationship between the SXS and myocardial reperfusion after primary PCI for STEMI has not been studied till now. The objective of the present study is to evaluate the impact of SXS on reperfusion, as well as on the short term prognosis in patients with STEMI.

Material and methods

Study design

A retrospective study was performed including all cases admitted with STEMI between 2010 January 01 to 2011 January 31 in the 2nd Cardiology Clinic of the Institute of Cardiovascular Diseases and Transplantation, Tirgu Mures. Subjects who met the following inclusion criteria were eligible: acute ischemic chest pain lasting at least 30 minutes associated with ≥ 1 mm ST segment elevation in ≥ 2 contiguous electrocardiographic leads, primary PCI as reperfusion therapy. In each case were reviewed the clinical recordings, as well as the emergency coronary angiography and the angioplasty procedure. As a surrogate for reperfusion, ST segment resolution after angioplasty was measured, comparing the electrocardiogram (ECG) before and 60 minutes after PCI. Total in-hospital mortality during the index admission was also evaluated.

The SXS was calculated for each patient on the basis of the diagnostic coronary angiography, (i.e. before performing the intervention) using the Version 2.1 of the SYNTAX Score calculator available online at www.syntaxscore.com. Briefly, all coronary lesions with a diameter stenosis of ≥ 50% in any vessel with a diameter ≥ 1.5mm receive a separate score. A multiplication factor of 2 is used for stenoses 50–99% and 5 for total occlusions. All other adverse lesion characteristics considered in the SXS have an additive value (localization within the coronary artery tree,

Table I. Clinical, electrocardiographic, echocardiographic and angiographic characteristics of the enrolled patients, according to the SYNTAX score tertiles. Values are N (%), unless otherwise stated.

	SXS low N = 28	SXS medium N = 28	SXS high N = 28	p value
Age (years)	59.4	62.8	66.5	0.11
Male	24 (85.7)	19 (67.8)	18 (64.2)	0.15
Hypertension	19 (67.8)	19 (67.8)	17 (60.7)	0.81
Diabetes mellitus	9 (32.1)	3 (10.7)	10 (35.7)	0.07
Current smoking	13 (46.4)	12 (42.8)	10 (35.7)	0.7
Obesity	11 (39.2)	8 (28.5)	11 (39.2)	0.62
Dyslipidemia	14 (50)	6 (21.4)	10 (35.7)	0.07
Ischemic period (hours, median)	4.5	4.0	4.5	0.9
Shock at admission	1 (3.5)	3 (10.7)	6 (21.4)	0.01
Cardiac arrest at admission	1 (3.5)	4 (14.2)	7 (25)	0.005
Anterior localization of STEMI	3 (10.7)	17 (60.7)	17 (60.7)	< 0.0001
ST-segment resolution (%, median)	81.5	66.0	70.5	0.03
LVEF (%, median)	50	44	40	< 0.0001
Multivessel disease	10 (35)	15 (53)	26 (92.8)	< 0.0001
Preprocedural TIMI flow 0 and 1	22 (78.5)	25 (89.2)	24 (85.7)	0.52
Postprocedural TIMI flow <3	8 (28.5)	3 (10.7)	10 (35.7)	0.07

SXS = SYNTAX score; STEMI = ST segment elevation myocardial infarction; LVEF = left ventricular ejection fraction; TIMI = thrombolysis in myocardial infarction

presence of a trifurcation or bifurcation, vessel angulation, aorto-ostial lesions, severe tortuosity, long, calcified and thrombotic lesions and "diffuse" disease).

Statistical analysis

All variables were stratified according to SXS tertiles. Discrete data were summarized as frequencies (%), whereas parametric continuous data were expressed as mean ± SD, and nonparametric continuous data were expressed as median. Gaussian distribution of data was evaluated with the Kolmogorov-Smirnov test. The Chi-square test (categorical variables), unpaired t-test, 1-way analysis of variance test (parametric, continuous variables), and Mann-Whitney U-test, as well as the Kruskal-Wallis test (nonparametric, continuous variables) were used to analyze differences between the 3 study groups. A probability value of < 0.05 was considered significant, and all tests were 2-tailed. Statistical analysis was performed using the Version 3.1 of the GraphPad InStat software.

Results

Corresponding to the inclusion criteria, eighty-four patients were enrolled in the study. The clinical, angiographic and procedural characteristics of the subjects are shown in table I. The SXS ranged from 3 to 61, with a mean±SD of 19.6±11.7, a median of 18, and a non-Gaussian distribution. Patients were stratified according to the following SXS tertiles: SXS low with a score ≤ 13 (N = 28); SXS medium with values > 13, but ≤ 22 (N = 28) and SXS high (values > 22, N = 28). Multivessel disease (> 50% stenosis in at least 2 of the 3 major epicardial vessels) was present in 60.7% of the subjects (table I).

The groups with low, medium and high values of SXS were homogenous with regard to: age, sex, presence of arterial hypertension, diabetes, dyslipidemia, current cigarette smoking, time interval between symptom onset and PCI, pre- and post-procedural TIMI-flow ($p > 0.05$, table I). However, anterior localization of the infarction, lower ejection fraction, cardiogenic shock, cardiac arrest at admission and presence of multivessel disease were more probable in the medium and high SXS tertiles ($p < 0.05$, table I).

According to the low, medium and high SXS tertiles, the mean±SD of ST segment resolution was 80.2±20%, 64.6±25% and 61.8±34%, with the medians of 81.5, 66.0 and 70.5 respectively and a nonparametric distribution. The difference between the three patient groups was statistically significant ($p = 0.03$; table I). ST-segment resolution was found to be significantly lower in the case of deceased patients (46.2±39.1% vs. 72.3±24.4%, medians: 40 and 75, $p = 0.02$).

A total in-hospital mortality of 13% was found; there were no exceptions: cardiogenic shock (10 patients, 50% mortality) and post resuscitation cases (12 patients, 41% mortality) were all included in calculations. Of the 11 deceased patients only 4 presented without cardiogenic shock and/or did not suffer a cardiac arrest before the emergent PCI. Mortality was 0%, 10.7% and 28.5% in the low, medium and high SXS tertiles, respectively, significantly higher in the SXS high group ($p = 0.008$).

Discussions

The negative influence of multivessel disease on the short- and long-term prognosis of STEMI is well known [1,2], and the presence of additional lesions in other coronary arteries than the infarct related one was incorporated in one scoring system [8] used for the evaluation of the probability of future cardiovascular events after an acute STEMI. There is also evidence, that successful reperfusion is harder to achieve even with primary PCI when remote coronary artery disease is present, although the exact reason for this observation is not known [2]. The term "multivessel" could be misleading: in different studies there are multiple definitions, and does not mean necessarily a complex anatomy [9] (figure 1).

Originally, the SXS was designed to predict outcomes related to anatomical characteristics and, to a lesser extent, the functional risk of occlusion in case of percutaneous revascularization for any segment of the coronary-artery bed in patients with stable disease, affecting the left main and/or all the three major epicardial coronary arteries [6,9]. The SXS was recently validated for clinical outcomes in patients with acute STEMI [7], but without the evaluation of the relationship with myocardial reperfusion, although the complexity of coronary anatomy could have an important role in poor reperfusion, despite the restoration of normal epicardial flow [2]. Indeed, medium and high values of SXS

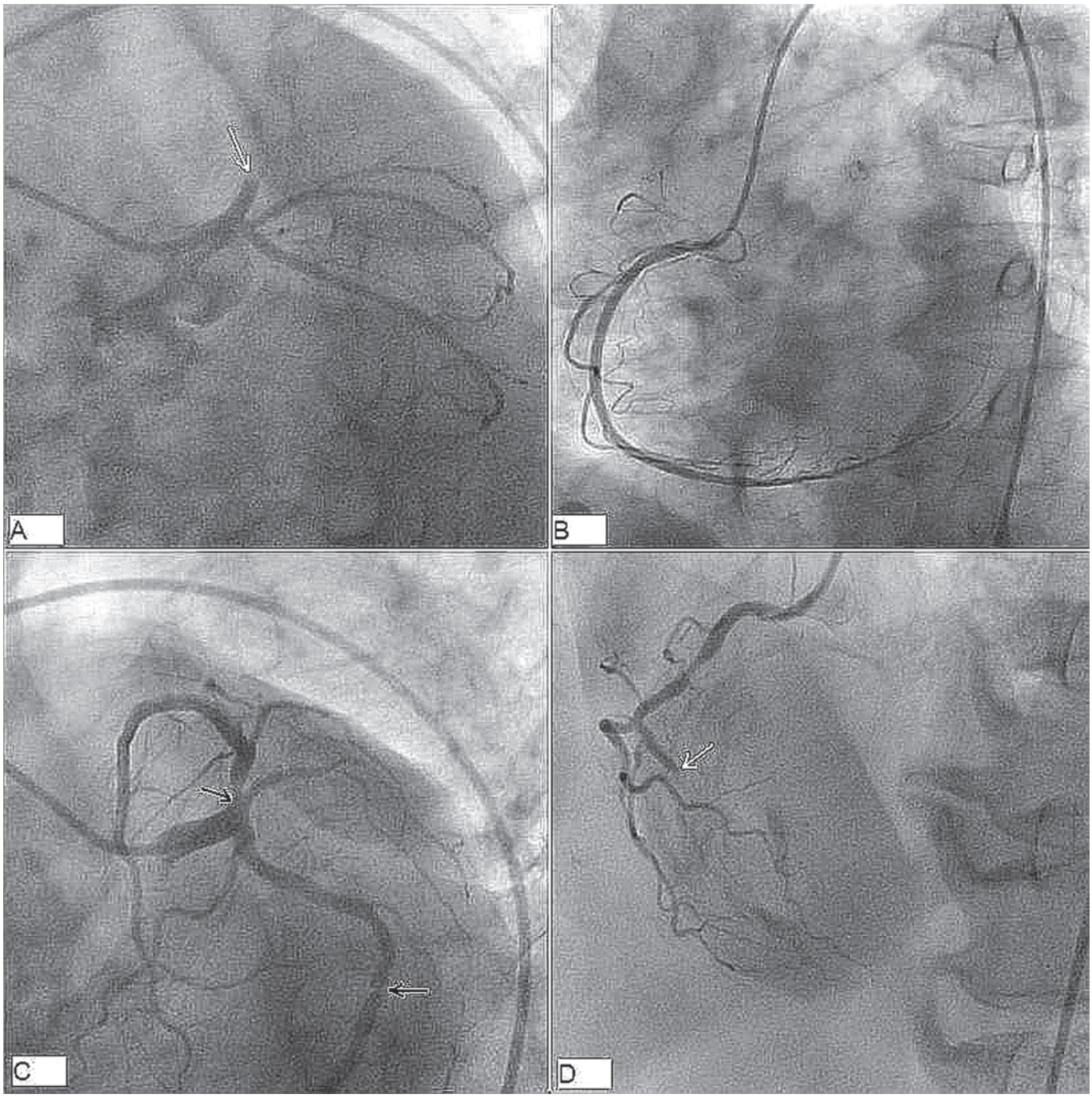

Fig. 1. Possible differences between a "high SYNTAX score" and a "multivessel disease" case. A and B – left and right selective coronary angiogram of a patient with a unique lesion: acute occlusion of the LAD (white arrow on A), calculated SXS = 23.5. C and D – left and right selective coronary angiogram of a patient with focal stenoses on the LAD and the LCX (black arrows on C) and acute occlusion of the RCA (white arrow on D), calculated SXS = 13.5. LAD = left anterior descending artery; LCX = left circumflex artery, RCA = right coronary artery, SXS = SYNTAX score.

were significantly associated with poor ST segment resolution in our study; although the post-PCI epicardial flow assessed conform the TIMI trial grading system [10] was not significantly different in the predefined patient tertiles. This could be as a result of more extensive atherosclerosis, which involves the microvasculature, or a higher grade of endothelial dysfunction [2]. Also, higher total in-hospital mortality was found in the SXS high group. In this latter tertile, there was more frequent the incidence of anterior infarction, depressed left ventricular systolic function, as well as cardiogenic shock or cardiac arrest at admission, and all these clinical variables are known to be associated with a poor prognosis in STEMI [1,7]. Obviously, successful reperfusion was significantly less frequently observed in the group of deceased subjects. The exact mechanism by which complex atherosclerotic disease of the coronary arteries negatively influences the effect of mechanical reperfusion therapy in STEMI deserves further studies.

Our study has the limitations of the retrospective design and the small sample size analyzed; we consider that these results should be reproduced in larger, prospective clinical trials.

Conclusions

Complex coronary anatomy defined by high values of the SYNTAX score has a negative influence on the short-term prognosis of STEMI, possibly partially by poor reperfusion, in spite of achieving a good epicardial flow. Future, preferably prospective and larger studies are needed to validate this observation.

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