



## Original article

## Association of syntax score with short-term outcomes among acute ST-elevation myocardial infarction patients undergoing primary PCI



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## ABSTRACT

**Objective:** Syntax score (SX) has emerged as a reproducible angiographic tool to quantify the extent of coronary artery disease based on location and complexity of each lesion. It has been shown to predict long-term clinical outcomes in patients with left main or multi-vessel disease and recently also in ST-segment elevation myocardial infarction undergoing primary PCI. The aim of this study was to evaluate whether the syntax score is associated with short-term cardiovascular outcomes in patients treated with primary percutaneous coronary intervention (PCI) for acute ST-segment elevation myocardial infarction (STEMI).

**Methods:** Syntax score was determined in 90 consecutive patients (mean age  $54.2 \pm 11.6$ ) of STEMI undergoing primary PCI. Outcomes were stratified according to syntax score groups: SX low  $\leq 15$  ( $n = 33$ ), SX mid  $16-22$  ( $n = 30$ ), and SX high  $\geq 23$  ( $n = 27$ ). The primary endpoint was all-cause mortality at 30 days. Secondary endpoints were nonfatal major adverse cardiac and cerebrovascular events (MACE) defined as a composite of any repeat revascularization, acute coronary syndrome, and stroke at 30 days in patients discharged alive.

**Results:** Mortality at 30 days was higher in the SX high group compared to the SX mid and SX low group (18.5% vs 3.3%  $p = 0.011$ ), MACE at 30 days was higher in SX high group compared to SX mid and SX low group (48.1% vs 16.6% vs 9.1%,  $p = 0.001$ ).

**Conclusions:** The syntax score is associated with 30-day mortality in patients with STEMI undergoing primary PCI. In those discharged, it is associated with risk of MACE at 30 days.

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## 1. Introduction

Acute treatment of ST elevation myocardial infarction (STEMI) is restoration of myocardial perfusion by recanalization of the occluded vessel. Early reperfusion is associated with better outcomes. Thus primary percutaneous coronary intervention (PCI) has become the treatment of choice for acute STEMI. Most scoring systems such as TIMI, GRACE that predict adverse events in patients with acute coronary syndrome (ACS) rely on clinical variables such as age, heart rate, blood pressure, Killip class, ST-segment changes, and serum creatinine levels, while not taking into account the characteristics of coronary lesions.<sup>1–4</sup>

The SYNTAX (Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery) score (SX) has been developed as a comprehensive angiographic scoring tool for quantification of coronary lesions with respect to their number, location, and complexity. It was initially tested in patients with stable coronary artery disease, multi-vessel disease or complex

coronary lesions allocated to PCI or coronary artery bypass graft (CABG) surgery in the landmark SYNTAX trial.<sup>5–8</sup> Subsequently, this score was also validated for left main disease and in all-comers population undergoing PCI.<sup>9,10</sup> It is a good predictor of adverse cardiovascular events including cardiac death, myocardial infarction (MI), and target lesion revascularisation.<sup>9,11,12</sup> Recently, it has also validated for risk stratification in STEMI undergoing primary PCI, where it was found associated with mortality, major adverse cardiac events, and stent thrombosis at 1-year follow-up.<sup>11</sup> Previous studies using the syntax score have focused on long-term clinical outcomes after PCI and data on its impact on short-term outcome is limited. Thus, we determined the association of syntax scores with short-term outcomes in patients with STEMI undergoing primary PCI.

## 2. Methods

## 2.1. Study population

All patients who were admitted at our institution with STEMI and underwent primary PCI during January 2014 to January

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2015 were included in the present analysis ( $n = 90$ ; mean age  $54.2 \pm 11.6$  years). None of these patients had been treated with fibrinolytic therapy. Performa has been designed to collect information regarding age, gender, history of risk factors, diabetes, dyslipidemia, hypertension, smoking, and family history of premature coronary artery disease (CAD). Patient's clinical parameters, left ventricular function, and killip class were recorded. Laboratory data including hemoglobin, total leukocyte count, platelet count, creatinine, and cardiac enzymes, etc. were noted. Clinical characteristics at baseline are shown in Table 1. Pre-treatment with drugs according to standard guidelines was initiated. Urgent diagnostic coronary angiography followed by primary PCI was performed. All primary PCI procedures were performed by experienced interventional cardiologists using femoral approach. The decision to perform PCI and to implant bare-metal or drug-eluting stents was at the discretion of the operator. Current guidelines for the management of STEMI indicate that culprit-only intervention should be performed acutely during primary PCI in the absence of cardiogenic shock and thus, it was followed at our institution. Pre-dilatation or post-dilatation after stent implantation, thrombosuction, use of eptifibatid was at the operator's choice. There was no restriction on the type, length or number of implanted stents. Baseline lesion and procedure characteristics are listed in Table 2. Exclusion criteria were previous CABG surgery or PCI and if emergent CABG surgery indication was present.

## 2.2. Determination of Syntax score

The Syntax score was calculated from baseline angiograms, for all coronary lesions with a diameter stenosis greater than 50% in vessels larger than 1.5 mm, using syntax score online calculator. All

angiographic variables involved in the calculation were computed by two independent investigators who were blinded to all clinical data. If the infarct-related artery was occluded, it was scored as an occluded artery of <3-month duration.

## 2.3. Study endpoints

The study's primary endpoint was mortality at 30-day follow-up. Secondary endpoints were nonfatal major adverse cardiac and cerebrovascular events (MACE) defined as a composite of any repeat revascularization, acute coronary syndrome and stroke within 30-day follow-up period in discharged patients. Any repeat revascularization was defined as repeat PCI or bypass grafting of both infarct related artery and non-infarct related artery, driven by ischemic symptoms.

## 2.4. Statistical methods

Continuous variables are expressed as mean and standard deviation. Categorical variables are expressed as percentage. The difference in means would be analyzed using student's 't' test. A two-sided  $p < 0.05$  was considered as statistically significant. The difference in categorical variables were analyzed using Chi-square test.

## 3. Results

Out of 90 patients undergoing primary PCI for STEMI during 2014–2015, mean syntax score was 17.4 (range 6–46). Groups were computed as SX low  $\leq 15$  ( $n = 33$ ), SX mid 16–22 ( $n = 30$ ), and

**Table 1**  
Baseline characteristics of patients according to syntax score (SXS).

Variables	N=90 (%)	SX low n=33 (37%)	SX mid n=30 (33%)	SX high n=27 (30%)	p value
Number	N=90	n=33	n=30	n=27	
Age, year	54.2	51.3 ( $\pm 12.74$ )	55.9 ( $\pm 11.04$ )	55.7 ( $\pm 10.73$ )	0.213
<b>Gender</b>					
Male	70 (77.8%)	28 (84.8%)	22 (73.3%)	20 (74.1%)	0.47
Female	20 (22.2%)	5 (15.2%)	8 (26.7%)	7 (25.9%)	
<b>Risk factors</b>					
Tobacco use	49 (54.4%)	17 (51.5%)	17 (56.7%)	15 (55.5%)	0.911
Hypertension	39 (43.3%)	15 (45.4%)	12 (40%)	12 (44.4%)	0.9
Diabetes	24 (26.7%)	6 (18.2%)	8 (26.7%)	10 (37%)	0.259
Hyperlipidemia	20 (22.2%)	7 (21.1%)	7 (23.3%)	6 (22.2%)	0.98
F/H CAD	14 (15.5%)	5 (15.1%)	5 (16.7%)	4 (14.8%)	0.978
<b>Clinical profile</b>					
SBP, mm Hg	120.6	126.3 ( $\pm 17.40$ )	124.8 ( $\pm 13.89$ )	110.6 ( $\pm 13.47$ )	0
Heart rate	75.4	72.4 ( $\pm 11.3$ )	73.1 ( $\pm 11.62$ )	80.8 ( $\pm 14.7$ )	0.023
Killip class $\geq 2$	13 (14.4%)	2 (6.1%)	5 (16.6%)	6 (22.2%)	0.19
Creatinine (mg/dL)	1.1	1.0 ( $\pm 0.24$ )	1.1 ( $\pm 0.36$ )	1.2 ( $\pm 0.49$ )	0.118
Ejection fraction (%)	42.3	45.5 ( $\pm 6.90$ )	41.8 ( $\pm 6.96$ )	39.07 ( $\pm 7.08$ )	0.002
Time symptom onset to hospital [min]	211	218	195	221	
Door to balloon time [min]	82	74	89	82	
Total ischemic time (TIT)	293	292 ( $\pm 144.6$ )	284 ( $\pm 144$ )	303 ( $\pm 155.4$ )	0.887
<b>Type of STEMI</b>					
AWMI	49 (54.4%)	15 (45.4%)	15 (50%)	19 (70.4%)	0.263
IWMI $\pm$ RV/PWMI	32 (35.6%)	13 (39.4%)	13 (43.3%)	6 (22.2%)	
Others	9 (10%)	5 (15.2%)	2 (6.7%)	2 (7.4%)	
<b>In-hospital medication</b>					
Aspirin	90 (100%)	33 (100%)	30 (100%)	27 (100%)	1
Clopidogrel/prasugrel	90 (100%)	33 (100%)	30 (100%)	27 (100%)	1
Beta blockers	70 (77.8%)	25 (75.7%)	25 (83.3%)	20 (74.1%)	0.661
ACE inhibitors/ARB	80 (88.9%)	31 (93.9%)	27 (90%)	22 (81.5%)	0.303
Statins	90 (100%)	33 (100%)	30 (100%)	27 (100%)	1
Inotropic drugs	10 (11.1%)	1 (3.0%)	3 (10%)	6 (22.2%)	0.061
Diuretics	9 (10%)	2 (6.1%)	3 (10%)	4 (14.8%)	0.531
GPIIb/IIIa inhibitors	43 (47.8%)	15 (45.5%)	14 (46.7%)	14 (51.8%)	0.876

**Table 2**  
Baseline lesion and procedural characteristics.

Variables	N=90 (%)	SX low n=33 (%)	SX mid n=30 (%)	SX high n=27 (%)	p value
SX score	17.4	9.9	18.4	23.9	
<b>IRA</b>					0.012
Left anterior descending	40 (44.4%)	8 (24.2%)	13 (43.3%)	19 (70.4%)	
Circumflex artery	15 (16.7%)	8 (24.2%)	5 (16.7%)	2 (7.4%)	
Right coronary artery	35 (38.9%)	17 (51.6%)	12 (40%)	6 (22.2%)	
Left main disease	1 (1.1%)	0	1 (3.3%)	0	0.044
<b>Number of diseased vessels</b>					0.044
SVD	42 (46.7%)	20 (60.6%)	13 (43.3%)	9 (33.3%)	
DVD	30 (33.3%)	11 (33.3%)	11 (36.7%)	8 (29.6%)	
TVD	18 (20%)	2 (6.1%)	6 (20%)	10 (37.1%)	
Total occlusion with thrombus	81 (90%)	29 (87.9%)	27 (90%)	25 (92.6%)	0.833
Total no. of stents implanted	1.3	1.1 (±0.28)	1.3 (±0.45)	1.6 (±0.48)	0
<b>Stent type</b>					0.906
BMS	19 (21.1%)	7 (21.2%)	7 (23.3%)	5 (18.5%)	
DES	71 (78.9%)	26 (78.8%)	23 (76.7%)	22 (81.5%)	

SX high  $\geq 23$  ( $n = 27$ ). Baseline clinical and angiographic characteristics of patients are presented in Table 1. Mean age, gender, baseline investigations, and risk factor profile – hypertension, dyslipidemia, smoking, diabetes, and family history of CAD were similar between the three groups. At presentation, patients in SX high group had higher heart rate (80.8 vs 73.1 vs 72.4,  $p = 0.02$ ) and lower systolic blood pressure (110.6 vs 124.8 vs 126.3,  $p < 0.001$ ) than SX mid and SX low groups. Left ventricular ejection fraction (mean) was lower in patients with high syntax score compared to those with mid-low scores (39.07% vs 41.8% vs 45.5%,  $p = 0.002$ ). Killips class, total ischemic time, type of STEMI, and in hospital treatment did not differ between the groups.

There were higher rates of left anterior descending as the culprit vessel in SX high group (70.4% vs 43.3% vs 24.25,  $p = 0.012$ ). Triple vessel disease (37.1% vs 20% vs 6.1%,  $p = 0.014$ ) and number of stents implanted (1.6 vs 1.3 vs 1.1,  $p < 0.001$ ) were higher in SX high group than SX low and mid groups.

### 3.1. Outcomes at 30-day follow-up

Six patients died within 30 days of the procedure (4 during hospitalization and 2 after discharge) and 21 MACCE were recorded during this period (Table 3).

## 4. Discussion

Syntax score is an important determinant of treatment decision making in stable patients with left main or multi-vessel disease undergoing elective PCI or CABG surgery and is validated to predict the outcomes in these patients. The Syntax score was recently validated in patients with STEMI undergoing primary PCI. The first dedicated analysis of the this score in patients with STEMI, published by Garg et al. in 2011, showed that this score is a

significantly associated with mortality, MACE, and any stent thrombosis at 1-year follow up.<sup>15</sup>

In this study, rates of all cause mortality were higher in patients of SX high group than SX mid group (18.5% vs 3.3%, respectively  $p = 0.01$ ). Six patients died during hospitalization and follow up period. One of them had acute renal failure due to contrast-induced nephropathy. Four of them were caused by either cardiogenic shock or acute pulmonary edema. One patient with anterior wall STEMI, in SX mid group developed acute pancreatitis with multi-organ dysfunction during hospitalization and died later. Previous studies in patients undergoing primary PCI have also reported syntax score as an independent predictor of mortality.<sup>5,8,11,15</sup> Our study shows that patients in the SX high group had a higher prevalence of triple vessel disease compared with those in the SX mid and low. The well-established association between multi-vessel disease and cardiogenic shock may partly explain the increase in the peri-procedural risk and high mortality.<sup>11,14</sup> In addition, as shown in our study, patients with high syntax score had greater systolic dysfunction (lower LVEF) and greater LAD occlusion, so they had greater area of myocardium involvement, which may partly explain bad outcome in this group.<sup>11</sup> Previous studies have shown syntax score as a predictor for TIMI flow grade  $< 3$  and no reflow, which are associated with bad outcome.<sup>19,20</sup> Biondi-Zoccai et al. showed in a meta-analysis that patients of STEMI with multi-vessel disease have worse clinical outcomes than those with single-vessel disease.<sup>12</sup> Likewise, Brown et al. showed that lesion complexity was predictive of mortality at a follow-up of 2 years.<sup>13</sup> This observation presumably reflects the predominant role of anatomic complexity of coronary lesions in determining mortality.

MACE were more common in patients with SX high group compared to SX mid and SX low group (48.1% vs 16.6% vs 9.1%,  $p = 0.001$ ). In our study patients with high syntax score had higher rates of any repeat revascularization than those with intermediate

**Table 3**  
Clinical outcome at 30 days.

Variables	N=90 (%)	SX low n=33 (%)	SX mid n=30 (%)	SX high n=27 (%)	p value
All cause mortality	6 (6.7%)	0	1 (3.3%)	5 (18.5%)	0.01
Cardiac death	5 (5.5%)	0	0	5 (18.5%)	0
Any repeat revascularization	8 (8.9%)	1 (3%)	1 (3.3%)	6 (22.2%)	0.01
Acute coronary syndrome	10 (11.1%)	1 (3%)	3 (10%)	6 (22.2%)	0.06
Cerebrovascular events	3 (3.3%)	1 (3%)	1 (3.3%)	1 (3.7%)	0.99
Rehospitalization	15 (16.7%)	2 (6.1%)	5 (16.7%)	8 (29.6%)	0.05
Overall MACE	21 (23.3%)	3 (9.1%)	5 (16.6%)	13 (48.1%)	0

and low score (22.2% vs 3.3% vs 3%,  $p = 0.014$ ). Since patients in SX high group had more multi-vessel disease or complex lesions, not opening the non-culprit lesions during the initial procedure may partly explain these findings. But our study followed PCI of infarct related artery in the light of current ACC/AHA STEMI guidelines.<sup>17</sup> Recently, the Preventive Angioplasty in Acute Myocardial Infarction study reported that the primary outcome of cardiac death, MI, or refractory angina was significantly less common in the preventive-PCI group, as compared with optimal medical therapy alone.<sup>18</sup> Therefore, the best strategy for staged revascularization in STEMI with MVD is yet to be clarified further. Similarly, Sorajja et al. reported that multi-vessel disease was associated with a higher rate of revascularization in patients with STEMI after primary PCI.<sup>16</sup> Thus, a high syntax score was found to be associated with re-infarction and need for revascularization.

Occurrence of cerebrovascular events did not differ between the three groups.

The present study shows that the high Syntax score is associated with mortality and MACE at 30 days in patients with STEMI undergoing primary PCI. These results are in agreement with recent studies showing that the syntax score has risk predictive value both in patients undergoing elective PCI and in those undergoing primary PCI for STEMI.

#### 4.1. Study limitations

Number of patients in our study group was less, but it was sufficient to reach statistically significant results and conclusions particularly with respect to 30-day mortality.

#### Conflicts of interest

The author has none to declare.

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