Original Article

The Prognostic Significance of SYNTAX Score After Early Percutaneous Transluminal Coronary Angioplasty for Acute ST Elevation Myocardial Infarction

Chia-Hung Yang, M.D, Ming-Jer Hsieh, M.D, Chun-Chi Chen, M.D, Chao-Yung Wang, M.D, Shang-Hung Chang, M.D, Cheng-Hung Lee, M.D and I.-Chang Hsieh, M.D *

Department of Second Section of Cardiology, Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Linkou, Taiwan

Introduction: **SYNergy between percutaneous coronary intervention (PCI) with TAXUS and Cardiac Surgery (SYNTAX) score, which is based on the characteristics of atherosclerotic lesions and the complexity of coronary artery anatomy, is useful for choosing an intervention strategy, but its prognostic significance for acute ST elevation of myocardial infarction (STEMI) remains unknown. This study aimed to redress this issue.**

Methods: **Our observational study included 151 consecutive patients admitted for acute STEMI who underwent primary PCI between January 1, 2008 and December 31, 2009. The primary endpoint for analysis was 30-day cardiac death.**

Results: **Among the 151 patients, cardiac death occurred in 10 (7%) within 30 days. After the first month, five patients died of non-cardiac causes, but no cardiac death occurred. Multivariate analysis showed that SYNTAX score (odds ratio [OR], 13.79, 95% confidence interval [CI], 1.24–153.38; $p = 0.033$) and a symptom onset-to-therapy time interval >4 h (OR, 11.13; 95% CI, 1.08–114.42; $p = 0.043$) were independent risk factors for 30-day mortality. The SYNTAX score cut-off for discriminating low and high risk was 22.**

Conclusions: **SYNTAX score is an independent predictor of short-term cardiac mortality in patients with acute STEMI.**

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Keywords. Acute ST elevation myocardial infarction; SYNTAX score; Cardiac death

Introduction

Acute ST elevation myocardial infarction (STEMI) is a potentially life threatening medical condition with an overall in-hospital mortality rate of 7–10% [1]. Immediate intervention in the early hours following an acute STEMI event has been shown to reduce the incidence of death, recurrent MI, and hospital readmission, and shorten the length of in-hospital stay [2,3]. Several clinical variables have been reported to be independent predictors of mortality among patients with acute STEMI; these include age, sex, body weight, heart rate, hypotension (systolic pressure < 100 mmHg), Killip classification, infarction area, symptom onset-to-therapy time interval, and the presence of diabetes mellitus, hypertension, anaemia, or acute kidney injury [4–8].

The SYNergy between percutaneous coronary intervention (PCI) with TAXUS and Cardiac Surgery (SYNTAX) score is a new scoring system based on the characteristics of atherosclerotic lesions and the complexity of the coronary artery anatomy. It is currently recommended for decision-making purposes, specifically for choosing the appropriate method of coronary revascularisation (coronary artery bypass surgery vs. PCI) among patients with significant coronary artery disease (CAD), for whom SYNTAX scores have been shown to be of great value [9]. However, it is still unclear whether the SYNTAX score is helpful for predicting the prognoses of patients with CAD in general, and of those with acute STEMI in particular. The purpose of this study was to assess the prognostic value of a SYNTAX score obtained soon after hospital admission among patients undergoing early PCI for acute STEMI.

Materials and Methods

Study Design and Patient Population

This was an observational study of 153 consecutive patients admitted for acute STEMI who underwent primary PCI during a two-year period between January 1, 2008 and December 31, 2009. The diagnosis of acute STEMI was

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* Corresponding author at: 5 Fuhsing Street, Taoyuan 333, Taiwan. Tel.: +886 3 3281200x8115; fax: +886 3 3281451.

E-mail address: capful36@yahoo.com.tw (I.-C. Hsieh).

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based on a history of typical chest pain lasting for more than 30 min within 24 h prior to the hospital consult, the presence of ST segment elevation >1-mm in two or more consecutive limb or precordial leads on the electrocardiogram, and elevation of serum levels of troponin-I or the MB fraction of creatine kinase (CK-MB). The patients' baseline demographic and significant medical data were reviewed from hospital records. Hypercholesterolaemia was defined as a serum total cholesterol level >200 mg/dL, or the use of a cholesterol lowering agent. Hypertension was defined as systemic blood pressure >140/90 mmHg or the use of antihypertensive medication. Diabetes mellitus was defined as an HbA1c >6.5%, a plasma glucose level ≥126 mg/dL (7.0 mmol/L) after an overnight fast, or the use of oral antidiabetic medications. Anaemia was defined as haemoglobin (Hb) <12 g/dL or haematocrit (Hct) <36% for women and Hb <14 g/dL or Hct <41% in men. Acute kidney injury was defined as an abrupt increase in serum creatinine ≥0.3 mg/dL within 48 h after hospital admission or a similar increase over a few weeks or months. Coronary angiography and primary PCI were performed soon after early clinical assessment and ECG analysis. Patients with co-existent sepsis, infection, or acute stroke during the course of their hospital stay were excluded. Clinical status after hospital discharge was determined through outpatient hospital consultation records and confirmed by phone interview for up to two years after initial hospital admission for acute STEMI. Thirty-day cardiac death was the primary endpoint of the study.

The definition of the SYNTAX score in the coronary tree segments was based on the classification proposed by the American Heart Association (AHA) [10], and the modifications used for the Arterial Revascularization Therapies I and II trials [11]. The SYNTAX score for each patient was calculated retrospectively by scoring all coronary artery lesions with at least 50% stenosis of vessels at least 1.5 mm in diameter using the SYNTAX scoring algorithm, which is described in full elsewhere [9,12] as well as on the SYNTAX score website (http://www.syntaxscore.com) [13].

Statistical Analysis

Continuous variables were expressed as mean ± SD and compared using Student's *t* test. Discrete variables were expressed as proportions (percentages) and analysed using the Chi-square test. Univariate predictors with a significance level <0.05 were entered into a multivariate Cox proportional hazards model using all important biological variables. A *p*-value <0.05 was considered significant. A receiver operating characteristics (ROC) curve was used to determine the cut-off point for the SYNTAX score. Statistical analyses were performed using SPSS software (version 19, SPSS Inc., Chicago, IL).

Results

Clinical Characteristics

A total of 153 patients were initially considered for study inclusion. Two patients were excluded from further analysis due to in-hospital mortality caused by sepsis. Overall, 151 patients were included in the study. The baseline characteristics of these patients are shown in Table 1. The patients' ages ranged from 26 to 94 (mean 60 ± 14) years, and 133 (88%) were men. Diabetes mellitus was present in 40 (26%), hypertension in 75 (50%), hypercholesterolaemia in 20 (13%), and a significant smoking history in 93 (62%). A total of 88 (58%) and 36 (24%) patients had anterior STEMI and Killip class III–IV status, respectively, on hospital arrival. PCIs were performed within 4 h of the onset of anginal symptoms in 82 (54%) of the subjects. Multivessel disease was found in 83 (55%). Balloon angioplasty alone was performed in 19 (12%) patients, bare mental stent deployment in 30 (20%), and a drug-eluting stent was deployed in 102 (68%).

Table 1. *Baseline Clinic Characteristics of the 151 Patients.*

Age (years)	60 ± 14 (26–94)
Men	133 (88%)
Previous myocardial infarction	10 (7%)
Diabetes mellitus	40 (26%)
Smokers	93 (62%)
Hypertension	75 (50%)
Hypercholesterolaemia	20 (13%)
Anterior myocardial infarction	88 (58%)
Symptom onset-to-therapy interval > 4 h	82 (54%)
Sinus tachycardia	22 (15%)
Hypotension	24 (16%)
Killip class III–IV	36 (24%)
Multi-vessel disease	83 (55%)
Anaemia	30 (20%)
Acute kidney injury	18 (12%)
30-day cardiac death	10 (7%)

Among the 151 patients who underwent primary PCI for acute STEMI, 10 patients (7%) died within 30 days after the said cardiac event. Table 2 lists several predictor variables and the corresponding number of survivors and non-survivors for each variable. A higher incidence of cardiac death within 30 days after acute STEMI was observed among older patients (70 ± 9 vs. 59 ± 14 years, $p = 0.019$), as well as among those with hypotension (50% vs. 14%; $p = 0.002$), sinus tachycardia (40% vs. 13%; $p = 0.018$), a symptom onset-to-therapy time interval >4 h (90% vs. 52%; $p = 0.019$), Killip class III–IV status (100% vs. 18%; $p < 0.001$), left ventricular ejection fraction (LVEF; 37 ± 16 vs. 52 ± 12; $p = 0.002$), anaemia (50% vs. 18%; $p = 0.013$), acute kidney injury (50% vs. 9%; $p < 0.001$), and high SYNTAX score (29 ± 12 vs. 15 ± 7; $p < 0.001$).

Multivariate Analysis by Cox Regression

Multivariate analysis using Cox regression for cardiac mortality within 30 days after an acute STEMI event showed that SYNTAX score (OR, 13.79; 95% CI, 1.24–153.38; $p = 0.033$) and symptom onset-to-therapy time interval >4 h (11.13, 1.08–114.42; $p = 0.043$) were independent risk factors (see Table 3).

Table 2. *Difference in Clinical Characteristics Between Survivors and Non-survivors of 30 days.*

Predictor variable	Survival ($n = 141$)	Mortality ($n = 10$)	p value
Age (years)	59 ± 14	70 ± 9	0.019*
Men	126 (89%)	7 (70%)	0.068
Diabetes mellitus	36 (26%)	4 (40%)	0.316
Hypertension	73 (52%)	2 (20%)	0.052
Dyslipidaemia	19 (14%)	1 (10%)	0.754
Anterior myocardial infarction	80 (57%)	8 (80%)	0.149
Symptom onset-to-therapy interval > 4 h	73 (52%)	9 (90%)	0.019*
Sinus tachycardia	18 (13%)	4 (40%)	0.018*
Hypotension	19 (14%)	5 (50%)	0.002*
Killip class III–IV	26 (18%)	10 (100%)	<0.001*
Highest CPK (IU/L)	2821 ± 2340	3897 ± 3101	0.173
High ratio of CK-MB (%)	12 ± 5	12 ± 5	0.807
LVEF (%)	52 ± 12	37 ± 16 ($n = 7$)	0.002*
Anaemia	25 (18%)	5 (50%)	0.013*
Acute kidney injury	13 (9%)	5 (50%)	<0.001*
SYNTAX score	15 ± 7	29 ± 12	<0.001*

CPK: creatine kinase.
* Significance was defined as $p < 0.05$.

ROC Curve

The area under the ROC curve (AUC) for the diagnosis of cardiac death after acute STEMI was 0.849 (SE, 0.05; 95% CI, 0.75–0.95; $p < 0.001$) with 90% sensitivity and 77% specificity. The cut-off point for risk stratification of ≤30-day post-STEMI cardiac mortality based on SYNTAX score was 22. A patient was at low risk of cardiac death within 30 days following an acute STEMI if the SYNTAX score was ≤22. The patient was at a high risk of cardiac death if the SYNTAX score was >22. The differences in clinical characteristics between patients with SYNTAX scores ≤22 and >22 are listed in Table 4. Patients with SYNTAX scores >22 had more sinus tachycardia (24% vs. 11%; $p = 0.046$), were more frequently classified as Killip class III–IV (43% vs. 17%; $p = 0.001$), were lower LVEF ($42 \pm 11\%$ vs. $55 \pm 11\%$, $p < 0.001$), more frequently experienced anterior myocardial infarction (88% vs. 47%; $p < 0.001$) and acute kidney injury (24% vs. 7%; $p = 0.005$), and had less hypertension (36% vs. 55%; $p = 0.033$) than patients with a SYNTAX score ≤22. As expected, higher 30-day cardiac mortality was noted in patients with SYNTAX scores >22 (21% vs. 1%; $p < 0.001$).

Of the patients who managed to survive the first month after STEMI, one patient died from a non-cardiac cause. This was an 87 year-old male patient with type 2 diabetes mellitus and hypertension who had previously had a stroke. He reportedly died from asphyxia 11 days after the initial cardiac event. No other cardiac deaths were observed during the two-year follow-up period.

Discussion

It is well known that prognosis after AMI is associated with many demographic parameters, risk factors for atherosclerosis, and clinical behaviour after anginal symptom onset [3–7,14–17]. Primary PCI performed soon after an acute STEMI has been proven to be of benefit for patients [18,19], and also offers the opportunity to assess the overall anatomical structure of the coronary arterial system, which is rarely used to evaluate clinical prognosis, particularly during the early stages after a STEMI event. Our study is the first to show that SYNTAX score, which is used to assess the characteristics and sites of coronary arterial lesions, is an independent predictor of 30-day cardiac death after an acute STEMI event.

Several scoring methods, such as the Gensini, Leaman, and Americal College of Cardiology/AHA (ACC/AHA) scoring systems, have been used previously to evaluate the severity of coronary arterial disease [10,20–23]. Although the weighting factors differ among these three scoring systems, their scores are based on the summation of points for lesions of varying degrees of stenosis weighted by proximity. These scoring systems have been found to have

Table 3. *Cox Proportational Hazards Model (Multivariate) Analysis using for Predictors of 30-day Cardiac Death.*

Predictor variable	Odds ratio (95% confidence interval)	p value
SYNTAX score	13.79 (1.24–153.38)	0.033
Symptom onset-to-therapy interval > 4 h	11.13 (1.08–114.42)	0.043

Table 4. *Difference in Clinical Characteristics Between Patients with SYNTAX Score ≤ 22 and >22.*

Variables	SYNTAX score ≤ 22 ($n = 109$)	SYNTAX score > 22 ($n = 42$)	p value
Age (years)	60 ± 14	60 ± 14	0.841
Men	96 (88%)	37 (88%)	0.997
Previous myocardial infarction	6 (6%)	4 (10%)	0.374
Diabetes mellitus	26 (24%)	14 (33%)	0.237
Smokers	66 (61%)	27 (64%)	0.672
Hypertension	60 (55%)	15 (36%)	0.033*
Anterior myocardial infarction	51 (47%)	37 (88%)	<0.001*
Symptom onset-to-therapy interval > 4 h	59 (54%)	23 (55%)	0.944
Sinus tachycardia	12 (11%)	10 (24%)	0.046*
Hypotension	15 (14%)	9 (21%)	0.248
Killip class III–IV	18 (17%)	18 (43%)	0.001*
LVEF(%)	55 ± 11	42 ± 11 ($n = 39$)	<0.001*
Proximal lesion	39 (36%)	42 (100%)	<0.001*
Multi-vessel disease	54 (50%)	29 (69%)	0.031*
Pre-infarction angina	11 (10%)	10 (24%)	0.029*
DES	75 (77%)	27 (75%)	0.779
Anaemia	18 (17%)	12 (29%)	0.096
Acute kidney injury	8 (7%)	10 (24%)	0.005*
30-day cardiac death	1 (1%)	9 (21%)	<0.001*

DES = drug-eluting stent.
* Significance was defined as $p < 0.05$.

prognostic value for patients with acute coronary syndromes [24].

Besides using weighting factors based on the proximity of coronary artery lesions, the SYNTAX scoring system also simplifies the grading of lesions by classifying these as total occlusion or >50% stenosis; it also adds items related to the site of each lesion (at a trifurcation or bifurcation), severe vessel segment tortuosity, lesion length, the presence of calcifications, and thrombus formation at the site of the lesions to the calculation. From the ROC curve, we found that a SYNTAX score >22 implies a higher risk of cardiac mortality during the initial 30 days following an acute STEMI, a level similar to that found in the original study of the SYNTAX score. Based on the results of our study, a patient is considered to be at intermediate-to-high cardiac risk if they have a SYNTAX score >22.

Although there was no significant differences with regards to age, sex, incidence of diabetes mellitus or previous myocardial infarction, or smoking history between patients with lower and higher SYNTAX scores, those with SYNTAX scores >22 had a higher incidence of pre-infarction angina, anterior myocardial infarction, sinus tachycardia or acute kidney injury, higher Killip classifications, and lower LVEF. Angiographically, our patients with SYNTAX scores >22 also had a higher incidence of proximal lesions and multi-vessel disease (see Table 4). These clinical conditions might explain the higher cardiac mortality within 30 days after acute STEMI among patients with higher SYNTAX scores (see Table 2).

Our study also showed that delayed hospital arrival and subsequent PCI from the time of onset of anginal symptoms also predicted a poor outcome within the initial 30 days following the acute cardiac event in our small population of 151 patients. Such a finding confirms the value of early PCI for acute STEMI; clearly, time is muscle (Fig. 1).

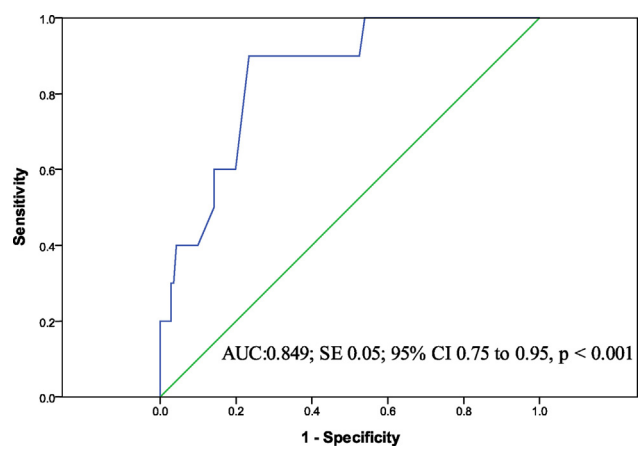

Figure 1. *Receiver operating characteristics curve analysis of the ability of the SYNTAX score to predict 30-day cardiac mortality with acute ST elevation myocardial infarction. AUC, area under the curve; SE, standard error; CI, confidence interval.*

Study Limitation

This study was confined to patients with acute STEMI who were eligible for primary PCI, which is the standard management approach. Because of the limited sample size, the patients in our study might not be representative of the entire population of acute STEMI patients who receive primary PCI. In order to confirm our findings, a study with a larger sample of patient is required.

Conclusion

The SYNTAX score, by assessing the nature and anatomical characteristics of lesions on the coronary arteries, is an independent predictor of short-term cardiac mortality in patients with acute STEMI.

Conflict of interest statement

None.

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