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The Association Between SYNTAX Score and Left Ventricular Myocardial Function in Patients with Acute ST-Elevation Myocardial Infarction

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Abstract Background: Left ventricular dysfunction were mainly caused by acute ST-elevation myocardial infarction (STEMI), often indicates a poor prognosis of cardiac arrest or sudden cardiac death. There were up to 50% patients with acute STEMI developed to left ventricular dysfunction even with the timing of coronary revascularization and mortality continues to rise in this population. The SYNTAX score is a new system that calculates risk on the basis of the complexity of coronary artery anatomy and is used to select the optimal technique for revascularization in patients with significant coronary artery disease. This observational study aimed to investigate the associations of SYNTAX score and left ventricular dysfunction caused by acute STEMI. Methods: 198 patients admitted to the Cardiovascular Center of the Seventh Affiliated Hospital of Sun Yat-Sen University because of acute STEMI from 1 January 2022 to 31 December 2022, who subsequently underwent emergency or elective coronary angiography (CAG) or percutaneous coronary intervention (PCI), were included in this study. According to left ventricular dysfunction patients were divided into two groups as the group1 of left ventricular dysfunction and the group2 of normal left ventricular function. SYNTAX score was calculated immediately after the CAG to assess the complexity and severity of coronary artery disease. Results: We included 198 hospitalizations for acute STEMI with a mean age of 57.0 ± 13.3 years, 14.3% patients were female. There were 43 patients in group1 and 153 patients in group2. The baseline characteristics of the study population are shown in Table 1. There was significant difference between the two groups with SYNTAX score, white blood cell (WBC) count, neutrophil count, urea, estimated glomerular filtration rate (eGFR), high density lipoprotein cholesterol (HDL-C), N-terminal pro-B-type natriuretic peptide (NT-proBNP), cardiac troponin I (cTnI), creatine kinase-MB (CK-MB), and in-hospital mortality. Univariate and Multivariable regression models suggested that SYNTAX score was an independent risk factor for left ventricular dysfunction. The fitted curve indicates a linear relationship between SYNTAX score and left ventricular dysfunction. Conclusion: SYNTAX score was an independent risk factor for left ventricular dysfunction in patients with acute STEMI, and the relationship between them are negative.

Keywords: *coronary artery disease, Acute ST-elevation myocardial infarction, SYNTAX score, left ventricular dysfunction, in-hospital mortality*

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1. Introduction

Left ventricular dysfunction occurs when patients present with symptoms and signs of elevated intra-cardiac filling pressure and/or reduced cardiac output. ST-elevation myocardial infarction (STEMI) is the most common cause of left ventricular dysfunction. There were up to 50% patients with acute STEMI developed to left ventricular dysfunction even with the timing of coronary revascularization and mortality continues to rise in this population [1].

The SYNTAX score is a unique tool to score complexity of coronary artery disease. It was calculated by evaluating stenosis > 50% in all coronary arteries with diameters > 1.5mm from the coronary angiography images and is used to select the optimal technique for revascularization in patients with significant coronary artery disease [2].

Some studies focused on the predictors of the cardiac function, only a few about SYNTAX score and left ventricular myocardial function, we evaluated the association between SYNTAX score and left ventricular myocardial function caused by acute STEMI. In order to provide some evidence for clinical physicians to diagnose and treatment earlier.

2. Method

Population

The present research was a single-center, retrospective, observational study included 198 patients who admitted to the Cardiovascular Center of the Seventh Affiliated Hospital of Sun Yat-Sen University because of acute STEMI from 1 January 2022 to 31 December 2022, they subsequently underwent emergency or elective CAG or PCI.

Inclusion criteria

Patients with typical chest pain for at least 20 min and elevated troponin I values with ≥1 mm ST segment elevation in 2 adjacent leads (>0.2 mV in leads V1, V2 or V3), or a new left bundle branch block in ECG were defined as having STEMI [3].

Exclusion criteria

Patients with prior history of CABG or PCI, non-STEMI, Serious rheumatic autoimmune disease, cancer, incomplete patient data.

Treatment strategy

Treatment strategy was decided by the experienced attending physicians according to coronary angiography. All patients were given coronary secondary prevention.

Data collection

The following data were retrospectively collected: (1) demographic factors and cardiovascular risk factors, including gender, age, family history of coronary artery disease (CAD), smoking history, hypertension history, diabetes mellitus history. (2) laboratory data at admission, including WBC, neutrophil count, lymphocyte, hemoglobin, blood platelet, urea, serum creatinine, eGFR, serum potassium, serum sodium, triglyceride (TG), total cholesterol (TC), HDL-C, LDL-C, hemoglobin Alc (HbAlc), NT-proBNP, cTnI, CK-MB and left ventricular ejection fraction (LVEF). (3) Calculation of the SYNTAX Score was performed as following: Using the SYNTAX score calculator (available at http://www.syntaxscore.com), two experienced interventional cardiologists retrospectively calculated the SYNTAX score according to the diagnostic angiograms obtained prior to PCI. The total score was calculated by adding up all individual scores for each separate lesion with a stenosis diameter ≥50% in a vessel ≥1.5mm in diameter by visual assessment. (4) Cardiac function evaluation is according to clinical symptoms, laboratory indicators, and Cardiac ultrasound examination which is based on the comprehensive assessment by three or more experienced attending physicians.

Cardiac ultrasound examinations are performed on all patients with acute ST-segment elevation myocardial infarction (STEMI) using the VIVID 5 system equipped with a 2.5MHz probe, which by experienced sonographers in the ultrasound department. Measurements were performed according to guidelines of American Society of Echocardiography. The LVEF was calculated by the Simpson biplane formula. The LV WMSI was calculated according to 16-segment model. Baseline comprehensive 2-dimensional transthoracic echocardiography including M mode and Doppler echocardiography was performed by two experienced cardiologists, using Vivid-S5, GE (United State) instrument, with 3.6 MHz transducer [4].

Statistical analysis

Categorical variables were represented by proportions (%) while continuous variables were described by the mean (standard deviation, SD) or median (interquartile range, IQR), as appropriate. To compare the differences across groups, one-way analyses of variance (normal distribution), Kruskal–Wallis tests (skewed distribution), and chi-square tests (categorical variables) were undertaken. Logistic regression models were used to determine the odds ratios (OR) and 95 percent confidence intervals (95% CIs) for the relationship between SYNTAX score and left ventricular dysfunction. Furthermore fitted curve analysis to assess the relationship between SYNTAX score and left ventricular dysfunction. All analyses were performed using the Free Statistics software version 1.7. A descriptive study was conducted on all participants. By a two-tailed testing, a p-value of <0.05 was declared significant.

3. Results

Study population

412 patients admitted to the Cardiovascular Center of the Seventh Affiliated Hospital of Sun Yat-Sen University because of acute myocardial infarction from 1 January 2022 to 31 December 2022, 216 were excluded for the following reasons:

- non-STEMI (n=160);
- prior history of CABG or PCI (n=23);
- Serious rheumatic autoimmune disease (n=12);
- Cancer (n=9); or
- incomplete patient data (n=12).

Thus, 196 patients were included in the analysis (Figure 1)

Baseline characteristic

In all, 196 patients had acute STEMI. Table 1 presents the baseline characteristics of the 196 patients according to left ventricular function. The mean age of the study participants was 57.0±13.3y, and 28 (14.3%) participants were women. There were significantly differences between the two groups in SYNTAX score, WBC, neutrophil count, urea, eGFR, HDL-C, NT-proBNP, cTnI, CK-MB, and in-hospital mortality. The SYNTAX score was higher in Group1 than Group2 (20.4 ± 5.5 versus 11.6 ± 6.9, p<0.05), The left ventricular dysfunction was also associated with a higher white blood cell (13.1 ± 4.8 versus 11.5 ± 3.7, p<0.05), higher neutrophil counts (10.5 ± 4.8 versus 8.7 ± 3.7, p<0.05), poorer renal function eGFR(80.4 ± 29.6 versus 91.0 ± 21.6, p<0.05), higher NT-proBNP (5815.5 ± 8058.4 versus 2200.2 ± 4180.4, p<0.05), cTnI (20.9 ± 7.8 versus 13.9 ± 9.8, p<0.05), higher CK-MB (325.6 ± 294.5 versus 175.6 ± 183.7, p<0.05) and higher In-hospital mortality (9 [20.9%] versus 5 [3.3%], p<0.05).

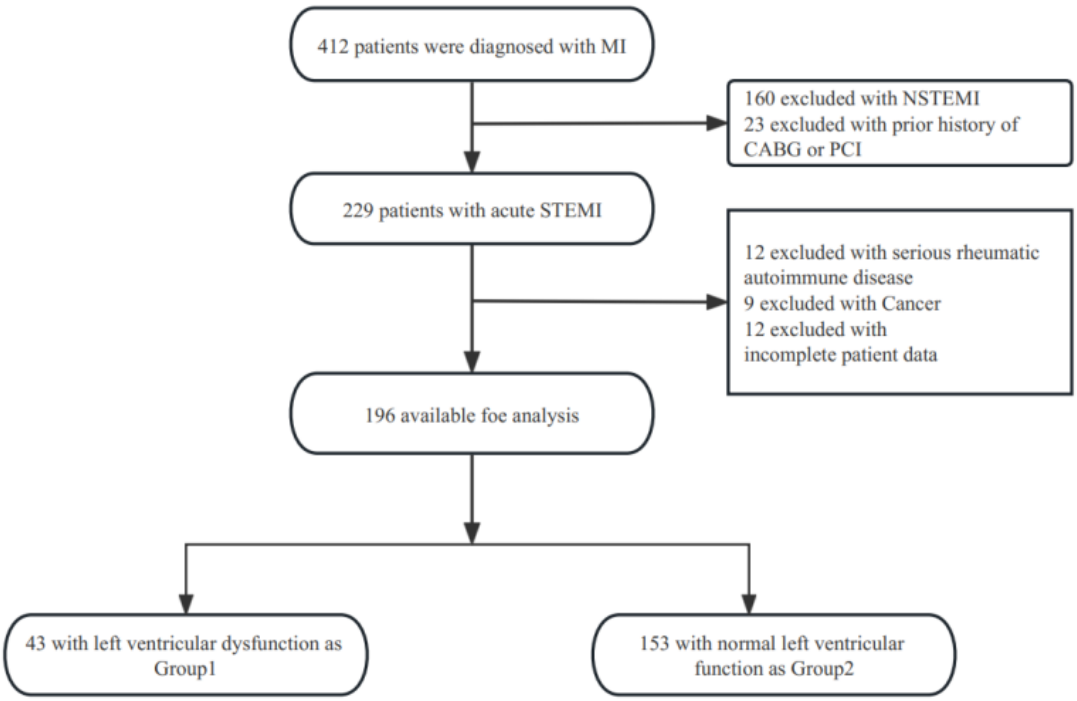

Figure 1. Inclusion and exclusion process for the final analysis

Table 1. Baseline characteristics of participants

Characteristic	All patients (n = 196)	Group1 (n = 43)	Group2 (n = 153)	p
Female, n (%)	28 (14.3)	9 (20.9)	19 (12.4)	0.16
age, years	57.0 ± 13.3	59.9 ± 14.3	56.2 ± 12.9	0.11
Smoking history, n (%)	116 (59.2)	24 (55.8)	92 (60.1)	0.61
hypertension history, n (%)	76 (38.8)	19 (44.2)	57 (37.3)	0.41
diabetes mellitus history, n (%)	36 (18.4)	9 (20.9)	27 (17.6)	0.62
family history of CAD, n (%)	10 (5.1)	2 (4.7)	8 (5.3)	1.00
SYNTAX score	13.5 ± 7.6	20.4 ± 5.5	11.6 ± 6.9	<0.05
WBC (×10^9/L)	11.8 ± 4.0	13.1 ± 4.8	11.5 ± 3.7	<0.05
Hemoglobin (g/L)	141.4 ± 19.6	141.0 ± 22.4	141.5 ± 18.8	0.88
blood platelet (×10^9/L)	235.6 ± 69.1	229.2 ± 72.6	237.4 ± 68.2	0.50
neutrophil count (×10^9/L)	9.1 ± 4.0	10.5 ± 4.8	8.7 ± 3.7	<0.05
Lymphocyte (×10^9/L)	2.2 ± 3.7	1.7 ± 1.1	2.3 ± 4.2	0.34
Urea (mmol/L)	5.8 ± 3.1	6.6 ± 3.6	5.6 ± 2.9	<0.05
serum creatinine (umol/L)	89.4 ± 76.7	104.2 ± 78.5	85.2 ± 76.0	0.15
eGFR	88.7 ± 24.0	80.4 ± 29.6	91.0 ± 21.6	<0.05
serum potassium (mmol/L)	3.7 ± 0.5	3.8 ± 0.6	3.7 ± 0.5	0.54
serum sodium (mmol/L)	138.7 ± 9.4	138.9 ± 3.2	138.6 ± 10.6	0.85
TG (mmol/L)	1.9 ± 1.8	2.1 ± 2.4	1.9 ± 1.6	0.66
TC (mmol/L)	4.8 ± 1.3	4.8 ± 1.4	4.8 ± 1.3	0.97
HDL-C (mmol/L)	1.0 ± 0.2	1.1 ± 0.3	1.0 ± 0.2	<0.05
LDL-C (mmol/L)	3.0 ± 1.1	2.9 ± 1.2	3.0 ± 1.1	0.63
hba1c (%)	6.4 ± 1.5	6.6 ± 1.8	6.3 ± 1.4	0.32
NT-proBNP (pg/ml)	2993.4 ± 5464.3	5815.5 ± 8058.4	2200.2 ± 4180.4	<0.05
cTnI (ng/ml)	15.4 ± 9.8	20.9 ± 7.8	13.9 ± 9.8	<0.05
CK.MB (ng/ml)	208.6 ± 221.2	325.6 ± 294.5	175.6 ± 183.7	<0.05
In-hospital mortality, n (%)	14 (7.1%)	9 (20.9%)	5 (3.3%)	<0.05

Association between SYNTAX score and left ventricular dysfunction

The results of the univariable and multivariable logistic regression analysis of SYNTAX score and left ventricular dysfunction are shown in Table 2.

Univariable logistic regression analysis shows that a high SYNTAX score was associated with left ventricular dysfunction (odds ratio [OR], 1.20; 95% confidence interval [CI], 1.13~1.28; p<0.05). Even after adjusting for all potential covariate, the association remain significant with SYNTAX score expressed as a continuous variable (OR, 1.21; 95%CI, 1.13-1.29; p<0.05; Table 2

Table 2. univariable and multivariable logistic regression analysis of SYNTAX score and left ventricular dysfunction

Variable	Univariable logistic regression		Multivariable logistic regression	
	OR_95CI	P_value	OR_95CI	P_value
Female, n (%)	1.87 (0.78~4.49)	0.16		
age, years	1.02 (1.00~1.05)	0.11		
Smoking history, n (%)	1.19 (0.6~2.36)	0.61		
hypertension history, n (%)	1.33 (0.67~2.65)	0.41		
diabetes mellitus history, n (%)	1.24 (0.53~2.87)	0.62		
family history of CAD, n (%)	1.14 (0.23~5.57)	0.87		
SYNTAX score	1.20 (1.13~1.28)	< 0.05	1.21 (1.13-1.29)	< 0.05
WBC (×10^9/L)	1.10 (1.01~1.19)	< 0.05	1.13 (1.03-1.23)	< 0.05
Hemoglobin (g/L)	1.00 (0.98~1.02)	0.88		
blood platelet (×10^9/L)	1.00 (0.99~1.00)	0.50		
neutrophil count (×10^9/L)	1.11 (1.02~1.21)	< 0.05	1.14 (1.04-1.25)	< 0.05
Lymphocyte (×10^9/L)	0.85 (0.60~1.19)	0.34		
Urea (mmol/L)	1.10 (1.00~1.22)	0.06		
serum creatinine (umol/L)	1.00 (1.00~1.01)	0.21		
eGFR	0.98 (0.97~1.00)	< 0.05	0.98 (0.97-1.00)	< 0.05
serum potassium (mmol/L)	1.23 (0.64~2.38)	0.54		
serum sodium (mmol/L)	1.00 (0.96~1.05)	0.85		
TG (mmol/L)	1.04 (0.87~1.24)	0.66		
TC (mmol/L)	1.00 (0.77~1.29)	0.97		
HDL-C (mmol/L)	0.13 (0.03~0.54)	< 0.05	0.01 (0.00-0.28)	< 0.05
LDL-C (mmol/L)	1.08 (0.78~1.5)	0.63	0.67 (0.15-2.98)	0.60
hba1c (%)	1.11 (0.90~1.38)	0.32		
NT-proBNP (pg/ml)	1.00 (1.00~1.00)	< 0.05	1.00 (1.00-1.00)	< 0.05
cTnI (ng/ml)	1.09(1.04~1.14)	< 0.05	1.11 (1.06-1.17)	< 0.05
CK.MB (ng/ml)	1.00 (1.00-1.00)	< 0.05	1.00 (1.00-1.00)	< 0.05

Accordingly, the association between SYNTAX score and left ventricular dysfunction was liner relationship (p=0.251) in the fitted curve after adjusting for all potential covariate (Figure 2).

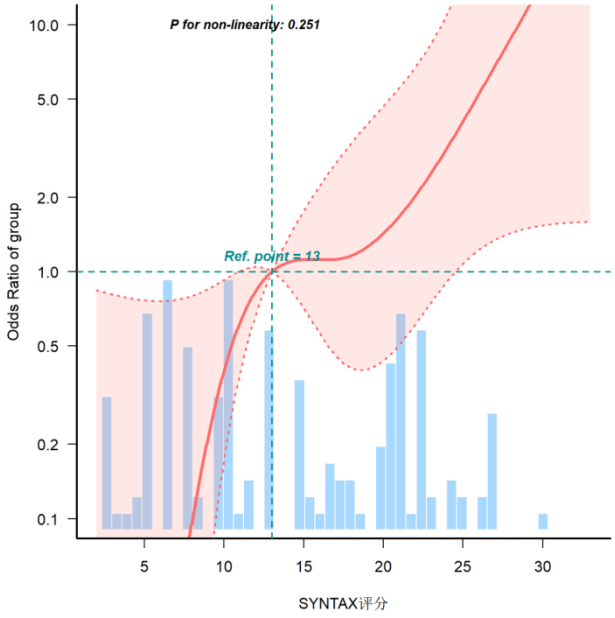

Figure 2. fitted curve of the association between SYNTAX score and left ventricular dysfunction

4. Discussion

In this study, the main observations were as follows:

- There were significantly differences between the left ventricular dysfunction patients and normal left ventricular function patients in SYNTAX score, WBC, neutrophil count, urea, eGFR, HDL-C, NT-proBNP, cTnI, CK-MB, and in-hospital mortality.
- The In-hospital mortality was higher in the left ventricular dysfunction patients.
- SYNTAX score is an independent risk factor for left ventricular dysfunction in acute STEMI patients and a high SYNTAX score was associated with left ventricular dysfunction

Left ventricular dysfunction were mainly caused by acute ST-elevation myocardial infarction, often indicates a poor prognosis of cardiac arrest or sudden cardiac death. There were up to 50% patients with acute STEMI developed to left ventricular dysfunction even with the timing of coronary revascularization and mortality continues to rise in this population [1]. Previous studies have suggested that the inflammatory plays a major role in the process of atherosclerosis and myocardial infarction [5-7]. Among the inflammatory mediators that are elevated post-MI, neutrophils infiltrate the myocardium within hours of infarction and contribute to myocardial injury through recruitment of other inflammatory mediators, degranulation and production of reactive oxygen species, aside from expulsion of reactive oxygen species and other proteins, neutrophils also release extracellular traps, which have been shown to be cytotoxic, proinflammatory and prothrombotic, potentially augmenting myocardial injury [8]. Additionally, high level of WBC, C-reactive protein, macrophage, lymphocyte have been suggested to affect both myocardial

infarct size and post-MI left ventricular remodeling [9-13]. In our study, we find that left ventricular dysfunction in acute STEMI patients was associated with a higher white blood cell and higher neutrophil counts, this is consistent with previous studies.

The SYNTAX score is a unique tool to score complexity of coronary artery disease and is used to select the optimal technique for revascularization in patients with significant coronary artery disease [2]. Previous studies have shown that high SYNTAX score was frequently associated with complex coronary lesions and poor prognosis. Yang found patients with high SYNTAX score at admission have higher risk of in-hospital cardiovascular death, suggesting that SYNTAX score is a strong predictor of cardiovascular death in patients with acute STEMI [14]. Urgent revascularization is required for better survival, reduce the extent of ischemic injury and protect cardiac function, however, there were up to 50% patients with acute STEMI developed to left ventricular dysfunction even with the timing of coronary revascularization and mortality continues to rise in this population [15]. Acute myocardial infarction leads to ventricular remodeling in response to oxygen demand, and the maladaptive ventricular remodeling post-MI predisposes to the development of left ventricular dysfunction, which is high risk of severe cardiac events [16,17]. In this study, we found SYNTAX score is an independent risk factor for left ventricular dysfunction in acute STEMI patients and a high SYNTAX score was associated with left ventricular dysfunction, we should maintain our focus and take close monitoring on these patients and national efforts are needed to improve the care and outcomes for patients with STEMI [18], in order to identify and position the potential damages of the patient early and reduce the risk of mortality.

5. Conclusion

SYNTAX score is an independent risk factor for left ventricular dysfunction in acute STEMI patients.

Abbreviations

STEMI, ST-elevation myocardial infarction;
CAG, coronary angiography;
PCI, percutaneous coronary intervention;
WBC, white blood cell;
eGFR: estimated glomerular filtration rate;
HDL-C: high density lipoprotein cholesterol;
NT-proBNP: N-terminal pro-B-type natriuretic peptide;
cTnI: cardiac troponin I;
CK-MB: creatine kinase-MB;
TG: triglyceride
TC: total cholesterol;
MACE: major adverse cardiac events;
RWMA: Regional wall motion abnormalities

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Author Contributions

Tingting Su collected data and wrote and revised the manuscript. Zhaohui Liu assisted in the preparation and responsible for managing medical images. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work. All authors take full responsibility for the integrity of the study and final manuscript. All authors have read and approved the final manuscript.

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Availability of Data and Materials

All data generated or analyzed during this study are included in this published article, futher inquiries can be directed to the first author.

Declarations

Ethics approval and consent to participate

The requirement of ethics approval and consent for this research was waived by the Ethics Committee of The Seventh Affiliated Hospital of Sun Yat-Sen University due to the retrospective nature of the study.

Competing interests

The authors declare that they have no competing interests.

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