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Original Contribution

Modified shock index is a predictor for 7-day outcomes in patients with ST-segment elevation myocardial infarction☆,☆☆

Qing Shangguan, MD [1], Jing-song Xu, MD [1], Hai Su, MD, PhD *, Ju-xiang Li, MD, PhD, Wen-ying Wang, Kui Hong, MD, PhD, Xiao-shu Cheng, MD, PhD

Department of Cardiology, Second Affiliated Hospital of Nanchang University

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ABSTRACT

Subject: The aim of this study was to compare the predictive values of modified shock index (MSI) and shock index (SI) for 7-day outcome in patients with ST-segment elevation myocardial infarction (STEMI).

Methods: This retrospective study included 160 consecutive patients with STEMI and emergency percutaneous coronary intervention. The blood pressure (BP) and heart rate (HR) measured at emergency department were used to calculate SI (HR/systolic BP) and MSI (HR/mean artery pressure). The major adverse cardiac events (MACE) included all-cause mortality, life-threatening arrhythmias, cardiogenic shock, and Killip class within 7 days.

Results: Forty-nine patients had increased MSI ($\geq$1.4), whereas 72 had increased SI ($\geq$0.7). Except the parameters on BP and HR, other parameters were similar between the normal and increased SI groups. However, the increased MSI group had significantly higher age (69.0 $\pm$ 13.0 years vs 63.9 $\pm$ 12.9 years, $P = .025$) than the normal MSI group. The 7-day all-cause mortality was 8.8%, and MACE rate was 24.4% in this study. Both increased SI and increased MSI predicted higher MACE rates. However, the odds ratios of increased MSI for all-cause mortality (6.8 vs 3.4), cardiogenic shock (3.0 vs 1.6), life-threatening arrhythmias (9.1 vs 4.6), and MACE (6.8 vs 3.4) were higher than those of increased SI. Modified shock index and SI were independent factor for MACE, but the odds ratio of MSI was higher than of SI (3.05 vs 1.07).

Conclusions: Both SI and MSI in emergency department could predict the all-cause mortality and MACE rates within 7 days in patients with STEMI, but MSI may be more accurate than SI.

1. Introduction

Shock index (SI) is a simple index, defined as the ratio of heart rate (HR) and systolic blood pressure (SBP). It has been demonstrated as a useful predictor for hospital mortality among adult patients with trauma [1-3]. Shock index is better not only than SBP, diastolic blood pressure (DBP), and HR alone but also than some risk stratification systems, for example, SI is more useful than the Triage Sort (TSO) for secondary triage in a mass-casualty situation [4].

In addition to trauma, SI could predict the risk of short- and long-term mortality for other nontrauma diseases, such as pulmonary embolism and aortic dissection. In patients with pulmonary embolism, SI could provide information to stratify the risk of short- and long-term mortality [5]. In patients with acute pulmonary embolism, Toosi et al [6] found that an elevated SI was associated with increased inhospital mortality, independent of echocardiographic findings. Meanwhile, in the patients with aortic dissection, a significant linear correlation was found between the ratio of false/true lumen and the SI [7]. Therefore, the usefulness of SI is beyond to trauma and hemorrhagic diseases.

In clinical, the risk stratification for the patients with ST-segment elevation myocardial infarction (STEMI) is very important to identify those patients who are relatively more serious. Risk assessment provides an opportunity to integrate various patient characteristics into a semiquantitative score that can convey an overall estimate of a patient's prognosis; can dictate the acuity, intensity, and location of care; and can provide the patient and family with a more informed sense of potential outcome [8]. At present, several systems of risk stratification such as Thrombolysis In Myocardial Infarction (TIMI) and Globle Register Acute Coronary Events (GRACE) are used, but the sophisticated calculation usually makes them inconvenient to operate at bedside in daily

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* Corresponding author. No 1 Minded Road, Nanchang, Jiangxi, China 330006 Tel./fax: +86 791 86262262.

E-mail addresses: shangguan8910@163.com (Q. Shangguan), xujinsong636@sohu.com (J. Xu), suyihappy@sohu.com (H. Su), ljx912@126.com (J. Li), wwy20080601@163.com (W. Wang), hongkui88@163.com (K. Hong), xiaoshumenfan@126.com (X. Cheng).

[1] Contributed equally.

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clinical practice [9,10]. Recently, Huang et al [11] suggested that admission SI of 0.7 or greater is a useful predictor for short-term outcomes in the patients with STEMI. Other studies also indicated that an SI of 0.8 of greater is a novel predictor for inhospital and long-term mortality in the patients with STEMI [12,13]. These results provided a simple index for risk stratification in the patients with STEMI.

In last year, a new index, modified shock index (MSI), is created as the ratio of HR and mean artery pressure (MAP) [12] because DBP is an undeniable parameter when determining clinical severity. Some studies have found that MSI is a better predictor than SI for the outcome in adult patients with trauma [14,15]. However, the predictive value of MSI has not been evaluated in the patients with STEMI. This study was to identify whether MSI is better than SI for predicting the short-term outcomes in the patients with STEMI.

2. Patients and methods

This retrospective study included 160 consecutive patients with acute STEMI attended to the emergency department (ED) in our hospital from September 2013 to October 2014. The including criteria are arriving in the ED within 12 hours after symptom onset, diagnosis of STEMI, and received emergency percutaneous coronary intervention (PCI) later. ST-segment elevation myocardial infarction was defined as follows: chest pain or equivalent symptoms in combination with dynamic electrocardiographic changes consistent with STEMI (in the presence of ST elevation >0.1 mV in ≥2 extremity leads, >0.2 mV in ≥2 precordial leads, or accompanying with left bundle branch block morphology) and increased serum biochemical markers of cardiac necrosis, including creatine kinase–MB and troponin I. The excluding criteria were atrial fibrillation and obvious arrhythmia at blood pressure (BP) measurement.

Age, sex, and histories of myocardial infarction, hypertension, diabetes, and heart failure were obtained. Fasting blood glucose, results of coronary angiography, and Killip classes were also recorded [16].

All patients received standard medication therapy according to the detection of physicians under the guidelines for the management of STEMI, including antiplatelet and anticoagulation, statins, angiotensin-converting enzyme inhibitor or angiotensin receptor antagonists, nitrates, β-blockers, calcium channel blockers [8,17,18]. The use of vascular active drugs including dopamine, adrenaline, noradrenaline, metaraminat, and isoprenaline was recorded.

2.1. SI and MSI

The BP and HR measured (Comen C50 Multi-parameter Patient Monitor, Shenzhen COMEN Medical Instruments CO, Shenzhen, China) at ED were used to calculate SI and MSI. Blood pressure and HR were measured twice with 1-minute interval, and their average was used as final value.

Shock index is the ratio of HR to SBP.

Modified shock index is the ratio of HR to mean blood pressure (MAP). Here, $MAP = [(DBP \times 2) + SBP]/3$.

The cutoff value of SI was referred as 0.7 in the study by Huang et al [11], whereas the cutoff value of MSI was determined as 1.4 on the receiver operating characteristic curve. The C-statistic of MSI of 1.4 was 0.690.

2.2. Major adverse cardiac events

In this study, major adverse cardiac events (MACE) include all-cause mortality, life-threatening arrhythmias (LTA), cardiogenic shock, and heart failure within 7 days. The all-cause mortality was defined death caused by any reason; cardiogenic shock was defined as persistent hypotension (SBP <90 mm Hg) that did not respond to fluid titration and requirement of an intra-aortic balloon pump or intravenous inotropic therapy. Heart failure was diagnosed on the Killip class of II or more. Life-threatening arrhythmias included sustained ventricular tachycardia and ventricular fibrillation in hospitalization [8,18].

3. Statistical analysis

All statistical analyses were carried out using the SPSS statistical software, version 19.0 (SPSS Inc, Chicago, IL).The data were presented with mean ± SD or median and interquartile range for continuous variables and were compared by analysis of variance and Bonferroni correction if the data had normal distribution, otherwise by Wilcoxon signed rank test. Categorical variables presented as percentage were compared by the Pearson χ^2 test.

Multiple logistic regression analysis was performed for 7-day MACE [12]. The dependent variables were SI of 0.7 or greater (or MSI ≥1.4), age, sex (male, 1; female, 2), the history of old myocardial infarction (yes, 1; no, 2), diabetes (yes, 1; no, 2), hypertension (yes, 1; no, 2), stroke (yes, 1; no, 2), and the levels of blood blood glucose. *P* values were statistically significant at <.05.

Table 1
The general information of the studies patients and the comparison between 2 groups divided on SI of 0.7 or more or MSI of 1.4 or more

Variable	All (n = 160)	SI <0.7 (n = 88)	SI ≥0.7 (n = 72)	*P*	MSI <1.4 (n = 111)	MSI ≥1.4 (n = 49)	*P*
Age (y)	65.5 ± 13.1	64.5 ± 13.0	66.6 ± 13.4	>.05	63.9 ± 12.9	69.0 ± 13.0	<.01
Male	132 (82.5%)	73 (83.0%)	59 (81.9%)	>.05	92 (82.9%)	40 (81.6%)	>.05
History of MI	3 (1.9%)	1 (1.81%)	2 (2.8%)	>.05	2 (1.8%)	1 (2.0%)	>.05
Diabetes mellitus	32 (20%)	17 (19.3%)	15 (20.8%)	>.05	22 (19.8%)	10 (20.4%)	>.05
Hypertension	92 (57.5%)	54 (61.4%)	38 (52.8%)	>.05	68 (61.3%)	24 (49.0%)	>.05
History of stroke	10 (6.3%)	5 (5.7%)	5 (6.9%)	>.05	7 (6.3%)	3 (6.1%)	>.05
Onset to admission intervals (h)[a]	5.0 (4.0, 8.0)	5.0 (4.0, 7.5)	5.0 (4.0, 8.0)	>.05	5.0 (4.0, 7.5)	5.25 (4.0, 8.0)	>.05
SBP (mm Hg)	119.1 ± 24.9	130.6 ± 23.5	105.1 ± 18.7	<.01	126.7 ± 23.4	101.9 ± 18.9	<.01
DBP (mm Hg)	73.2 ± 14.9	77.1 ± 14.3	68.5 ± 14.1	<.01	76.8 ± 13.7	65.0 ± 14.3	<.01
MAP (mm Hg)	64.1 ± 12.2	69.2 ± 11.6	57.8 ± 9.9	<.01	67.8 ± 11.3	55.6 ± 9.8	<.01
Heart rate (beat/min)[a]	77 (68, 90)	71 (61, 78)	90 (79, 102)	<.01	72 (64, 81)	93 (84, 107)	<.01
Killip class				>.05			>.05
I	139 (86.9%)	78 (88.6%)	61 (84.7%)		100 (90.1%)	39 (79.6%)	
II	15 (9.4%)	8 (9.1%)	7 (9.7%)		9 (8.1%)	6 (12.2%)	
III	2 (1.3%)	0	2 (2.8%)		0	2 (4.1%)	
IV	4 (2.5%)	2 (2.3%)	2 (2.8%)		2 (1.8%)	2 (4.1%)	
Blood sugar (mmol/L)[a] culprit vessel	6.2 (5.2, 7.7)	6.4 (5.2, 7.7)	5.9 (5.2, 7.4)	>.05	6.1 (5.2, 7.3)	6.7 (5.3, 8.3)	>.05
Anterior descending artery	81 (50.6%)	46 (52.3%)	35 (48.6%)	>.05	60 (54.1%)	21 (42.9%)	>.05
Left circumflex branch	18 (10.6%)	7 (8.0%)	10 (13.9%)	>.05	8 (7.2%)	9 (18.4%)	.050
Right coronary artery	62 (38.8%)	35 (39.8%)	27 (37.5%)	>.05	43 (37.8%)	19 (38.8%)	>.05

Data are presented as mean ± SD, number (percentage), or median (25th, 75th percentiles).
[a] Median (25th, 75th percentiles).