ISSN 2618-1584 Vol. 4, Issue 14: 37-42, DOI: 10.25236/FMSR.2022.041405

Analysis of Risk Factors for Acute ST-segment Elevation Myocardial Infarction Complicated by Cardiac Rupture

Hao Chen[1,a], Shaning Yang[1,b,*]

[1]The First Affiliated Hospital of Yangtze University, Jingzhou, Hubei, China
[a]1018967318@qq.com, [b]yang-sn130@sina.com
[*]Corresponding author

Abstract: *Objective: Cardiac rupture is a catastrophic but uncommon complication of acute ST-segment elevation myocardial infarction (STEMI). In today's era, the incidence and risk factors associated with cardiac rupture are unclear, and the purpose of this study was to investigate the risk factors for complications of cardiac rupture. Methods: From June 2019 to June 2022, 416 patients with STEMI admitted From June 9 to June 2022, 416 patients with STEMI admitted to the Department of Cardiovascular Medicine of the First People's Hospital of Jingzhou City were selected, and the clinical characteristics of patients with STEMI and patients with concomitant cardiac rupture were collected and analyzed. Results: Twenty-six (6.3%) cardiac ruptures were clinically confirmed, including 23 (6.3%) cardiac ruptures in patients with STEMI and patients with concomitant cardiac rupture. clinically confirmed, including 23 (88.5%) left ventricular free wall ruptures and 3 (11.5%) ventricular septal ruptures, of which 14 (53.8%) were Binary logistic regression analysis showed that women (OR:4.82, 95% CI: 2.143 to 10.843, P=0) and older age (OR:1.066, 95% CI: 1.014 to 1.121, P=0.012) increased the risk of cardiac rupture, while effective pPCI (OR:0.146, 95% CI: 0.057 to 0.379, P=0) helped prevent cardiac Smoking (OR:0.092, 95% CI: 0.021 to 0.403, P=0.002) appeared to reduce the risk of cardiac rupture complicated by STEMI. Conclusion: In this study women, old age, and low pPCI reperfusion therapy increased the risk of cardiac rupture complicating STEMI, so early prevention and treatment should be achieved.*

Keywords: *ST-Elevation Myocardial Infarction, Cardiac Rupture, Risk Factors*

Cardiac rupture (CR) is a catastrophic complication of acute ST-segment myocardial infarction (STEMI) and is classified according to the location of rupture as free wall rupture (FWR), ventricular septal perforation (VSR), and papillary muscle rupture (PMR). With the widespread use of primary percutaneous coronary intervention (pPCI) and pharmacological treatment, the incidence of CR has gradually decreased over the past decades[1] .However, CR remains a common cause of in-hospital death in STEMI[2] . Due to the poor prognosis, early diagnosis and treatment of CR is crucial and requires us to identify the risk factors for CR in advance and intervene early. Since current treatment focuses on pPCI and pharmacological therapy, and risk factors for cardiac rupture after STEMI are not well understood, the aim of this study was to investigate the risk factors for concomitant CR in patients hospitalized with STEMI.

1. Materials and Methods

1.1 Study population

416 patients with AMI were admitted to the Department of Cardiovascular Medicine of the First Affiliated Hospital of Yangtze University from June 2019 to June 2022, of whom 26 (6.3%) were diagnosed with cardiac rupture after STEMI, including 23 cases of left ventricular free wall rupture, 3 cases of septal rupture, and 0 cases of papillary muscle rupture. Patients were analyzed for basic information (age, sex), history (diabetes, smoking, hypertension, cerebrovascular lesions), infarct site, time of first visit, Killip classification, laboratory data (blood count, creatinine, etc.), perfusion therapy, drug therapy, and prognosis.

ISSN 2618-1584 Vol. 4, Issue 14: 37-42, DOI: 10.25236/FMSR.2022.041405

1.2 Diagnostic criteria

The clinical diagnosis of AMI should be accompanied by at least two of the following three features: chest pain, elevated cardiac enzymes (CK-MB, cTnI) and acute electrocardiographic changes. Myocardial infarction site determination: anterior wall myocardial infarction refers to ST-segment elevation in leads V1 -V6, I and aVL of ECG; inferior wall myocardial infarction refers to ST-segment elevation in leads II, III, aVF and V7 -V9 of ECG; posterior wall, inferior wall and right ventricular myocardial infarction refers to ST-segment elevation in leads II, III, aVF, V7 -V9 and V3R -V5R; multiwall myocardial infarction refers to greater than or equal to two infarction sites. Diagnostic criteria for free wall rupture:signs and symptoms of pericardial tamponade, inaudible or absent heart sounds, undetectable blood pressure, absent pulse, electro-mechanical separation, echocardiography suggestive of emerging pericardial compression, and pericardial puncture to extract non-coagulable blood. Diagnostic criteria for papillary muscle rupture: A loud, rough systolic murmur in the apical region, conduction to the axilla, with acute left heart failure, and a large amount of mitral regurgitation visible on echocardiography or direct observation of papillary muscle rupture. Diagnostic criteria for ventricular septal perforation: A rough, full systolic murmur with extensive conduction between 3-4 ribs at the left edge of the sternum with systolic tremor or manifestations of right heart failure, atrioventricular block on electrocardiogram, and a bundle of blood flow through the septum on echocardiogram.

1.3 Statistical methods

Mean values with SDs and counts with percentages were used to describe clinical characteristics and factors related to cardiac rupture, along with the evaluation of the differences by conducting unpaired T test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Binary logistic regression analysis with interaction terms was also performed to determine the possible factors influencing cardiac rupture. All P values were two-sided, and P values of <0.05 were considered as statistically significant. The SPSS 26.0 (SPSS Inc, Chicago, Illinois, USA) was used to perform statistical analyses.

2. Results

2.1 Clinical features of STEMI patients with cardiac rupture

Table 1: Basic characteristics of STEMI patients with cardiac rupture

Characteristics	values
Incidence of cardiac rupture in STEMI patients, *n*/*n* (%)	26/416(6.3%)
Sex: female, n/n(%)	14/26(53.8%)
Age(years, $\bar{x}\pm s$)	70.88(8.282)
Smoking, n/n(%)	3/26(11.5%)
Hypertension, n/n(%)	11/26(42.3%)
DM , n/n(%)	4/26(15.4%)
Stroke/TIA, n/n(%)	2/26(7.7%)
Time from symptom onset to door, n/n(%)	
≤6h	9/26(34.6%)
6h-12h	6/26(23.1%)
≥12h	11/26(42.3%)
Myocardial infarction site, n/n(%)	
Anterior wall	13/26(50.0%)
Inferior wall	8/26(30.8%)
2 walls or more	5/26(19.2%)
Location of cardiac rupture, n/n(%)	
Left ventricle free wall	23/26(88.5%)
Ventricular septum	3/26(11.5%)
Time of cardiac rupture occurrence after STEMI symptom onset, n/n(%)	
≤24h	11/26(42.3%)
24-7d	14/26(53.8%)
≥7d	1/26(3.8%)
pPCI ,n/n(%)	8/26(30.8%)
In-hospital death, n/n(%)	22/26(84.6%)

$\bar{x}\pm s$: Mean values ± SDs ; DM: diabetes mellitus; TIA: transient ischemic attack; pPCI: primary percutaneous coronary intervention

From June 2019 to June 2022, 416 patients with acute STEMI were admitted to Jingzhou First People's Hospital. More than 2/3 of these patients were male (78.4%). There were 26 (6.3%) clinically

ISSN 2618-1584 Vol. 4, Issue 14: 37-42, DOI: 10.25236/FMSR.2022.041405

confirmed cardiac ruptures, of which 14 (53.8%) were female and 12 (46.2%) were male with a mean age of 70.9±8.3. Left ventricular free wall rupture (88.5%) significantly outnumbered septal rupture (11.5%). Among patients with cardiac rupture, anterior wall myocardial infarction was the most common (50%), followed by inferior wall myocardial infarction (30.8%), and multiwall myocardial infarction was relatively uncommon (19.2%). Delayed time to first hospital visit was particularly common in 42% of patients, compared with 23.1% and 34.6% for visits of 6h-12h and less than 6h, respectively. 42.3%. Only 8 patients in the ruptured heart group were treated with PPPCI without surgical intervention. Of the 26 cardiac ruptures, deaths amounted to 22 (84.6%) and 4 were referred to higher hospitals for treatment.

2.2 Clinical features of patients with acute ST-segment elevation myocardial infarction with or without cardiac rupture

Of the 416 patients with acute STEMI (Table 2), 26 (6.3%) had a clinically confirmed diagnosis of

Table 2: Comparison of clinical characteristics of non-cardiac rupture and cardiac rupture in patients with acute ST-segment elevation myocardial infarction

Patients	In total rupture	Without cardiac rupture	With cardiac	P value
Patients, n(%)	416	390	26	
Female, n(%)	90/416(21.6)	76/390(19.5%)	14/26(53.85%)	<0.05
Age(years, $\bar{x}$±s)	60.85(11.9)	60.18(11.8)	70.88(8.3)	<0.05
Smoking, n(%)	233/416	230/390(59.0%)	3/26(11.5%)	<0.05
Hypertension ,n(%)	189/416	178/390(45.6%)	11/26(42.3%)	0.741
DM, n(%)	92/416	88/390(22.6%)	4/26(15.4%)	0.393
Stroke/TIA n(%)	30/416	28/390(7.2%)	2/26(7.7%)	1
Blood pressure(mmHg， $\bar{x}$±s)				
SBP	129.64(26.6)	130.12(26.0)	122.58(33.3)	0.161
DBP	82.54(16.1)	82.71(15.6)	79.92(22.4)	0.394
Heart rate(beats/min， $\bar{x}$±s)	79.4(19.1)	79.36(18.7)	79.92(23.8)	0.885
Time from symptom onset to door, n(%) ≤6h	46/416(59.1%)	237/390(60.8%)	9/26(34.6%)	
6h-12h	40/416(9.6%)	34/390(8.7%)	6/26(23.1%)	0.01
≥12h	130/416(31.3 %)	119/390(30.5%)	11/26(42.3%)	
Myocardial infarction site, n(%)				0.501
Anterior wall	220/416(52.9 %)	207/390(53.1%)	13/26(50.0%)	
Inferior wall	145/416(34.9 %)	137/390(35.1%)	8/26(30.8%)	
2 walls or more	50/416(12.0%)	45/390(11.5%)	5/26(19.2%)	
Killip class, n(%)				
I	321/416 (77.2%)	305/390(78.2%)	16/26(38.5%)	0.05
II-IV	95/416 (22.8%)	85/390(21.8%)	10/26(21.8%)	0.05
WBC(10^9/L， $\bar{x}$±s)	10.9(7.9)	10.8(8.2)	12.5(2.9)	0.298
Hb(g/L, $\bar{x}$±s)	133.0(20.3)	134.0(8.2)	124.1(14.6)	0.02
PLT(10^9/L, $\bar{x}$±s)	214.9(124.9)	215.9(128.0)	200.0(59.9)	0.531
Cr(μmol/L, $\bar{x}$±s)	98.8(95.1)	99.1(97.1)	93.2(32.3)	0.759
ACEI/ARB	157(37.7%)	151(36.3%)	6(1.4%)	0.111
β- receptor blocker n(%)	152(36.5%)	148(35.6%)	4(1.0%)	0.021
pPCI, n(%)	298/416	290/390(74.4%)	8/26(30.8%)	<0.01
In-hospital death, n(%)	41/416	19/390(4.9%)	22/26(84.6%)	<0.01

DM: diabetes mellitus; TIA: transient ischemic attack; SBP: systolic blood pressure; DBP: diastolic blood pressure; WBC: white blood cell; Hb: hemoglobin; PLT: platelet; Cr: creatinine; ACEI/ARB: angiotensin-converting enzyme inhibitors/angiotensin receptor blockers; pPCI: primary percutaneous coronary intervention cardiac rupture.

Compared to non-cardiac rupture, the following factors were more likely to be associated with cardiac

ISSN 2618-1584 Vol. 4, Issue 14: 37-42, DOI: 10.25236/FMSR.2022.041405

rupture (P< 0.05): female, elderly patients, smoking, decreased hemoglobin, time to first medical contact, and lower receipt of pPCI and β-blocker therapy. In contrast, hypertensive disease, diabetes, cerebrovascular disease, admission blood pressure and heart rate, site of myocardial infarction, Killip classification, red blood cells, hemoglobin, creatinine, and ACEI/ARB treatment did not differ statistically significantly (P> 0.05) between the cardiac rupture and non-cardiac rupture groups.

Based on the analysis of potential factors affecting heart rupture, further multivariate binary logistic analysis was performed (Table 3). Our findings showed that among all potential factors, female (OR:4.82, 95% CI: 2.143 ~ 10.843 , P=0) and age (OR:1.066, 95% CI: 1.014 to 1.121, P=0.012) increased the risk of cardiac rupture, whereas effective pPCI (OR:0.146, 95% CI: 0.057 to 0.379, P=0) helped to prevent cardiac rupture after STEMI. Surprisingly smoking (OR:0.092, 95% CI: 0.021 to 0.403, P=0.002) appeared to reduce the risk of post-STEMI cardiac rupture.

Table 3: Binary logistic analysis of factors associated with heart rupture

Variables	B	SE	wald	P	OR	95% CI
Female	1.573	0.414	14.457	0.000	4.820	2.143 ~ 10.843
Age	0.064	0.026	6.239	0.012	1.066	1.014 ~ 1.121
Smoking	-2.383	0.753	10.023	0.002	0.092	0.021 ~ 0.403
Time from symptom onset to door			2.872	0.238		
Time from symptom onset to door 6h-12h	1.074	0.643	2.792	0.095	2.928	0.83 ~ 10.325
Time from symptom onset to door ≥12h	0.231	0.535	0.186	0.666	1.26	0.441 ~ 3.598
Hb	0.002	0.015	0.011	0.915	1.002	0.973 ~ 1.032
$\boldsymbol{\beta}$-receptor blocker	-0.995	0.598	2.77	0.096	0.370	0.114 ~ 1.194
pPCI	-1.922	0.485	15.68	0.000	0.146	0.057 ~ 0.379

OR: Odds ration; CI: confidence interval; Hb: hemoglobin; pPCI: Primary percutaneous coronary

3. Discussion

Cardiac rupture, a catastrophic complication following STEMI, has been challenging in all aspects from diagnosis to treatment. In this study, clinical data of STEMI patients were collected and analyzed to provide data for current treatment. In previous studies, women, elderly patients, no history of myocardial infarction and angina, single vessel occlusion, and hypertension were risk factors for cardiac rupture after acute myocardial infarction[3, 4] . The present study showed that women, elderly patients, and lack of pPCI reperfusion therapy were associated with the occurrence of cardiac rupture after myocardial infarction.

With the widespread use of pPCI and standardized drug therapy, the incidence of cardiac rupture after acute myocardial infarction has been significantly reduced[5, 6] . However, there has been no significant reduction in cardiac rupture mortality over the past 20 years[7] . Foreign studies suggest that the incidence of cardiac rupture after STEMI is 0.27%-0.9%, with a mortality rate of about 44.5%[2, 8] .A recent study in China found that the incidence of cardiac rupture complicating STEMI was 1.8%, with an in-hospital mortality rate of 89.3%[9] .A recent study in China found that the incidence of STEMI complicated by cardiac rupture was 1.8% and the in-hospital mortality rate was 89.3%. In the present study, the incidence of STEMI complicated by cardiac rupture was 6.3%, and the mortality rate was 84.6%. One of the most important reasons why the incidence of cardiac rupture was significantly higher in this study than in other studies was due to the significant inadequacy of pPCI reperfusion therapy (30.8%). Therefore, aggressive implementation of pPCI reperfusion therapy is an effective way to prevent cardiac rupture.

Of all the factors associated with cardiac rupture, age and female are probably the most relevant, as

ISSN 2618-1584 Vol. 4, Issue 14: 37-42, DOI: 10.25236/FMSR.2022.041405

has been confirmed in several clinical studies[10-13] . In another study, the incidence of cardiac rupture was found to be as high as 10% in patients > 70 years of age[14] . In an animal study, a higher incidence of CR was observed in older mice (12 months of age) than in younger mice (3 months of age), and pathological examination revealed a stronger inflammatory response and extracellular matrix damage in the infarcted myocardium of older mice[15] , and this evidence supports the idea that clinically CR is more likely to occur in older patients. The mean age of the cardiac rupture group in this study was significantly higher than that of the control group, suggesting that the risk of cardiac rupture increases with age, a finding consistent with previous studies. The rate of cardiac rupture was higher in women than in men in this study, which is consistent with the results of previous studies. The exact mechanism by which female patients are prone to cardiac rupture after acute myocardial infarction is unclear. It is speculated that it may be related to the small size of the female heart, thin ventricular walls, reduced fat content, and the tendency to become emotionally upset and agitated after myocardial infarction, which are factors that accelerate cardiac rupture after acute myocardial infarction. In clinical practice, most female AMI patients are older, so the effect of gender may be partially attributable to advanced age. Surprisingly, smoking is a traditional cardiovascular risk factor, and patients with a history of smoking in this study had a reduced risk of cardiac rupture after acute myocardial infarction, which may be associated with increased coronary collateral circulation formation from smoking[16] .

In patients with AMI, timely and effective pPCI is a key step to save the surviving myocardium and can greatly improve the prognosis of patients with acute myocardial infarction. Early reperfusion of the infarct-related artery is an important measure to prevent cardiac rupture. Early reperfusion therapy has been shown to be effective in reducing cardiac rupture after AM[5, 17] . Moreno et al.[18] in a study found that pPCI independently reduced the risk of FWR compared with thrombolysis (OR=0.46, 95% CI 0.22-0.96, p=0.0371). The proportion of pPCI treatments in the cardiac rupture group in this study was significantly lower than in the control group, which was associated with delayed first presentation and more severe disease in patients, making it difficult to complete timely pPCI treatment in such patients. Although this study did not show an association between time to first visit and cardiac rupture, Wei TF et al.[19] in their study analyzed the impact of time from the onset of patient symptoms to the first medical contact on the prognosis of patients with acute STEMI. The results of this study showed that time to first medical contact > 90 min was a risk factor for 1-year mortality (OR=2.90, 95% CI 1.22-6.92, P=0.016) and 1-year incidence of major adverse cardiovascular events (OR=5.19, 95% CI 1.21-22.20, P=0.026). Therefore, patients should be seen promptly when they develop symptoms.

Treatment with ACEI/ARB and beta-blocker is cardioprotective and helps prevent CR, as has been demonstrated in several studies[4, 20] . ACEI/ARB and β-blockers in this study did not show a protective effect in preventing cardiac rupture after acute myocardial infarction, considered to be related to the small sample size of this study, which did not show a significant difference. β receptor blockers The mechanism of preventing CR is unclear, one explanation is sympathetic excitation after myocardial infarction, which increases heart rate, elevates blood pressure, and enhances myocardial contractility, leading to the occurrence of CR , and Beta receptor blockers prevent cardiac rupture after AMI by inhibiting sympathetic excitation. ACEI/ARB has also been shown to prevent cardiac rupture after acute myocardial infarction in previous studies[20] and the effect was not demonstrated in the present study. Local inflammation is the main feature of the infarcted myocardium, with monocyte, neutrophil and macrophage infiltration as the main changes. ACEI/ARB attenuates the systemic and regional inflammatory response by blocking the release of monocytes and neutrophils from the spleen ACEI/ARB prevents cardiac rupture in the acute phase of AMI by blocking monocyte and neutrophil release from the spleen, thereby attenuating systemic and regional inflammatory responses[20] . Therefore, ACEI/ARB and β-blocker therapy should be given early in appropriate patients to prevent cardiac rupture.

This study has some limitations: firstly, this study was a single-center retrospective study with a small sample size, and the results of the statistical analysis may be highly biased. Second, the study population consisted of patients from a single regional teaching hospital; therefore, the results may not necessarily be applicable to patients from other hospitals. Third, the effect of unmeasured confounders cannot be completely excluded in this type of study.

In conclusion, this study suggests that women, old age, and lack of pPCI reperfusion therapy are risk factors for complications of cardiac rupture in patients with acute myocardial infarction. Therefore, early prevention, targeted treatment and care for patients with acute myocardial infarction at high risk of cardiac rupture may reduce the incidence of cardiac rupture.

ISSN 2618-1584 Vol. 4, Issue 14: 37-42, DOI: 10.25236/FMSR.2022.041405

References

[1] FIGUERAS J, ALCALDE O, BARRABES J A, et al. Changes in hospital mortality rates in 425 patients with acute ST-elevation myocardial infarction and cardiac rupture over a 30-year period [J]. Circulation, 2008, 118(25): 2783-9.

[2] FRENCH J K, HELLKAMP A S, ARMSTRONG P W, et al. Mechanical complications after percutaneous coronary intervention in ST-elevation myocardial infarction (from APEX-AMI) [J]. The American journal of cardiology, 2010, 105(1): 59-63.

[3] CHANG R-Y, TSAI H-L, HSIAO P-G, et al. Comparison of the risk of left ventricular free wall rupture in Taiwanese patients with ST-elevation acute myocardial infarction undergoing different reperfusion strategies: A medical record review study [J]. Medicine, 2016, 95(44): e5308.

[4] LOPEZ-SENDON J, GURFINKEL E P, LOPEZ DE SA E, et al. Factors related to heart rupture in acute coronary syndromes in the Global Registry of Acute Coronary Events [J]. European Heart Journal, 2010, 31(12): 1449-56.

[5] UERTO E, VIANA-TEJEDOR A, MARTINEZ-SELLES M, et al. Temporal Trends in Mechanical Complications of Acute Myocardial Infarction in the Elderly [J]. J Am Coll Cardiol, 2018, 72(9): 959-66.

[6] BIRNBAUM Y, FISHBEIN M C, BLANCHE C, et al. Ventricular septal rupture after acute myocardial infarction [J]. The New England journal of medicine, 2002, 347(18): 1426-32.

[7] MOREYRA A E, HUANG M S, WILSON A C, et al. Trends in incidence and mortality rates of ventricular septal rupture during acute myocardial infarction [J]. The American journal of cardiology, 2010, 106(8): 1095-100.

[8] ELBADAWI A, ELGENDY I Y, MAHMOUD K, et al. Temporal Trends and Outcomes of Mechanical Complications in Patients with Acute Myocardial Infarction [J]. JACC Cardiovasc Interv, 2019, 12(18): 1825-36.

[9] HAO Z, MA J, DAI J, et al. A real-world analysis of cardiac rupture on incidence, risk factors and in-hospital outcomes in 4190 ST-elevation myocardial infarction patients from 2004 to 2015 [J]. Coron Artery Dis, 2020, 31(5): 424-9.

[10] FU Y, LI K-B, YANG X-C. A risk score model for predicting cardiac rupture after acute myocardial infarction [J]. Chin Med J (Engl), 2019, 132(9): 1037-44.

[11] MENON V, WEBB J G, HILLIS L D, et al. Outcome and profile of ventricular septal rupture with cardiogenic shock after myocardial infarction: a report SHould we emergently revascularize Occluded Coronaries in cardiogenic shocK? [J]. Journal of the American College of Cardiology, 2000, 36(3 Suppl A): 1110-6.

[12] CRENSHAW B S, GRANGER C B, BIRNBAUM Y, et al. Risk factors, angiographic patterns, and outcomes in patients with ventricular septal defect GUSTO-I (Global Utilization of Streptokinase and TPA for Occluded Coronary Arteries) Trial Investigators [J]. Circulation, 2000, 101(1): 27-32.

[13] MARKOWICZ-PAWLUS E, NOZYŃSKI J, SEDKOWSKA A, et al. Cardiac rupture risk estimation in patients with acute myocardial infarction treated with percutaneous coronary intervention [J]. Cardiol J, 2007, 14(6): 538-43.

[14] BUENO H, MARTINEZ-SELLES M, PEREZ-DAVID E, et al. Effect of thrombolytic therapy on the risk of cardiac rupture and mortality in older patients with first acute myocardial infarction [J]. Eur Heart J, 2005, 26(17): 1705-11.

[15] GAO X M, WHITE D A, DART A M, et al. Post-infarct cardiac rupture: recent insights on pathogenesis and therapeutic interventions [J]. Pharmacol Ther, 2012, 134(2): 156-79.

[16] KOERSELMAN J, DE JAEGERE P P T, VERHAAR M C, et al. Coronary collateral circulation: the effects of smoking and alcohol [J]. Atherosclerosis, 2007, 191(1): 191-8.

[17] Birnbaum Y, Fishbein MC, Blanche C, Siegel RJ. Ventricular septal rupture after acute myocardial infarction. N Engl J Med. 2002 Oct 31; 347(18):1426-32.

[18] Moreno, Raúl et al. "Primary angioplasty reduces the risk of left ventricular free wall rupture compared with thrombolysis in patients with acute myocardial infarction." Journal of the American College of Cardiology vol. 39, 4 (2002): 598-603.

[19] WEI T F, ZHAO B, LIU P L, et al. [Impact of symptom onset to first medical contact time on the prognosis of patients with acute ST-segment elevation myocardial infarction] [J]. Zhonghua Xin Xue Guan Bing Za Zhi, 2017, 45(5): 393-8.

[20] Gao XM, Tsai A, Al-Sharea A, Su Y, Moore S, Han LP, Kiriazis H, Dart AM, Murphy AJ, Du XJ. Inhibition of the Renin-Angiotensin System Post Myocardial Infarction Prevents Inflammation-Associated Acute Cardiac Rupture. Cardiovasc Drugs Ther. 2017 Apr; 31(2):145-156.