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Original Article

Early and Midterm Prognoses of Mechanical Complications Following Acute Myocardial Infarction: Role of Surgical Repair in Improving Survival

Farshad Shakerian[1], MD; Hamid-Reza Sanati[1], MD; Hosein Hoseinzadeh[2], MD; Ata Firouzi[1], MD; Ali Zahedmehr[1], MD; Reza Kiani[1], MD; Mahdieh Doaee[3], MD; Akbar Nikpajouh[2]*, MD

ABSTRACT

Background: Large numbers of patients are faced with mechanical complications after myocardial infarction (MI). Such complications occur when the patient does not receive immediate treatment, leading to adverse consequences and even death. The present study was conducted to determine the short- and long-term prognoses of this group of mechanical complications.

Method: The present case-series study recruited all patients (N = 88) who had a diagnosis of cardiac mechanical complications following acute MI at Rajaie Cardiovascular, Medical, and Research Center between 2005 and 2011. The short-term prognosis of the study population was recorded before discharge (hospital mortality rate), and the patients were followed up 6 months later through phone calls. The results and 6 months' prognosis—including mortality, survival rate, and hospitalization—were recorded again.

Results: The mean age of the study population was 70.50 ± 10.23 years (31–95 y) and 46.6% were male. The most common complications were apical ventricular septal rupture (VSR) (67.1%), ventricular free-wall rupture (14.8%), basal VSR (7.9%), pseudoaneurysm (4.5%), VSR with pseudoaneurysm (3.4%), and papillary muscle rupture (2.3%)–respectively. The rate of death caused by mechanical complications was 4.61%. The rate of re-hospitalization was 6.8%. In this study, 36.3% of the patients died after reconstructive surgery and 34.1% of them died after medical treatment in the hospital. The 6-month survival rate of the patients was 34.1%.

Conclusions: The mechanical complications of the heart occur mainly in women and older patients. In this regard, apical VSR and ventricular free-wall rupture are the most common complications. However, in the case of timely medical interventions such as reconstructive surgery, the survival rate improves significantly. ***(Iranian Heart Journal 2017; 18(4):21-28)***

KEYWORDS: Myocardial infarction, Angiography, Echocardiography, Ventricular septal rupture, Coronary angiography

[1] Cardiovascular Intervention Research Center, Rajaie Cardiovascular, Medical, and Research Center; Iran University of Medical Sciences, Tehran, IR Iran.
[2] Rajaie Cardiovascular, Medical, and Research Center, Iran University of Medical Sciences, Tehran, IR Iran.
[3] Community Medicine Specialist, Iran University of Medical Sciences, Tehran, IR Iran.

***Corresponding Author:** Akbar Nikpajouh, MD; Rajaie Cardiovascular, Medical, and Research Center, Iran University of Medical Sciences, Tehran, IR Iran.
Email: dr.nikpajouh@gmail.com **Tel:** 02123922719

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The most common mechanical complications after acute myocardial infarction (MI) include ventricular septal rupture (VSR), papillary muscle rupture (PMR), cardiac free-wall rupture, pseudoaneurysm, and true aneurysm. Rupture of the heart muscle is one of the most common complications after MI (1%–4%), and it accounts for 20% of deaths in patients with these complications. [1] Such complications are reduced significantly after early revascularization. Patients with this disease often experience their first episode of infarction and do not mention a history of angina. [2] It is seen mainly in women and people over 55 years of age. The patients are faced with long-term hospitalization; 50% of the patients are hospitalized for less than 5 days but more than 90% of them are hospitalized for more than 15 days. VSR occurs in about 1% to 2% of all patients after acute MI. [3] The incidence of this disorder declines significantly after reperfusion treatment. In a trial conducted by Becker et al, [1] the VSR incidence was reduced to about 0.2%. The mortality rate in these patients after drug treatment is high: about 24% in the first 3 days and 75% in the 3-week period after the occurrence; consequently, the surgical treatment of the injury must be a priority. Other complications are PMR and moderate-to-severe valve failure (especially mitral valve), occurring in 13% to 45% of the patients following acute MI. [4-6] The immediate treatment of patients through surgery should be taken into consideration, and coronary artery angiography is necessary before surgery. The medical treatment of this group of patients is associated with undesirable prognoses, but the replacement of the mitral valve and the restoration of papillary muscles with revascularization are associated with short- and long-term improvement in the outcome. [7]
Another important complication is free-wall rupture, which occurs in 1% to 6% of patients in the wake of acute MI, and it accounts for 10% of mortality cases following acute MI. [8, 9] Almost 50% of the cases of this complication occur in the first 5 days and 90% of the cases occur in the first 2 weeks. This complication is seen only in patients with acute MI. Other important risk factors for this complication are older age, female gender, hypertension, first-time infarction, and low numbers of collaterals in coronary arteries. The main treatment of this complication is open-heart surgery and the immediate restoration of the rupture. [9] Another important complication is the occurrence of pseudoaneurysms following rupture in the left ventricular free wall. The aneurysm may be mild or severe. In one-third of the patients, aneurysms might be seen with simultaneous rupture. Emergency surgery is recommended for all patients because this complication without treatment can lead to sudden death. [10]
Other mechanical complications following acute MI are a variety of aneurysms and cardiogenic shock. [11] The occurrence of acute mitral failure is another mechanical complication, with a prevalence rate of 1% to 2% before treatment with thrombolytics. This complication is also reduced mainly after revascularization. Acute mitral failure is also observed frequently in women and in older patients with a history of hypertension; it occurs mainly at the inferior wall of the heart rather than its anterior wall. This complication is associated with multiple coronary artery involvement in 40% of the cases. A significant number of patients are liable to suffer mechanical complications after MI, and if they do not receive immediate treatment, they will experience undesirable consequences and even sudden death. [12]
In a study conducted by Janion et al, [13] free-wall rupture in the left ventricle was seen in 2.86% of the patients. In their study, the diagnosis of rupture was based on clinical evidence and echocardiography, and the authors reported that the mortality rate in the patients with ventricular rupture was 55.6%—accounting for 20.5% of the total mortality in the study population. Additionally, while the

rate of mortality in the surgery group was 22.2%, it was 72.2% in the patients that underwent medical treatment.

In a study conducted by Singh et al, [14] ventricular rupture occurred in 8 males and 2 females, who underwent surgery following acute MI. The authors reported 5 cases of VSR, 4 cases of PMR, and 1 case of free-wall rupture in their study population. Following catheterization, all the patients underwent reconstructive surgery with and without coronary artery bypass graft surgery. Three patients with inferior wall MI died. All the patients with PMR underwent valve replacement, but one of them died after multi-organ failure. Additionally, those with septal wall rupture underwent emergency surgery, which was associated with 40% mortality.

Widmer et al [15] evaluated all patients with mechanical complications following MI over a 10-year period and reported that lack of timely revascularization, left ventricular ejection fraction less than 50%, Killip class higher than 2, and age higher than 70 years were the risk factors for mechanical complications.

In the present study, we sought to determine the short- and long-term prognoses of mechanical complications after MI in patients referring to Rajaie Cardiovascular, Medical, and Research Center.

METHOD

In the present case-series study—conducted at Rajaie Cardiovascular, Medical, and Research Center—all patients admitted with cardiac mechanical complications following acute MI as confirmed by echocardiography were consecutively enrolled between 2005 and 2011. The inclusion criteria comprised post-acute MI mechanical complications—namely PMR, VSR, free-wall rupture, and pseudoaneurysm. Patients were excluded if they were hospitalized for acute MI without any mechanical complications. Convenient sampling was used in this study, and the sample size was determined to be 88 patients. The data collected from the study population consisted of demographic data such as gender, age, height, and weight; history of risk factors for cardiovascular diseases such as hypertension, diabetes, dyslipidemia, dysphonia, and smoking; history of cardiovascular disorders such as cardiac arrhythmic disorders, history of coronary heart disease, history of heart valve diseases, history of any previous therapeutic intervention in the cardiovascular system, and history of hospitalization due to cardiovascular reasons; laboratory values for fasting plasma glucose, serum total cholesterol, triglycerides, high-density lipoprotein, and low-density lipoprotein; last blood pressure recorded after hospitalization; and the results of the angiographic reports such as the number of the coronary arteries involved, left main lesions, and the left ventricular ejection fraction.

The demographic characteristics of the patients with mechanical complications were collected by referring to their medical file, and their short-term prognosis before discharge (hospital mortality) was recorded. Six months later, the patients were followed up through phone calls and their 6-month results and prognosis—including mortality, survival rate, and re-hospitalization—were recorded.

Statistical Analysis

The results are expressed as means and standard deviations (means ± SDs) for the quantitative variables and as percentages for the qualitative variables. Comparisons between the quantitative variables of the 2 groups were performed using the T-test or the Mann–Whitney test. Comparisons between the qualitative variables were also performed using the χ^2 test or the Fisher exact test. The Kaplan–Meier curve was used to determine the survival rate of the patients. A *P* value less than 0.05 was considered statistically significant. For the statistical analysis of the data, SPSS 15 and SAS 9.1 were employed.

Ethical considerations

All the patients were interviewed, and they underwent diagnostic tests by their own treating physicians. Written informed consent was obtained from all the patients or their first-degree relatives. The patients were reassured that all their information in the study would be kept confidential and they were allowed to leave the study at any point. This study was funded by the project executor, and no expense was imposed on the hospital and the patients in this regard.

RESULTS

The study population was comprised of 88 patients: 46.5% male and 53.4% female. In terms of the prevalence of the risk factors for heart disease, 71.6% of the study population had hypertension, 40.9% hyperlipidemia, and 58% diabetes mellitus. Accordingly, the most common heart disease risk factor was hypertension, followed by diabetes and hyperlipidemia. The mean blood glucose level was 163.00 ± 97.69 mg/dL, and it was above 200 mg/dL in 24 patients. The mean serum total cholesterol level was 163.00 ± 45.93 mg/dL; it was higher than 200 mg/dL in 16 patients. The mean high-density lipoprotein level in the patients was 36.00 ± 5.95 mg/dL; it was lower than 40 mg/dL in 67 patients. The mean low-density lipoprotein level in the patients was 110.00 ± 27.65 mg/dL, and it was higher than 100 mg/dL in 61 patients.

Apropos the type of the myocardial wall position involved in MI, the most involvement was seen in the anterior wall (78.4%), followed by the inferior wall (13.6%). In 4.5% of the cases, the inferior-posterior wall involvement was observed. The mean left ventricular ejection fraction was 35.00 ± 8.15%. In terms of the number of the coronary arteries involved, in the patients who underwent coronary angiography (n = 74), 1-artery involvement (20.5%), 2-artery involvement (25%), and 3-artery involvement (38.6%) were reported. None of the patients that underwent angiography had left main involvement, and 43.2% of them were injected with streptokinase. Pertaining the incidence of the mechanical complications after MI, the most common complication was related to apical VSR (67.1%), followed by ventricular free-wall rupture (14.8%), basal VSR (7.9%), pseudoaneurysm (4.5%), VSR with pseudo-aneurysm (3.4%), and PMR (2.3%). With respect to the age distribution of the mechanical complications, different types of VSR were observed mainly in the women, while pseudoaneurysms and wall and muscle rupture were more common in the men. The prevalence of hypertension was observed mainly in the various VSR cases rather than in the other complications (Table 1). However, in regard to age distribution and the distribution of the other risk factors for heart disease, no significant difference was found between the various types of the mechanical complications. Vis-à-vis the distribution of the number of the coronary arteries involved in the mechanical effects, there was no significant difference, and nor was there any difference between the groups with various complications in terms of receiving streptokinase. Concerning the type of MI, no significant difference was found between the types of the mechanical complications and complications such as apical VSR occurring mainly after anterior wall MI, while ventricular wall rupture or aneurysm occurred mainly after inferior wall MI. In relation to mortality and morbidity after the mechanical complications of MI, the rate of hospital mortality was estimated to be 61.4%. In addition, 4 cases died during the 6-month period after hospital discharge. Re-hospitalization among the discharged patients was 6 (6.8%) cases. Out of the total patients, 58 (65.9%) cases underwent reconstructive surgery; 32 cases died in the hospital despite the reconstructive surgery. Out of the cases with medical treatment (34.1%), 22 patients died in the hospital. In total, the 6-month survival rate of the patients was 34.1%. No

significant difference was found between the various mechanical complications resulting from the occurrence of MI pertaining to the reconstructive surgery protocol. In addition, no significant difference was found between the types of the mechanical complications regarding the need for re-hospitalization. Nonetheless, mortality was mostly observed in the patients with free-wall rupture (84.6%), apical VSR (64.4%), and basal VSR (57.1%). Accordingly, the maximum 6-month survival rate of the patients was seen in those with pseudoaneurysm and PMR (Table 2). Our multivariate logistic regression analysis model revealed that among all the studied indicators, only reconstructive surgery was correlated with the patients' survival rate insofar as early reconstructive surgery—by comparison with medical treatment—increased the 6-month survival of the patients by 5.5 times (Table 3).

Table 1. Prevalence of the mechanical complications following MI related to the patients' risk factors

Variable	Apical VSR	Basal VSR	VSR With Aneurysm	Free-Wall Rupture	Papillary Rupture	Pseudoaneurysm	*P*
Male gender	37.3%	57.1%	33.3%	61.5%	100%	100%	0.049
Age > 70 y	55.9%	42.9%	66.7%	23.1%	0.0%	75.0%	0.105
Hypertension	79.7%	71.4%	66.7%	53.8%	0.0%	50.0%	0.050
Hyperlipidemia	35.6%	42.9%	66 .7%	69.2%	0.0%	25.0%	0.177
Diabetes mellitus	59.3%	57.1%	66.7%	61.5%	50.0%	25.0%	0.843
Number of diseased vessels							
1	27.1%	0.0%	66.7%	30.0%	0 .0%	0.0%	0.222
2	20.8%	42.9%	33.3%	60.0%	50.0%	25.0%	
3	52.1%	57.1%	0.0%	10.0%	50.0%	75.0%	
SK administration	45.8%	42.9%	66.7%	23.1%	100%	25.0%	0.216
Type of MI							
anterior wall	98.3%	0.0%	100%	53.8%	0.0%	25.0%	0.001
inferior wall	1.7%	100%	0.0%	23.1%	50.0%	0.0%	
Others	0.0%	0.0%	0.0%	23.l%	50.0%	75.0%	

MI, Myocardial infarction; VSR, Ventricular septal rupture; SK, Streptokinase

Table 2. Maximum 6-month survival rate of the patients with mechanical complications after MI

Variable	Apical VSR	Basal VSR	VSR With Aneurysm	Free-Wall Rupture	Papillary Rupture	Pseudo aneurysm	*P*
Surgical repair	57.6%	100%	100%	61.5%	100%	100%	0.070
Re-hospitalization	3.4%	14.3%	33.3%	7.7%	0.0%	25.0%	0.201
Early mortality	64.4%	57.1%	33.3%	84.6%	0.0%	0.0%	0.017

MI, Myocardial infarction; VSR, Ventricular septal rupture

Table 3. Correlation between the patients' survival rate and their risk factors (multivariate logistic regression analysis)

Variable	*P*	OR	Lower Limit	Upper Limit
Male gender	0.074	0.345	0.107	1.108
Age > 70 y	0.968	0.999	0.951	1.050
Hypertension	0.592	0.726	0.225	2.343
Hyperlipidemia	0.066	3.254	0.924	11.456
Diabetes mellitus	0.470	0.653	0.205	2.076
LVEF	0.541	0.979	0.913	1.049
SK use	0.163	2.204	0.727	6.686
Type of MI	0.690	1.199	0.492	2.923
Surgical repair	0.010	0.181	0.049	0.668

MI, Myocardial infarction; SK, Streptokinase; LVEF, Left ventricular ejection fraction

DISCUSSION

The present study can be deemed unique insofar as it is the first analytical and observational study on mechanical complications caused by MI in Iran. We carried out the current study to determine both the results and survival rate of patients with these complications during the first 6 months and the factors and variables predicting the survival of such patients. We found that the occurrence of these complications was high in the women and older patients; these results chime in with those reported by other studies. Concordant with our study, Tassel et al [16] evaluated 40 patients and reported that complications such as cardiac muscle rupture and acute mitral failure occurred mainly in the women and patients aged 55 or higher. Our results also revealed that the most common mechanical complication following MI was apical VSR, which had the highest frequency of all the complications compared to similar studies. In this regard, other complications such as free ventricular wall rupture, basal VSR, and VSR with pseudoaneurysm ranked after apical VSR in terms of the frequency of prevalence. Several studies have reported results that are similar to those obtained in the current study. [17-19] Another finding of the present study revealed that about two-thirds of the patients experiencing mechanical complications caused by MI suffered from hypertension. Indeed, hypertension was considered one of the important underlying factors in these patients; this finding is in line with the results of other studies. In a study conducted by Crenshaw et al [17] on patients who had received streptokinase after MI, it was revealed that hypertension was among the underlying factors in the mechanical complications after MI. In terms of the outcomes of mechanical complications arising from MI, we found that after this event, more than half of the patients died at the hospital and the 6-month survival rate of the patients was about 34%. Reconstructive surgery significantly increased the survival rate of the patients. The 6-month survival rate and the role of surgery as a method for preventing mortality have also been emphasized in other studies. In studies conducted by Stone et al [20] and Athanasuleas et al, [21] it was found that reconstructive surgery after the occurrence of the mechanical complications arising from MI increased the survival rate of the patients. In light of the results obtained, it is recommended that echocardiography be performed as a standard method to evaluate mechanical complications in patients with MI. Echocardiography is especially recommended for patients with hemodynamic abnormalities at the time of hospitalization. Although echocardiography is able to diagnose these complications accurately and completely, this procedure should be conducted by skilled experts in unstable patients. In stable patients and in case of lack of contraindications for surgery, experts should always consider reconstructive surgery. In the present study, we observed no relationship between the risk factors for heart diseases and mechanical complications arising from the occurrence of MI. Nevertheless, it is essential that these complications be controlled because this relationship might be confirmed in other studies, especially studies conducted with larger sample sizes.

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