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Surgical Treatment of Left Ventricular Free Wall Rupture after Myocardial Infarction: Case Series

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Aim. To analyze the results of surgical treatment of left ventricular free wall rupture after acute myocardial infarct in a case series.

Method. From 1984 to 2001, 25 patients (10 women and 15 men) were surgically treated in our Center for left ventricular free wall rupture after acute myocardial infarction. Their mean age was 62 years (range, 42-80). Cardiac symptoms (chest pain and/or dyspnea) prior to admission were recorded in 4 patients. One patient had acute myocaridal infarction of the anterolateral wall, 6 patients of the lateral wall, 13 patients of the anterior wall, 4 patients of the inferior wall, and one patient had a right ventricle infarction. Thrombolytic therapy was administered in 10 patients, according to the criteria of the American Heart Association and Spanish Society of Cardiology criteria. In all patients, the final diagnosis was established echocardiographically before the surgery.

Results. All patients underwent surgical intervention on an emergency basis. Extracorporeal circulation was used in the first 9 cases, whereas the next 16 patients had off-pump surgery. Two patients had heart arrest during off-pump surgery, which required extracorporeal circulation support. One patient was found false positive for rupture only at surgery. In the first 4 cases, we performed a direct suture after excising necrotic tissue, in the next 15 cases we sutured a patch over the infarction zone, and in the last 5 patients we used Teflon patch fixed with fibrin glue and polypropylene and stitched to the epicardium with a continuous suture. Out of 24 patients, 8 died: one in the surgical room from uncontrollable bleeding and another 7 between 30 and 90 days after the surgery in the intensive care unit. All of them underwent surgery with extracorporeal circulation. There were no deaths among the patients undergoing off-pump surgery. Three out of 4 patients in whom direct suture and necrotic tissue excision was performed died in the hospital. Five out of 19 patients in whom "patch" correction with direct suture was done died in the hospital.

Conclusion. The left ventricle free wall rupture, as a complication of acute myocardial infarction, can be diagnosed early and treated on time. Rapid diagnosis and emergency surgery are crucial for successful treatment of patients with impending heart rupture. Off-pump surgery and "patch with glue" technique seem to yield best results.

Key words: *adhesives; cardiac tamponade; extracorporeal circulation; heart rupture, post-infarction; myocardial infarction; myocardial ischemia; surgical procedures, operative*

The rupture of the left ventricle free wall after acute myocardial infarction is a rare event. There is no exact protocol in the surgical treatment of that complication and the repair outcome depends on several circumstances (1-6). Pharmacological treatment of the patients with acute myocardial infarction, which includes ß-blockers, angiotensin-converting enzyme (ACE) inhibitors, inotropic and volume support or fibrinolysis, can change the clinical form of present or impending rupture (1,2). The rupture occurs either within the first few hours (1,2), first two days (3), or up to 7 days (7) after myocardial infarction, depending on the thrombolytic treatment (1-7), age (6), and admission delay (2). The incidence of free wall rupture in patients with acute myocardial infarction varies between 1% and 5% (1-6) and is responsible for 12-25% of in-hospital deaths (3,6). The incidence of rupture after myocardial infarction increases with age and delay of thrombolytic treatment and hospital admission (1,2), amounting to 86% in patients over 70 years of age (1,6). Transthoracic echocardiography and pericardial puncture can confirm a suspicion of free wall rupture (8-14). Intra-aortic balloon pump was used with favorable outcome in patients with hemodynamic instability unresponsive to pharmacological inotropic support (8,12-15). There are many studies reporting on a variety of corrective techniques, from more aggressive ones, with excising

Table 1. Preoperative characteristics of patients undergoing surgical repair of the left ventricular free wall rupture[a]

Surgical intervention	No. of patients[b]	Sex (men/women)	Age (years; mean ± SD; median, range)	Timing of surgery[b] (< 12h/> 12h)	Thrombolytic therapy (yes/no)	Previous heart history (yes/no)
Direct suture over excised infarct zone	4	1/3	60.7 ± 8.6 (60, 52-71)	1/3	0/4	1/3
Suture of a patch over the infarct zone	15	6/9	63.2 ± 8.2 (62, 50-69)	7/8	6/9	5/10
Patch fixed with bio-glue over the infarct zone	5	2/3	62.6 ± 8.4 (62, 42-80)	4/1	4/1	2/3
Total	24	9/15	62.1 ± 8.5 (61, 42-80)	12/12	10/14	8/16

[a]In one patient out of initial 25, cardiac rupture could not be confirmed on surgery.
[b]No. of patients operated within 12 h after acute myocardial infarction (< 12), and after more than 12 h (> 12).

and direct suturing (14,15) of heart wall with teflon strips and reinforced stitches to careful epicardial patching (8) and sutureless patching (9-11) with cyanoacrylate (9,10) or fibrin glue (8) on the epicardial side of the heart. The techniques of infarction site exclusion with patch on the endocardial side were also described (8,16).

We reviewed our experience during the last 18 years and analyzed diagnostic indications, applied surgical methods, their evolution, and short- and mid-term outcome in surgically treated patients with heart rupture after acute myocardial infarction.

Patients and Methods

Patients

We analyzed a cohort of 25 patients treated in our hospital for a rupture of the left ventricle wall after transmural myocardial infarction, who were treated between 1984 and 2001. On admission, all patients were stage IV according to the New York Heart Association criteria (ie, unable to carry on any physical activity without discomfort, with symptoms of cardiac insufficiency or the anginal syndrome possibly present even at rest). Thrombolysis was administered in 10 patients, according to the criteria of the American College of Cardiology/American Heart Association (ACC/AHA) and Spanish Society of Cardiology (18-21).

A single patient had previous mitral valve conservative surgery, and 8 patients had evidence of previous cardiac history (Table 1). The period from the onset of acute myocardial infarction symptoms to the appearance of the free wall rupture was between 1 and 6 days, whereas in 2 cases it was difficult to determine the exact time of the infarct. Thirteen patients were surgically treated the second day, 9 the third day, and 3 on the sixth day after acute myocardial infarction.

Upon establishing the anatomical position of the infarction and corresponding heart wall rupture, a necrotic zone on the lateral left ventricular wall was found in 7 patients, on the diaphragmatic left ventricular wall in 3 patients, and on the anterior left ventricular wall in 14 patients. A single patient had a free wall rupture of the right ventricle.

Clinical diagnosis was based on the signs of cardiac tamponade, persistent pain, or ST elevation with cardiac failure, especially in patients with risk factors for free wall rupture (age > 60, one-vessel disease, and large transmural lesions, ref. 22). Bedside transthoracic echocardiography was always used as a diagnostic method. All patients had pericardial effusion and signs of cardiac tamponade. Most patients presented with a clinical picture suggesting the presence of intrapericardial clots. In one case, these findings were associated with severe mitral regurgitation due to papillary muscle rupture.

Pericardial puncture was used as a confirmation of the diagnosis. Swan-Ganz catheter was used in all cases with hemodynamic collapse (21).

In 4 patients, coronary angiography and ventriculography were done before the free wall rupture. Coronary angiography preformed preoperatively showed one-vessel disease in 3 patients, and three-vessel disease in one.

Clinical signs of cardiac tamponade were observed in 19 patients, 4 patients had cardiogenic shock, and 6 had persistent angina.

Once diagnosed, all patients received volume support and inotropic therapy (dobutamine preferentially and dopamine, 4-9 μg/kg/min). In 5 cases, an intra-aortic balloon pump was applied according to the guidelines of American College of Cardiology and American Heart Association (15,21). All patients were brought to the operating room in the shortest time (between 2 and 8 h), which allowed emergency surgical correction.

Surgical Management

All patients were operated by median sternotomy on an emergency basis. In one patient no macroscopic myocardial rupture/tear was visible. All patients showed immediate hemodynamic improvement after pericardial opening and heart decompression. A surgery with extracorporeal cardiopulmonary bypass was used in 11 patients.

We used three different surgical techniques for rupture repair (Fig. 1). In the first 4 patients, we performed an excision of necrotic myocardial tissue and applied a direct suture, using two strips of teflon felt for reinforcement. In these cases we used cardiopulmonary bypass and heart arrest with cold blood cardioplegia protection. In 15 patients, a direct suture with Teflon strip reinforcement was performed, covering the suture region with a teflon patch stitched onto the epicardium (prolene 4/0 continuous suture). In the last 4 cases in this group, glue (tissucol or cyanoacrylate) was applied beneath the Teflon patch. Five cases in this group were operated with cardiopulmonary bypass and heart arrest, coronary artery bypass graft was used in one patient, and mitral valve replacement in another. The third technique, applied in 5 patients, involved a teflon patch fixed with fibrin glue and polypropylene and stitched to the epicardium with a continuous suture. When it seemed necessary, more fibrin glue was injected beneath the patch at the time of tying stitches. Three interventions were performed off-pump and two with cardiopulmonary bypass. Direct myocardial stitch was used in 19 patients, with fibrin glue-fixed teflon patch in 5 patients. One patient was found false positive for rupture during surgery, so rupture repair was not performed.

Results

Eight patients were successfully weaned off cardiopulmonary bypass. Cardiopulmonary bypass was used in 2 out of 3 patients with bleeding. Two patients could not be weaned off bypass due to coagulopathy and excessive bleeding. In one of them bleeding was resolved and surgery was finished successfully.

One patient operated without extracorporeal circulation had bleeding problems due to coagulopathy. Other off-pump operated patients did not show any important hemodynamic problems that could complicate the transfer to the intensive care unit (ICU).

Fatal outcome of the surgery due to hemorrhage occurred in only one of the patients in whom we sutured the patch over the infarct zone (Table 2). Out of the 24 surgically treated patients, 7 died in the intensive care unit after a mean stay of 43.7 ± 17.8 days

(median 42, range, 30-92 days). The major causes of death were multiorgan failure and sepsis, with heart failure as leading problem.

The postoperative care in most patients was complicated by heart failure (n = 19). One of the patients needed Abiomed BVS 5000 VAD (Abiomed Cardiovascular Inc., Denvers, MA, USA) due to heart failure.

Sixteen patients were discharged; 11 of them were our last consecutive cases. Their mean ± SD hospital stay was 28.6 ± 7.5 days. In the group without infectious or septic complications (n = 9), mean hospital stay was 18.3 ± 2.8 days. Septic complications in 2 patients prolonged their hospital stay to 75.1 ± 9.8 days.

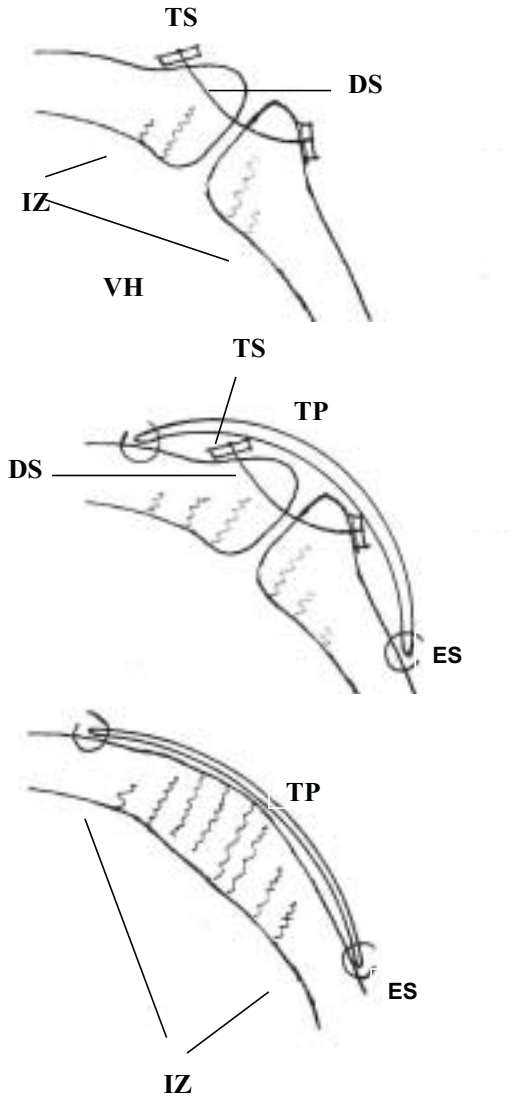

Figure 1. Surgical techniques of the heart free wall rupture repair. **Top.** Direct suture (DS) over excised infarct zone (IZ) of the myocardium, reinforcement with teflon felt strips (TS). **Middle.** Direct suture (DS) over the rupture tear (excised or not excised infarct part of the myocardium), reinforcement with teflon felt strips (TS), teflon patch (TP) over the sutured part, surgical glue (tissucol or cyanoacrylate) beneath the patch, epicardial suture (ES) on the patch border. **Bottom.** Stick on the teflon patch (TP) over infarcted zone (IZ) with surgical glue (tissucol or cyanoacrylate), epicardial suture (ES) on the patch border. VH – ventricle hole.

Coronary angiography was performed in 12 patients: preoperatively in 4 and postoperatively in 8 of them. Eight patients had one-vessel disease, three had two-vessel disease, and one had three-vessel disease. Percutaneous transluminal coronary angioplasty (PTCA) with stenting of the right coronary artery was performed in one patient with a two-vessels disease who presented with angina pectoris after surgery.

At discharge, all patients were classified as the functional class II according to the New York Heart Association, with the exception of one patients in the functional class III. At their last checkups performed in 2001 by phone call or directly by cardiologist or surgeon, their functional classes remained the same.

Discussion

The incidence of free wall rupture after acute myocardial infarction diagnosed in our center was about 0.35%, which is low in comparison with other European (2-5%) (1,2,6,8,17) or North American (< 1-3%) (3-5, 23) reports. The difference in the incidence can be explained by many factors, including accessibility of primary health care, cardiology, and heart surgery in those countries (24-26), with persistence of out-of-hospital acute myocardial infarction deaths (27-31).

Timing of the whole acute myocardial infarction accident can change the outcome in some of the patients. Exact data about the onset of the anginal symptoms were not available for all our patients, especially if more than 12 h had passed since the beginning of the symptoms. Early admission of patients with chest pain to cardiac unit, rapid diagnostic confirmation of life threatening diagnoses with probable surgical treatment (free wall rupture, aortic rupture, or aortic dissection), and rapid diagnostic procedure with early administered thrombolytic treatment can reduce number of complications of acute myocardial infarction. The influence of delayed hospital admission on the increased risk of complication development is logical, and the emergency protocol should be improved (2,25,26,32,33).

Volume replacement support with synthetic colloid solutions can produce coagulopathy in such patients if excessively used (34-36), and its administration should be therefore individually evaluated.

Echocardiography is the best available and most used diagnostic tool, sufficient for confirming diagnosis (1-5,7-17,23). Data on segmental contractility can help localize the lesion.

The quantity of pericardial effusion does not always correlate with clinical symptoms (37). If pericardial tamponade produces hemodynamic disbalance in spite of pharmacological inotropic support, pericardial effusion should be removed before completing diagnostic evaluation and surgery. This life-saving treatment can rapidly improve the clinical picture, but can also cause important and potentially

Table 2. Postoperative characteristics of patients with free wall rupture after acute myocardial infarction

Surgical intervention[a]	No. of patients			No. of days (mean ± SD)	
	sex (women/men)	CPB (on/off)[b]	hospital mortality (%)	ICU[c] stay	hospital stay
Direct suture over excised infarct zone (n = 4)	1/3	4/0	3 (75.0)	15.0 ± 37.3	36.0 ± 48.1
Suture of a patch over the infarct zone (n = 15)	6/9	5/10	5 (33.3)	12.4 ± 28.4	24.6 ± 33.8
Patch fixed with bio-glue over the infarct zone (n = 5)	2/3	2/3	0	16.8 ± 14.2	21.3 ± 18.7
Total (n = 24)	9/15	11/13	8 (33.3)	13.7 ± 19.9	23.8 ± 36.5

[a]In one patient out of initial 25, cardiac rupture could not be confirmed on surgery.
[b]Cardiopulmonary bypass with (on) or without (off) extracorporeal circulation.
[c]Intensive care unit.

dangerous increase in blood pressure, which consequently produces more tension on lesioned myocardium. Rational administration of inotropic support before tamponade removal could help avoid hypertensive crisis in those patients (8).

Intra-aortic balloon pump was used preoperatively in hemodynamically instable patients with acute myocardial infarction. The balloon pump decreases afterload, end-systolic pressure, and myocardial oxygen demand, thus preventing wall rupture and evolution of myocardial necrosis (15,37-41).

Rapid transfer to operating room should be provided after diagnosis confirmation, especially in hemodinamically instable patients. Coronary angiography could be provided preoperatively in stable patients (8).

Surgical approach to lateral and anterior wall lesions, which are the most frequent locations in surgical treatment (9-12), is possible through left thoracotomy. In case of lateral or inferior wall lesions, simple reparation techniques without extracorporeal circulation would be better (8).

Generally, the preferable intervention is the one without cardiopulmonary bypass and with simple patch gluing with or without epicardial stitch fixing, but the final choice of the procedure depends on the position of the lesion and hemodynamic stability of the patient (8-11). If a patient needs additional valvular or coronary surgery, extracorporeal circulation could be used because the risks it carries can be avoided, especially for coronary surgery. We used extracorporeal circulation in 3 patients: in two due to the size of the myocardial tear and in one to perform a coronary bypass to the left descending coronary artery and a mitral valve replacement. In 5 patients in whom the patch was fixed over the infarction zone with bio-glue, we tried to perform the procedure without extracorporeal circulation, but hemodynamic stability permitted off-pump correction only in 3 patients (Fig. 1).

Surgery with excision of necrotic tissue and direct myocardial suture seems abandoned today (8-14) but tissue quality of infarct zone and existence of visible myocardial tear may require this type of repair. The surgery should then be carried out with extracorporeal circulation and it can influence the outcome (8).

A simplified free wall rupture repair with sutureless patch gluing is preferable (9,11). Avoiding cardiopulmonary bypass also contributes positively to the outcome (10). Certainly, with rapid admission of all patients with acute myocardial infarction, exaggerated complications with extensive lesions that do not permit simple repair can be avoided (2).

Different materials can be used in patch repairs. We used teflon (10), but Dacron (9) or the pericardium (8) can also be used. Autologous pericardium could be used as the material for the ventricle wall repair (43,44).

As complementary technique in one of our patients, a left ventricular assistance with an Abiomed system was implanted during recovery due to extreme cardiac failure.

In postoperative course, all patients had hemodynamic problems and restored the correct ventricular function was very slow, with stay at the intensive care unit longer than 12 days). Septic problems and multiorgan failure continue to be mayor complications in such patients.

Despite the limitations of the retrospective approach and small number of patients, our study showed that final outcome in high risk patients could be improved with rapid admission, rapid diagnostic procedure, and emergent surgical treatment. The best choice is least aggressive approach with epicardial patching and off-pump revascularization when hemodynamic stability permits surgery without extracorporeal circulation.

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