

# Surgical treatment of postinfarction ventricular septal rupture

## Tratamiento quirúrgico de la ruptura septal ventricular postinfarto

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### Keywords:

Acute myocardial infarction, postinfarction ventricular septal rupture, surgical procedure.

### Palabras clave:

Infarto agudo al miocardio, ruptura septal ventricular postinfarto, procedimiento quirúrgico.

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Received: 08/23/2019  
Accepted: 05/30/2021



### ABSTRACT

**Introduction:** Postinfarction ventricular septal rupture is a mechanical complication of acute myocardial infarction, with high mortality. The evolution of techniques in the operating room has led to its early repair with better results. **Objective:** To describe the surgical experience in postinfarction ventricular septal rupture in patients at the Hospital de Cardiología, Centro Médico Nacional Siglo XXI. **Methods:** Descriptive, retrospective, observational, case series study. Data collected from records that met the inclusion criteria. **Results:** From January 1<sup>st</sup>, 1999 to April 30<sup>th</sup>, 2015, 49 patients who underwent restoration by surgery were registered. Only 27 met the inclusion criteria: 15 men and 12 women, with a mean age of 62 years. The overall mortality was 63%. Of the survivors, 50% presented residual ventricular septal defect: one patient was taken to reoperation for total correction and the rest of the patients continue to be followed up. **Conclusions:** The best surgical results were obtained in those patients who underwent reconstruction of the post-infarction ventricular septal rupture two weeks after the diagnosis of acute myocardial infarction, being in New York Heart Association functional class I and II. In terms of survival, the participants who underwent single-patch repair had a lower incidence of residual damage.

### RESUMEN

**Introducción:** La ruptura postinfarto del septum ventricular es una complicación mecánica del infarto agudo al miocardio, con alta mortalidad; pero la evolución de las técnicas en el quirófano ha llevado a su reparación temprana con mejores resultados. **Objetivo:** Describir la experiencia quirúrgica en la rotura septal ventricular postinfarto en pacientes del Hospital de Cardiología, Centro Médico Nacional Siglo XXI. **Métodos:** Estudio descriptivo, retrospectivo, observacional, serie de casos. Datos recabados de expedientes que cumplieron los criterios de inclusión. **Resultados:** Del 1o de enero de 1999 al 30 de abril de 2015 se registraron 49 enfermos que fueron sometidos a restauración mediante cirugía, sólo 27 cumplieron con los criterios de inclusión: 15 hombres y 12 mujeres, edad promedio 62 años, mortalidad general 63%. De los sobrevivientes, 50% presentaron defecto residual septal del ventrículo: un paciente fue llevado a nueva operación para corrección total y el resto de los enfermos continúa en seguimiento. **Conclusiones:** Los mejores resultados quirúrgicos se obtuvieron en aquellos sujetos a reconstrucción de la rotura del septum ventricular postinfarto luego de dos semanas del diagnóstico del infarto agudo al miocardio, encontrándose en clase funcional I y II de la New York Heart Association. En cuanto a la supervivencia, los participantes que se sometieron a reparación con parche simple presentaron menor incidencia de desperfectos residuales.

### Abbreviations:

PVSR = Postinfarction ventricular septal rupture.

AMI = Acute myocardial infarction.

CVRF = Cardiovascular risk factors.

EUROSCORE = European System for Cardiac Operative Risk Evaluation.

CPB = Cardiopulmonary bypass.

AoC = Aortic clamping.

IACB = Intra-aortic counter-pulsation balloon.

CICU = Coronary Intensive Care Unit.

NYHA = New York Heart Association.

ECG = Electrocardiogram.

ACIS = Acute coronary ischemic syndrome.

**How to cite:** Hernández-Meneses S, Meza-López LR, Olvera-Lozano JT, González-Díaz BE. Surgical treatment of postinfarction ventricular septal rupture. Cir Gen. 2020; 42(4): 281-287.

## INTRODUCTION

Mechanical complications of acute myocardial infarction (AMI) are one of the most undesirable and dramatic setbacks that can occur.<sup>1</sup> Despite their low incidence (< 1%),<sup>2</sup> the seriousness of these complications requires rapid and accurate diagnosis and timely treatment. They are presented as three well-defined entities: ventricular septal rupture, ventricular free wall rupture and papillary muscle rupture with mitral insufficiency.<sup>1</sup>

Post-infarction ventricular septal rupture (PSVR) occurs most frequently during the first week after an AMI, typically three to five days later.<sup>2</sup> The use of thrombolytic agents reduced its incidence from 1-2% in the pre-thrombolytic era to only 0.2% currently. However, despite prompt and effective care in the coronary reperfusion era (mechanical and chemical thrombolysis), a mortality of 73.8-87% has been reported, with an approximate figure of 45% for surgically treated patients and 90% among those undergoing medical treatment alone.<sup>3-5</sup>

Due to the poor results of the medical procedure, usually is necessary.<sup>5</sup> However, urgent surgery is also associated with tissue fragility and a residual short-circuit. The evolution of techniques in the operating room<sup>2</sup> has led to early repair and has decreased mortality from 90% to approximately 50%.<sup>3</sup>

Patients who are completely stable, without the support of ventricular assist devices, represent 5% or less of the cases of PSVR, and in these patients, surgery can be delayed with good results.<sup>6</sup> In contrast, postponing the procedure in those with cardiogenic shock represents an unsuccessful management. Patients in an intermediate position between cardiogenic shock and hemodynamic stability should be operated on promptly (12-24 hours) after an adequate preoperative evaluation. For many acutely decompensated patients, recent improvements in surgical techniques have allowed to perform early surgery and reduce the risk of hemodynamic deterioration, at the cost of increased technical difficulty.<sup>2,7,8</sup>

Due to the complexity of this pathology, different approaches have been developed to improve surgical outcomes and survival. Among

**Table 1: Demographic characteristics of the population with postinfarction ventricular septal rupture, cardiovascular risk factors and associated morbidities.**

	Patients, n (%)
Age, mean (range)	62 (48-83)
Sex	
Male	15 (55.56)
Female	12 (44.44)
Arterial hypertension	19 (70.37)
Diabetes mellitus 2	18 (66.67)
Smoking	12 (44.44)
Dyslipidemia	10 (37.04)
Obesity (BMI > 30)	6 (22.22)
Previous ischemic heart disease	0
Previous kidney disease	1 (3.70)

BMI = body mass index.

the known surgical techniques, we can mention an "infartectomy" (infarct zone resection) with closure, infarct exclusion, use of biological glue, double patch closure, septal exclusion, closure by a sandwich technique and single patch closure. On the other hand, the development of percutaneous techniques such as the use of an Amplatzer device has allowed, in selected cases, percutaneous closure of septal defects.<sup>2,8</sup>

The aim of this research was to describe the general characteristics of patients diagnosed with RSVP and the results obtained after surgical restoration, evaluating mortality, postoperative complications, and survival.

## METHODS

A descriptive, observational, retrospective, consecutive case series study was carried out, which included all hospitalized patients registered from January 1999 to April 2015, who underwent surgery for RSVP repair and who had complete records at the *Hospital de Cardiología del Centro Médico Nacional Siglo XXI* of the *Instituto Mexicano del Seguro Social* (Mexican Social Security Institute).

Descriptive statistics, measures of central tendency and  $\chi^2$  were used for the analytical management of the data to examine the factors related to mortality.

**Table 2: Clinical characteristics of patients before surgery.**

	Patients, n (%)
Type of infarction	
STEMI	26 (96.30)
Non-STEMI	1 (3.70)
Location of the infarct	
Anterior	18 (66.67)
Inferior	9 (33.33)
Treatment upon hospital admission	
Conservative	23 (85.19)
Thrombolysis	3 (11.11)
PCI	1 (3.70)
Coronary lesions	
Main vessel disease	13 (48.15)
AD	7 (53.85)
DC	4 (30.77)
CX	2 (15.38)
Two-vessel disease	5 (18.52)
Tri-vascular disease	4 (14.81)
MVAD	5 (18.52)
No. of short circuits	
Simple	27 (100)
Apical	7 (25.93)
Anterior	12 (44.44)
Posterior	6 (22.22)
Middle segment	2 (7.41)
Complexes	0
LVEF (%)	
< 30	5 (18.52)
31-50	16 (59.26)
> 50	6 (22.22)
Complications associated with PVSR	15 (55.56)
Cardiogenic shock	
Arrhythmias	3 (11.11)
Ventricular tachycardia	1 (33.33)
AVB	2 (66.67)

STEMI = ST-segment elevation, PCI = percutaneous coronary intervention, AD = anterior descending, DC = descending coronary; CX = circumflex, MVAD = multivessel atheromatous disease, LVEF = left ventricular ejection fraction, PVSR = postinfarction ventricular septal rupture, AVB = atrioventricular block.

## RESULTS

From January 1, 1999, to April 30, 2015, a total of 49 patients with a diagnosis of RSVP who underwent surgical reconstruction in the Cardiovascular Surgery service were registered, but only 27 met the inclusion criteria.

Population demographics, cardiovascular risk factors (CVRF) and associated morbidities are summarized in *Table 1*. The clinical characteristics of the participants are presented in *Table 2*.

The average EUROSCORE (European System for Cardiac Operative Risk Evaluation) indicator was 53.93%, with a range of 16.13-91.41%. All patients were hospitalized in the Coronary Intensive Care Unit (CICU) as part of the management of an AMI; the management provided during their stay in this service and the clinical status of these patients are shown in *Table 3*.

Regarding the operating room technique used, in 21 patients (77.78%) the repair was performed by single patch closure, while in six cases (22.22%) a double patch was used. The rest of the concomitant procedures performed, and the materials used are shown in *Table 4*.

The mean cardiopulmonary bypass (CPB) time was 135 minutes (range 62-313) with a mean aortic clamp (AoC) time of 90 minutes (range 49-153).

The postoperative setbacks reported were: bleeding greater than usual in five patients (18.52%), cardiogenic shock in 16 of the group (59.26%), acute renal failure in 10 of them (37.04%), perioperative infarction in one case (3.70%), metabolic acidosis refractory to treatment in another five (18.52%), arrhythmias in two patients (7.40%) (one patient with ventricular tachycardia and one with atrioventricular block), two events of arterial insufficiency in lower limbs (7.40%, both related to the use of intra-aortic counterpulsation balloon [IACB]), biventricular dysfunction in two cases (7.40%), infectious complications in nine patients (33.33%) of which six cases (66.66%) presented pneumonia associated with mechanical ventilation, one patient (11.11%) had an urinary tract infection and two more (22.22%) suffered from mediastinitis; and finally seven

**Table 3: Perioperative management of patients diagnosed with postinfarction ventricular septal rupture.**

	Patients, n (%)
Inotrope use	16 (59.26)
IACB	14 (51.85)
Interventionism	
Amplatzer	1 (3.70)
PCI	3 (11.11)
Successful	2 (66.67)
Failed	1 (33.33)
NYHA functional class	
I	1 (3.70)
II	10 (37.04)
III	4 (14.82)
IV	12 (44.44)
Time to diagnosis from an AMI to surgical PVSr (days)	
< 7	12 (44.44)
7-15	11 (40.74)
> 15	4 (14.82)

IACB = intra-aortic counter-pulsation balloon, PCI = percutaneous coronary intervention, NYHA = *New York Heart Association*, AMI = acute myocardial infarction, PVSr = postinfarction ventricular septal rupture.

patients (25.92%) presented a residual interventricular septal defect.

The overall mortality observed in the sample patients was 62.96% (17); and the survival rate was 37.04% (10).

The analysis of these deaths in relation to the preoperative clinical condition and treatment given in the CICU is shown in [Table 5](#). With respect to the surgical procedure, the analysis was carried out taking into consideration the type of technique used to repair the defect and the concomitant procedures performed during surgery ([Table 6](#)).

Of the 10 survivors, eight are still on follow-up, and of the latter, four persist with residual interventricular septal deterioration without hemodynamic repercussions that merit interventional or surgical closure, remaining clinically in NYHA functional class II.

Of those patients who survived without residual defect and who continue with follow-up, 75% underwent closure with single patch

and concomitant revascularization, and only one patient underwent reconstruction with double patch. As for the patients with residual damage, 50% were reconstructed with double patch, and one of them underwent reoperation in pursuit of closure of the residual defect; the size of the disarrangement reported in the records is 11, 9 and 3 millimeters, respectively which, as mentioned above, had not required treatment according to the outpatient follow-up.

## DISCUSSION

PSVR is a rare but lethal complication of AMI.<sup>1,4,7,9,10</sup> It usually produces a large left-to-right shunt that deteriorates the clinical status of patients.<sup>1,3,7,11</sup> Regarding the demographic characteristics of the population, in the present investigation<sup>1,11</sup> no correlation was found with what is reported in the literature with respect to sex; since a male:female ratio of 1:1 was practically observed.

The cardiovascular risk factors most frequently associated in this study were diabetes mellitus, hypertension, and dyslipidemia.<sup>1,11</sup> None of the cases had a history of previous ischemic heart disease found, which, as Caballero Borrego et al. comment, is a protective factor for the development of PVR in those affected by AMI, due to the development of collateral circulation.

ST-segment elevation acute coronary ischemic syndrome (STEMI) was predominantly found, and by electrocardiography (ECG) the most frequent location of the infarction was in the anterior aspect. Angiographic evaluation reveals that, in general, PSVR is associated with occlusion of a main coronary artery and these patients have less development of collateral vessels. Regarding the angiographic findings of the population, a main vessel was particularly affected (almost 50% of the cases), and of these, the most affected artery was the anterior descending artery. This also correlates with that reported in the literature.<sup>11,12</sup>

With the initiation of urgent reperfusion therapy for AMI (including thrombolysis and percutaneous coronary intervention), the incidence of PSVR has decreased, as the flow

of the infarct-related artery was restored, aiming to save the myocardium, and reducing the incidence of transmural infarction.<sup>4,10,11</sup> In this report, most of the patients (85%) did not undergo coronary reperfusion treatment.

The anatomical location of the defect was antero-apical in approximately 60% of the cases, and 20-40% in the posterior septum. In this study, all patients presented simple ventricular septal defects, described by echocardiography, which was corroborated by the surgical findings reported, and the most common location was in the anterior segment, which corresponded to the coronary lesion most frequently associated with AMI.<sup>11,12</sup>

Noteworthy, the left ventricular function was preserved in almost 80% of the cases, with an LVEF > 30% and, as was found in the complications of PSVR, more than 50% of the cases presented an overt cardiogenic shock; therefore, these factors were not intercorrelated. Ventricular function depends on the severity of the infarction, with subsequent myocardial stunning and the hemodynamic modifications generated by the left-to-right shunt, which cause right ventricular failure with risk of biventricular damage.<sup>1,2,7,11</sup>

The complications most frequently observed because of PSVR were cardiogenic shock (60%), and 11% arrhythmias of the ventricular tachycardia-type and a complete atrioventricular block.

Because of the complications and hemodynamic instability of those included in the study, most of them required management with inotropic drugs, as well as circulatory support with IACB in the preoperative period. And as a corroboration of the severity of the disease, the reason for this study, the average EUROSCORE II calculated for the patients was greater than 50%.<sup>2,4,7,8</sup>

Regarding the surgical management performed in this hospital, in approximately 85% of the cases, it was carried out within the first 15 days after diagnosis of an AMI, and the surgical technique most frequently used to repair the septal defect was the placement of a simple bovine pericardial patch. The mean CPB and AoC times were 135 and 90 minutes, respectively.

The most common complications in the immediate postoperative period were persistent cardiogenic shock (59%), acute renal failure (37%), and finally infections in 33% of cases (pneumonia, mediastinitis and urinary tract infection).

In this study, mortality correlated with the mortality rate reported worldwide, which was 63%.<sup>3-5,7,8,10-13</sup> The factors analyzed and associated with statistical significance were NYHA functional class IV and the time period in which they had undergone reconstruction of ventricular septal damage after AMI, since in those patients in whom the procedure was delayed for more than 15 days, the survival rate was 100%, and, as is found in the literature, among the determinants of this outcome of surgery are the time between an AMI and repair of the defect, cardiogenic shock, left ventricular dysfunction, renal failure and previous coronary artery disease.<sup>5,7,11,13-15</sup>

It is currently suggested that, if possible, surgical management should be delayed until the patient has an AMI of at least three weeks old in order to better delimit the area of necrosis, although it is clear that in most patients treatment cannot be postponed due to the hemodynamic instability that conditions the

**Table 4: Surgical management employed.**

Surgical treatment	Patients, n (%)
Single patch repair	21 (77.78)
Double patch repair	6 (22.22)
Closure + exclusion infarction	2 (7.41)
Closure + myocardial revascularization	13 (48.15)
Closing + VAD	1 (3.70)
Closure + mitral plasty	1 (3.70)
Type of material used	
Bovine pericardium	12 (44.44)
Autologous pericardium	1 (3.70)
Polyester	5 (18.52)
Teflon	3 (11.11)
Dacron	3 (11.11)
PTFE	3 (11.11)

VAD = ventricular assist device, PTFE = polytetrafluoroethylene.



**Table 5: Mortality associated with preoperative treatment and clinical status of patients diagnosed with postinfarction ventricular septal rupture.**

	Mortality (patients)	Survival (patients)	p*
Inotrope use	12	4	NS
Use of IACB	11	3	NS
Interventionism			
PCI	2	1	NS
Amplatzer	1	0	
Functional class			0.01
I/II	4	7	
III/IV	13	3	
Time between AMI diagnosis and surgery (days)			
< 7	11	1	0.012
7-15	6	5	
> 15	0	4	

\* p-value obtained by  $\chi^2$  test. IACB = intra-aortic counter-pulsation balloon, PCI = percutaneous coronary intervention, AMI = acute myocardial infarction, NS = not significant.

**Table 6: Mortality analysis of surgical treatment.**

	Mortality (patients)	Survival (patients)	p*
Technique for defect repair			
Single patch	14	7	NS
Double patch	3	3	
Concomitant procedures			
RVM	8	5	NS
Exclusion of infarction	1	1	
Mitral plasty	0	1	
VAD	1	0	

\* p =  $\chi^2$  test. RVM = myocardial revascularization, VAD = ventricular assist device, NS = not significant.

left-to-right shunt; in addition, in those patients who only receive medical care, mortality is practically 100%.<sup>4,7,8,11,13</sup>

Although avoiding residual shunts and minimizing damage to non-infarcted areas are the most important goals in the management

of PSVR, residual shunts continue to be a major problem in patients. The most important factor affecting leakage after reconstruction of posterior septal ruptures is the technical difficulty in identifying the defect in the septum, particularly when suturing necrotic muscle tissue. Residual defects can occur due to poor coverage of the damage or tearing of the friable myocardium at the suture line.<sup>15</sup>

In the follow-up of those patients who survived, it was observed that approximately half presented residual ventricular septal deterioration. It should be noted that, in these patients, 50% underwent repair of the damage with a single patch, while the rest were reconstructed with a double patch. However, there was no statistically significant difference to determine whether any technique influenced the presence of residual lesion.

Of those patients who survived, and in whom no residual ventricular septal defect was documented, 75% underwent repair with simple patch and concomitant revascularization. Likewise, no statistically significant difference was found in these results, but it could be established that, clinically, this may be due to the greater experience of the surgeons of this hospital with this technique, rather than to the advantages it may offer compared to others.

Due to limitations in the design of this analysis, it is not possible to establish further relationships between the variables; however, the authors consider it to be very useful to learn about the surgical experience in the management of this complication of AMI.

## CONCLUSIONS

PSVR is a lethal complication of AMI, the management of which is challenging and requires a comprehensive approach by a multidisciplinary team. Operating room intervention is a viable option for these patients. The best results were observed in those patients who underwent surgery two weeks after the diagnosis of AMI, and in those patients who were in NYHA CF I and II before undergoing a surgical procedure.

Due to the limitations of this research, it is also considered necessary to carry out more studies on this subject in this environment, to

broaden the experience in the treatment of this pathology.

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**Ethical considerations and responsibility:** Due to the nature of the study (review of clinical records only), neither informed consent nor approval by the research ethics committee was required.

**Funding:** No financial support was received for this research.

**Disclosure:** No conflict of interest is reported by any of the authors.

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