BRIEF REPORT

Medium-Term Echocardiographic Follow-up of Systolic and Diastolic Left Ventricular Abnormalities After Surgical Treatment of Subacute Rupture

Leopoldo Pérez de Isla, Enrique Rodríguez, Ali Alswies, Rosaly Bucce, Manuel Carnero, Carlos Macaya, and José Zamorano

Unidad de Imagen Cardiovascular, Hospital Clínico San Carlos, Madrid, Spain

Subacute rupture of the left ventricular free wall is a complication that occurs during the acute phase of a myocardial infarction. The subacute presentation makes surgical management possible. However, it is not known whether either pericardial manipulation or the use of pericardial patches influences left ventricular function over the medium term. Our aim was to monitor changes in left ventricular function and the development of constrictive pericarditis over the medium term in patients who had been treated surgically for subacute rupture of the left ventricle. Eleven patients with subacute rupture underwent surgery, of whom six were followed up over the medium term. A modest improvement in left ventricular systolic function was observed and there was no evidence of constrictive pericarditis. In conclusion, the surgical approach appears to be safe over the medium term and had no influence on left ventricular function. Nor did it lead to the development of constrictive pericarditis.

Key words: *Cardiac rupture. Ventricular function. Echocardiography.*

Seguimiento ecocardiográfico a medio plazo de las alteraciones de la función sistólica y diastólica del ventrículo izquierdo tras rotura subaguda tratada quirúrgicamente

La rotura subaguda de la pared libre del ventrículo izquierdo es una complicación de la fase aguda del infarto de miocardio. La presentación subaguda permite una resolución quirúrgica. No se conoce si la manipulación del pericardio y el empleo de parches pueden tener consecuencias a medio plazo en la función ventricular izquierda. Nuestro objetivo es evaluar la evolución de la función ventricular izquierda y el desarrollo de datos de constricción a medio plazo en pacientes con rotura subaguda del ventrículo izquierdo intervenida quirúrgicamente. Se intervino de rotura subaguda a 11 pacientes, de los que se siguió a medio plazo a 6. Los resultados muestran que a medio plazo hay una mejoría discreta de la función ventricular y no aparecen datos de constricción. Como conclusión, se puede decir que es una técnica segura a medio plazo y que no se acompaña de secuelas en la función ventricular izquierda ni de desarrollo de constricción.

Palabras clave: *Rotura cardiaca. Función ventricular. Ecocardiografía.*

INTRODUCTION

William Harvey was the first to describe rupture of the left ventricular (LV) free wall, in the year 1647. Currently, a combination of clinical, echocardiographic, and hemodynamic criteria are applied to establish the diagnosis of subacute cardiac rupture.[1-5] Urgent surgical repair is the treatment indicated in these cases.[6] However, it is unknown whether pericardial manipulation and the use of patches might have consequences on LV function at medium term.[7-18]

In this study, we evaluate the evolution of LV function and the development of evidence of pericardial constriction at medium term in patients with subacute rupture treated surgically.

METHODS

Study Population

From 2006 to 2008, 11 patients admitted to the coronary unit of our hospital were diagnosed of subacute rupture of the LV free wall following myocardial infarction. The condition was

Correspondence: Dr. J.L. Zamorano.
Unidad de Imagen Cardiovascular. Hospital Clínico San Carlos.
Prof. Martín Lagos, s/n. 28040 Madrid. España.
E-mail: jlzamorano@vodafone.es

Received October 20, 2008.
Accepted for publication March 11, 2009.

TABLE 1. **General Characteristics**

Patient/Sex	Time of Onset of Symptoms-Rupture	Coronary Involvement	Revascularization	Age	Location
1/woman	48	Not described	No	86	Anterior/apical aneurysm
2/woman	12	Not described	No	83	Lateral
3/man	6	3-vessel disease	No	71	Anterior
4/man	48	middle LAD	Yes	66	Anterior
5/man	24	3-vessel disease	Yes	72	Anterior/apical aneurysm
6/man	24	proximal LAD	No	58	Anterior/apical aneurysm

LAD indicates left anterior descending artery.

confirmed during exploratory surgery and repaired in the same procedure. Six of the 11 patients were followed-up to medium term. In the remaining 5 patients, follow-up was not completed: 2 died (one due to myocardial infarction and the other, bilateral pneumonia) and 3 were lost to follow-up.

Echocardiographic Study at the Time of the Diagnosis

Because of the extreme severity of the clinical picture, the initial study was carried out with the most immediately available echocardiography system.

Echocardiographic Study During Follow-up

All patients underwent 2D Doppler echocardiography with a Philips IE-33 system and S5-1 transducer (Philips, Bothell, Washington, USA). A complete evaluation of systolic and diastolic function was performed and signs of pericardial constriction were investigated.

A 3D echocardiographic study was carried out immediately after the conventional study, using a Philips X3-1 transducer (Philips, Bothell, Washington, USA). The 3D images were acquired from the apical window using a complete volume technique, stored in a central server, and analyzed off-line with Q-Lab (version 6.0) software[9] (Philips, Bothell, Washington, USA).

The criteria used to establish the diagnosis of constrictive pericarditis by Doppler echocardiography were ≥25% respiratory variation in peak mitral E-wave velocity at inflow and an increase in reverse diastolic flow in the hepatic veins or vena cava on expiration.

Statistics

Statistical calculations were performed with SPSS 11.0 (SPSS Inc., Chicago, Illinois). Quantitative data are expressed as the mean (standard deviation) and/or the median [interquartile interval]. Qualitative data are expressed as absolute number (percentage). The Student *t* test or Wilcoxon test were used for comparisons of parametric quantitative data.

RESULTS

Six of the 11 patients could be completely followed-up and assessed (Table 1). Median age was 71.5 [17] years and 4 (66%) were men. Median duration of follow-up was 7 [18] months, mean, 7.9 (11.2) months. All patients were treated with beta-blockers. None were treated with thrombolysis.

The diagnosis was established within the first 24 hours in 75% of patients. At the time of the diagnosis, all patients were hemodynamically unstable and showed syncope or presyncope on echocardiography, together with hemodynamic evidence of tamponade; 3 patients had findings consistent with cardiogenic shock.

The most common cardiovascular risk factors were hypertension (3 patients; 50%), smoking (3 patients; 50%), and diabetes mellitus (3 patients; 50%). The infarct was in an anterior location in 5 (83.3%) patients, and only 1 patient (16.7%) had had a previous infarct. Coronary angiography was performed before surgery in half the patients (n=3). One patient (16.7%) showed significant single-vessel disease that was revascularized in the same procedure as repair of the rupture, and 2 others presented significant 3-vessel disease, which was revascularized in 1 case. The rupture repair technique involved direct repair without support from on-pump circulation. The rupture area was identified and a heterologous pericardial patch (Peri-Guard, Synovis Life Technologies, Inc.) was cut to an appropriate size for coverage. Biological glue (2-octyl cyanoacrylate; Dermabond, Ethicon Inc.) was applied to one of the surfaces of the patch and the rupture area was then covered.

Echocardiographic Study at the Time of the Diagnosis

Echocardiography performed before the intervention showed moderate or severe pericardial

TABLE 2. **Echocardiographic Analysis of Systolic and Diastolic Function**

Systolic Function							
Patient	**LVEDVPre, mL**	**LVESV, mL**	**LVEF pre, %**	**LVEDV3d, mL**	**LVESV3dPost, mL**	**LVEF post**	**Tisular S, cm/s)**
1	154	35	45	68	39	43	6
2	49	27	55	46	19	59	10
3	—	—	55	71	40	45	8
4	220	165	25	132	78	41	4
5	144	106	30	67	37	45	7
6	—	—	30	143	81	43	6
Diastolic function							
Variables/patients	**1**	**2**	**3**	**4**	**5**	**6**	
Mitral E	0.55	0.72	0.56	0.52	0.65	0.73	
Mitral A	1.2	0.88	0.66	0.54	0.98	0.66	
EDT, ms	410	260	260	175	230	290	
Respiratory variation, %	14	6	14	10	15	13	
E/A	0.45	0.81	0.84	0.96	0.66	1.1	
Pulmonary S/D	1.32	0.93	1.41	1.21	1.29	1.02	
E/E'	11	7.2	5	6	10	10	
LA, cm	3.3	3.4	2.7	3.3	3.6	3.4	

LA indicates left atrium; mitral A, end-diastolic mitral inflow velocity; A', end-diastolic mitral annular velocity; mitral E, early diastolic mitral inflow velocity; E', early diastolic mitral annular velocity; E/E', early diastolic inflow velocity/early diastolic annular velocity ratio; LVEF post, postoperative left ventricular ejection fraction; LEVF pre, preoperative left ventricular ejection fraction; S/D, systolic/diastolic pulmonary venous flow velocity ratio; S, peak systolic tissue Doppler flow, averaged value of lateral mitral annulus and septal mitral annulus; EDT, E-wave deceleration time; LVEDV3d, preoperative left ventricular end-diastolic volume with 3D; LVEDVPre, preoperative left ventricular end-diastolic volume; LVESV3dPost, postoperative left ventricular end-systolic volume with 3D; LVESVPre, preoperative left ventricular end-systolic volume

effusion in all patients with evident signs of cardiac tamponade. Left-ventricular ejection fraction (LVEF) values and LV volume results are shown in Table 2. Quantitative assessment of LVEF was carried out *a posteriori* from digitized images using the modified Simpson method.

2D and 3D Echocardiographic Studies at Medium-Term Follow-up

The echocardiography results at the end of follow-up are shown in Table 2. No echocardiographic findings consistent with constrictive pericarditis were present in any of the studies. Comparison of the LVEF values before and after surgery did not show statistically significant differences (P=.7).

DISCUSSION

The present study reports for the first time echocardiographic findings of LV function at medium-term follow-up of surgical repair of subacute rupture of the ventricular free wall. The data obtained show that the technique used does not affect systolic or diastolic LV function. Furthermore, there was no evidence of constrictive pericarditis, despite the fact that the procedure involves pericardial manipulation and placement of bovine pericardial patches.

The medium-term follow-up of patients with LV free wall rupture has been described in some studies, but there are few reported Doppler echocardiography findings. It is noteworthy that the follow-up results of our patients (Table 2) do not indicate significant deterioration of diastolic function. Also of note in our series, 4 patients were diagnosed in the first 24 hours after the onset of symptoms; that is, they had a very early presentation.

Limitations

The main limitation of the study is the small number of patients included. Nevertheless, because of the low prevalence of this condition, this study contains one of the largest series in the literature. Another limitation is the lack of data available from the preoperative echocardiography study. In addition, there could be a relationship between the size of the patch and the degree of constriction, but the exact patch size could not be measured because of the urgent nature of the surgery. Lastly, the volume measurements obtained with 2D echocardiography in the preoperative study are not exactly equivalent to those measured with 3D echocardiography at follow-up.

In conclusion, surgical repair of subacute LV free wall rupture is safe at medium-term and is not

associated with sequelae related to LV function or the development of constrictive pericarditis. This is the largest series in which the middle-term follow-up findings of surgically treated subacute ruptures have been studied.

REFERENCES

1. Agnihotri K, Madsen J, Daggett W. Surgical treatment of complications of acute myocardial infarction: postinfarction ventricular septal defect and free wall rupture. En: Cohn LH, Edmunds LH Jr, ediores. Cardiac surgery in the adult. New York: McGraw-Hill; 2003. p. 681-714.
2. Reeder GS. Identification and treatment of complications of myocardial infarction. Mayo Clin Proc. 1995;9:880-4.
3. López-Sendon J, González A, López E, Coma-Canella I, Roldan I, Domínguez F, et al. Diagnosis of subacute ventricular wall rupture after acute myocardial infarction: sensitivity and specificity of clinical, hemodynamic and echocardiographic criteria. J Am Coll Cardiol. 1992;19:1145-53.
4. Coma-Canella I, López-Sendón J, Núñez González L, Ferrufino O. Subacute left ventricular free wall rupture following acute myocardial infarction: bedside hemodynamics, differential diagnosis, and treatment. Am Heart J. 1983;106:278-84.
5. Feigembaum H, Armstrong W, Ryan T. Complicaciones del infarto agudo de miocardio. Ecocardiografía. 6.ª ed. Madrid: Médica Panamericana; 2007. p. 461-3.
6. Lafci B, Yakut N, Göktogan T, Ozsöyler I, Emrecan B, Yasa H, et al. Repair of post-infarct ventricular septal rupture with an infarct-exclusion technique: early results. Heart Surg Forum. 2006;9:737-40.
7. Poulsen S, Praestholm M, Munk K, Wierup P, Egeblad H, Nielsen-Kudsk J. Ventricular septal rupture complicating acute myocardial infarction: clinical characteristics and contemporary outcome. Ann Thorac Surg. 2008;85:1591-6.
8. Pierli C, Lisi G, Mezzacapo B. Subacute left ventricular free wall rupture surgical repair prompted by echocardiographic diagnosis. Chest. 1991;100:1174-6.
9. Lang R, Mor-Avi V, Sugeng L, Nieman P, Sahn D. Three dimensional echocardiography: the benefits of the additional dimension. J Am Coll Cardiol. 2006;48:2053-69.
10. Amir O, Smith R, Nishikawa A, Gregoric ID, Samart FW. Left ventricular free wall rupture in acute myocardial infarction —a case report and literature review. Tex Heart Inst J. 2005;32: 424-6.
11. Yip HK, Wu CJ, Chang HW, Wang CP, Cheng CI, Chua S, et al. Cardiac rupture complicating acute myocardial infarction in the direct percutaneous coronary intervention reperfusion era. Chest. 2003;124:565-71.
12. Raitt MH, Kraft CD, Gardner CJ, Pearlman AS, Otto CM. Subacute ventricular free wall rupture complicating myocardial infarction. Am Heart J. 1993;126:946-55.
13. Sutherland FW, Guell FJ, Pathi VL, Naik SK. Postinfarction ventricular free wall rupture: strategies for diagnosis and treatment. Ann Thorac Surg. 1996;61:1281-5.
14. Purcaro A, Costantini C, Ciampani N, Mazzanti M, Silenzi C, Gili A, et al. Diagnostic criteria and management of subacute ventricular free wall rupture complicating acute myocardial infarction. Am J Cardiol. 1997;80:397-405.
15. García MA, Zamorano JL. Enfermedad coronaria. Complicaciones del infarto al miocardio. Procedimientos en ecocardiografía. México: McGraw-Hill; 2004. p.142-7.
16. Figueras J, Cortadellas J, Evangelista A, Soler-Soler J. Medical management of selected patients with left ventricular free wall rupture during acute myocardial infarction. J Am Coll Cardiol. 1997;29:512-8.
17. Padró JM, Mesa JM, Silvestre J, Larrea JL, Caralps JM, Cerrón F, et al. Subacute cardiac rupture: repair with a sutureless technique. Ann Thorac Surg. 1993;55:20-3.
18. McMullan MH, Maples MD, Kilgore TL Jr, Hindman SH. Surgical experience with left ventricular free wall rupture. Ann Thorac Surg. 2001;711:894-8.