Left Ventricular Aneurysm Resection With Port-Access Surgery: A New Mini-Invasive Surgical Approach

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Background. **In recent years port-access and endovascular extra-corporeal circulation techniques have allowed valvular and coronary operations to be performed by mini-thoracotomy. Experience with the technique suggested application to resection of ventricular aneurysms, which are usually approached through a median sternotomy with the use of traditional cardiopulmonary bypass.**

Methods. **We performed a left port-access mini-thoracotomy, with 6 to 8 cm skin incisions, in 7 patients undergoing endoventricular pericardial patch repair for anterior left ventricular aneurysm. Cardiopulmonary bypass was effected using the Heartport system. The mean interval between myocardial infarction and operation was 60.4 ± 57.7 months. Three patients developed sustained ventricular tachicardia. Mean preoperative ejection fraction was 34% ± 11%. Associated procedures were coronary bypass grafting in 2 patients and cryosurgery in 3 patients.**

Results. **All patients survived to discharge and are alive and well after an average 14.5 months. They are all in NYHA class I –II. Postoperative echocardiograms revealed an average ejection fraction of 48.0% ± 7.5% (p = 0.006 compared with preoperative value). The 3 patients who had cryosurgery did not demonstrate any recurrence of arrhythmias.**

Conclusions. **Left ventricular aneurysm can be successfully treated through port-access mini-thoracotomy with endovascular cardiopulmonary bypass, avoiding median sternotomy. This mini-invasive approach allows effective ventricular remodeling. Revascularization and antiarrhythmia surgery can also be done at the same time. In case of severely reduced ventricular function this approach permits fibrillatory arrest without aortic cross-clamping. The results are also good in terms of hospitalization time and long-term survival.**

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Left ventricular aneurysms (LVAs) are a well-known long-term complication of transmural myocardial infarction. For many years, since the initial report of Likoff and Bailey [1] in 1955 LVAs have been routinely treated with surgery. Surgical techniques have evolved since then, from the original linear resection [2] to more physiologic ventricular remodelling with a pericardial or Dacron endoventricular patch [3]. The aim of these more recent remodelling procedures is to exclude the dyskinetic and akinetic areas of the left ventricle, reshaping the ventricular cavity so as to redirect the myocardial fibers to a more favorable contraction geometry [4–6].

The surgical approach is usually through a median sternotomy with central cannulation for extracorporeal circulation, with or without aortic cross-clamping and cardioplegia. Coronary revascularization is associated if needed. Shapira and colleagues [7] reported successfully performing the operation through a left thoracotomy and femoro-femoral bypass in the exceptional case of a patient with patent coronary grafts. In more recent years the port-access technique of endovascular cardiopulmonary bypass (Endo-CPB) has allowed mitral valve and coronary artery bypass surgery to be performed through port mini-thoracotomy.

We report the successful application of these port-access techniques to LVA resection and recommend them as a feasible alternative approach to this surgical task.

Patients and Methods

From October 1999 to October 2001, we conducted port-access resection of LVAs with endo-CPB on 7 patients. Demographics and preoperative variables are summarized in Table 1.

All patients were affected by exertion dyspnoea and two by effort angina at the time of hospital admission. In all patients the aneurysm involved the anterior wall of the left ventricle and was the evolution of an anterior myocardial infarction caused by occlusion of left anterior descending artery (LAD). The average interval between the infarction and the operation was 60.4 ± 57.7 months (median 40 months; range 1 to 135 months). In 5 patients the size of the aneurysm was defined as large, widely

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Table 1. Demographic and Preoperative Variables

	Age	Sex	Aneurysm	Thrombus	CCS	NYHA	VT	LVEF	Mitral Regurgitation	CAD
Case 1	54	F	Antero-lateral, medium sized, dyskinetic	No	II	III	No	45%	Absent	LAD 75% Diagonal 75%
Case 2	54	M	Antero-lateral large, akinetic	Yes	I	II	No	15%	Absent	LAD 100% OM 90%
Case 3	65	M	Antero-apical, large, akinetic	No	II	II	Yes	44%	Mild	LAD 80%
Case 4	40	M	Antero-apical medium sized akinetic	No	I	II	Yes	30%	Mild	LAD 60%
Case 5	70	F	Antero-apical large, akinetic	No	I	III	No	25%	Mild	LAD 100%
Case 6	43	M	Antero-apical large, akinetic	Yes	I	II	Yes	42%	Mild	LAD 40%
Case 7	72	F	Antero-apical large, akinetic	No	I	IV	No	38%	Absent	LAD 30% OM 50% RCA 50%

CAD = coronary artery disease; CCS = Canadian coronary score; LAD = left anterior descendent; LVEF = left ventricle ejection fraction; NYHA = New York Heart Association; OM = obtuse marginal; RCA = right coronary artery; VT = ventricular tachycardia.

involving the interventricular septum. In 3 patients the clinical picture was characterized by sustained ventricular tachycardias. The mean preoperative ejection fraction was 34% ± 11% (range: 15% to 45%). Mild mitral regurgitation was present in 4 patients. Medical therapy included ACE-inhibitors in all cases and diuretics in 5 patients.

For all patients the operation was performed through a left port-access mini-thoracotomy using a Heartport Platform (Heartport Inc. Redwood City, CA). The Endo-CPB system ensures safe installation of extra-corporeal circulation through a 3-cm groin incision with venous and arterial cannulation of the femoral vessels. Aortic occlusion and cardioplegia can be attained through the endoaortic clamp catheter. In the last four patients the new Endo-Direct System was used, which allows direct aortic cannulation through a 8-mm port in the first intercostal space [8], with venous cannulation being performed percutaneously through the femoral vein. An anterolateral mini-thoracotomy (just medial to the anterior axillary line) was performed in the fourth intercostal space through a skin incision of 6 to 8 cm. In one patient the incision was made through the third intercostal space due to the fact that patient had a short, wide thoracic cage. In 2 cases the left internal thoracic artery was dissected out from the thoracic wall. A large piece of pericardium was obtained after pericardiotomy and fixed in gluteraldehyde to be used for the repair of the aneurysm. The technique used in all cases was an endoventricular patch-repair with ventriculoplasty reshaping, as described by Cooley and coworkers [9] and Dor and colleagues [3].

Results

The operative data are summarized in Table 2. In two patients surgical revascularization was obtained by grafting the internal thoracic artery onto the proximal LAD. Mean CPB duration and aortic cross-clamp time were 100 ± 30 minutes and 76 ± 21 minutes respectively, including the two patients who received a graft. In 6 of 7 patients the thoracotomy was performed in the fourth intercostal space, which generally corresponds nicely to the location of an anteroapical or anterolateral aneurysm. Viewing of the aneurysmatic region was very easy in all cases with perfect visibility of the scar region. After

Table 2. Operative Data

Case	Thoracotomy	Arterial Cannulation	CPB Duration (min)	Aortic x-Clamp (min)	Endo-Clamp Pressure (mm Hg)	Cryo	CABG
1	4th i.s	Femoral	125	90	378	No	Yes
2	4th i.s.	Femoral	120	75	330	No	No
3	4th i.s.	Femoral	145	105	330	Yes	Yes
4	4th i.s.	Aortic	95	85	300	Yes	No
5	4th i.s.	Aortic	70	No	-	No	No
6	4th i.s.	Aortic	90	60	347	Yes	No
7	3rd i.s.	Aortic	60	45	350	No	No

CABG = coronary artery bypass graft; CPB = cardiopulmonary bypass; Cryo = cryosurgery; i.s. = intercostal space.

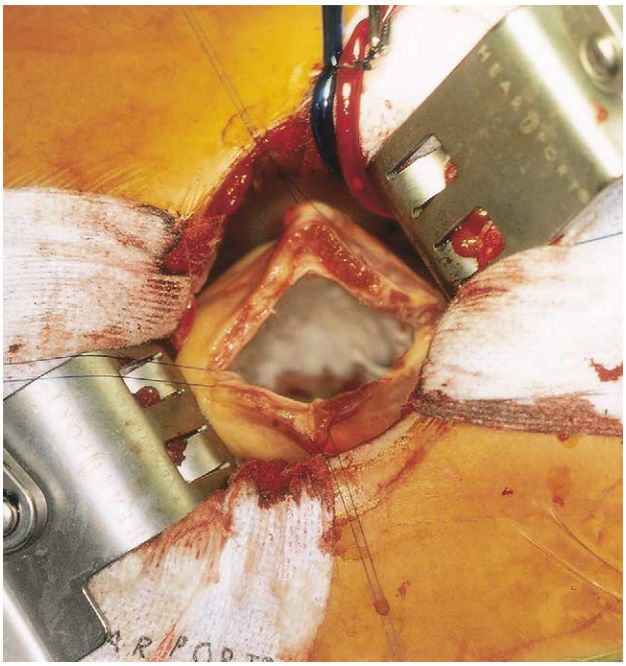

Fig 1. A perfect view of the left ventricle after aneurysm incision through the mini-thoracotomy.

ventriculotomy, the ventricular cavity with the submitral apparatus and the leaflets of the valve were nicely seen along their axis. Extension of the scar tissue into the septum and the lateral and diaphragmatic wall was precisely determined and the pericardial patch could be sutured along the scar border with ease (see Fig 1). The duration of CPB and aortic cross-clamp were substantially acceptable. In 1 patient with a very low left ventricular ejection fraction, the procedure was performed without balloon occlusion of the aorta, in the presence of fibrillation at moderate systemic hypothermia (24°C). Postoperative data are presented in Table 3. Patient 2 was originally scheduled for LVA resection and coronary artery bypass graft on obtuse marginal artery. Tough pericardial adhesions prevented adequate exposure of the target vessel. The patient was therefore weaned from CPB with an intraaortic balloon pump (IABP) and immediately after the operation underwent a percutaneous transcatheter angioplasty (PTCA) and stenting of the artery with good results: the IABP was removed on day 1. A superficial chest wound infection occurred in patient 7, which needed surgical debridement and closure. All patients survived to discharge and are alive and well after 14.5 months (range 3 to 26 months). Five of seven patients have been followed up in a routine postoperative examination and echocardiography at a mean of 9.7 months after the operation. The mean ejection fraction was 48.0% ± 7.5%. This value is significantly better (p = 0.006) than the preoperative left ventricular ejection fraction value of 31.8 ± 12.7 for these 5 patients. They are all in NYHA class I–II, free from angina.

Comment

The surgical technique used in the correction of postinfarction LVA have so far generally involved complete median sternotomy, traditional CPB and aortic cross-clamping. As an alternative approach, we investigated the application of port-access surgery through a mini-thoracotomy with either the Endo-CPB System or the Endo-Direct System for cardiopulmonary bypass.

Repair of LVA through a posterolateral thoracotomy without the use of CPB was first described by Bailey and Likoff [1] in the pioneering era of cardiac surgery. This approach was entirely abandoned in the era of cardiopulmonary bypass in favor of sternotomy. Only recently did Shapira and colleagues [7] describe one case of LVA with patent coronary bypass grafts and multiple aortic aneurysms being treated with endoaneurysmorraphy through a left thoracotomy during hypothermic cardiac fibrillation. The choice of approach was dictated in this case by the presence of patent grafts and aortic aneurysms.

The port-access platform is a system for mini-invasive cardiopulmonary bypass, aortic cross-clamping, and cardioplegia delivery, which together with special surgical instrumentation allows treatment of some cardiac diseases through reduced-size thoracotomies. It exists in two configurations: the Endo-CPB System, which is applied through a small groin incision with cannulation of the femoral vessel, and the Endo-Direct System, which allows the direct cannulation of the ascending aorta with

Table 3. Postoperative Data

Patient Number	IABP	Mechanical Ventilation (hours)	Days on Inotropes	Bleeding (mL)	Stay in ICU (hours)	Days in Hospital	Follow-Up (months)	Complications
1	No	46	5	610	64	12	29	
2	Yes	14	1	1360	22	14	25	PTCA
3	No	21	3	830	46	8	24	
4	No	11	0	260	15	11	22	
5	No	6	3	430	45	8	11	
6	No	4	0	470	24	10	6	
7	No	11	5	320	26	22	6	Superficial wound infection

IABP = intra-aortic balloon pulsation; ICU = intensive care unit; PTCA = percutaneous transcatheter angioplasty.

the venous drainage being obtained by percutaneous cannulation of the femoral vein. The latter option was devised to avoid the complications of groin cannulation.

Port-access surgery was adopted at our center 4 years ago and substantial experience has been gained since then in both mitral and coronary surgery. The perfect visualization of the apex and anterior wall of the left ventricle afforded by the Port-Access Platform was noticed during coronary surgery, when target vessels were approached through a mini-thoracotomy in the fourth intercostal space. It was thus natural to consider the thoracotomic approach in the treatment of LVA. Differently from what has been reported so far in the literature, this is a real mini-thoracotomy (through a 6- to 8-cm skin incision), made possible by the use of Endo-CPB system inserted through a 3-cm incision at the groin. In the last 4 patients we adopted the new Endo-Direct system for aortic cannulation, possible to insert through the same mini-thoracotomy, which allows antegrade arterial perfusion and avoids the rare but insidious complications of femoral artery cannulation.

The mini-thoracotomy in the fourth or third left intercostal space offers perfect visualization of the scar and being aligned with the axis of the left ventricle, affords an excellent view of the transition zone both on the septum and the free wall side. The area to be resected can thus be accurately determined. The subvalvular mitral apparatus can be inspected to preserve papillary muscles. The approach also permits coronary artery bypass grafts to be performed. In 2 patients in this series a left internal mammary artery to LAD graft was performed. Mounting experience with the technique suggests that multivessel revascularization is also possible, since our own and others' experience demonstrate that all vessels are graftable singly through this approach. In one patient with very depressed left ventricular function, a hypothermic fibrillatory arrest was preferred to aortic cross-clamping and cardioplegia. The port-access technique also proved to be of great value because the exposure of the aneurysm was perfect without lifting up the heart. This avoided the creation of aortic insufficiency and massive blood flooding of the operative field, as would probably have happened had we performed a median sternotomy.

In conclusion, this limited experience is the first report of a consecutive series of patients with left ventricular aneurysm treated by port-access mini-thoracotomy. The results are good in terms of hospitalization time and long-term survival. Ventricular function as measured by postoperative echocardiography was also found to have improved in 5 of 7 patients, confirming that despite limiting direct access to the operative field, the mini-invasive approach allows surgical techiques to be performed adequately. The same approach can also be used for coronary revascularization and antiarrhythmia surgery if needed. The new Endo-Direct System is particularly useful where severe peripheral vascular disease is present, because it avoids femoral artery cannulation. In cases of severely reduced left ventricular function, hypothermic fibrillatory arrest can be applied, thus avoiding aortic clamping. It also increases the safety of the procedure for patients with previous cardiac surgery, especially those with patent grafts, because the risks of adhesion dissection and patent graft lesion are avoided.

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