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Surgical Treatment of Left Ventricular Aneurysms: A Comparison of Long-term Follow-up of Left Ventricular Function for Classic Aneurysmectomy and Endoaneurysmorrhaphy Techniques

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ABSTRACT

Objective: Myocardial infarction may be complicated by the formation of a left ventricular (LV) aneurysm that distorts the normal elliptical geometry of the ventricle to produce a dilated spherical ventricle with limited contractile and filling capacities. One of the consequences is congestive heart failure, which may be refractory to medical therapy and require surgical treatment. The aim of this study was to evaluate LV function in the late term following repair of LV aneurysm.

Methods: Ninety-seven patients underwent repair of postinfarctional LV aneurysms. Sixty-one patients (62.9%) underwent classic aneurysmectomy, and 36 patients (37.1%) had endoaneurysmorrhaphy. The mean age (±SD) of the 87 men (89.7%) and 10 women was 55.98 ± 8.59 years. Coronary surgery was performed in 82 patients (84.5%), with a mean of 1.34 ± 0.77 grafts/patient. The mean preoperative ejection fraction (EF) was 39.74% ± 8.79% (classic, 39.92% ± 8.90%; endoaneurysmorrhaphy, 39.43% ± 8.61%; difference not statistically significant [NS]). Fifty-five patients (56.7%) had angina of Canadian Cardiovascular Society class III to IV (classic, 55.7%; endoaneurysmorrhaphy, 58.3%; NS), 31 patients (31.9%) were in New York Heart Association (NYHA) class III to IV (classic, 31.1%; endoaneurysmorrhaphy, 33.3%; NS), and the mean preoperative NYHA functional class was 2.88 ± 0.74 (classic, 2.83 ± 0.77; endoaneurysmorrhaphy, 2.97 ± 0.71; NS).

Results: The mortality rate at <30 days was 9.8% (n = 6) in the classic aneurysmectomy group and 2.7% (n = 1) in the endoaneurysmorrhaphy group. Long-term follow-up was available for 80 of these patients. During a mean follow-up of 79.3 ± 37.6 months (range, 6-156 months), 14 patients (17.5%) died of a cardiac-related cause (classic, 8 patients [16.6%]; endoaneurysmorrhaphy, 6 patients [18.7%]; NS). The cardiac-related survival rate was 82.5%. In the first year, at 5 years, and at 10 years, the survival rates of the patients who underwent classical aneurysmectomy were 98.8%, 93.5%, and 76.1%, respectively, and the rates for patients who underwent endoaneurysmorrhaphy were 100%, 93.0%, 71.2%, respectively (P = .2). In the follow-up patient population, the mean preoperative EF was 40.21% ± 9.44% in the classic aneurysmectomy group and 39.34% ± 8.61% in the endoaneurysmorrhaphy group. Postoperatively, mean EFs increased to 44.24% ± 9.50% and 43.80% ± 8.81%, respectively, at the last follow-up. NYHA functional class changed from 2.79 ± 0.77 preoperatively to 1.60 ± 0.73 postoperatively in the classic aneurysmectomy group and from 2.97 ± 0.71 preoperatively to 1.34 ± 0.54 postoperatively in the endoaneurysmorrhaphy group. There was no significant difference in hospital readmissions for cardiac causes (classic, 27.1%; endoaneurysmorrhaphy, 31.2%).

Conclusion: LV aneurysm can be repaired with acceptable surgical risk. Surgical treatment of LV aneurysm is associated with an improvement in long-term survival and symptoms.

INTRODUCTION

Large anterior transmural myocardial infarction causes both early and late distortion of the structure of the heart. After a transmural myocardial infarction, a well-delineated area of nonuniform interstitial fibrosis can develop, and this area of fibrosis can bulge increasingly outward during systole [Matsumoto 1985]. Aneurysm leads to an increase in both volume and thickness of the nonaneurysmal portion of the left ventricle (LV). The adverse shape increases wall tension and produces mechanical disadvantages and adverse remodeling. Asynergic segments do not contract to support cardiac output and can cause chronic heart failure after some time. The aims of operative techniques such as classic aneurysmectomy and endoaneurysmorrhaphy are to correct the size and geometry of the LV by reducing the ventricle cavity and paradox movement, to restore circular ventricular architecture and wall tension, and to improve systolic function of the LV [Di Donato 1992; Mills 1993; Grossi 1995; Dor 1998]. The aim of this study was to evaluate LV function in the later term following repair of LV aneurysm.

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Table 1. Preoperative Patient Characteristics

Variable	All Patients (n = 97)	Classic (n = 61)	Endoaneurysmorrhaphy (n = 36)	*P*
Age, y	55.98 ± 8.59	55.13 ± 9.24	57.42 ± 7.51	NS
Male/female sex, n	87/10	55/6	32/4	–
Obstructive pulmonary disease, %	6.2	6.6	5.5	NS
Peripheral vascular disease, %	10.3	11.5	8.3	NS
Renal insufficiency, %	6.2	6.6	5.5	NS
Diabetes mellitus, %	20.6	19.7	22.2	NS
Neurologic dysfunction, %	2.1	1.6	2.8	NS
Ejection fraction, %	39.74 ± 8.79	39.92 ± 8.90	39.43 ± 8.61	NS
CCS angina class III-IV, %	56.7	55.7	58.3	NS
NYHA class III-IV, %	31.9	31.1	33.3	NS
NYHA class	2.88 ± 0.74	2.83 ± 0.77	2.97 ± 0.71	NS
Nonelective surgery, %	5.2	4.9	5.5	NS
No. of diseased vessels	1.85 ± 0.77	1.92 ± 0.83	1.74 ± 0.68	NS
Anterior aneurysm, %	86.6	88.5	83.3	NS

*Data are presented as the mean ± SD where indicated. NS indicates not statistically significant; CCS, Canadian Cardiovascular Society; NYHA, New York Heart Association.

MATERIALS AND METHODS

Patient Characteristics

Ninety-seven patients underwent repair of postinfarctional LV aneurysms. Coronary surgery was performed in 82 patients (84.5%). To avoid eventual confounding factors, we did not include patients who underwent valve surgery. Sixty-one patients (62.9%) underwent linear closure, and 36 patients (37.1%) had endoaneurysmorrhaphy. The diagnosis of LV aneurysms was made preoperatively according to their echocardiographic and angiographic appearance. The indications for surgery were a low functional New York Heart Association (NYHA) class with symptoms of congestive heart failure, malignant ventricular arrhythmia, recurrent embolization, angina pectoris, or a combination of these presentations. Linear repair of the LV was performed mostly in the early part of the period, and endoaneurysmorrhaphy was performed in the later part.

The variables selected for analysis were age, sex, obstructive pulmonary disease, peripheral vascular disease, renal insufficiency, diabetes mellitus, neurologic dysfunction, Canadian Cardiovascular Society (CCS) angina class, New York Heart Association (NYHA) functional status, recent myocardial infarction, surgical priority (elective, urgent, or emergent), number of diseased vessels, LV function, number of grafts, and use of the internal thoracic artery (ITA).

Preoperative clinical, echocardiographic, and angiographic data are detailed in Table 1. There were 87 male patients (55 linear closure, 32 endoaneurysmorrhaphy) and 10 female patients (6 linear closure, 4 endoaneurysmorrhaphy). The mean (±SD) age of the patients was 55.98 ± 8.59 years with no statistically significant difference between the 2 groups. Six patients had obstructive pulmonary disease, 10 had peripheral vascular disease, and 6 had renal insufficiency. Twenty patients were diabetic, and 2 had neurologic disorders secondary to cerebral embolism. Fifty-five patients (56.7%) were in CCS class III to IV (classic, 55.7%; endoaneurysmorrhaphy, 58.3%), 31 patients (31.9%) were in NYHA class III to IV (classic, 31.1%; endoaneurysmorrhaphy, 33.3%), and the mean preoperative NYHA functional class was 2.88 ± 0.74 (classic, 2.83 ± 0.77; endoaneurysmorrhaphy, 2.97 ± 0.71). The mean preoperative LV ejection fraction (LVEF) was 39.74% ± 8.79% (classic, 39.92% ± 8.90%; endoaneurysmorrhaphy, 39.43% ± 8.61%). Eighty-four patients had anterior wall aneurysms, and 13 patients had aneurysms of the posterior wall. The mean number of diseased coronary vessels per patient was 1.85 ± 0.77 (linear closure, 1.92 ± 0.83; endoaneurysmorrhaphy, 1.74 ± 0.68). Twenty-two patients had 3-vessel coronary disease (16 linear closure, 6 endoaneurysmorrhaphy), 37 patients had 2-vessel disease (24 linear closure, 13 endoaneurysmorrhaphy), and 38 patients had 1-vessel disease (21 linear closure, 17 endoaneurysmorrhaphy). All patients had experienced at least 1 myocardial infarction, and only 5 patients had experienced a recent myocardial infarction (3 linear closure, 2 endoaneurysmorrhaphy). A majority of the patients (94.8%) underwent their operations electively.

Operative Technique

All operations were performed with cardiopulmonary bypass, cold crystalloid cardioplegia, and moderate systemic hypothermia. Cardiopulmonary bypass was instituted with a membrane oxygenator and nonpulsatile flow. The surgical procedures were performed by the same surgeon, and there was no difference in intraoperative management with regard to the myocardial-protection strategy. While the patient was under cardiopulmonary bypass but before cardiac arrest, the region of the aneurysm was confirmed visually and by palpation of the thinned wall of the LV. In performing classic aneurysmectomy, we preserved the left anterior descending coronary artery and incised the aneurysm. We removed any thrombus that we saw. The aneurysm was excised except for a border of fibrous tissue 1 cm in width. Both sides of the incision were sutured with 2-0 polypropylene suture buttressed with a longitudinal Teflon patch. In the endoaneurysmorrhaphy group, the aneurysm was opened parallel to the interventricular septum, the clot was removed, and an elliptical Teflon patch was sutured to the viable myocardium border with continuous 4-0 polypropylene suture. We then excluded the remaining aneurysmal wall with the patch and closed the ventriculotomy with 2-0 polypropylene suture. Once the ventricular repair was completed, bypass grafting was carried out. Revascularization, including the area of ventricular aneurysm repair, was performed whenever indicated and technically possible.

Follow-up

Long-term follow-up data are available for 80 of these patients (48 patient in the linear-closure group, 32 in the endoaneurysmorrhaphy group). These patients have been invited every year to the hospital for a control evaluation. Follow-up data were obtained directly from the patients or from their relatives via a telephone call whenever a visit to the hospital was not possible. We obtained data on survival, NYHA functional status, LVEF, arrhythmia, CCS angina class, and cardiac-related hospital readmission. Ten patients (7 linear closure, 3 endoaneurysmorrhaphy) were lost to follow-up because of migration or for unknown reasons. The patients who applied to the hospital were scheduled for an echocardiographic follow-up examination. The LVEF was calculated with Simpson's formula from biplane apical 4- and 2-chamber views by one experienced cardiologist.

Statistical Analysis

Data are reported as the mean and SD for continuous variables and as percentages for discrete variables. Data were analyzed on a database prepared with the Statistical Package for the Social Sciences, version 15.0 (SPSS, Chicago, IL, USA). Because the data were normally distributed, we used the Student *t* test for independent samples for group comparisons. Differences in the distribution of variables were evaluated with the χ^2 test when appropriate. The Cox regression test was performed for survival analysis. Results was considered statistically significant when the *P* value was <.05.

RESULTS

The 2 groups were not significantly different with respect to age, sex, the number of diseased coronary arteries, urgency of the procedure, preoperative LVEF, functional status, and comorbid risk factors. Indications for operation were angina, congestive heart failure, malignant ventricular arrhythmia, recurrent embolization from the LV, or a combination of these presentations; the 2 groups had similar distributions for these indications. Concomitant myocardial revascularization was performed in 82 patients (84.5%). We could not perform coronary artery bypass grafting in 8 patients (13.1%) who underwent classic aneurysmectomy and in 7 patients (19.4%) who underwent endoaneurysmorrhaphy. ITA grafts were used in 77 patients (79.4%); the 2 groups did not differ significantly in this respect (linear closure, 80.3%; endoaneurysmorrhaphy, 77.8%). The mean number of grafts per patient was 1.42 ± 0.83 in the linear group and 1.22 ± 0.68 in the endoaneurysmorrhaphy group, a difference that was not statistically significant (Table 2).

The rate of postoperative early mortality (<30 days) was 9.8% (n = 6) after classic aneurysmectomy and 2.7% (n = 1) after endoaneurysmorrhaphy. In the classic aneurysmectomy group, 2 patients died during the first 30 postoperative days from ventricular septal defect after an acute myocardial infarction and a low cardiac output. Two patients in the endoaneurysmorrhaphy group experienced pseudoaneurysm rupture, and one of these patients died within the first 30 days.

Ten patients were lost to follow-up. Follow-up characteristics of the patients are detailed in Table 3. The mean follow-up time of the other 80 survivors was 89.73 ± 38.21 months in the linear-closure group (range, 6-156 months) and 63.81 ± 36.66 months in the endoaneurysmorrhaphy group (range, 6-113 months). The follow-up period was longer for the linear closure group because the patients in this group underwent their operations in the early phase of the study. Twenty-one patients died in the late period, and 14 (66.6 %) of the deaths were for a possible cardiac-related cause. The cardiac-related survival rate was 82.5%. The 89.7-month cardiac-related mortality rate was 16.6% (n = 8) in the group with classic

Table 2. Operative Data*

Variable	All Patients (n = 97)	Classic (n = 61)	Endoaneurysmorrhaphy (n = 36)	*P*
No. of grafts/patient	1.34 ± 0.77	1.42 ± 0.83	1.22 ± 0.68	NS
Patient with no grafts, % (n)	15.5 (15)	13.1 (8)	19.4 (7)	NS
Internal thoracic artery used, % (n)	79.4 (77)	80.3 (49)	77.8 (28)	NS
Mortality (<30 d), % (n)	7.2 (7)	9.8 (6)	2.7 (1)	NS

*Data are presented as the mean ± SD where indicated. NS indicates not statistically significant.

Table 3. Follow-up of Patients*

Variable	Classic (n = 48)	Endoaneurysmorrhaphy (n = 32)	*P*
Follow-up time, mo	89.73 ± 38.21	63.81 ± 36.66	<.05
NYHA class			
Preoperative	2.79 ± 0.77	2.97 ± 0.71	
Postoperative	1.60 ± 0.73 ($P < .05$)	1.34 ± 0.54 ($P < .05$)	
Ejection fraction, %			
Preoperative	40.21 ± 9.44	39.34 ± 8.61	NS
Postoperative	44.24 ± 9.50	43.80 ± 8.81	
CCS angina class III-IV, %			
Preoperative	55.7	58.3	
Postoperative	12.5 ($P < .05$)	15.6 ($P < .05$)	
Cardiac mortality rate, %	16.6	18.7	NS
Hospital readmission, %	27.1	31.2	NS

*Data are presented as the mean ± SD where indicated. NS indicates not statistically significant; NYHA, New York Heart Association; CCS, Canadian Cardiovascular Society.

aneurysmectomy. The 63.8-month mortality rate was 18.7% (n = 6) in the endoaneurysmorrhaphy group.

The mean preoperative EF was 40.21% ± 9.44% in the classic aneurysmectomy group and 39.34% ± 8.61% in the endoaneurysmorrhaphy group. Postoperatively, the mean EF increased to 44.24% ± 9.44% in the classic aneurysmectomy group at the last follow-up and to 43.80% ± 8.81% in the endoaneurysmorrhaphy group. The mean NYHA functional class for the classic aneurysmectomy group decreased from 2.79 ± 0.77 preoperatively to 1.60 ± 0.73 postoperatively, and that for the endoaneurysmorrhaphy group decreased from 2.97 ± 0.71 to 1.34 ± 0.54. There was no significant difference between the groups (Figure 1).

The CCS angina class improved significantly for the entire group of patients. Preoperatively, 55 patients (56.7%) were in CCS angina classes III to IV, whereas only 11 patients (13.7%) were in CCS angina classes III to IV at the last follow-up (linear closure, 12.5%; endoaneurysmorrhaphy, 15.6 %). The incidence of hospital readmission for cardiac causes was 28.7% (23 patients), with no significant difference between the 2 groups (linear closure, 13 patients; endoaneurysmorrhaphy, 10 patients) (Figure 2).

In the first year, at 5 years, and at 10 years, the survival rates of patients who underwent endoaneurysmorrhaphy and were followed up were 100%, 93.0%, 71.2%, respectively, and the corresponding rates for the patients who underwent classic aneurysmectomy were 98.8%, 93.5%, and 76.1% (Figure 3). No deaths occurred in the endoaneurysmorrhaphy group in the first year. The 2 groups showed no significant difference for any of the survival rates ($P = .2$). The risk factors for survival were patient age ($P = .04$) and number of diseased vessels ($P = .28$). For patient age, mortality was increased 1.09 times per each year (95.0% confidence interval [CI], 1.004-1.178) and for the number of diseased vessels, the mortality rate increased 2.43 times per each year (95.0% CI, 1.098-5.399).

DISCUSSION

Ventricular aneurysms are a common complication of extensive myocardial infarction. A LV aneurysm produces mechanical impairment not only because of the lost contractile tissue but also because of significant systolic expansion [Bartel 2002]. Many patients with ventricular aneurysms experience symptoms of congestive heart failure, coronary insufficiency,

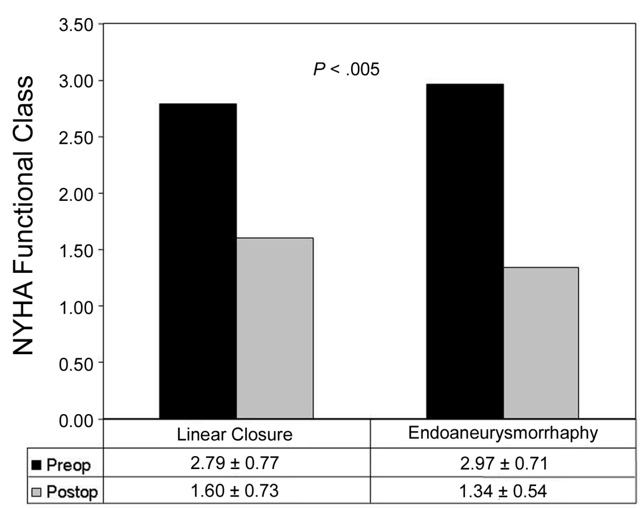

Figure 1. New York Heart Association (NYHA) functional class at the preoperative (Preop) and postoperative (Postop) follow-up times for the classic aneurysmectomy (linear closure) and endoaneurysmorrhaphy techniques.

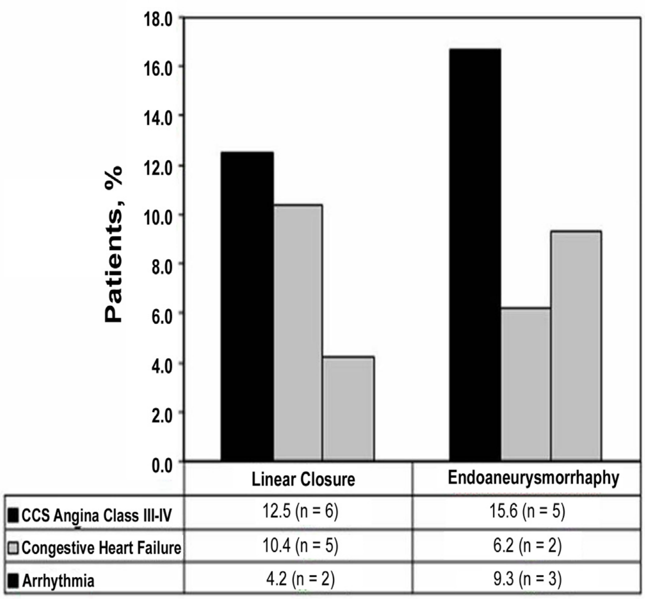

Figure 2. Morbidities of the patients who underwent aneurysm repair by linear closure and endoaneurysmorrhaphy. CCS indicates Canadian Cardiovascular Society.

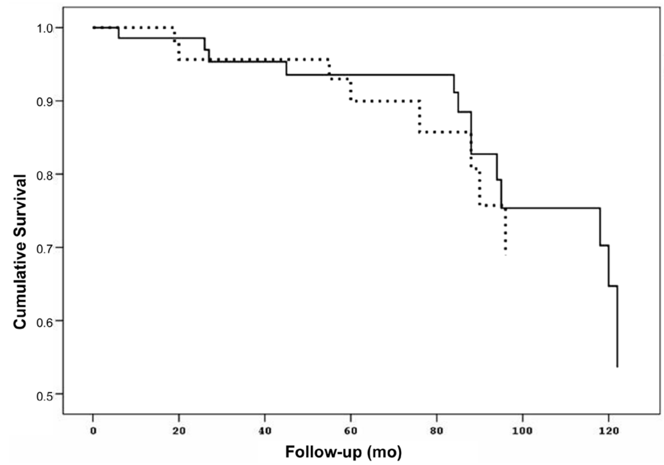

Figure 3. Survival after repair of left ventricular aneurysm by the classic (linear repair) technique (solid line) and the endoaneurysmorrhaphy technique (dotted line).

arrhythmia, or embolic events. Medical management of these patients has been palliative, and outcomes may be disappointing [Krajcer 1992]. Patients with LV aneurysms who are treated medically have a 13% to 18.5% mortality rate during the first year of treatment, and a 46% to 88% mortality rate during the first 5 years [Shaw 1978; Olearchyk 1984]. Surgical treatment of LV aneurysms has offered improvement for certain patients, with satisfactory early and late results.

The first successful repair of LV aneurysm was performed by Likoff and Bailey in 1954 with the help of a side-clamp on a beating heart [Likoff 1955]. In 1958, Cooley et al first performed an LV aneurysmectomy by plication and linear closure under extracorporeal circulation [Cooley 1958]. The operative technique remained unchanged until the mid 1980s, when it became apparent that the clinical results were suboptimal, early mortality was relatively high, and late outcome was unsatisfactory, with many patients experiencing persistent symptoms of congestive heart failure [Jatene 1985]. Attention was then focused on finding new methods to restore an elliptical shape to the LV. A new approach, endoventriculoplasty, was introduced by Jatene [1985] and later modified by Dor et al [1989]. In this technique, a patch is sutured along the interface of a scar and viable myocardium. In the same year, Cooley introduced a new technique that he termed *endoaneurysmorrhaphy*. This surgical approach retains the aneurysm wall to allow closure over the intracavitary prosthetic patch with remodeling of the LV, thereby providing both hemostasis and support [Cooley 1992].

The tubular shape of the LV is maintained by spherical myocardial fibrils that both optimize diastolic filling and enable maximal intracavitary wall tension during systole [Kesler 1992]. Theoretically, preserving the normal LV shape and size after surgery will produce a more physiological contraction and relaxation in areas remote from the aneurysm, particularly adjacent to the transitional zone. Both surgical methods eliminate the paradoxic motion of the LV free wall. Endoaneurysmorrhaphy also excludes the septal akinesis and may decrease the tension on the transitional zone [Shapira 1997].

Endoventricular patch plasty has today become the method of choice for most surgeons, however, and there is no generally accepted approach to the selection of the optimal method for surgical repair of LV aneurysms. Some surgeons have described good short-term and long-term results after classic aneurysmectomy, whereas others prefer the new technique of LV reconstruction with patch endoventriculoplasty [Parolari 2007].

Cooley and Walker, in analyzing their 1533 classic aneurysmectomies, reported a 5-year mortality rate of 6% to 13% [Cooley 1980]. Kesler et al compared the results of linear closure and patch endoventriculoplasty and found no significant difference with respect to mortality, angina, congestive heart failure, or echocardiographic variables [Kesler 1992]. Komeda et al [1992] also did not find any difference in mortality among various types of LV aneurysm repair. Tavakoli et al [2001] found no significant differences in hospital mortality, functional status, and survival rates among patients who underwent endoventriculoplasty and linear closure.

In this study, we compared the late results of 97 patients who underwent repair of LV aneurysms and were nonrandomly assigned to either classic aneurysmectomy or endoaneurysmorrhaphy. All procedures were performed by the same surgeon, and there was no difference in intraoperative management with regard to the myocardial-protection strategy. In general, the choice of repair technique depends on factors such as localization, size, and extension of the scar. An extensive and clearly defined fibrotic, globoid aneurysm sac with a well-formed neck generally leads to patch repair, especially when it is located near the apical area, whereas a linear repair is usually preferred for a wide-based dyskinetic segment that is imprecisely separated from the surrounding viable myocardium [Antunes 2005]. In this study, the early mortality rate in the classic aneurysmectomy group was 9.8%, but mortality was 2.7% in the endoaneurysmorrhaphy group. The early postoperative mortality rate was high in our study, especially in the classic aneurysmectomy group; however, 3 of these cases involved very high–risk patients who underwent their operations under emergency conditions. In the classic aneurysmectomy group, the 2 patients who died had a ventricular septal defect after acute myocardial infarction and had a low cardiac output. In the endoaneurysmorrhaphy group, only 1 patient who had a pseudoaneurysm rupture died within the first 30 days. We demonstrated a significant improvement in angina class and functional status, but the 2 groups were not significantly different. In addition, there was no significant difference between the groups in survival rate. The 1-, 5- and 10-year survival rates for the patients who were followed up and had undergone endoaneurysmorrhaphy were 100%, 93.0%, and 71.2%, respectively; the corresponding rates for the patients who underwent classic aneurysmectomy were 98.8%, 93.5%, and 76.1%. These survival rates are similar, with no statistically significant differences between the groups.

The prognosis for patients with an LV aneurysm is primarily related to LV dysfunction. Myocardial systolic or diastolic dysfunction secondary to coronary artery disease as a consequence of myocardial ischemia is the leading cause of LV dysfunction. Diastolic dysfunction is often diagnosed when symptoms and signs of heart failure occur in the presence of preserved LV dysfunction. Therefore, to develop signs and symptoms of heart failure, a patient must not have a low EF. Our study population consisted patients with ischemia-induced LV dysfunction that involved both systolic and diastolic dysfunction. Patients with preserved systolic dysfunction could be as symptomatic as patients with a low EF. For that reason, a low EF in this population is not necessary. A low LVEF does not necessarily produce symptoms of heart failure; such patients are classified according to guidelines as being in stage B.

LV global pump function is improved after the operation. The increase in pump function is actually due to the more physiological LV shape, which reduces afterload and, concomitant with complete myocardial revascularization, allows an increase in contraction of the muscle. No controlled studies have evaluated the benefit of coronary artery bypass grafting during LV aneurysm repair because grafting is usually performed whenever indicated and technically possible. Nevertheless, coronary artery bypass grafting is highly recommended for 2 reasons. First, it reduces or prevents angina pectoris. Second, an ITA graft to the left anterior descending coronary artery may be important for revascularizing viable interventricular septum through the preservation of septal and diagonal branches, for controlling ventricular arrhythmia originating in the transitional zone, and for providing long-term patency [Lundblad 2003]. In the present study, concomitant myocardial revascularization was performed in 82 patients (84.5%). We could not perform coronary artery bypass grafting in 8 patients who underwent classic aneurysmectomy and in 7 patients who underwent endoaneurysmorrhaphy. ITA grafts were used in 77 patients (79.4%). There was no ITA bypass to the left anterior descending artery in 80% of the patients in the classic aneurysmectomy and endoaneurysmorrhaphy groups who died. We also demonstrated a significant improvement in the NYHA class after operation. The mean NYHA class improved from 2.79 ± 0.77 to 1.60 ± 0.73 in the classic aneurysmectomy group and from 2.97 ± 0.71 to 1.34 ± 0.54 in the endoaneurysmorrhaphy group.

In conclusion, postinfarction LV aneurysm can be repaired with acceptable surgical risk and good long-term survival. Both the classic aneurysmectomy technique and the endoaneurysmorrhaphy technique improve cardiac function, symptoms, and life expectancy. In our study, we could not demonstrate any significant differences between the 2 techniques in late-term results, possibly because the patient populations are different. Endoaneurysmorrhaphy may be particularly suitable for the larger, more diffuse aneurysms that are less suitable for plication or resection. In the first 3 years, we performed classic aneurysmectomy for all LV aneurysms (small and large). This practice may have led to a worse survival rate for patients who underwent classic aneurysmectomy in the first year. We believe that if classic aneurysmectomy is used for small aneurysms and endoaneurysmorrhaphy is used for large aneurysms, patients will have a better chance of long-term survival.

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REFERENCES

Antunes PE, Silva R, Ferrao de Oliveira J, Antunes MJ. 2005. Left ventricular aneurysms: early and long-term results of two types of repair. Eur J Cardiothorac Surg 27:210-5.

Bartel T, Vanheiden H, Schaar J, Mertzkirch W, Erbel R. 2002. Biomechanical modeling of hemodynamic factors determining bulging of ventricular aneurysms. Ann Thorac Surg 74:1581-8.

Cooley DA, Collins HA, Morris GC, Chapman DW. 1958. Ventricular aneurysm after myocardial infarction; surgical excision with use of temporary cardiopulmonary bypass. JAMA 167:557-60.

Cooley DA, Frazier OH, Duncan JM, Reul JR, Krajcer Z. 1992. Intracavitary repair of ventricular aneurysm and regional dyskinesia. Ann Surg 215:417-24.

Cooley DA, Walker WE. 1980. Surgical treatment of postinfarction ventricular aneurysm: evolution of technique and results in 1533 patients. In: Moran JM, Michaelis LL, eds. Surgery for the complications of myocardial infarction. New York, NY: Grune & Stratton. p 273-87.

Di Donato M , Barletta G, Maioli M, et al. 1992. Early hemodynamic results of left ventricular reconstructive surgery for anterior wall left ventricular aneurysm. Am J Cardiol 69:886-90.

Dor V, Saab M, Kornaszewska M, Montiglio F. 1989. Left ventricular aneurysm: a new surgical approach. Thorac Cardiovasc Surg 37:11-9.

Dor V, Sabatier M, Di Donato M, Montiglio F, Tosa A, Maioli M. 1998. Efficacy of endoventricular patch plasty in large postinfarction akinetic scar and severe left ventricular dysfunction: comparison with a series of large dyskinetic scars. J Thorac Cardiovasc Surg 116:50-9.

Grossi EA, Chinitz LA, Galloway AC, et al. 1995. Endoventricular remodeling of left ventricular aneurysm. Functional, clinical, and electrophysiological results. Circulation 92(suppl):II98-100.

Jatene AD. 1985. Left ventricular aneurysmectomy. Resection or reconstruction. J Thorac Cardiovasc Surg 89:321-31.

Kesler KA, Fiore AC, Naunheim KS, et al. 1992. Anterior wall left ventricular aneurysm repair. A comparison of linear versus circular closure. J Thorac Cardiovasc Surg 103:841-8.

Komeda M, David TE, Malik A, Ivanov J, Sun Z. 1992. Operative risks and long-term results of operation for left ventricular aneurysm. Ann Thorac Surg 53:22-9.

Krajcer Z, Elayda MA, Cuasay L. 1992. Ventricular endoaneurysmorrhaphy: results of a new operation for repairing left ventricular aneurysms in 100 patients. Tex Heart Inst J 19:42-6.

Likoff W, Bailey CP. 1955. Ventriculoplasty: excision of myocardial aneurysm; report of a successful case. JAMA 158:915-20.

Lundblad R, Abdelnoor M, Svennevig L. 2003. Repair of left ventricular aneurysm: surgical risk and long-term survival. Ann Thorac Surg 76:719-25.

Matsumoto M, Watanabe F, Goto A, et al. 1985. Left ventricular aneurysm and the prediction of left ventricular enlargement studied by two-dimensional echocardiography: quantitative assessment of aneurysm size in relation to clinical course. Circulation 72:280-6.

Mills NL, Everson CT, Hockmuth DR. 1993. Technical advances in the treatment of left ventricular aneurysm. Ann Thorac Surg 55:792-800.

Olearchyk AS, Lemole GM, Spagna PM. 1984. Left ventricular aneurysm. Ten years' experience in surgical treatment of 244 cases. Improved clinical status, hemodynamics, and long-term longevity. J Thorac Cardiovasc Surg 88:544-53.

Parolari A, Naliato M, Loardi C, et al. 2007. Surgery of left ventricular aneurysm: a meta-analysis of early outcomes following different reconstruction techniques. Ann Thorac Surg 83:2009-16.

Shapira OM, Davidoff R, Hilkert RJ, Aldea GS, Fitzgerald CA, Shemin RJ. 1997. Repair of left ventricular aneurysm: long-term results of linear repair versus endoaneurysmorrhaphy. Ann Thorac Surg 63:701-5.

Shaw RC, Ferguson TB, Weldon CS, Connors JP. 1978. Left ventricular aneurysm resection: indications and long-term follow-up. Ann Thorac Surg 25:336-9.

Tavakoli R, Weber A, Brunner H, Pretre R, Turina M. 2001. Is patch remodelling of LV aneurysm superior to linear repair? Final program and book of abstracts of the EACTS/ESTS Joint Meeting 2001; p 268.