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Long-Term Clinical Outcomes of Patients Undergoing Left Ventricular Aneurysm Repair: A Single-Center Experience in Syria

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Abstract

Background: Left ventricular aneurysm (LVA) is a common complication of myocardial infarction (MI); however, the optimal surgical technique for LVA repair has remained controversial.
Methods: In this retrospective study, we analyzed the long-term outcomes of 65 patients, who underwent LVA surgical repair between January 2005 and December 2009. The LVA repair approaches comprised of patch plasty (n = 16), linear (n = 23), and plication (n = 26) repair techniques.
Results: Male gender was predominant (89%), and the patients' mean age was 56 ± 7.1 years. The rate of in-hospital mortality was 4.6%, 4.6%, and 9.2% in the plication, linear and patch plasty repair groups, respectively (P = 0.077). The amount of increase in early postoperative LV ejection fraction was 4.5%, 7% and 9.5%, in the plication, linear and patch plasty techniques, correspondingly (P < 0.001). During the follow-up period (50.6 ± 15.6 months), there were seven (16.7%) cardiac deaths: five deaths in the linear repair group, one in the plication, and one in the patch plasty repair group (P = 0.057). There was no significant difference regarding the survival rate between the patients undergoing different surgical repairs (P = 0.098).
Conclusions: Despite having relatively high in-hospital and long-term mortality, LVA after MI could be repaired with similar outcomes using different surgical techniques, including linear, patch plasty, and plication techniques.

Keywords: Left Ventricular Aneurysm, Myocardial Infarction, Linear Repair, Patch Plasty Repair, Plication Repair

1. Background

One of the common complications of transmural myocardial infarction (MI) is left ventricular aneurysm (LVA) accompanied by a high rate of mortality (1). In this situation, the affected part of the ventricle becomes dyskinetic or akinetic, leading to impaired contractile and filling capacities (2). Moreover, the paradoxical motion of the aneurysm reduces LV output and may eventually contribute to heart failure. Other LVA consequences include thromboembolic complications due to aneurysmal mural thrombi, ventricular arrhythmias caused by electrophysiological discrepancies in the region of necrosis, repeated admissions and ultimately cardiac death (3).

Medical therapy is usually ineffective, and surgical ventricular restoration (SVR) has increasingly been found to improve both cardiac function and survival. The surgical repair of LVA was first developed by Bailey (4), and the first aneurysmal tissue resection under cardiopulmonary bypass surgery was performed by Cooley et al. (5). These techniques were evolved over decades, leading to the development of linear repair and patch plasty techniques and improved outcomes. Dor et al. (6) reported that ventricular geometry is distorted by linear suture and incomplete septal infarct excision. The geometric repair technique involves further exclusion of the infarct lesion with a circular patch; however, the optimal surgical technique for LVA repair is still controversial.

2. Objectives

In this retrospective study, we analyzed and compared the outcomes of three techniques for LVA repair, linear, endoventricular circular patch plasty and plication methods.

3. Methods

3.1. Patients and Protocols

Between January 2005 and December 2009, 5100 consecutive patients underwent coronary artery bypass graft (CABG) surgery at our center, Damascus university cardiac surgery hospital, Damascus, Syria. Of those, 65 patients, who underwent SVR with concomitant CABG, were included in the study. Demographic and surgical data were

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obtained from medical charts, and all the patients were followed up concerning their in-hospital and long-term outcomes. The study was approved by the local ethics committee at our university.

3.2. Definitions and Surgical Techniques

Left ventricular aneurysm was preoperatively identified using transthoracic echocardiography and coronary angiography, and cineangiography was also performed in 45 (69.2%) patients. The diagnosis of LVA was made preoperatively and confirmed intraoperatively.

During the study period, SVR was performed via the plication repair technique in 26 (39.7%) patients, linear repair in 23 (35.3%), and endoventricular circular patch plasty in 16 (25%). All the surgeries were performed under cardioplegic arrest for both the SVR techniques and revascularization. A linear ventricular incision was made parallel and 2 - 3 cm lateral to the Left anterior descending artery (LAD). All the arterial clots observed during the procedure were removed. Depending on the size and shape of the ventricular cavity, a portion of the thinned ventricular wall was also resected. For the linear repair technique, the edges were sutured directly by using two strips of Teflon® for better hemostasis. For patch plasty repair, the aneurysmal tissue was opened and an elliptical or a circular patch of Dacron® or polytetrafluoroethylene (PTFE) was sutured to the border zone, inside the ventricular cavity. In addition, for small LVAs, the plication technique without opening the aneurysm was performed. This procedure is reserved only for small aneurysms that do not contain mural thrombi. A two-layer suture line was placed across the aneurysm using a strip of Teflon® felt on either side. The suture line was oriented to reconstruct a relatively normal LV contour and did not exclude all the aneurysmal tissue.

3.3. Follow-Up

All the patients were followed up regarding their in-hospital and long-term outcomes. Data gathering was performed using either the medical records of our institution or telephone interviews. Eleven (17%) patients were lost to follow-up, mainly due to migration.

3.4. Statistical Analysis

Continuous and categorical variables are reported as mean (standard deviation) and number (percentage), respectively. The Kaplan-Meier survival analysis was used to identify differences between the groups with different surgical techniques concerning the long-term outcomes; log-rank test was used to detect differences in survival analysis. P values of < 0.05 were considered statistically significant. All statistical analyses were performed by the SPSS software, version 18.0 (SPSS Inc., Chicago, IL, USA).

4. Results

4.1. Baseline Characteristics

Sixty-five LVA repairs were performed. The other baseline characteristics of the entire study population are summarized in Table 1. Male gender was predominant (89%), and the mean of the patients' age was 56 ± 7.1 years. The majorities of the LVAs were located in the anterior wall (92.3%) and were dyskinetic (81.5%). In 40 (61.5%) patients, accompanying mitral regurgitation (MR) was found, the mechanism of which was ischemic (type IIIb, according to the Carpentier classification). Eleven patients had more than moderate MR and underwent valve repair. Among them, ten patients underwent ring annuloplasty and one patient underwent mitral valve repair through the LV, and a commissuroplasty suture (annuloplasty) on both commissures was performed during the LV aneurysm repair.

4.2. In-Hospital Outcomes

Acute renal failure occurred in five (8.2%) patients, of whom four were managed conservatively and one required peritoneal dialysis. Cerebrovascular attacks occurred in two (3.3%) patients, one of whom died. Four (6.5%) patients developed atrial fibrillation. Three (4.5%) patients underwent reoperation due to bleeding. The rate of improvement in cardiac function, defined as a rise in early postoperative left ventricular ejection fraction (LVEF), was 4.5%, 7% and 9.5%, in the plication, linear, and patch plasty repair groups, respectively ($P < 0.001$). In addition, the implementation of an intra-aortic balloon pump was required in 14 (21.5%) patients, of whom two were discharged and 12 died.

In-hospital mortality following LVA repair occurred in 12 (18.4%) patients. These patients' mean age was 65.2 ± 5.3 years. The rate of in-hospital mortality was higher, albeit not significantly, in the patch plasty repair group than in the other groups: 4.6%, 4.6% and 9.2% for the plication, linear, and patch plasty repair groups, respectively ($P = 0.077$). All these patients had three-vessel disease involvement and nine patients had diabetes mellitus. The causes of in-hospital mortality were low cardiac output in seven, failure to wean off bypass in four, and acute kidney injury in one.

4.3. Long-Term Outcomes

All discharged patients (53 subjects, 81.5%) were followed up for a period of 50.6 ± 15.6 months (range = 15 to 72 months). Eleven (20.7%) patients were lost to follow-up, primarily due to migration. Cardiac death occurred in seven (16.7%) patients: five deaths were in the linear repair group and one death in each of the plication and patch plasty repair groups ($P = 0.057$). The mean age of patients, who died

Table 1. Preoperative Characteristics of the Patients Undergoing Left Ventricular Aneurysm Repair[a]

Characteristics	All Patients, n = 65
Baseline Characteristics	
Age, y	56 ± 7.1
Male	58 (89)
Diabetes mellitus	40 (61)
Hypertension	30 (46)
NYHA functional class	
Class I	2 (3)
Class II	21 (32)
Class III	35 (54)
Class IV	7 (11)
LVEF	
> 40%	9 (14)
20% - 40%	53 (81.5)
< 20%	3 (4.5)
Extension of CAD	
Single-vessel disease	8 (13)
Two-vessel disease	0 (0)
Three-vessel disease	57 (87)
MR	
Mild	27 (41.2)
Moderate	4 (6.1)
Severe	9 (13.8)
LVA features	
LVA location	
Anterior	60 (92.3)
Posterior	4 (6.2)
Anteroposterior	1 (1.5)
Type of LVA	
Dyskinetic	53 (81.5)
Akinetic	12 (18.5)
Aneurysmal mural thrombus	14 (21.5)
Surgical features	
Concomitant CABG surgery	62 (95)
LAD graft	62 (95)
IABP	14 (21.5)
MR repair	11 (17)
Follow-up duration, m	50.6 ± 15.6

Abbreviations: CABG, coronary artery bypass graft surgery; CAD, coronary artery disease; IABP, intra-aortic balloon pump; LVA, left ventricular aneurysm; LVEF, left ventricular ejection fraction; MR, mitral regurgitation; NYHA, new york heart association.
[a] Data are presented as mean ± SD or No. (%).

at follow-up was 59.9 ± 9.4 years. The causes of deaths were heart failure in four and sudden cardiac death in three. The LVEF values were 30.9 ± 9.7 and 30.3 ± 14.2% upon preoperative and early postoperative echocardiographic evaluations, respectively.

4.4. Survival Analysis

Our survival analysis revealed no significant differences regarding the survival rate between the patients undergoing different surgical repair techniques for LVA (log-rank test P = 0.098) (Figure 1).

5. Discussion

Left ventricular aneurysm is a common serious complication of MI; and despite reperfusion therapy, LVA develops in approximately 10% - 35% of patients (2). The aneurysmal portion of the ventricular wall reduces LVEF to some extent and leads to cardiac failure, which may prove refractory to medical therapy and require surgical treatment (7). Initially SVR was performed via the linear repair technique, but the greatest weakness of this method (i.e. leaving an undisturbed scarred area of the septum) led to the introduction of a new technique. Cooley et al. (5) suggested two approaches to restoring the scarred portion of the interventricular septum. The first technique was the plication of the scarred portion with interrupted stitches, and the second one was the closure of the aneurysm of the septum with a Dacron® patch (7). In addition to these techniques, the endoventricular patch plasty was also developed to address the aneurysmal portion, leading to a further decrease in LV volume and more improvement in cardiac performance as measured by LVEF (6). For all these advances, however, controversy still exists as to what constitutes the best surgical approach to repair LVA following transmural MI.

In the present study, the rate of in-hospital mortality was high (18.4%) among the MI patients undergoing LVA repair. We think that three-vessel disease and surgery-related factors may have resulted in such a relatively high mortality rate. Pasini et al. studied the prognosis of LVA repair among MI patients and demonstrated that extended coronary artery disease was an independent predictor of early mortality (8). However, the authors reported no significant difference in terms of long-term survival between the different approaches. In addition, the in-hospital mortality rate was relatively high in the patch plasty repair group compared with that in the linear repair group, and the investigators concluded that it might have been due to either the experience of the surgeons, who performed the

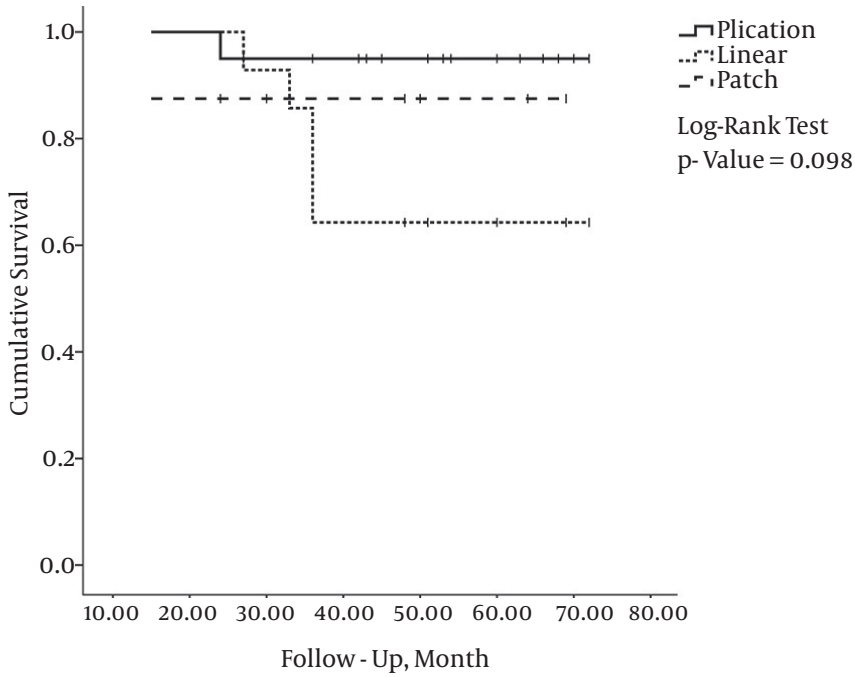

Figure 1. Comparing the Survival Rate Between Different Surgical Approaches

patch plasty repair, or the larger extent of myocardial ischemic damage, which obligated the surgeons to perform the patch plasty repair technique.

Some studies have previously evaluated differences between different approaches to LVA repair. Mukaddirov et al. (9) compared the outcomes of patients undergoing LVA repair via linear closure or patch plasty repair and reported no significant differences between these approaches at short- and long-term follow-up. Elsewhere, Antunes et al. (2) in a retrospective study found that the results of LVA repair through patch plasty versus linear repair were associated with good and comparable results concerning perioperative mortality, late functional status and survival. They concluded that the repair of postinfarction dyskinetic LVA should be modified in each patient based on the cavity size and shape and the dimension of the ischemic scar. In another study, Tavakoli et al. (3) found no differences between patch plasty and linear repair for postinfarction LVA with respect to perioperative mortality, late functional status and survival. In the present study, we found that there were no significant differences vis-a-vis long-term clinical outcomes between the three surgical approaches of patch plasty, linear, and plication techniques, although there was a trend toward an association with more in-hospital mortality in the patch plasty repair group compared with the other groups. Further large-scale randomized studies will clarify whether there is any difference between the available surgical treatments for postinfarction LVA repair.

Left Ventricular Aneurysm cases are often associated with total occlusion of the LAD and a poor collateral supply. Herein we confirm that LVA repair should be carried out in conjunction with revascularization, even if either a large area of the aneurysm is resected or the distal part of the LAD is occluded. Even the small area of the ventricular septum should be revascularized: this is of great importance for therapeutic results in proximal and distal stages (7, 8, 10). Left anterior descending artery revascularization increases flow through the peri-aneurysmal portions of the septum and lateral wall, thereby contributing to improved LV function (11). For the linear repair technique, the interventricular septum should be intact; and it is of great advantage in anterolateral and anteroapical aneurysms (12). Chen et al. showed that the outcomes of the linear and patch plasty repair techniques were similar except for LVEF and suggested that the selection of the repair technique for LVA should be individualized for each patient, according to the aneurysm size and the extent of the scarring of the septum and the subvalvular mitral apparatus (13). In the present study, the outcomes of the linear and patch plasty techniques were comparable, while LVEF was higher in the latter. This may be explained by the fact that the linear repair method is not an accurate way to adjust LV vol-

ume, and a small LV volume may lead to its diastolic dysfunction (7). Hence, this technique requires an intact interventricular septum (12). In the Dor procedure, a patch is implanted inside the LV, thereby excluding the akinetic portion of the LV septum and permitting the reconstruction and restoration of LV geometry (14). Dor plasty may, therefore, be an effective approach for dealing with large anteroseptal or posterobasal aneurysms (12). This procedure can be drawn upon in cases with more severe LV damage, where the implantation of a patch avoids inadequate LV dimensions and provides better geometry (15).

It is important to note that this study has some limitations. It is a single-center report comprised of 65 patients. In addition, due to time limitation and being retrospective, we were unable to calculate the power of the study compared to previous reports.

Although in-hospital and long-term mortality were relatively high in our cohort, which may be attributable to either poor coronary targets or other technical issues, postinfarction LVA can be repaired with similar outcomes using different surgical techniques, including linear, patch plasty, and plication techniques. However, further large-scale studies are required to evaluate the outcomes of different surgical techniques in such cases.

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