ENDOVENTRICULAR PERICARDIAL PATCH PLASTY IN THE MANAGEMENT OF LEFT VENTRICULAR ANEURYSMS

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Gazi Medical Journal 2001; 12: 5-13

SUMMARY :

Background: *Early and late surgical outcomes of endocardial resection and aneursymectomy repaired with autologous pericardial patch were studied.* ***Methods:*** *We retrospectively studied 105 patients who underwent endoaneurysmorrhaphy with pericardial patch during the period from June 1993 until June 1999. 104 patients had associated coronary artery lesions and 1 had concomittant mitral valve stenosis. Preoperative, early postoperative results of all patients and late clinical outcome of 102 patients, echocardiography of 45 and hemodynamic controls of 12 patients within a mean follow-up of 42±8 months were analyzed.* ***Results:*** *Mean New York Heart Association Class (NYHA) improved to postoperative 1.2±0.5 from preoperative 2.7±0.4. Mean number of bypass grafts was 2.6±1.1. Left ventricular ejection fraction rate improved to 46.8±8% in the early and 50.2±9% in the late follow-up compared with the preoperative 38.2±9% (p<0.05). Mean pulmonary artery pressure decreased to 16.3±3.2 mmHg from 22.1±2.3 mmHg (p<0.05) in the early postoperative period. End-diastolic left ventricular pressure decreased to 11.6±2 mmHg from the preoperative 20.2±4.8 mmHg (p<0.05) and performance score to 9.2±2 from the preoperative 14.1±2 (p<0.01). Hospital mortality was 2.8% (3 patients) and no deaths were observed in the late follow-up.* ***Conclusion:*** *Endoaneurysmorrhaphy with pericardial patch may be an appropriate option in the management of left ventricular aneurysms with acceptable surgical results.*

Key Words: *Left Ventricular Aneursyms, Endoaneurysmorraphy, Pericardium-Autologous.*

INTRODUCTION

For the last four decades, the standard approach to the treatment of left ventricular aneurysm has been to resect the aneurysm wall and close it in a linear fashion. During the past decade, evidence has accumulated that this simple approach may not be the most efficacious in terms of either short term ventricular function or long term survival and quality of life. Attention was then focused on finding new methods of reconstruction to restore left ventricular three-dimensional geometry. These concepts were introduced by Jatene (1), and later modified by Dor (2). Cooley finally presented intracavitary repair or endoaneursymorrhaphy (3). This technique retaines the aneurysm wall to allow closure over the intracavitary prosthetic patch with remodeling of the left ventricle, providing both excellent hemostasis and support for the patch from the pericadial surface. John et al. (4) and Frore et al. (5) reported the use of

autologous pericardial patch repair instead of the prosthetic material.

We have modified the endoaneurysmorraphy technique by using autologous pericardial patch which we believe is easier to manipulate, compliant, readily available, inexpensive, hemostatic and more resistant to infection. In this study, we have presented and discussed the early and late results of this technique.

PATIENTS AND METHODS

The study was approved by the Medical Ethics Committee of the institution on May 24th, 1993, and informed consent was obtained from each patient included in the study.

Patients: During the period from June 1993 until June 1999, 105 patients (85 male and 20 female, mean age: 54.9±8 years) underwent endoaneurysmorraphy with pericardial patch plasty due to left ventricular aneursym; 104 were associated with coronary artery disease and one with mitral valve stenosis.

Eighty-seven patients suffered from angina pectoris and 18 from dyspnea as well as complaints due to congestive heart failure. 20 patients had diabetes mellitus, 43 hypertension and 20 hyperlipidemia as comorbid risk factors.

Mean preoperative NYHA was 2.7±0.4 for the patients.

Preoperative echocardiographic evaluation demonstrated mean ejection fraction as 38.2±9%, fractional shortening as 19.1±5%. Aneurysms were localized apically in all cases; with additional septal involvement in 22, lateral involvement in 17 cases, septal+lateral involvement in 11 cases and inferior involvement in 8 cases.

Preoperative routine catheterization showed that mean left ventricular end-diastolic pressure was 20.2±4.8 mmHg and mean pulmonary artery pressure was 22.1±2.3 mmHg.

Ventricular function was evaluated by the ventricular performance scoring system (6). Left ventriculogram was divided into a total of seven segments: five for the right anterior oblique projection (apical, anterobasal, anterolateral, posterobasal and inferior) and two for the left anterior oblique projection (septal and posterolateral). Then the following points were given for each segment and the left ventricular performance score was calculated as the sum of these scores.

Normal wall motion: 1 point

Hypokinesia: 2 points

Akinesia: 3 points

Dyskinesia: 4 points

Aneurysm: 5 points

On performance score basis patients had 14.1±2 ventricular score, preoperatively . Preoperative baseline evaluation of the patients is summarized in Table 1.

Operative Technique:

After premedication with diazepam (10 mg I.M.), a radial artery catheter, two peripheral intravenous catheters and a pulmonary artery catheter were inserted.

Hemodynamic parameters; Heart rate , mean arterial pressure, central venous pressure, pulmonary artery pressure (PAP), rectal temperature and arterial blood gases were monitored throughout the procedure.

Anesthesia was induced by fentanyl (35 mcg /kg) and muscle relaxation was established with pancronium (0.1 mg/kg).The patients were intubated endotracheally and ventilated with 100% oxygen.

Standard median sternotomy incision was used for the exposure of the heart.

The left internal mammary artery (LIMA) was harvested and saphenous vein was prepared, if necessary.

The ascending aorta was cannulated for arterial inflow, and the right atrium for venous return. Moderate hypothermia was induced at 30°C.

Following cross clamping of the aorta, the heart was arrested by using 10-15 cc/kg crystalloid potassium cardioplegia, continued with cold blood cardioplegia every 20 min and finally warm blood cardioplegia was administered before releasing the aortic cross clamp. A longitudinal incision was made over the apex at the thinnest portion of the aneurysm, parallel to the interventricular groove. After the

Table 1: Preoperative baseline evaluation of the patients.

AGE	54.9+8.9
SEX (Male/Female)	85/20
PRIMARY INDICATION FOR OPERATION	
A) Angina	87
B) Congestive Heart Failure	18
LOCALIZATION	
A) Septal	
B) Septal + Lateral	
C) Lateral	
D) Inferior	
CORONARY ARTERY DISEASE	
A) Single Vessel	21
B) Two-vessel	28
C) Triple-vessel	34
D) Multivessel	21
CONCOMITTANT VALVULAR DISEASE	1
PREOPERATIVE NYHA	2.7+0.4
PREOPERATIVE EJECTION FRACTION	38.2+9 %
PREOPERATIVE END-DIASTOLIC PRESSURE	20.2+4.8 mmHg
PREOPERATIVE MEAN PULMONARY ARTERY PRESSURE	22.1+2.3 mmHg
PREOPERATIVE PERFORMANCE SCORE	14.1+2

NYHA : New York Heart Association Classification

aneurysmal cavity was opened, any thrombus found was removed. The aneurysm was then dissected until both edges of the ventriculotomy incision had a sufficient exposure up to the transition zone between the more normal, maroon-coloured myocardium and the whitish, fibrous area of the scar tissue (Fig. 1A).

Once the extent of the defect was determined, the optimal size and shape of the pericardium needed to restore the normal three-dimensional geometry and volume of the ventricle was decided. An elliptical pericardial patch was tailored to fit the single apical defects, asymmetric elliptical patch for the cases with additional septal, lateral and inferior involvement. The patch was not treated by gluteraldehyde.

Starting from the septum, the pericardial patch was secured by 3-0 continuous polypropylene sutures into the firm fibrous tissue adjacent to the transition zone, then sewn endocavitarily on the lateral and inferior walls

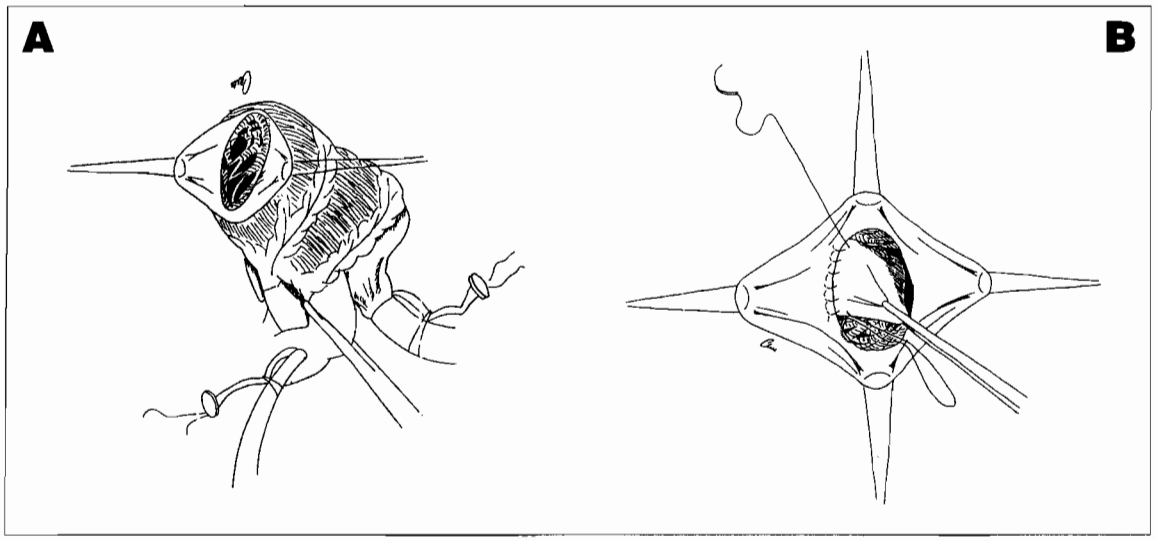

Fig. 1: Exposure of the defect to be repaired (A). Pericardial patch is tailored to fit the defect (B).

with running stitches closer on the patch side and wider on the ventricular side (1X distance from the patch and 1.5-2 X distance from the ventricular wall) for remodelling of the ventricular cavity (Fig. 1B).

In 2 cases, the pericardial patch was tightened by a dacron patch, with pericardium on the ventricular side since the pericardium was too thin and damaged at the suture line. Ventricular walls were trimmed in appropriate cases and finally the ventriculotomy was repaired by using continuous 3-0 continuous polypropylene sutures.

Felt strips were used to buttress the suture line, if the fibrous tissue was not strong enough. Air was evacuated from the left ventricle before the warm blood cardioplegia was administered and the aortic cross clamp was released.

Mitral valve replacement was performed via ventriculotomy before aneurysm repair. Coronary artery bypass grafting were performed following aneurysm repair. Internal mammary graft was used for LAD lesions and saphenous vein grafts for the remainder.

Cardiopulmonary bypass was discontinued after rewarming and the operation was then finished by standard procedure.

Hospital Data:

Patient medical records were reviewed retrospectively. Data collected included the following:

1) Demographic information: Sex, age, primary indication for operation

2) Preoperative functional status (NYHA) and type of angina

3) Comorbid risk factors: Diabetes mellitus, hypertension, hyperlipidemia, prior cerebrovascular disease, smoking, chronic obstructive pulmonary disease, chronic renal failure.

4) Preoperative echocardiographic and angiographic evaluation: Localization of aneurysm, coronary artery stenosis, valvular lesions, ejection fraction rate, end-diastolic pressure, mean pulmonary artery pressure and ventricular performance score

5) Operative data: concomittant procedures, valve replacement, coronary artery bypass grafting, thrombus, cardiopulmonary bypass and aortic cross clamp time, use of inotropic agents and intraaortic balloon pumping (IABP), intraoperative complications, operative mortality

6) Postoperative complications: Postoperative mortality, substantial morbidity defined as reoperation for bleeding, mediastinal infection, respiratory support, cerebrovascular and respiratory complications, perioperative myocardial infarction, low cardiac output and the need for inotropic support or IABP and other major complications, postoperative improvement in echocardiograhic measurements, pulmonary artery pressure.

Long-term Follow-up:

All clinical records were reviewed. Data obtained included survival, functional status, long-term medical management, procedure related complications, echocardiography controls and repeated angiography for coronary restenosis.

Statistical Analysis:

Data were expressed as mean±standard error of mean. The two-tailed paired t test was used to analyze continuous variables. p value less than 0.05 was considered significant.

RESULTS

Early Results:

104 patients received coronary artery bypass grafts and 1 had mitral valve replacement in addition to endoaneurysmorraphy repair with autologous pericardium.

Operative profiles of the study group is demonstrated in Table 2.

ICU follow-up data is summarized in Table 3. 30 patients suffered from perioperative arrhythmia; 18 from atrial fibrillation (AF), 8 from ventricular premature beats (VPB), 2 from AF+VPB and 2 from ventricular fibrillation (VF). Patients with AF received slow infusion of propafenon HCl 70 mgr i.v and 14 cases were treated. The remaining 16 patients responded to amiodaron HCL infusion of 150 mgr. i.v.

4 patients with VPB responded well to bolus lidocaine 100 mgr i.v. 2 patients were treated with propafenon HCl infusion of 70 mgr i.v. and 2

Table 2: Operative data of the patients.

Cardiopulmonary Bypass Time (min)	74.3+22
Aortic Cross Clamp Time (min)	45.3+15
Concomittant Coronary Bypass Grafting	104
Number of Grafts	2.6+1.1
Thrombus	57
Concomittant Valve Replacement	1
Use of Inotropic Agents	38
IABP (Intraaortic Balloon Pumping)	5
Operative Mortality	-

Table 3: Early postoperative data of the patients.

Postoperative Hemorrhage	850+300 cc
Respiratory Support	14.7+2.6 hrs
Intensive Care Unit Stay	2.5+1.7 days
Hospital Stay	8.4+2.1 days
New York Heart Association Class on discharge	1.2+0.5
Use of postoperative inotropics	52
Intraaortic Balloon Pumping	-
Persistant Low Cardiac Output	2
Perioperative Arrhythmia	30
Perioperative Myocardial Infarction	-
Perioperative Mediastinal Infection	-
Perioperative Cerebrovascular Events	-
Postoperative Respiratory Problems	2
Reoperation for Bleeding	2
Perioperative Mortality	2.8% (3)

with amiodaron HCl 150 mgr i.v. infusion.

Two patients with VF were defibrillated and responded well to lidocaine infusion.

Two cases underwent revision due to hemorrhage. 2 patients had Adult Respiratory Distress Syndrome in the early postoperative period. One needed supportive respiratory therapy, and the response was good.

Three patients died in the perioperative period. The data of these patients is summarized in Table 4. They were preoperative high-risk patients.

For hemodynamic comparison, all patients underwent Doppler echocardiographic evaluation before discharge. Mean postoperative pulmonary pressure was also recorded via pulmonary artery catheter before discharging the patients from the intensive care unit (ICU).

Table 4: Overall evaluation of mortality (three patients).

	I.patient	**II.patient**	**III.patient**
Gender/Age	Female/72	Female/68	Female/69
Preoperative EF	32%	30%	30%
Preoperative EDP	20 mmHg	25 mmHg	25 mmHg
Preoperative PAP	35 mmHg	38 mmHg	35 mmHg
Preoperative PS	14	14	14
Complications	ARDS, LCO	Acute Renal Insuff. LCO	
Support	IABP	Hemodialysis	IABP
Inotropics	Dopamine+Dobutamine+ Adrenaline	Dopamine+Dobutamine +Adrenaline	Dopamine+Dobutamine+ Adrenaline
Survival	2 days	14 days	3 days

EF: Ejection Fraction EDP: End-diastolic pressure PAP: Pulmonary artery pressure
PS: Performance score ARDS: Adult respiratory distress syndrome
LCO: Low cardiac output IABP: Intraaortic baloon pumping

Comparing the data of preoperative 105 and postoperative 102 patients, mean pulmonary artery pressure decreased to 16.3±3.2 mmHg from preoperative 22.1±2.3 mmHg ($p \leq 0.05$, paired t test, Fig. 2A); echocardiographic measurement of left ventricular ejection fraction on discharge increased to 46.8±8% versus preoperative 38.2±9% ($p \leq 0.05$, paired t test, Fig. 2B).

Mean functional status was 1.6±0.7 for these patients. Preoperative EF of 35±2.4% improved well up to 45.1±3.6% ($p \leq 0.05$, paired t test); 20.2±4.8 mmHg of end-diastolic pressure decreased to 11.6±2.1, demonstrating better ventricular functions and better ventricular geometry (Fig. 3 A and 3B). Control angiography was negative for 3 patients, restenosis was detected in 6 patients and new stenotic lesions

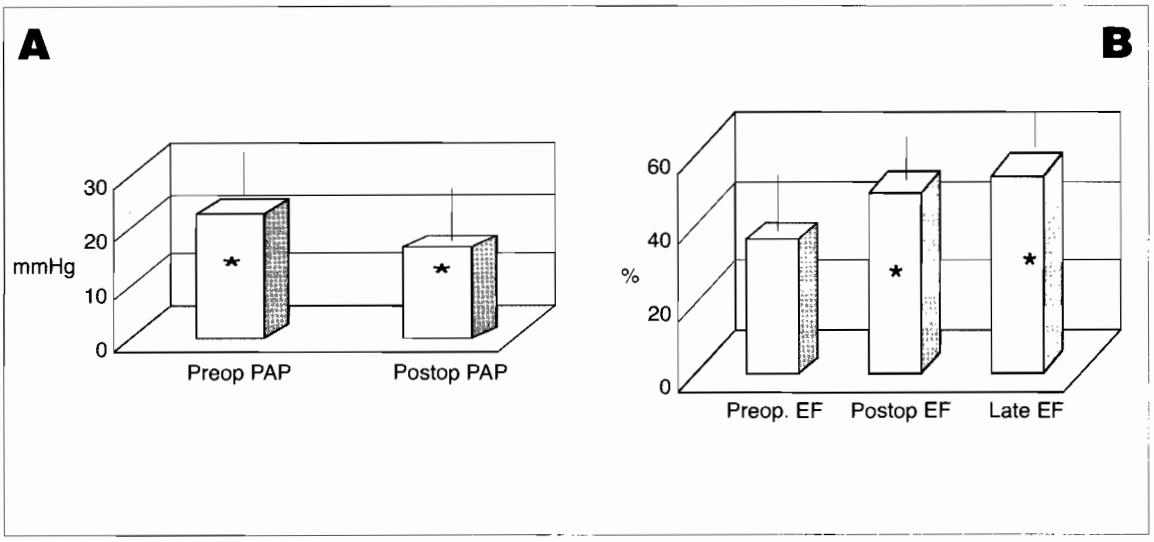

Fig. 2: Preoperative and early postoperative improvement of pulmonary artery pressure. * p_0.05 (A). Preoperative, early and late postoperative improvement in ejection fraction rate. * p_0.05 (B)

Postoperative echocardiography demonstrated a better ventricular geometry with the pericardial patch.

Late Follow-up:

Data of 102 patients within a mean follow-up of 42±8 months were included. Functional status has been substantially better than preoperative levels, percentage of patients in NYHA I/II has been 88%. No additional mortality was observed in the whole follow-up period.

45 patients (44.1%) had repeated echocardiography controls in the first 6 months of the follow-up period. Mean EF was 50.2±9% ($p<0.05$, paired t test with respect to preoperative measurements). Echocardiography demonstrated appropriate ventricular geometry by pericardial patch.

12 patients (11.7%) had anginal symptoms and needed control coronary angiography. Data of these patients is demonstrated in Table 5. Ventricular performance score improved to 9.2±2 versus preoperative 14.1±2 ($p \leq 0.01$).

were observed in 3 patients.

The follow-up of other patients was uneventful.

DISCUSSION

There has been considerable change in recent years regarding surgical repair of left ventricular aneurysms. The frequency of aneurysm operations has declined precipitously due to the use of thrombolytic therapy very early after myocardial infarction leading to a healing process with retained viable myocardium with no potential for dilatation. Aneursymectomy procedure associated with a complete myocardial revascularization, in particular of LAD, and a larger use of LIMA may permit by means of reconstruction of the left ventricular geometry, a better outcome for the patients (7). We have performed concomittant coronary artery bypass grafting in all patiyents with coronary artery disease as extensive ly as possible and utilised IMA in every case to obtain better postoperative ventricular performance.

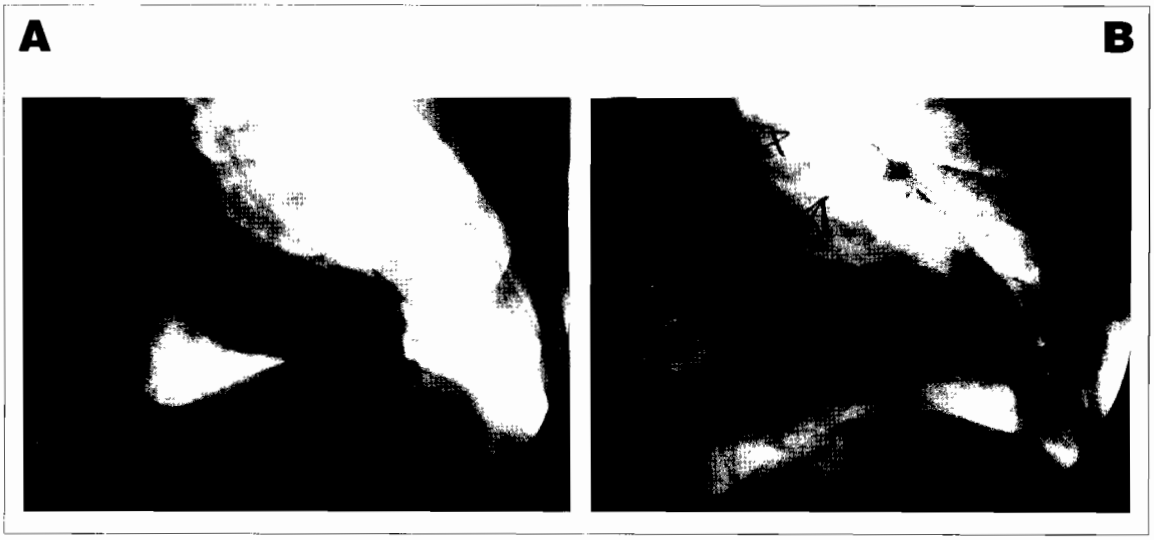

Fig. 3: Angiographic view of a patient before (A) and after the pericardial patch repair (B).

Table 5: Data of patients that underwent control coronary angiography.

	Gender/ Age	Prior CABG	Symptom-free Interval	NYHA	Indication	Preop EF (%)	Postop EF	Preop EDP (mmHg)	Postop EDP	Findings	Management
1	64/M	3	4 years	1	sap	34	43	25	10	PDA restenosis	Medical
2	56/M	3	4 years	1	sap	35	47	25	8	OM restenosis	Medical
3	54/M	1	2 years	2	uap+Arrhyt	32	48	20	12	PDA stenosis	PTCA
4	49/M	3	2 years	3	uap+CHF	36	49	15	10	RCA stenosis	PTCA
5	62/M	2	3 years	1	uap	35	47	15	10	No stenosis	Medical
6	67/M	1	1 year	2	sap	34	42	20	12	LIMA anastomosis 50% stenosis	PTCA
7	47/M	2	1 year	2	uap+Arrhyt	32	44	20	15	No stenosis	Medical
8	65/F	3	2 years	1	sap	39	45	25	14	OM restenosis	Medical
9	69/F	3	3 years	1	sap	40	52	10	10	Diag restenosis	Medical
10	70/M	3	1 year	3	uap+CHF	34	43	25	13	LIMA anastomos--is stenosis	PTCA
11	55/M	3	6 months	2	uap+Arrhyt	33	38	20	12	No stenosis	-

CABG: Coronary artery bypass grafting
EF: Ejection fraction
Sap: Stabile angina pectoris
CHF: Congestive heart failure
PDA: Posterior descending coronary artery
RCA: Right coronary artery
NYHA: New York heart association class
EDP: Enddiastolic pressure
Uap: Unstable angine pectoris
PTCA: Percutaneous transluminal coronary angioplasty
LIMA: Left internal mammary artery
OM: Obtuse marginal coronary artery

Alterations have also occurred in operative technique, with the most prominent change being the introduction of endoventricular patch plasty which aims at replacing the aneurysmal

myocardial wall with an elliptical patch to restore the geometry, contour and volume of left ventricle in diastole while simultaneously reducing end-systolic volume. Patch reconstruction allows circular reorganization of the remaining left ventricular muscle which can not be accomplished using traditional linear closure, also using circular reconstruction permitting easier LAD revascularization (8). Our technique is also based on endoventricular aneurysmorrhaphy. Our results also demonstrated significant improvement in left ventricular geometry, performance and clinical status of the patients and decreased end-diastolic and pulmonary artery pressures as well.

Many authors have been using synthetic material as a patch in surgical repair. However, usually the synthetic material is bulky, non-compliant and prone to infection (9). Autologous pericardium is compliant, readily available, inexpensive and hemostatic as well as resistant to infections (10). It has several applications in the current treatment techniques. Surgeons using Dacron as the primary circular patch material, have sewn the pericardium onto Dacron patch lining so that the smooth visceral pericardial surface becomes the pseudoendocardium, potentially reducing the risk of clot formation onto the patch (11). Many surgeons still use pericardium as pledgets or as linear strips to reinforce any of the suture lines during circular reconstruction (12).

Considering various types of utilization of pericardium, we have used it as the primary material to restore circular geometry following left ventricular reconstruction. We observed no infection and only 2 early reoperations for hemorrhage due to aneursym repair in the study group.

Mean postoperative follow-up is not very long (42±8 months), since 102 patients are living in different parts of the country but may be reliable enough to demonstrate the functional indices of the ventricular function.

We have demonstrated a significant improvement in ejection fraction and performance score in the early as well as in the late postoperative period. The number of late postoperative echocardiography is 45 (44.1%). However we used echocardiographic control only when some symptoms were present.

We had the opportunity to control only 12 patients angiographically because of anginal symptoms, arrhythmia or signs of congestive heart failure. This 11.7% patient population may give an idea about the hemodynamic improvement following operation, although they had probable coronary restenosis. We observed a significant difference in end-diastolic pressure and ejection fraction rates.

Our aim is to increase our patient population and follow-up period as well as late postoperative controls of echocardiography and angiography in the ongoing study.

Considering our data, it may be concluded that endoventricular pericardial patch plasty in the surgery of left ventricular aneurysms would be an alternative option with acceptable surgical and perioperative results.

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