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Midterm Results after Septal Reshaping for Anteroseptal Scars

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ABSTRACT

Background: Midterm clinical and morphologic results of the septal-reshaping exclusion of anteroseptal dyskinetic or akinetic areas were evaluated.

Methods: From January to June 2003, 44 patients with myocardial infarction following left anterior descending coronary artery (LAD) occlusion underwent septal reshaping. The mean (± SD) New York Heart Association (NYHA) class of the patients at admission was 2.7 ± 0.9. Angina was referred in 21 cases. The incision was started at the apex and directed parallel to the LAD toward the base of the heart. The septum was rebuilt with 1 or 2 U-stitches passed from the inside to join the anterior wall to the septum by starting as high as possible where the scar began and continuing in an oblique direction toward the new apex. An oval polyethylene terephthalate fiber (Dacron) patch was then sutured from the septum (at the end of the direct suture through the border with the inferior septum) to the anterior wall (between the healthy wall and the scarred wall) and up to the new apex.

Results: The 30-day mortality rate was 2.2% (1 patient, due to the failure of a previously implanted defibrillator). Three patients experienced acute renal failure. No patient had restrictive syndrome. After a mean follow-up period of 8.5 ± 4.9 months (range, 4-22 months), the mean NYHA class improved from 2.7 ± 0.9 to 1.6 ± 0.5 ($P < .001$). The 18-month survival rate and the probability of being alive in NYHA class I or II were 93.2% ± 2.0% and 90.9% ± 4.3%, respectively. Echocardiographic results showed reductions in the left ventricle volume with a normalization of the stroke volume. The diastolic longitudinal length remained unchanged, and the diastolic sphericity index was reduced but not significantly.

Conclusions: At 1 year after surgery, the good clinical and morphologic results demonstrate the safety and effectiveness of septal reshaping for anteroseptal scars.

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INTRODUCTION

Linear resection and direct closure, which was originally described by Cooley et al [1958], remained the primary surgical treatment for the correction of left ventricular (LV) aneurysms until the mid 1980s, when Jatene [1985], Dor et al [1985], and Guilmet et al [1984] independently reported 3 different techniques for excluding dyskinetic or akinetic areas following myocardial infarction in the territory of the left anterior descending coronary artery (LAD) while maintaining the LV in a more physiological shape.

With time, the anatomical presentation of LV anteroseptal scars changed because of the diffusion of fibrinolysis or primary angioplasty during acute myocardial infarction. LVs were less dilated, and the involved areas were more akinetic than dyskinetic, because the subepicardial muscle was partially salvaged.

In January 2002, we began using a different technique developed at our institution for the treatment of anteroseptal dyskinetic or akinetic areas of differing extension.

The aim of this study was to evaluate midterm clinical and morphologic results of patients who underwent this procedure, known as septal reshaping, as it is used mainly in the rebuilding of a new septum.

MATERIALS AND METHODS

From January 2002 to June 2003, 44 patients underwent septal reshaping for the treatment of anteroseptal dyskinetic or akinetic areas. Table 1 reports the preoperative characteristics of these patients.

Coronary artery bypass grafting was performed in 35 patients (77.7%) with a mean (± SD) of 2.6 ± 1.3 anastomoses per patient. Revascularization of the LAD was performed in 21 patients (44.4%). Functional mitral regurgitation was corrected in 22 patients. The valve was repaired in 21 patients and replaced in the remaining patient. Six patients had a concomitant tricuspid valve repair. Synchronization of both ventricles was obtained in 5 patients by implanting an atrial-biventricular pacer. One patient had a postinfarction ventricular septal defect treated by patch closure. Mean cardiopulmonary bypass and aortic cross-clamping times were 111 ± 38 minutes and 86 ± 26 minutes, respectively.

Table 1. Preoperative Characteristics (n = 44)*

Age (range), y	65.9 ± 11.0 (42-82)
Female sex, n (%)	11 (25.0)
Diabetes, n (%)	9 (20.5)
NHYA class, n (%)	
I	5 (11.3)
II	11 (25.0)
III	20 (45.5)
IV	8 (18.2)
Mean	2.7 ± 0.9
Angina, n (%)	21 (47.7)
Ventricular arrhythmias, n (%)	11 (25.0)
AMI to intervention (range), mo	39.2 ± 67.7 (1-218)
Redo, n (%)	2 (4.5)
Chronic renal failure (dialysis), n (%)	1 (2.2)

*Data are presented as the mean ± SD where appropriate. NYHA indicates New York Heart Association; AMI, acute myocardial infarction.

Surgical Technique

The technique has previously been described [Calafiore 2004] (video 1). Briefly, an incision 5 to 8 cm long is started at the apex and extended toward the heart base at a distance of 1 cm from the LAD. The anterior wall is joined to the septum by means of an oblique linear suture with 1 or 2 U-stitches (polyester [Ti-cron] 2-0 suture) (Figure 1). Four polypropylene (Prolene) 3-0 suture stitches are then positioned. The first stitch is passed at the level of the last interrupted suture, the second is passed at the level of the new apex, the third is passed at the border between the scar and the healthy posterior septum, and the fourth is passed in the anterior wall at the limit of the scar (Figure 2). These 4 stitches are the marker points for an oval polyethylene terephthalate fiber (Dacron) patch (approximately 6 cm × 3 cm) that will constitute the new distal septum (Figure 3, videos 2 and 3). The incision is then closed in a double layer.

The purpose of this procedure is to create a new ventricular chamber that has a more conical shape and that excludes the anteroseptal scar (Figure 4). The excluded cavity remains full of blood that will clot after a few weeks (Figure 5, videos 4 and 5).

Mitral Valve Repair. The mitral valve was repaired when necessary by means of an overreductive posterior annuloplasty. A pericardial strip 40 mm long was always used, as previously described [Calafiore 2003a].

Tricuspid Repair. A DeVega-like suture annuloplasty with Atrial-Biventricular Pacer. In the presence of left bundle branch block, an atrial-biventricular pacer (InSync III 8042; Medtronic, Minneapolis, MN, USA) was positioned to synchronize the left and the right ventricles. Synchronization was performed in the operating room and controlled on the second and fourth postoperative days. The heart rate was maintained at 100 beats/min in the operating room, at 90 beats/min on the first postoperative day, and at 80 beats/min in the following postoperative period.

Perioperative and Postoperative Course

All of the patients had standard monitoring and a Swan-Ganz catheter to continuously measure cardiac output. Elective infusions of dobutamine (5 µg/kg per minute) and sodium nitroprusside (Nipride) (according to peripheral

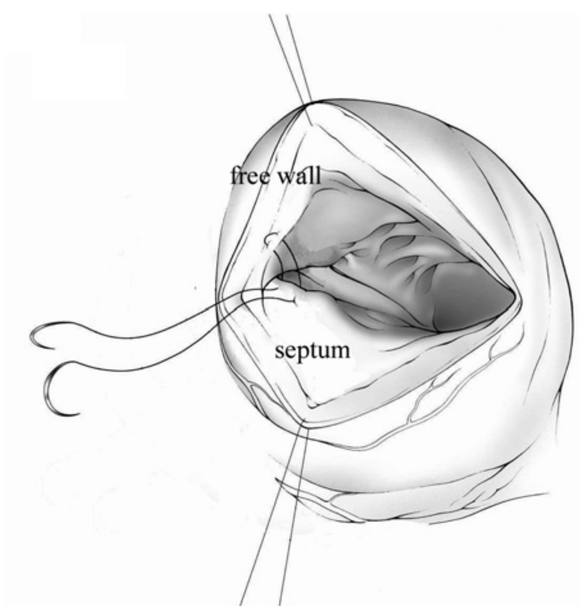

Figure 1. The anterior wall was joined to the septum by means of an oblique linear suture with 1 or 2 polyester (Ti-cron 2-0) U-stitches.

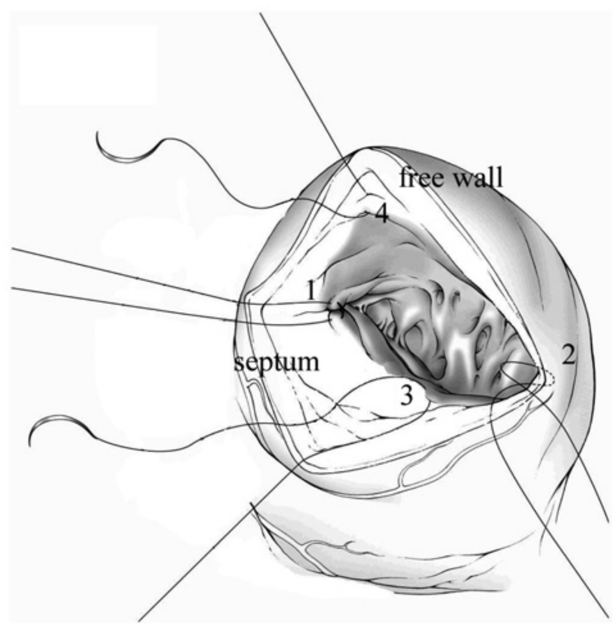

Figure 2. Stitches are made at 4 positions in the septum: at the end of the last interrupted suture (1); at the level of the new apex (2); deep in the septum at the border between the scar and the healthy posterior septum (3); and in the anterior wall, again at the limit of the scar (4).

resistances) were started when the aorta was unclamped (during the closure of the ventriculotomy). If necessary, low-dose adrenaline (0.03 μg/kg per minute) therapy was added. When cardiopulmonary bypass was stopped, cardiac output was continuously monitored, and the drug infusion was adjusted according to the cardiac index and systemic and pulmonary resistances. The patient was then admitted to the intensive care unit and remained there until the cardiac index was stable and the adrenaline and Nipride infusions were stopped. The dobutamine infusion was continued in the ward and was reduced day by day. All of the patients were started on orally administered angiotensin-converting enzyme inhibitors on the first postoperative day and, when the dobutamine infusion was discontinued, beta-blockers if necessary. All of the patients were moved from the surgical ward to the cardiologic ward and were discharged home from there.

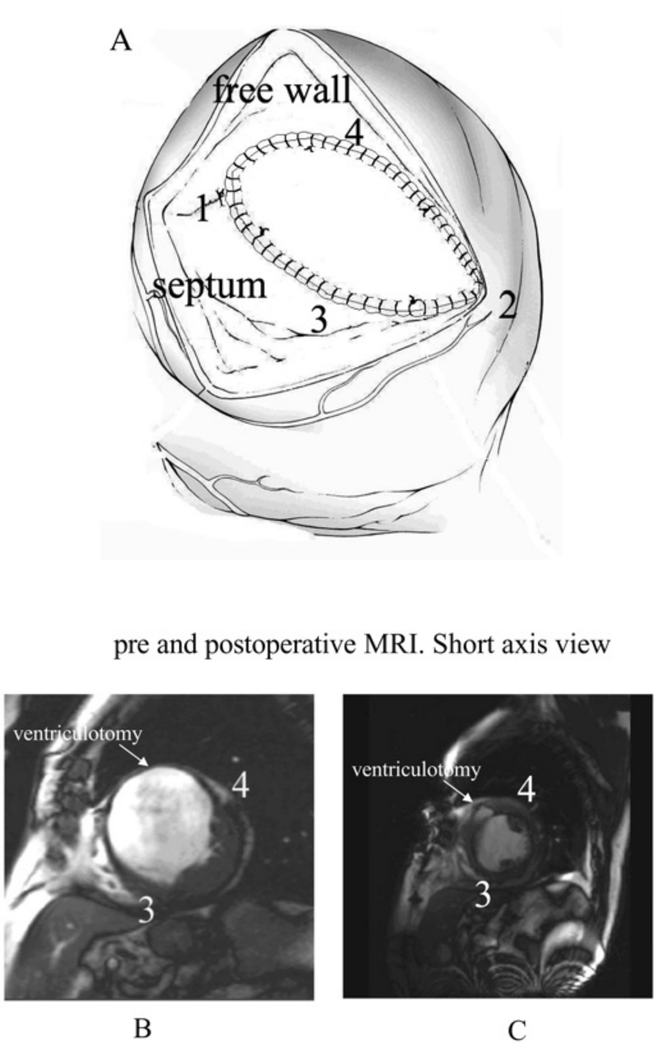

Figure 3. An oval polyethylene terephthalate fiber (Dacron) patch is tailored and fixed with the 4 stitches previously placed (A). Preoperative (B) and postoperative (C) magnetic resonance imaging short-axis views. Numbered positions are described in the legend to Figure 2.

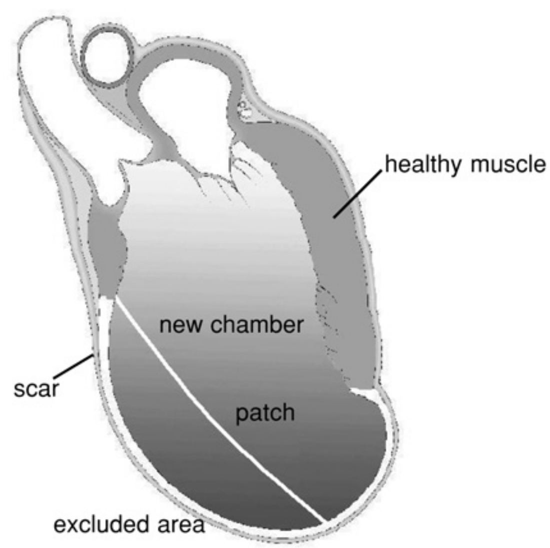

Figure 4. The purpose of the procedure is to create a new ventricular chamber that has a more conical shape and excludes the anteroseptal scar.

Echocardiographic Evaluation

All of the patients had preoperative, perioperative, and postoperative transesophageal or transthoracic echocardiograms (Figure 6, videos 6 and 7). LV volumes (end-diastolic and end-systolic) were measured according to the biapical Simpson disk method [Schiller 1989] and indexed to body size, and the ejection fraction was calculated. The sphericity index was calculated as the ratio of the transverse length to the longitudinal length. Values obtained from 10 volunteers of similar body surfaces were used as controls.

Follow-up

All of the patients were followed up every 3 months at our outpatient clinic, and a transthoracic echocardiographic examination was performed. Follow-up was 100% complete.

Statistical Analysis

Results are expressed as the mean ± SD. Statistical comparisons of means for 2 groups were performed with the paired 2-tailed Student *t* test, and categorical variables were evaluated with the χ^2 test. Survivorship curves were obtained by means of the Kaplan-Meier method. The SPSS statistical software package (SPSS, Chicago, IL, USA) was used. A *P* value <.05 was considered statistically significant.

RESULTS

Early Clinical Results

The 30-day mortality rate was 2.3% (1 patient), the death being due to the failure of a previously implanted defibrillator. Three patients needed an intra-aortic balloon pump. Acute renal failure occurred in 3 cases. One patient affected by chronic obstructive pulmonary disease before the operation experienced an acute respiratory insufficiency in the early postoperative period that was caused by a pneumonia. Early clinical outcomes are summarized in Table 2.

Late Clinical Results

After a mean follow-up period of 5.5 ± 3.5 months, 2 patients had died, 1 patient at 3 months from respiratory insufficiency that followed postoperative pneumonia and the other from sudden death at 8 months. The actuarial 18-month survival rate was 93.2% ± 3.8% (Figure 7).

The mean follow-up period for the survivors was 8.5 ± 4.9 months (range, 4-22 months). The mean New York Heart Association (NYHA) class of the 41 survivors changed from 2.7 ± 0.9 to 1.6 ± 0.5 ($P < .001$). The NYHA class improved in 31 patients (75.6%) and remained unchanged in 10 (24.4%). Globally, only 1 patient was in NYHA class III. The actuarial 18-month probability of being alive and in NYHA class I to II was 90.9% ± 3.8% (Figure 7).

Echocardiographic Results

After 5.9 ± 3.1 months (range, 3-12 months), 32 patients (69.6%) underwent an echocardiographic examination (Table 3). In all of the controlled patients, the LV volume was significantly reduced. The stroke volume normalized, and the ejection fraction increased although not significantly. The mitral regurgitation grade was reduced significantly from 2.5 to 0.6. No new mitral regurgitation developed.

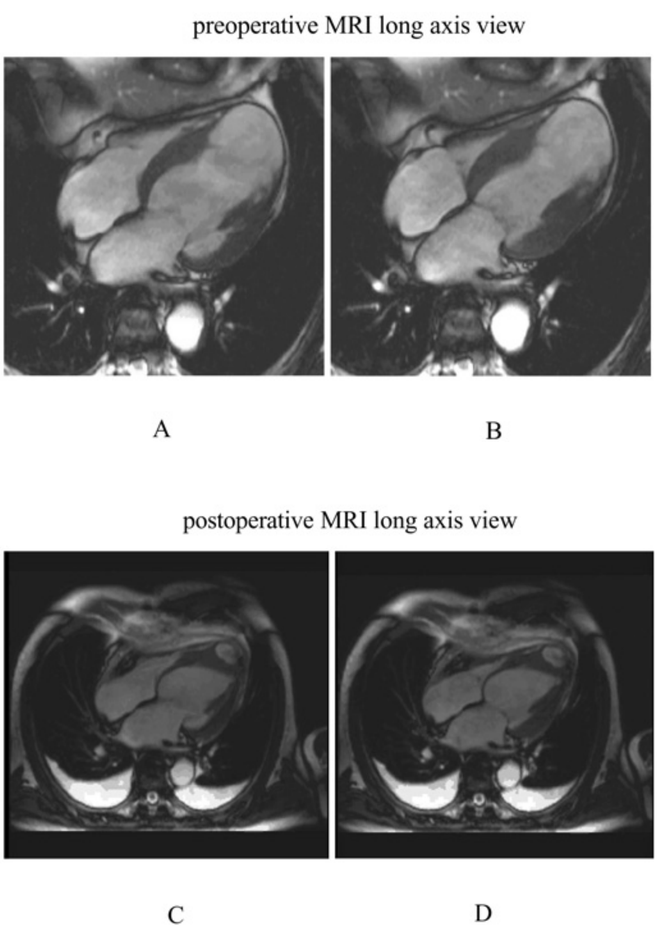

Figure 5. Preoperative magnetic resonance imaging (MRI) long-axis view (A, diastole; B, systole) and postoperative MRI long-axis view (C, diastole; D, systole).

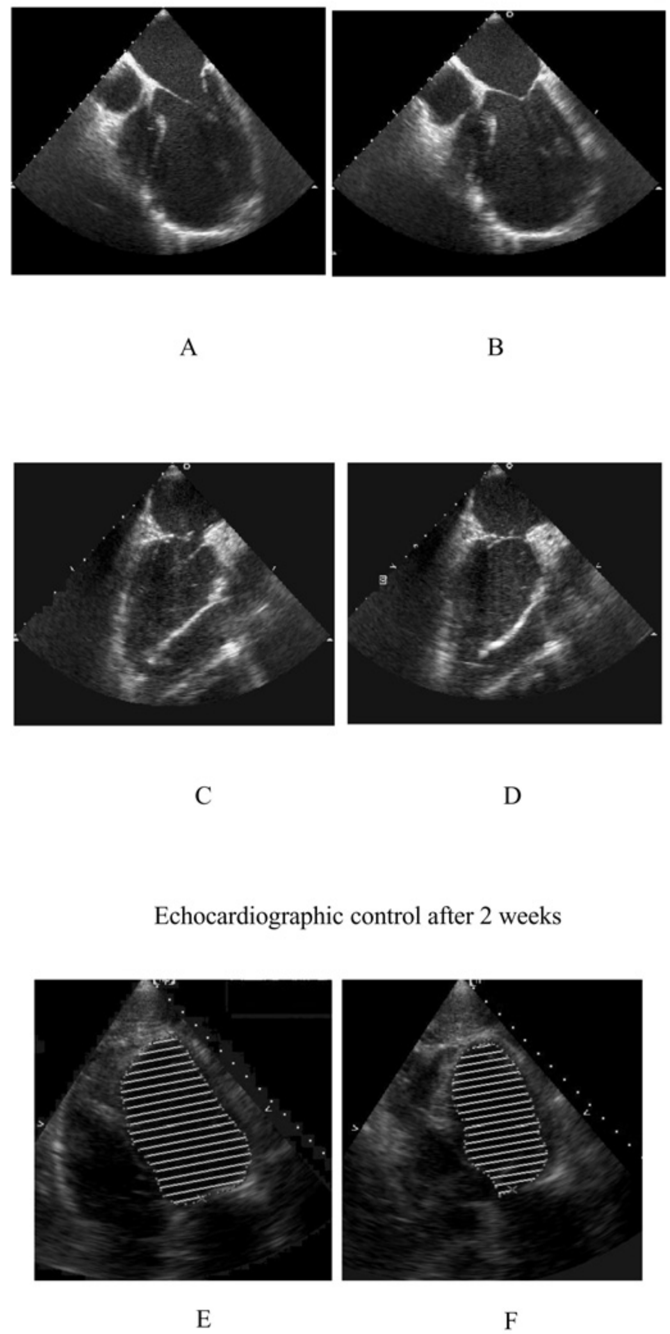

Figure 6. Perioperative transesophageal echocardiograms. Before the operation, the distal septum is dyskinetic, and the apex is widened (4-chamber view: A, diastole; B, systole). At the end of the procedure, the linear suture and the patch divide the left ventricular cavity into 2 portions, the real and the excluded cavities (2-chamber view: C, diastole; D systole). Transthoracic echocardiographic control evaluation 2 weeks after surgery shows that the excluded cavity is clotting; the shape of the real cavity appears more conical (E, diastole; F, systole).

Table 2. Thirty-Day Clinical Results (n = 44)*

Deaths, n (%)	1 (2.2)
Acute myocardial infarction, n	0
Low-output syndrome, n (%)	3 (6.8)
Acute renal failure, n (%)	3 (6.8)
Acute respiratory failure, n (%)	1 (2.2)
Bleeding, mL/12 h	603 ± 321
Patients with transfusion, n (%)	36 (81.8)
Awaking time, h	3.4 ± 2.1
Extubation time, h	6.6 ± 4.1
Intensive care unit stay, h	30 ± 18
Hospital stay, d	7.9 ± 2.7

*Data are presented as the mean ± SD where appropriate.

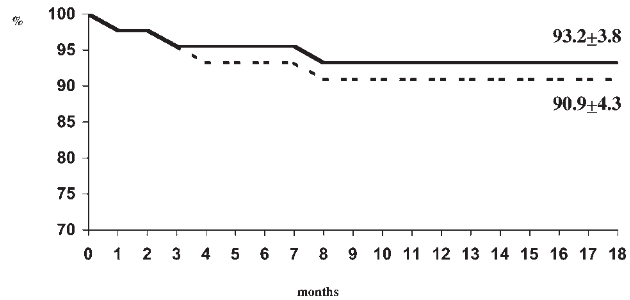

Figure 7. The 18-month survival rate (solid line) and the probability of being alive in New Heart Association class I or II (dashed line).

COMMENT

In the mid 1980s, Jatene [1985] and Dor et al [1985] independently developed the concept of LV reshaping using purse-string sutures, which replaced the method of linear resection of the LV aneurysm introduced by Cooley et al [1958]. With some differences, these 2 techniques were indicated for patients with a similar involvement of the free wall and the septum. During the same period, Daniel Guilmet and colleagues proposed a new surgical technique to treat LV aneurysms in cases in which the septum is more involved than the free wall [Calafiore 2003b].

Large dyskinetic or akinetic areas, which widely involve the septum, are the consequence of a proximal occlusion of the LAD. Septal branches arise from the LAD at angles of 70° to 90°. When the LAD becomes occluded, necrosis extends deep into the septum (Figure 8). Diagonal branches arise from the LAD in a more oblique direction (approximately 45°). Consequently, the necrosis in the anterior free wall extends from the LAD occlusion toward the apex like the delta of a river (Figure 9).

As recently maintained by Torrent-Guasp et al [2001] and Buckberg [2002], the aim of any technique of LV reshaping has to be not only a reduction in LV volume but also the preservation of a conical shape to restore a more anatomically natural fiber orientation. This goal can be obtained by maintaining a longitudinal length as similar as possible to the preoperative one. This length can be achieved by excluding the septum as high as possible and by maintaining an oblique direction toward a new apex. As a consequence, the sphericity index is not changed (or is reduced), and this aspect can be important in preventing a delayed onset of mitral regurgitation after LV reshaping [Di Donato 2001, Yuge 2003].

The purpose of the technique herein described is to obtain a reduction in the LV volume, to preserve a conical shape, and to maintain a diastolic volume sufficient to ensure a normal stroke volume. This goal is achieved by excluding all of the septum with both linear suture (approximately up to the level of the papillary muscles) and an oval patch.

In our experience, 75.6% of the surviving patients showed an improvement of at least 1 NYHA class, and 97.5% of these patients were actually in NYHA class I or II. These results demonstrate the improved efficiency of the LV pump function obtained with this procedure. Furthermore, no patient showed a restrictive syndrome, the most dangerous effect of an excessive reduction in LV volume.

Table 3. Echocardiographic Results (n = 32)*

	Normal Values†	Preoperative	Postoperative‡	*P*
End-diastolic volume, mL/m^2	48 ± 6	124 ± 38	85 ± 20	<.001
End-systolic volume, mL/m^2	18 ± 4	80 ± 34	52 ± 19	.001
Stroke volume, mL/m^2	30 ± 4	45 ± 7	33 ± 7	<.001
Ejection fraction, %	63 ± 3	38 ± 7	43 ± 8	NS
Sphericity index (diastole)	—	0.78 ± 0.06	0.75 ± 0.12	NS
Longitudinal length (diastole), cm	7.8 ± 0.3	8.7 ± 0.9	8.4 ± 0.6	NS
Mitral regurgitation§	—	12/2.5 ± 0.7	4/0.6 ± 0.7	<.001

*Data are presented as the mean ± SD; NS indicates not significant.

†Values are obtained from 10 healthy volunteers with similar body surfaces.

‡Patients were evaluated at 5.9 ± 3.1 months after surgery.

§Number of mitral regurgitation patients/mitral regurgitation grade.

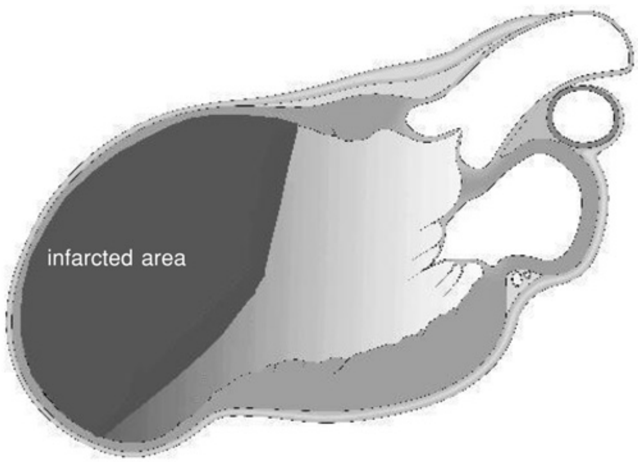

Figure 8. Septal branches start from the left anterior descending coronary artery (LAD) in a 70° or 90° angle. When the LAD is occluded, necrosis extends deep into the septum.

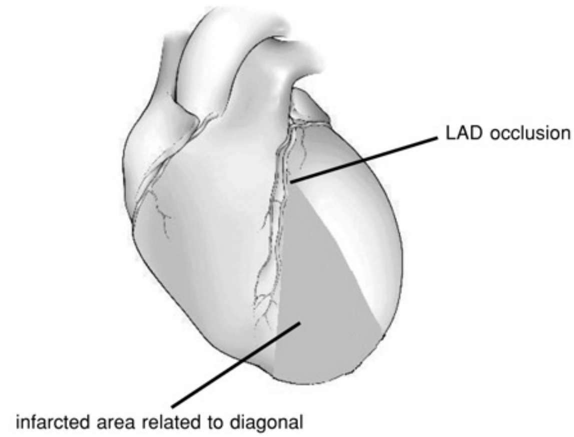

Figure 9. Diagonal branches extend from the left anterior descending coronary artery (LAD) in a 45° oblique direction, so the necrosis in the anterior free wall extends as a small triangle from the point of LAD occlusion toward the apex.

In conclusion, good clinical and morphologic results obtained at 18 months after surgery demonstrate the safety and the effectiveness of this technique to treat all of the dyskinetic or akinetic areas following LAD occlusion when the septum is more involved than the anterior free wall.

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