Clinical Investigation

Surgical Repair of Ventricular Aneurysms

Early Results with Cooley's Technique

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Using bovine pericardium instead of Dacron for grafting, we performed ventricular endoaneurysmorrhaphy (Cooley's technique) in 13 patients with postmyocardial infarction left ventricular aneurysm. Twelve patients were men and 1 was a woman; their ages ranged from 38 to 67 years (mean, 51.2 ± 11.4 years). Eight patients had large anterolateral aneurysms, 4 had apical aneurysms, and 1 had a false inferior aneurysm. Postoperatively, the mean cardiac index increased from 2.07 ± 0.50 to 3.09 ± 0.99 L/min/m² (p <0.05), with a mean percentage increase of 50.17% ± 37.03%. No patient required postoperative mechanical circulatory assistance, and pharmacologic support could be withdrawn soon after surgery. All patients had uncomplicated recoveries and were asymptomatic upon discharge, at a mean time of 9.0 ± 2.3 days after surgery. We conclude that ventricular endoaneurysmorrhaphy provides excellent initial results, and we believe, through subjective analysis of ventriculograms, that the use of bovine pericardium for grafting produces better functional results than does the use of Dacron. ***(Texas Heart Institute Journal 1993;20:19-22)***

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The prevalence of postmyocardial infarction left ventricular aneurysm varies somewhat in accordance with the criteria used for diagnosis. Using clinical criteria, Mourdjinis and colleagues[1] reported a prevalence of 14%, similar to the 11% prevalence reported by Johnston and coworkers[2] after their application of pathological and surgical criteria. Postmyocardial infarction left ventricular aneurysms may be classified as true or false. While the correction of a false ventricular aneurysm is always surgical, medical treatment is advised for true ventricular aneurysm unless the lesion is responsible for embolism, heart failure, arrhythmia, or angina pectoris; surgical treatment is also advised when true aneurysms are not responsive to medical therapy or when the patient needs open-heart surgery for some other reason, e.g., myocardial revascularization. Since the initial report of Cooley and associates in 1958,[3] many techniques have been applied to surgical repair of ventricular aneurysms. In 1985, Jatene[4] reported a great technical improvement. More recently, Cooley[5] described an even better method, incorporating some of the same principles as Jatene's; his excellent initial results stimulated us to use the technique in 13 of our patients, the only variation being that we used a bovine epicardial patch in lieu of a woven Dacron patch. Since then, Krajcer and co-authors[6] have published an expanded and updated report on Cooley's Texas Heart Institute series that includes 100 patients and confirms the preliminary results after a mean follow-up period of 10 months.

Patients and Methods

Thirteen patients (12 men and 1 woman), ranging in age from 38 to 70 years (mean, 52.92 ± 10.95 years), underwent endoaneurysmorrhaphy for repair of postmyocardial infarction left ventricular aneurysm. Candidates were chosen solely in the order of their presentation, for comparison with the immediately preceding 13 patients who had undergone conventional repair of postmyocardial infarction left ventricular aneurysm (Table I). Eight of the 13 patients undergoing endoaneurysmorrhaphy had large anterolateral aneurysms, 4 had apical aneurysms, and 1 had a false inferior aneurysm. The indications for surgery were angina in 8 patients, heart failure in 4, and arrhythmia in 1. Moreover, myocardial revascularization was performed in 9 of the 13 patients, who had from 1 to 4 coronary artery bypass grafts implanted; the most common coronary artery bypassed in (5 of the 9 pa-

Table I. Comparative Data on Age, Postoperative Bleeding, and Simultaneous Myocardial Revascularization in Patients Undergoing Ventricular Endoaneurysmorrhaphy and Conventional Ventricular Aneurysm Repair

Variables	Endoaneurysmorrhaphy (n=13)	Conventional (n=13)
Age (years)		
Range	38-70	46-75
Mean	(52.9 ± 10.9)*	(59.6 ± 8.9)*
Bleeding (mL)		
Range	145.0-1790.0	326.0-2045.0
Mean	(764.0 ± 398.7)*	(848.8 ± 568.1)*
Revascularization (n)	9 (69.2%)	12 (92.3%)

*Mean ± standard deviation

tients) was the left anterior descending. A mitral bioprosthesis was inserted in 1 patient, and an aortic bioprosthesis in another.

The procedure was performed under cardiopulmonary bypass and moderate hypothermia of 28 to 30 °C, using cold cardioplegic solution for myocardial protection. A longitudinal incision was made through the aneurysm, parallel to the interventricular groove (Fig. 1A). Next, the extent of fibrosis was determined (Fig. 1B), and a patch of bovine pericardium, preserved in glutaraldehyde, was fashioned into a shape and size similar to that of the diseased myocardial tissue. We then sutured the patch graft to the edges of the contractile myocardium (Figs. 1C and 1D) with continuous 3-0 Prolene suture, taking care not to damage the papillary muscles. Finally, we repaired the ventriculotomy (Fig. 1E) with continuous 2-0 Prolene suture, avoiding damage to the left anterior descending coronary artery.

In the 9 patients who underwent myocardial revascularization, cardiac output was measured by the thermodilution method just before cardiopulmonary bypass was started, and 24 hours postoperatively; we used a balloon-tipped cardiac catheter and a cardiac output computer (Model 9520, Edwards Laboratories; Santa Ana, California, USA). Cardiac index was calculated by dividing the cardiac output by the corporeal surface, and was expressed as liters per minute per square meter.

Postoperative bleeding was measured and compared with postoperative bleeding observed in the immediately preceding 13 cases of left ventricular aneurysm repair, which had been treated conventionally.

Student's *t*-test for unpaired data and the χ^2 test were used to evaluate the data; p values of less than 0.05 were considered significant. The data are presented as mean ± standard deviation.

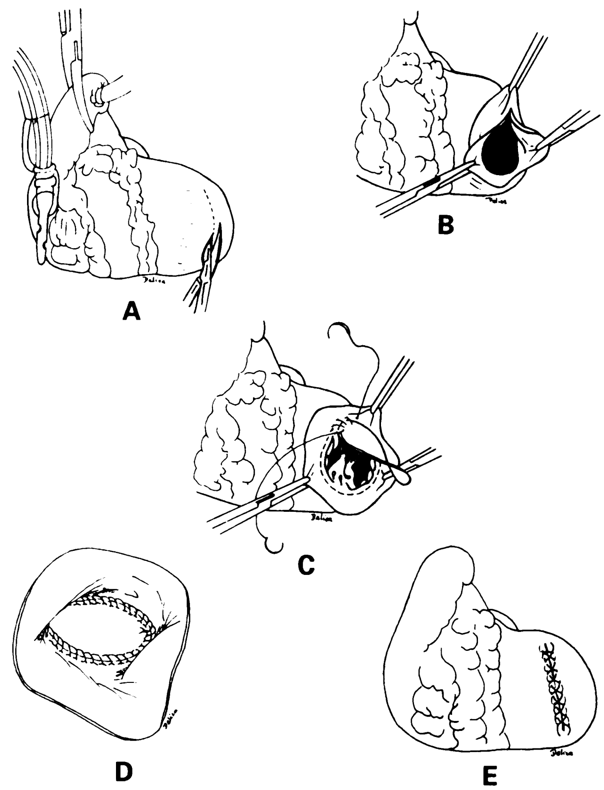

Fig. 1 *Technique of ventricular endoaneurysmorrhaphy (see text).*

Results

All 13 patients who underwent ventricular endoaneurysmorrhaphy were weaned easily from bypass and had uncomplicated recoveries. They were asymptomatic upon discharge 7 to 12 days postoperatively (mean, 9.0 ± 2.3 days).

The preoperative cardiac index (Table II) ranged from 1.61 to 3.30 L/min/m^2 (mean, 2.07 ± 0.50 L/min/m^2), increasing significantly ($p < 0.05$) after operation from 2.11 to 5.23 L/min/m^2 (mean, 3.09 ± 0.99 L/min/m^2). The relative increase in cardiac index ranged from 23.03% to 136.65% (mean, 50.17% ± 37.03%). No patient required postoperative mechanical circulatory assistance, and pharmacologic support usually could be interrupted soon after surgery. Figures 2 and 3 show ventriculograms of a patient with a large anterolateral aneurysm due to an extensive anterior myocardial infarction: preoperative ventriculograms in diastole (2A) and systole (2B) are contrasted with postoperative ventriculograms that depict a decrease in left ventricular cavity size during diastole (3A) and no paradoxical dilatation during systole (3B). The cardiac index in this patient increased from 2.2 to 5.2 L/min/m^2 (136.6%). The

Table II. Preoperative and Early Postoperative Cardiac Indexes in Patients Undergoing Ventricular Endoaneurysmorrhaphy

Patient	Cardiac Index (L/min/m²) Preop	Cardiac Index (L/min/m²) Postop	Percentage Increase
1	1.99	2.53	27.14
2	2.21	5.23	136.65
3	1.83	3.34	82.51
4	1.61	2.11	31.06
5	3.30	4.06	23.03
6	2.11	2.79	32.23
7	1.94	2.86	47.42
8	2.00	2.60	30.00
9	1.64	2.32	41.46
Mean ± SD	2.07 ± 0.50*	3.09 ± 0.99*	50.17 ± 37.03

*p <0.05

patient who had undergone implantation of a mitral bioprosthesis, in addition to left ventricular endoaneurysmorrhaphy for repair of a false inferior aneurysm, displayed an increase in cardiac index from 1.6 to 2.1 L/min/m² (31.1%).

Postoperative bleeding ranged from 145.0 to 1,790.0 mL (mean, 764.0 ± 398.7 mL); this mean figure was somewhat lower, although not to the point of statistical significance, than that observed in the preceding 13 patients who had undergone conventional left ventricular aneurysm repair (Table I): 326.0 to 2,045.0 mL (mean, 848.8 ± 568.1 mL). It can also be seen in Table I that the mean age was greater (52.9 ± 10.9 years vs 59.6 ± 8.9 years) in the conventional technique group, and that more patients in that group underwent myocardial revascularization (69.2% vs 92.3%).

Discussion

It has been asserted that if a patient can survive with a left ventricular aneurysm, however large, the patient can show hemodynamic improvement after appropriate surgical repair.[4,5] This idea has stimulated continual research to improve the original technique of left ventricular aneurysmectomy reported by Cooley and associates[3] in 1958. Various authors[7-9] have proposed or implemented some type of geometric left ventricular reconstruction. In 1985, Jatene[4] reported an important modification of the principles of aneurysmal repair that enabled the restoration of left ventricular anatomy to normal, or as close to normal as possible. More recently, we encountered the

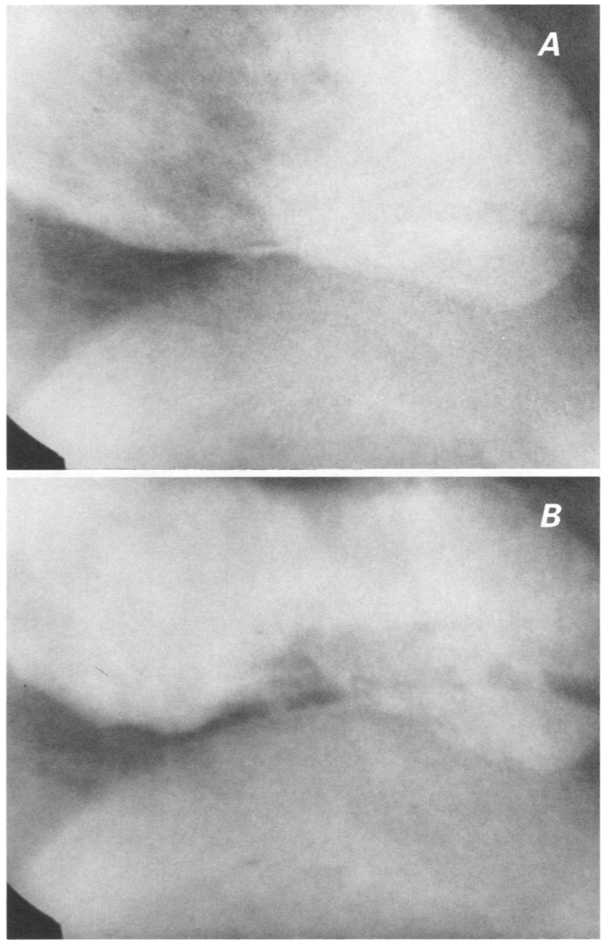

*Fig. 2 Preoperative ventriculograms showing large anterolateral aneurysm upon diastole (**A**) and systole (**B**). Right anterior oblique view.*

report by Cooley[5] of a technique that involves a longitudinal incision over the apex of the aneurysm and replacement of the diseased area by an elliptical patch graft of woven Dacron in order to restore shape, contour, and volume of the left ventricle in diastole, while reducing volume in systole. This technique also permits revascularization of the coronary arteries—even the left anterior descending, when indicated. The initial results obtained by Cooley[5] in treating 4 patients were so satisfactory that we decided to use the technique in our patients. Now it has come to our attention that a subsequent report[6] of the Texas Heart Institute's experience with this technique summarizes results in 100 patients, which continued to be very good after a mean follow-up of 10 months. The results in our 1st 13 cases have also been excellent: there were no perioperative complications, no patient required mechanical circulatory assistance after surgery, and pharmacological support could be discontinued soon after operation. Our patients showed a mean increase of 50% in cardiac index and were asymptomatic upon discharge, at a

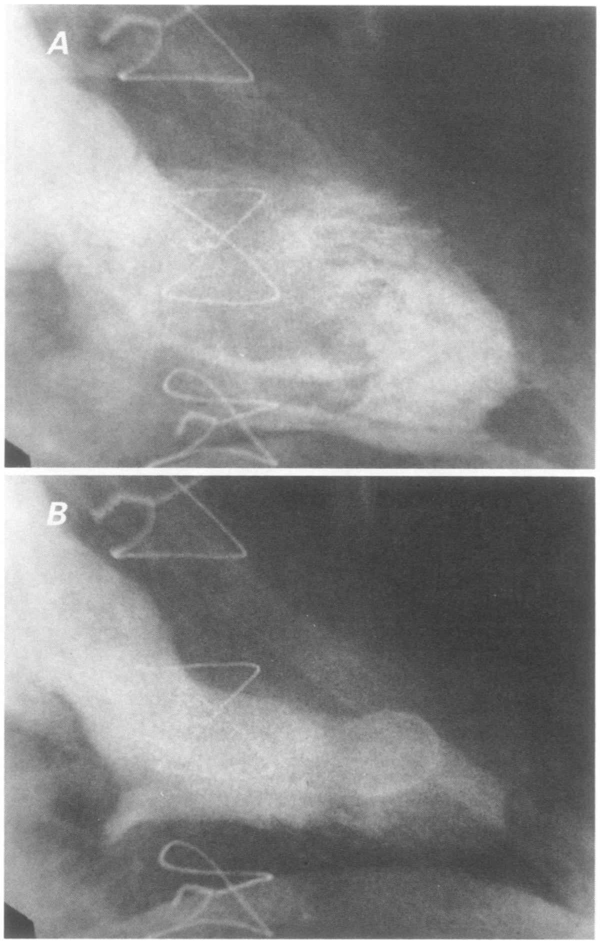

*Fig. 3 Postoperative ventriculograms showing right anterior oblique view of left ventricle after endoaneurysmorrhaphy. Note decrease in left ventricular cavity size upon diastole (**A**) and the absence of paradoxical dilatation upon systole (**B**).*

mean time of 9.0 ± 2.3 postoperative days. One of the basic ideas in endoaneurysmorrhaphy[5] is to retain scarred tissue that would be resected in conventional repair, and to use it as support for the woven Dacron patch graft. We slightly modified Cooley's original method[5] by substituting a patch of bovine pericardium for the Dacron patch. We believe that bovine pericardium is easier to handle and (through subjective analysis of ventriculograms) that it produces better restoration of the left ventricular shape, because it follows the left ventricular wall during systole.

In conclusion, endoaneurysmorrhaphy with bovine pericardium for postinfarction left ventricular aneurysms seems to be a simple and reliable method, providing excellent results in surgical morbidity and short-term postoperative hemodynamic improvement. Nonetheless, our report must be considered preliminary, because our results were obtained in a small group of patients who had not, at the time of data compilation, been subjected to long-term follow-up. Since then, we have operated on another 25 patients using this technique, and we are doing late follow-up on the early patients studied. We are also planning random, prospective comparison of endoaneurysmorrhaphy with the conventional technique of left ventricular aneurysm repair.

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Editorial Comment

Commercial bovine or even glutaraldehyde-treated autologous pericardium has been used in some of our own cases. The major advantage of pericardium, as mentioned by Dr. Prates and his associates, is its flexibility. Many surgeons today prefer pericardium to fabrics for closure of congenital septal defects. However, the fate of bovine pericardium is unknown. As biologic material, it may be more subject to infection, degeneration, or calcification. I have yet to discover an infection, though, in the thousands of fabric patches used in this hospital. Moreover, at our center, a bovine patch is 4 times more expensive than a fabric patch.

Regardless of the material used, the functional principle behind the intracavitary repair is the same, and the authors are to be complimented on their excellent results.

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