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Surgical Ventricular Restoration in End-Stage Ischemic Cardiomyopathy Patients

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ABSTRACT

Background: Surgical ventricular restoration (SVR) has generally been contraindicated in patients with an ejection fraction (EF) <20%, with pulmonary arterial (PA) pressure >60 mm Hg, and being treated with inotropic agents.

Patients and Methods: The patients in this study were 6 men and 5 women 50 to 78 years of age (mean, 62.4 years). Three patients were in New York Heart Association (NYHA) class III with an EF <30%. Eight patients were in NYHA class IV with EF <20%, PA pressure >70 mm Hg, and left ventricular asynergy. Three patients had had recent myocardial infarction (MI) with shock and multiple organ failure. Three patients had mitral regurgitation, 1 patient had ventricular septal defect (VSD), 4 patients had diabetes mellitus, and 5 had morbid obesity. All patients underwent intraoperative transesophageal echocardiography and were being treated with milrinone or nesiritide. Seven patients had intraaortic balloon pumps. All patients underwent coronary artery bypass (CAB), receiving 1 to 5 (average, 3.54) grafts per patient. The SVR (Dor) procedure was performed with a Chase Mannequin device. Preoperative end-diastolic volume was 240 to 330 mL, and postoperative volume decreased to 110 to 130 mL. Two patients underwent mitral valve repair, and 1 underwent VSD closure. One patient underwent microwave ablation for atrial fibrillation.

Results: Ten (91%) of 11 patients were discharged home in 10 to 14 days. There was 1 death: A 78-year-old man with acute MI died 43 days later of septic shock due to hemodialysis.

Conclusion: End-stage ischemic cardiomyopathy patients with EF <20% can safely undergo surgery after meticulous preoperative preparation to decrease PA pressure, pulmonary capillary wedge pressure, and peripheral vascular resistance and to increase CO by SVR, CAB, and correction of associated lesions. Mortality was 9% with improved hemodynamics and relief of congestive heart failure in all survivors for 3 to 12 months.

INTRODUCTION

Congestive heart failure (CHF) is the most important public health problem in cardiovascular medicine today and is the single most common cause of hospitalization in patients 65 years and older. An aging population and improved therapies for acute myocardial infarction as well as improved medical therapy for the early stages of heart failure (CHF) contribute to this emerging epidemic. Medical therapy for CHF, including digitalis and diuretics, spironolactone, angiotensin-converting enzyme inhibitors, and β-blockers, has improved treatment in the early phases of heart failure, but the mortality among patients in New York Heart Association (NYHA) classes III and IV has not improved. The 1-year survival rate for class III is 80% but for class IV is only 50% [O'Connell 1994, 2000]. Cardiology procedures to establish early reperfusion for acute myocardial infarction have altered the pathophysiology so that frequently there is reperfusion of the epicardial and myocardial surfaces while endocardial necrosis remains. Progressive dilation of the left ventricle results in symptoms of CHF. Menicanti and DiDonato [2002a] addressed surgical ventricular restoration (SVR) in the treatment of CHF. They used the Dor procedure to reverse remodeling, exclude ventricular scar, and restore left ventricular size and elliptical shape to as close to normal as possible. Coronary revascularization was done and mitral regurgitation was repaired by annuloplasty when appropriate. Overall results with the procedure have included a 90% 1-year survival rate and 80% 5-year survival rate among patients undergoing SVR [Menicanti 2002b]. Contraindications to the procedure are increased risk of mortality, including ejection fraction (EF) <30% and pulmonary hypertension with pulmonary arterial (PA) pressure >60 mm Hg [Menicanti 2002a]. We recently accepted a small number of patients with end-stage ischemic cardiomyopathy, NYHA class III-IV, EF <20% to <30%, and PA pressure >60 mm Hg for alternative surgical revascularization and ventricular restoration as an alternative to cardiac transplantation. These patients were excluded from transplantation because of the presence of comorbid illnesses such as prolonged diabetes, obesity, older age, or previous stroke.

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MATERIALS AND METHODS

All 11 patients were referred to our cardiac transplantation program for transplantation or high-risk alternative surgical procedures. Projected 1-year mortality ranged from 30% to 50% with continued medical therapy. There were 6 men and 5 women, 50 to 78 years of age with a mean age of 62.4 years. Three (26%) of the patients were in NYHA class III with EF <30%. Eight (73%) of the patients were in NYHA class IV with EF 10% to 20%. All patients had pulmonary hypertension, including 10 of 11 with PA pressure >60 mm Hg. Pulmonary capillary wedge pressure (PCWP) was generally 25 to 35 mm Hg with a maximum of 42 mm Hg. Three (27%) of the patients had acute myocardial infarction with cardiogenic shock, 4 (36%) had multiple organ failure, 3 (27%) had significant mitral regurgitation, and 1 (9%) had ventricular septal defect (VSD). Comorbid illness included diabetes mellitus in 4 (36%) of the patients and morbid obesity in 5 (45%). Two patients were 75 years or older. Two patients had chronic atrial fibrillation, and 2 patients had undergone previous automatic implantable cardioverter-defibrillator implantation for ventricular arrhythmia. Seven (64%) of the patients had been referred from other cities and were being treated with inotropic agents, including dobutamine and dopamine, at the time of transfer.

All patients underwent viability studies that confirmed the presence of nonviable areas, or areas of the anterior/inferior myocardium with identifiable areas of ischemia. All patients were hospitalized for preoperative medical therapy. Medical therapy included routine insertion of a Swan-Ganz catheter, use of intravenous nesiritide for acutely decompensated CHF, and use of milrinone in all other patients for CHF with pulmonary hypertension and elevated PCWP. Diuresis was continued, and 7 (64%) of the patients needed preoperative insertion of an intraaortic balloon pump to further resolve heart failure until PA pressure fell to <50 mm Hg. Preoperative therapy lasted 4 to 10 days with a mean of 6.5 days. Preoperative transesophageal echocardiography (TEE) was used in surgical patients.

The operation included coronary bypass. All patients received 1 to 5 grafts, or an average of 3.54 grafts per patient. Ten of 11 patients received grafts of left internal mammary artery (LIMA) to the left anterior descending coronary artery (LAD). The left ventricle was opened through the ventricular scar, anteriorly or at the apex. Mural thrombus was removed, and in several patients endomyocardial resection of calcific scar was required. The TR^3 ISVR Mannequin device (Chase Medical, Richardson, TX, USA) [Burch 1972] was selected on the basis of the patient's body surface area and inserted in the ventricle for identification of the new elliptical apex. The mannequin was partially inflated while it was seated against the aortic and mitral valve annuli and then fully inflated for identification of the new ventricular apex location. A Fontan suture of 2-0 polypropylene (Prolene) was started at the new apex point and continued around the border between the viable and nonviable myocardium representing the akinetic zone. This stitch was then tightened around the mannequin, and a patch was cut into an elliptical teardrop shape to complete the spherical shape of the ventricle over the mannequin. This patch was sutured with 2-0 polypropylene beginning at the basal portion with an inverted technique, and the mannequin was deflated and removed prior to completion of the patch at the apex. In most instances, the epicardial residual was sutured over the patch to maintain additional hemostasis. The 2 patients with inferior scarring were treated with plication of the redundant scar tissue and primary closure of the ventricular incision. Two patients needed mitral valve repair with mitral ring annuloplasty, and 1 patient needed closure of a large VSD. All patients were slowly weaned from cardiopulmonary bypass with milrinone and/or, frequently, nesiritide with vasopressin or norepinephrine to maintain mean arterial pressure >65 mm Hg. Intravenous amiodarone was used to minimize arrhythmias in all patients. One patient with chronic atrial fibrillation also underwent a modified maze procedure with Flex 4 probe (Guidant, Santa Clara, CA, USA) microwave ablation [Gillinov 2002].

RESULTS

Ten (91%) of 11 patients survived and were discharged from the hospital. All patients were weaned from cardiopulmonary bypass with milrinone, usually combined with epinephrine or norepinephrine. Intraaortic balloon pumps in the 7 patients preoperatively were continued and removed in the early postoperative period. Preoperative TEE measurements included left ventricular end-diastolic diameter of 5.7 to 8.4 cm and left ventricular end-diastolic volume of 240 to 330 mL. All patients underwent surgical revascularization with 1 to 5 grafts, an average of 3.54 grafts per patient. Ten of 11 patients had grafts of LIMA to LAD. Two patients underwent mitral valve repair with annuloplasty, and 1 patient underwent VSD repair. All patients underwent SVR by the Dor technique and the Fontan stitch over the Chase Mannequin sizer on the basis of body surface area. Eight operations included teardrop-shaped elliptical patch closure of the anterior left ventricle. Two patients had only plication of the inferior ventricular scar and primary closure of the ventriculotomy. Postoperative ventricular volume was 110 to 130 mL, as determined with the Chase Mannequin. Postoperative TEE showed improved ventricular function and absence of mitral regurgitation in all patients but those being treated with inotropic agents. We await later echocardiographic assessment of ventricular function and NYHA classification.

One (9%) of the patients died. He was a 78-year-old man who had experienced acute anterior myocardial infarction. He arrived at our hospital 3 weeks after myocardial infarction taking multiple inotropics and had multiple organ failure including respiratory, hepatic, and renal insufficiency. Preoperative tracheostomy was performed, and hemodialysis was required for renal failure. After 10 further days of preparation, the patient underwent surgical revascularization with 3 grafts and ventricular restoration with the Mannequin device and Dor technique. A modified maze procedure with microwave ablation catheter (AFx, Inc., Fremont, CA, USA) was done for chronic atrial fibrillation. Postoperative recovery was dramatic with total weaning of inotropic, balloon pump, and respirator support. The patient was ambulatory in his intensive care unit room 2 weeks postoperatively. He remained in chronic renal failure, however, and was treated with a Quinton catheter for hemodialysis. In the third postoperative week, the patient developed staphylococcal septic shock from the Quinton catheter, experienced multiple organ failure, and died.

At the time of discharge of the 10 surviving patients, all were in NYHA class II-III, and all continued to be treated with heart failure medications, including digitalis, diuretics, angiotensin-converting enzyme inhibitors, and/or β-blockers. Long-term follow up findings were not available because 1 year had not elapsed since the operation; in 70% of cases less than 6 months had elapsed since the operation.

DISCUSSION

Cardiac transplantation is generally offered to patients with end-stage ischemic cardiomyopathy who are younger than 65 years and have no serious comorbid illness, such as advanced diabetes, morbid obesity, or stroke. Because of the donor shortage, fewer than 2500 heart transplantation procedures are performed each year in the United States [Taylor 2003]. With medical therapy the mortality rate for these class IV CHF patients approaches 50% at 1 year [O'Connell 1994].

Left ventricular aneurysm resection for late sequelae of acute anterior myocardial infarction was first described by Cooley [1989] and Jatene [1985]. In 1984 Dor, recognizing that akinetic and dyskinetic tissue should be treated in the same manner, clearly defined the difference between aneurysmectomy and SVR [Dor 1985]. Initial SVR results from a multicenter study (restore group) included 439 patients at 11 medical centers. SVR achieved a 91% functional improvement rate and a rehospitalization rate of only 8.8% [Kono 1992]. Kono et al [1992] described the severity of mitral regurgitation in patients with CHF in association with the sphericity of the patient's ventricle. Buckberg [2001] addressed the importance of treating the underlying disease responsible for the development of CHF rather than its resulting symptoms. Buckberg [1998] further appealed to surgeons to learn from Dor's large clinical experience with SVR to exclude postinfarction scarring and restore normal left ventricular size and shape. The procedure includes the akinetic segment or scar under more normal-appearing anterior left ventricular myocardium and excludes of dyskinetic or "bulging" aneurysm segments. Menicanti and DiDonato [2002b] introduced surgical techniques for SVR that entail an endovascular shaper or mannequin [Burch 1972] for ensuring surgical correction of both the volume and the elliptical shape of the ventricle. Surgical mortality increases from 7.2% for CAB and SVR to 15.3% with a mitral valve procedure. NYHA class IV and EF <20% further increase mortality. Menicanti and DiDonato also defined high-risk individuals and emphasized that PA pressure >60 mm Hg, EF <20%, and older age all are contraindications to surgery or carry markedly increased risk of mortality. Because of our transplantation base for referrals, we had to exclude a number of patients with ischemic cardiomyopathy who had comorbid illnesses or were of older age and who also did not want or qualify for destination therapy. We recently admitted to the hospital patients who had received a preoperative trial of intravenous medication with milrinone and/or nesiritide and aggressive diuresis because of NYHA class IV symptoms of CHF. The goal was decreasing pulmonary wedge pressure from 35 to <20 mm Hg, increasing cardiac output and cardiac index from <2 to >2, and decreasing PA pressure from >60 mg mm Hg to a more ideal 40 to 50 mm Hg. We then considered surgical therapy with SVR, coronary artery revascularization, and correction of associated defects, such as mitral regurgitation or VSD when present. Our early and limited experience gave acceptable operative results with 91% survival at >30 days and all survivors discharged with improvement in functional status by at least 1 NYHA class and discharged within 10 to 24 days. These early results appear acceptable in contrast to those of conventional medical treatment of CHF with end-stage ischemic cardiomyopathy, aggressive dyspnea, heart failure, recurrent hospitalization, and a mortality of 50% at 1 year. Long-term follow-up findings at 1 year and beyond will give a better understanding of the efficacy of this treatment in desperately ill CHF patients.

CONCLUSION

Previously excluded ischemic cardiomyopathy patients can be medically treated to reduce pulmonary hypertension and increase cardiac output and then to undergo SVR with an acceptable mortality of 9% and early improved NYHA functional class. Long-term results await further follow-up.

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