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Surgical Coronary Revascularization with or without Mitral Valve Repair of Severe Ischemic Dilated Cardiomyopathy

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ABSTRACT

Background: Because patients with dilated cardiomyopathy tend to have a poor prognosis with medical therapy, surgery with coronary bypass alone or associated with mitral valve repair should be a promising feasible therapeutic option. We evaluated the early effects of surgical coronary revascularization with or without mitral valve repair in patients with severe dilated ischemic cardiomyopathy.

Methods: The study group consisted of 38 patients aged 65 ± 8 years with severe dilated ischemic cardiomyopathy, chest pain, and heart failure. Twenty-four patients were in a New York Heart Association (NYHA) class ≥3, and 14 patients were in class 2. Twenty patients had a degree of mitral regurgitation defined as an effective regurgitant orifice ≥20 mm^2. The mean values (±SD) of the EuroSCORE, which evaluates operative risk, were 5 ± 2.2. Clinical and echocardiographic reevaluation followed at 6 months.

Results: All patients underwent coronary artery bypass surgery with a mean of 2.3 ± 0.8 grafts, and mitral valve repair with annuloplasty and Cosgrove ring insertion were performed in 20 patients. No deaths occurred during the operative period. Ten patients could not be reevaluated at 6 months, and 3 patients died (7.9% mortality). At 6 months, the end-systolic volumes in 15 patients who underwent coronary bypass plus mitral valve repair (group A) and in 13 patients who underwent coronary bypass alone (group B) decreased, respectively, from 139 ± 56 mL to 121 ± 94 mL and from 122 ± 48 mL to 96 ± 36 mL ($P < .05$). The wall motion score index also decreased from 1.9 ± 0.3 to 1.4 ± 0.4 and from 2.1 ± 0.3 to 1.8 ± 0.2, respectively. The mean values of the ejection fraction, the peak early mitral inflow velocity, and the ratio of the peak early mitral inflow velocity to the peak late mitral inflow velocity increased significantly in both groups ($P < .001$, $P < .01$, and $P < .05$, respectively). The mean NYHA functional class significantly improved in both groups ($P < .0001$).

Conclusions: In patients with severe ischemic dilated cardiomyopathy, surgical coronary revascularization can be safely carried out during the operative and early postoperative periods with low mortality rates. This procedure decreased left ventricular end-systolic volume, consistently increased contractility, and subsequently ameliorated the ejection fraction to produce improvements in clinical condition according to the NYHA functional class. Similar results have been obtained in patients who have undergone coronary bypass surgery and mitral valve repair, despite a higher operative risk and longer cardiopulmonary bypass circulation and aortic cross-clamping times.

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INTRODUCTION

Coronary artery disease is a major common etiology, either incidental or known, underlying left ventricular heart failure [Gillum 1993, Fox 2001]. In patients with severe dilated ischemic cardiomyopathy, coronary revascularization has provided better survival prospects and quality of life than has medical therapy [Baker 1994].

Mitral regurgitation as a complication of coronary artery disease is an independent determinant of poor outcome and survival [Lamas 1997]. In dilated cardiomyopathy, it induces further dilation and a worsening of the cardiomyopathy itself [Bolling 1995].

Optional treatment of the ischemic mitral valve in dilated cardiomyopathy seems to be controversial [Duarte 1999]. Nowadays, attention has been focused on mitral annuloplasty and/or valvuloplasty (with or without coronary bypass grafting) as a surgical alternative to valvular prosthesis implantation [von Oppel 2000], which involves high operative and perioperative mortality risks [Rankin 1988]. We thus conducted a clinical and echocardiographic study to evaluate survival, clinical outcome, and left ventricular remodeling in patients with severe ischemic cardiomyopathy who underwent extreme surgical coronary revascularization with or without mitral valve annuloplasty. Evaluation of the patients who underwent revascularization and a comparison of the 2 groups were performed preoperatively and at 6 months after surgery.

MATERIALS AND METHODS

From January 1999 to December 2000, we prospectively evaluated 49 consecutive patients with severe ischemic dilated

Table 1. Echocardiographic and Doppler Parameters Considered and Their Abbreviations

Echocardiographic Parameters	Doppler Parameters
LVEDD, left ventricular end-diastolic dimension	PE, peak early mitral inflow velocity
LVESD, left ventricular end-systolic dimension	PA, peak late mitral inflow velocity
IVSd, intraventricular septum end-diastolic thickness	PE/PA ratio
IVSs, intraventricular septum end-systolic thickness	AT, PE acceleration time
LVPWd, left ventricular posterior wall end-diastolic thickness	DT, PE deceleration time
LVPWs, left ventricular posterior wall end-systolic thickness	IVRT, isovolumic relaxation time
FS, left ventricular fractional shortening	ERO, effective regurgitant orifice area
LVM, left ventricular mass	
LVMi, left ventricular mass index	
LA, left atrial dimension	
Ao, aortic root dimension	
LVEDV, left ventricular end-diastolic volume	
LVESV, left ventricular end-systolic volume	
LVEF, left ventricular ejection fraction	
LVWMSI, left ventricular wall motion score index	

cardiomyopathy, angina, and heart failure who underwent surgical coronary revascularization at the Heart Surgery Department of Parma University.

Exclusion criteria included the presence of flutter or atrial fibrillation, complex ventricular arrhythmias, a pacemaker, heart valvular disease (with the exception of mitral valve incompetence), pericardial or infiltrative disease, primary right ventricular disease, and severe lung disease. The study was approved by the ethical committee of our institution, and written informed consent was obtained from all participants. Of the 49 patients, 38 participated in the study (33 men and 5 women; mean age [±SD], 65.5 ± 8 years), and 11 did not for logistic or personal reasons. However, we were informed that all of the patients were alive at 6 months after surgery. Surgical risk was calculated according to the EuroSCORE from demographic, clinical, and surgical data [Nashef 1999]. The New York Heart Association (NYHA) functional class was ≥3 in 24 of the 38 patients and 2 in the remaining patients.

Echocardiographic Examination

Twenty-four hours before surgery, echocardiographic examination was performed with the patient in the left lateral decubitus position. A GE VingMed System Five ultrasound device (Horten, Norway) with a multifunctional probe and second harmonic imaging was used. All data were recorded on standard VHS videotape.

Quantitative analysis was carried out according to American Society of Echocardiography guidelines [Cheitlin 1997] by 2 experienced independent examiners who were unaware of the patients' clinical data. Averages of at least 5 consecutive cardiac cycles were used to measure all echo-Doppler variables. Left ventricular and left atrial M-mode parameters were calculated in the left parasternal long-axis view, and left ventricular volumes and ejection fractions were obtained by the biapical Simpson disk method. Left ventricular segmental kinesis and the wall motion score index were examined by using all parasternal and apical views.

The transmitral flow velocity signal was obtained in the 4-chamber apical view by placing pulsed-wave Doppler sample volume at the tips of the mitral leaflets. Color flow imaging was used to determine the presence of mitral regurgitation. The degree of mitral regurgitation was graded by quantitatively measuring the proximal isovelocity surface area with an analysis of the proximal flow convergence and the effective regurgitant orifice (ERO) [Enriquez-Sarano 1995]. An ERO cutoff at ≥0.2 cm^2 (corresponding to grade III-IV of the mitral insufficiency classification) was used to determine whether patients could undergo mitral valve repair.

The echo-Doppler parameters measured and their abbreviations are listed in Table 1.

Surgical Technique

Surgery was performed by means of a median sternotomy with moderate systemic hypothermic cardiopulmonary bypass, aortic cross-clamping, and combined anterograde/retrograde multidose cardioplegia. Surgery was initiated by completing the distal coronary bypass anastomosis, followed by mitral valve annuloplasty and finally by the proximal bypass anastomosis during a single aortic cross-clamp period. The mitral valve was exposed through a standard left atriotomy at the intra-atrial groove. Sizing for ring valvuloplasty was established according to the size of the mitral valve's anterior leaflet.

Annuloplasty was carried out by inserting a Cosgrove ring (Baxter Health Care, Irvine, CA, USA) on the posterior leaflet of the mitral valve (no. 28 in 13 patients and no. 26 in 7 patients). Valvular competence was assessed intraoperatively by injecting physiological saline solution through the valve into the left ventricle and observing leaflet coaptation. Intraoperative transesophageal echocardiography was also carried out.

Follow-up

All patients underwent clinical and echocardiographic follow-up at 6 months after surgery. Ten patients (26.3%) were excluded for various reasons. Two patients were in atrial fibrillation, 2 underwent pacemaker implantation, 3 presented a suboptimal acquired acoustic window, and 3 died. The baseline characteristics of these patients did not differ from those who were followed up. The 28 patients (73.7%) who could be followed up were divided into 2 groups according to the surgical procedure employed. Fifteen patients underwent coronary bypass plus mitral valve annuloplasty (group A), and 13 underwent coronary bypass alone (group B). The demographic, clinical, and surgical data of the 2 groups are listed in Table 2. All patients continued to receive medical therapy for congestive heart failure and ischemic heart disease.

Statistical Analysis

Statistical analyses by the Student *t* test and analysis of variance were carried out according to a split-plot factorial model. Procedures of the SPSS 10.0 statistical package (SPSS, Inc, Chicago, IL, USA) were followed.

Table 2. Clinical and Surgical Data of the 2 Groups of Patients*

Parameters	Group A (n = 15)	Group B (n = 13)	*P*
Age, y	68 ± 5	64 ± 8	NS
BSA, m^2	1.8 ± 0.2	1.9 ± 0.1	NS
Ejection fraction, %	26 ± 5	28 ± 5	NS
EuroSCORE	6.5 ± 1.6	3.3 ± 1.6	<.001
NYHA class	2.9 ± 0.9	2.8 ± 0.8	NS
Grafts, n	2.8 ± 0.8	2.4 ± 0.7	NS
CPB time, min	144 ± 44	103 ± 50	<.05
ACC time, min	96 ± 20	53 ± 23	<.001
Intensive care stay, d	3.1 ± 3	4.4 ± 5.1	NS

*Group A, patients with coronary bypass plus mitral annuloplasty; group B, patients with coronary bypass alone. Data are presented as the mean ± SD. NS indicates not statistically significant; BSA, body surface area; NYHA, New York Heart Association; CPB, cardiopulmonary bypass; ACC, aortic cross-clamping.

The results of the interobserver evaluation for the 2 independent examiners using echo-Doppler variable measurements did not differ by more than 4%.

RESULTS

All patients survived the surgical procedure, and no deaths occurred during the intensive care period. Three patients died during follow-up. One death occurred suddenly at 35 days after surgery (group A), 1 death due to renal failure occurred at 45 days (group A), and 1 patient died from progressive heart failure at 5 months (group B).

We observed significant improvement in all patients who completed follow-up. The mean values of the NYHA functional class decreased significantly from 2.8 ± 0.8 to 1.3 ± 0.5 (P < .0001). The end-systolic volume and wall motion score index also decreased, respectively, from 130.8 ± 51.7 mL to 109.3 ± 54.7 mL (P < .05) and from 2.0 ± 0.3 to 1.6 ± 0.3 (P < .01). The ejection fraction increased significantly from 29.8% ± 5.6% to 42.1% ± 7% (P < .001). In addition, a significant improvement in diastolic function was observed. The peak early mitral inflow velocity increased from 0.8 ± 0.4 m/s to 0.9 ± 0.4 m/s (P < .01), and the ratio of the peak early mitral inflow velocity to the peak late mitral inflow velocity increased from 1.2 ± 0.7 to 1.6 ± 1.2 (P < .05).

Similar changes in these variables were observed when we compared patients in group A (coronary bypass plus mitral valve repair) to those in group B (coronary bypass alone), even though the operative risks were higher and the cardiopulmonary bypass and aortic cross-clamping times were longer in group A (Tables 2 and 3).

Mitral regurgitation after implantation of the Cosgrove ring was not significant (grade I of the mitral insufficiency classification).

COMMENTS

That left ventricular systolic dysfunction is a major factor underlying unfavorable prognosis in patients with coronary

Table 3. Baseline and 6-Month Clinical and Echocardiographic Data for the 2 Patient Groups*

Parameters	Group A Baseline	Group A 6 Months	*P*	Group B Baseline	Group B 6 Months	*P*	*P′*
LVM, g	416.0 ± 133.4	410.1 ± 122.4	NS	311.3 ± 83.7	343.2 ± 83.5	NS	NS
LVMi, g/m^2	254.3 ± 61.3	242.8 ± 44.7	NS	202.2 ± 45.1	187.6 ± 44.0	NS	NS
NYHA class	2.8 ± 0.6	1.3 ± 0.4	<.0001	2.7 ± 0.8	1.3 ± 05	<.0001	NS
LVEDD, mm	65.8 ± 10.7	64.9 ± 9.1	NS	61.8 ± 6.3	61.4 ± 7.3	NS	NS
LVESD, mm	52.0 ± 10.9	53.5 ± 9.5	NS	45.9 ± 8.8	45.9 ± 8.3	NS	NS
FS, %	20.4 ± 6.9	17.5 ± 6.7	NS	22.5 ± 10.6	24.3 ± 9.5	NS	NS
IVSd, mm	12.3 ± 3.1	12.3 ± 2.7	NS	12.2 ± 2.8	11.4 ± 3.3	NS	NS
IVSs, mm	15.8 ± 4.0	14.6 ± 3.5	NS	15.9 ± 4.3	14.3 ± 3.4	NS	NS
LVPWd, mm	10.4 ± 3.5	9.9 ± 3.0	NS	10.4 ± 1.8	10.3 ± 2.6	NS	NS
LVPWs, mm	12.9 ± 4.3	13.7 ± 4.4	NS	13.9 ± 3.3	14.3 ± 3.6	NS	NS
LVEDV, mL	194.6 ± 68.5	184.5 ± 93.9	NS	192.82 ± 71.5	175.8 ± 60.1	NS	NS
LVESV, mL	138.8 ± 55.7	121.0 ± 67.3	<.05	122.0 ± 48.2	96.5 ± 35.7	<.05	NS
LVEF, %	30.0 ± 4.5	42.0 ± 7.4	<.001	30.2 ± 4.6	43.5 ± 5.6	<.001	NS
LVWMSI	1.9 ± 0.4	1.5 ± 0.4	<.01	2.1 ± 0.3	1.8 ± 0.2	<.01	NS
LA, mm	48.6 ± 7.6	47.9 ± 7.6	NS	43.3 ± 6.9	44.7 ± 7.3	NS	NS
Ao, mm	37.0 ± 8.8	38.5 ± 11.0	NS	35.0 ± 6.4	32.2 ± 6.9	NS	NS
PE (m/s)	1.1 ± 0.3	1.2 ± 0.4	<.01	0.6 ± 0.2	0.7 ± 0.2	<.01	NS
PE/PA	1.7 ± 0.6	2.4 ± 1.6	<.05	0.9 ± 0.5	1.1 ± 0.4	<.01	NS
DT, ms	262.3 ± 122.4	271.0 ± 102.7	NS	227.1 ± 108.8	205.2 ± 91.2	NS	NS
AT, ms	87.5 ± 22.6	73.7 ± 30.8	NS	71.7 ± 34.1	74.7 ± 16.8	NS	NS
IVRT, ms	100.3 ± 16.5	97.0 ± 8.8	NS	102.7 ± 13.4	107.12 ± 11.9	NS	NS

*Group A, patients with coronary bypass plus mitral annuloplasty; group B, patients with coronary bypass alone. Data are presented as the mean ± SD. NS indicates not statistically significant; NYHA, New York Heart Association. Other abbreviations are expanded in Table 1.

artery disease is well known [Emond 1994]. Furthermore, several studies have demonstrated that surgical coronary revascularization in cases of severe ischemic cardiomyopathy improves survival prospects and the quality of life compared with medical therapy [Bounous 1988, Baker 1994]. Major improvements have been reported after coronary surgery in coronary artery disease patients with a viable myocardium. In such patients, operative and in-hospital mortality rates were negligible (3.2% per year), whereas the operative and in-hospital mortality rates in coronary artery disease patients without a hibernating myocardium were 10% and 7.7% per year, respectively [Pegley 1997, Bax 1999]. The angina referred in our patients represents myocardial areas that can greatly benefit from coronary revascularization, at least as well as hibernating myocardium.

In fact, we had no deaths in either patient group during the operative and in-hospital periods and had a 7.9% death rate at 6 months. In addition, the left ventricular ejection fraction increased significantly and substantially after coronary bypass grafting in all of the patients treated. This improvement seems related to a more prolonged survival time [Pegley 1997]. Moreover, the quality of life and the clinical symptoms according to the NYHA class clearly improved in all our patients who underwent operations. Thus, coronary bypass surgery in patients with severe ischemic cardiomyopathy and angina can produce early beneficial effects on clinical state and left ventricular function with low mortality rates.

Mitral valve surgery in patients with severe left ventricular dysfunction would seem prohibitive, inasmuch as a depressed left ventricular ejection fraction is an indicator of poor prognosis [Enriquez-Sarano 1994, Bishay 2000]. Even mild mitral regurgitation is an independent predictor of mortality in the post–myocardial infarction period [Lamas 1997]. The incidence of concomitant mitral regurgitation in patients with coronary artery disease is higher in those with a poor left ventricular ejection fraction [Christenson 1995].

However, mitral valve surgery in association with coronary artery bypass grafting brings a higher surgical risk than either procedure alone [Flameng 1996]. A mitral valve prosthesis has been suggested to be necessary in patients who undergo coronary artery bypass surgery only if the mitral insufficiency is severe [Christenson 1995]. This approach seems to be supported by observations that patients who had moderate mitral regurgitation and coronary artery disease treated solely with coronary artery bypass grafting had acceptable early and late results [Duarte 1999].

Because the long-term prognosis of coronary artery disease patients with mitral regurgitation is influenced by the degree of mitral dysfunction, the quantification of the degree of mitral valve regurgitation could be crucial [Enriquez-Sarano 1994]. Studying the long-term outcome and prognostic implications of ischemic mitral regurgitation with quantitative Doppler assessment, Grigioni et al found that a degree of mitral regurgitation defined by an ERO ≥20 mm^2 leads to a high mortality risk as well as to a depressed ejection fraction [Grigioni 2001].

Aside from considering the clinical variables, we used a cutoff ERO value of ≥20 mm^2 in making the decision for mitral valve surgery.

Mitral valve repair with annuloplasty is usually used as a safe alternative to prosthetic mitral valve replacement overburdened by early high mortality rates [Rankin 1988]. Annuloplasty has been carried out through the insertion of a rigid or flexible ring or suture annuloplasty [Czer 1992, Fucci 1995, von Oppel 2000]. The reimplantation of papillary muscle appears to be a developing yet controversial surgical option [Menicanti 2002]. In spite of reports of poor outcomes [Bishay 2000], the surgical treatment of dilated ischemic cardiomyopathy with coronary bypass and mitral valve repair has gained importance.

Even with the longer cardiopulmonary bypass and aortic cross-clamping times for the patients treated with the addition of a Cosgrove ring in the present study, the early outcomes of these patients have been similar to the good ones obtained with coronary bypass alone. There was no mortality during the operative and in-hospital periods, and the mortality rate at 6 months was 7.9%. The NYHA class improved significantly in both groups.

After surgical coronary revascularization, contractility can improve immediately to some extent and definitely improves in a more consistent manner at 3 to 6 months after surgery, depending on the functional recovery of the hibernating myocardium [Wijins 1998]. In fact, at the echocardiographic evaluation 6 months after surgery, both groups showed a significant reduction (approximately 25%) in the wall motion score index, an increase of 10 points in the mean value of the ejection fraction, and a consistent reduction in the end-systolic volume. These improvements in systolic function brought our patients into a lower risk category regarding later predictive mortality factors [Christenson 1995].

In addition, the increases in the peak early mitral inflow velocity and in the ratio of the peak early mitral inflow velocity to the peak late mitral inflow velocity at Doppler assessment confirm an improvement in left ventricular diastolic function. The increased ejection fraction, the decreased left ventricular end-systolic volume, and probably metabolic factors related to surgical coronary revascularization seem to have contributed to this improvement.

CONCLUSIONS

Revascularization can be safely carried out with low operative and perioperative mortality in patients with severe ischemic dilated cardiomyopathy and angina. In our patients, bypass surgery significantly improved the NYHA functional class and left ventricular systolic and diastolic functions and placed the patients in a better position along the course of the natural evolution of ischemic cardiomyopathy [Rihal 1994].

In addition, similar results were obtained for patients with severe ischemic dilated cardiomyopathy and angina who underwent coronary artery bypass in combination with mitral valve repair (group A), even though this procedure involved a higher operative risk and required longer cardiopulmonary bypass and aortic cross-clamping times.

Limitations

The number of patients enrolled in the present study might be considered low, and the data obtained should be confirmed with a larger patient population. However, the exclusion and inclusion criteria we used in selecting the patients render our findings very reliable with respect to the type of patient studied (ie, patients symptomatic for heart failure and angina with severe ischemic dilated cardiomyopathy associated with or without severe mitral valve incompetence). Long-term evaluation of morbidity and mortality is necessary to complete the study, even if clinical and instrumental data collected at 6 months suggest a later favorable outcome.

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