Original Article

Mitral Valve Repair for 52 Patients with Severe Left Ventricular Dysfunction

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Background: Mitral valve (MV) repair is considered to provide more favorable results than MV replacement. MV repair in a patient with severe left ventricular (LV) dysfunction could be associated with higher early and late mortality. Surgical indication of MV repair for those with low LV ejection fraction (LVEF) is still controversial.

Patients and Methods: Fifty-two patients with severe mitral regurgitation (MR) and severe LV dysfunction (EF < 35%) underwent MV repair with or without concomitant procedure. The commonest etiology of MV disease was ischemic origin (78.8%), which underwent annuloplasty alone. Their pre- and perioperative parameters were analyzed to identify the risk factor for mortality. The follow-up data of hospital survivors were collected.

Results: Early mortality was 9.6%. The cause of all deaths was low cardiac output syndrome. Actuarial survival was 81.6% at 2 years and 76.5% at 5 years. Multivariate analyses revealed chronic hemodialysis and EF < 25% to be the risk factors for early and late mortality. Among hospital survivors, significant improvement of LVEF (29.9 to 37.4%) and reduction of LV diastolic dimension (62.8 to 57.9 mm) were observed during follow-up.

Conclusion: MV repair is effective to improve long-term prognosis of high-risk patients of severe MR with severe LV dysfunction. (Ann Thorac Cardiovasc Surg 2009; 15: 160–164)

Key words: mitral regurgitation, mitral valve repair, left ventricular dysfunction, mitral annuloplasty

Introduction

Compared with mitral valve (MV) replacement, MV repair has been shown to provide the clinical advantage over early and late mortality,[1] left ventricular (LV) function, avoidance of thromboembolic complications, and freedom from long-term anticoagulation.[2] The MV repair can preserve the whole geometry of the mitral complex and left ventricle, resulting in superior LV function. Improved early and late outcomes of MV repair have been reported particularly in this decade,[1] and even prophylactic MV repair for asymptomatic severe mitral regurgitation (MR) has been recommended in experienced surgical centers.[2] Even though the rapid progress of surgical results has expanded surgical indication for high-risk cases,[3] especially for severe LV, dysfunction is still strongly associated with high operative mortality and morbidity, short life expectancy, and a high grade of postoperative New York Heart Association (NYHA) classification.[4–8] Few reports are available on the management of patients with severe LV dysfunction requiring MV repair. Controversy remains on how to select patients, which technique to be applied, when to perform the operation, and how to assist postoperative hemodynamics. Some recent studies present fine results for

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Received November 2, 2007; accepted for publication May 26, 2008

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Table 1. Preoperative characteristics

Age (yrs)		63.8 ± 9.0 (range: 41–81)
Sex (male/female)		45/7
NYHA functional class	3	23 (44.2%)
	4	15 (28.8%)
Grade of MR	3	36 (69.2%)
	4	16 (30.8%)
Previous cardiac operation		5 (9.6%)
LVEF (%)		29.9 ± 4.6
LVDd (mm)		62.8 ± 5.8
Diabetes mellitus	Oral medication	8 (15.4%)
	Insulin dependent	7 (13.5%)
Peripheral vessel disease		6 (11.5%)
Chronic obstructive pulmonary disease		2 (3.8%)
Chronic atrial fibrillation		10 (19.2%)
Chronic hemodialysis		5 (9.6%)
Preoperative inotropic support		12 (23.1%)
Preoperative intra-aortic balloon pumping		7 (13.5%)
Euroscore (point)		8.21 ± 3.36
Predicted mortality (%)		14.47 ± 13.68

yrs, years; NYHA, New York Heart Association; MR, mitral regurgitation; LVEF, left ventricular ejection fraction; LVDd, left ventricular end-diastolic diameter.

Table 2. Operative data

Emergency		4 (7.7%)
Etiology	Degenerative	7 (13.5%)
	Ischemic	41 (78.8%)
	Secondary to aortic valve disease	4 (7.7%)
Location of disease	Anterior leaflet	4 (7.7%)
	Posterior	4 (7.7%)
	Annular dilatation	44 (84.6%)
Repair procedure	Resection and suture	1 (1.9%)
	Artificial chordae	2 (3.8%)
	Chordal shortening	2 (3.8%)
	Leaflet plication	1 (1.9%)
	Annuloplasty alone	46 (88.5%)
Annuloplasty ring	Carpentier-Edwards Physio ring	35 (67.3%)
	Carpentier-Edwards Classic ring	9 (17.3%)
	Cosgrove-Edwards flexible band	7 (13.5%)
	Duran ring	1 (1.9%)
Concomitant procedure	CABG	41 (78.8%)
	AVR	5 (9.6%)
	TAP	13 (25.0%)
	Maze	7 (13.5%)
	Dor operation	6 (11.5%)
Cardiopulmonary bypass time (min)		205 ± 51.9
Aortic cross-clamp time (min)		118 ± 53.3

CABG, coronary artery bypass graft; AVR, aortic valve replacement; TAP, tricuspid annuloplasty.

subsets of LV dysfunction, but they are still limited to early outcome or rather simple procedures, such as isolated MV repair[3,9,10] or coronary artery bypass graft (CABG).[11] Therefore this retrospective study was carried out to investigate our results of MV repair in patients with a severe LV function on early and late mortality and preoperative factors that will affect their survival.

Patients and Methods

Patient population

From February 1992 to October 2006, a total of 444 consecutive patients underwent MV repair at Shin-Tokyo Hospital. Fifty-two patients of this group had severe LV dysfunction, defined as LV ejection fraction (LVEF) < 35%, measured with transthoracic echocardiography preoperatively. Forty-five were men (86.5%) and 7 were women (13.5%); the mean age was 63.8 ± 9.0 years (41–81). Preoperative functional status was recorded with NYHA classifications. Twenty-three patients (44.2%) were class 3, and 15 (28.8%) were class 4. This study enrolled any etiology of MV disease, ischemic MR, degenerative, and secondary MR to aortic valve disease. The mean LVEF was 29.9% ± 4.6%, and LV end-diastolic diameter (LVDd) was 62.8 ± 5.8 mm preoperatively. The preoperative patient characteristics are summarized in Table 1.

Surgical techniques

In all cases, MV repair with or without concomitant surgery was performed via mediansternotomy and under cardiopulmonary bypass. Except for 5 patients who underwent beating-heart surgery, myocardial protection was achieved with both antegrade and retrograde cardioplegia at normothermia.

Artificial rings or bands were implanted in all patients for mitral annuloplasty with or without additional procedures for valve reconstruction. Isolated MV repair was performed for only 4 patients (7.7%), and other patients underwent concomitant surgery, including CABG, aortic valve replacement (AVR), tricuspid annuloplasty (TAP), maze procedure, and left ventriculoplasty, as shown in Table 2.

Operative data

Of all 52 patients, 4 patients (7.7%) underwent emergency surgery, and others were treated electively. Forty-one patients (78.8%) had ischemic MR, and all of the patients received CABG concomitantly. To treat MR, 46 patients (88.5%) underwent only annuloplasty, and other patients

Table 3. Early outcomes

In-hospital death (or within 30 days)	5 (9.6%)
Reexploration for bleeding	2 (3.8%)
Low output syndrome	2 (3.8%)
Cerebrovascular event	4 (7.7%)
ICU stay (hours)	135.8 ± 169.0
Hospital stay (days)	26.9 ± 16.7

ICU, intensive care unit.

Table 4. Univariate analyss of predictive factors for early death

Factors	OR	95% CI	P value
Chronic HD	12.60	1.680–94.527	0.014
LVEF < 25%	10.25	1.410–74.515	0.021
Preoperative inotropic support	16.50	1.616–168.48	0.018
History of cardiac surgery	9.78	1.153–82.90	0.037

OR, odds ratio; CI, confidential interval; HD, hemodialysis; LVEF, left ventricular ejection fraction.

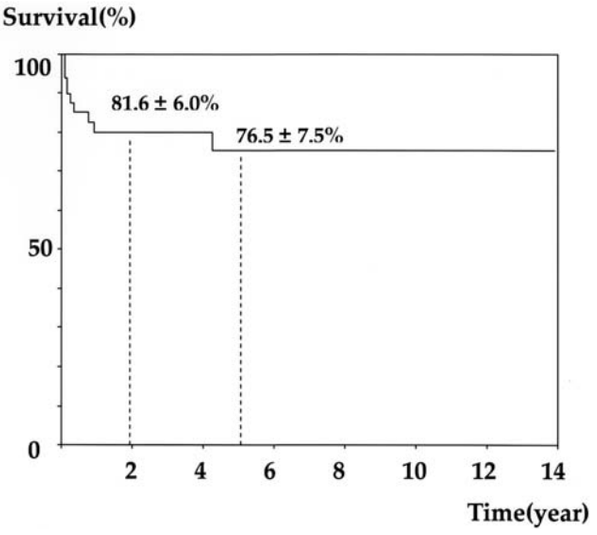

Fig. 1. Actuarial survival rate.

required chordal reconstruction with Gore-Tex Sutures (W. L. Gore & Associates, Inc., Flagstaff, AZ) in 2 patients (3.8%) and chordal shortening in 3 (5.8%). Carpentier-Edwards Physio rings (Edwards Lifesciences, Irvine, CA) was used for 35 patients (67.3%) and Carpentier-Edwards Classic rings (Edwards Lifesciences, Irvine, CA) for 9 (17.3%). For the remaining patients, Cosgrove-Edwards flexible bands (Edwards Lifesciences, Irvine, CA) for 7 (13.5%) and a Duran ring (Medtronic, Inc., Minneapolis, MN) for 1 (1.9%) were used. Table 2 summarizes the surgical details of the patients.

Follow-up

Patients were followed up at the outpatient clinic of Shin-Tokyo Hospital or at satellite hospitals. Perioperative data were reviewed with hospital records. Follow-up data of operative survivors were collected by telephone interview or by letters to their physicians. Follow-up was 94.2% completed, and the mean follow-up period was 35.3 months (range: 1–167 months).

Statistical analysis

Continuous data were presented as a mean ± standard deviation. Logistic regression analysis was used to detect predicting factors for mortality. The Kaplan-Meier method was used to analyze late survival. A p value of 0.05 or less was considered statistically significant. All analyses were performed utilizing SPSS for Windows version 11.5.1 (SPSS Inc., Chicago, IL).

Results

Early outcomes

Intraoperative postrepair transesophageal echocardiography (TEE) showed no MR or trivial MR in all patients. In-hospital mortality totaled 5 patients (9.6%), including 3 on hemodialysis (HD) for chronic renal failure. All patients died as a result of low output syndrome (LOS). Eleven patients (21.2%) required intra-aortic balloon pumping (IABP) insertion for weaning from cardiopulmonary bypass. Four patients (7.7%) had neurological complications after surgery (Table 3). At the time of hospital discharge, LVEF was significantly improved from 29.9% ± 4.6% to 34.8% ± 8.3% (p = 0.016), and LVDd was reduced from 62.8 ± 5.8 mm to 59.4 ± 6.8 mm (p = 0.000). The risk factors predicting early death by univariate analysis are presented in Table 4. Multivariate analyses found chronic renal failure on HD to be the only one independent risk factor for early death.

Survival

During follow-up, 5 patients (9.6%) died from myocardial infarction (MI), congestive heart failure (CHF), pneumonia, or unknown causes. Figure 1 demonstrates actuarial survival using the Kaplan-Meier method, showing actuarial survival at 2 years as 81.6% and at 5 years as 76.5%. Late complications were cerebrovascular events in 1 patient (1.9%) and bradyarrhythmia requiring permanent pacemaker implantation in another (1.9%).

Mitral regurgitation and left ventricular remodeling

The change of MR during follow-up is summarized in Fig. 2. More than moderate recurrent MR after discharge was observed in 5 patients (9.6%). One patient underwent reoperation, and the remainder continued medical treatment. At the time of reoperation, the cause of recurrent MR was shown to be a progression of valve degeneration. LVDd and LVEF measured with echocardiography during follow-up showed significant improvement. LVDd reduced from 62.8 mm preoperatively to 57.9 mm at follow-up, and LVEF improved from 29.9 to 37.4%. The functional status in NYHA classification was significantly improved from 3.18 to 1.87 ($p = 0.024$) at follow-up.

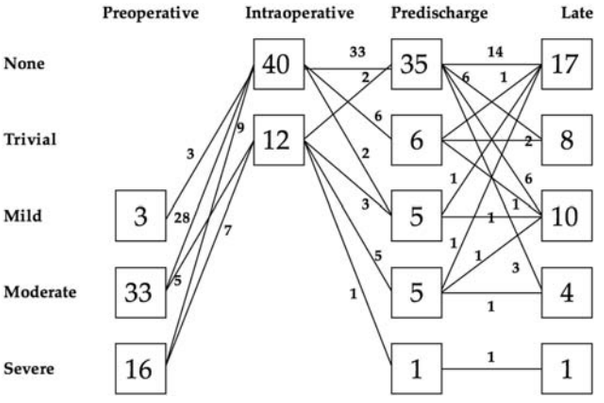

Fig. 2. Change of MR during follow-up.

Comment

This study contains two important findings. First, early outcome was relatively fine for these extremely sick patients with severe LV dysfunction undergoing MV repair. In-hospital mortality was 9.6%, and this is comparable with the results of these high-risk patients with low EF.[4,6] Second, the independent risk factors for in-hospital deaths were chronic renal failure on HD ($p = 0.023$) and LVEF <0.25 ($p = 0.034$).

Braun and co-workers reported a decrease of LV dimension and symptomatic improvement achieved with restrictive mitral annuloplasty in cases of ischemic MR and LV dysfunction.[10] Tulner and colleagues stressed the effects of restoring MV competence with restrictive annuloplasty for patients with end-stage heart failure.[12] Our study also showed a significant decrease of LV dimension and an increase of LVEF, along with an improvement of NYHA classification. Although the American College of Cardiology/American Heart Association (ACC/AHA) guidelines state that the surgical candidacy of patients with MR and advanced LV dysfunction (LVEF < 30%) is controversial,[13] we should suggest a positive conduction of open-heart surgery for that population.

Recent studies suggested not only mitral annular dilatation, but also that the tethering associated with ventricular dilatation is an important mechanism of MR in cases with severe LV dysfunction. We treated severe MR with only annuloplasty in 88.5% of our 52 patients in this study. All patients showed good control of MR less than trivial residual MR evaluated by intraoperative TEE. No doubt tethering is an important mechanism of MR in dilated ventricle; however, as Tulner and colleagues suggested,[12] severe MR could be treated with annuloplasty alone, utilizing annuloplasty rings one or two sizes smaller. Our study also supported their findings of good control of MR with only annuloplasty.

We lost 5 patients in the early period for LOS, including 3 chronic HD patients, and 5 in the late period, including an additional HD patient. Multivariate analyses revealed chronic HD and LVEF < 25% to be the risk factors for early and late deaths. Haan and colleagues presented fine results of MV surgery in patients with low EF and identified three characteristics (age over 75 years, renal failure, and emergent or salvage operation) for high risk.[9]

Numerous reports on cardiac surgery for patients with chronic renal failure have been published, and their poor long term has been emphasized.[14–17] Water-salt balance and toxic metabolites of patients on chronic HD are almost completely regulated with artificial control, but rapid changes of intracellular and extracellular fluids in acute postoperative phase would give much more intrinsic impact on their hemodynamics than those with normal renal function. Chang and Kao reported 5 cases of MV repair with uremic congestive cardiomyopathy and discussed their systolic dysfunction, inadequate LV hypertrophy or dilatation after a long period of HD.[18] Furthermore, not only the cardiovascular system, but also every other organ system in patients on HD may have its function compromised by surgical stress more easily than in those with normal kidneys.

MV repair is convincing as the ideal treatment for chronic renal failure patients requiring chronic HD, considering the high risks accompanying valve replacement, such as cerebrovascular accidents, bleeding complications, and calcification of bioprosthesis.[14] Further efforts are

required to detect operative candidates before the emersion of far-advanced deterioration in LV function, especially in chronic renal failure patients on HD.

Because of the few cases enrolled in our study, an inspection of risk factors might lack precision about the influence of each factor on the outcome. Another limitation of our study is that the subject period (1992–2006) includes a decade of remarkable advancement of MV repair. Concepts and techniques have been greatly changed in this period, and quality and durability of repair may differ in the most recent stage compared with the first stage.

Our results suggest that we should offer MV repair even in extremely high-risk patients having moderate to severe MR with severe LV dysfunction because of their fair early and late results. However, careful surgical indication must be considered in regard to patients with chronic renal failure on HD.

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