

Long-Term Survival After Surgical Revascularization for Moderate Ischemic Mitral Regurgitation

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Background. We sought to characterize patient survival and degree of late mitral regurgitation (MR) in patients undergoing surgical revascularization with moderate ischemic MR.

Methods. We retrospectively reviewed 251 patients undergoing coronary artery bypass graft (CABG) surgery between 1991 and 2001 with 3+ ischemic MR, including 31 patients who had concomitant mitral annuloplasty. Univariate and multivariable testing was employed.

Results. Actuarial 1-, 5-, and 10-year survival was 84.0%, 67.5%, and 37.1% in the overall group of 251 patients. Independent predictors of long-term mortality were age 70 years or more (hazard ratio 2.50 [95% confidence interval 1.82 to 3.44]), prior myocardial infarction (3.99 [2.15 to 7.39]), unstable angina (2.27 [1.69 to 3.04]), chronic renal failure (4.87 [3.13 to 7.58]), atrial fibrillation (2.21 [1.65 to 2.96]), left internal mammary artery to left anterior descending artery graft (0.28 [0.18 to 0.43]), preoperative β -blocker (0.43 [0.28 to 0.67]), ejection fraction (0.71/10% [0.64 to 0.80]), left atrium size (0.88/mm [0.84 to 0.92]), diffuse wall motion abnormalities (2.83 [1.77 to

4.55]), and mitral leaflet restriction (3.85 [2.46 to 5.99]). The model controlled for the performance of annuloplasty, which did not emerge as an independent predictor. Patients undergoing annuloplasty did have less mean late MR than those having CABG alone ($p = 0.005$). Overall, 57.8% of patients (63 of 109) with follow-up echocardiograms had improvement in grade of MR compared with baseline. In 54 of 95 patients (56.8%), intraoperative transesophageal echocardiography downgraded the degree of MR compared with the preoperative study.

Conclusions. Patients with moderate ischemic MR undergoing CABG had relatively poor long-term survival, with significant differences when stratified according to preoperative characteristics. Performance of mitral annuloplasty reduced the degree of regurgitation but was not a predictor of long-term survival. Intraoperative transesophageal echocardiography frequently downgraded the degree of MR.

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Myocardial damage from coronary artery disease may secondarily distort the mitral valve and produce mitral regurgitation. This syndrome of ischemic mitral regurgitation (IMR) is considered a marker for worsened prognosis after myocardial infarction, percutaneous coronary intervention, and coronary artery bypass grafting surgery (CABG) [1–3]. As presently employed, the term IMR is really a misnomer as the syndrome is usually not related to acute ischemia. In most IMR patients, regurgitation occurs as a result of annular dilation or apical tethering, or both, of the mitral leaflets due to distortion in ventricular wall and papillary muscle geometry from myocardial injury and scarring [4, 5].

In addition to surgical revascularization, restrictive

annuloplasty has become accepted as standard therapy for IMR [6]. While there is widespread agreement that trace or mild regurgitation is adequately treated by isolated CABG, and that mitral annuloplasty or replacement is appropriate for severe MR, the optimal surgical approach to moderate IMR remains controversial [7, 8]. It is in this gray zone of surgical decision-making that the long-term results of surgery and the influence of patient characteristics are most important to decipher. When the variability of IMR under different conditions of loading and ischemia is added to the fact that most studies group several grades of MR together with several approaches to therapy, it is not surprising that there is no clear consensus within the literature on what are the critical factors, including surgical approach, that influence outcomes.

In this report, we retrospectively reviewed patients undergoing CABG with or without annuloplasty who had moderate (3+) IMR and attempted to identify character-

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Table 1. Selected Baseline and Operative Characteristics (n = 251)

	N (%)	p Value ^a
Age ≥70 yrs	151 (60.1%)	0.15
Male sex	144 (57.4%)	0.21
Hypertension	158 (62.9%)	0.84
Diabetes	111 (44.2%)	0.91
Myocardial infarction	199 (79.3%)	0.84
Unstable angina	136 (54.2%)	0.27
Congestive heart failure	93 (37.1%)	0.32
Chronic renal insufficiency	53 (21.1%)	0.49
Atrial fibrillation	55 (21.9%)	0.92
Preoperative beta-blocker	124 (49.4%)	0.79
Preoperative IABP	75 (29.9%)	0.34
Left main disease	65 (25.9%)	0.64
Number of grafts		0.67
1	3 (1.2%)	
2	27 (10.8%)	
3	99 (39.4%)	
4	85 (33.9%)	
5+	37 (14.7%)	
LIMA graft to LAD	221 (88.0%)	0.23

^a Chi-square, Fisher's exact, or *t* test comparing the CABG and CABG + MVA subgroup.

CABG = coronary artery bypass grafting; IABP = intra-aortic balloon pump; LAD = left anterior descending coronary artery; LIMA = left internal mammary artery.

istics that influence long-term survival and degree of late MR.

Patients and Methods

Patients

STUDY GROUP. Ethics approval for this study was obtained from the Institutional Review Board. Between 1991 and 2001, 8,442 patients at our hospital underwent first-time CABG as determined by a prospectively collected institutional database of cardiac surgical procedures. By matching patients in this group with our echocardiographic database, 3,641 patients were found with a total of 7,799 echocardiography studies performed at this institution. Of these, 325 had moderate (3+) mitral regurgitation on a preoperative transthoracic echocardiogram within one month before surgery. After excluding myxomatous mitral disease, prolapse, chordal or papillary muscle rupture, mitral stenosis, vegetations, and other intrinsic valvular disease from the echocardiography and operative reports, 251 patients remained with moderate ischemic MR who underwent isolated CABG plus or minus concomitant mitral annuloplasty.

SURGICAL DETAILS. The use of intraoperative transesophageal echocardiography (TEE), and the decision to perform a mitral annuloplasty were at the discretion of the surgeon. The prevailing strategy at the beginning of this interval favored performing isolated CABG particularly when TEE showed downgrading of MR. Annuloplasty

rings were generally not undersized in the early part of the series.

PATIENT CHARACTERISTICS AND FOLLOW-UP. Baseline demographics, comorbidities, operative details, and short-term in-hospital outcomes were extracted retrospectively. Echocardiographic follow-up was restricted to studies performed at this institution and was obtained similarly from chart review. Follow-up echocardiograms were performed as clinically indicated. Long-term survival was the primary outcome and was assessed by searching a national social security death index; it excluded 9 patients (3.6%) from outside the United States who were censored at discharge. Survival follow-up ended on October 1, 2003.

Data Analysis

UNIVARIATE ANALYSES. All statistical analysis was performed using SAS software (SAS Institute, Cary, North Carolina). Univariate analyses included two-tailed Wilcoxon rank sum or *t* tests for continuous variables and χ^2 or Fisher's exact tests for discrete variables. Survival was estimated by the Kaplan-Meier technique, with log-rank tests to compare stratified groups. Tests are considered statistically significant at *p* less than 0.05. No correction for multiple analyses was utilized.

MULTIVARIABLE ANALYSES. Time-specific effects were estimated with parametric, multiphase (mixture distribution components) hazard regression, using analytical tools available from the Cleveland Clinic Heart Center Hazard website (available at: <http://www.clevelandclinic.org/heartcenter/hazard/default.htm>). Covariates were modeled in both discrete and continuous forms after assessing logistic plots of continuous and categorical variables. Missing values were assigned the mean for that covariate. Variable selection for the multivariable model was performed by first considering each potential covariate in each phase of the model univariately. Those significant to *p* less than 0.10 were considered for inclusion in the model using automated stepwise selection, with manual oversight of each step, using entry and stay criteria of *p* less than 0.10 and *p* less than 0.05, respectively. While not statistically significant itself, mitral annuloplasty was forced into both phases of the final model as a clinically relevant variable; it was not an important confounder (less than 10% change in the effect estimates for the other variables) but did reduce the power of the model slightly. With this model we were able to distinguish between risk factors that acted during (two) different phases of follow-up, and to avoid assumptions about the proportionality of hazards inherent to Cox modeling. Model validation of the significant predictors (not including annuloplasty) was performed by calculating estimates for the final model using 1,000 datasets, each containing 251 patients selected from the original set with replacement (bootstrap method); the standard deviations of the means of the bootstrap estimates were used to test the original parameter estimates from the final model by means of a χ^2 test. Logistic regression was used for multivariable analysis of secondary echocardiographic outcomes.

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