Minimally invasive fibrillating mitral valve replacement for patients with advanced cardiomyopathy: A safe and effective approach to treat a complex problem

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Objective: The optimal management of mitral regurgitation (MR) in patients with cardiomyopathy has been controversial. Minimally invasive fibrillating mitral valve replacement (mini-MVR) might limit postoperative morbidity and mortality by minimizing recurrent MR. We hypothesized that mini-MVR with complete chordal sparing would offer low mortality and halt left ventricular (LV) remodeling in patients with severe cardiomyopathy and severe MR.

Methods: From January 2006 to August 2009, 65 patients with an LV ejection fraction (LVEF) of ≤35% underwent mini-MVR. The demographic, echocardiographic, and clinical outcomes were analyzed.

Results: The operative mortality compared with the Society of Thoracic Surgeons-predicted mortality was 6.2% versus 6.6%. It was 5.6% versus 7.4% for patients with an LVEF of ≤20% and 8.3% versus 17.9% among patients with a Society of Thoracic Surgeons-predicted mortality of ≥10%. At a median follow-up of 17 months, no recurrent MR or change in the LV dimensions or LVEF had developed, but the right ventricular systolic pressure had decreased ($P = .02$). At the first postoperative visit and latest follow-up visit, the New York Heart Association class had decreased from 3.0 ± 0.6 to 1.7 ± 0.7 and 2.0 ± 1.0, respectively ($P < .0001$ for both). Patients with an LVEF of ≤20% and LV end-diastolic diameter of ≥6.5 cm were more likely to meet a composite of death, transplantation, or LV assist device insertion ($P = .046$).

Conclusions: Our results have shown that mini-MVR is safe in patients with advanced cardiomyopathy and resulted in no recurrent MR, stabilization of the LVEF and LV dimensions, and a decrease in right ventricular systolic pressure. This mini-MVR technique can be used to address severe MR in patients with advanced cardiomyopathy. (J Thorac Cardiovasc Surg 2014;148:2045-51)

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The optimal treatment of patients with advanced heart failure and severe mitral regurgitation (MR) has been controversial. Up to 50% of patients with chronic heart failure will have significant MR, and worsening severity has conferred a proportional decrease in survival.[1] Decreasing the severity of MR has been shown to decrease congestive heart failure symptoms and improve patients' quality of life.[2] Although the benefit of preserving the subvalvular apparatus during mitral valve (MV) surgery has been established, the relative superiority among MV annuloplasty, repair, and replacement has remained an open question.

In early studies, MV replacement (MVR) was associated with greater surgical risk compared with MV repair. However, the surgical outcomes might be similar in high-risk populations with advanced heart failure.[3] In patients with functional MR from cardiomyopathy, the recurrence of moderate or greater MR has approached 30% within 1 year after MV repair.[4,5] This could explain, in part, the lack of survival benefit for patients with advanced cardiomyopathy undergoing MV repair and annuloplasty.[6]

We have adopted a technique for MVR with anterior/posterior chordal sparing through a 5-cm right anterolateral thoracotomy without aortic crossclamping (mini-MVR). Previous work by our group has shown that this technique is associated with low surgical mortality in patients with severe MR and a wide range of left ventricular (LV) function.[7] In patients with LV dysfunction and severe MR, combining a minimally invasive approach with preservation of the subvalvular apparatus during MVR

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Abbreviations and Acronyms

LV = left ventricular
LVEF = LV ejection fraction
mini-MVR = minimally invasive fibrillating mitral valve replacement
MR = mitral regurgitation
MV = mitral valve
MVA = MV annuloplasty
MVR = MV replacement
NYHA = New York Heart Association
RV = right ventricular
STS = Society of Thoracic Surgeons

might minimize adverse LV remodeling and maximize postoperative functional status. We hypothesized that this technique would be durable and offer favorable perioperative morbidity and mortality compared with the Society of Thoracic Surgeons-predicted rates in patients with an LV ejection fraction (LVEF) of ≤35% and advanced heart failure.

METHODS

Study Design

The Vanderbilt University institutional review board approved the present study (institutional review board no. 101741). From January 2006 to August 2009, 65 patients with an LVEF of ≤35% underwent anterior/posterior chordal sparing mini-MVR under cold fibrillatory arrest and without aortic crossclamping. All patients had symptomatic heart failure with at least moderate (>2+) MR. Operative mortality was defined as death within 30 days of the surgical procedure. In-hospital mortality was defined as death during the same admission as the surgical procedure. All causes of MR were included. Patients with endocarditis, congenital disease, or concomitant mitral stenosis were excluded from the analysis.

Selection Rationale

The procedure has become our standard approach for MV surgery in patients with or without cardiomyopathy in the absence of concomitant aortic valve disease or coronary artery disease involving the left main or left anterior descending artery. This approach was also contraindicated if the aortic insufficiency were greater than moderate. For patients with concomitant coronary artery disease and mitral disease, if a lesion in the left circumflex artery or right coronary artery were amenable to percutaneous coronary intervention, we stented the coronary artery lesion and then performed minimally invasive valve surgery. For coronary artery disease involving the left main or left anterior descending artery, this approach was contraindicated.

Surgical Technique

The surgical technique has been previously described.[7] In brief, after induction of general anesthesia and endotracheal intubation, a pacing Swan-Ganz pulmonary artery catheter, a transesophageal echocardiogram probe and external defibrillator (Zoll Medical Corp, Chelmsford, Mass) were placed. A 5-cm right anterolateral thoracotomy was performed through the fourth intercostal space. If the descending aorta was free of atheroma greater than grade III, the femoral artery was cannulated using a 16F or 18F straight cannula (Edwards Lifesciences, Irvine, Calif). Otherwise, axillary cannulation was preferred.

The femoral vein was cannulated with a 28F venous return cannula (Cardiovations, Inc, Calif), and the patients were placed on cardiopulmonary bypass with vacuum-assisted drainage. Fibrillatory arrest was induced by cooling the patients to 28°C. The left atrium was immediately opened in the atrioventricular groove. Carbon dioxide was continuously insufflated into the chest throughout the procedure to displace the intracardiac air, and left atrial sump suction was used to maintain a clear operative field. The anterior and posterior leaflet chordae were preserved in all patients included in the present study. The anterior leaflet was divided in the middle, and the 2 created edges were reattached to the annulus, thus, reattaching all the chordal support of the anterior leaflet. Toward the end of the procedure, the patient was rewarmed, and the left atrial appendage was oversewn. Careful examination for air using transesophageal echocardiography with the patient in a deep Trendelenburg position was performed. Strict air evacuation using carbon dioxide and de-airing using a LV vent through the valve was performed before complete rewarming and defibrillation. Therefore, if the patient spontaneously cardioverted, the MV was kept incompetent to prevent air ejection. The MV was kept incompetent, and cardioversion was accomplished using the Zoll pads (Zoll Medical Corp) before completing left atrial closure.

Echocardiographic Analysis

Echocardiograms were performed at Vanderbilt University using either an iE33 (Philips, Amsterdam, The Netherlands) or Acuson (Siemens, Mountain View, Calif) cart as a part of routine clinical care. The echocardiographic data were reviewed by 2 experienced physicians (L.A.M. and K.B.C.). Quantitative analysis was performed on echocardiograms of adequate quality according to the guidelines published by the American Society of Echocardiography.[8] The LV volumes were measured using the method-of-discs from the orthogonal apical views. The severity of MR was graded using the proximal isovelocity area method, vena contracta, and pulmonary vein Doppler characteristics. The right ventricular (RV) systolic pressure was estimated using the simplified Bernoulli equation according to the American Society of Echocardiography guidelines.

Statistical Analysis

Continuous data are expressed as the mean ± standard deviation. The unpaired, 2-tailed Student t test and Mann-Whitney U test were used to measure differences in continuous variables between the groups according to the specifications. Categorical variables were compared between groups using the χ^2 test. Event-free survival was defined as freedom from a combined endpoint of death, heart transplantation or transplant listing, or LV assist device insertion. Survival curves were constructed using the Kaplan-Meier method, and survival differences were compared using the log-rank test. Logistic regression analysis was used to estimate the effect of various parameters. The Society of Thoracic Surgeons (STS) estimated rates of mortality and morbidity were calculated using the online STS calculator.[9] From previous work from our group, we prespecified the subgroup analysis in the high-risk group with either an LVEF of ≤20% or STS-predicted operative mortality of >10%.[10] The observed and predicted mortality rates were compared using the Wilcoxon signed rank test. Statistical analyses were performed using Prism, version 5.0, software (Graph Pad Software, Inc, La Jolla, Calif) and the Statistical Package for Social Sciences, version 20, software (SPSS, Inc, Chicago, Ill).

RESULTS

Patients

A total of 65 patients (74% male, 26% female), with a mean age of 65 ± 10 years, underwent mini-MVR. Of the 65 patients, 6 (9%) underwent concurrent tricuspid valve repair or replacement and 10 (15%)