Surgical management of moderate ischemic mitral regurgitation at the time of coronary artery bypass grafting remains controversial

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Ischemic mitral regurgitation (IMR) is a consequence of regional wall motion abnormalities induced by myocardial ischemia or infarction.¹ Adverse left ventricular (LV) remodeling develops in approximately 50% of patients after a myocardial infarction, and *moderate* mitral regurgitation (MR) occurs in more than 10% of patients.^{2,3} The presence of any degree of IMR discriminates patients with LV dysfunction who have a higher mortality risk than those without IMR, regardless of the treatment.²

MR results from a combination of regional wall motion abnormalities, papillary muscle displacement, leaflet tethering, reduced closing forces, and annular dilatation.¹ The mitral valve leaflets appear normal to the surgeon. Most patients have multivessel coronary artery disease requiring revascularization, so surgeons must consider whether to add a mitral valve repair procedure to coronary artery bypass grafting (CABG) in patients with *moderate* IMR.

The appropriate surgical management of moderate IMR at the time of CABG remains controversial. Some experts advocate revascularization alone for moderate IMR, expecting improvements in regional and global LV function and geometry after CABG to lead to a reduction in MR.^{4,5} Others support restrictive mitral annuloplasty (RMA) repair at the time of CABG to address the IMR more directly, expecting to prevent further adverse remodeling and to decrease the risk of heart failure.^{6,7} Importantly, the addition of a mitral valve procedure to CABG surgery necessitates open heart exposure and is associated with longer durations of aortic crossclamping and cardiopulmonary bypass, which can increase perioperative risk.⁸

Numerous observational, nonrandomized, single-center experiences are informative, but they suffer from the limitations of single-center experiences, study design, nonrigorous definition of the degree of MR, and the inclusion in the analysis of patients with both moderate

Papillary muscle approximation reduces LV end-systolic dimension and leaflet tethering. Reprinted with permission.¹⁴

Central Message

A reparative procedure is recommended for select cases of moderate ischemic MR: LV scar or aneurysm/dyskinesia, large ventricles, and poor coronary targets because of a low likelihood to improve LVEF.

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and severe degrees of MR. Three recent randomized clinical trials of moderate IMR with well-defined criteria for the measurement of MR have compared CABG alone versus CABG plus RMA.⁶⁻⁸

Both Fattouch and colleagues⁶ and the Randomized Ischemic Mitral Evaluation (RIME) investigators⁷ demonstrated that the addition of RMA resulted in improvements in LV reverse remodeling, LV ejection fraction, New York Heart Association functional class, and MR grade, but not in survival. Fattouch and colleagues⁶ randomly assigned 102 patients to undergo CABG alone or CABG plus RMA. They demonstrated that the addition of RMA significantly reduced LV end-systolic dimension (LVESd). The RIME trial⁷ randomly assigned 73 patients to undergo CABG alone or CABG plus RMA and demonstrated a 28% reduction in LV end-systolic volume index (LVESVI) relative to baseline (mean baseline, 78 mL/m²).

The National Heart, Lung, and Blood Institute–sponsored Cardiothoracic Surgical Trials Network (CTSN) more recently conducted a multicenter randomized trial^{8,9} comparing CABG alone with CABG plus RMA in 301 patients with moderate IMR. RMA resulted in a significant reduction relative to CABG alone in prevalences of MR at 1 and 2 years, with no progression to severe MR in the

RMA group.⁹ There were no differences between the 2 groups in the degree of LV reverse remodeling (LVESVI), New York Heart Association functional class, LV ejection fraction, survival, or major adverse cardiac and cerebrovascular events at 1 and 2 years. RMA was associated with a longer hospital stay after surgery, a higher incidence of post-operative supraventricular arrhythmias and more postoperative neurologic events, (which included metabolic encephalopathy, seizures, transient ischemic attack, and stroke).

It is well established that improvements in global and regional wall motion as well as reverse LV remodeling after CABG alone are indicative of viable myocardium.^{5,10} For example, Penicka and colleagues⁴ found that in a series of patients with moderate IMR who underwent CABG alone, resolution of MR after surgery was associated with more viable segments and less LV dyssynchrony at baseline.

In the CTSN trial, irrespective of treatment arm, patients with resolution of IMR had greater reverse remodeling and better wall motion scores than those who did not.⁹ This latter point is noteworthy, because it provides evidence that many patients in both arms of the CTSN trial must have had viable myocardium and not LV scar tissue, which resulted in an improvement in wall motion, a reduction in LV size, and less MR with just the revascularization procedure.

There are multiple comparative points to emphasize regarding these 3 clinical trials. First, the sample sizes differed greatly; the CTSN trial enrolled more than 3 times the number of patients in the other trials. Second, the 3 clinical trials used different primary end points. Third, the analytic approaches were different, with the CTSN trial counting patients who died as treatment failures in the primary end point analysis, whereas the other trials used a survivor analysis. Fourth, the CTSN trial had significantly lower rates of baseline previous MI and possibly less LV scar tissue. Fifth, and perhaps most importantly, baseline LV size was significantly larger in the trial of Fattouch and colleagues⁶ and the RIME trial⁷ than in the CTSN trial. This fact alone may have favored patients who received a restrictive annuloplasty, especially if more scar tissue was present, because CABG alone in these patients would be less likely to result in an improvement in LV wall motion and reduced LV size, precisely those factors that lead to less MR.

Not surprisingly, it is in patients with LV scar tissue for whom CABG alone is less likely to provide benefit and precisely those patients who may need the addition of RMA to reduce IMR. In the RIME trial,⁷ a 28% reduction in LV size from baseline (mean baseline, 78 mL/m²) was achieved with CABG plus RMA, whereas in the CTSN trial, those patients who received the combined procedure saw only a 9% reduction in LV size from baseline (mean, baseline 57 mL/m²). To underscore this important point, patients in the CTSN trial had smaller ventricles at baseline

and, as the evidence suggests, more viable myocardium—precisely the clinical substrate that is likely to benefit most from CABG alone.

Surgical decision making for patients with moderate IMR therefore could be enhanced by preoperative identification of those patients most likely to have an improvement in regional wall motion and global LV function from CABG alone. Not one of these 3 clinical trials required preoperative evaluation of myocardial viability. It is known that viability assessment can predict the effectiveness of revascularization in specific patient populations, and one should therefore consider it in this setting.¹¹ Cardiac magnetic resonance imaging with gadolinium hyper-enhancement is an appropriate tool when viability imaging results are equivocal or LV scar tissue is suspected.

Individual treatment decisions require balancing the risks of adverse perioperative events against the benefits of a lower incidence of postoperative MR. Effective revascularization, as reflected in improved regional and global LV function, plays an important role in reducing MR, independent of restrictive annuloplasty repair. In other clinical settings, the anticipated low likelihood of generating significant functional improvement and reverse remodeling from CABG should lead to the performance of a mitral valve reparative procedure. Such circumstances include patients with documented scar tissue or basal aneurysm or dyskinesia in the inferoposterior lateral LV, large ventricles (LVESVI >60 mL/m² and left ventricular end diastolic diameter >50 mm) and poor coronary targets in the circumflex and right coronary distributions because of the reduced likelihood that revascularization will provide significant enhancement of LV contractility and LV reverse remodeling.

Recent post hoc analysis by the CTSN authors¹² has highlighted the importance of evaluating the ratio of LVESd to prosthetic annuloplasty ring size in predicting the risk of persistent or recurrent MR after surgery in patients with moderate and severe IMR. The CTSN authors¹² noted that a LVESd/ring size ratio of at least 2 was associated (multivariate analysis) with increased risk of persistent or recurrent MR. Therefore, insertion of too small of a prosthetic ring could increase this ratio and lead to persistent MR or even mitral stenosis. In my judgment, patients with an enlarged ventricle (especially those with scar tissue, dyskinesia, or a basal aneurysm) in whom mitral repair is feasible should therefore receive a ventricular procedure to surgically reduce LVESd together with a restrictive annuloplasty procedure. A papillary muscle approximation has been used in clinical trials of severe IMR to produce excellent long-term freedom from recurrent or persistent IMR.¹³ A papillary muscle approximation procedure mechanically reduces the LVESd and has the potential to reduce leaflet tethering, thus producing a lower ratio of LVESd to ring size and a realistic expectation of reducing MR.

My current decision algorithm for managing *moderate* IMR focuses on 5 preoperative factors that help determine the surgical plan. In conjunction with echocardiography and cardiac catheterization, cardiac magnetic resonance imaging can complete a comprehensive analysis of these factors.

1. Severity of MR
2. Severity of LV dysfunction
3. Severity of LV remodeling (LVESVI)
4. Presence and extent of LV scar tissue
5. Quality and distribution of the left circumflex and right coronary circulations

Whether RMA repair together with CABG will predictably benefit patients with an enlarged LV or with baseline inferoposterior lateral wall motion abnormalities considered to represent scar tissue remains unknown. Until such evidence is available, RMA and papillary muscle approximation should be considered an essential part of the surgical armamentarium for patients with moderate IMR.

Conflict of Interest Statement

Author has nothing to disclose with regard to commercial support.

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