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Should all ischemic mitral regurgitation be repaired? When should we replace?

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Abstract

Purpose of review—Ischemic mitral regurgitation (IMR) is a major source of morbidity and mortality. Although mitral valve repair has become recently popularized for the treatment of IMR, select patients may derive benefits from replacement. The purpose of this review is to describe current surgical options for IMR and to discuss when mitral valve replacement (MVR) may be favored over mitral valve repair.

Recent findings—Current surgical options for the treatment of IMR include surgical revascularization alone, mitral valve repair, or MVR. Although surgical revascularization alone may benefit patients with mild–moderate IMR, most surgeons advocate the performance of revascularization in combination with either mitral valve repair or replacement. In the current era, mitral valve repair has proven to offer improved short-term and long-term survival, decreased valve-related morbidity, and improved left ventricular function compared with MVR. However, MVR should be considered for high-risk patients and those with specific underlying mechanisms of IMR.

Summary—In the absence of level one evidence, mitral valve repair offers an effective and durable surgical approach to the treatment of mitral insufficiency and remains the operation of choice for IMR. MVR, however, is preferred for select patients. Future randomized, prospective clinical trials are needed to directly compare these surgical techniques.

Keywords

ischemic mitral regurgitation; mitral valve repair or replacement; survival

Introduction

Ischemic mitral regurgitation (IMR) describes insufficiency of the mitral valve in the setting of myocardial ischemia, resulting from coronary artery disease. Although IMR may present in the acute setting, usually as a papillary rupture (Carpentier type II), it is usually a consequence of chronic myocardial ischemia that typically presents weeks following a complete infarction [1,2]. IMR describes mitral insufficiency in the absence of degenerative (structural) mitral valve disease. The underlying pathophysiologic mechanisms of IMR are often complex, resulting from several different structural changes involving left ventricular geometry, the mitral annulus, and the valvular/subvalvular apparatus. Although changes to any one component may result in detectable mitral valve insufficiency, moderate-to-severe

IMR requiring surgical correction often involves the complex interplay of several co-existent anatomic changes. These underlying mechanisms result in clinically significant valve incompetence due to the combined effects of decreased ventricular function and restricted motion of the valve itself due to tethering.

IMR is a major source of patient morbidity and mortality. Although the frequency of IMR differs based upon imaging modality, estimates have suggested that nearly 20–30% of patients experience mitral insufficiency following myocardial infarction [3,4]. Furthermore, its intimate association with heart failure and poor outcomes for suboptimal medical management further complicates the management of clinically significant IMR. Recent evidence suggests that moderate or severe mitral regurgitation may be associated with a three-fold increase in the adjusted risk of heart failure and a 1.6-fold increase in risk-adjusted mortality at 5-year follow-up [5]. In addition, unfavorable patient profiles and co-existing comorbid disease, including renal failure, chronic obstructive pulmonary disease, diabetes, and impaired left ventricular function [6], further complicate the clinical picture for those with IMR. Consequently, surgical correction of this condition is often required.

Historically, the surgical management of IMR was associated with poor outcomes, high mortality, and compromised patient survival. Recently, however, several series have reported improved outcomes for the surgical management of IMR, with mortality rates of less than 5% [1,2,7–9]. Surgical operations for IMR include myocardial revascularization alone with coronary artery bypass grafting (CABG), mitral valve replacement (MVR) with concomitant CABG, or a variety of mitral valve repair techniques combined with CABG. Although CABG alone may prove beneficial for some patients, a majority of published series support the use of CABG with a combined mitral valve operation. Thus, evidence supporting the performance of MVR vs. repair for IMR remains mixed, and the preference of one approach over another remains a question of patient selection and a source of continued debate.

The purpose of this review is to analyze published results for the surgical correction of IMR and to provide current opinion regarding the selection of mitral valve procedure in the setting of myocardial ischemia. Herein, we review current surgical options for IMR and discuss when MVR may be favored over mitral valve repair.

Surgical options for ischemic mitral regurgitation: surgical revascularization alone

Surgical revascularization alone with CABG may be beneficial for some patients. Although CABG alone may be performed in cases of mild-to-moderate IMR, for the treatment of severe IMR, evidence supports performance of CABG with a mitral valve procedure [1,2,7,8,10,11]. In fact, a lack of evidence exists to support the performance of CABG alone for severe IMR. In one retrospective review of propensity-matched cohorts, Diodato *et al.* [12] suggested that addition of a mitral valve procedure to patients undergoing CABG for moderately severe to severe IMR did not increase mortality or improve survival over the performance of CABG alone. This study, however, was limited by small sample sizes (51 CABG + mitral valve repair vs. 51 CABG alone) and 3-year follow-up. To the contrary, substantial evidence exists to support the performance of surgical revascularization alone in cases of mild-to-moderate IMR.

Previous series have suggested that revascularization without mitral valve intervention may provide some benefit to patients with mild-to-moderate IMR. A study by Aklog *et al.* [13] investigated the role of CABG alone in the correction of moderate IMR. In their series of 136 patients with moderate IMR, they demonstrated that performance of revascularization

alone conferred improvement of mitral regurgitation in 51% of patients with complete resolution in an additional 9%. Despite these results, 40% of patients remained with 3–4+ mitral regurgitation, leading the authors to conclude that CABG alone may not be the optimal therapy for most patients and suggest that concomitant mitral annuloplasty may improve results. Other series similarly suggest that complete resolution of functional IMR is uncommon following revascularization alone [14,15]. Despite the presence of residual mitral regurgitation following revascularization, the impact of performance of CABG without a valve procedure on long-term survival remains ill defined. Although some studies have suggested that residual mild-to-moderate mitral regurgitation following CABG alone decreases long-term survival [14], others have failed to demonstrate the independent influence of mitral insufficiency on long-term mortality [16–18]. In their comparison of patients with IMR undergoing CABG alone compared with CABG with mitral valve repair, Kim *et al.* [19] reported similar 5-year actuarial survival between groups (44% CABG + repair vs. 52% CABG alone, P = not significant). A recent report by Goland *et al.* [20*] corroborates these findings. Consequently, select patients with well defined pathophysiology and minimal mitral regurgitation may benefit from revascularization without valve intervention. Currently, on-going prospective evaluation may help to define the potential role of revascularization alone for patients with moderate IMR. Until the completion of these trials, however, evidence supports the performance of surgical revascularization combined with a mitral valve procedure for moderate-to-severe mitral regurgitation.

Surgical revascularization with a mitral valve procedure

The majority of patients with moderate-to-severe IMR require surgical revascularization with a concomitant mitral valve procedure (MVR or mitral valve repair). Historically, these procedures have been associated with high morbidity and mortality as well as poor long-term survival [21–27]. However, improved surgical techniques and postoperative management have improved contemporary outcomes [20*,28].

The optimal strategy for surgical management of IMR remains controversial. Those favoring mitral valve repair promote its beneficial effects on survival, preserved ventricular function, and the avoidance of long-term anticoagulation, whereas those favoring MVR argue that it ensures long-term freedom from recurrent mitral insufficiency. In addition, proponents of MVR argue that improved surgical techniques to preserve the subvalvular apparatus reduce the previously observed survival benefits of mitral valve repair, and that the use of bioprosthetic valves avoids the use of long-term anticoagulation. Moreover, a lack of published prospective randomized trials comparing mitral valve repair with MVR further contributes to the ensuing debate.

Mitral valve replacement vs. mitral valve repair

The use of MVR for IMR eliminates the possibility of recurrent IMR. In addition, previous literature suggests improvements in surgical technique for MVR [29–32]. For patients with IMR, MVR with preservation of the subvalvular apparatus using a chordal sparing technique has been shown to be beneficial [33]. David and Ho [33] demonstrated a significant survival benefit for patients undergoing MVR with preservation of chordae tendineae (89%) compared with complete excision of the mitral valves (59%) in a cohort of 51 patients with IMR. In addition, Cohn *et al.* [34] suggested disproportionate survival benefits favoring MVR in a cohort of 150 patients with both functional and structural IMR, concluding that survival following performance of mitral valve procedures for IMR was more dependent on underlying pathophysiology rather than surgical technique. More recently, series have suggested equivalent results for the MVR and mitral valve repair. Mantovani *et al.* [35] report that prosthetic MVR and mitral valve repair offer very similar results for chronic IMR, demonstrating similar operative mortality and 5-year actuarial survival for both

techniques. In a similar report, Magne *et al.* [36**] compared short-term and long-term outcomes for 370 patients undergoing mitral valve repair ($n = 186$) and MVR ($n = 184$) for IMR. Although operative mortality was lower for mitral valve repair compared with MVR (9.7 vs. 17.4%, $P = 0.03$), 6-year survival was similar for both operations (73 ± 4 vs. $67 \pm 4\%$, $P = 0.17$). Type of procedure was also not an independent predictor of mortality following risk adjustment. As a result, the authors suggest that mitral valve repair is not superior to MVR for patients with IMR.

In contrast, other series favor the performance of mitral valve repair for functional IMR. Although several repair techniques exist, restrictive annuloplasty remains the most commonly performed operation [37*] and has been shown to be beneficial in both functional and chronic IMR [38*]. The purported benefits of improved survival, decreased valve-related morbidity, and improved left ventricular function have been previously established, and several series have reported lower hospital mortality with mitral valve repair compared with MVR [1,9,11,39–42].

The Cleveland Clinic published a landmark review of 482 patients undergoing mitral valve procedures for IMR to study the influence of mitral valve procedure type on survival [1]. In this series, propensity-matched cohorts were compared: mitral valve repair ($n = 397$) vs. MVR ($n = 85$). Concomitant CABG was performed in 95% of operations, and annuloplasty for repair occurred in 98% of cases. After matching, patients were risk stratified into five quintiles. Group 1 represented the highest-risk patients with higher degrees of heart failure and emergent operations, and group 5 represented the lowest-risk patients. Subsequent survival analysis revealed that overall 5-year survival was poor for patients with IMR (58% mitral valve repair vs. 36% MVR, $P = 0.08$). Moreover, within matched quintiles, the highest-risk patients (quintile 1) had the worst survival, but survival was similar ($P = 0.4$) despite mitral valve procedure type. In contrast, survival favored mitral valve repair over replacement for quintiles III–V ($P = 0.003$).

Other series report similar results for the performance of mitral valve repair for IMR. Grossi *et al.* [2] analyzed 223 patients undergoing both mitral valve repair and MVR. Using multivariable logistic regression modeling, they concluded that early mortality was similar for the performance of mitral valve repair or replacement, and that poor outcomes were related to the burden of preoperative comorbid disease. In 2004, Reece *et al.* [11] compared outcomes in 110 patients undergoing either mitral valve repair ($n = 54$) or MVR ($n = 56$) with concomitant CABG in a 7-year retrospective review. In this series, hospital mortality was reduced among those undergoing mitral valve repair compared with MVR (1.9 vs. 10.7%), and mitral valve repair patients incurred lower rates of postoperative infections and worsening renal function. In another report, Gazoni *et al.* [6] further bolstered the performance of mitral valve repair for IMR in 350 patients ($n = 105$ IMR vs. $n = 245$ degenerative) undergoing mitral valve repair over an 8-year study period. Similar reductions (0–1+) in mitral regurgitation were observed for both groups, and hospital mortality rates were equivalent. Furthermore, studies performed by Silberman *et al.* [42] and Milano *et al.* [41] corroborate the survival advantage of mitral valve repair over MVR in the recent surgical era. Despite their significant findings, however, these studies are limited by retrospective study designs.

In the absence of published randomized trials, two recently published meta-analyses provide more robust comparisons of the influence of surgical mitral valve repair or replacement. Shuhaiber and Anderson [43] compared outcomes of 29 studies, including over 10 000 patients. Study groups were stratified based upon mitral valve etiology into ischemic, degenerative/myxomatous, rheumatic, and mixed groups. Summary analyses indicated worse overall survival for MVR (early mortality odds ratio = 2.24 and total survival hazard

ratio = 1.58) compared with repair. Mitral valve repair was also associated with lower rates of thromboembolism. Moreover, a nonsignificant trend toward lower 30-day mortality favored mitral valve repair for those with IMR. The most recent meta-analysis to date compared short-term and long-term survival of mitral valve repair vs. replacement specifically for IMR [44**]. In this analysis, nine studies were included based upon stringent exclusion criteria to ensure direct comparisons of survival for mitral valve procedures exclusively performed for IMR. Interestingly, in this series, although patients undergoing MVR were older, those undergoing repair often had higher rates of hypertension and diabetes with lower ejection fractions. Further, the proportion of patients with severe ventricular dysfunction was similar between procedure groups. These findings conflict with a common assumption that an inherent selection bias exists within published studies for the performance of mitral valve repair in healthier patients. Nevertheless, MVR was associated with worse short-term mortality (odds ratio = 2.667) and long-term mortality (hazard ratio = 1.35) compared with mitral valve repair, and the authors advocate that choice in mitral procedure should be based upon individual patient profile.

When not to repair ischemic mitral regurgitation?

Within the context of published literature and current dogma among practicing surgeons, the fundamental question of when not to repair an ischemic mitral valve remains. For several years, accumulated evidence supports the performance of mitral valve repair over replacement for the surgical treatment of functional IMR. The aforementioned benefits of repair include improved long-term survival, durability and efficacy, improved ventricular function, and avoidance of chronic anticoagulation therapy. Nevertheless, MVR still plays a select role in the treatment of IMR.

The performance of MVR appears more suited, and thus preferable to mitral valve repair, for the treatment of IMR in several circumstances. One important indication is in the presence of severe leaflet tethering or in those cases when the surgeon does not plan to surgically address the tethering as a culprit mechanism. Failure to do so will likely result in a failed repair, requiring reoperation. In addition, MVR should be considered for cases of mitral insufficiency due to complex or uncertain mechanism. These include cases involving combinations of degenerative and IMR as well as mitral valves with rheumatic involvement. Reoperation for moderate or severe mitral regurgitation following a prior repair (either at the time of primary operation or during redo) warrants valve replacement. For these patients, we believe that a good replacement is better than a bad repair. Additionally, all IMR resulting from papillary muscle rupture should undergo replacement. Although several reports describe successful reimplantation techniques, we believe that an acute failure of such a procedure may prove disastrous, and this should not be the approach of choice for inexperienced surgeons. Moreover, mitral valve repair for IMR may not be preferable for cases of severe mitral regurgitation for those surgeons who do not frequently perform mitral valve procedures. Finally, we believe that the most complex, high-risk, and sickest patients derive an important benefit from the performance of MVR over repair.

With respect to the performance of MVR, the use of bioprosthetic valves and the avoidance of mechanical valve replacement are preferred. This choice is largely driven by the avoidance of complications due to long-term anticoagulation use as well as by the belief that it is unlikely that the majority of patients requiring MVR are likely to encounter bioprosthetic deterioration in their lifetime. In addition, MVR with techniques to preserve the subvalvular apparatus should be performed when possible.

Summary

Undoubtedly, the debate regarding when to perform repair or replacement for IMR remains unsettled. In the recent era, mitral valve repair has proven efficacious and remains the preferred surgical strategy for most cases of IMR. However, a chordal sparing replacement in some circumstances is not a felony. Moreover, MVR should be considered for severe tethering, complex or uncertain mechanisms of mitral insufficiency, regurgitation due to papillary muscle rupture, and perhaps for the sickest and highest-risk patients.

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References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 168–169).

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for IMR. The authors demonstrate worse short-term and long-term mortality for MVR. Their analysis offers an up-to-date and robust comparison of these two surgical techniques.