

## Moderate mitral regurgitation in aortic root replacement surgery: Comparing mitral repair with no mitral repair

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**Objectives:** Patients often present for aortic root replacement surgery with concomitant mitral valve pathology. Moderate mitral regurgitation is the point of clinical equipoise where the benefits of intervention compared with observation are currently unknown. This study compares outcomes in patients undergoing aortic root replacement surgery who did or did not receive a mitral valve repair for their preoperative moderate mitral regurgitation.

**Methods:** A total of 1316 patients who underwent aortic root replacement surgery between 2000 and 2011 were evaluated, with 104 patients meeting the inclusion criteria by presenting with moderate preoperative mitral regurgitation. A total of 73 patients (70%) received no mitral intervention, and 31 patients (30%) received a mitral repair. Patients underwent preoperative, postoperative, and greater than 6-month follow-up echocardiograms. Average clinical follow-up was 6.5 years.

**Results:** The mitral repair group had increased preoperative New York Heart Association III/IV and heart failure, longer crossclamp times, and more postoperative renal failure ( $P = .0003$ ,  $P = .04$ ,  $P < .0001$ , and  $P = .03$ , respectively). The improvement in mitral regurgitation was greater for the mitral repair group ( $-2.1 \pm 0.3$  vs  $-1.1 \pm 0.8$ ,  $P < .0001$ ), and mitral regurgitation remained significantly lower on follow-up at 6 months or more ( $0.6 \pm 0.4$  vs  $0.9 \pm 0.2$ ,  $P = .002$ ). A significantly greater percentage of patients undergoing mitral repair compared with patients with no repair had improvement of at least 1 grade in mitral regurgitation postoperatively (100% vs 70%,  $P = .001$ ) and on follow-up at 6 months or more (90% vs 61%,  $P = .006$ ). There was no difference in long-term survival, freedom from 2+ or greater mitral regurgitation, or mitral reinterventions.

**Conclusions:** Mitral repair along with aortic root replacement has acceptable operative risk. Aortic root replacement surgery alone improved mitral regurgitation, but the addition of mitral repair further reduced mitral regurgitation, suggesting that repairing moderate mitral regurgitation should generally be considered along with aortic root replacement. (*J Thorac Cardiovasc Surg* 2014;147:938-41)

Patients frequently present with both aortic and mitral valve pathology. In published series of aortic valve replacement (AVR), as many as 61% to 90% of patients have some degree of mitral regurgitation (MR).<sup>1</sup> Patients undergoing aortic root replacements also frequently present with MR because many of the degenerative diseases of the aortic root also affect the mitral valve.<sup>2</sup> Consensus exists that severe MR requires intervention at the time of aortic intervention, but there is ongoing debate regarding the benefit of intervening on less severe MR. Recent literature also suggests that when mitral intervention is undertaken

for MR, mitral valve repairs are likely more beneficial than mitral valve replacements.<sup>3</sup> Clinical equipoise still exists whether the conservative approach of observation or the interventional approach of mitral repair is best for patients with moderate MR undergoing aortic valve intervention. This study compares echocardiographic and clinical outcomes in patients undergoing aortic root replacement surgery who did or did not receive a mitral valve repair for their preoperative moderate MR.

### PATIENTS AND METHODS

The institutional review board at the University of Pennsylvania approved the study and waived the need for patient consent. A total of 1316 patients who underwent aortic root replacement surgery between January 2000 and December 2011 were evaluated. Exclusion criteria included mitral stenosis, endocarditis, aortic dissection, and mitral replacement. A total of 104 patients met the inclusion criteria and presented preoperatively with moderate MR, defined as greater than mild (1+) and less than severe (4+). A total of 73 patients (70%) received no mitral intervention, and 31 patients (30%) received a mitral repair.

All patients underwent preoperative and postoperative echocardiograms. Preoperative transthoracic echocardiograms (TTEs) were preferentially selected for all echocardiograms to provide consistent loading conditions and comparable parameters without the confounding effect of general anesthesia on the severity of MR. Transesophageal

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**Abbreviations and Acronyms**

AVR	= aortic valve replacement
CABG	= coronary artery bypass grafting
MR	= mitral regurgitation
TTE	= transthoracic echocardiogram

echocardiograms were used when TTEs were unavailable. Preoperative TTEs had to be performed within 6 months of the date of surgery. Postoperative TTEs had to occur before the patient left the hospital. Greater than 6-month echocardiograms were obtained on 62% ( $n = 65$ ) of patients with an average echocardiographic follow-up time of 3.3 years. If more than 1 follow-up echocardiogram was available, the most recent examination was used to show the greatest degree of ventricular remodeling, hemodynamic changes, and stability of mitral repairs. Data points were extrapolated from echocardiogram reports using the MR grades of mild (1+), mild-moderate (1.5+), moderate (2+), moderate-severe (3+), and severe (4+). Median clinical follow-up was 6.5 years.

Statistical analysis was carried out using SPSS 19 (SPSS Inc, Chicago Ill). Categorical variables were compared using chi-square tests with the Fisher exact test. Continuous variables were analyzed using the Student *t* test. For comparison of changes in ordinal categories, nonparametric Mann–Whitney tests were conducted. Long-term mortality and freedom from late events were computed using Kaplan–Meier estimators and log-rank tests.

**RESULTS**

The mitral repair group had increased incidence of preoperative New York Heart Association III/IV (63.6% vs 31.5%,  $P < .001$ ) and heart failure (78.7% vs 64.3%,  $P = .04$ ). There were no other significant differences in patient characteristics, preoperative comorbid conditions, or previous cardiothoracic interventions. Operative characteristics and perioperative outcomes are detailed in [Table 1](#). The repair group had a higher percentage of mixed aortic insufficiency/stenosis than the no repair group (36.3% vs 19.1%,  $P = .047$ ). The presenting cause of mitral diseases was different for both groups, with fewer functional (45% vs 75%,  $P = .007$ ) and increased number of myxomatous (32% vs 10%,  $P = .01$ ) and rheumatic (10% vs 0%,  $P = .02$ ) mitral valves in the repair group. Crossclamp time was increased in the repair group ( $244.8 \pm 42$  vs  $179.6 \pm 50.6$ ,  $P < .0001$ ), as was postoperative renal failure (9% vs 1.3%,  $P = .03$ ) despite no difference in preoperative renal failure (3% vs 8.2%,  $P = .43$ ). There were 3 operative deaths in the no repair group and zero operative deaths in the repair group, but this difference was not statistically significant.

The mean improvement in MR was greater in the mitral repair group compared with the no repair group postoperatively ( $-2.1 \pm 0.3$  vs  $-1.1 \pm 0.8$ ,  $P < .0001$ ) and at more than 6-month follow-up ( $-1.8 \pm 0.6$  vs  $-1.3 \pm 0.5$ ,  $P < .0001$ ). Mean MR remained significantly lower on more than 6-month follow-up ( $0.6 \pm 0.4$  vs  $0.9 \pm 0.2$ ,  $P = .002$ ). A significantly greater percentage of those receiving mitral repair compared with no repair had

improvement of at least 1 grade in MR postoperatively (100% vs 70%,  $P = .001$ ) and at more than 6-month follow-up (90% vs 61%,  $P = .006$ ) ([Figure 1](#)). There was no difference in MR improvement in either group depending on the cause of the presenting MR, the type of repair, or concomitant coronary artery bypass grafting (CABG).

The long-term clinical outcomes of freedom from 2+ or greater MR were 100%,  $98.5\% \pm 1.5\%$ ,  $96.5\% \pm 2.5\%$ , and  $96.5\% \pm 2.5\%$  in the no repair group at 1, 3, 5, and 8 years, respectively, and  $93.2\% \pm 4.7\%$  for all time points in the repair group ( $P = .32$ ). Freedom from mitral interventions was 100%, 100%,  $97.9\% \pm 2.1\%$ , and  $97.9\% \pm 2.1\%$  at 1, 3, 5, and 8 years, respectively, in the no repair group and  $96.4\% \pm 3.4\%$  for all time points in the repair group ( $P = .49$ ). Survival was  $94.5\% \pm 3\%$ ,  $90.2\% \pm 4\%$ ,  $83.2\% \pm 4.7\%$ , and  $81.2\% \pm 5\%$  at 1, 3, 5, and 8 years, respectively, in the no repair group and  $93.4\% \pm 4.5\%$ ,  $90.1\% \pm 5.4\%$ ,  $90.1\% \pm 5.4\%$ , and  $67.3\% \pm 16.3\%$  at 1, 3, 5, and 8 years, respectively, in the repair group ( $P = .93$ ). There was a trend toward worse survival in the mitral repair group, although this difference is not statistically significant. There was 1 repair failure at 9 months leading to a mitral valve replacement. Two patients receiving no repair underwent mitral repair at 1 and 4.5 years after root replacement.

**DISCUSSION**

Patients frequently present with both aortic and mitral valve pathology. Management of double-valve disease remains clinically and technically challenging. The presence of MR affects operative planning for both mitral and aortic valves, because MR has been associated with decreased survival and increased mortality risk in AVR and aortic root replacement.<sup>4</sup> Some hesitancy exists to perform concomitant mitral valve interventions, because some MR has been shown to improve with AVR alone, and simultaneous aortic and mitral valve procedures have been associated with a 2-fold increase in mortality over isolated AVR.<sup>5</sup> On the other hand, unaddressed MR after AVR also has significant consequences and has been associated with increased long-term mortality.<sup>6</sup>

Consensus exists that severe MR requires intervention, but there is ongoing debate regarding less severe MR. Trace or minimal MR is mostly observed with the expectation that MR improves with aortic valve intervention alone.<sup>7</sup> Clinical equipoise exists on the best approach to the patient with moderate MR undergoing aortic intervention. A number of series have evaluated moderate MR for patients undergoing AVR, but the issue of comparing intervention with observation has yet to be explored in patients undergoing aortic root replacement. Considering the increased operative complexity of aortic root replacement and the potential for aortic root replacements to affect the aortomitral continuity, the decision to perform concomitant

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