



# Outcomes after mitral valve repair: A single-center 16-year experience

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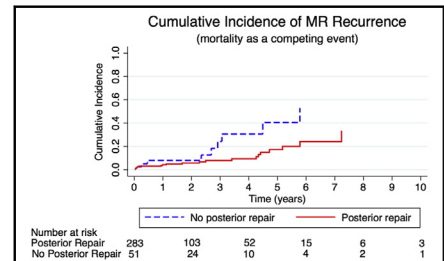
## ABSTRACT

**Objective:** To evaluate outcomes after mitral valve repair.

**Methods:** Between May 1999 and June 2015, 446 patients underwent mitral valve repair. Isolated mitral valve annuloplasty was excluded. A total of 398 (89%) had degenerative valve disease. Mean follow-up was  $5.5 \pm 3.8$  years. Postoperative echocardiograms were obtained in 334 patients (75%) at a mean of  $24.3 \pm 13.7$  months.

**Results:** Survival was 97%, 96%, 95%, and 94% at 1, 3, 5, and 10 years. Risk factor analysis showed age  $>60$  years and nondegenerative etiology predict death (hazard ratio, 2.91; 95% confidence interval, 1.06-8.02,  $P = .038$ ; and hazard ratio, 1.87; 95% confidence interval, 1.16-3.02,  $P = .010$ , respectively). Considering competing risks due to mortality, the cumulative incidence of reoperation was 2.8%, 4.2%, 5.1%, and 9.6% at 1, 3, 5, and 10 years. Competing risk proportional hazard survival regression identified nondegenerative etiology and previous cardiac surgery as predictors of reoperation, and posterior repair was protective (all  $P < .05$ ). Cumulative incidence of progression of mitral regurgitation (2 or more grades) with mortality as a competing risk was 4.7%, 10.5%, 21.0%, and 35.8% at 1, 3, 5, and 10 years. Patients with previous sternotomy, repair or coronary artery bypass grafting, and concurrent tricuspid valve procedure or isolated anterior leaflet repair were more likely to develop progression of mitral regurgitation (all  $P < .05$ ), and posterior leaflet repair was protective ( $P = .038$ ). On multivariate analysis diabetes, previous coronary artery bypass grafting and concurrent tricuspid valve intervention predicted MR progression.

**Conclusions:** Mitral valve repair has excellent outcomes. Our results demonstrate failures appear to occur less in those who undergo posterior leaflet repair. (*J Thorac Cardiovasc Surg* 2017;154:822-30)



Cumulative incidence of progression of mitral regurgitation by posterior leaflet repair.

### Central Message

Mitral valve repair is associated with excellent survival, reoperation rates, and durability, especially in those undergoing posterior leaflet repairs.

### Perspective

Recurrence of mitral regurgitation after mitral valve repair is associated with increased morbidity and mortality. Current outcomes with mitral valve repair are excellent particularly in those who require posterior leaflet repairs. We should consider these surgical results in an era of potential increased application of percutaneous mitral valve therapy.

See Editorial Commentary page 831.

Mitral valve repair is accepted widely to improve survival and quality of life.<sup>1,2</sup> Rates of reoperation and the progression of mitral regurgitation (MR) after mitral valve repair vary widely. In addition, numerous studies demonstrate a persistent failure rate after repair inherently

related to the inability of surgery to correct the underlying disease process.<sup>3-16</sup> The Brigham and Women's Hospital group reported a 20-year incidence of mitral reoperation of 18%, whereas the Toronto group reported a reoperation rate of only 5.9%.<sup>6</sup> Recurrence of moderate-to-severe MR

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### Abbreviations and Acronyms

CI	= confidence interval
HR	= hazard ratio
MR	= mitral regurgitation
SHR	= subhazard ratio
TTE	= transthoracic echocardiography
USC	= University of Southern California

Scanning this QR code will take you to a procedural video, supplemental figure, and tables for this article.



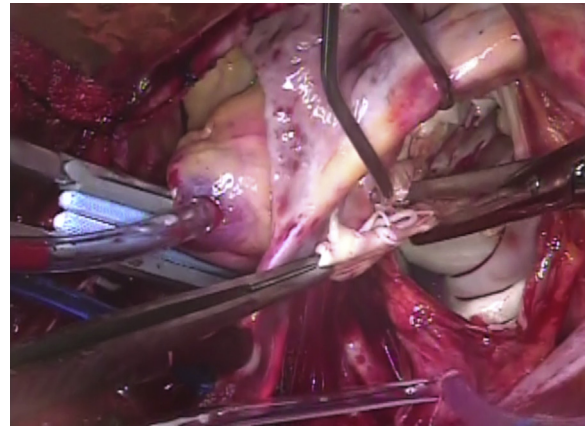
at 20 years in the latter study was 30.8%, whereas the Mayo clinic group recently reported a 15-year incidence of significant recurrent MR of 13.3%.<sup>6-8</sup> Risk factors for the recurrence of MR after mitral valve repair vary greatly but most consistently include factors such as presence of anterior or bileaflet pathology, absence of posterior leaflet pathology, lack of an annuloplasty ring, and longer cardiopulmonary bypass times.<sup>6-9</sup>

We sought to examine outcomes of mitral valve repair and analyze risk factors for death, reoperation, and progression of MR. An analysis of this nature is especially timely, given the increasing adoption of percutaneous mitral valve repair and replacement technology.

## MATERIALS AND METHODS

This study was conducted in accordance to the “Guidelines for reporting mortality and morbidity after cardiac valve interventions.”<sup>17</sup> This was a systematic retrospective cohort study of consecutive patients undergoing mitral valve repair at the University of Southern California (USC; formerly USC University Hospital, now Keck Hospital of USC) between May 1999 and July 2015. The follow-up period closed July 2016. Mitral valve repair was defined as mitral valve reconstruction with or without an annuloplasty ring. Patients who underwent isolated mitral valve annuloplasty for the treatment of MR were excluded. Patients undergoing other concomitant cardiac procedures were included. The institutional review board of the University of Southern California Health Sciences Campus approved this study (HS-15-00509) and waived the requirement for patient consent. The senior author performed 85% of the procedures.

Patients, baseline demographics, operative characteristics, and perioperative outcomes were identified through the USC Cardiac Surgery Research Database and our Society of Thoracic Surgeons Adult Cardiac Database. Subsequent outcomes (follow-up transthoracic echocardiograms [TTEs], need for reoperation, and mortality) were collected actively and passively. All available medical records from our electronic medical record and the referring providers were reviewed. Recurrent MR was assessed from the report of an institutional or outside facility echocardiogram. Reoperation is defined as a repeat operation to the mitral valve, ie, second mitral valve repair or mitral valve replacement. No patient received a mitral valve clip or valve in band. Mortality was confirmed through direct patient, family, or provider contact; a search of local obituaries; and through access



**VIDEO 1.** Minimally invasive mitral valve repair of myxomatous disease. P2 is resected, folding valvuloplasty of P1 and P3 is performed, followed by reconstruction of the posterior leaflet. A neochord is placed to A1, which is secured after placement of a partial annuloplasty ring and distension of left ventricle to ensure proper neochordal height. Video available at: [http://www.jtcvsonline.org/article/S0022-5223\(17\)30185-X/addons](http://www.jtcvsonline.org/article/S0022-5223(17)30185-X/addons).

of the Social Security Death Index in collaboration with the University of California at San Francisco Clinical Translational Science Institute. Follow-up TTEs were not obtained at fixed time points but at the discretion of the physician.

The primary endpoints were mortality, need for mitral valve reoperation, and the progression of MR. MR was coded 0 to 4 based on echocardiogram reports (0 = none, 1 = trace, 2 = mild, 2.5 = mild-to-moderate, 3 = moderate, 3.5 = moderate-to-severe, 4 = severe). Progression of MR was defined as worsening of MR by more than 2 grades. As a secondary assessment, the incidence of grade 3.5 or 4 (moderate-to-severe or severe) MR over time was included.

Patients with partial follow-up were included; however, only patients with mortality data were included in the analysis of mitral reoperation or recurrence. Patients were censored from further recurrence analysis on the event of reoperation.

Surgical approach was either full sternotomy or minimally invasive right thoracotomy as per surgeon's preference. The mitral valve typically was accessed via the interatrial sulcus, although transeptal and left atrial dome approaches also were used. Peripheral cannulation was used for the minimally invasive approach. Posterior leaflet mitral valve repair generally involved resection of the diseased segment, annular plication, and reconstruction of the posterior leaflet (Video 1). The anterior leaflet was repaired by the placement of polytetrafluoroethylene neochordae (W. L. Gore & Associates, Inc, Flagstaff, Ariz) or resection and reconstruction. A true-sized, partial posterior mitral valve annuloplasty primarily was used.

## Statistical Analysis

Preoperative and operative characteristics were summarized. For mortality, Cox proportional hazards regression was used to estimate and test associations of variables with time-to-event; Kaplan-Meier survival curves were used and comparisons between groups were made by log-rank tests. Statistical analysis of time to reoperation and MR recurrence considered mortality as a competing risk event. Nonparametric estimates of cumulative incidence (probability of reoperation or MR recurrence) were calculated.<sup>18</sup> Survival regression used competing risks analysis with the Fine-Gray model<sup>19</sup>; results are presented as subhazard ratios (SHRs) and 95% confidence intervals (CIs). Characteristics that were associated with time-to-event at  $P < .10$  on univariate analysis were selected for

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