Mitral Valve Re-repair

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Background and aim of the study: **Between January 1998 and March 2004, a total of 1,596 mitral valve repairs was performed at the authors' institution. Among these operations, 23 constituted re-repair of previously repaired mitral valves. The cases were analyzed retrospectively to ascertain the etiology of the failed repair, the technical considerations of re-repair, and outcome.**

Methods and Results: **Previous repairs were performed for myxomatous valve disease in 14 of 23 patients. In seven patients recurrence occurred within three months of the original procedure (two as a result of infective endocarditis and five after technical failure). Incorrect annuloplasty ring size or failure to use a ring, resulting in progressive annular dilatation with or without new valvular dysfunction, were the main causes of delayed recurrence of mitral regurgitation (i.e. more than one year after the original repair procedure). Most patients (n = 12) required a new annuloplasty ring and additional repair procedures. Two patients died within the immediate postoperative period, and five died subsequently from non-cardiac causes during a mean follow up period of 24 months. Among the remaining 16 patients, 13 were free from mitral regurgitation at follow up and two required subsequent mitral valve replacement.**

Conclusion: **Re-repair of the mitral valve is a technically feasible operation that can be safely performed with good functional results. It is, however, associated with some increase in postoperative morbidity and mortality due to the reoperative setting.**

The Journal of Heart Valve Disease 2005;14:583-587

Mitral valve repair is currently the standard of care for most etiologies of mitral valve disease. A variety of techniques has been developed for mitral valve repair, most of which are reproducible and lead to a durable and lasting result. Mitral valve repair improves long-term survival, preserves ventricular function, and provides greater freedom from endocarditis, thromboembolism and hemorrhage. Although, infrequently, mitral valve repair can fail, this does not necessarily indicate the need for mitral valve replacement at reoperation. An analysis of the underlying valve defects and previous repair at reoperation can permit re-repair of the valve if the anatomic and functional elements allow. To this end, those patients who required re-repair of the mitral valve at the authors' institution were analyzed, the aim being to better understand the etiologies of failed repair and to establish the technical feasibility of re-repair.

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Materials and methods

Patient population

Between January 1998 and March 2004, a total of 1,596 mitral valve repairs was performed at the Division of Cardiac Surgery at the Brigham and Women's Hospital. Among this cohort, 23 patients (16 males, seven females; median age 60 years; range: 13 to 86 years) underwent re-repair of the mitral valve. The primary cause of the mitral regurgitation was myxomatous in 14 patients, while four were ischemic and two were rheumatic. One patient was cardiomyopathic, one was traumatic, and one had a congenital cleft mitral valve. All patients had severe (grade 3 to 4+) mitral regurgitation.

Seven of the 23 patients (30%) had early failure of their original repair and recurrence of mitral regurgitation within three months of the initial procedure. Two of these failures were due to infective endocarditis, in one patient there was dehiscence due to the annuloplasty ring being too small, one patient had incorrect annuloplasty ring placement with leaflet perforation, one had an anterior leaflet perforation due to aggressive debridement, one had mitral stenosis subsequent

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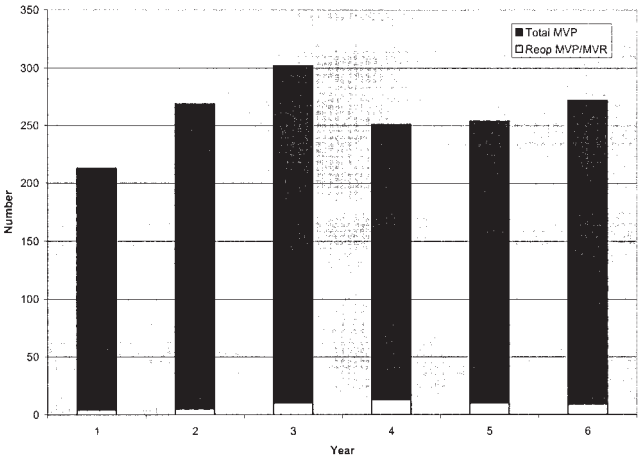

Figure 1: Linearized rate of reoperation at the authors' institution for mitral valve re-repair or replacement (1988-2003).

to an edge-to-edge repair, and one had hemolysis from prosthetic neochordae.

Sixteen patients (70%) had a delayed recurrence of mitral regurgitation (more than one year after the original procedure). Decisions regarding the use of annuloplasty rings played a prominent role in determining recurrence: four patients had no ring at the previous operation, five had rings that were too small and dehisced, and four had rings that were too large. Seven patients had progression of myxomatous disease pathology, three had progressive annular dilatation, and five had other findings such as leaflet perforations or dehiscence of repair.

The linearized rate of reoperation for re-repair or replacement ranged from 1.8 to 5.4% per year (average 3.4% per year) (Fig. 1).

The collection of data for the purpose of this study (Protocol # 2002-P-002027/1; BWH) was approved by The Brigham and Women's Hospital Institutional Review Board.

Surgical approach

All patients were operated on under general anesthesia. Intraoperative transesophageal echocardiography (TEE) was performed to delineate the mitral valve pathology before surgery, and adequacy of repair after the procedure. All procedures were performed using standard cardiopulmonary bypass (CPB) after full systemic heparinization. A median sternotomy approach was used for most patients, although a right thoracotomy was used in two patients who had multiple patent coronary bypass grafts, including a patent left internal mammary artery-to-left anterior descending (LIMA-LAD) artery graft. For a median sternotomy, the patient was cooled to 28°C and the procedure performed after aortic cross-clamping and administration of antegrade and retrograde cardioplegia. For a right thoracotomy, the patient was placed on bypass by peripheral cannulation, cooled to 25°C, and the procedure performed on a fibrillating heart without aortic cross-clamping. The mitral valve was approached through either the left or right atrium (trans-septal approach) depending on surgeon preference, the presence of adhesions, the approach used during previous surgery, and any need for additional procedures. The re-repair techniques utilized for early recurring mitral regurgitation (n = 7) are listed in Table I, while those for late recurring mitral regurgitation (n = 16) are listed in Table II. All patients were weaned off CPB in standard fashion, and TEE was used to evaluate intracardiac air removal.

Results

All patients left the operating room without mitral regurgitation, no mitral stenosis, and no systolic anterior motion of the anterior mitral leaflet at the end of the procedure, as documented by TEE.

There were two in-hospital mortalities. One patient died from a cerebrovascular event on postoperative day 7, and one from sequelae of sepsis on postoperative day 19. One patient was reoperated on for postoperative bleeding, and two other patients had non-fatal neurological events, with no adverse sequelae.

Re-repair in early recurrent patients

In two patients who had infective endocarditis the valve was debrided and the leaflets repaired in both cases. In one of these patients, annular stabilization was carried out with a glutaraldehyde-fixed pericar-

Table I: Early recurrence of mitral valve regurgitation.

Patient no.	Cause of early recurrence	Re-repair technique
1	Infective endocarditis	Debridement and pericardial ring annuloplasty
2	Dehiscence of a small ring	Larger ring
3	Hemolysis with neochordae	Excision of neochordae and Alfieri suture
4	Stenosis of valve	Removal of Alfieri suture
5	Perforation of anterior leaflet	Pericardial patch of the anterior leaflet
6	Infective endocarditis	Debridement
7	Large ring and leaflet perforation	Repair of leaflet perforation, leaflet resection and smaller ring

dial ring. One patient had dehiscence of a small rigid ring, which was replaced with a larger rigid ring, and another had problems with a larger flexible ring which resulted in leaflet perforation. This problem was repaired by leaflet resection and placement of a smaller flexible ring. A pericardial patch was used to fix a perforation in the anterior leaflet of one patient. Finally, one patient had obstructive problems arising from an Alfieri edge-to-edge repair, which resolved upon release of the suture. Another patient had hemolysis due to the neochordae, which were replaced by an Alfieri suture (Table I).

Re-repair in late recurrent patients

Four patients who received no ring at previous surgery required annuloplasty rings. Five patients had annuloplasty rings placed at previous surgery that were too small, and these were replaced with larger rings. Three patients who presented with mitral regurgitation had annuloplasty rings that were too large, and these were replaced with smaller rings. Five of the eight patients needing new rings had previously placed flexible rings, emphasizing that it was the technical faults that led to ring failure rather than the type of ring itself. Patients with smaller annuloplasty rings presented more commonly with dehiscence of the posterior annulus, while those with larger rings presented with central regurgitation. Twelve patients required leaflet surgery, which included leaflet resection, obliteration of clefts, or commissuroplasty. Six patients required an edge-to-edge repair (Table II).

Late follow up

Thirteen (61%) of the 21 patients who survived surgery remained well and free of mitral regurgitation at follow up (mean 24 months). During the follow up period, five patients died from non-cardiac causes (one each from renal failure, respiratory failure and unrelated neurological disease; two patients from other unrelated infections). Two patients required subsequent mitral valve replacement for failure of mitral valve re-repair.

Discussion

Although, originally, mitral valve replacement was considered to be the standard surgical treatment for all types of mitral valve disease, the deleterious effect of excision of the valvar and subvalvar apparatus has long been recognized (1). Since the introduction of mitral valve repair techniques by Carpentier in 1971, mitral valve repair has evolved, and has become the

Table II: Late recurrence of mitral regurgitation (MR).

Patient no.	Cause of late recurrence	Re-repair technique
1	Dehiscence of previous repair and annular dilatation. No previous ring	Commissuroplasty and placement of a new ring
2	Progressive annular dilatation. No ring	New ring annuloplasty
3	Large ring. Central MR	Alfieri suture
4	Dehiscence of a small ring. Dehiscence of posterior leaflet	Repair of posterior leaflet and larger ring
5	No ring. Progression of myxomatous disease (P3)	New ring. Leaflet resection, cleft repair and Alfieri suture
6	Progressive annular dilatation. Large ring	Smaller ring
7	Ruptured chord	Alfieri suture
8	Dehiscence of small ring	Larger ring and cleft repair
9	No ring. Progression of myxomatous disease	New ring. Leaflet resection and repair
10	Dehiscence of a small ring. Progression of myxomatous disease	Larger ring. Obliteration of P3 and commissuroplasty
11	Small ring. Progression of myxomatous disease	Larger ring. Alfieri suture repair and cleft repair
12	Dehiscence of ring. Leaflet perforation	Repair of perforation and larger ring
13	Progression of myxomatous disease	Cleft repair and Alfieri suture
14	Robotic inadequate resection and larger ring	Leaflet resection and smaller ring
15	Progression of myxomatous disease	Commissuroplasty and Alfieri suture repair
16	Large ring and leaflet perforation	Repair of perforation and smaller ring

J Heart Valve Dis
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September 2005

standard of care in most cases of mitral regurgitation (2). Reparative techniques have been shown to be superior to replacement because they improve long-term survival, preserve left ventricular function, and provide greater freedom from endocarditis, thromboembolism and hemorrhage (3,4). Mitral valve repair has also been shown to be associated with lower morbidity and mortality compared with replacement (5). Among the various causes of mitral regurgitation, myxomatous degeneration is the most common in the Western hemisphere (6). Over 90% of cases of mitral valve degenerative disease can be repaired (7,8), and mitral valve repair techniques are now considered as standard, easily reproduced, and widely disseminated. Moreover, the widespread adoption of reparative techniques has accelerated since the advent of minimally invasive procedures (9).

Gillinov, Cosgrove and colleagues (7,10) have suggested that the risk of recurrent mitral valve disease requiring reoperation is higher with anterior leaflet prolapse, use of chordal shortening, and failure to use an annuloplasty ring. In the present series, it was confirmed that the lack of an annuloplasty ring or use of an inappropriately sized annuloplasty ring contributed to failed repair in 60% of patients. Eishi (11), in his review, suggested that incomplete repair, tissue injury on the sutured portion, recurrent annular dilatation, reprolongation of chordae, and hemolysis were the primary reasons for mitral valve reoperation.

Recurrent mitral valve regurgitation can develop from a variety of technical causes, but these do not preclude mitral valve re-repair. Studies by Gillinov et al. (12) and Cerfolio et al. (13) have shown that mitral valve re-repair can be successfully performed with relatively low mortality and morbidity - a finding also demonstrated in the present investigation. In the same study, Gillinov et al. (12) showed that recurrent mitral regurgitation is procedure-related in degenerative disease and valve-related in rheumatic disease.

The right thoracotomy approach to the mitral valve is an alternative to sternotomy, and may be the procedure of choice in patients who have patent coronary bypass grafts, especially the LIMA-LAD graft, to avoid injury to these grafts. This approach has been summarized in a study from the present authors' institution (14,15), and was used in two of the present patients.

The techniques of mitral valve repair performed during reoperation are the same as those used during a primary procedure. These include leaflet resection, sliding valvuloplasty, commissuroplasty, chordal transfer, neochord placement and annuloplasty. The Alfieri edge-to-edge repair technique is a useful tool for complex reconstructions, although its use as a solitary repair technique and/or for rescue procedures, including patients with annular calcification or rheumatic disease, has been shown to produce poor results (16). In the present study, this repair technique was used in six patients who presented with delayed mitral regurgitation. In five of these cases, the method was used in conjunction with other techniques, and all patients received an annuloplasty ring.

Mitral valve repair is a safe and durable operation for myxomatous mitral valve disease when correctly performed, and if several important principles are borne in mind. Adequate leaflet resection and attention to all aspects of leaflet pathology at the initial operation are elements of paramount importance. All leaflet repairs should be stabilized with an annuloplasty ring, the size of which is critical and should be determined by the height of the anterior leaflet rather than the intercommissural distance. In patients with degenerative disease it is better to upsize the ring rather than to downsize, since in the present authors' experience most recurrences occur with smaller rings. To achieve adequate repair when using partial annuloplasty bands, the end of the band should be sutured about 2 mm beyond the trigone. Using only the intercommissural distance to determine ring size may result in an inappropriately sized ring. Anchoring the ends of a partial flexible annuloplasty band at the commissures will result in early failure, as occurred in some of the present patients, whilst anchoring the ring to the commissures may allow further annular dilatation over time. Although adherence to these principles can prevent recurrent mitral regurgitation in most patients, there will always be a subgroup with ongoing myxomatous changes who develop new disease over time. When patients present with recurrent mitral regurgitation after repair, replacement is not necessarily indicated. The mitral valve should be evaluated thoroughly and re-repair considered, particularly if the cause of the regurgitation is an incorrectly sized annuloplasty ring.

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Erratum

Twenty-Eight-Year Survival of Stent-Mounted Aortic Homograft in the Mitral Position: Case Report
Ganapathy Subramaniam, Ujjwal K. Chowdhury, Sandeep Seth, Somnath Prusty, A. Sampath Kumar
The correct page number of the above article in the July 2005 is *The Journal of Heart Valve Disease 2005;14:559-562*