

# A New Approach to Mitral Valve Repair for Rheumatic Disease: Preliminary Study

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**Background and aim of the study:** The initial application of repair to rheumatic mitral disease was fraught with unacceptable recurrence rates. For this reason, rheumatic valves primarily have been replaced in recent years. Early and late outcomes with replacement, however, have continued to be suboptimal, prompting a re-examination of repair.

**Methods:** All eight patients encountered by the authors with rheumatic mitral valve disease over the past three years were considered for valve repair. One patient had pure stenosis, three patients had pure regurgitation, and four had advanced forms of mixed stenosis and regurgitation. Because posterior leaflet retraction was a prominent and almost uniform feature of rheumatic disease, posterior leaflet glutaraldehyde-fixed autologous pericardial gussets were placed in all cases. In the five patients with stenosis, commissural calcium was debrided, the thickened chords to the anterior leaflet were resected, extended commissurotomies performed, and an anterior leaflet 'hinge' mechanism restored. The anterior leaflet then was reattached to the base of the

papillary muscles using Gore-Tex artificial chords, and all eight patients had full ring annuloplasties.

**Results:** Postoperatively, all patients had negligible gradients and no residual leak. The first patient (with mixed stenosis and regurgitation) was restudied with transesophageal echocardiography after three years, and had continued excellent valve function. There have been no intermediate-term recurrences, complications or mortalities. Operative videos and echocardiograms from these patients are available at [JScottRankinMD.com](http://JScottRankinMD.com).

**Conclusion:** A combination of pericardial posterior leaflet gusset, anterior leaflet chordal resection/Gore-Tex replacement, extended commissurotomy and full ring annuloplasty allows the repair of rheumatic valves over a full range of pathologies. Early and intermediate-term results appear satisfactory. Continued aggressive application of this type of repair to rheumatic mitral disease seems to be indicated.

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Reparative procedures have become the mainstay of mitral valve surgery, increasing to 70% of all isolated mitral valve operations in North America in recent years (1). As compared to prosthetic replacement, valve repair is associated with a lower operative mortality, better durability, and improved long-term survival (2-5). Upon examining simultaneous repair and replacement procedures in a single practice over the past decade (6), mortality after replacement continued to be significantly higher than after repair, despite identical myocardial protection and perioperative care. Over that period, repair was uniformly used for prolapse, pure annular dilatation and ischemic etiologies

(7), so that valve replacement patients primarily had rheumatic disease and endocarditis. Thus, given the suboptimal replacement outcomes, an effort was made to devise a more effective repair for rheumatic mitral valve disease. The results of that effort form the subject of this report.

## Clinical material and methods

### Concept of rheumatic repair

Many previous applications of repair to rheumatic valves have been fraught with unacceptable recurrence rates (8-12). In most cases, commissurotomy was used either alone or in combination with simple ring annuloplasty, and up to one-third of patients required reoperation in the intermediate term. The primary causes of recurrence were: (i) worsening mitral regurgitation due to continued scarring and retraction of the posterior leaflet; and/or (ii) persistent or worsening of

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submitral valvar obstruction and anterior leaflet immobility. Although Frater first described pericardial leaflet augmentation for the management of retracted posterior leaflet in 1964 (13), with further contributions being made by Carpentier's group in 1991 (14), very few surgeons - at least in the United States - have adopted the procedure. This technique offered the potential for treating posterior leaflet retraction in selected patients, based on published late follow up data (15).

In considering rheumatic chordal abnormalities, Gore-Tex artificial chordal replacement also was described by Vetter and Frater (16), and recently has become established for the management of chordal disease in prolapse (17-24). In considering options in rheumatic valves, this method offered the potential for the treatment of submitral chordal fusion and retraction. Therefore, these methods were combined with extended commissurotomy, calcium debridement and full ring annuloplasty in an attempt to more comprehensively repair the full spectrum of rheumatic mitral valves. It should be emphasized that none of these procedures actually is 'new', but was originated by multiple groups over the past three to four decades. However, the techniques were combined in an effort to better manage rheumatic mitral valve disease, and the application of artificial chords to rheumatic pathology is novel.

### Patients and operative procedure

Over a three-year period beginning in January 2005, eight consecutive patients with rheumatic mitral valve disease were referred for surgical therapy. The baseline and operative characteristics of patients are listed in Table I. Four patients had advanced forms of mixed stenosis and regurgitation, one patient had pure mitral stenosis, and three patients had pure regurgitation. Each patient received a prophylactic amiodarone anti-arrhythmic protocol perioperatively (25), and all were approached via a median sternotomy, standard cardiopulmonary bypass (CPB), bicaval cannulation, antegrade St. Thomas' Hospital cold potassium cardioplegia, and the Daily heart jacket for topical hypothermia. All patients were managed with valve repair. In those patients with stenosis, the initial step was commissural calcium debridement, sometimes using the Cavitron ultrasonic debridement device, and extended commissurotomy to the annulus.

Each patient manifested a scarred retracted posterior leaflet, and the valve procedure progressed to the insertion of a glutaraldehyde-fixed autologous pericardial gusset (Fig. 1). The posterior leaflet was incised 2 mm from (and parallel to) the annulus, leaving short segments of leaflet intact at the commissures. Autologous pericardium was immersed in 0.6% glu-



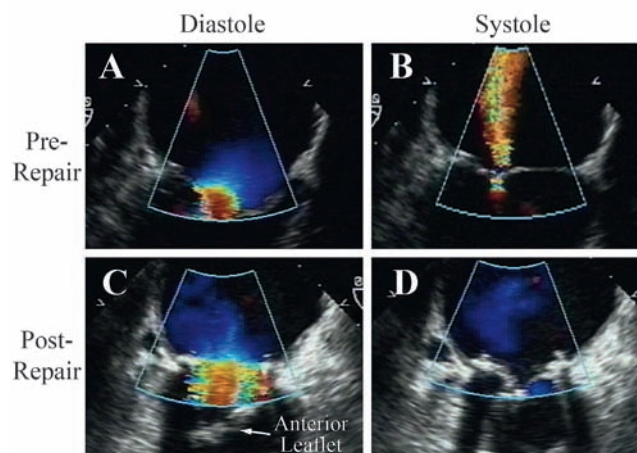
Figure 1: The completed procedure, showing the pericardial posterior leaflet gusset, Gore-Tex artificial chords in the anterior leaflet, and full rigid ring annuloplasty.

taraldehyde for 10 min, and then rinsed thoroughly three times in magnesium sulfate solution. One edge of the patch was fashioned with a gentle curve and sutured to the posterior aspect of the leaflet incision with a running 5-0 Prolene suture, beginning at the center and proceeding to each corner. The anterior margin of the patch then was trimmed to size, and the anterior suture line completed similarly, tying to the posterior suture at each commissural corner. In the three pure regurgitation patients, this was the only leaflet procedure required. Occasional patients have asymmetric scarring and retraction of the posterior leaflet; in these cases the patch is made wider and extended more to the commissure in the more severely affected area. Additionally, some will have scarring and retraction of adjacent anterior leaflet chords, contributing to the insufficiency. In this situation, the affected anterior leaflet chord is resected and replaced with an artificial chord (see below).

In the five stenosis patients, the submitral apparatus was thickened, scarred and retracted, and exhibited calcification or direct insertion of the leaflet into the papillary muscle heads. The attachments of the anterior leaflet were resected from the papillary muscles, taking care to preserve posterior leaflet support. All primary and secondary chords to the anterior leaflet were divided. Further calcium was debrided from the endocardium of the anterior leaflet, and gradually, a satisfactory appearing anterior leaflet emerged. If

excessive scarring was present on the under-surface of the leaflet at the sites of thickened chordal insertions, the fibrous tissue was trimmed until a pliable anterior leaflet was developed, with a good 'hinge' or trap-door mechanism. Pledged anchor sutures then were placed into the bases of both papillary muscles; 2-0 Gore-Tex artificial chords were passed through the anchor pledgets and left untied, and the chords were stuffed into the ventricle for later retrieval (22).

A full rigid ring (CarboMedics AnnuloFlow) then was inserted into the mitral annulus using horizontal mattress sutures of Teflon-coated 2-0 braided suture, buttressed with supra-annular Teflon felt pledgets. A full rigid ring was employed to overcome rigidity of the annulus in rheumatic disorders, and to achieve a permanent 7:10 Carpentier annular shape. After ring placement, the two chords were retrieved and woven into the front 'corners' of the rectangular-shaped anterior leaflet in three full-thickness bites: free edge, surface of coaptation, and through the line of coaptation, emerging onto the atrial surface. The chords were tied at the annular plane with temporary slip knots, after which the valve was tested by injecting cold saline across the valve and into the ventricle. The slip knots were adjusted incrementally by shortening or lengthening by 1 cm (22), until the valve was completely competent with good left-to-right and anterior-posterior leaflet symmetry (Fig. 1). Three patients with chronic atrial fibrillation also underwent concomitant Cox-maze IV procedures (26). All three had tricuspid valve repairs using Carpentier ring annuloplasty, and two had coronary bypass. The average CPB time was 220 min (range: 179-268 min) and the average aortic cross-clamp time 185 min (range: 152-223 min). All patients were continued on secondary rheumatic prophylaxis, as well as endocarditis prophylaxis when



*Figure 2: Intraoperative transesophageal echocardiogram of a valve with mixed rheumatic mitral stenosis and regurgitation. Echocardiograms are shown during diastole and systole, and before and after repair (patient #5). After repair, the anterior leaflet opens widely, with laminar diastolic flow, minimal gradient and complete competence.*

indicated. All were treated with aspirin for anticoagulation in the long term.

Each patient and his/her family was informed pre-operatively about the limited follow up information available regarding this repair, as well as the general advantages and disadvantages of valve repair versus replacement. All patients signed an informed consent for the procedure, as well as a specific informed approval for scientific follow up and public presentation of their data. Additionally, this retrospective study was exempted by the Western Institutional Review Board for Centennial Medical Center, Nashville, TN, USA.

*Table I: Baseline and operative characteristics of patients.*

Patient no.	Age (years)	Gender	EF (%)	Status	Valve lesion(s)	Preop. rhythm	Procedure				
							PG	ACR	Com	TVR	CAB
1	57	F	45	E	MR/MS	NSR	Y	Y	Y	N	N
2	74	F	50	E	MR/TR	AF	Y	N	N	Y	N
3	55	F	55	A	MS	NSR	Y	Y	Y	N	N
4	67	M	50	E	MR	AF	Y	N	N	N	N
5	68	M	40	E	MR/MS	AF	Y	Y	Y	N	N
6	57	M	45	A	MR/TR	NSR	Y	N	N	Y	Y
7	67	F	40	A	MR/MS/TR	NSR	Y	Y	Y	Y	Y
8	44	F	60	E	MR/MS	NSR	Y	Y	Y	N	N

A: Acute presentation; ACR: Artificial chordal replacement; AF: Atrial fibrillation; CAB: Coronary artery bypass; Com: Commissurotomy; E: Elective; EF: Ejection fraction; MR: Mitral regurgitation; MS: Mitral stenosis; NSR: Normal sinus rhythm; PG: Posterior leaflet pericardial gusset; Status: Emergency status; TR: Tricuspid regurgitation; TVR: Tricuspid valve repair.



## Results

All patients achieved a completely competent valve intraoperatively, based on post-bypass transesophageal echocardiography (Fig. 2). The posterior leaflet pericardial gusset seemed to provide an extra surface area of coaptation and an ample 'margin of safety', even in the most severely diseased valves. The anterior leaflet moved more normally, being unencumbered by thickened chordal insertions or endocardial calcium. Minimal immediate postoperative gradients were observed in most patients, but in two with a high cardiac output a mean diastolic gradient in excess of 10 mmHg was calculated. Both of these had resolved by the one-week transthoracic echocardiogram, which suggested that operative gradients could be overestimated and should be managed expectantly in most cases. It became apparent that, in stenosis patients, the anterior leaflet Gore-Tex chords should be attached away from the papillary tips, and toward the bases of the papillary muscles. Because the native chords were foreshortened in these patients, artificial chordal reattachment to the papillary tips tended to produce very short Gore-Tex chords, and a limited opening of the valve (although this was not a significant problem in any patient). However, postoperative anterior leaflet mobility and valve opening were much better when the artificial chords were longer, and attached toward the papillary bases.

Seven of the eight patients had no complications. One seriously ill, elderly, obese diabetic female, who also required tricuspid repair and coronary bypass, developed refractory pulmonary dysfunction/multiorgan failure syndrome, preventing extubation, and associated with a rising serum creatinine, falling platelet count and a low IgG level of 350 mg/dl (lower limit of normal = 650 mg/dl). This patient was treated with intravenous immunoglobulin (27), and made a prompt and full recovery. No other complications occurred, and all eight patients recovered uneventfully. The three patients who underwent the maze procedure converted to sinus rhythm. At present, all patients are in NYHA class I or II for congestive heart failure, while routine yearly echocardiography has demonstrated stable and continued good valve function with no recurrences to a maximal follow up of four years (two years).

## Discussion

The advent of repair for mitral valve disease has improved patient outcome significantly. However, procedural refinement does seem to be an on-going process, and artificial chordal replacement and pericardial leaflet augmentation clearly have extended the

application of repair in recent years (28-30). More effective attention to chordal pathology also may be important in rheumatic mitral repair (31,32). Interestingly, rheumatic valves have constituted 21% of the present authors' practice over the past decade, but management of these patients with prosthetic valve replacement has continued to carry a 5-10% operative mortality, at a time when mortality for valve repair was approaching zero (6). It was hypothesized that the development of more effective repairs for rheumatic disease could bring these patients into the repair prognostic category, with low operative mortality and excellent long-term results. Especially in younger patients, who otherwise would require mechanical valve insertion, repair could avoid the consequences of warfarin anticoagulation or the higher incidence of late endocarditis. In patients having a limited follow up or anticoagulation potential, repair could be a much better option than the use of tissue valves (33,34), which have high failure rates in the mitral position. Assuming that the technique described herein continues to be stable in the long term, a uniform method of repair for most types of rheumatic mitral valve disease would be quite useful. The ability to take one of the very worst categories of mitral valve disease (calcified, stenotic and insufficient rheumatic valves with chronic atrial fibrillation) and to convert the patients to a stable and normal functioning native valve, in sinus rhythm, and only receiving aspirin anticoagulation, is gratifying indeed.

This series, however, will clearly require a longer follow up and more experience to establish the technique as a standard option. One might suggest, though, that the less satisfactory results observed with prosthetic valve replacement, together with the good intermediate-term outcomes in the present series, support the continued application and refinement of repair in rheumatic disease. It is possible that the establishment of good motion of the anterior leaflet will minimize late commissural re-fusion, and chordal replacement procedures also seem to hold up quite well (22,35,36). Although the pericardial gusset might calcify in this setting, the posterior leaflet would function as a fixed baffle, the anterior leaflet coaptation in most patients, and so calcification might not prove serious. Together with the application of chordal replacement and pericardial reconstruction in endocarditis patients (37-39), these techniques offer the potential of increased repair rates for all mitral valve disease etiologies towards 100% (6,40). These are complex and lengthy procedures, requiring advanced myocardial protection techniques. The availability of the Daily hypothermia jacket has clearly facilitated the development of complex valve repair, and is essential for obtaining these types of uniformly good results. Clearly, a better

assessment of valve repair versus replacement in rheumatic disease could be obtained with a randomized trial, although such a study is unlikely to occur in the United States, because of recruitment difficulties and the low incidence of rheumatic disorders. It might be suggested that the excellent healthcare systems in developing countries such as India, having a higher incidence of rheumatic disease, could readily undertake such a study.

*In conclusion*, a method incorporating decalcifying commissurotomy, posterior leaflet pericardial augmentation, anterior leaflet chordal resection/Gore-Tex replacement and full ring annuloplasty shows promise for increasing the applicability of repair to rheumatic disorders. The intermediate-term results have been quite satisfactory, and support the continued use of this procedure. A randomized trial of valve repair versus prosthetic replacement is suggested for rheumatic mitral disease. Videos and echocardiograms from four of these patients are available at: JScottRankinMD.com.

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