Anterior Leaflet Augmentation with Autologous Pericardium for Mitral Repair in Rheumatic Valve Insufficiency

Christophe Acar, José Saez de Ibarra, Emmanuel Lansac

Institut de Cardiologie, Hopital de la Salpêtrière, Paris, France

Background and aim of the study: **The mechanism of insufficiency in rheumatic valve disease includes annulus dilatation and restricted leaflet motion. In order to improve the treatment of restriction, the anterior mitral leaflet (AML) can be augmented with a piece of glutaraldehyde-treated autologous pericardium.**

Methods: Between January 1995 and December 1999, among 274 patients referred for rheumatic mitral disease, 143 (52%) underwent a valve repair. Of these patients, 81% had pure regurgitation and 19% had significant associated stenosis. Ring annuloplasty was used in all cases. Techniques used to treat the restrictive component of the regurgitation were compared in two consecutive cohorts of patients, either with (n = 62) or without (n = 81) AML augmentation. Mean patient age was 42 ± 3 years, and all preoperative variables were comparable except for the incidence of redo patients, who all underwent AML extension.

Results: In-hospital mortality was 0.7% (n = 1 with AML extension), and there was one early reoperation for pericardial patch dehiscence. After a mean follow up of 3.2 years, there was one sudden death (no AML extension). The reoperation rate was lower with (2.5%) than without (12.9%) AML augmentation (p <0.05). Echocardiography showed a lower incidence in recurrence of mitral insufficiency when AML augmentation was performed (grade 2, 9% versus grade 3, 3%) as compared to no AML augmentation (grade 2, 35% versus grade 3, 14%) (p <0.05). The mitral orifice area was larger (AML augmentation 2.2 ± 0.3 cm^2 versus no AML augmentation 1.8 ± 0.4 cm^2).

Conclusion: Ring annuloplasty alone failed to correct rheumatic mitral insufficiency in all cases. AML augmentation improved the quality of the repair, and decreased the risk of reoperation.

The Journal of Heart Valve Disease 2004;13:741-746

Rheumatic valve disease represents the main limitation for mitral valve reconstruction, and the feasibility of the repair as well as its early and late results are suboptimal compared to the other etiologies (1-3). Surgical repair of prolapsed mitral valves with Carpentier's technique has provided excellent and durable results (4-6). However, the restrictive component of rheumatic mitral regurgitation has remained difficult to treat. Since 1996, the present authors have adopted a new approach which consists of augmentation of the amount of tissue on the anterior leaflet with autologous pericardium, the aim being to improve the repair of restriction in rheumatic mitral valve insufficiency (7). The goal of the present study was to assess the results of this surgical technique.

Address for correspondence:
Christophe Acar MD, Institut de Cardiologie, Hopital de la Salpêtrière, 50-52 Boulevard Vincent Auriol, 75013 Paris, France
e mail: c.acar@psl.ap-hop-paris.fr

Clinical material and methods

Patients

Between January 1995 and December 1999, 274 consecutive patients underwent mitral valve surgery for rheumatic valve disease. All patients were considered as potential candidates for mitral valve repair, the only discriminatory factor being valve anatomy. Reconstructive surgery was possible in 143 cases; thus, the feasibility of the repair was 52%.

The mean age of patients undergoing a repair was 42 ± 3 years (range: 7 to 72 years). Patients were in either NHYA functional class I (n = 46; 32%), II (n = 70; 49%), III (n = 20; 14%) or IV (n = 7; 5%). Preoperative atrial fibrillation was noted in 33 cases (23%), and sinus rhythm in 120 (77%). In asymptomatic patients (NYHA class I), surgery was performed in case of a severe (grade 3 or 4) mitral insufficiency with either: (i) a past history of transient atrial fibrillation; or (ii) echocardiographic evidence of left ventricular dilatation (end-sys-

J Heart Valve Dis
Vol. 13. No. 5
September 2004

tolic diameter >45 mm or end-diastolic diameter >65 mm) or dysfunction (ejection fraction <60% or systolic pulmonary pressure >50 mmHg). A past history of percutaneous mitral dilatation was found in nine cases (6%). Nine (6%) patients were redo cases and had already undergone a previous repair procedure. Associated valve disease was noted in 51 cases (36%), including 17 patients with triple valve disease; tricuspid regurgitation was seen in 35 cases (24%), and aortic valve disease in 33 (23%).

Echocardiographic analysis showed a mitral insufficiency grade 3 or 4 in 117 cases (82%), and grade 2 in 26 cases (18%). The mean mitral orifice area was 2.3 ± 0.5 cm^2. Mitral stenosis defined as an orifice area <1.8 cm^2 was noted in 26 cases (18%), whereas 117 cases (82%) had no stenosis.

Operative technique

Patients were individualized to two groups according to the surgical technique used to treat the restrictive component of the mitral insufficiency (Carpentier type III) (1). Between January 1995 and September 1996, the repair technique consisted of prosthetic ring annuloplasty (8) alone without leaflet augmentation, and 62 patients were operated on accordingly. Between September 1996 and December 1999, the repair technique combined both an augmentation of the anterior leaflet with autologous pericardium and ring annuloplasty, and 81 consecutive patients were operated on accordingly.

The anterior leaflet was completely detached from its insertion using an incision running from the posteromedial commissure to the anterolateral commissure, taking care to preserve the leaflet tissue normally present at the level of the commissures. At the base of the anterior leaflet, a remnant of 2 mm of leaflet tissue was maintained attached to the mitral annulus. A piece of pericardium which had been harvested at the opening of the chest was carefully freed from any mediastinal adhesion and treated by immersion in a 0.6% glu-

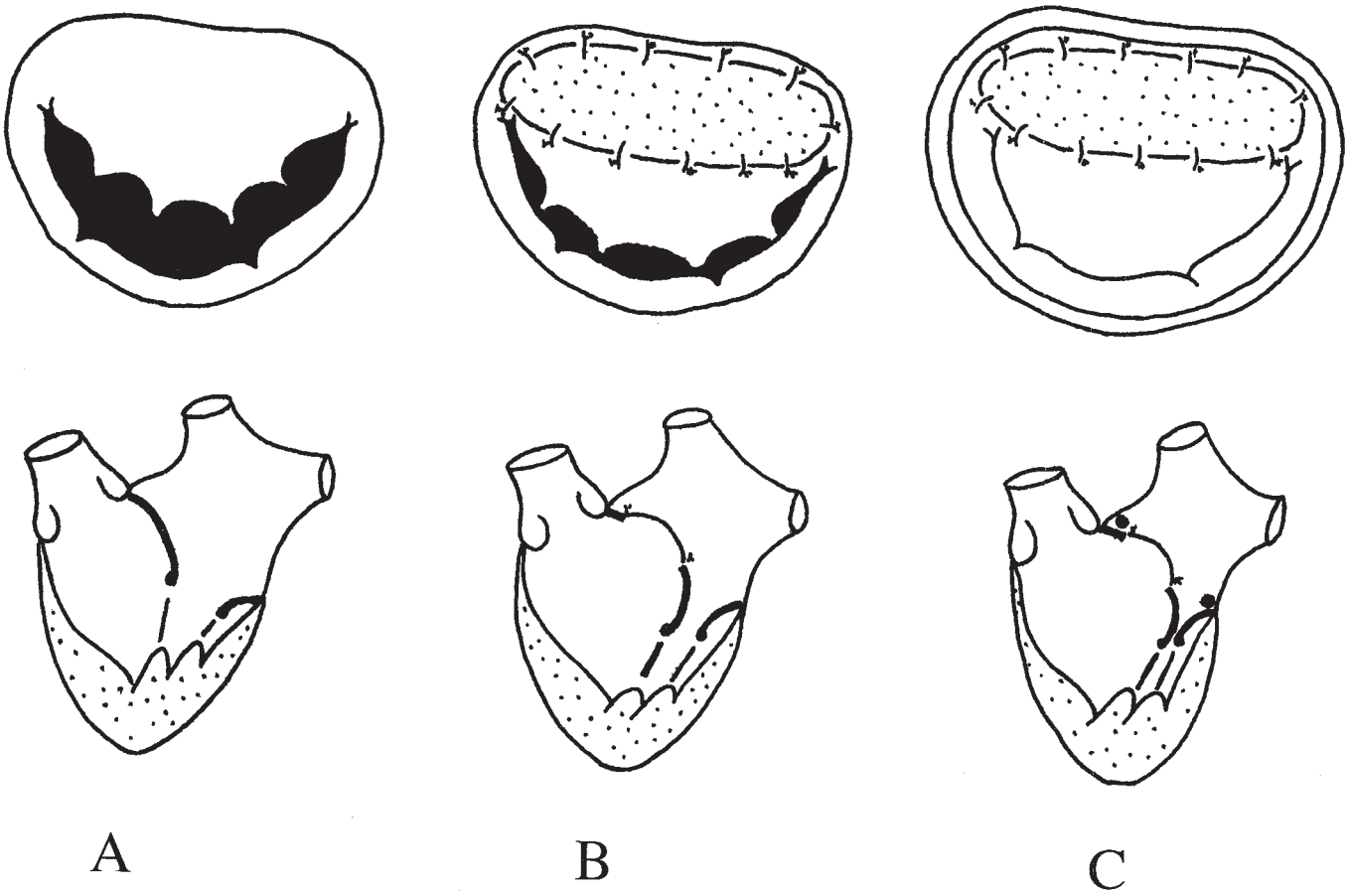

Figure 1: A) Rheumatic mitral valve insufficiency. The leaflets and chordae are thickened and retracted, resulting in valve restriction (type III), and the mitral annulus is dilated. As a result, there is a central lack of coaptation. B) Anterior leaflet augmentation with a piece of autologous pericardium. A few millimeters of leaflet tissue are spared attached to the annulus. The patch extends from one commissure to the other. The area of the anterior leaflet is doubled. C) Prosthetic ring annuloplasty. A slightly downsized ring is inserted, and the surface of coaptation is restored.

A **B** **C**

Figure 2: A) Color Doppler showing massive residual insufficiency after valve repair with prosthetic ring annuloplasty alone. B) Persistent restriction due to leaflet and chordae retraction resulting in a central lack of coaptation in spite of a downsized annuloplasty. C) Result following a re-repair using anterior leaflet augmentation with autologous pericardium. There is a large surface of coaptation. Note that most of the native anterior leaflet is displaced towards the ventricle and serves for coaptation.

taraldehyde solution for a 15-min period (1,8). After having been rinsed in a saline bath, the pericardium was tailored according to an ovoid shape. The width of the patch was adjusted to that of the incision on the anterior leaflet, and increased by a few millimeters so as to allow a tension-free anastomosis. The height of the pericardial patch was arbitrarily fixed at 1.5-2 cm according to the remaining amount of anterior leaflet tissue. The piece of pericardium was sutured in place using a 5-0 Prolene running suture, starting from the posteromedial commissure and progressing counterclockwise by primary fixation of the pericardium to the mitral annulus. Once inserted to the annulus and to the commissures, the pericardial patch was anastomosed to the anterior leaflet progressing from the posteromedial commissure to the anterolateral commissure. This technique allowed a doubling of the amount of tissue on the anterior leaflet. The operation was completed with a prosthetic ring annuloplasty. Anteriorly, the stitches used for ring fixation had been placed before suturing the pericardium so as to avoid the needles of the ring stitches making the running monofilament suture fragile. Once enlarged, the new dimensions of the anterior leaflet were measured using a Carpentier ring sizer, and a smaller prosthetic ring was selected (two sizes down as compared to the anterior leaflet; i.e. a ring size 30 for an anterior leaflet size 34).

The following operative techniques were utilized in order to treat the other components of the mitral dysfunction: commissurotomy with papillary muscle splitting in case of associated stenosis (n = 26); chordal transposition from the posterior to the anterior leaflet in case of anterior leaflet prolapse (type II associated with type III) (n = 4); and closure of an anterior leaflet tear secondary to balloon dilatation (type I associated with type III) (n = 4). Patients in whom chordal rupture was likely to be related to an episode of infective endocarditis, as well as those requiring partial valve replacement with a mitral homograft, were excluded from this series.

The following associated procedures were performed: tricuspid annuloplasty (n = 35), aortic valve replacement with a prosthesis (n = 12), homograft (n = 17) or Ross operation (n = 4) and surgical cure of atrial fibrillation according to the Cox technique (n = 7).

Follow up

Medical follow up was obtained by telephone contact or by direct mail to the patient and to his/her general practitioner and cardiologist. Clinical and echocardiography data were obtained for all patients. Results were expressed as mean ± SD, and statistical comparisons between groups were performed using Student's *t*-test.

Results

Among 274 patients operated upon for rheumatic valve disease, the presence of an associated stenosis had a negative influence on the possibility of mitral repair. Thus, the ratio of mitral repair ranged from 11% when the orifice area was <1.8 cm^2, to 89% when the area was >1.8 cm^2 ($p < 0.05$).

Among the 143 patients undergoing a valve repair, there was no significant difference with regard to preoperative variables between groups with and without anterior leaflet augmentation, except for the frequency of redo patients. All patients who had already undergone a previous repair were included in the anterior leaflet augmentation technique group.

In-hospital events

One death occurred in the anterior leaflet augmenta-

J Heart Valve Dis
Vol. 13. No. 5
September 2004

Table I: Echocardiographic assessment of valve function: Comparison with and without anterior mitral leaflet (AML) augmentation.

Condition	AML augmentation	No AML augmentation
Mitral regurgitation		
Grade 0/1 (n)	72 (88)	31 (51)*
Grade 2 (n)	7 (9)	22 (35)*
Grade 3 (n)	2 (3)	9 (14)*
Mitral stenosis		
Area (cm^2)	2.2 ± 0.3	1.8 ± 0.4*
Gradient (mmHg)	4.3 ± 0.7	5.8 ± 0.9

Values in parentheses are percentages.
*p <0.05 versus AML augmentation.

tion group (mortality 0.7%); this was due to biventricular failure in spite of a functional mitral repair. One early reoperation (day 5) was required for a massive mitral regurgitation related to the disinsertion of a pericardial patch. Examination of the valve revealed a lack of leaflet thickening and fibrosis, and the friability of the tissue most likely accounted for the dehiscence. In retrospect, the diagnosis of rheumatic disease was questionable in this case. Mitral valve replacement with a bioprosthetic valve was accomplished, and the postoperative course was uneventful.

Clinical results

The mean follow up was 3.2 years (range: 3 months to 7 years). There was one late sudden death in the group without leaflet augmentation. In addition, one transient cerebral ischemic attack (hemiplegia) was noted in a patient in atrial fibrillation, and one hemorrhagic event (hemopericardium) occurred during the fifth postoperative month while the patient was receiving anticoagulation treatment.

Reoperation was necessary in nine cases at a mean of 2.8 years; eight of these patients were in the group without leaflet augmentation, and one patient was in the group with leaflet augmentation. The overall rate of reoperation was higher in the group without (12.9%) than with (2.5%) leaflet augmentation ($p < 0.05$). The mechanisms of valve dysfunction included persistent leaflet restriction responsible for a central lack of coaptation (n = 7) and predominant mitral stenosis on a fibrotic valve with a restrictive ring (n = 2).

The remaining 132 patients were in NYHA functional classes I or II (n = 125; 95%) or class III (n = 7; 5%), there being no significant difference between the groups.

Echocardiography

The results of the control echocardiography are listed in Table I, and showed a valve function of better quality in the group with leaflet augmentation. The recurrence of mitral insufficiency was more frequent among patients without leaflet augmentation; likewise, mitral stenosis was more frequent, as indicated by a smaller mitral orifice area and a higher transvalvular gradient.

Discussion

The results of the present study confirmed that valve anatomy is the main parameter influencing the possibilities of repair in rheumatic mitral valve disease. In this surgical series, the presence of a mitral stenosis was associated with a low chance of repair (11%), mainly because the preferred treatment for pure mitral stenosis was percutaneous dilatation. Surgery was considered only in case of a contraindication for dilatation, or when this procedure failed (9), and concerned mostly those valves with an unfavorable anatomy in which rigidity rather than commissural fusion was mainly responsible for the stenosis. Conversely, most cases of pure mitral insufficiency were amenable to valve repair (89%).

Before the era of echocardiography, identification of the mechanism of regurgitation relied heavily on macroscopic analysis of the valve by the surgeon. If the recognition of prolapse was relatively easily viewed in a chord or papillary muscle lesion, an intraoperative diagnosis of restriction was more difficult. Thus, in the absence of a prolapse, the surgeon would conclude that mitral insufficiency was due to isolated dilatation of the annulus (type I), and this led logically to the use of a prosthetic ring annuloplasty as the sole technique of repair. The importance of a lack of tissue involving mitral leaflets and chordae in the genesis of regurgitation has long been undervalued. A generalization of echocardiography in the assessment of mitral valve

disease has shown that annulus dilatation was always associated with restricted leaflet motion in the case of a rheumatic etiology (type III).

The use of a prosthetic ring appears to be essential for correcting rheumatic mitral insufficiency (10). On the one hand, this aims at treating annulus dilatation (11), and on the other hand it aims at compensating in a palliative fashion the leaflet restriction by forcing the coaptation. However, many authors have noted that the use of an undersized prosthetic ring was often not sufficient to counteract the consequences of the retraction (2,3). On occasion, leaflet closure remained incomplete and restrained, and in the present series - in spite of a relatively short follow up - a high rate of residual mitral insufficiency was observed when the restrictive component of the leak was treated by annuloplasty alone. In addition, the choice of a small-sized prosthetic ring had a tendency to create a stenosis because the valve was already thickened and restrictive.

Since 1996 (4), a systematic approach which consisted of enlarging the anterior leaflet by means of an autologous pericardial patch was applied to all reparable cases with rheumatic mitral insufficiency. This technique allowed significant improvement of the results with a lower rate of residual insufficiency and fewer reoperations. In addition, the mitral orifice area was larger because anterior leaflet augmentation allowed the placement of a larger ring which was chosen according to the dimensions of the anterior leaflet, once enlarged.

For many years, autologous pericardium has been used for mitral valve repair in case of a defect created by infectious endocarditis (1). The use of this substitute, with the aim being to treat the retraction secondary to rheumatic valve disease, is more recent (12). The fate of autologous pericardial patches fixed with glutaraldehyde and used for mitral repair has been studied by Chauvaud et al. (12). Intraoperative observations in case of reoperation in the present series, as well as echocardiographic follow up, confirmed the quality of this substitute as being free from any retraction or calcification. The site of valve enlargement remains controversial, however.

Some authors have proposed that valve extension be performed at the level of the posterior leaflet (12). This leaflet is anatomically less developed and allows insertion to the chordae along its entire surface; thus, any restriction occurring at this site is especially obvious. Echocardiography usually shows a motionless leaflet reduced to a slim string. Using color Doppler, the direction of the jet is posterior along the mural leaflet and the free wall of the left atrium (false anterior leaflet prolapse). Nevertheless, the use of a prosthetic ring alone causes restriction of the posterior leaflet independently of any rheumatic disease, and it is usual to observe a non-functional and still posterior leaflet following annuloplasty, whatever the etiology. This finding reduces interest in the posterior leaflet as a site for valve augmentation.

Although more visible on the posterior leaflet, anatomical observations have shown that *Streptococcus*-induced scarred retraction is in reality a diffuse process which involves the whole mitral apparatus, and in particular the anterior leaflet and chordae. In the present series, the anterior leaflet was chosen as the site for augmentation because it is the mobile and functionally most important part of the valve.

Finally, the present patient cohort included some redo cases who presented with recurrent mitral insufficiency following a first repair procedure. Anterior leaflet augmentation with an autologous pericardial patch allowed the restoration of perfect valve function in all cases.

The main indications for mitral repair in children and teenagers are primarily represented by rheumatic valve disease before the atrioventricular canal. Most often, the valve is mainly insufficient with pliable leaflets, but without calcification. Although the anatomy usually appears to be favorable, the results of valve repair in children are less satisfactory than in adult patients (13,14). According to Al Jubair et al. (13) a mild to moderate residual insufficiency was noted in 75% of cases as early as the in-hospital period, and 30% of the patients were subsequently reoperated on within four years. A lack of tissue is the most important obstacle to valve repair in this age group, and the use of a small-sized prosthetic ring is undesirable due to the risk of subsequent stenosis as the patient grows. Hopefully, the anterior leaflet augmentation technique with autologous pericardium will permit an improvement of results, because no substitute is entirely satisfactory for mitral valve replacement in childhood.

Leaflet extension is most likely not necessary in all cases of rheumatic mitral insufficiency, and its exact indications remain to be determined. At present, it is proposed that leaflet augmentation with autologous pericardium be applied whenever measurement of the anterior leaflet suggests severe retraction in which the use of a downsized prosthetic ring (by two sizes) exposes the patient to a risk of mitral stenosis. However, the acceptable degree of annular reduction must be evaluated according to the patient's morphology and the severity of leaflet rigidity.

References

1. Carpentier A. Cardiac valve surgery - the 'French correction'. J Thorac Cardiovasc Surg 1983;86:323-337
2. Deloche A, Jebara VA, Relland JY, et al. Valve repair

J Heart Valve Dis
Vol. 13. No. 5
September 2004

with Carpentier techniques: The second decade. J Thorac Cardiovasc Surg 1990;99:990-1002
3. Duran CM, Gometza B, De Vol EB. Valve repair in rheumatic mitral disease. Circulation 1991;84:III-125-III-132
4. Antunes MJ, Magalhaes MP, Colsen PR, et al. Valvuloplasty of rheumatic mitral valve disease. J Thorac Cardiovasc Surg 1987;94:44-56
5. Kalangos A, Beghetti M, Vala D, et al. Anterior mitral leaflet prolapse as a primary cause of pure rheumatic mitral insufficiency. Ann Thorac Surg 2000;69:755-761
6. Chauvaud S, Fuzellier JF, Berrebi A, Deloche A, Fabiani JN, Carpentier A. Long term (29 years) results of reconstructive surgery in rheumatic mitral valve insufficiency. Circulation 2001;104:I12-I15
7. Acar C. Plastie mitrale in Cardiopathies valvulaires acquises. Acar J, Acar C (eds), Flammarion, Paris, 2000:393-405
8. Chachques JC, Vasseur B, Perrier P, Balansa J, Chauvaud S, Carpentier A. A rapid method to stabilize biological materials for cardiovascular surgery. Ann N Y Acad Sci 1988;529:184-186
9. Acar C, Jebara V, Grare P, et al. Traumatic mitral insufficiency following percutaneous mitral dilatation: Anatomic lesions and surgical implications. Eur J Cardiothorac Surg 1992;6:660-664
10. Carpentier A. La valvuloplastie reconstitutive. Une nouvelle technique de valvuloplastie mitrale. Press Med 1969;77:251-253
11. Carpentier A, Guerinon J, Deloche A, Fabiani JN, Relland J. Pathology of the mitral valve: Introduction to plastic and reconstructive valve surgery. In: Kalmanson D (ed.), The mitral valve: A pluridisciplinary approach. Publishing Sciences Group, Acton, Massachusetts, 1976:65-77
12. Chauvaud S, Jebara V, Chachques JC, et al. Valve extension with glutaraldehyde-preserved autologous pericardium. Results in mitral valve repair. J Thorac Cardiovasc Surg 1991;102:171-178
13. Al Jubair KA, Jaralla A, Fadala M, et al. Repair of the mitral valve because of pure rheumatic mitral valvar incompetence in the young. Cardiol Young 1998;8:90-93
14. Gometza B, Al Halees Z, Shahid M, et al. Surgery for rheumatic mitral regurgitation in patients below twenty years of age: An analysis of failures. J Heart Valve Dis 1996;5:294-301