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Late Outcome of Unsupported Annuloplasty for Rheumatic Mitral Regurgitation

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Objectives. **The aim of this study was to evaluate medium- and long-term (range 4 months to 17 years) clinical results in a series of patients treated surgically by unsupported mitral annuloplasty.**

Background. **Mitral valve regurgitation has usually been treated by valve replacement or ring annuloplasty. A few series have reported plastic repair procedures without annular support or remodeling. Furthermore, in rheumatic lesions the results have been inferior to those in degenerative mitral insufficiency, and the majority of previous reports have provided information on short- or medium-term follow-up.**

Methods. **One hundred fifty-four patients were operated on (55 male [36%] and 99 female [64%]). The mean age ± SD was 36 ± 16 years (range 5 to 73). Associated lesions comprised 47 aortic and 21 tricuspid valve lesions and 2 atrial septal defects. Patients with concomitant mitral stenosis were not included. Preoperative functional class was I or II in 19% and III or IV in 81%. The cardiothoracic ratio was 0.61 ± 0.10. All patients underwent an unsupported mitral annuloplasty procedure in which the mural portion of the annulus was reduced by applying two buttressed mattress sutures at the commissures without compromising the width of the septal leaflet. When necessary, additional chordal procedures were performed. No patients received ring or posterior annular support.**

Results. **The early mortality rate was 1.9% (three patients; one of the three died of myocardial failure and two of pulmonary thromboembolism). The late mortality rate was 5.8% (nine patients; three of the nine died of myocardial failure, one each of septicemia, pulmonary thromboembolism and sudden arrhythmic death and three of unknown causes). Twenty-eight patients (18.2%) were reoperated on because of mitral valve dysfunction and 2 (1.3%) because of prosthetic aortic valve dysfunction. A residual late systolic murmur was present in 48% of patients. Late complications were systemic thromboembolism in 5.8% (one third with an aortic valve prosthesis), infective endocarditis in 1.3% and pulmonary thromboembolism in 0.6%. Postoperative functional class was I or II in 84% and III or IV in 16%. Cardiothoracic ratio was 0.58 ± 0.10. Actuarial probability of late survival was 79.5 ± 5.3% at 10 years and 71.0 ± 7.4% at 14 years. Event-free survival was 67.9 ± 8.9% at 10 years and 56.1 ± 11.7% at 14 years.**

Conclusions. **Rheumatic mitral regurgitation can be effectively treated by annuloplasty without prosthetic annular support, with late results comparable to those obtained with more complicated procedures. This observation is particularly important for treatment of children and young adult patients.**

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Mitral valve repair is now the established procedure of choice for correction of regurgitation. Most techniques are based on the implantation of ring devices or posterior graft supports (1–4), and in most reported series of valve repair, patients with nonrheumatic forms of mitral valve regurgitation predominate (2,5). Only a few reports of results of rheumatic mitral regurgitation treated conservatively have been reported (2,6,7,8), and these have usually included the implantation of an annular ring support. Very few patients in these series have been followed up for >10 years.

Since 1974, we have been employing an unsupported mitral annuloplasty technique similar to that described by Wooler et al. in 1962 (9) in a series of patients who were predominantly young and whose disease was primarily of rheumatic origin. Evaluation of the early and late results in this group forms the basis of this report.

Methods

Patients. The study group comprised 154 patients who, during the period 1974 to 1991, underwent a mitral annuloplasty procedure unsupported by an implanted device for the correction of mitral regurgitation. During the same time period, 3,451 valvular heart operations were performed: 1,050 aortic, 1,747 mitral, 12 tricuspid and 641 multiple-valve procedures. The overall mortality rate was 7.9%. Isolated mitral regurgitation was treated in 398 patients: The valve was replaced in 244 patients (34 deaths, 13.9%) and repaired in 154 (3 deaths, 1.9%). Mitral stenosis was treated in 602

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patients with 134 valve replacements (61 deaths, 10.1%). Rheumatic disease was present in 90.2% of cases.

In the present series, there were 55 male (36%) and 99 female (64%) patients whose age ranged from 5 to 73 years (mean 36 ± 16); 45 patients were <20 years old. The etiology of disease was rheumatic in all patients. Patients with congenital and degenerative mitral insufficiency were excluded from this study although such patients have been treated by a similar technique at our institution.

Ninety patients had associated lesions including 47 patients with aortic valve lesions, 21 with tricuspid regurgitation and 2 with a concomitant atrial septal defect. Preoperative New York Heart Association functional class was I or II in 29 patients (19%) and III or IV in 125 (81%). Preoperative cardiothoracic ratio was 0.61 ± 0.10.

Annuloplasty procedure. All patients underwent an unsupported mitral annuloplasty procedure (Fig. 1) that consisted of reducing the mural portion of the annulus by applying two buttressed mattress sutures of 2-0 polyester with Teflon pledgets, one at each commissure to obtain annulus reduction without compromising the septal leaflet width. This procedure is similar to that described by Wooler et al. (9), Kay and Egerton (10), and Reed et al. (11). When necessary, additional procedures were performed in the leaflets or chordae in cases of chordal elongation or rupture. For elongation, the compromised chorda was held with a 2-0 polyester suture and tied to the respective papillary muscle, passing the suture across it and anchoring it on Teflon felt. Chordal shortening was best performed before annuloplasty. When need for a chordal procedure was not clear, a rubber caval tourniquet was snugged at each commissural stitch and the valve tested with saline solution for competency. If it was competent, the stitches were tied; otherwise, they were loosened for a better chordal approach. This procedure was repeated at each test, the annular stitches were definitively tied. For chordal rupture of the anterior leaflet, we performed a triangular resection of the flail leaflet segment (12). For chordal rupture of the posterior leaflet, we performed a quadrangular resection (13). Triangular resection of the anterior leaflet had to be performed before completion of the annuloplasty. After quadrangular resection of the posterior leaflet, it was usually not necessary to place annuloplasty stitches to obtain competency.

The patients were operated on under conventional cardiopulmonary bypass with a bubble oxygenator and moderate hypothermia (28° to 30°C) through a median sternotomy incision. The left atrium was opened after aortic cross-clamping. Myocardial protection was provided with a cold hyperkalemic crystalloid cardioplegic solution and external cardiac cooling with cold saline solution in the pericardial sac, except in the few patients operated on before 1977 in whom only external cardiac cooling was employed. Associated cardiac lesions were appropriately corrected after the mitral repair was completed. The mean bypass and aortic cross-clamp times for the total series were 48 ± 19 min and 29 ± 16 min, respectively, and, when associated lesions were absent, 40 ± 11 min and 23 ± 8 min, respectively. Tests for valvular competence were done by the infusion of saline solution with a rubber syringe through the mitral orifice while the heart was arrested. In some cases, small regurgitant jets were tolerated when it was believed that further procedures could compromise the orifice and cause stenosis. In these cases, the decision was based on the premise that a slightly imperfect valve was preferable to a prosthesis.

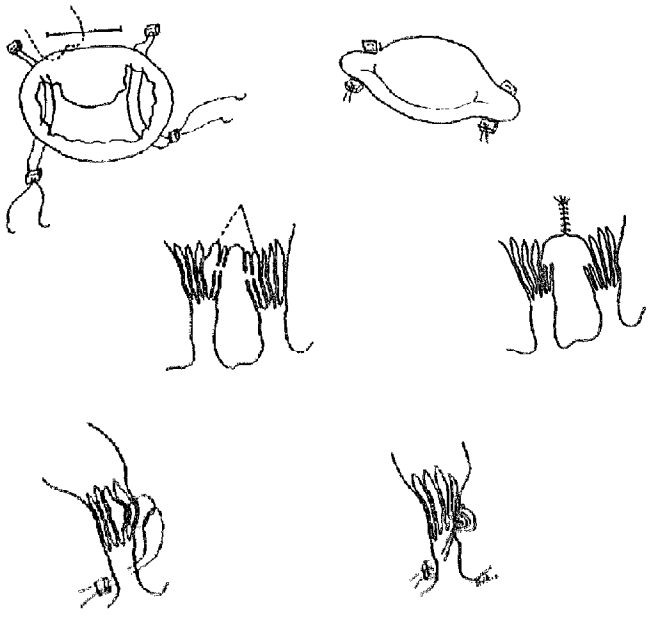

Figure 1. The unsupported mitral annuloplasty procedure consisted of a reduction in the mural portion of the annulus obtained with the application of two buttressed mattress sutures of 2-0 polyester with Teflon pledgets (**upper left**), one at each commissure, to obtain annulus reduction with no compromise of the septal leaflet width (**upper right**). When necessary, additional procedures were performed in the leaflets or chordae in cases of chordal elongation or rupture. For elongation, the technique employed was to hold the compromised chorda with a 2-0 polyester suture (**lower left**) and tie it down to the respective papillary muscle, passing the suture across it and anchoring it in Teflon felt (**lower right**). Chordal shortening was best performed before the annuloplasty. When there was doubt whether a chordal procedure was necessary, a rubber caval tourniquet could be snugged at each commissural stitch and the valve tested with saline solution for competency. If it was competent, the stitches were tied; otherwise, they were loosened for better chordal approach. For chordal rupture in the anterior leaflet, a triangular resection of the flail leaflet segment (**middle left and right**), and, in the posterior leaflet, a quadrangular resection were performed before the annuloplasty. This was usually not necessary after quadrangular resection of the posterior leaflet.

Postoperative care. Routine postoperative care was provided as for general open heart surgery. Special care was taken to provide prompt effective treatment of acute rheumatic fever, if any signs of it appeared in the early postoperative period. Treatment included an intensive course of anti-inflammatory and corticosteroid agents. Unexplained tachycardia in the early postoperative period was initially treated in the same manner as rheumatic fever while routine

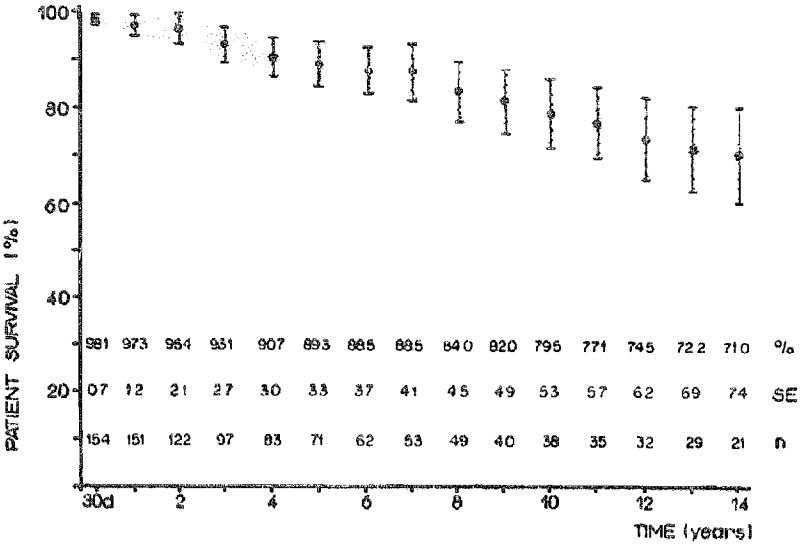

Figure 2. Actuarial patient survival curve, including early mortality, for the initial 14 years of follow-up. The numbers below the curve represent: percent survival (top row [%]); standard error of the mean (middle row, SE); number of patients at risk during the interval shown (bottom row, n). After the 14th year, the curve was omitted due to the small number of patients.

laboratory tests were performed. The intent of this approach was to avoid any inflammatory weakening of valvular tissues that could disrupt the surgical sutures.

Clinical analysis. For clinical analysis, patient data were tabulated according to age, gender, associated cardiac lesions and procedures, severity of heart failure by the New York Heart Association classification and postoperative presence of a regurgitant murmur. The cardiothoracic ratio was evaluated. Routine echocardiography and cardiac catheterization were not performed in all patients because these procedures were considered unnecessary for the evaluation of clinical status and durability of the repair. Doppler echocardiographic studies were performed preferentially for evaluation and qualification of residual regurgitation, when it was present, as well as for the verification of left ventricular function, when necessary.

Early mortality was defined as death occurring in the 1st 30 postoperative days. Patients were followed up in person by the surgeons or the hospital outpatient clinic or by telephone calls or letters from the referring physicians. Event-free survival was defined as the probability of the patients remaining alive and free of reoperation or major valve-related complications. For statistical purposes, patients reoperated on for causes such as failure of an aortic valve prosthesis were not considered to have failure of mitral repair, but were included in the group undergoing reoperation.

Data were expressed as mean value ± SE. The probability of late survival was calculated by the actuarial method for analysis of surgical results, as described by Grunkemeier and Starr (14).

Results

Mortality. There were three early deaths (1.9%); one was due to myocardial failure and two were due to pulmonary thromboembolism. The late mortality rate was 5.8% (nine patients); three of these late deaths were due to myocardial failure, one each to septicemia, pulmonary thromboembolism and sudden arrhythmic death and three to unknown causes. Two patients were lost to follow-up. Mean follow-up time was 46 ± 42 months (range 4 months to 17 years).

Reoperations. Thirty patients (19.5%) were reoperated on at a mean follow-up time of 69 months (range 2 months to 10 years postoperatively). Two patients (1.3%) were reoperated on primarily because of dysfunction of an aortic valve prosthesis and 28 (18.2%) because of mitral valve lesions (residual stenosis in 2 [1.3%] and regurgitation in 26 [16.9%]). At reoperation, the annuloplasty was redone in 2 patients; in 26, the surgeons found it advisable to replace the mitral valve. The most usual finding at reoperation was increased leaflet fibrosis and annular dilation. In some instances leaflet scarring occurred, causing valvular stenosis. As more confidence arose in the annuloplasty procedure in recent years, a second annuloplasty seems to be indicated whenever the valve morphology permits.

Late follow-up. Late complications were systemic thromboembolism in nine patients (5.8%), including three who also had an implanted aortic prosthesis; infective endocarditis in two patients (1.3%), and pulmonary thromboembolism in one patient (0.6%). Because anticoagulation was not routine, there were no events of anticoagulant-related hemorrhage.

At late evaluation of the 112 survivors with no reoperation, 84% were in functional class I or II and 16% in class III or IV. The 30 patients with reoperation were in class III at the time of operation. The postoperative mean cardiothoracic ratio was 0.58 ± 0.10.

The late survival rate was 89.3% at 5 years, 79.5% at 10 years and 71% at 14 years postoperatively, including early mortality (Fig. 2). The event-free survival rate was 86% at 5 years, 67.9% at 10 years and 56.1% at 14 years (Fig. 3).

A residual systolic murmur was present in 72 patients (48% of the early survivors). Of these 72 patients, 46 had only mild mitral regurgitation and required no therapy.

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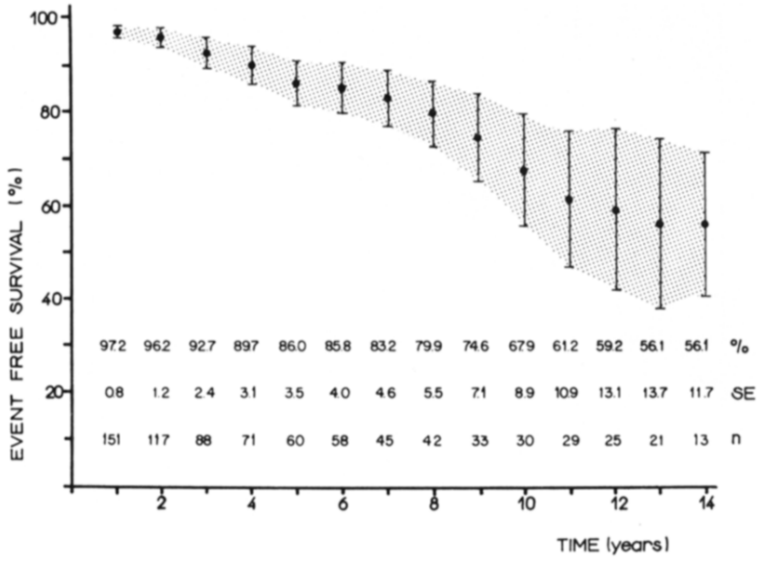

Figure 3. Actuarial event-free survival curve including early mortality for the total series during the initial 14-year period. Format as in Figure 2.

whereas 26 had more severe regurgitation and underwent reoperation. The severity of mitral regurgitation was evaluated clinically by noninvasive methods. Reoperation was indicated in patients in functional class III or IV. Patients with a systolic murmur who were in functional class I or II and had mild regurgitation on echocardiography and no progressive cardiac enlargement were not considered for reoperation.

Figure 4 shows the aortogram and ventriculogram of a 12-year old patient, treated with aortic valvuloplasty by the Trusler technique and mitral annuloplasty as described here, demonstrating trivial aortic regurgitation and mitral competence at 6 months of follow-up. This patient, operated on in 1976, was one of the first patients in our series.

Discussion

Plastic repair for mitral regurgitation is currently the preferred method of surgical treatment (15). Most reported series have included a majority of patients with nonrheumatic mitral insufficiency and, almost always, the use of some form of annular support. The well known Carpentier ring has been extensively implanted and its use is reported to result in an overall actuarial survival, at 15 years, of 72% (2). Results are significantly better in patients with degenerative disease: 73% free of mitral valve dysfunction at 15 years compared with 51% in the rheumatic group. Duran et al. (7) reported 77% of patients with rheumatic mitral disease free from reoperation 30 months after repair with implantation of

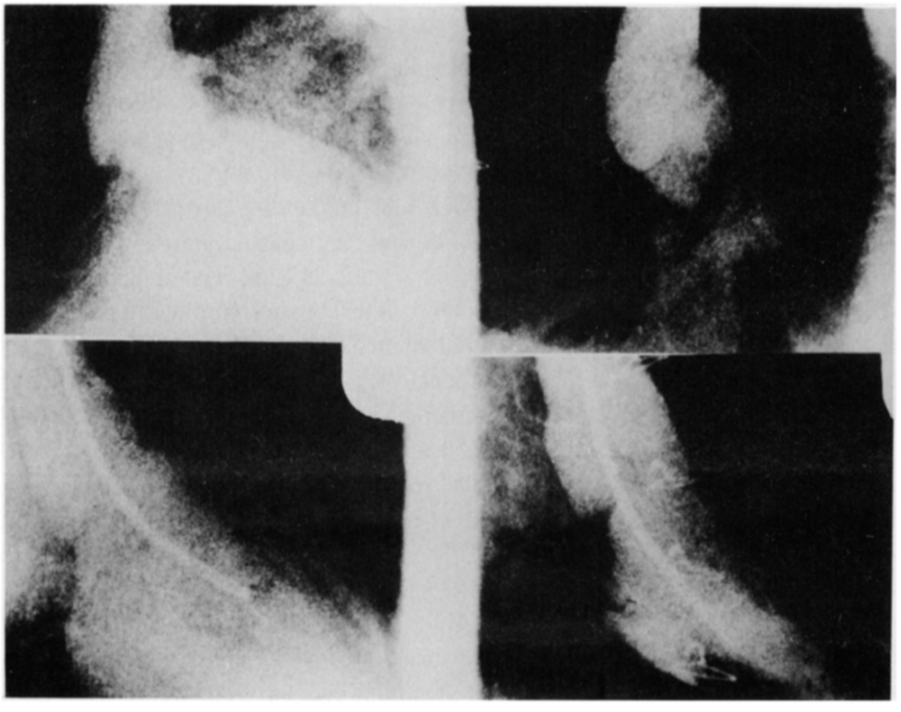

Figure 4. Surgical outcome in a 12-year old boy who underwent mitral and aortic valvuloplasty. **Left,** Preoperative aortogram (**top**) and ventriculogram (**bottom**). **Right,** Postoperative aortogram (**top**) and ventriculogram (**bottom**).

the Duran ring. Antunes et al. (6) reported a series of 241 patients with rheumatic mitral valve disease with a mean age of 21 years of whom 175 had regurgitation predominantly and were operated on with use of the Carpentier ring. The overall survival rate at 4 years was 90%, and 78% had had no reoperation. Lessana et al. (8) reported a 67% event-free survival rate at 13 years after repair of rheumatic mitral regurgitation by placement of a Carpentier ring for correction of annular deformation or dilation in most patients. A few series (10,11) of nonsupported mitral annuloplasty have been reported. Our previous findings, including treatment of patients with nonrheumatic disease with annuloplasty or valvuloplasty, have been reported elsewhere (16). The overall survival rate for our first 50 patients was 84%, and 62% were free of mitral valve dysfunction after 10 years of follow-up (17,18).

The patients reported in this series had mitral regurgitation as the predominant lesion. Some had associated lesions, but none had mitral stenosis. The valves were invariably dilated without calcifications or fusions at chordae and leaflet levels. A mild to moderate diffuse fibrosis was characteristic of rheumatic mitral regurgitation sometimes in association with chordae elongation and rupture.

Basically this method of mitral valve repair respects the same principles already reported by Kay and Egerton (10), Reed et al. (11) and Wooler et al. (9) and incorporates chordal interventions similar to those described by McGoon (12), Nunley and Starr (13) and Carpentier et al. (1). The differences are that annular shortening is achieved by buttressed U-shaped stitches without standardized measurement, so placed that the entire width of the septal or anterior leaflet is preserved and both leaflets are forced to invaginate into the ventricle as the sutures are tied. In addition, chordal shortening is performed in a very simple manner and only when it is judged necessary after temporary placement of rubber tourniquets, a procedure that greatly facilitates assessment and improves surgical results.

We realize that valves with degenerative disease may not hold sutures as long as valves with rheumatic and congenital disease. Therefore, if this technique is employed in myxomatous disease, it might be advisable to add a strip of Teflon felt or bovine pericardium (19) sutured at the posterior annulus between the two commissural stitches, as we have done in some cases of this disease. The friable characteristic of myxomatous tissue might be the reason why most surgeons prefer to implant a ring for annular remodeling and support. From the results presented here and comparing them with a series of rheumatic patients in whom rings were implanted, as mentioned above (2,6–8), it can be inferred that for rheumatic mitral regurgitation a simple Wooler type annuloplasty without annular support is sufficient and provides similar long-term survival.

Mortality and morbidity. The causes of early and late deaths in our series were not valve related but due to myocardial failure and pulmonary embolism. This outcome was probably due to the slow deterioration of the repair when it failed, allowing time for the patients to be restudied and reoperated on before major complications were manifested.

The 19.5% incidence rate of reoperations is similar to that of cited series and considered acceptable for the time period studied. The most common finding at reoperation was leaflet retraction in association with increased dilation that resulted in regurgitation. In some instances, it was possible to perform a new repair because of the good condition of the valve tissue. The presence of mitral stenosis in two cases could have been due to the rheumatic process. Dysfunction of an aortic prosthesis was an associated cause for reoperation not related to the repair.

Systemic thromboembolism was the most common nonfatal complication (and perhaps was the cause of some deaths classified as sudden or unknown). Three patients with thromboembolism had an aortic valve prosthesis and were receiving anticoagulant therapy. The remaining six patients had atrial fibrillation. In addition to embolism, pulmonary or systemic, infective endocarditis occurred and could be cured after an appropriate course of antibiotic treatment. Thus, infection in repaired valves was successfully treated medically. The absence of an implanted device may have been a factor contributing to this cure.

Young patients with isolated mitral regurgitation usually have large, pliable leaflets with only mild fibrosis and no calcification. In a few patients the chordae were elongated or ruptured, but this never compromised the feasibility of repair. In the beginning of the series, some patients were left with mild regurgitation. This complication has been greatly minimized lately as more experience has been acquired and the simple procedure described for chordal shortening has been employed. Older patients with rheumatic disease usually have mixed lesions (stenosis and regurgitation) in heavily calcified and retracted valves. Mixed lesions were not included in this study, although they are also suitable for repair. The older patients included here were those with pure mitral regurgitation. In these patients, the valves were pliable, and a simple unsupported annuloplasty was successfully employed.

Advantages of present technique. The present technique has several advantages over other methods of treating rheumatic mitral regurgitation. 1) The recent finding (20) that implanted rings can be deleterious to left ventricular function, suggests one advantage for annuloplasty without support. 2) Another advantage of simple annuloplasty over rings is the technical simplicity of placing only two buttressed sutures instead of several stitches on the annulus and ring. 3) No prosthesis is left in the heart. 4) The valve is allowed to grow freely with no annular compromise, an important factor in young patients. 5) Hospital costs are reduced. 6) If a chorda is found to be elongated after the valve is tested, there is no need to remove the ring or to try to correct through it when the tourniquet maneuver is performed. 7) Myocardial ischemia and perfusion times are reduced. 8) As already mentioned, the absence of a prosthesis may facilitate

cure of postoperative endocarditis. 9) The technique may be particularly suited to valves with rheumatic disease because the fibrosis characteristic of such valves may contribute to a better holding of the sutures. Nevertheless, the procedure has been used successfully in valves with degenerative disease.

Conclusions. Rheumatic mitral regurgitation can be effectively and durably treated with an unsupported, simple annuloplasty technique that avoids synthetic implants. This results in a more expeditious procedure with excellent functional performance and does not compromise the growth of valves operated on at a young age.

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