Mitral valve repair for isolated prolapse of the anterior leaflet: an 11-year follow-up

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Received 21 September 1998; received in revised form 23 November 1998; accepted 1 December 1998

Abstract

Objective: Mitral valve insufficiency (MVI) because of involvement of the anterior mitral leaflet may pose additional risks for late outcome after mitral valve repair, because of more complex techniques. We retrospectively reviewed our experience in patients operated on for isolated anterior mitral leaflet prolapse approached by various techniques. Methods: Between 1986 and 1997, 616 patients underwent mitral valve repair at our Institution. Isolated pathology of the anterior mitral leaflet was the cause of MVI in 84 patients (13.6%). Age ranged from 23 to 74 years (mean 50 ± 14). Etiology of MVI was predominantly degenerative (57 patients, 67.8%), and the mechanism of the regurgitation was mainly due to a chordal rupture (58 patients, 69%). Annular dilatation was present in 75 patients (89.5%). A variety of surgical techniques were applied including chordal shortening (five patients, 5.9%), chordal transposition (three patients, 3.5%), artificial chordae (11 patients, 13%), since 1992, however, the majority of procedures was performed using the ‘edge to edge’ technique (52 patients, 51.9%). Annular dilatation was treated mainly by means of a prosthetic ring (46 patients, 61.3%) whereas 18 patients (24%) underwent posterior annuloplasty using gluteraldehyde-treated native pericardium. Results: Follow-up ranged from 3 to 122 months (mean 46 ± 24 months). There were three hospital deaths (3.5%) and five late deaths (5.9%) for a Kaplan-Meier estimated survival of 87.6% at 8 years. Three patients underwent early reoperation within 30 days (3.5%), and six patients underwent late reoperation (7.1%), for a cumulative freedom from reoperation of 85.4% at 8 years. Seventy-four percent of the survivors (50 patients) are still in New York Heart Association Class I, and 92% of survivors (62 patients) have no or trivial (1+) residual mitral regurgitation at echocardiographic follow-up. Conclusion: In spite of the greater complexity, conservative surgery to correct anterior mitral valve prolapse pertains high success rate at long term. Recent technical modifications (‘edge-to-edge’ technique) may allow more expeditious and reproducible procedures with expected favorable influence of mitral valve repair applicability. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Mitral regurgitation; Mitral valve repair; Anterior leaflet prolapse

1. Introduction

Mitral valve repair is the procedure of choice for mitral valve insufficiency (MVI) because of better early and long-term postoperative results compared to valve replacement [1]. Nonetheless, MVI due to anterior leaflet (AL) defect has been representing a more challenging pathologic condition for surgical reconstruction, and may account for less favorable postoperative results in the presence of complex patterns of MVI [2,3]. The introduction of novel techniques to correct MVI secondary to AL abnormality has been shown to effectively broaden the surgical options and mitral valve repair applicability, and to positively influence postoperative outlook [4–8], but did not enhance standardization of the surgical approach. Furthermore, long-term data of mitral valve repair for involvement of AL are still scarce. We retrospectively analyzed our personal experience in treating patients who underwent mitral valve repair for isolated prolapse of the AL using several surgical options and followed-up for 11 years.
2. Materials and methods

2.1. Patient's selection

From October 1989 to November 1997, 616 patients underwent mitral valve repair for mitral regurgitation at our department. In 124 patients (20.1%) the mechanism of the valve regurgitation consisted of a pathology involving the AL, being the isolated cause of MVI in 84 (13.6%). These 84 patients (mean age 52 ± 16 years; male/female ratio 49/35) represent the cohort of the present study. Mitral regurgitation was preoperatively studied by transthoracic (TT) or transesophageal (TE) echocardiography. All patients, at the time of surgery, had either severe (4+) or at least moderate (3+) mitral regurgitation. The preoperative diagnosis consisted of degenerative mitral regurgitation in 57 patients (67.8%), rheumatic mitral regurgitation in 13 (15.4%), post endocarditis-related degeneration (acute in five patients and healed in nine patients) in 14 (16.6%). According to Carpentier classification type I mitral valve (i.e. normal leaflet motion) was detected in eight patients (9.5%), type II mitral valve (i.e. leaflet prolapse) in 69 patients (82.1%), type III mitral valve (i.e. restricted leaflet motion) in 7 (8.3%).

2.2. Operative techniques

All but five patients opted for elective surgery. In five patients emergency surgery was required either for acute congestive heart failure, caused by acute massive mitral insufficiency, or septic embolization due to mitral leaflet vegetation. After anaesthetic induction, cardiopulmonary bypass (CPB) was established in all patients via conventional approach. In all but nine patients myocardial protection was achieved by topical and systemic cooling, and antegrade intermittent infusion of cold crystalloid cardioplegia. In nine patients, antegrade warm blood cardioplegia was used during normothermic CPB. The mitral valve was approached in 70 patients (83.3%) throughout a standard left atriotomy. Alternative approaches were: vertical transatrial approach (eight patients, 10.7%), and extensive oblique transatrial approach (five patients, 5.9%). In one patient, with a preoperative diagnosis of aortic valve endocarditis involving the anterior mitral valve leaflet, the repair was performed through the aortotomy, after excision of the aortic valve. The mechanism of the regurgitation was verified by means of forceful injection of cold saline solution inside the left ventricle, and once the precise mechanism of the regurgitation was confirmed or better identified the appropriate surgical option was designed and performed. The mechanism of the regurgitation was chordal rupture in 58 patients (69.0%), chordal elongation in 13 (15.4%), leaflet perforation in 6 (7.1%). A complex mechanism of regurgitation was detected in 7 (8.3%) patients. A variety of surgical procedures was utilized until 1992 including chordal shortening (five patients), chordal transposition (three patients) and artificial chordae implantation (11 patients). From 1992 most of the mitral valve repair were performed by means of ‘edge to edge’ techniques [9] (Figs. 1 and 2) either performing a ‘double orifice’ repair (28 patients) or a ‘paracommissural’ repair (24 patients). Additional techniques of mitral valve repair were used in seven patients. Mitral annuloplasty was performed in 75 patients (92%), with the majority (46 patients, 61.3%) receiving a Carpentier–Edwards (Baxter, Irving, CA) prosthetic ring. Eighteen patients (24%) received a posterior annuloplasty with a pre-treated pericardial strip and seven patients (9.33%) had a paracommissural annuloplasty (Kay technique). Associate procedures consisted of aortic valve replacement in eight patients (29.6%), tricuspid valve repair in seven (30.2%) coronary artery bypass grafts in six (26.8%). Cardiopulmonary bypass and aortic cross-clamp (ACC) times were 83 ± 38 and 51 ± 16 min, respectively, for the entire series, whereas 79 ± 40 and 48 ± 14 min, respectively, in case of isolated mitral repair.

2.3. Follow-up

Follow-up was 100% complete at an average of 46 ± 24 months (range 3–122 months). All the 76 surviving patients were assessed either by mean of outpatient clinic attendance or telephone interview. At the postoperative follow-up, TT or TE echocardiography was performed (95% complete), and the main parameters of the mitral valve were collected. Residual mitral valve regurgitation was, again, graduated from 1+ to 4+. Transmitral gradients were also collected, as well as mitral valve effective functional area.

2.4. Statistical analysis

Results are presented as mean ± standard deviation. When appropriate results of $\chi^2$ or t-test are presented. Kaplan–Meier estimates were constructed for survival probability and freedom from reoperation.

3. Results

3.1. Postoperative mortality

There was no intraoperative death, whereas the hospital mortality was of two patients (2%). One patient had a combined aortic valve replacement, and suffered from massive sudden bleeding from the aortotomy; the second patient died because of refractory right ventricle failure, despite prolonged right ventricular circulatory support. A third patient died on the 21st postoperative day, during the rehabilitation course for sudden death, thereby leading to a cumulative 30-day mortality of 3.5%. In all the three cases, the perfect haemodynamic result of the mitral valve repair had been detected by echocardiography, intraopera-
tively for the first two patients, and before hospital discharge for the third patient. Another five patients died in the late follow-up period at a mean interval of 26 ± 18 months from surgery, for a cumulative 8-year survival rate of 87.6 ± 5.9% (Fig. 3). In four of the five late deaths the cause was cardiac related, but in only one patient was valve-related. Postoperative causes of death are summarized in Table 1.

Fig. 1. The figure shows postoperative evaluation by intraoperative transesophageal echocardiography showing the double-orifice valve (A), as performed during the operation by apposition of the facing central portions of the two mitral valve leaflets (B). Calculated area of both orifices demonstrate a normal opening area value.
3.2. Freedom from reoperation

Three patients underwent early reoperation within 30 days from mitral valve repair. Two had been operated on emergency basis for acute endocarditis. A reparative approach was attempted at first operation with use of pericardial patch, but they ultimately underwent reoperation the following day for a residual massive mitral incompetence.

Fig. 2. Intraoperative (A) and 1-year follow-up (B) assessment of mitral valve function by transesophageal echocardiography, demonstrating optimal surgical result (shown in Fig. 1) obtained with a ‘double-orifice’ technique with no residual mitral valve insufficiency or stenosis.
The third patient was operated on elective basis for degenerative anterior leaflet prolapse, and underwent reoperation on the 21st postoperative day because of acute recurrent mitral regurgitation due to a partial detachment of the Carpentier ring. Another six patients underwent reoperation during the follow-up, at a mean interval of 26 ± 25 months, for a cumulative 8-year freedom from reoperation of 85.4 ± 7.4% (Fig. 4). All the postoperative causes of reoperation are listed in Table 2.

3.3. Postoperative functional status and echocardiography evaluation

At follow-up, 50 patients (74.6% of the survivors) are still in New York Heart Association (NYHA) Class I, 16 patients (23.8%) are in NYHA Class II and only one patient (1.4%) is in NYHA Class III, with an overall average of 1.2 ± 0.49. Regarding the echocardiography evaluation 24 patients (35.8% of the survivors) had no residual regurgitation, 38 patients (56.7%) had 1+ (trivial) residual regurgitation, and 5 patients (7.4%) had 2+ (mild) regurgitation. The overall average of functional mitral valve area was 2.6 ± 0.7 cm² (for patients with double-orifice repair the sum of the two orifice areas was considered). No patients developed significant mitral stenosis postoperatively. The calculated transvalvular pressure gradient across the mitral valve was less than 5 mmHg in all patients.

4. Discussion

Superiority of conservative techniques over valve replacement to treat MVI, either in terms of postoperative mortality or morbidity, has been extensively demonstrated [1,10,11]. Reconstructive procedures showed to provide effective and durable competence of the repaired mitral valve [12]. Nonetheless, initial experiences with mitral valve repair in the presence of AL disease were less satisfactory, leading to more frequent valve replacement in this setting due to more complex mechanisms of valvar incompetence, and related demanding reparative techniques. Carpentier rationalized the surgical approach to MVI, and accurately defined the underlying mechanisms and type of lesions encountered in MVI. Accordingly, he proposed specifically designed reconstructive techniques to deal with the various patterns of mitral incompetence secondary to failure of the anterior, posterior, or both leaflets [12]. Since that pioneering report, additional techniques have been proposed to selectively repair AL defects [4–8]. However, several reconstructive approaches appeared to provide suboptimal results, although substantial discrepancies are evident among reported data in the literature. Smedira and colleagues [13] found that chordal shortening was associated with higher incidence of reoperation at long term as compared to chordal transfer (26% versus 10% at 5 years, respectively). In our previous analysis, application of artificial chordae was linked to reduced freedom from reoperation at long-term [9], but recent reports seem to support the use of polytetrafluoroethylene chordae for efficient mitral valve repair at long-term [7,8]. Deloche and colleagues showed that the use of triangular resection of the AL because of ruptured chordae provided less satisfactory results (8.8% of early reoperations) [14]. Chordal transposition, either obtained from the posterior leaflet or from secondary chordae of the AL, was generally reserved for chordal rupture, but some authors advocate its wider application [13,15] particularly in the presence of degenerative prolapse of the AL.

In our series, chordal transfer was rarely applied, due to frequent extensive involvement of the AL during the early experience, and to the adoption of the ‘edge-to-edge’ technique as the procedure of choice from 1992.

Etiology and mechanisms responsible for MVI may represent negative prognostic factor for mitral valve repair results with increased incidence of recurrent MVI and reoperation. Rheumatic disease may result in less satisfactory long-term results after mitral valve repair, as confirmed by Grossi and associates [16]. Ischemic MVI is widely recognized as potential negative determinant of mitral valve reconstruction due to complex dynamic mechanisms responsible for valvular incompetence. Our series did not
include any case secondary to ischemic valvular regurgitation, even if some authors advocate extension of repair procedures also in this high risk group [14]. Mitral regurgitation due to impaired AL coaptation may be secondary to dilated left ventricle and displaced papillary muscles, although annular dilatation represents the predominant cause of MVI. Mitral valve repair in treating idiopathic dilated cardiomyopathy [17,18] represents another appealing application of conservative mitral valve surgery for the restoration of a more appropriate left ventricular-mitral continuity to enhance left ventricular performance. Patient selection remains a critical factor in this peculiar setting, since in our series 2 patients died during the follow-up because of progressive dysfunction of dilated left ventricle, despite initial promising hemodynamic improvements.

Time required for surgical correction may be associated with increased morbidity. The introduction of the ‘edge-to-edge’ repair at our Institution in 1991 by Alfieri, as an alternative technique to correct MVI, allowed a more expeditious and reliable reconstruction of difficult AL defects. Short CPB and ACC times to accomplish mitral valve repair may represent an additional advantage, particularly when other surgical procedures or depressed left ventricular function are associated with mitral valve repair. David reported, using artificial chordal transposition a CPB and ACC times of 57 ± 5 and 44 ± 6 min, respectively, in patients submitted to isolated mitral repair, whereas 76 ± 11 and 61 ± 14, respectively, in patients submitted to associate procedures [19]. Similar ACC time (62 ± 26 min) has been reported by Sousa Uva, using chordal transposition, in a series which included only one case of additional aortic valve replacement. [15] In contrast, Maisano and associates showed short CPB and ACC times (52 ± 11 and 35 ± 4 min, respectively), for the entire series, and 48 ± 7 and 31 ± 2 min, respectively, for isolated mitral repair using the ‘edge-to-edge’ technique [20]. The latest findings are in accordance with our results. Nonetheless, despite reduced CPB and myocardial ischemic times, a major concern of such a technique was represented by the potential of creating a residual valve stenosis. Our follow-up and other recent experiences in applying the ‘edge-to-edge’ procedure in primary or secondary MVI [17,20] seems to refute this hypothesis. Accordingly, no moderate or severe mitral valve stenosis was detected in our series with a mean follow-up of 34 months, and a residual mean calculated valve area orifice of about 2.5 cm² support the safety of this technique.

Long-term experiences dealing with a follow-up longer than 10 years are limited [8,16,21,22]. Our clinical experience represents a rather homogeneous patient group, although using potentially biased retrospective analysis, where isolated prolapse of the AL constituted the only mechanism responsible for MVI. Postoperative mitral valve repair failure in our series was primarily related to ring-related complications or to novel involvement of the previously intact posterior leaflet where an ‘edge-to-edge’ technique was not applied. These findings suggest the hypothesis that fragile annular and posterior leaflet tissues should be carefully looked for, and preventively treated by supportive measures (rigid prosthetic ring and ‘edge-to-edge’ technique) which may prove to permanently stabilize a likely weak reconstruction. Contradictory findings have been reported by some authors regarding the need of an associated annuloplasty with mitral valve repair. Avoidance of annular remodeling during mitral valve repair has been described to adversely affect postoperative outlook in terms of MVI recurrence and need for reintervention [12], even if these results have not been confirmed by other investigators [13,21]. Uncertainty, however, still persists whether a rigid,

Table 2

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Time after surgery</th>
<th>Procedure performed</th>
<th>Cause of reoperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37 days</td>
<td>Edge-to-edge + Carpentier ring</td>
<td>Ring detachment</td>
</tr>
<tr>
<td>2</td>
<td>36 days</td>
<td>Edge-to-edge + Carpentier ring</td>
<td>Ring detachment</td>
</tr>
<tr>
<td>3</td>
<td>1.1 years</td>
<td>Artificial chordae + Carpentier ring</td>
<td>Chordal rupture (posterior leaflet)</td>
</tr>
<tr>
<td>4</td>
<td>2.2 years</td>
<td>Chordal transposition + pericardial annuloplasty</td>
<td>Chordal rupture (posterior leaflet)</td>
</tr>
<tr>
<td>5</td>
<td>4.4 years</td>
<td>Artificial chordae + edge to edge + pericardial annuloplasty</td>
<td>Ring detachment (posterior leaflet)</td>
</tr>
<tr>
<td>6</td>
<td>4.7 years</td>
<td>Artificial chordae + Carpentier ring</td>
<td>Chordal rupture (posterior leaflet)</td>
</tr>
</tbody>
</table>
flexible, or biologic complete or partial ring should be used or safely avoided in treating isolated defects of the AL, and further clinical evaluations are required in this respect.

The use of conservative techniques has been recently shown to be effective even in the presence of extensive destruction of AL secondary to acute endocarditis [23–25]. Even extensive involvement of the AL, condition often considered a contraindication for conservative approach in acute setting, appeared to be amenable to repair in our series [26]. Nevertheless, less favorable results should be expected in this peculiar pathologic condition of the mitral valve, and no hesitation should be undertaken to replace the native valve in case of suboptimal result of repair or in case of incomplete excision of the infected tissue. Two out of three early postoperative failures in our series have been observed following mitral valve repair for acute bacterial endocarditis, requiring early reintervention and inevitable valve replacement. Therefore, MVR for active endocarditis may account for fewer successful attempts, but it should be taken into account in the surgical decision-making, and may find more frequent application as potential alternative to prosthetic valve replacement thanks to recent technical developments (‘edge-to-edge’ procedure).

5. Conclusions

Treatment of MVI due to AL disease does not adversely influence postoperative results and may provide long-term effective mitral valve repair, with maintained functional improvement. The use of recent technical developments to correct MVR due to AL failure seems to further enhance reproducibility and ease to perform it, therefore representing the technique of choice even in presence of complex mechanisms of incompetence, associated surgical procedures, particular pathological settings (dilated cardiomyopathy or acute valve endocarditis), or minimally invasive procedures.

References

Appendix A. Conference discussion

**Dr A. Royse** (Melbourne, Australia): It seems to me that the Alfieri repair is particularly good where there is poor coaptation, for whatever reason, between the anterior and posterior leaflets, and I think you have shown that nicely here. I would also use that routinely for the so-called ‘tethered posterior leaflet’ where you have had inferior myocardial infarction. The posterior leaflet does not coapt properly due to reduced inferior ventricular wall motion. You can force the two leaflets to coapt in the same plane by simply suturing them together, and I wonder if you could perhaps comment on your hospital’s experience in relation to this so-called tethering of the posterior leaflet.

**Dr Totaro**: This is just a particular series of patients with an isolated anterior leaflet prolapse, but this technique has been adopted also for prolapse of both leaflets. Nevertheless, we have limited experience in using the ‘double-orifice’ technique for restricted posterior leaflet, which could represent another indication.

**Dr N. DeVega** (Malaga, Spain): I have been using the Alfieri technique for several years but I have never used a ring, because it seems to me that if you use a ring, probably you can get some degree of stenosis. To produce a double orifice mitral valve, it seems to me that it needs a big annulus, otherwise probably it is not going to be enough, these two holes. What is your feeling about that?

**Dr Totaro**: As I told you in the presentation, we don’t report any post-repair mitral stenosis in the entire series. Nevertheless, the real need of the annuloplasty for such patients has to be confirmed by further study.

**Dr. F. Fontan** (Bordeaux, France): Did you have patients in whom you did not do any annuloplasty? With the Alfieri suture did you have patients in whom you did not apply any annuloplasty in addition to the Alfieri?

**Dr Totaro**: In the entire series 10% of the patients underwent mitral valve repair and no annuloplasty, and for the Alfieri technique there were only two patients.

**Dr Fontan**: What makes for you the decision, in addition to the Alfieri technique, to do an annuloplasty, since it is a disease of the anterior leaflet?

**Dr Totaro**: It mostly depends on the result of the ‘edge-to-edge’ repair and also from the annular dilatation. We use not only Carpentier ring annuloplasty, but also partial posterior annuloplasty in some case. Nevertheless a previous analysis performed at our Institution showed that the lack of annuloplasty during mitral valve repair represented a risk factor for long-term postoperative failure of the repair. Unfortunately this study included also patients with posterior leaflet involvement. Therefore, we agree that no real evidence is available in favor of the necessity of the application of whatever ring to complete mitral valve repair in the presence of isolated anterior leaflet prolapse.