Is a prosthetic ring required for mitral repair of mitral insufficiency due to posterior leaflet prolapse? Long-term results in 96 patients submitted to repair with no ring

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Abstract

Objective: It is a common statement that every mitral repair should be stabilized by some type of prosthetic mitral ring. In the very specific situation of isolated prolapse of the posterior leaflet (PPL), this statement may be enhanced by the possible anatomically discontinuity of the mitral annulus. This article concerns 96 patients with 'isolated' PPL (IPPL) who were operated upon without ring insertion. Long-term follow-up was obtained in order to ascertain the survival, stability of the repair and the need for reoperation, thus justifying or not the lack of use of a ring. Methods: A total of 96 patients, 70 male and 26 female, underwent mitral repair for mitral insufficiency (MI) almost exclusively caused by PPL. Age ranged from 33 to 81 years (mean 60.7 ± 11.3). All underwent quadrangular resection of the prolapsed portion and plication of the annulus. In 69 cases local stabilization was achieved by four U stitches, two on each side of the plication, passed through and sutured on some flexible material, 2–3 cm in length. Twenty seven patients had no such local reinforcement. Results: There was one case of early death (1%) caused by refractory hypoxemia in a patient with long lasting pre-operative pulmonary edema. Two patients were lost for follow-up after 2 months. Follow-up was from 0.2 to 14.7 years (mean 4.5), for a total of 422.7 patient-years. There were four late deaths at a mean of 6-year follow-up (0.9–10 years). Actuarial survival was 95.5 and 90.5% at 5 and 8 years, respectively. Event-free for recurrence of significant mitral insufficiency (MI) was 96 and 92% at 5 and 8 years. Event-free of thromboembolic or hemorrhagic events was 84.3 and 72.3% at 5 and 8 years. Conclusion: One can conclude that (a) IPPL repair without insertion of a ring is safe and long-lasting (b) the incidence of late death, recurrence of MI, thromboembolic/hemorrhagic events, need for reoperation, is not higher in this subset of patients than in conventional repair (c) such repair might work better and for a longer time, as reaction and sclerosis resulting from ring insertion are avoided (d) minor advantages could be due to an easier surgical procedure, especially through a minimally invasive approach. © 1998 Elsevier Science B.V. All rights reserved

Keywords: Cardiac surgery; Mitral insufficiency; Mitral valve repair; Surgical technique; Ring

1. Introduction

That surgical outcome in mitral regurgitation is better after repair than after replacement [1,2] is well documented by many reports. Preservation of the subvalvular apparatus [3,4] results in better left ventricular function, and explains the surgical efforts to safeguard as much as possible the physiology of the mitral complex. Today, most surgeons use as a part of the repair a ring, in order to 'reshape and resize a dilated annulus, improve leaflet coaptation and prevent recurrent or progressive dilatation'.

A number of devices have been designed to meet the aforementioned requirements, either by a rigid ring or by a partially or fully flexible device to maintain annulus flexibility and motion. However, there is a number of mitral regurgitations where there is only minimal or trivial annulus dilatation. This is the case in many patients with isolated prolapse of the posterior leaflet (IPPL) as is seen in myx-
omatosus degeneration. As the defect accounting for the insufficiency appeared very localized, we assumed there is no need for a ring to be used, once the responsible defect is cured and leaflet coaptation restored. This report analyses the long-term follow-up of this series in order to support the assumption.

2. Material and methods

Between December 1981 and February 1996, all patients with isolated posterior valve prolapse were tentatively submitted to repair without insertion of a ring. Ninety-six patients had a successful repair as described later, representing 90% of submitted cases, 75% carried out by one senior surgeon. Only those with isolated PPL were included in this study, in order to have an homogeneous subset of patients, referred as having had a ‘simple repair’. Nearly all regurgitations were secondary to myxomatous degeneration: obvious in 88 cases, possible in seven remaining cases. The last one could possibly be rheumatic in origin.

The repair consisted in resection of the flail portion of the prolapsed valve, and plication of the posterior annulus. They represent nearly 40% of all patients submitted to repair. All those who required implantation of a ring, leaflet transfer, chordal shortening, or neo chordae, were excluded. Patients with significant aortic valve involvement were also excluded from this series.

There were 70 males and 26 females. Mean age was 60.7 ± 11.3 years ranging from 33 to 81 years, and 20 patients were 70 or older. Fifty-seven patients (66%) were in New York Heart Association (NYHA) functional 3 or 4 class; two were on mechanical ventilation at the time of operation. Sinus rhythm was recorded in 73 patients, 23 had arrhythmia. Mean ejection fraction was 63.6 ± 9.4% with only eight patients having less than 50% ejection fraction. All underwent preoperative coronary angiography, 11 patients had ischemic coronary disease, eight underwent concomitant CABG. A small grade aortic insufficiency appeared very localized, we assumed there is no need for a ring to be used, once the responsible defect is cured and leaflet coaptation restored. This report analyses the long-term follow-up of this series in order to support the assumption.

The strip was cut out of a snare, most often from a Gore-Tex® vascular prosthesis. The posterior annuloplasty reinforcement technique was used in 69 patients.

In a few cases, marginal techniques were added (Table 1) as two cases of annular decalcification in order to allow the plication of the annulus after quadrangular resection.

Thus, all attempts were made to promote maximum annulus flexibility and minimize any deleterious effect on the adjacent leaflets. Leaflet coaptation was assessed by injecting saline into the left ventricular cavity through the mitral valve during concomitantly antegrade cardiopulmonary delivery ensuring simultaneous myocardial protection and avoidance of coronary air embolization. In almost all cases, excellent coaptation of the leaflets was obtained; in some, grade 1 (in a scale of 4) mitral regurgitation was assumed satisfactory.

The heart was not allowed to resume its function until good repair was obtained. In doubtfull cases an immediate replacement was undertaken. After 1989, intraoperative transesophageal echocardiography (TEE) was used to assess the repair. Results were uniformly good, in concordance with the intra-operative saline assessment, and until now never led to immediate or early post-operative reoperation. Therefore, the use of intraoperative TEE was no longer systematic for the last 20 patients.

All patients were post-operatively given anticoagulation therapy with warfarine. Anticoagulants were given during the early years for 2 months and since 3 years they were given for up to 6 months, even in patients in sinus rhythm. Patients in atrial fibrillation were given anticoagulants indefinitely.

Data were obtained by in-hospital examinations of the patients or from those collected from their cardiologists. Functional and echocardiographic data were obtained in 81 patients. Regurgitation was graded from 0 to 4 by color-flow and pulsed-wave Doppler measurements. Grade 3 and 4 were accepted as significant regurgitation for considering reoperation.

2.1. Statistical Analysis

Patient characteristics are summarized with percentages for category data and with mean ± standard deviation for

<table>
<thead>
<tr>
<th>Technique</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sliding annuloplasty</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Annular decalcification</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Commisural repair</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Posterior leaflet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadrangular resection</td>
<td>96</td>
<td>(100%)</td>
</tr>
<tr>
<td>Double quadrangular resection</td>
<td>1</td>
<td>(1%)</td>
</tr>
<tr>
<td>Anterior leaflet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wedge resection</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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continous data. Due to the small samples in some subgroups, results were recalculated by Fischer’s exact test. Multivariate analysis was assessed by logistic regression. Life time analysis of post-operative events such as death, thromboembolism, endocarditis, reoperations were calculated with the Kaplan–Meier’s method. A probability value less than 0.05 was considered significant.

Factors assessed were: age > 69-years old (n = 20), NYHA functional class III and IV (n = 57), LV ejection fraction <50% (n = 8), concomitant ischemic heart disease (n = 11), heart rhythm (arrhythmia n = 23), type of posterior annuloplasty (without annular strip n = 27). Univariate and multivariate analysis were used to determine their significance on early- and late-death and on all post-operative events taken as a whole.

The SOLO® statistical software package from BMDP was used for statistical computation.

3. Results

The follow-up was 98% complete as two patients were lost for follow-up at the 2nd post-operative month. Follow-up duration ranged from 0.2 to 14.7 years, for a total of 422.7 patients years; average follow-up was 4.5 years.

The 30-day mortality was 1% (1 of 96 patients). This patient was a 72-year-old woman, who had been suffering for bilateral pulmonary edema for many weeks. She was operated on while on mechanical ventilation and on intra-aortic balloon counterpulsation. Despite a good mitral repair and excellent cardiac function, she died on the 30th post-operative day due to refractory pulmonary hypoxia.

There were four late deaths, at a mean duration of 6 years (0.9–10 years). They were due to: (i) myocardial failure in a 85-year-old woman, 10 years after mitral repair (ii) myocardial failure occurring 10 months after repair (iii) sudden death at 8 years (iv) malignancy by melanoma at 4 years.

Three deaths were valve-related, and myocardial failure was the main cause of death, especially if the sudden death is included in that category. No predictive factor of early or late death could be identified either by univariate or multivariate analysis, due to the small number of events. Therefore, all valve-related events (death, mitral insufficiency and thromboembolic episodes) were aggregated and plotted against the variables. No correlation could be found (Table 2).

Late echocardiographic data was obtained in 85 patients (out of 93 patients alive) at a mean follow-up time of 4.5 years, with a mean post-op MR of 0.63 ± 0.8, comparing with a mean pre-op MR of 3.2 ± 0.5. Fifty-three patients have no or trivial MR, 11 grade 1/4 MR, 8 grade 2/4 MR, and 2 grade 3/4 and 1 grade 4/4 MR. There were three significant recurrent mitral insufficiencies, two of which were reoperated on after 3.8 and 6.5 years in another institution and underwent successful mitral replacement. Pathologic findings were, regurgitation due to recurrent prolapse (1x) and retraction (1x). As reoperations were performed in an other institution, so we were unable to get more pathologic data for the reports. The last patient whose repair was performed 2.5 year before, had a grade 3 recurrent MR, might be considered for reoperation in the next future.

There were eight thromboembolic and two hemorrhagic events. One patient sustained a transient ischemic attack (TIA) 2 months post-operatively. This patient had had reinforcement of the annulus plication by a string of Gore-Tex®. All but one were fully regressive. Two occurred early (at 2 months post-op). The others occurred later on, between the 1st and 5th post-operative years. Four patients were in sinus rhythm while six presented with arrhythmia.

No post-operative endocarditis was observed. There was neither hemolysis reported in this series, nor mitral stenosis, nor again left ventricular outflow tract obstruction.

Linearized rates of post-operative events were:0.9%/year for late mortality, 0.5%/year for late reoperation, 2.3%/year for late thromboembolic or hemorrhagic events, 0%/year for late endocarditis, 0.7%/year for late recurrent mitral insufficiency.

3.1. Survival

Overall actuarial survival was 95.5% ± 2.7 at 5 years and 90.5% ± 5.5 at 8 years (Fig. 1). The actuarial rate of recurrence-free from significant MR was 96.2 ± 2.6% at 5 years and 92.6 ± 4.3% at 8 years (Fig. 2). Reoperation-free actuarial rate for reoperation on mitral valve was 97.8 ± 2.1% at 5 years.

Table 2
Multivariate analysis: valve related events

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYHA 3 + 4</td>
<td>1.67</td>
<td>0.19</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>2.67</td>
<td>0.10</td>
</tr>
<tr>
<td>Age</td>
<td>2.67</td>
<td>0.24</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>0.38</td>
<td>0.53</td>
</tr>
<tr>
<td>Coronary disease</td>
<td>0.77</td>
<td>0.38</td>
</tr>
</tbody>
</table>

*Early and late death, reoperation, thromboembolic and hemorrhagic events.

The figure 1 shows the actuarial survival of mitral valve repair patients. The survival rate at 5 years is 95.5% ± 2.7 for all patients and 90.5% ± 5.5 for those who have not undergone reoperation. The incidence of significant mitral regurgitation is 0.7% per year for late endocarditis and 0.9% per year for late mortality. The incidence of reoperation-free survival is 96.2% ± 2.6% at 5 years and 92.6% ± 4.3% at 8 years.
years and 94.2 ± 4.1% at 8 years. Fig. 3, event-free actuarial rate for thromboembolic or hemorrhagic events was 84.3 ± 4.3% at 5 years and 72.3 ± 11.9% at 8 years (Fig. 4), for endocarditis 100% at 5 years and later. Actuarial rate of event-free from any possible valve related complication was 80.5% at 5 years and 65.8% at 8 years.

4. Comments

It has been well established that protection of an intact mitral subvalvular apparatus is required in maintaining optimal left ventricular function. It was documented in experimental studies [5] and in the clinical setting [3]. This may be the main reason why lower operative mortality is observed in recent reports on mitral repair [1,6–8], which is 0–6%, and it compares favorably with that of prosthetic mitral replacement as high as 4–13% [1]. The trend to enhance further left ventricular function protection is represented by the development of flexible devices, although the impact of safeguarding mitral annulus flexibility seems marginal. Protection of mitral annular contraction could account for 2.9% in global post-operative ventricular function [5]. In animal studies, [9], annular motion is less reduced by a flexible ring than a rigid one, but its use results in no significant hemodynamic advantages. Rayhill [10] and Castro [11] were unable to demonstrate any difference in left ventricular systolic function by use of either a rigid or a flexible ring. Similarly, Van Rijk-Zwikker [9] documented that flexible ring as compared with rigid ones gave less impairment of ventricular filling and larger unloaded stroke volume, but these differences were small and clinically unimportant Changes in ejection fraction correlate with changes in ventricular geometry [12]. The ring also decreases the effective hemodynamic mitral valve area.

Despite numerous studies, no significant improvement has been documented between the older rigid or the more recent flexible rings [13]. The progressive loss of annular flexibility could be one of the suggested explanations, but until now has not yet been demonstrated. Flexibility is more long-lasting with some devices, and annular contraction could improve over time [13]. Therefore, the beneficial impact could be important only in patients with significant preoperative left ventricular dysfunction. According to the good results reported it may seem unnecessary to keep off a ring. However, these results are frequently based on midterm studies and the possible drawbacks of a ring may only appear in a later phase.

In most of our mitral reoperations where a ring had been inserted during the first procedure (19 patients) one could clearly identify gross fibrosis and sometimes calcifications on the site of implantation; these changes overlapped significantly to the adjacent mitral leaflets. The precise role played by fibrosis in the ultimate failure of the primary repair has still to be defined, but it has a possible role.

Cerfolio [14] reports the recent experience of the Mayo Clinic with 49 reoperations after mitral valve repair. If there are some technical failures, in 32 patients the initial repair was intact and above all, there was fibrosis formation, thickening and calcifications involving the leaflets and in seven cases the annulus. In addition, the authors report that 41 patients showed on echocardiographic examination signs of (recurrent?) annular dilatation; and at least in some cases, it happened in the probable presence of a ring! Whether or not annulus involvement was determining, whether or not the primary aetiology was evolving cannot
be established. It is also probable that the 2.7% reoperation rate may be higher, since not all of the 1500 patients with mitral repair were contacted. It seems, accordingly, that a ring may be detrimental in the long-term, and if there is not definite need for it, it might be discarded.

Our series consists only of the very special subset of patients presenting with myxomatous degeneration where the pathologic process is an isolated prolapse of the posterior leaflet. In those patients there is usually no obvious annular dilatation. Also leaflet coaptation appears generally satisfactory apart from the prolapsed section, and left ventricular function is also protected, though the patients may be in high grade functional class [13,15,16]. These patients are candidates for the very ‘simple operation’.

It may be stated in favor of the ring that in myxomatous degeneration the whole leaflet is sick, and if there is no gross dilatation of the annulus, such a dilatation may develop in the long run. Nevertheless, there is no difference in histological appearance of the annulus of myxomatous degeneration and that of a normal valve. In both cases, there is a frequent discontinuity of the annulus [17]. Though in isolated PPL as there is no other obvious cause of mitral regurgitation, no preventive action such as a mitral ring insertion can be taken and warrants the effects. The long-term results of the present series are in favor of this interpretation; it allows for a simplified operation. Cohn [18] found that in myxomatous degeneration patients receiving a ring are doing better than those without a ring. But his patients were often submitted to complex repair including techniques on the anterior leaflet and the chordae. Diffuse degeneration is a risk factor for late failure [15], possibly independent from the presence of a ring. Surprisingly in some cases of severe mitral dystrophy, it has been suggested not to insert a ring because of a tissue ‘being to fragile’ [19]. Theoretically, these cases would have been the best indications of this procedure!

We stopped performing routine TEE after mitral repair. Although good results have been reported in patients with less than ‘echo-perfect’ results after mitral repair [20], we are in favor of a quasi perfect repair to promote good long-term results. This may also account for the excellent long-term stability of this series after surgery and explain the lack of discrepancy between the intra-operative competence-test and the TEE during surgery. In other situations, TEE remains an invaluable tool. In a series of 309 patients [21], TEE could document intraoperatively 26 immediate failures (8%), ten incomplete corrections, ten left ventricular outflow tract obstructions (LVOTO), and six suture dehiscences which led to immediate surgical correction. We consider that in difficult or complex repairs including chordae shortening, leaflets transfers, and each time the repair appears unsatisfactory, performing a peroperative TEE remains mandatory.

Dehiscence of the ring does not occur rarely [14,20]. If a ring is not required, it seems advisable to avoid implanting one. Occurrence of LVOTO has raised much interest [22], and to some extent, remains an unclear situation, though it has been infrequently reported following the sliding technique, or in repairs without a ring [23]. In this series there was neither LVOTO nor hemolysis case [24].

One such patient presented with a TIA 2 months postoperatively. As the patient was in sinus rhythm, the reason may be clot formation on the intra-cardiac foreign material and embolization. Therefore, anticoagulation is now continued up to 6 months post-operatively, even in the presence of a sinus rhythm. It also raised the question played by intra-cardiac prosthetic material and that of the consistency of anticoagulation. In order to reduce the amount of foreign material and potential sites of thrombus formation, the strip has been discarded since February 1996 by a modification of the sliding technique [4]. The flail portion is resected, an appropriate incision along the remnants of the posterior leaflet on each side is made; and at each endpoint of the leaflet incision the annulus is plicated. By this way traction as well as the amount of foreign material is reduced. The posterior leaflet is easily reconstructed by continuous suture.

5. Conclusion

Although the series presented is a small one, it is characteristic of a significant subset of patients with mitral insufficiency due to isolated PPL. This easy surgical procedure allows for excellent results which remain stable during 8–10 years. That this fact will still be true during the second decade requires further follow-up.

References


Appendix A. Conference discussion

Dr J. Vanek (Prague, Czech Republic): Is there some correlation between the diameter of the annulus and not using the ring? Since in the case when the ring is too large, I would be afraid not to use the annuloplasty ring. Is there some correlation? Are you using your method in every case in posterior leaflet prolapse?

Dr Eisenmann: To tell you that the ring is not necessary in all undilated mitral annulus when you do repair, we try to use it in a special subset of patients. And in this subset of patients, we, at 10 years, had no deleterious effect of the absence of the ring. Maybe, that the ring is not necessary in other cases but I can’t comment about that.

Dr A. Ashmeg (Jeddah, Saudi Arabia): I think quite a few surgeons around the world do mitral valve repair without a ring. And one of them is actually Dr Yacoub in London, he’s been using complex mitral repairs with no ring for many years. We have done 221 cases of mitral repair and in about 30% of them we used no ring, for mitral regurgitation. Recently we have done a redo for two cases who had complex mitral repair, 15 and 17 years ago. If those patients had rings put in at that time, it probably would have been very difficult to repeat a repair on them. Those two who I have put a ring on, it will probably unlikely that a third repair will be done in the future. But I think that is an important point. A patient who receives no ring has a chance of a re-repair in the long-term.