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Transaortic Repair of Mitral Regurgitation

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ABSTRACT

Background: In the operative management of mitral regurgitation (MR) associated with aortic valve disease, a transaortic approach combining the bowtie mitral valve repair with replacement of the aortic valve appears to offer a less invasive and technically simple, expeditious alternative to conventional left atriotomy and Carpentier style repair.

Methods: Between February 1997 and December 1999, six patients underwent a bowtie repair of the mitral valve via the aortic root with concomitant aortic valve replacement. The diagnosis of MR was established and followed postoperatively by echocardiogram. The operative technique involved a transaortic annular approach to the mitral valve with a single edge-to-edge suture approximating the prolapsing posterior mitral leaflet to a normal segment of the anterior leaflet.

Results: There were no operative mortalities. Mean cross-clamp time for both valve procedures was 104 ± 24 min and cardiopulmonary bypass was 155 ± 31. Mean postoperative cardiac output was 5 ± 1 L/min. Semiquantitative estimation of mitral regurgitation by doppler improved from a mean of 3.2 ± 0.5 preoperatively to a mean of 0.25 ± 0.5 ($p = 0.0052$) postoperatively, while ejection fraction (EF) remained stable (49 ± 9% preoperatively and 48 ± 9% prior to discharge). One patient with rheumatic mitral pathollogy had a mild increased mitral gradient which did not resolve with takedown of the bowtie repair. Mitral stenosis was not evident in any of the other patients.

Conclusions: Our initial experience with the combined transaortic bowtie repair and aortic valve replacement has demonstrated that this approach is very quick, feasible, effective, and technically simple with gratifying midterm results.

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INTRODUCTION

Severe aortic valve pathology (stenosis and/or regurgitation) is often associated with congestive heart failure, ventricular dilatation, and mitral regurgitation. In many patients, mild to moderate mitral regurgitation (MR) may improve after relief of pressure and/or volume overloading of the left ventricle following aortic valve replacement (AVR). However, with moderate to severe mitral regurgitation, operative repair is imperative to avoid the need to readdress the mitral valve once a prosthetic aortic valve is in place.

Conventional approaches to mitral valve repair require some form of left atriotomy. In the setting of combined aortic and mitral disease, development of a transaortic mitral repair technique would offer technical advantages including the avoidance of bicaval cannulation and left atriotomy.

Mitral valve repair has obvious advantages over replacement including the avoidance of long-term anticoagulation, thromboembolism, and preservation of chordal and ventricular function. The “bowtie” edge-to-edge repair has been shown to be an effective, simple, and durable means of repair for MR with low operative mortality and 95% freedom from reoperation at 6 years [Alfieri 1991, Maisano 1998]. The term “bowtie” originates in the characteristic appearance of the post-repair mitral orifice on followup echocardiography. The simplicity of this technique lends itself to less invasive approaches for mitral repair. For our patient population with combined aortic valve disease and severe mitral regurgitation, we investigated the efficacy of a single-suture “bowtie” repair performed through the aortic annulus and report our technique, the operative considerations, and medium term results.

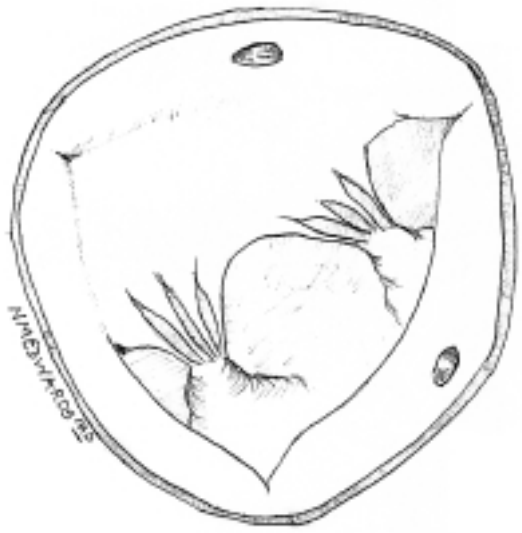

Figure 1. Exposure of the mitral valve through the aortic root.

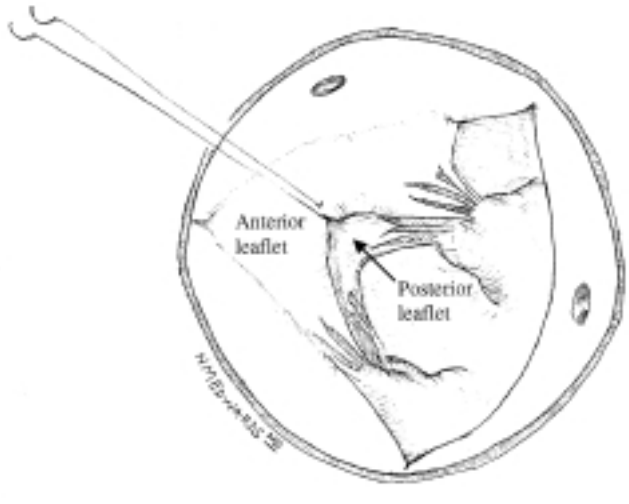

Figure 2. Transaortic bowtie repair.

MATERIALS AND METHODS

Patients

The charts of six patients (4 men and 2 women) who underwent a combined

bowtie repair of the mitral valve through the aortic root concommitant with aortic valve replacement were reviewed in a retrospective manner. The patients were operated on electively between February 1997 and December 1999, for moderately-severe MR leading to progressively worsening congestive heart failure associated with aortic valve disease. Mean age was 74 ± 7 years. The diagnosis of MR was established and followed postoperatively by echocardiogram in all patients and graded as severe (4+), moderately severe (3+), mild-moderate (2+), mild (1+) and trace regurgitation.

Operative Technique

After induction of anesthesia, the mitral valve was visualized by transesophageal echocardiography (TEE) and the likely mode of failure determined with special emphasis on the presence of leaflet prolapse along with the site and direction of the regurgitation jet. Patients were placed on extracorporeal circulation through a conventional median sternotomy with venous uptake through a single (dual-staged) right atrial cannula insert through the appendage. An oblique aortotomy was created and the aortic valve inspected. After resection of the diseased aortic valve leaflets and annular debridement, the anterior mitral leaflet was visible. The anterior leaflet blocks the surgeons' view of the posterior leaflet at this time. (Figure 1, ◎). We do not attempt to assess leaflet coaptation at this point. A figure-of-eight 4-0 polypropylene suture (Ethicon, Somerville, NJ) is passed through a point on the anterior leaflet where the direction of fibers of the chordae converge. Traction on this suture will expose the posterior leaflet where the direction of chordae converges (Figures 2 and 3, ◎). The figure-of-eight suture is then attached through a corresponding point on the posterior leaflet (see Movie 1 ◎). The suture is passed through each leaflet just as the edge turns down to attach to the primary chordae. Commonly the suture is approximately in the center of the valve (see Figure 4 ◎) and a double orifice valve is created that resembles a bowtie when viewed by the postoperative echocardiogram.

In non-redo patients where the pericardium is free of adhesions, another means to expose the posterior leaflet is to relax the chordae by repositioning the ventricle. A moist laparatomy tape is inserted into the apex of the pericardium to displace the apex of the ventricle more towards the base of the heart. This moves the papillary muscles towards the base of the annulus and relaxes the chordae tendinae. Now it is possible to lift the anterior mitral leaflet and inspect the posterior leaflet structures. A trans-aortic bowtie repair using a single 4-0 CV Gortex suture and this modification of exposure is illustrated in Movie 2 (◎). Our experience with Gore-Tex® is that it has good handling properties, but breaks more easily than polypropylene.

After replacement of the aortic valve and closure of the aortotomy, the patient is separated from cardiopulmonary bypass. Post-repair transesophageal echocardiography (TEE) is used to confirm the adequacy of the repair. During follow-up, standard and exercise echocardiography is used to establish the competency of the repair as well as the absence of a significant gradient across the mitral valve.

RESULTS

Preoperatively, all patients had moderately severe or severe MR confirmed by transthoracic echocardiogram. Three patients had undergone prior aortic valve replacements. Two patients had aortic para-valvular leaks and one

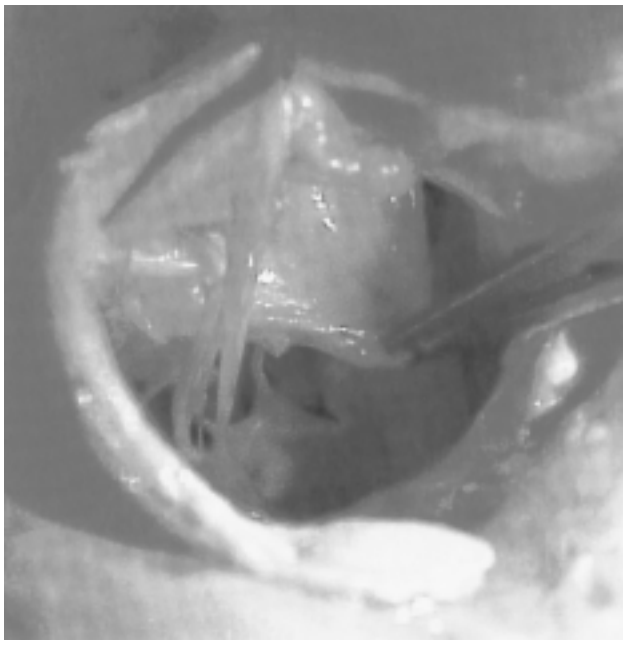

Figure 3. Retraction of the anterior leaflet to expose the posterior leaflet.

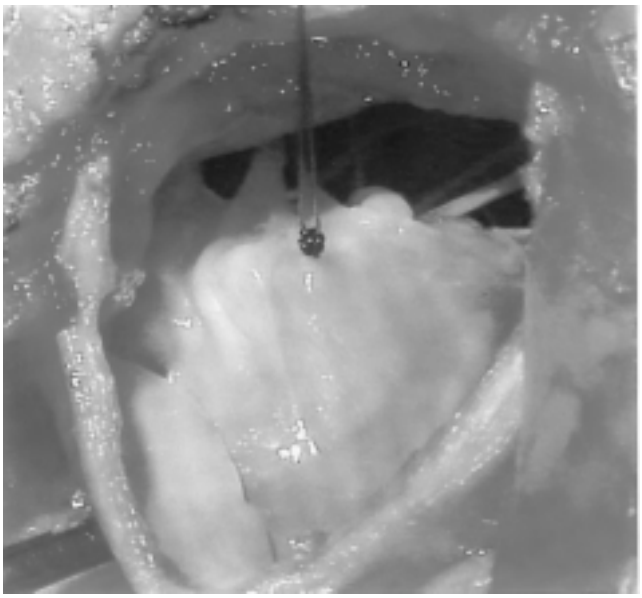

Figure 4. Completed bowtie repair.

had concomitant four-vessel coronary artery disease. The mean degree of preoperative MR was 3.2 ± 0.5 with a mean preoperative ejection fraction 49% ± 9%. Mean cross-clamp time for correction of both valves was 104 ± 24 min and the mean cardiopulmonary bypass time was 155 ± 31. Mean cardiac output postoperatively was 5 ± 1 L/min. Four patients underwent AVR using tissue valves (Carpentier-Edwards) and two had a mechanical valve (Carbomedics) implant.

One patient had severe rheumatic valvular disease with a decreased mitral valve area (1.9 cm^2). An increased diastolic gradient (12 mm) developed intraoperatively after application of a bowtie repair and repair of the aortic valve, which did not improve on removal of the bowtie suture.

There were no perioperative mortalities. One late death occurred four months postoperatively from sepsis leading to multi-organ failure. Except for this patient, pressor support was required for an average of 1.5 days (range 1 to 2 days). Average intensive care length of stay was 1.5 days (range 1 to 2 days) and average hospital stay 11.6 days (range 10 to 12 days).

Postoperatively, echocardiograms revealed well-controlled MR, decreasing from a mean of 3.2 ± 0.4 to a mean of 0.25 ± 0.5; p = 0.0052 (Figure 5, ⊙). Paradoxically, we observed a slight increase rather than the expected decrease in mean ejection fraction: from 49.1% ± 9.4% to 50% ± 4.0%, p = 0.71 (Figure 2, ⊙).

DISCUSSION

The advantages of mitral valve repair over replacement have been described and include preservation of chordal function [Christakis 1985, Loop 1991, Oz 1994] and the mitral subvalvular apparatus. Avoidance of the resection of the chordae and subvalvar apparatus has been shown to minimize the ventricular dysfunction usually observed after full replacement [Grossman 1975, Wisenbaugh 1984, Sarris 1988, Hansen 1989, Corin 1991, Umana 1997].

The bowtie repair, as an adjunct and/or potential alternative to conventional annuloplasty, has yielded satisfactory hemodynamic and clinical results [Maisano 1999 (a), Umana 1998]. Prior reports of bowtie repairs through a transatrial approach indicate a 92% survival and 95% freedom from reoperation at 6 years [Maisano 1998]. Fucci et al. reported 35 cases performed over a 3-year period with uniform success and no reoperations [Fucci 1995]. However, 93% of the repairs were done as an adjunct to ring annuloplasty. The remaining 7% of repairs were pure bowtie repairs (without annuloplasty) and still resulted in full correction of MR. In their most recent series, the same group successfully applied this technique of mitral repair in 73 consecutive patients with severe MR secondary to Barlow's disease [Maisano 1999(b)]. The increasing incidence of isolated bowtie repair without an annuloplasty is encouraging, but without any long-term outcome data.

The bowtie repair appears to be particularly useful and effective in the difficult group of patients suffering from ischemic mitral regurgitation. Previous reports from our institution reveal adequate correction of subvalvular dysfunction observed in ischemic MR using this technique with a remarkable preservation of ejection fraction. Control of MR was achieved with the edge-to-edge suture, decreasing the semi-quantitative measure of MR from 3.6 ± 0.5 to 0.8 ± 0.4 (p = 0.001), while associated with a significant increase in mean ejection fraction, from 33 ± 13% to 45 ± 11% (p = 0.0156) [Umana 1997, Umana 1998]. This

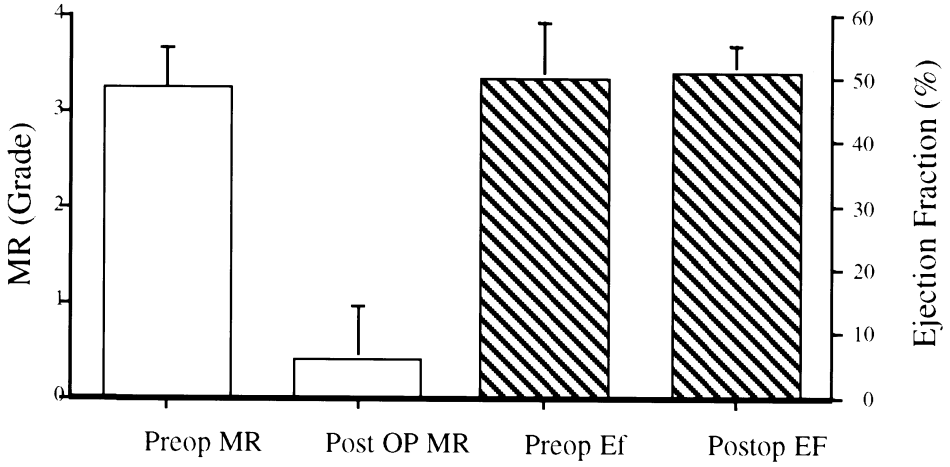

Figure 5. Comparison of preoperative and postoperative mitral regurgitation.

technique has also been used successfully as sole therapy for MR (without annuloplasty) during left ventricular volume reduction procedures without a significant incidence of early recurrence of MR [Batista 1996, Starling 1997].

Based on these experiences, we began to utilize the bowtie repair through a transaortic approach for aortic valve disease with severe MR. In our first 4 cases, the repair demonstrated that it could be performed quickly and reproducibly. The reduction in semi-quantitative MR scoring was very dramatic. We have seen no disadvantages to the repair at this time. Rather, there are numerous advantages, including 1) reduced cross clamp time, pump time, and total operative time, 2) simplification of the surgical technique, 3) avoidance of atriotomy, 4) avoidance of bicaval cannulation, and 5) avoidance of the need for full lysis of adhesions and cardiac mobilization during reoperations. These advantages translate to reduced mechanical trauma and duration of myocardial ischemia when compared to a conventional mitral repair [Maisano 1999(a)]. The adequate exposure and the ease with which this repair is executed make the bowtie operation an appealing technique. Although this procedure is technically easy if the aortic annulus is relatively large, a small inelastic annulus can make it technically more demanding.

The mechanism of action of the bowtie repair is still a matter of some debate. It appears that one of the primary mechanisms of action is to create a functional equivalent of a chordal transfer procedure. By suturing the flail segment to a leaflet with normal chordal length and function, the appositional plane of both leaflets is restored and maintained by the chords to the normal leaflet. This simple maneuver immediately corrects the prolapse and reconfigures the mitral closure mechanism to a normal subannular plane. At the same time, the bowtie avoids the need for quadrant resection, sliding leaflet annuloplasty, or placement of artificial chordae tendinae.

Although concern has been raised that suturing the anterior and posterior mitral leaflets together could create stenosis, this has not been our experience providing the anterior leaflet has no restriction in motion. If the anterior leaflet is mobile and not involved in scarring or calcification (i.e. restricted movement), the mitral apparatus will not become stenotic with this repair. In the one patient in our series that did develop a post-bowtie increase in mitral gradient, rheumatic pathology was present and the gradient did not decrease after removal of the bowtie suture. For non-rheumatic, degenerative mitral pathology, the presence of a mobile anterior leaflet indicates the repair is feasible.

Posterior mitral annular calcification (MAC) is not a contraindication for the bowtie repair. In fact, with MAC, a conventional repair would be quite complex and dangerous, requiring decalcification and reconstruction of the atrioventricular groove. The bowtie is a considerably less difficult repair in this setting. Even with MAC, the orifice of the mitral valve has sufficient reserve to remain nonstenotic after bowtie repair in our experience.

The bowtie repair is finding its niche as an important technique for correction of mitral regurgitation in carefully selected patients with ischemic or degenerative pathology. Our experience with the bowtie repair via the aortic root has demonstrated that this approach is feasible, effective, and technically simple. While we await our long-term follow-up results, this first report of isolated bowtie mitral valve repair through the aortic root has provided us with encouraging results including full correction of MR with markedly reduced operative times and remarkably simplicity.

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