Review

Surgical Treatment of Active Infective Mitral Valve Endocarditis

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Although infective endocarditis is primarily treated conservatively with antimicrobial therapy, early surgical intervention is often mandatory when various complications arise. These include intractable heart failure, persistent uncontrollable infection, large mobile vegetations, peripheral embolism and prosthetic valve endocarditis. Optimal timing of surgical intervention in patients with infected heart valves results in reduced early and late mortality. In the context of healed infective endocarditis, mitral regurgitation is treated with mitral valve repair, which produces long-term results similar to those seen for treatment of degenerative mitral regurgitation. Mitral valve repair should also be considered for patients with mitral regurgitation due to active infective endocarditis. Superficial infection without valve destruction is the best candidate for valve repair. Discrete vegetations on the valve leaflets are excised along with underlying leaflet tissue (vegetectomy). Although valve lesions can be repaired by standard techniques, particular care (e.g., reinforcement with a pericardial patch) should be taken to avoid excess tension on the suture line. The feasibility of valve repair depends on the extent of tissue destruction. Large defects of the anterior leaflet, due to transmural infection or lesions that encompass greater than one-third of the entire posterior leaflet with annular abscess, are not amenable to repair. Also, the involvement of the aortic valve frequently necessitates valve replacement. Further, unstable preoperative hemodynamics leads to the decision to perform valve replacement immediately rather than complicate valve repair in an attempt to avoid prolonged operation time for life salvage. In the context of the feasibility of valve repair, timely surgical intervention and precise repair technique are essential. (Ann Thorac Cardiovasc Surg 2007; 13: 150–155)

Key words: mitral valve repair, active infective endocarditis

Introduction

Despite recent improvements in the diagnosis and therapeutic strategy of infective endocarditis (IE), mortality remains relatively high at 20%,[1,2] and there has been no substantial improvement over the last two decades.[3] This is partially due to the development of drug resistance by the microorganisms that commonly cause IE, and updated guidelines from the American Heart Association (AHA) on the treatment of IE .[4] Although IE is primarily treated conservatively with antimicrobial therapy, early surgical intervention is often mandatory when various complications arise, including intractable heart failure, persistent uncontrollable infection, large mobile vegetations, peripheral embolism, prosthetic valve endocarditis. Appropriately timed and performed surgical therapy of the infected heart valve contributes substantially to reduced early and late mortality,[5] While mitral valve regurgitation (MR) in the context of IE is typically treated with mitral valve replacement using a prosthesis, recent clinical studies[6–11] suggest that mitral valve repair may also be of use. However, surgeons are biased against the procedure, because of fears of complicated techniques and/or inferior durability against recurrent infection, which results in the de-

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Table 1. Echocardiographic features that suggest potential need for surgical intervention[4)]

Vegetation
Persistent vegetation after systemic embolization
Anterior mitral leaflet vegetation, particularly with size >10 mm
>1 embolic events during first 2 weeks of antimicrobial therapy
Increase in vegetation size despite appropriate antimicrobial therapy
Valvular dysfunction
Acute aortic or mitral insufficiency with signs of ventricular failure
Heart failure unresponsive to medical therapy
Valve perforation or rupture
Perivalvular extension
Valvular dehiscence, rupture, or fistula
New heart block
Large abscess or extension of abscess despite appropriate antimicrobial thrapy

fault use of valve replacement especially in patients with active IE. The following material reviews the clinical characteristics and outcomes of patients undergoing valve repair for active IE of the mitral valve.

Surgical Indications—AHA's Recommendations[4)]

Patients with IE and congestive heart failure (CHF), irrespective of the cause or mechanism, should be immediately evaluated for possible surgical therapy (Class I). CHF in IE portends a grave prognosis with medical therapy alone and is also the most powerful predictor of poor outcome with surgical therapy. Despite a higher operative mortality rate in patients with CHF than in those without CHF, patients with IE who have CHF and undergo valve surgery have a substantially reduced mortality rate compared with those treated with medical therapy alone.[12)]

Surgical intervention should be considered in the following clinical situations (Class I); fungal IE, infection with aggressive antibiotic resistant bacteria or bacteria that respond poorly to antibiotics, left-sided IE caused by Gram-negative bacteria, persistent infection with positive blood cultures after 1 week of antibiotic therapy, or 1 or more embolic events during the first 2 weeks of antimicrobial therapy.

Echocardiographic evidence of valve dehiscence, perforation, rupture, fistula, a large perivalvular abscess, and obstructive vegetation warrant consideration of surgical intervention (Class I). Echocardiographic findings that indicate the possible need for surgery are anterior mitral leaflet vegetation (particularly with size >10 mm) or persistent vegetation after systemic embolization (Class IIa). Echocardiographic features that suggest potential need for surgical intervention are shown in Table 1.

The role of surgical intervention to prevent systemic embolization must be considered in the context of the specific patient, with the greatest benefit in the early phase of IE, when embolic rates are highest and other predictors of a complicated course (e.g., recurrent embolization, CHF, aggressive antibiotic-resistant organisms, prosthetic valve IE) are present. The greatest risk of embolization appears to occur with vegetations >10 mm in diameter occurring on the anterior mitral leaflet[13)] and during the first 1 to 2 weeks of therapy.[14)]

Extension of IE beyond the valve annulus is associated with higher mortality rate, CHF, and the need for surgical intervention. Prosthetic valve IE, particularly early prosthetic valve IE (<12 months after valve replacement), often is caused by infection by *Staphylococcus* species and may encounter such severe clinical situations. For theses reasons, surgical intervention is more commonly indicated in prosthetic valve IE than in native valve IE.

Classification of recommendations is as follows:
Class I: Conditions for which there is evidence, general agreement, or both that given procedure or treatment is useful and effective.
Class II: Conditions for which there is conflicting evidence, a divergence of opinion, or both about the usefulness/efficacy of a procedure or treatment.
Class IIa: Weight of evidence/opinion is in favor of usefulness/efficacy.

Table 2. Feasibility of mitral valve repair in patients with active infective endocarditis

Authors	Reported	N	Active IE (%)	Onset to surgery (day)	Valve repair for active IE (%)
Iung B, et al.[6]	2004	78	32 (41)	20	25 (78)
Podesser BK, et al.[7]	2000	22	22 (100)	30	22 (100)*
Muehrcke DD, et al.[8]	1997	146	58 (40)	?	26 (45)
Sternik L, et al.[9]	2002	44	44 (100)	<42	16 (36)
Dreyfus G, et al.[10]	1990	40	40 (100)	30	40 (100)*
Ruttmann E, et al.[11]	2005	68	68 (100)	11	34 (50)

*, Report on valve repair alone.

Table 3. Surgical results of mitral valve repair in patients with active infective endocarditis

Authors	N	Operative mortality (%)	Reinfection (%)	Reoperation (%)	Event free survival (%)
Iung B, et al.[6]	78	4	1.6	4.8	62 (5 years)
Podesser BK, et al.[7]	22	9.1	0	13.6	75 (5 years)
Muehrcke DD, et al.[8]	146	3.8	1	1	74 (6 years)
Sternik L, et al.[9]	44	0	0	0	?
Dreyfus G, et al.[10]	40	2.5	0	2.5	?
Ruttmann E, et al.[11]	68	11.8	2.9	?	80 (10 years)

Class IIb: Usefulness/efficacy is less well established by evidence/opinion.
Class III: Conditions for which there is evidence, general agreement, or both that the procedure/treatment is not useful/effective and in some cases may be harmful.

Feasibility of Mitral Valve Repair in Active IE

Published series on mitral valve repair for IE have generally included a limited number of patients. Iung et al.[6] reviewed 78 patients of mitral valve IE and reported that valve repair was performed in 25 of 32 patients (78%) with active IE (i.e., during active treatment with antibiotics), and in 38 of 46 patients (83%) with healed IE. Muehrcke et al.[8] reported that valve repair was achieved in 26 of 58 patients (45%) with active mitral valve IE (positive blood culture, operative findings of acute inflammation, or positive cultures of excised tissue), whereas 76 of 88 patients (86%) with healed IE underwent valve repair. Sternik et al.[9] defined active IE as the persistence of clinical symptoms and a diagnosis less than 6 weeks prior to operation. In that series of patients, 28 patients had valve replacement and 16 patients (36%) of 44 patients with active native mitral valve IE underwent valve repair. Dreyfus et al.[10] reported that less than 20% of their patients with active IE (in patients operated on within the first 6 weeks after onset of symptoms and before completion of the initial full course of antibiotics) required mitral valve replacement. Clearly, the varying definitions of active IE among these studies introduces some confusion as to the frequency at which mitral valve repair is feasible in the acute phase of IE. Regardless, these data suggest that mitral valve repair should be considered, even in patients with active IE (Table 2).

Since surgical treatment of active IE requires complete resection of all involved tissues, the feasibility of valve repair depends on the extent of pathological lesions.[6,10] Sternik et al.[9] compared valve pathology in patients undergoing valve repair with those in patients undergoing valve replacement. In their analysis, the only significant determinant associated with valve replacement was near-total bileaflet destruction, and other abnormalities of vegetations, annular abscess or chordal rupture did not prevent repair. Muehrcke et al.[8] reported that patients with vegetations on the anterior or posterior leaflet and those with previous mitral valve repair procedures were more likely to require valve replacement. However, some of the patients in their series requiring valve replacement also needed associated concomitant procedures, which influenced the surgeon's decision not to attempt valve repair in order to avoid prolonged cross-clamp and bypass times in these patients. In addition, we often encounter more severe preoperative heart failure in patients with active IE. According to the experience of Toronto Hospital on surgery for active IE (in any valve position), 88 of 122 patients (72%) with active IE were classified as New

York Heat Association functional class IV, and 19 patients (16%) were in cardiogenic and/or septic shock. In this series, only 8 patients underwent valve repair, while 32 patients were treated with valve replacement for active IE in the mitral position.[15)]

Between April 1999 and December 2005, we performed mitral valve surgery in 23 patients with active IE, which was defined according to Manhas's classification.[16)] Fourteen of 23 patients (61%) underwent successful mitral valve repair. Six of 9 patients undergoing valve replacement were in shock or intractable heart failure preoperatively and required emergent operation, and 8 patients underwent combined aortic valve replacement for concomitant aortic valve involvement. Preoperative unstable hemodynamics and a time consuming concomitant procedure necessitated the use of simple valve replacement rather than electing for a complicated attempt at valve repair.

Mitral Valve Repair Technique

The surgical principles for mitral valve repair consist of complete removal of all infected tissues and anatomical reconstruction of the mitral valve. Those patients with superficial infection without valve destruction are the best candidates for valve repair. All vegetations are removed one by one with a surgical blade and scissors, followed by ablation of the affected surface with an electric cautery (vegetectomy). When little underlying valve lesions causing MR are present, valve repair can be achieved through simple plication of elongated leaflets or direct closure of the perforation following vegetectomy. Even in the presence of chronic valve pathology, valve repair can be successfully achieved with conventional repair technique. Lesions of the posterior leaflet can be managed by resection up to one-third of the entire posterior leaflet. For commissural lesions, fixation between anterior and posterior leaflet is performed, following the resection of the lateral portion of both leaflets. In the case of the anterior leaflet involvement, local perforations or small defects of the leaflet caused by debridement can be repaired using an autologous pericardial patch, whereas large defects caused by transmural destruction are difficult to repair. Dreyfus et al.[10)] performed mitral valve repairs according to Carpentier's techniques in patients with a large range of valvular pathologies, including those with active IE involving the anterior leaflet. However, they observed that repair of the entire anterior leaflet with pericardium was possible only when the marginal chordae were not involved.

Special care should be taken to avoid excess tension to the suture line. Little normal valve tissue may be left to allow valve repair, since all infective lesions must be resected. In performing leaflet resection and suture of the posterior leaflet or commissural area, annular plication or sliding plasty are needed. We prefer to use autologous pericardium to cover the suture line in order to reduce the risk of leaflet dehiscence.

In cases of MR secondary to active IE, neither underlying valve pathology nor annular dilatation are generally present. Therefore, annuloplasty is not indicated.We basically perform posterior ring annuloplasty with autologous pericardium. A rectangular strip of the pericardium (approximately 3×6 cm^2) is harvested and cleared of adherent adipose tissue. The strip is folded the serosal surface outside and then twisted. The twisted pericardial ring was fixed with mattress sutures along the posterior annulus, just beyond the anatomic commissures. The aim of performing posterior annuloplasty with autologous pericardium is to prevent excess tension to the suture line rather than for the purposes of remodeling the annulus. By contrast, ring annuloplasty is often necessary when chronic valve lesions predate the onset of IE. Prosthetic material is more prone to infection, compared with native tissues, so it is therefore avoided when ever possible. However, in patients with a dilated annulus or with anterior leaflet pathology, remodeling of the annulus, including reduction of the anteroposterior diameter and stabilization of the anterior annulus using a total annular prosthetic ring is essential for durability of the repair.

Durability of Mitral Valve Repair in Active IE

According to an analysis of 6,627 patients with IE undergoing mitral valve surgery at 661 participating centers of the Society of Thoracic surgeons,[17)] mitral valve repair was less frequently used for patients with active IE (423 of 2,654; 15.9%), and mortality rate was 10.6% for those undergoing mitral valve repair and 15.7% for those undergoing mitral valve replacement. Other case series[6–11)] report a hospital mortality rate ranging from 0–11.8% for those patients with active mitral valve IE who undergo valve repair and 0–21.9% for those undergoing prosthetic valve replacement. As patients undergoing valve replacement often had more severely damaged valves as a result of IE, simple retrospective comparison between outcome of valve repair and those of valve replacement may be misleading. Regardless, hospital mortality is lower for

those undergoing mitral valve repair when compared with those undergoing valve replacement.

Of note, the risk of late endocarditis after mitral valve repair for active IE is very low (0–2.9%).[6–11] Ruttmann et al.[11] showed that actuarial freedom from recurrence of infection at the 5-year follow-up was 96% in the valve repair group and 83% in the replacement group. Further, 10-year event-free survival was 80% in the valve repair group and 46% in the replacement group. Also, Muehrcke et al.[8] showed that patients having valve repair rather than replacement for active IE had improved event-free survival (74% versus 20% at 6 years). Even in patients with active IE, an event-free survival rate of greater than 60% at 5 years were guaranteed following valve repair.[6–8,11] Preservation of the native valve tissue during repair and avoiding prosthetic materials in an infected area likely accounts for these excellent outcomes. Mitral valve repair in the presence of active IE demonstrated similar durability and low need of reoperation when compared with valve replacement.[8]

In our experience 14 patients with active mitral valve IE undergoing valve repair, the hospital mortality rate was 7.1%, and there was no late death at the 29-month follow-up. Whereas 2 patients required reoperation due to residual MR, no recurrent IE occurred. None to grade 1+ MR were noted in 10 patients, and one patent had developed grade 2+ MR at the most recent follow-up.

Mitral Valve Replacement

Not all patients with complicated active IE are candidates for valve repair. Since favorable outcomes have been seen with prosthetic valve replacement,[15,17–19] this strategy should be elected when valve repair is too technically demanding or in a patient with life-threatening complications. Bauernschmitt et al.[20] reported that the use of mechnical valve in patients with IE achieved results that were comparable to those seen with the use of a homograft. The predominance of bioprostheses over mechanical valves with regard to reinfection has not yet been adequately addressed. Mechanical valves are most appropriate for use in younger patients with native valve IE, while bioprosthesis are typically used in patients with IE who are greater than 60 years of age.[21] For active IE in the mitral position, valve replacement with a bioprosthesis should be used in patients over 70 years of age if valve repair is not indicated.

Early Surgical Intervention

The timing of surgical intervention is an important determinant for a good outcome following mitral valve repair for active IE. When endocarditis is complicated by valvular regurgitation and significant impairment of cardiac function, surgical intervention before the development of severe intractable hemodynamic dysfunction is recommended, regardless of the duration of antimicrobial therapy. Previous studies have demonstrated that the feasibility of mitral valve repair was dependent on the extent of tissue destruction and that earlier intervention may help to ensure valve repairability.[8,10] Although vegetation size alone has rarely been used as an indication for surgery,[22] meta-analysis suggested that the risk of systemic embolization is increased in patients with vegetations >10 mm relative to those with smaller or no detectable vegetations (33% versus 19%).[23] Further, a recent prospective multicenter study demonstrated that vegetation length >10 mm and high vegetation mobility were predictors of new embolic events and that vegetation length >15 mm was a predictor of 1-year mortality.[24] Also, preoperative cerebral embolism requires modification of the timing of surgery. The rate of exacerbation of cerebral complications decreased to 10% in patients who underwent surgical treatment more than 15 days after cerebral infarction and decreased to 2.3% in those who underwent surgical treatment more than 4 weeks later.[25] According to AHA guidelines,[4] early surgical intervention before embolic events is indicated in patients with friable vegetations >10 mm with significant regurgitation, even if hemodynamics remains stable or the course of antimicrobial treatment has not been completed.

In our series, the mean interval from initiation of antibiotic therapy to surgery was 13 days, which was shorter than those of previous reports from institutions performing valve repair more aggressively for active IE. This may account for the fact that none of our patients developed paravalvular absceses, which otherwise occurs in 11–23%[26,27] of patients with native valve endocarditis. This may also contribute to the higher rate of feasibility of valve repair, especially in patients with solitary mitral valve active IE.

In conclusion, mitral valve repair is feasible with favorable durability, even in patients with active IE. Thus, mitral valve repair should be considered regardless of the etiology of MR. In the context of the feasibility of valve repair, timely surgical intervention and precise repair technique are essential.

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