Mitral Valve Replacement: Indications and Types

J H Abernathy, III, MD, MPH, FASE
Associate Professor
Chief, Division of Cardiothoracic Anesthesiology
Medical University of South Carolina

The first mitral valve replacement was performed in 1959 by Nin Braunwald at the National Institutes of Health and used a homemade device with artificial cordae made of polyurethane. Two years later, Albert Starr, a cardiac surgeon, and Lowell Edwards, a mechanical engineer, developed the Starr-Edwards ball-and-cage mitral valve. This was the first commercially available valve and soon became widely implanted. Significant thromboembolic complications and inadequate durability prompted the development of second and third generation prosthetic valves.

Developed by Viking Bjork and Early Shiley, the Bjork-Shiley tilting disk mitral valve had superior hemodynamics and quickly replaced the Starr-Edwards valve. Thromboembolic events, although less than the Starr-Edwards valve, remained a significant problem.

St Jude Medical developed the bileaflet tilting disk valve in the 1970s and by 1980 had become the mechanical valve of choice. Its superior hemodynamic profile and reduced incidence of thromboembolic complications lead to its quick adaptation into clinical practice.

Biomechanical valves were developed in the 1960s. By 1970 the Hancock and Carpentier-Edwards that utilized glutaraldehyde fixation were widely adapted. These valves had satisfactory hemodynamics and obviated the need for anticoagulation. The early valves suffered from high early failure rates. Third generation valves now use advanced fixation techniques for porcine aortic valves and have utilized bovine pericardium to build valves. Their long-term failure rates have been greatly reduced.

Indications

Indications for Mitral valve surgery (repair or replacement) are divided into regurgitant lesions, stenotic lesions and endocarditis by the American College of Cardiology. In most circumstances it is preferable to repair a mitral valve than replace it. For those valves that need to be replaced, it is preferable to spare the subvalvular apparatus.

Regurgitation

Class I evidence:

1. MV surgery is recommended for the symptomatic patient with acute severe MR.* (Level of Evidence: B)
2. MV surgery is beneficial for patients with chronic severe MR* and NYHA functional class II, III, or IV symptoms in the absence of severe LV dysfunction (severe LV dysfunction is defined as ejection fraction less than 0.30) and/or end-systolic dimension greater than 55 mm. (Level of Evidence: B)
3. MV surgery is beneficial for asymptomatic patients with chronic severe MR* and mild to moderate LV dysfunction, ejection fraction 0.30 to 0.60, and/or end-systolic dimension greater than or equal to 40 mm. (Level of Evidence: B)
4. MV repair is recommended over MV replacement in the majority of patients with severe chronic MR* who require surgery, and patients should be referred to surgical centers experienced in MV repair. (Level of Evidence: C)

Class IIa

1. MV repair is reasonable in experienced surgical centers for asymptomatic patients with chronic severe MR* with preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom the likelihood of successful repair without residual MR is greater than 90%. (Level of Evidence: B)

2. MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and new onset of atrial fibrillation. (Level of Evidence: C)

3. MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise). (Level of Evidence: C)

4. MV surgery is reasonable for patients with chronic severe MR* due to a primary abnormality of the mitral apparatus and NYHA functional class III–IV symptoms and severe LV dysfunction (ejection fraction less than 0.30 and/or end-systolic dimension greater than 55 mm) in whom MV repair is highly likely. (Level of Evidence: C)

Class IIb

MV repair may be considered for patients with chronic severe secondary MR* due to severe LV dysfunction (ejection fraction less than 0.30) who have persistent NYHA functional class III-IV symptoms despite optimal therapy for heart failure, including biventricular pacing. (Level of Evidence: C)

Class III

1. MV surgery is not indicated for asymptomatic patients with MR and preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom significant doubt about the feasibility of repair exists. (Level of Evidence: C)

2. Isolated MV surgery is not indicated for patients with mild or moderate MR. (Level of Evidence: C)
**Stenosis**

**Class I**

1. MV surgery (repair if possible) is indicated in patients with symptomatic (NYHA functional class III–IV) moderate or severe MS* when 1) percutaneous mitral balloon valvotomy is unavailable, 2) percutaneous mitral balloon valvotomy is contraindicated because of left atrial thrombus despite anticoagulation or because concomitant moderate to severe MR is present, or 3) the valve morphology is not favorable for percutaneous mitral balloon valvotomy in a patient with acceptable operative risk. (Level of Evidence: B)

2. Symptomatic patients with moderate to severe MS* who also have moderate to severe MR should receive MV replacement, unless valve repair is possible at the time of surgery. (Level of Evidence: C)

**Class IIa**

MV replacement is reasonable for patients with severe MS* and severe pulmonary hypertension (pulmonary artery systolic pressure greater than 60) with NYHA functional class I–II symptoms who are not considered candidates for percutaneous mitral balloon valvotomy or surgical MV repair. (Level of Evidence: C)
Class IIb

MV repair may be considered for asymptomatic patients with moderate or severe MS* who have had recurrent embolic events while receiving adequate anticoagulation and who have valve morphology favorable for repair. (Level of Evidence: C)

Class III

1. MV repair for MS is not indicated for patients with mild MS. (Level of Evidence: C)
2. Closed commissurotomy should not be performed in patients undergoing MV repair; open commissurotomy is the preferred approach. (Level of Evidence: C)

Endocarditis

Indications for endocarditis are classified by native or prosthetic valve endocarditis.

Surgery for Native Valve Endocarditis

Class I

1. Surgery of the native valve is indicated in patients with acute infective endocarditis who present with valve stenosis or regurgitation resulting in heart failure. (Level of Evidence: B)

2. Surgery of the native valve is indicated in patients with acute infective endocarditis who present with AR or MR with hemodynamic evidence of elevated LV end-diastolic or left atrial pressures (e.g., premature closure of MV with AR, rapid decelerating MR signal by continuous-wave Doppler (v-wave cutoff sign), or moderate or severe pulmonary hypertension). (Level of Evidence: B)

3. Surgery of the native valve is indicated in patients with infective endocarditis caused by fungal or other highly resistant organisms. (Level of Evidence: B)

4. Surgery of the native valve is indicated in patients with infective endocarditis complicated by heart block, annular or aortic abscess, or destructive penetrating lesions (e.g., sinus of Valsalva to right atrium, right ventricle, or left atrium fistula; mitral leaflet perforation with aortic valve endocarditis; or infection in annulus fibrosa). (Level of Evidence: B)

Class IIa

Surgery of the native valve is reasonable in patients with infective endocarditis who present with recurrent emboli and persistent vegetations despite appropriate antibiotic therapy. (Level of Evidence: C)

Class IIb

Surgery of the native valve may be considered in patients with infective endocarditis who present with mobile vegetations in excess of 10 mm with or without emboli. (Level of Evidence: C)

Surgery for Prosthetic Valve Endocarditis
Class I

1. Consultation with a cardiac surgeon is indicated for patients with infective endocarditis of a prosthetic valve. (Level of Evidence: C)
2. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with heart failure. (Level of Evidence: B)
3. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with dehiscence evidenced by cine fluoroscopy or echocardiography. (Level of Evidence: B)
4. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with evidence of increasing obstruction or worsening regurgitation. (Level of Evidence: C)
5. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with complications (e.g., abscess formation). (Level of Evidence: C)

Class IIa

1. Surgery is reasonable for patients with infective endocarditis of a prosthetic valve who present with evidence of persistent bacteremia or recurrent emboli despite appropriate antibiotic treatment. (Level of Evidence: C)
2. Surgery is reasonable for patients with infective endocarditis of a prosthetic valve who present with relapsing infection. (Level of Evidence: C)

Class III

Routine surgery is not indicated for patients with uncomplicated infective endocarditis of a prosthetic valve caused by first infection with a sensitive organism. (Level of Evidence: C)

Types of Valves

Currently approved FDA valves are the Starr-Edwards, Medtronic-Hall tilting disk, Ominicarbon tilting-disk, St Jude Medical bileaflet, Carbomedics bileaflet, the ATS bileaflet, and the ON-X bileaflet.

Currently approved bioprosthetic valves are the Hancock II porcine heterograft, Carpentier-Edwards standard, Mosaic porcine heterograft, Carpentier-Edwards pericardial bovine heterograft, and the St Jude biocor porcine heterograft.

The choice of valve types is delineated by the ACC/AHA guidelines. For young patients, anyone in atrial fibrillation who require long-term anticoagulation and any patient who wants to minimize reoperation should receive a mechanical valve. The most commonly place mechanical valve is the St Jude because of its hemodynamic characteristics and its ease of insertion. Choice of a specific valve often depends upon surgeon and institution preference. Valves with a low profile might be beneficial in patients with a small left ventricular cavity. In these patients, tall valves can obstruct the left ventricular outflow tract. If the annulus has been destroyed by endocarditis, the surgeon may choose a valve with a large sewing ring so that inverted sutures can be placed.

Prosthetic valves should be offered to patients who wish to avoid anticoagulation, are over 70 years of age, or are not expected to outlive the prosthetic valve. Because of the high systolic pressures any valve in the mitral position must endure, structural valve degeneration occurs rapidly. Prosthetic valves inserted in anyone younger than 60 are likely to need replacement. Despite the need for eventual reoperation, there maybe some patients for whom they are indicated. For instance, young women who wish to become pregnant. For them, anticoagulation is contraindicated.
The ACC/AHA guidelines are as follows:

Class I
A bioprosthesis is indicated for MV replacement in a patient who will not take warfarin, is incapable of taking warfarin, or has a clear contraindication to warfarin therapy. (Level of Evidence: C)

Class IIa
1. A mechanical prosthesis is reasonable for MV replacement in patients under 65 years of age with long-standing atrial fibrillation. (Level of Evidence: C)
2. A bioprosthesis is reasonable for MV replacement in patients 65 years of age or older. (Level of Evidence: C)
3. A bioprosthesis is reasonable for MV replacement in patients under 65 years of age in sinus rhythm who elect to receive this valve for lifestyle considerations after detailed discussions of the risks of anticoagulation versus the likelihood that a second MV replacement may be necessary in the future. (Level of Evidence: C)

References

