Percutaneous Techniques for the Treatment of Patients with Functional Mitral Valve Regurgitation

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KEYWORDS

• Mitral Valve • Regurgitation • Valvular insufficiency
• Percutaneous device

SCOPE OF THE PROBLEM

Mitral regurgitation (MR) is the most common type of valvular insufficiency. It is estimated that approximately 5 million people in the United States and more than 20 million worldwide suffer from congestive heart failure, often associated with dilated ventricles and coexisting MR. Ischemic cardiomyopathy is the most common cause of heart failure in the United States.[1] This disease is marked by diffuse myocardial damage, left ventricular remodeling, and often functional ischemic MR.[2] Although surgery can be effective in treating MR, it is frequently associated with high operative morbidity, disease recurrence, and increased mortality.[3–5] Currently, potential percutaneous options for the treatment of mitral regurgitation are in different stages of development, either in the early phases of clinical use or being preclinically tested. These techniques are as follows:

- Leaflet coupling with edge-to-edge repair (Evalve MitraClip, Edwards Stitch)
- Coronary sinus reshaping (MONARC device, Carillon device, Miltralife ev3, Cardiac Dimensions, Viacor)
- Annular plication with posterior annulus reshaping (Mitralign, Guided Delivery Systems)
- Left ventricular remodeling (Myocor, Ample PS3 [percutaneous septal sinus shortening]).

This article discusses current options and future directions for the percutaneous treatment of mitral valve regurgitation.

MITRAL VALVE STRUCTURE AND FUNCTION

It is important to understand the anatomic and functional substrate underlying the development of MR. The mitral valve is a complex anatomic structure and its proper function depends on the structural and functional integrity of its individual components (**Fig. 1**). Abnormalities in 1 or more of its components can result in stenosis or regurgitant valvular dysfunction.

The distinction between primary and secondary (functional) MR is important for the potential role of percutaneous device therapies for MR (**Box 1**). In primary organic MR, there is an abnormality of the mitral valve components, whereas in secondary functional MR, the mitral valve itself is

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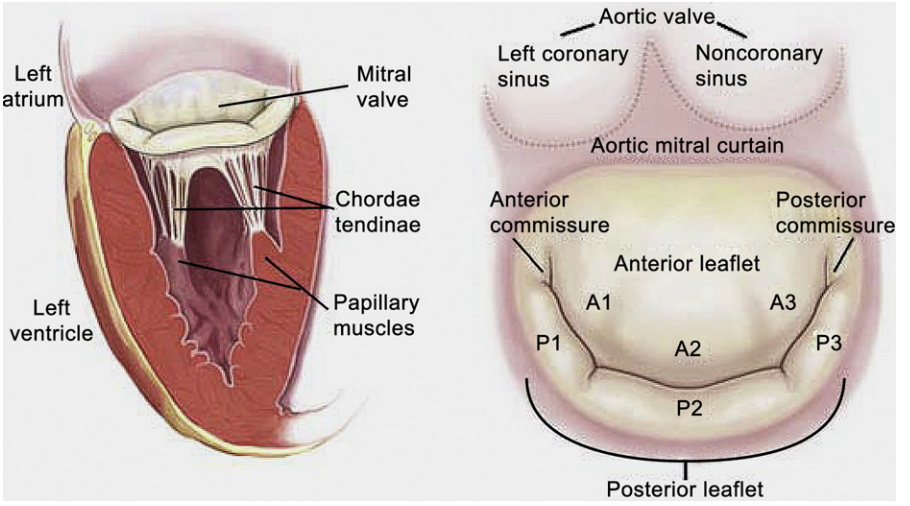

Fig. 1. Anatomy of the mitral valve.

usually unaffected. However, previous damage of the left ventricle (LV) by coronary artery disease or by dilated cardiomyopathy can cause malcoaptation of anatomically normal mitral leaflets in the setting of geometric distortion of the LV, with displacement of papillary muscles and/or annular dilatation with subsequent MR.

Functional MR has been associated with an adverse prognosis among patients with dilated and ischemic cardiomyopathy.[6,7] Although surgical intervention is associated with improved symptoms of heart failure and reverse remodeling of the LV, surgical treatment of functional MR has not been shown to improve survival.[8] Mitral valve repair with reduction annuloplasty rather than replacement is currently favored for the treatment of functional MR.[9,10] Lessons from surgical experience showed that mitral valve repair can effectively treat many, but not all, patients with functional MR.

Potential factors that can predict the recurrence of MR after mitral repair include the following:

- Annular ring geometry
- Chordae tendineae repositioning
- Concomitant reshaping of the LV during repair
- The need for a complete (D-shaped) annuloplasty ring rather than a partial (C-shaped) ring.[11,12]

Until recently, available treatment options for functional MR were limited to open surgical repair or replacement, an option that is often challenged and associated with high operative morbidity, disease recurrence, and increased mortality.[3–5] The most common form of mitral valve repair involves annuloplasty, the placement of a ring around the mitral annulus to reduce the mitral valve orifice by decreasing the distance between the septal and lateral dimensions of the mitral valve, thereby bringing the leaflet edges closer together. Annuloplasty is used as an adjunctive therapy in most forms of mitral valve repair including functional MR. A less commonly used surgical leaflet repair approach pioneered by Alfieri and colleagues[13] is the edge-to-edge repair that creates a double-orifice mitral valve by suturing the free edges of the mitral leaflets together to form a double orifice. Although the isolated use of this surgical technique has been controversial because of the concomitant use of annuloplasty with most leaflet repairs, follow-up

Box 1
Primary and secondary (functional) MR

Primary organic MR

- Abnormality of the mitral valve components

Secondary functional MR

- Mitral valve usually unaffected
- Previous damage of the LV (by coronary artery disease or by dilated cardiomyopathy) can cause malcoaptation of anatomically normal mitral leaflets in the setting of geometric distortion of the LV, with displacement of papillary muscles and/or annular dilatation with subsequent MR