Echocardiographic Imaging of the Mitral Valve for Transcatheter Edge-to-Edge Repair

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KEYWORDS

• 3D Transesophageal echocardiography • Procedural guidance
• Percutaneous mitral valve repair • MitraClip

KEY POINTS

- Advances in echocardiography have paralleled advances in percutaneous mitral valve repair, resulting in the ability to guide less invasive procedures more accurately and seamlessly.
- MitraClip mitral valve repair requires unique imaging approaches to successfully treat noncentral primary valve disorder.
- The echocardiographer must anticipate how each planned clip will affect the leaflet morphology around the clip.
- Each clip placement will affect the ability and success of the subsequent clip placement.

INTRODUCTION

Echocardiography continues to be the most effective imaging tool for the diagnosis and follow-up of mitral valve disease. The diagnosis of mitral regurgitation (MR) or stenosis is generally accomplished with the use of transthoracic imaging, whereas transesophageal imaging, given the posterior probe location, is ideally positioned for clear resolution of mitral valve structure, which is critically important in understanding the underlying etiology of mitral valve disease and for management and procedural planning. With the development of transcatheter intervention for the mitral valve and other structures, there has been a coevolution in echocardiography. True to the adage of necessity being the mother of invention, the milieu of echo imaging has expanded to real-time support and guidance of structural intervention. In this role, early adopters have recognized the value but also the limitations of 2-dimensional (2D) imaging. Real-time 3-dimensional (3D) imaging developed in the context of 2D limitations. The advantages of 3D imaging in mitral valve diagnosis and intervention are many, with the clearest example being the ability to obtain en-face views of the valve (visualization of the entire atrial aspect of the valve and adjacent structures in one real-time view). With a more intuitive anatomic presentation, this 3D modality facilitates direct communication with the interventional team, both before and during the procedure, in a graphical representation that all members of the team can interpret and discuss. Consequently, 2D and 3D transesophageal echocardiography (TEE) is now indispensable in mitral valve transcatheter intervention.

This review addresses the use of transthoracic echocardiography (TTE) and TEE in the planning and guidance of transcatheter mitral valve therapies. Many of the echo-imaging guidance techniques are applicable to transcatheter intervention as a whole. However, given that the

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MitraClip (Abbott Vascular, Santa Clara, CA) is the only device approved by the Food and Drug Administration (FDA) for MR at present, specific attention is paid to this procedure, with additional focus on the guidance of noncentral repair. The imaging techniques discussed will be applicable to future devices.

EVALUATION OF MITRAL VALVE REGURGITATION WITH ECHOCARDIOGRAPHY

Evaluation of chronic MR is nuanced, given that the distinction between primary versus secondary MR has significant implications for management strategy.

In general, clinical assessment and TTE provide most of the useful data for evaluating the severity of MR and initial clinical decision-making. Particularly with secondary (functional) MR, in addition to the finding of significant MR, the expectation is to define left ventricular structural abnormalities on the echocardiogram, including depressed left ventricular systolic function, left ventricular and/or atrial chamber dilatation, and Doppler evidence of elevated intracardiac pressures. By contrast, primary (degenerative) MR involves abnormality of one or more of the components of the valve apparatus (leaflets, chordae tendineae, papillary muscles, annulus).[1]

Consistent with this discussion, pre-MitraClip evaluation begins with TTE for confirmation of MR severity. A thorough 2D structural assessment should be performed for chamber enlargement, wall motion abnormalities, and gross valve derangements such as perforation, flail leaflet, leaflet tethering, and mal-coaptation, among others. Doppler and color flow interrogation of the mitral valve and pulmonary veins allows for thorough quantitative and qualitative assessment of the severity of valve disease. Based on the updated 2014 American College of Cardiology/American Heart Association Valvular Heart Disease Guidelines, there are now separate criteria for valve severity depending on pathology (primary vs secondary MR) (Tables 1 and 2). MR classification for severe secondary MR occurs at lower Doppler thresholds than primary MR.[1]

At present, the FDA indication for MitraClip is for treatment of moderate to severe (≥3+) primary MR in patients who have been evaluated as appropriate by a heart team and deemed to be at prohibitive risk for mitral valve surgery.

Given the improved image resolution of the mitral valve, all patients being evaluated for MitraClip routinely undergo TEE to determine valve abnormality and assess whether the morphology of the affected valve is suitable for percutaneous repair. During the initial EVEREST trials, intervention was limited to A2-P2 area,

Table 1
Severity classification of primary MR

Grade	Definition	Valve Hemodynamics
A	At risk of MR	No MR jet or small central jet area <20% LA on Doppler Small vena contracta
B	Progressive MR	Central jet MR 20%–40% LA or late systolic eccentric jet MR Vena contracta <0.7 cm Regurgitant volume <60 mL Regurgitant fraction <50% ERO <0.40 cm^2 Angiographic grade 1–2+
C	Asymptomatic severe MR	Central jet MR >40% LA or holosystolic eccentric jet MR Vena contracta ≥0.7 cm Regurgitant volume ≥60 mL Regurgitant fraction ≥50% ERO ≥0.40 cm^2 Angiographic grade 3–4+
D	Symptomatic severe MR	Same as grade C, with the following clinical findings: Decreased exercise tolerance Exertional dyspnea

Abbreviations: ERO, effective regurgitant orifice area; LA, left atrium; MR, mitral regurgitation.

Adapted from Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2014;63:e57–185; with permission.