EDITORIAL COMMENT

3D Echocardiographic Quantification in Functional Mitral Regurgitation*

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Functional mitral regurgitation typically occurs in patients with ischemic cardiomyopathy or idiopathic dilated cardiomyopathy and is independently associated with excessive morbidity and mortality (1–8).

In functional mitral regurgitation, it has been demonstrated that abnormal mitral valve kinematics result from a restriction of leaflet closure as a result of enhanced apical tethering of the mitral valve leaflets due to displaced papillary muscles, dilation of the mitral annulus, and reduced closing force of the leaflets without primary valve leaflet pathology.

Three-dimensional (3D) echocardiography, with its higher spatial resolution, has been used to effectively quantitate these morphoanatomic changes (9–15). Specifically, it has demonstrated that changes in left ventricular shape rather than function cause shifts in annular-papillary muscle relationships leading to abnormal leaflet tension. Recently, 3D echocardiography also suggested that mitral valve leaflets may be elongated in response to the stress imposed by increased tethering caused by dilated cardiomyopathy or inferior myocardial infarction (9,13,14,16).

In this issue of JACC, Saito et al. (17) analyzed 3D transesophageal datasets from 48 patients with functional mitral regurgitation and used 2 different types of software to directly measure lateral and medial papillary muscle tethering lengths, which were defined as the distance between the tip of the anterior or posterior papillary muscles and the inter-avulcer fibrosa. To evaluate the degree of coaptation, the authors measured both coaptation area and coaptation length at the medial, middle, and lateral sites of the mitral valve. The aims of their study were to examine whether chronic tethering of the mitral leaflets affected regional coaptation in patients with functional mitral regurgitation and to assess the interaction between mitral coaptation and mitral regurgitation severity. The findings of this study were that in patients with functional mitral regurgitation and symmetrical tethering, mitral leaflet coaptation decreases proportionally to the bilateral papillary muscle displacement, despite the presence of increased total leaflet area, to compensate for the increased mitral annular area and enhanced tethering. Coaptation area was the strongest determinant of mitral regurgitation severity. The authors demonstrated that in patients with left ventricular remodeling, global systolic dysfunction, and nonsignificant functional mitral regurgitation, their annular area was smaller and the leaflet-to-annular area ratio larger compared with patients with significant functional mitral regurgitation.

Although the 3D methodology used in this and other studies is useful to describe the morphoanatomy and physiology of the mitral valve complex in a research setting, this approach is not ready for “prime time” clinical use because it is extremely labor and time intensive. An automated approach for mitral valve quantification that minimizes inter-operator variability needs to be developed to allow these studies to be rapidly acquired, analyzed, and interpreted at the bedside or with the surgeon in the operating room. It would be of value if this analysis could also be performed on transthoracic datasets.

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As shown in this study, quantitative 3D echocardiographic parameters measuring leaflet deformation, as a result of tethering, can offer mechanistic clues along with prognostic information on the durability of certain mitral valve approaches. However, the conclusions of this study should be taken with caution because the authors only studied patients with symmetrical tethering. In clinical practice, patients with functional mitral regurgitation have a large variability in mitral valve geometry due to differences in infarct location and size and extent of left ventricular remodeling.

Currently, a similar surgical strategy of downsized complete ring annuloplasty is used in the majority of patients with functional mitral regurgitation, irrespective of the type of the individual mitral valve geometry (18,19). Such a simplistic strategy is likely responsible for recurrent mitral valve regurgitation in many patients. In the future, quantitative 3D echocardiographic—based surgical planning is likely to improve patient outcomes and become an important adjunctive tool for the interdisciplinary heart valve team caring for patients with functional mitral regurgitation. Understanding the coaptation deficiencies of the mitral valve beforehand, and especially modeling the coaptation characteristics likely to result after a particular repair strategy including ring characteristics (rigid, flexible, symmetrical, or asymmetrical), ring size (targeted down-sizing), and potentially subvalvular adjustments (chordal cutting, papillary muscle repositioning), remains the ultimate promise of 3D imaging.

**Key Words:** coaptation area • functional mitral regurgitation • leaflet tethering • left ventricular remodeling • quantitative 3D.

**REFERENCES**