The Role of Objective Assessment of the Mitral Annulus

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Short Editorial related to the article: Mitral Annulus Diameter's Relevance in the Diagnosis of Atrial Etiology in Mitral Regurgitation: A Comparative Analysis

The mitral annulus is a complex and dynamic structure responsive to both structural and functional changes involving the mitral valve, as well as those affecting the geometry of the left ventricle (LV) and left atrium (LA). Its bean-shaped or "D"-shaped three-dimensional structure is similar to a horse's saddle, in which the nadir (height) varies throughout the cardiac cycle. The malleability of the mitral annulus is important for valve competence. The posterior portion of the annulus, which is less fibrotic, moves during left ventricular systole, increasing the height of the saddle and reducing its circumferential area. In situations of left atrial dilation and dysfunction, mainly accompanied by atrial fibrillation (AF) and commonly associated with various causes of LV diastolic dysfunction, mitral annulus' dynamics are often compromised. This results in reduced mobility of the posterior leaflet, annulus stiffness, and diminished oscillation of the saddle height, in addition to valve retraction (tethering), which contribute to mitral coaptation failure.[1]

The mitral annulus can be studied using echocardiography, both two-dimensional and three-dimensional, with transesophageal imaging being the preferred approach. Three-dimensional imaging allows for various quantitative measurements facilitated by computational reconstruction software. These measurements can also be dynamic, capturing structural modifications throughout the cardiac cycle in both systole and diastole (Figure 1). Key measurements include annular circumference and area, anteroposterior and inter-commissural diameters, and saddle height. The three-dimensional approach offers significant advantages, particularly when segmentation of valve anatomy is required, such as in cases of mitral valve prolapse that necessitate detailed anatomical analysis of valve bulges.[2] Different etiologies of mitral regurgitation (MR) are accompanied by different degrees of mitral annulus deformation, with the most subtle ones observed in ischemic MR and the most significant in the most advanced spectra of mitral degenerative diseases, such as Barlow's disease.[3] For example, in rheumatic disease—still largely common in Brazil despite its low prevalence in more developed countries—mitral annulus changes are characterized by a "flattening of the saddle shape" and an increased area without a significant change in the perimeter.[4]

The etiological diagnosis of MR, whether functional or primary, can often be challenging. When functional (secondary), regurgitation is commonly related to the enlargement of the left chambers, as well as to the isolated enlargement of the LA in some cases, as occurs in various cardiomyopathies or heart failure with preserved ejection fraction (HFpEF). Regurgitation itself can cause mild secondary valve thickening due to jet lesions, making the etiological diagnosis even more difficult. Distinguishing between MR as a cause or consequence of cardiac chamber dilation remains challenging and often relies on subjective assessments. Addressing this issue is crucial, particularly in the context of primary MR treatments and the evolving role of percutaneous devices for secondary MR. In cases of MR associated with AF but without left ventricular dilation or dysfunction, the possibility of functional or secondary MR (the so-called atrial MR) should be considered, whose etiopathogenesis is not yet well understood.[5] One theory suggests that LA dilation is responsible for the displacement of the posterior mitral annulus towards the LV crest, thus reducing the posterior leaflet's coaptation surface.[6] Other mechanisms of functional MR are also proposed for situations where LV dilation and dysfunction are also present, such as in dilated cardiomyopathies, due to the lack of adequate remodeling/stretching of mitral valve leaflets.

A recent systematic review by Kagiyama et al. provides a comprehensive discussion on functional MR related to AF and the mitral annulus alterations that may accompany left atrial remodeling, even in patients with preserved ventricular function.[1] Based on the published articles, they estimate a 3 to 15% prevalence of atrial MR. The study also revealed that patients with AF presenting atrial MR have more adverse events throughout the clinical evolution. A few studies and publications of isolated cases suggest the role of annuloplasty as a treatment for cases of atrial MR. Furthermore, there is growing clinical interest in the potential role of percutaneous treatments, with some devices under development alongside mitral "clipping," though scientific evidence remains limited. Percutaneous treatments may offer advantages over open surgery, particularly for older patients with AF and multiple comorbidities. This reinforces the relevance of a more detailed assessment of the mitral annulus.

The study by Souza et al.,[7] published in this issue of *ABC Imagem*, analyzed a cohort of 109 patients with significant MR from various etiologies, including 28 cases of atrial MR. Patients were evaluated by two-dimensional transesophageal echocardiography. The linear commissural measurement of the mitral annulus, indexed by CS, obtained from a two-chamber transesophageal image. Patients classified as having "atrial etiology" had preserved left ventricular ejection fraction (LVEF). The commissural measurement power was tested to identify the

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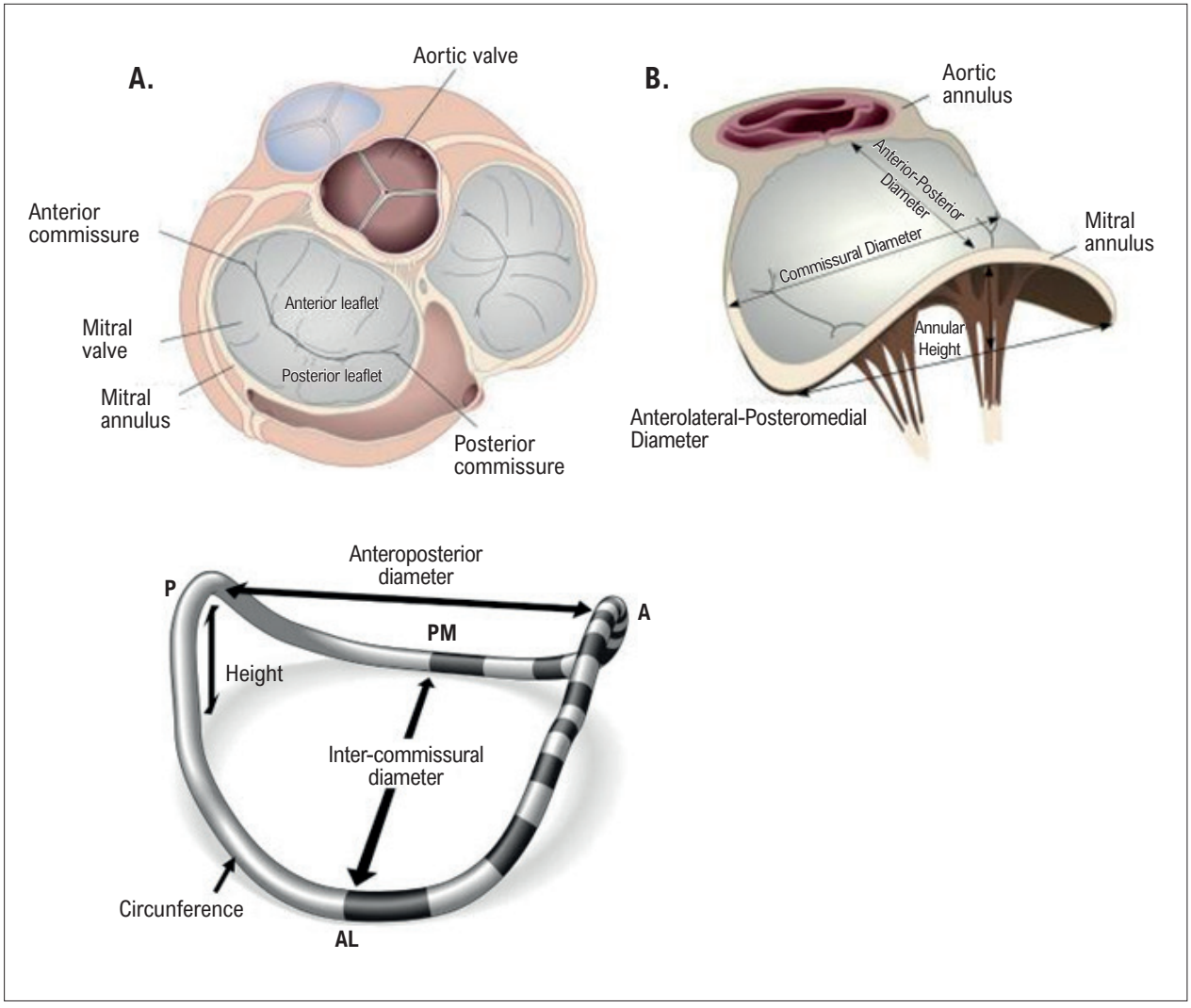

Figure 1 – *Anatomical characteristics of the mitral annulus. Panels A and B demonstrate the mitral annulus anatomy related to other cardiac structures, such as the aortic valve. Panel C highlights the objective measurements that can be performed on the mitral annulus. Figures adapted from Grewal et al. Circulation 2010 and Levine et al. Circulation 1989. PM: posterior-medial; AL: anterior-lateral.*

28 cases of MR of atrial etiology. The authors demonstrated good accuracy of the indexed variable (AUC = 0.77) in identifying patients with MR of atrial etiology, which was slightly superior to the non-indexed linear measurement of the inter-commissural diameter. Despite the small sample size and the use of a single measurement parameter, the results suggest the importance of quantitative mitral annulus assessment, even in patients with preserved LVEF. This approach may aid in differentiating mitral disease etiologies associated with MR.

In conclusion, echocardiography remains a valuable tool for evaluating the mitral annulus, that can be assessed using various parameters, including two-dimensional imaging, and providing even more detail with three-dimensional echocardiography aided by 3D reconstruction software. Studying mitral annulus characteristics in MR cases can assist in distinguishing functional or secondary MR, identifying its etiology, and recognizing a subset of patients with atrial MR related to AF, even in the absence of left ventricular alterations.

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