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Editorial

The Cardiac Anesthesiologist as an Interventional Echocardiographer

NEW SURGICAL or interventional procedures impose new anesthetic goals. The field of cardiac anesthesiology has been evolving rapidly, and has always kept pace with the advances in cardiac sciences. It is incumbent on the cardiac anesthesiologists to be familiar and equipped with advancements in cardiac sciences to be able to fulfill their pivotal role in the "Heart Team."[1] The most recent calling in this regard is the management of transcatheter mitral valve repair for atrial functional mitral regurgitation (aFMR).

Traditionally, functional or secondary mitral regurgitation (MR) has been known to occur in patients with left ventricular (LV) dilatation and systolic dysfunction. It occurs in 20%-to-25% of patients after myocardial infarction, and in up to 50% in patients in heart failure .[2] A distinct class of functional MR in patients with atrial fibrillation (AF), but normal LV size and function, now has been recognized and labeled as aFMR. This entity has received little attention, and occurs in patients with AF and/or heart failure with preserved ejection fraction with severe left atrial (LA) dilatation. Isolated mitral annular dilatation has been considered the major culprit for the occurrence of MR, but other important factors have been added in understanding the pathophysiology that have been recently summarized.[3,4] It is suggested that because of its peculiar pathophysiology, aFMR may require a different approach compared with secondary MR caused by LV dysfunction.[3]

Mitral valve repair with the use of a surgical approach to create a double orifice valve was first performed by Alfieri in 1991,[5] the results of which were later shown to be satisfactory in selected patients.[6,7] Based on the surgical technique, percutaneous mitral valve repair has been designed by applying a clip rather than suture to hold the mitral leaflets. This has been labeled as "mitral valve transcatheter edge-to-edge repair" (M-TEER). It was shown in 2009 that percutaneous M-TEER can be performed with low rates of morbidity and mortality, with acute MR reduction to <2+ in most patients.[8] Now, M-TEER has been established as an effective treatment approach for patients with MR and increased surgical risk.[9]

A recent publication by Doldi et al. reported encouraging results of M-TEER in the underrecognized entity of aFMR.[4] In a large series of 1,608 patients with functional MR, 7.8% accounted for aFMR (defined as LV ejection fraction >50%, absence of regional wall motion abnormality [RWMA], Carpentier type I leaflet motion, and dilated LA), and M-TEER was successful in 87.2% patients, with significant improvement in the New York Heart Association functional class, and 2-year survival was comparable to those with non-aFMR (defined as presence of regional wall motion abnormality and leaflet calcification), and ventricular functional MR. With increasing incidences of AF and heart failure with preserved ejection fraction in the elderly population, the prevalence of symptomatic aFMR patients is likely to increase in the future. Although the current guidelines recommend mitral valve surgery in aFMR patients with persistent symptoms despite medical therapy, a large proportion of these patients are considered nonsurgical candidates because of their advanced age, comorbidities, and frailty. Indeed, all aFMR patients in the study by Doldi et al, were considered nonsurgical candidates by the local heart team. Thus, it is expected that the anesthesiologists will be dealing with a growing number of patients with aFMR who are subjected to M-TEER. It is prudent to discuss the new challenges that these patients might pose for the cardiac anesthesiologist.

The procedure is performed under general anesthesia, with transesophageal echocardiography (TEE) / transthoracic echocardiography / fluoroscopic guidance. The anesthetic management should consider the associated comorbidities; the LV function is usually well-preserved so that the hemodynamic complications, such as hypotension and significant arrhythmias, are rare.[4] What is more important is the echocardiographic guidance during the procedure, and one should be proficient in 2D and 3D imaging skills. The procedure entails preprocedure assessment, procedural guidance, and postprocedure evaluation of the mitral valve. Although transthoracic echocardiography and TEE both can be used, due to close proximity of the TEE probe to the LA, the mitral valve can be viewed optimally by TEE, which is preferred.

Preprocedure evaluation includes not only assessment of MR severity, but also the suitability of leaflets for adequate grasping. In addition, a suitable site for transatrial septal puncture should be selected. This should be superior and posterior between 3 cm and 4 cm from the mitral annulus. Midesophageal bicaval and aortic valve short-axis views are used for this purpose. Procedural

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TEE guidance can be performed using 3D live imaging, and includes insertion of the guidewire via the chosen site of transatrial septal puncture, followed by navigating the delivery sheath and clip delivery system into the LA, alignment of the MitraClip arm perpendicular to the coaptation line, and entry into the LV and grasping of the leaflets. Postprocedure, assessment of the clip location and MR, area of the mitral valve and gradient across it, and transatrial septal puncture site are important. In addition, one should be mindful of the complications, such as new intracardiac thrombus on the guidewire and/or delivery sheath, rupture of chordae, and leaflet perforation.

The 3D mitral valve en-face view is useful for assessment of the clip location. Regarding the gradients, the alignment of the cursor to the flow across any orifice is considered reasonable, as the areas of the 2 orifices can be different, but the mean gradient remains the same. A cut-off value of mean gradient of 4 mmHg is suggested, but individualization may be necessary based on the age, sex, and heart rate of the patient, as well as the acceptable MR in a given patient. For mitral valve area, planimetry from the 2D transgastric view, 3D zoom from the LV with a zoom box at the leaflet tips, or 3D multiplanar reconstruction can be used. The clip implantation leads to a double-orifice mitral valve where the lateral and medial orifices are no longer in one plane. Therefore, postprocedure, the areas of the 2 orifices should be appropriately measured separately, and the total valve area is calculated by summing up the medial and lateral orifice areas.[10] The MR severity assessment of an obviously trivial or severe MR is not difficult, and quantification may not be necessary. However, assessment of borderline cases can be challenging. Three-dimensional (3D) vena-contracta area (sum of the 2 vena contracta areas obtained for the 2 regurgitant jets at the 2 orifices) is useful, and a cut-off value of 0.25 cm^2-to-0.27 cm^2 has been reported.[11,12] At this juncture, assessing the need for another clip is an important consideration that can be helped by adjunctive measures such as comparing the pre- and postprocedure LA pressure or S-wave obtundation on the pulmonary venous Doppler. In the rare event of any complication during the procedure, necessitating surgical intervention, the hemodynamic management and transferring the patient to the cardiac operating room (if a hybrid operating room is not being used) will have to be executed by the cardiac anesthesiologist.

The value of echocardiography guidance has been greatly appreciated in the successful conduct of M-TEER. It is important for the cardiac anesthesiologist to think ahead and anticipate the next step and be ready to show the relevant image to the interventional cardiologist. Communication among the team is vital for seamless conduct of the procedure. It is needless to emphasize that the advances in imaging have made a great difference in the conduct of M-TEER. In this regard, the X-plane and real-time multiplanar image guidance have been central. The essential echocardiographic skills relate to choosing an appropriate site for the atrial-septal puncture, navigating the delivery sheath and clip delivery system, and guiding the grasping of an appropriate part of the leaflets. The ventilation may have to be adjusted (reduce the tidal volume) during these steps to minimize the swing of the images. These are the technical skills of the highest order that can make a difference in the success of M-TEER performed in all types of secondary MRs, and not just aFMR. Evidently, there is a learning curve, and cardiac anesthesiologists will have to learn the new skills or sharpen the existing skills to establish themselves as an important member of the team. Not only that, as the experience grows and new data accumulate, further evolution and refinement in the technique of M-TEER, and its assessment on TEE, are very likely. The cardiac anesthesiologist must strive to be a part of such future developments so that he or she gears themself to don the new role of an interventional echocardiographer.

Conflict of Interest

D.K.T. is the section editor of the *Journal of Cardiothoracic and Vascular Anesthesia*. S.H. does not declare any conflicts of interest.

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