Transapical Mitral Valve Implantation for the Treatment of Severe Native Mitral Valve Stenosis in a Prohibitive Surgical Risk Patient

Importance of Comprehensive Cardiac Computed Tomography Procedural Planning

Guilherme F. Attizzani, MD, Anas Fares, MD, Chor Cheung Tam, MD, Bimal Padaliya, MD, Stacey Mazzurco, RN, Kehllee L. Popovich, NP, Angela C. Davis, RN, Elizabeth Staunton, NP, Hiram G. Bezerra, MD, PhD, Alan Markowitz, MD, Daniel I. Simon, MD, Marco A. Costa, MD, PhD, Basar Sareyyupoglu, MD

A 66-year-old woman with severe mitral stenosis (mean gradient, 13.81 mm Hg; valve area, 0.8 cm²) and extensive mitral annular calcification (MAC) presented with New York Heart Association functional class IV congestive heart failure. Balloon mitral valvuloplasty was not considered due to the high Wilkins score (i.e., 12) Because of a Society of Thoracic Surgeons mortality score of 10.04% and cirrhosis (Child-Pugh B), the heart team deemed her at prohibitive surgical risk. We, therefore, decided to perform a transapical transcatheter mitral valve implantation using a SAPIEN XT valve (Edwards Lifesciences, Irvine, California). Cardiac computed tomography (CCT) performed as part of the procedural planning revealed heterogeneous C-shape MAC distribution that was greater in ventricular and posterior locations Across the 17-mm axial distribution, the maximal area perpendicular to the MAC centerline was 4.0 cm² (Figure 1). Across that area, a virtual valve was simulated in 3 different sizes, 23, 26, and 29 mm, using advanced post-processing software (3mensio Version 7.2, Pie Medical, Maastricht, the Netherlands) to help, along with the maximal area and calcium distribution, determine the optimal valve sizing and positioning (i.e., achieving the best sealing while minimizing the risk of valve embolization) (Figure 2). We, therefore, selected a 26-mm valve (~30% oversizing) aiming at positioning it 60% ventricular and 40% atrial (i.e., in line with the MAC distribution) (Figures 2G and 2H). Although severe MAC can be clearly visualized on fluoroscopy, using it as a single
FIGURE 1  MAC Morphology and Functional Assessment

(A) Pre-procedural transesophageal echocardiogram showing severe mitral stenosis.  
(B) Pre-procedural 3-dimensional volume-rendered cardiac computed tomography (CCT) demonstrating, in a double oblique plane, C-shaped MAC distributed more posteriorly (detailed in the yellow square).  
(C) A more ventricular axial distribution of MAC is revealed (17 mm, white line between the 2 yellow dots); the red line corresponds to the maximal area (4.0 cm²) across the MAC, which is demonstrated as a cross section (D).  
MAC = mitral annulus calcification.
landmark could be potentially imprecise in this procedure due to its broad axial distribution. Hence, besides the best angiographic view (i.e., perpendicular to the perpendicular cross-sectional planes through the centerline of the MAC), the course of the left circumflex (LCX) artery was depicted to serve as an additional landmark, taking advantage of its anatomic proximity to the mitral valve annulus (Figure 3C to 3F). To help locate the optimal surgical access in the best angiographic views, a virtual catheter was simulated from the access site to the left atrium through the center of the MAC. A 3-dimensional volume rendering demonstrated that the most coaxial position to the MAC could be achieved by accessing the sixth intercostal space, lateral to the apex (Figures 3A to 3C). The fluoroscopy images were comparable to the ones predicted by CCT, and the valve was successfully deployed in the intended position (mean gradient, 5.08 mm Hg) with a trace of paravalvular leak (Figures 3G and 3H). This case demonstrates the usefulness of CCT for procedural planning in the complex scenario of a native mitral valve intervention. Notably, the post-processing capabilities of CCT provided, in addition to valve sizing information, optimal access route and valve positioning, ultimately contributing to procedural success. Further investigation is warranted to better elucidate the role of transcatheter valve therapies in this setting.
Three-dimensional volume-rendered (A) and maximal intensity projection (B) images of the left chest wall with the simulated catheter crossing the center of the mitral annulus calcification (MAC) determine the access through the sixth intercostal space more lateral from the apex (blue asterisk) to obtain a more coaxial position. (C) In a simulated angiography best view, the course of the left circumflex coronary (LCx) is depicted (top curved white dashed line) to be used as a landmark during the procedure. The catheter (yellow solid line) is simulated as it passes through the center of the MAC (white line). (D) Intraprocedural fluoroscopy demonstrated a comparable course of the LCx (curved dotted red line) in relation to the MAC (dotted white line). Valve positioning (E) and deployment (F) in a more ventricular location were accomplished using the LCx course as an additional landmark. (G) Post-implantation transesophageal echocardiogram showed a mean gradient of 5 mm Hg and a trace paravalvular leak. Optimal results in terms of valve expansion and position are revealed by fluoroscopy (H) and post-procedural cardiac computed tomography (I).