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COMMENTARY

Neo-LVOT measurement in TMVR: time for Multimodality?

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This issue of Echocardiography: a Journal of Multicardiac Imaging Modality presents the interesting findings of Soha Hekal & Amr Y. Emam al.[1]

In recent years, transcatheter mitral valve replacement (TMVR) procedures have emerged as an alternative solution for patients who have a prohibitive surgical risk for mitral valve surgery.

A peculiar risk of TMVR procedures is the left ventricular outflow tract (LVOT) obstruction. The prosthesis, implanted in the mitral position, protrudes into the LVOT, narrowing it and creating a new space smaller than the original LVOT, called the neo-LVOT.[2] To date, computed tomography (CT) assessment is the gold standard for measuring the neo-LVOT area.

With the aim of standardizing the phase of the cardiac cycle showing the narrowest neo-LVOT at cardiac CT, Soha Hekal & Amr Y. Emam also compared a CT with 3DTEE measurements of the neo-LVOT.

In this monocentric, retrospective study, first, a group of 20 patients underwent CT to identify the phase displaying the narrowest neo-LVOT area following a simulated TMVR. Following this, a cohort of 49 patients was examined using the end-systolic phase, which was found to be the one with the narrowest neo-LVOT. A commercially available CT-based software and a newly developed three-dimensional transesophageal echocardiography (3DTEE)-based software (3mensio Structural Heart, Pie Medical Imaging, The Netherlands) were employed for analysis. The parameters obtained from 3DTEE were then compared with those derived from CT-based measurements. Remarkably, there was a strong correlation between measurements obtained via 3DTEE and CT for various parameters, including mitral annulus dimensions and neo-LVOT area (all $p < .0001$). Virtual valve sizing based on annulus measurement exhibited consistency between CT and 3DTEE. Furthermore, both interobserver and intraobserver agreements were excellent, with ICCs exceeding .80 for all measurements.

The authors suggest two possible clinical implications of these results:

- 3DTEE could serve as a valid alternative for patients with contraindications to CT, for example, compromised renal function.
- 3DTEE could act as a gatekeeper for a CT scan if the patient is found suitable based on the analysis.

The authors should be commended for their work. Firstly, it marks the first comparison between a specialized 3DTEE software for TMVR planning and CT measurements. Unlike previous studies in literature,[3,4] this new software enables the simulation of valve implantation at the mitral annulus and measures the remaining neo-LVOT area afterwards. Secondly, the study provides remarkable insights into the best phase of the cardiac cycle displaying the narrowest neo-LVOT area following TMVR. Indeed, the dimensions of the LVOT change during the cardiac cycle, being smaller during diastole and bigger during systole. However, no consensus exists on the best phase to measure the neo-LVOT. The result of the study suggests that the end-systolic phase should be used corresponding to the narrowest one.

Nevertheless, we have to acknowledge two crucial limitations of the study. First, it is a retrospective study that included patients who

were not candidates for TMVR but underwent CT and TEE for different clinical indications.

Second, since patients with prior cardiac surgery were included, we are unsure whether this 3DTEE software would perform well enough for planning TMVR in patients after a mitral valve repair or a mitral valve replacement with a biological prosthesis.

TMVR has emerged as an alternative solution for patients with mitral stenosis, mitral regurgitation, and a combination of the two conditions that have a prohibitive surgical risk for mitral valve surgery. TMVR can be performed using a transapical or percutaneous approach, with the latter via the venous system and necessitating an interatrial septal puncture.

Different TMVR treatments are possible for patients with native valvulopathies or after mitral valve surgery, including valve-in-MAC (ViMAC), valve-in-valve (ViV) procedures, and valve-in-ring (ViR). While TMVR has been primarily performed using transcatheter aortic valves,[5] various prostheses with different characteristics and anchoring systems have been proposed.[6] Significant discrepancies exist among ViV, ViMAC, and ViR concerning procedural efficacy and outcomes.[7] TMVR in ViV for degenerated bioprostheses demonstrates a remarkable feasibility rate of 94.4%, accompanied by 30-day and 1-year all-cause mortality rates of 6.2% and 14%, respectively.[7] In contrast, ViMAC exhibits a procedural success rate of only 62.8%, with corresponding 30-day and 1-year all-cause mortality rates of 34.5% and 62.8%.[7] ViR has intermediate feasibility and mortality rates between ViMAC and ViV extremes.[7]

Indeed, with the exception of ViV interventions, TMVR remains a high-risk procedure, and multimodality imaging is paramount to detail the anatomy of the patient before the procedure.

Thanks to its high spatial resolution, CT assessment is considered the gold standard for neo-LVOT measurement. This assessment is done using dedicated software, which allows the insertion of a virtual valve inside the mitral valve annulus or the degenerated bioprosthesis.

New software based on 3DTEE datasets is the focus of the analysis of the study of Soha Hekal & Amr Y. Emam et al.[1] and holds promises to provide a further method for neo-LVOT measurements.

A comprehensive non-invasive imaging study of the patient's anatomy with echocardiography and CT is paramount before TMVR to reduce the risk of complications. Echocardiography remains the first-line test for the evaluation of the mechanism and severity of mitral valve dysfunction. Moreover, it is valuable for assessing different parameters that represent a risk of LVOT obstruction after TMVR, including left ventricle dimension, interventricular septum thickening, and angle between the septum and the mitral annulus. Beyond the measurement of the area of the neo-LVOT, CT can help identify the best angulation for fluoroscopy during the procedure, rule out coronary artery disease, and assess the patency of the venous system in a one-stop-shop approach.[6] In the transapical approach, preprocedural CT is also used to identify the best access route to the LV apex to ensure a coaxial deployment of the prosthesis.[8]

New prospective studies, including patients with and without a history of previous surgery on the mitral valve, are warranted to understand if 3D TEE could represent a valid alternative, a gatekeeper, or a valuable companion to CT for measuring the neo-LVOT.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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