Commentary: Three-dimensional P3 tethering angle at the heart of future surgical decision making in ischemic mitral regurgitation

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In complex mitral valve disease, such as ischemic mitral regurgitation (IMR), different mechanisms go on to produce IMR to different extents and the relative contributions of these mechanisms may change over time, partially due to the delicate interrelated geometry of the mitral valve.¹ In a rather sophisticated study employing 3-dimensional echocardiography (3DE), Sun and colleagues² show that the 2 main pathophysiologic mechanisms of IMR; that is, annular dilatation and flattening (Carpentier type I) and posterior leaflet (segment P3) tethering due to left ventricle dilatation (Carpentier type IIb), both independently predict moderate IMR improvement 1 year after coronary artery bypass grafting (CABG). Receiver-operating characteristic analysis showed that a nonplanar angle $< 158.1^\circ$ and a P3 tethering angle (P3TA) $< 28.8^\circ$ reliably predict IMR improvement after CABG.² This is an important finding because the presence of IMR significantly worsens prognosis³ yet a beneficial effect on prognosis for mitral valve surgery in addition to CABG for moderate IMR has never been shown.⁴ Thus, when reliable predictors are established that advocate for declining to intervene on moderately regurgitant ischemic mitral valves of certain subgroups it is of huge clinical and financial consequence.

Sun and colleagues² show, in an off-pump CABG cohort, that remodeling effects after coronary revascularization may attenuate tethering and IMR in select patients. Although off-pump CABG can be advantageous for select patients, it seems unlikely that the coronary revascularization technique (ie, on pump vs off pump) would influence IMR improvement. However, it is a limitation of the study and more work is needed in larger, more heterogeneous cohorts to determine this with more certainty.

The 3DE imaging and modeling in the study by Sun and colleagues² are based on methods that were introduced by

3DE P3TA may be at the heart of future surgical decision making in IMR.

Central Message

Preoperative 3DE P3TA may be at the heart of more refined surgical decision making in ischemic mitral regurgitation.

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our group.⁵ Additional studies from our group with similar modeling algorithms have shown that preoperative 3DE P3TA is a strong (ie, independent) predictor of IMR recurrence after undersized ring annuloplasty for severe IMR⁶ and that 3DE is superior over 2-dimensional echocardiography because it is not dependent on viewing plane selection.⁷ Those studies and the study by Sun and colleagues² are, however, limited by the fact that IMR severity was measured semiquantitatively with jet area/left atrium area. Future IMR studies should include quantitative IMR severity assessment with effective regurgitant orifice area and regurgitant volume.

On a day-to-day basis, cardiac surgeons are faced with 2 important questions regarding IMR: Should we operate on this (moderately) regurgitant mitral valve and, Should we repair or replace this (severely) regurgitant mitral valve? As shown by Sun and colleagues² and by our group,^{6,7} 3DE P3TA may be the key to answering these questions. At this point, both questions are difficult to answer for an individual patient based on current guidelines. In the 2017 American Heart Association/American College of Cardiology focused update of the 2014 guidelines, mitral valve repair is no longer recommended for patients with chronic moderate IMR undergoing CABG (“the usefulness is uncertain”; class IIb recommendation [weak], level of evidence B [randomized]) and it is reasonable to choose chordal-sparing mitral valve replacement over repair in patients with chronic severe IMR (class IIa recommendation [moderate], level of evidence B [randomized]).⁸ The current

guidelines provide generalized statements on patients with IMR and do not account for patient subgroups with milder or more extreme forms of tethering. In an effort to do so, the American Association of Thoracic Surgery updated its consensus guidelines on IMR and now identifies subgroups based on (amongst other factors) tethering.⁹ At this point, we are in need of studies such as that performed by Sun and colleagues² to pave the way for more refined evidence-based guidelines on surgical treatment of IMR. Future predictive models should not only include geometric and strain-related factors but also clinical patient-related factors (including age, comorbidity, and left ventricular function) and procedure-related factors (including the risk of surgery and the risk of repair failure with prolonged cardiopulmonary bypass and aortic crossclamping) to decide between surgery or no surgery or between a sophisticated custom-made repair or chordal-sparing mitral valve replacement. Although there is still a long road ahead before we can refine the guidelines, it is becoming more and more clear that 3DE P3TA may be at the heart of more refined future surgical decision making in IMR.

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