CAN PAPILLARY MUSCLE INTERVENTIONS IMPROVE MITRAL VALVE REPAIR DURABILITY FOR ISCHEMIC MITRAL REGURGITATION?

To the Editor:

We read with great interest the recent report by Kron and colleagues¹ regarding the recurrence of mitral regurgitation after mitral valve repair in patients with severe ischemic mitral regurgitation, in the randomized trial conducted by the Cardiothoracic Surgical Trials Network.¹ The authors identified no preoperative echocardiographic parameters that are predictive for recurrent mitral regurgitation, which at 1-year was observed in 32.6% of patients undergoing valve repair, versus 2.3% of those undergoing chordal-sparing valve replacements. However, a multivariable model found that the presence of inferior basal aneurysm and/or dyskinesis was a strong

predictor of recurrent moderate or severe mitral regurgitation, which may have implications for future strategies aimed at treating ischemic mitral regurgitation.

The main pathophysiologic mechanism of ischemic, or secondary, mitral regurgitation is progressive left ventricular remodeling and dilatation, which leads to: a loss of papillary muscle systolic shortening; increased interpapillary muscle distance; and displacement of the papillary muscles posteriorly, laterally, and apically.^{2,3} These geometric perturbations cause tethering of the mitral leaflets, resulting in a decreased zone of coaptation and leaflet malapposition, and ultimately leading to the development of secondary mitral regurgitation. Placed in the context of the current findings, the presence of inferior basal aneurysm and/or dyskinesis represents advanced ventricular remodeling, which often translates into imbalanced geometric distortions of the papillary muscles and posterior leaflet tethering and restriction. Additionally, restrictive annuloplasty has been shown to augment the tethering angle of the posterior leaflet by displacing the posterior annulus anteriorly, which itself is a risk factor for recurrent mitral regurgitation.²

Thus, a pathophysiologic-guided approach to surgical repair may be preferable, with the goal of alleviating the leaflet tethering forces and the ventricular geometric distortions that contribute to suboptimal outcomes with annuloplasty repair. One such target is the approximation or realignment of the papillary muscles, which can be

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TABLE 1. Adjunctive papillary muscle interventions for ischemic mitral regurgitation

Procedure	Surgical technique
Papillary muscle sling	<ul style="list-style-type: none"> • Placement of a 4-mm polytetrafluoroethylene sling around each papillary muscle base • Anchored by weaving the graft between the ventricular trabeculae
U-shaped suturing	<ul style="list-style-type: none"> • Annuloplasty ring size based on size of the anterior leaflet • Single 2-0, U-shaped suture passed through the middle height of the papillary muscles • Reinforced by 2 patches of autologous pericardium • Undersized ring annuloplasty
Papillary muscle realignment	<ul style="list-style-type: none"> • 2 to 3 mattress sutures placed through the base and body of each papillary muscle, avoiding the fibrous tips • Tied to create contact between the muscles • Undersized ring annuloplasty
“Ring + String”	<ul style="list-style-type: none"> • Transventricular suture through the tip of the posterior papillary muscle to the intervalvular fibrosa • Suture exteriorized through the aortic wall • Undersized ring annuloplasty
Posterior papillary muscle relocation	<ul style="list-style-type: none"> • Suture of the posterior papillary muscle tip through the posterior annulus • Placed posterior to the right fibrous trigone • Undersized ring annuloplasty
Papillary muscle elevation	<ul style="list-style-type: none"> • 2 felt-reinforced sutures on either side of the posterior papillary muscle base used to elevate the muscle • Via ventriculotomy and concomitant plication of the infarcted wall • Undersized ring annuloplasty
Mitral complex remodeling	<ul style="list-style-type: none"> • Multifaceted approach <ol style="list-style-type: none"> 1. Secondary chordal cutting 2. Polytetrafluoroethylene (Gore-Tex, registered trademark of W. L. Gore & Associates, Inc, Flagstaff, Ariz) artificial chords from both papillary muscles to the anterior mitral leaflet 3. Two sutures from each papillary muscle to the posterior annulus for realignment 4. Undersized ring annuloplasty

accomplished via suture or graft-based techniques⁴ (Table 1). Combining annuloplasty with a papillary muscle intervention may support: (1) a reduction in septal-lateral annular dilatation; (2) movement of the anterolateral papillary muscle closer to the annulus; (3) correction of the lateral displacement and apical restriction of the posterior papillary muscle; and (4) alleviation of chordal tethering forces, which affect the balancing forces necessary for proper leaflet closure and competence.^{2,3} Furthermore, supporting the subvalvular apparatus by targeting the papillary muscles allows for consideration of a true-sized ring placement for annular support, which may help avoid the untoward effects of augmented posterior leaflet tethering, and functional mitral stenosis, that can occur with restrictive annuloplasty.⁵

Addressing the mechanisms underlying ischemic mitral regurgitation is critical to applying the optimal surgical strategy. Although combined annuloplasty and papillary muscle interventions targeting the annular and subvalvular distortions present in ischemic mitral regurgitation are promising, the reported data are from small, single-center, retrospective or observational studies. Multicenter registries and future randomized trials are warranted to define the durability of these procedures.

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WE NEED A BETTER WAY TO REPAIR ISCHEMIC MITRAL REGURGITATION

Reply to the Editor:

We very much appreciate the interest of Mihos and Santana in our study, “Predicting Recurrent Mitral Regurgitation After

Mitral Valve Repair for Severe Mitral Regurgitation.” We developed a model that demonstrates good discrimination in identifying patients with severe ischemic mitral regurgitation (MR) who, with repair, will survive 2 years without moderate or severe MR. We agree with their concept of a pathophysiologically guided approach to surgical mitral valve repair, including the use of various papillary muscle interventions possibly to improve the durability of reduction annuloplasty repair for ischemic MR. Although there have been individual reports of subvalvular approaches to mitral repair in this setting, these have not been subjected to large scale trials across multiple centers. We agree that additional work is needed to ensure adequate and durable correction of severe ischemic MR with repair techniques tailored to the anatomy and physiology of individual patients. We have a limited but improving understanding of why and when MR recurs after repair for severe ischemic MR. Patients who have the appropriate preoperative pathophysiology would serve as the best subjects for new repair techniques that can be rigorously tested in a randomized fashion.

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ORIENTATION OF BILEAFLET MECHANICAL AORTIC VALVE PROSTHESES FOR OPTIMAL EVALUATION BY TRANSTHORACIC ECHOCARDIOGRAPHY

To the Editor:

Transthoracic echocardiography remains the first step in the noninvasive assessment of prosthetic valve function. Adequate visualization of leaflet mobility and surrounding structures are essential parts of the routine echocardiographic evaluation of prosthetic valves. Many prosthetic components, however, particularly those of mechanical valves, do not transmit ultrasound and generate artifacts