Author has nothing to disclose with regard to commercial support.

0.43; $P < .001$) when subvalvular pathology was addressed with papillary muscle approximation and muscle slings, and left ventricular reverse remodeling (as assessed by left ventricular end-diastolic volume diameter) were improved (mean diameter of 3.6 mm; $P < .001$).⁷

The challenge for clinicians assessing patients with IMR is how best to assess proportionate and disproportional physiology (degree of IMR as an index of left ventricular end-diastolic volume), as well as asymmetric anatomies, in a highly heterogeneous patient population. The first goal is to distinguish patients who will benefit from a mitral valve intervention from those who will not. The second goal is to select the most appropriate approach. It is unclear what the overlap between alternative pathoanatomic grading and progression schemata mean and whether these schemata are mostly complementary or offer subtle distinctions in specific subsets of patients. Increased awareness of variable asymmetric anatomy and further detailed studies and analyses should help us to discern and direct adjunctive individualized therapies in a rapidly evolving field. Finally, in patients with very advanced grades (very low ejection fraction, enlarged ventricles, nonreversible myocardial damage) such schemes should also help to refocus treatments away from mitral valve intervention and toward end-stage heart failure therapies.

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References

1. Badhwar V, Alkhouli M, Mack MJ, Thourani VH, Ailawadi G. A pathoanatomic approach to secondary functional mitral regurgitation: evaluating the evidence. *J Thorac Cardiovasc Surg*. 2019;158:76-81.
2. Aldea GS. Commentary: reassessing efficacy of treatment strategies for secondary mitral regurgitation—combining pathoanatomic and pathophysiologic perspectives. *J Thorac Cardiovasc Surg*. 2019;158:84-5.
3. Grayburn PA, Sannino A, Packer M. Proportionate and disproportionate functional mitral regurgitation: a new conceptual framework that reconciles the results of MITRA-FR and COAPT trials. *JACC Cardiovasc Imaging*. 2019;12:353-62.
4. Nappi F, Lusini M, Avtaar Singh SS, Santana O, Chello M, Mihos CG. Risk of ischemic mitral regurgitation recurrence after combined valvular and subvalvular repair. *Ann Thorac Surg*. 2019;108:536-43.
5. Nappi F, Avtaar Singh SS, Santana O, Mihos CG. Functional mitral regurgitation, an overview for surgical management framework. *J Thorac Dis*. 2018;10:4540-55.
6. Mihos CG, Capoulade R, Yucel E, Xydias S, Nappi F, Williams RF, et al. Mitral valve and subvalvular repair for secondary mitral regurgitation: rationale and clinical outcomes of the papillary muscle sling. *Cardiol Rev*. 2018;26:22-8.
7. Mihos CG, Xydias S, Yucel E, Capoulade R, Williams RF, Mawad M, et al. Mitral valve repair and subvalvular intervention for secondary mitral regurgitation: a systematic review of randomized controlled and propensity matched studies. *J Thorac Dis*. 2017;9(Suppl 7):5582-94.

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REPLY: SURGICAL AND

TRANSCATHETER THERAPY FOR SECONDARY MITRAL REGURGITATION

Reply to the Editor:

Recent clinical trials have added valuable information, as well as controversy, for the surgical and transcatheter management of secondary mitral regurgitation (MR). One thing is clear, secondary MR is not a binary disease state. It is not present or absent. It is a pathoanatomic continuum. Based on the evidence, a recent grading system has been proposed to suggest targeted surgical and transcatheter therapy of secondary MR based on pathoanatomy and comorbid risk.¹

The experience of Nappi and colleagues² with a subvalvular adjunct to restrictive annuloplasty informed a recent letter to the Editor.² They make a few important points. First, they re-emphasize the importance of revascularization in ventricular remodeling and suggest potential improvement of secondary MR when viable myocardium is noted. Second, they attest that for patients with nonviable myocardium, a restrictive annuloplasty combined with a subvalvular sling repair should be considered. Finally, by the title of their letter they suggest that a proposed grading system for mitral valve (MV) intervention forfeits the opportunity for MV repair as an important therapy. Each of these points will be reviewed.

The importance of myocardial revascularization for viable myocardium is the cornerstone for the management of ischemia whenever appropriate targets exist. For patients with ischemic cardiomyopathy undergoing surgery for secondary MR, incomplete revascularization is a marker of mortality,³ but evidence that it influences residual MR in all patients remains lacking. For example, patients with chronic severe secondary MR often have papillary muscle fibrosis and the subsequently tethered MV apparatus is unlikely to improve regardless of the revascularization strategy. This is similar to the point that Nappi and colleagues² make when discussing their approach to patients with nonviable myocardium. Although their experience with subvalvular papillary muscle repositioning or polytetrafluoroethylene tube reapproximation is compelling, widespread reproducibility of this technique remains limited.

The nomenclature and assessment of MR is clear.⁴ Prolapse is defined in a patient with primary MR when leaflet motion extends above the annular plane in systole. There is no such entity in secondary MR, as the authors may suggest.^{2,5} In the case of a tethered posterior leaflet following myocardial infarction remodeling, a posteriorly directed jet of MR may be commonly misinterpreted as anterior leaflet prolapse and primary MR when it is in fact

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best defined as anterior leaflet override and secondary MR. Appropriate identification of pathology directs appropriate management.^{1,4}

Nappi and colleagues² are to be congratulated for their steadfast outcome reporting of adjunctive subvalvular papillary muscle repair and their institutional results are admirable, yet their recent identification of failures of this technique indicate that it may not actually be for everyone.⁶ They report failures of MV annuloplasty and subvalvular repair with MV tenting area ≥ 3.1 cm² and left ventricle end-diastolic diameter ≥ 64 mm. In fact, their findings that patients with significant left ventricle remodeling and MV tenting have a higher incidence of recurrent MR aligns precisely with the recently proposed grading system.¹ The cumulative evidence and surgical outcomes with MV repair and replacement in secondary MR do not amount to forfeiture of this complex disease state to transcatheter therapy. To the contrary, the proposed grading system suggests that MV repair still has a role in at least Grade I secondary MR in patients the heart team believes may

benefit from surgical therapy (Figure 1). Perhaps MV annuloplasty and subvalvular repair may have a role in Grade II secondary MR, provided the patient does not have the predictors identified by Nappi and colleagues.^{1,6}

Given the controversy surrounding recent transcatheter MV repair trials¹ and compelling early results with transcatheter MV replacement,⁷ the validation of a pathoanatomic grading system¹ may aid clinical decision making and the safe and effective application of novel therapies for secondary MR.

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FIGURE 1. Pathoanatomic grading system and therapeutic options for secondary mitral regurgitation. Adapted from Badhwar and colleagues.¹

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References

1. Badhwar V, Alkhouli M, Mack MJ, Thourani VH, Ailawadi G. A pathoanatomic approach to secondary functional mitral regurgitation: evaluating the evidence. *J Thorac Cardiovasc Surg.* 2019;158:76-81.
2. Nappi F, Santana O, Mihos CG. Geometric distortion of the mitral valve apparatus in ischemic mitral regurgitation: should we really forfeit the opportunity for a complete repair? *J Thorac Cardiovasc Surg.* 2019;158:e91-2.
3. Kusunose K, Obuchowski NA, Gillinov M, Popovic ZB, Flamm SD, Griffin BP, et al. Predictors of mortality in patients with severe ischemic cardiomyopathy undergoing surgical mitral valve intervention. *J Am Heart Assoc.* 2017;6(11). pii: e007163.
4. O'Gara PT, Grayburn PA, Badhwar V, Afonso LC, Carroll JD, Elmariah S, et al. 2017 ACC expert consensus decision pathway on the management of mitral regurgitation: a report of the American College of Cardiology Task Force on Expert Consensus Decision Pathways. *J Am Coll Cardiol.* 2017;70:2421-49.
5. Nappi F, Nenna A, Spadaccio C, Lusini M, Chello M, Fraldi M, et al. Predictive factors of long-term results following valve repair in ischemic mitral valve prolapse. *Int J Cardiol.* 2016;204:218-28.
6. Nappi F, Lusini M, Avtaar Singh SS, Santana O, Chello M, Mihos CG. Risk of ischemic mitral regurgitation recurrence after combined valvular and subvalvular repair. *Ann Thorac Surg.* January 23, 2019. pii:S0003-4975(19)30100-30106.
7. Sorajja P, Moat N, Badhwar V, Walters D, Paone G, Bethea B, et al. Initial feasibility study of a new transcatheter mitral prosthesis: the first 100 patients. *J Am Coll Cardiol.* 2019;73:1250-60.

<https://doi.org/10.1016/j.jtcvs.2019.04.057>