Dr Gillinov serves as a consultant to Edwards Lifesciences, Medtronic, AtriCure, CryoLife, Abbott, and ClearFlow. Dr Wierup serves as a consultant to Medtronic and CryoLife.

REPLY: RINGS AND THINGS: CHOICES IN MITRAL VALVE REPAIR

Reply to the Editor:

Whereas Ma and colleagues¹ note the deleterious consequences of elevated post-repair mitral gradients, Kim and Choi² suggest that the combination of an edge-to-edge repair and a small, complete annuloplasty ring can lead to higher transmitral gradients and ensuing complications. We agree with both.

Nearly 100% of degenerative mitral valves can be repaired by experienced surgeons.^{3,4} Relative to replacement, repair confers significant clinical advantages, including greater freedoms from anticoagulant-related hemorrhage, thromboembolism, and endocarditis; better left ventricular function; and, possibly, improved long-term survival. Mitral valve repair is therefore the preferred procedure for those with degenerative mitral valve disease. This statement is not controversial.

The choice of repair techniques, however, is controversial. Surgeons argue the relative merits of artificial chord creation versus leaflet resection (respect vs resect) and the type of annuloplasty device (complete ring vs posterior band). Combinations of all these techniques have yielded excellent short- and long-term results.³⁻⁵ Application of the edge-to-edge repair as a primary repair technique is relatively uncommon. De Bonis and colleagues⁶ report good results in a variety of settings, while others reserve this strategy primarily for patients with Barlow disease. In patients with Barlow disease, the valves are very large, rendering the likelihood of postrepair stenosis low after an edge-to-edge repair.

The surgical goal in patients with degenerative mitral valve disease is a repair that exhibits neither stenosis nor regurgitation. An edge-to-edge repair is rarely necessary in such patients, and a downsized annuloplasty device is generally inappropriate. Repair is best achieved with a relatively large annuloplasty device (labeled size 34 or larger) and either creation of artificial chords (anterior or posterior leaflet prolapse) or leaflet resection (posterior leaflet prolapse).

Marc Gillinov, MD

Per Wierup, MD, PhD

Department of Thoracic and Cardiovascular Surgery
Cleveland Clinic Cleveland
Cleveland, Ohio

References

1. Ma W, Shi W, Wu W, Ye W, Kong Y, Zhu D, et al. Elevated gradient after mitral valve repair: the effect of surgical technique and relevance of postoperative atrial fibrillation. *J Thorac Cardiovasc Surg.* 2019;157:921-7.
2. Kim NY, Choi JB. Small rings and edge-to-edge technique elevate transmitral gradients in mitral valve repair. *J Thorac Cardiovasc Surg.* 2020;159:e53.
3. Gillinov AM, Mihaljevic T, Javadikagari H, Suri RM, Mick S, Navia JL, et al. Early results of robotically assisted mitral valve surgery: analysis of the first 1000 cases. *J Thorac Cardiovasc Surg.* 2018;155:82-91.e2.
4. Castillo JG, Anyanwu AC, Fuster V, Adams DH. A near 100% repair rate for mitral valve prolapse is achievable in a reference center: implications for future guidelines. *J Thorac Cardiovasc Surg.* 2012;144:308-12.
5. Falk V, Seeburger J, Czesla M, Borger MA, Willige J, Kuntze T, et al. How does the use of polytetrafluorethylene neochords for posterior mitral valve prolapse (loop technique) compare with leaflet resection? A prospective randomized trial. *J Thorac Cardiovasc Surg.* 2008;136:1200-5; discussion 1205-6.
6. De Bonis M, Lapenna E, Lorusso R, Buzzatti N, Gelsomino S, Taramasso M, et al. Very long-term results (up to 17 years) with the double-orifice mitral valve repair combined with ring annuloplasty for degenerative mitral regurgitation. *J Thorac Cardiovasc Surg.* 2012;144:1019-24. Erratum in: *J Thorac Cardiovasc Surg.* 2013;145:617.

<https://doi.org/10.1016/j.jtcvs.2019.05.069>

REPLY: HESITATE TO APPROXIMATE?

Reply to the Editor:

I read with great interest the astute commentary of Kim and Choi¹ on the genesis of postoperative valvular gradients after degenerative mitral valve repair, as described by Ma and colleagues.² We can all agree that the combination of a small complete ring and the Alfieri leaflet approximation can lead to increased transmitral gradients. This is not inevitable, however, and may vary with width of the approximation and its location. In a subset of 54 patients with end-stage cardiomyopathy and significant ischemic mitral regurgitation repaired with undersized complete rings (mean size, 28.2 ± 2.3 mm) and leaflet approximation, De Bonis and colleagues³ reported mean transmitral gradients of 3.8 ± 1.2 mm Hg at hospital discharge and 3.3 ± 2.1 mm Hg at 1.5 postoperative years. Larger rings (36.6 ± 2.5 mm) were used when repairing degenerative pathology with the edge-to-edge technique to, however, maintain valve area greater than 2.5 cm² in patients with preserved myocardial function.⁴ In the setting of significant degenerative disease and associated annular dilatation, the entire length of the P2 scallop is often approximated with deep bites to the rough zone of the corresponding anterior leaflet segment, yet Alfieri's group outlines that a "shorter suture should be used in patients with smaller valves."⁵ If the width of edge-to-edge approximation is not extensive, it is feasible to achieve acceptable mitral gradients even in the setting of smaller annuloplasty rings, such as those used in the study at hand of Ma and colleagues,² particularly when the average body surface area of the patients was only approximately 1.7 m², which is unusual for Western

Author has nothing to disclose with regard to commercial support.

populations. It is this flexibility of location and extent of approximation that makes the Alfieri technique valuable and attractive in selected clinical scenarios; however, caution and experience should be exercised to avoid valvular stenosis. The resultant gradients after leaflet approximation may also be related to whether the edge-to-edge approximation was used as a primary technique or a bailout to achieve competence after leaflet resection or chordal procedures that may have already compromised orifice area. Without clear data regarding prosthesis size and type, length and location of leaflet approximation, and diastolic mitral gradient in each individual patient in the series presented by Ma and colleagues,² one can only speculate what combination of leaflet approximation and annuloplasty prosthesis size yields an “acceptable” result clinically, yet still may underlie the distant pathogenesis of atrial fibrillation.

Tomasz A. Timek, MD, PhD
Division of Cardiothoracic Surgery
Spectrum Health
Michigan State University College of Human Medicine
Grand Rapids, Mich

References

1. Kim NY, Choi JB. Small rings and edge-to-edge technique elevate transmitral gradients in mitral valve repair. *J Thorac Cardiovasc Surg.* 2020;159:e53.
2. Ma W, Shi W, Wu W, Ye W, Kong Y, Zhu D, et al. Elevated gradient after mitral valve repair: the effect of surgical technique and relevance of postoperative atrial fibrillation. *J Thorac Cardiovasc Surg.* 2019;157:921-7.e3.
3. De Bonis M, Lapenna E, La Canna G, Ficarra E, Pagliaro M, Torracca L, et al. Mitral valve repair for functional mitral regurgitation in end-stage dilated cardiomyopathy: role of the “edge-to-edge” technique. *Circulation.* 2005; 112(9 Suppl):402-8.
4. De Bonis M, Lapenna E, Lorusso R, Buzzati R, Gelsomino S, Taramasso M, et al. Very long-term results (up to 17 years) with the double-orifice mitral valve repair combined with ring annuloplasty for degenerative mitral regurgitation. *J Thorac Cardiovasc Surg.* 2012;144:1019-24; discussion 1024-6.
5. Maisano F, Schreuder JJ, Oppizzi M, Fiorani B, Fino C, Alfieri O. The double-orifice technique as a standardized approach to treat mitral regurgitation due to severe myxomatous disease: surgical technique. *Eur J Cardiothorac Surg.* 2000;17:201-5.

<https://doi.org/10.1016/j.jtcvs.2019.06.036>

REPLY FROM THE AUTHORS: TIGHTROPE WALKERS IN MITRAL VALVE REPAIR

Reply to the Editor:

We thank Kim and Choi¹ for their response to our previous study.² They raised 2 important points regarding the size of mitral

annulus in normal human subjects and the minimal ring size with the use of the edge-to-edge technique.

Kim and Choi¹ pointed out that the average ring size of patients with a mean height of 1.66 m should be 32 mm. Our previous 3-dimensional echocardiographic study demonstrated that body surface area was more closely correlated with intercommissural distance than was height.³ Consistently, the mean intercommissural distance in normal subjects with a mean body surface area of 1.67 m² was 31.5 mm.³ From this perspective, we agree that mitral annuloplasty at our institution was downsized relative to the normal value. Our previous study included patients undergoing surgery between 2006 and 2016. During the early years of mitral valve repair, we focused on complete elimination of regurgitation and tended to choose a smaller annuloplasty ring so as not to cause systolic anterior motion. Once we noticed the adverse effect of high transmitral gradient and started to choose larger rings, the level of transmitral gradient was significantly lowered. Overall, in our study, the mean selected ring size (29.1-mm ring for patients with 1.67 m² body surface area) was comparable to that reported in other Asian studies (28.1-mm ring for patients with 1.65 m² body surface area), according to Kawamoto and colleagues.⁴ On the basis of our recent study investigating the phenomenon of patient-prosthesis mismatch in mitral valve repair,⁵ implantation of a 30-mm Carpentier-Edwards Physio I ring (Edwards Lifesciences, Irvine, Calif) with unrestrictive leaflet repair techniques could be safe in patients with a body surface area no greater than 1.9 m², for a mean transmitral gradient of 2.7 mm Hg and a low risk of late atrial fibrillation. Moreover, our data showed a higher degree of recurrent mitral regurgitation in patients with a prosthetic orifice area larger than 2.4 cm²/m², indicating that the ring size of 32 mm, despite being a physiologic reference in patients with an average height of 1.66 m, might not be necessary in real-life procedures.⁵ To provide the minimal ring size thresholds for mitral annuloplasty was the main purpose of our serial studies.^{2,5}

The edge-to-edge technique is a simple yet effective option in eliminating mitral regurgitation. The edge-to-edge repair can be a primary choice or an addition to other techniques for further reduction of the residual regurgitant jets, as identified by the saline solution test. It is particularly useful in early experience of repairing anterior leaflet prolapse. Because of the wide use of neochordal implantation, however, the prevalence of isolated edge-to-edge repair had been fading in our series. Among 44 patients undergoing the edge-to-edge repair, the mean ring size was 29.5 mm, and the mean gradient was 4.0 mm Hg. Consistent with the view of Kim and Choi,¹ our results suggested that the effect of edge-to-edge technique on transmitral gradient should be counteracted