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.

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<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

Authors have nothing to disclose with regard to commercial support.

by a larger ring. The edge-to-edge technique directly increases coaptation strength by reducing leaflet motility and thus may require minimal or even no coaptation reinforcement from annuloplasty rings. On the basis of the long-term outcome of the Endovascular Valve Edge-to-Edge Repair Study (EVEREST) II study, residual mitral regurgitation did not significantly progress during follow-up (severity, $>2+$; rate, 18% at 1 year and 19% at 5 years).⁶ On the other hand, in a recent multicenter study, a mean post-operative transmitral gradient of 3.5 mm Hg was reported in patients undergoing isolated MitraClip (Abbott, Abbott Park, Ill) implantation, which was 13% higher than our results and might cause stenosis in the future.⁷ The edge-to-edge technique thus leads to distinct hemodynamic changes to the mitral valve and influences ring selection strategy in surgical practice. With use of the leaflet repair techniques that may elevate transmitral gradient, a larger ring should be implanted to allow adequate orifice area, as estimated either by intraoperative transesophageal echocardiography or by measurement during the saline solution test.

It is intriguing that 2 divergent concepts of mitral valve repair—a smaller ring with full leaflet motility and a larger ring (or no ring) with the edge-to-edge technique—may converge toward similar repair outcomes. Surgeons with expertise in mitral valve repair are like tightrope walkers: no matter how light or heavy poles they may carry, the delicate balance must be maintained between annuloplasty

and leaflet repair, and thereby between regurgitation and stenosis.

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<https://doi.org/10.1016/j.jtcvs.2019.06.002>