Mitral surgery on the precipice of transformation

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In the current issue of the *Journal*, Dearani¹ provides a thoughtful reflection on the growing national experience with robotic mitral valve operations, as evidenced by the first 1000 case experiences of Gillinov and colleagues.² When a standardized approach to patients selected for robotic mitral surgery was used, in-hospital outcomes at the Cleveland Clinic revealed a high repair rate and low early mortality for focal degenerative disease. As Dearani¹ astutely points out, high-volume centers with experienced mitral repair surgeons being highly selective in which cases are performed robotically is a clear recipe for success. However, is this recipe applicable to all surgeons and all centers? Does this prescriptive approach help propel the field forward? Yes and no.

Gillinov and colleagues² are to be commended for a large series and outstanding results. Although other reports³⁻⁵ have also documented the safety and efficacy of robotically assisted mitral valve surgery, their algorithm-derived selectiveness to include patients without reduced ejection fraction, moderate-severe pulmonary hypertension, mitral calcification or image-guided peripheral vascular disease offers a bona fide pathway to launch a safe and successful program. However, once center and surgeon expertise can be attained, reproducibility of excellent outcomes may actually provide a natural impetus for a broader application to those patients at greater risk who stand to benefit most from the aggregate advantages a robotic approach.

Much has been learned during the 25-year evolution of minimally invasive and robotic mitral surgery. Advances in perfusion and robotic technology have now made these operations reproducible and routine in many centers.⁶ Early concerns with myocardial protection and peripheral malperfusion have given way to consistent outcome improvements to align with, and perhaps even surpass, those achieved with sternotomy.³⁻⁶ Currently, 14% of all mitral operations in the United States are performed via a minimally invasive right thoracotomy, and 11% of all mitral repairs are performed robotically.^{7,8} Although a substantive advance over years past, clearly many more patients could potentially benefit

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Central Message

Our specialty may advance by widening access to safe, effective robotic repair to those patients at greater operative risk who stand to benefit most from the aggregate advantages of a robotic approach.

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from the rapid recovery to normal activity afforded by a minimally invasive approach.

It is resolved that to be a safe and effective robotic mitral valve surgeon/center, one must first have reasonable mastery of open mitral repair, consistent volume, the support of an excellent intraoperative team, and access to high-quality echocardiography and computed tomography angiography.⁹ Preoperative transesophageal imaging is essential to provide pathoanatomic-directed mitral planning at all levels of experience. However, following stepwise progression and a track record of safety with minimally invasive video-assisted operations, many experienced robotic programs now effectively approach nearly all mitral patients robotically. This includes all pathologies counting endocarditis and patients deemed to be at greater risk for sternotomy. Virtually all isolated mitral and/or tricuspid operations, concomitant surgical ablation for atrial fibrillation, or stand-alone surgical ablation may be approached robotically. Techniques identical to those used in sternotomy cases are employed, including rigid partial and complete annuloplasty rings, sliding leaflet valvuloplasty, neochordae, autologous pericardial patches, and mitral valve replacement for stenosis.

Yet, before a widespread shift to robotic technology can be expected, telemanipulation must show superiority over conventional video-assisted mitral repair on the basis of durability at advancing levels of pathoanatomic complexity. If established, then training and dissemination of the cumulative experience must be shared to make this a routine, and perhaps cost-effective procedure in all advanced mitral

centers. For the evolving mitral specialist, mastery of safe and durable robotic mitral repair is an essential companion to one's simultaneous expertise in transcatheter mitral repair and replacement.

In the journal *Science*, Kaebnick and colleagues¹⁰ recently described that the optimal approach to emerging technology is to balance precaution with meaningful scientific advancement. For robotic mitral surgery, we must not reject precautionists out of hand as obstructing innovation. Precaution must serve as the meaningful guardrails to a broader advancement of our specialty. Given recent advances in the safe, effective, and reproducible outcomes achieved with robotic telemanipulation, if we can respect the epistemologic guardrails of precaution as we advance to all levels of complexity, we will soon arrive at the precipice of a transformation of mitral surgery in which the high-quality, routine approach to repair will be provided robotically.

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