The contemporary evolution of mitral valve surgery

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The surgical treatment of mitral valve disease remains dynamic. Within the past few years, new concepts in leaflet repair techniques and disease management have gained popularity, novel innovations in annuloplasty ring design have been introduced, and transcatheter alternatives for mitral valve repair and replacement have evolved.

With regard to disease management, improvement in the clinical outcomes of mitral valve surgery has rejuvenated advocacy for intervention earlier in the disease process, before the development of symptoms or ventricular dysfunction. Despite a lack of randomized, controlled trials, there is increasing evidence from large-scale retrospective studies that earlier surgery in patients with degenerative mitral valve disease imparts a long-term survival advantage.¹⁻³ As such, the American College of Cardiology and American Heart Association task force now assigns a class IIa recommendation (“should be considered”) for mitral valve surgery in symptom-free individuals.⁴ The importance of repair probability as a metric for early surgery eligibility has also emerged in professional society guidelines; intervention is only recommended if the probability of repair exceeds 95% and expected mortality is less than 1%. Enter the mitral valve “Center of Excellence.” Should patients with more extensive valve lesions be preferentially referred to accredited reference centers? Analogous to the SYNTAX score for coronary artery disease, a lesion-based scoring system that predicts technical complexity of mitral valve repair has been developed.⁵ If validated, such a score may help to discriminate patients who would be best suited to have surgery at a center with expert mitral valve surgeons.

Since the inception of the quadrangular resection, innovation in valve repair has primarily focused on techniques for leaflet remodeling, adjunctive measures to facilitate neochord tying, and the minimization of leaflet resection. Remodeling techniques whereby redundant, prolapsed tissue is excluded to restore a smooth coaptation surface have gained considerable popularity.^{6,7} The use of native, intact chordae has also gained appeal, as noted in the leaflet flip technique and the resurgence in

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Central Message

Recent innovations in disease management, techniques, and devices drive the contemporary evolution of mitral valve surgery.

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transposing secondary chordae to the primary position.⁸ On the other hand, extensive quadrangular resections are now less prevalent as a result of concerns of postoperative monoleaflet function and obligate small annuloplasty. As such, targeted leaflet resection has evolved with the aim of preserving functional leaflet tissue—triangular and butterfly resections also reduce the need for annular plication or leaflet sliding.⁹ Calcified leaflets and annuli, once contraindications to valve repair, are now routinely managed with focused resection or debridement to restore tissue pliability.

Mitral valve repair may now be extended to those with rheumatic mitral regurgitation.¹⁰ Pliable, functional leaflets are reformed through a combination of commissural and scallop division, fibrotic peeling to free mobile tissue, and pericardial patch leaflet augmentation to reestablish appropriate coaptation. Similarly, new repair techniques focused on papillary muscle manipulation and leaflet augmentation may improve the durability of repair for ischemic mitral regurgitation. Intentional chordal-sparing mitral valve replacement may supplant repair for ischemic mitral regurgitation, however, because of its comparable early survival and improved freedom from recurrent mitral regurgitation.¹¹

It should be noted that many of the newer repair techniques were developed to facilitate the increasingly popular minimally invasive surgical approaches. To date, no particular technique has definitively demonstrated

superiority relative to another, and minimally invasive and robotic mitral valve surgery centers reproducibly demonstrate outcomes equivalent to those of conventional sternotomy.^{12,13}

Beyond robotics, technologic advances in medical devices now provide surgeons with a multitude of annuloplasty rings and transcatheter valve repair and replacement systems. The first in its class, the Attune annuloplasty ring (St Jude Medical, St Paul, Minn) enables postimplantation size reduction. Modifications to other rings simplify the challenges of certain repair techniques. For example, the Memo 3D Rechorde annuloplasty ring (Sorin, Milan, Italy) standardizes artificial neochordoplasty; the difficulties of sizing polytetrafluoroethylene neochordae are mitigated by the incorporation of removable guides for tying neochordae at the annular plane.¹⁴ Whether these new devices improve operative time, valve repairability, or valve durability, however, remains unknown.

Recently, there has been rapid adoption and implementation of percutaneous treatments for structural heart disease, specifically transcatheter aortic valve replacement. Initial efforts to recreate the complex surgical techniques of mitral valve repair with catheter-based technologies, however, have been less successful. The MitraClip (Abbott, Abbott Park, Ill) replicates the edge-to-edge repair and is the first catheter-based mitral valve repair system approved for use in the United States. Despite an excellent safety profile, its limited procedural efficacy, as evidenced by only modest reductions in mitral regurgitation, should confine this percutaneous treatment to patients not considered operative candidates or at prohibitively high risk.¹⁵ “Clip first” strategies should be avoided in patients able to undergo operation, because salvage surgery for clip failure may require valve replacement because of irreparable leaflet damage, or at a minimum, escalate the level of complexity of valve repair. Similar to conventional mitral valve repair, perhaps the most effective and durable transcatheter repair strategy will use more than one repair technique and will be tailored to the etiology of the mitral regurgitation. Additional transcatheter therapies execute mitral repair through transapical neochordal implantation or percutaneous annuloplasty (directly, or indirectly through coronary sinus remodeling). Direct annuloplasty devices, such as the Cardioband (Valtech Cardio, Or Yehuda, Israel), use a transseptal approach to affix an annuloplasty band that is subsequently adjusted under echocardiographic guidance.¹⁶ Finally, transcatheter alternatives for mitral valve replacement have now entered human testing.¹⁷

The landscape of mitral valve surgery has changed significantly within the past 5 years. With regard to disease management, the benefits of earlier referral for mitral valve surgery are increasingly being recognized, and valve

repairability has become ever more important. Innovations in imaging, surgical instruments, and transcatheter devices fostered the development of new repair techniques that accommodate minimally invasive and endovascular approaches. Finally, the natural evolution toward transcatheter mitral valve surgery has begun; it is critical that cardiovascular surgeons become familiar with, and participate in, transcatheter device development, as well as that they recognize the limitations of these fledgling therapies until equivalence to conventional surgery has been achieved.

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