Mitral valve repair using robotic technology: Safe, effective, and durable

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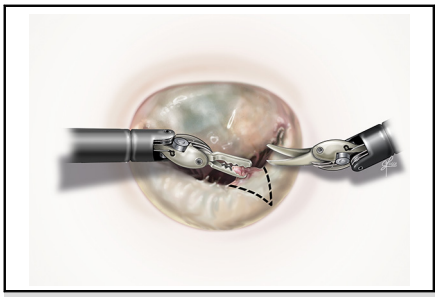

Robotic MV repair of middle scallop posterior mitral leaflet prolapse using triangular resection followed by a 2-layer Prolene suture reconstruction.

Central Message

Robotic MV repair is reproducible, effective, and durable with excellent midterm survival and freedom from heart failure.

See Editorial Commentary page 1455.

Robot-assisted mitral valve (MV) repair was introduced in the late 1990s with the goal of improving the technical precision of less-invasive surgical MV reconstruction. The broad advantages of robotic MV repair include an excellent 3-dimensional view of the valve pathology and better maneuverability of the endoscopic instruments (Figure 1). In this review, we sought to (1) delineate the timing and patient selection criteria for robotic MV repair, (2) review important technical criteria, and (3) describe the early postoperative and midterm outcome advantages of this technology.

WHAT ARE THE CONTEMPORARY INDICATIONS FOR MITRAL VALVE REPAIR AND WHAT IS THE IDEAL TIMING OF THE OPERATION?

Over the past decade, there has been significant progress in the understanding of the deleterious natural history of uncorrected severe degenerative mitral regurgitation (MR), which has led to an evolution in the type of patients who are referred for robotic MV repair. This has led to a growing body of data supporting the performance of early MV repair. The recent 2014 American College of Cardiology (ACC)/American Heart Association (AHA) Heart Valve Guidelines thus have moved to categorize patients with severe chronic degenerative MR into 5 stages: (A) minimal disease, (B) progressive disease, (C1) severe MR in asymptomatic patients with preserved left ventricular (LV) function (LV ejection fraction >60% or LV end-systolic diameter <40 mm), (C2) severe asymptomatic MR in patients with early evidence of LV dysfunction (LV ejection fraction <60% or LV end-systolic diameter >40 mm), and (D) severe symptomatic MR in patients.[1] Although prompt surgical correction for patients in stages D and C2 is strongly recommended (class I recommendation), there has been debate regarding the ideal timing of intervention for severe asymptomatic MR in patients without LV dysfunction (stage C1). Recently, new information supporting the advantages of prompt surgical correction of primary MR to both prevent excess long-term mortality and diminish heart failure risks[1,2] has led to a further evolution in thinking regarding the ideal timing for MV repair.

Evidence supporting the early referral of patients with severe asymptomatic MR with preserved LV function for MV repair can be divided into 4 main categories. First, severe uncorrected MR is a disease state with deleterious clinical outcomes, and MV surgery is unavoidable in this condition.[3] Second, MV repair is now reproducible with approximately 99% certainty; it is effective, durable, and safe with very low risks of postoperative mortality and morbidity, particularly in high-volume centers.[3-6] In contrast, percutaneous techniques, such as the MitraClip device (Abbott Vascular, Abbott Park, Ill), are reserved for high-risk inoperable patients merely requiring palliative downgrading, but not elimination of MR.[7] Third, performance of MV surgery within 3 months of diagnosis results in significant improvements in long-term survival and freedom

from heart failure.[2] Finally, strategies capable of minimizing the perceived burden of early intervention, such as thoracoscopic port access approaches and robotic MV repair, are now routinely available at heart valve centers. These procedures can be cost-neutral in comparison with open operation at certain centers and are often associated with rapid patient recovery and quicker return to normal activity.[3-6] Because delaying surgery until symptom onset during ''watchful waiting'' exposes patients to the risks of suboptimal outcomes and poor long-term survival, the class IIa recommendation to offer MV repair for asymptomatic patients without evidence of LV dysfunction when likelihood of repair is greater than 95% and risk is less than 1% has become more applicable in contemporary practice.[1,8]

The type and extent of MV disease also have historically affected the timing of referral for surgery because of the perception that patients with anterior leaflet prolapse are less ideal candidates for valve repair. Further, the 2014 ACC/AHA guidelines detail that although MR caused by posterior mitral leaflet prolapse (simple disease) often is reliably addressed by using both conventional and robotically associated approaches, recurrence of MR after repair of complex MV disease (severe multi-scallop degeneration or anterior leaflet involvement) traditionally has been assumed to be higher.[1] In the past, this perception led to uncertainty about the ability of robotic approaches to effect durable correction of complex degenerative disease and thus tempered the widespread recommendation for early intervention in these patients.[1] However, the recent demonstration that the midterm outcomes of robotic correction of primary MR are reproducibly excellent with equally impressive outcomes, high survival, excellent durability, and infrequent complications regardless of disease complexity has led to an evolution in thinking.[9] In centers with expertise in both MV repair and robotic surgery, most if not all patients with severe primary MR with appropriate vascular and coronary anatomy may reasonably be considered for early MV repair via robotic approaches regardless of the extent of MV prolapse.

WHO SHOULD UNDERGO ROBOTIC MITRAL VALVE REPAIR?

Patient Selection and Stratification

Robotic mitral repair is appropriate for both *degenerative* and *functional* MV disease. However, operative risks and mitral anatomy/pathology should be considered when selecting patients for the procedure.

Risk Stratification

Patients should be screened for comorbid conditions that may preclude the selection of the robotic technique.[10]

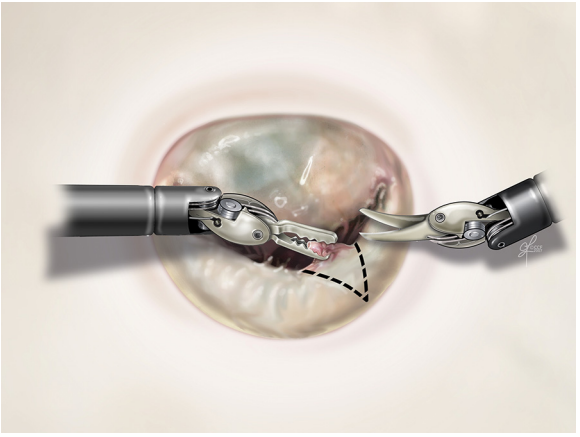

FIGURE 1. Robotic MV repair of middle scallop posterior mitral leaflet prolapse using triangular resection followed by a 2-layer Prolene suture reconstruction.

Robotic MV repair generally is done through a right chest approach, and thus, intra-thoracic pathology may be a contraindication. Table 1 demonstrates plausible and relative contraindications for selecting the robotic MV repair approach. Many of the latter can be managed to provide a safe robotic MV repair operation.

Patho-Anatomic Stratification

Patients who have degenerative MV disease and meet the risk selection criteria can be stratified according to anatomic location, pathology, and robotic MV repair complexity. Surgeons beginning a robotic MV repair program may consider initially selecting patients with posterior leaflet pathology alone. Thereafter, anterior leaflet repair techniques may be added to a surgeon's repair armamentarium. Having gained expertise in repairing anterior and posterior pathology subsets, experienced surgeons may consider advancing selection criteria to incorporate bileaflet prolapse, including Barlow's disease. The latter may require the use of several different techniques during the repair procedure.

The assessment of patients with functional MV disease may require further selection criteria. In this condition, repair technique relates to the degree of annular and ventricular dilatation, papillary muscle displacement, dynamic cardiac function, and degree of leaflet tethering. Patients with localized regional ventricular dysfunction are more amenable to robotic MV repair.

Imaging

Patients with significant risk factors for carotid/peripheral vascular disease should be screened by computed tomography (CT)/ultrasound. Patients at risk for coronary artery disease should undergo a cardiac catheterization or CT angiography. A right heart catheterization may be indicated in patients who have significant pulmonary