Masters of Cardiothoracic Surgery

Robotic mitral valve repair in the setting of mitral annular calcification

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Introduction

Mitral annular calcification (MAC) is a progressive, degenerative process characterized by dystrophic calcium deposition in the mitral annulus, often encountered in elderly patients and those with comorbidities (1). While MAC is frequently asymptomatic, severe disease can distort mitral valve anatomy, impair leaflet mobility, and contribute to regurgitation or stenosis (2). The presence of MAC introduces technical challenges during mitral valve surgery, including risk of atrioventricular groove disruption, paravalvular leak, and coronary artery injury (1,3).

Mitral valve repair (MVr) remains the preferred treatment for degenerative mitral disease, offering superior long-term survival and durability compared to replacement (1,4). However, repair in the presence of MAC is complex, as calcification can limit reconstruction (1,2). The robotic-assisted approach offers enhanced visualization, precision, and instrumentation, facilitating technically demanding repairs (3,5). Here, we describe our operative approach to robotic MVr in the setting of MAC, highlighting key technical considerations and lessons learned.

Clinical vignette

A 59-year-old female with a history of vasovagal syncope, and premature ventricular contractions (PVCs) status post ablation, presented to clinic for evaluation of severe mitral valve regurgitation. She was asymptomatic but reported a mild reduction in exercise tolerance. Transesophageal echocardiography (TEE) revealed severe mitral regurgitation secondary to prolapse, mitral annular disjunction, annular dilation, and a mildly dilated left ventricle with a reduced ejection fraction of 51%. Cardiac computed tomography (CT) angiography demonstrated no significant coronary artery disease and favorable anatomy for peripheral cannulation. Significant MAC was identified posteriorly. Following a comprehensive multidisciplinary and patient-centered discussion, she elected to proceed with robotic-assisted repair.

Surgical technique

Preparation

Patients with significant mitral valve disease with concomitant MAC are evaluated in a dedicated multidisciplinary mitral valve clinic. In addition to baseline transthoracic echocardiography (TTE) or TEE, a coronary CT angiogram or four-dimensional (4D) cardiac CT is performed to assess the extent and character of MAC, degree of leaflet involvement, and proximity of the circumflex. A CT angiogram of the chest, abdomen, and pelvis is also obtained to evaluate suitability for safe femoral cannulation.

Exposition

Following systemic heparinization, cardiopulmonary bypass is initiated and mild hypothermia is induced. An antegrade cardioplegia needle is placed in the proximal ascending aorta, and an endoballoon aortic occlusion device is inflated.

Antegrade cold del Nido cardioplegia is administered to achieve electromechanical arrest.

Operation

A left atriotomy is performed, and the mitral valve is exposed (*Video 1*). Scissors are used to detach the posterior leaflet from the calcified annulus. The fibrous capsule overlying the MAC is opened, and the calcium bar is removed piecemeal. Copious irrigation and aspiration are used to minimize the risk of embolization from calcium debris.

Following debridement, the posterior leaflet is reattached to the annulus using a double-layered running suture. Careful attention is paid to the lateral aspect of the annulus to avoid injury to the circumflex artery. Additional repair maneuvers are performed as needed. The annulus is sized, and a band is secured from trigone to trigone.

A saline leak test is performed to confirm adequacy of repair. A vent is positioned across the valve, and the atriotomy is closed with a running suture. Reperfusion is initiated. The robotic system is undocked, the patient is weaned from bypass, decannulated, and rewarmed. Cannulation sites are secured, and all incisions are closed in layers. Intraoperative TEE is performed to assess for residual mitral regurgitation, mitral stenosis, or systolic anterior motion.

Comments

Clinical results

The patient was extubated on postoperative day 0 and required no vasopressor support. She progressed well and had all drains and pacing wires removed prior to discharge on postoperative day 4. She subsequently reported an uncomplicated recovery. Follow-up echocardiography has demonstrated preserved left ventricular ejection fraction with only mild residual mitral regurgitation and no evidence of mitral stenosis at 4 years postoperatively. The patient continues to do well clinically.

Advantages

The robotic platform provides superior visualization, improved instrument articulation, and refined precision—features that facilitate the performance of technically complex procedures, including MVr in the setting of MAC. The platform also facilitates concomitant procedures when indicated. The enhanced visualization provides multiple levels of quality control during repair and enables *en-bloc* excision of large, bulky calcification without disruption of the atrioventricular (AV) groove. If AV groove disruption is noted following resection, small perforations may be repaired using pledgeted suture and larger disruptions repaired using pericardial patches and sutures passed through the atrial and ventricular muscle. Additionally, the minimally invasive nature of the robotic approach allows for complex mitral interventions to be performed without median sternotomy, thereby reducing associated morbidity. The precision and range of motion afforded by robotic instrumentation optimize repair quality, particularly in anatomically challenging settings such as MAC.

Caveats

Robotic-assisted cardiac surgery requires advanced technical proficiency and institutional commitment to dedicated equipment, infrastructure, and team development. Careful patient selection through multidisciplinary discussion remains critical when considering MVr in the setting of MAC. In particular, meticulous attention must be given to the anatomic relationship of the circumflex coronary artery to the posterior annulus; injury to this vessel is not always apparent intraoperatively, and subsequent repair mandates sternotomy and is challenging. Aspiration of calcium fragments following extensive debulking is best handled by a qualified assistant through a working port, as robotic suction devices are inconvenient and require repetitive changing of instruments. If calcium is too large and obstructive, and prevents adequate traditional repair, patients may require transition to transcatheter aortic valve replacement (TAVR)-in-MAC. And when patients are not a candidate for peripheral perfusion, or if certain concomitant procedures are indicated [e.g., coronary artery bypass grafting (CABG)], we opt for a sternotomy instead of a robotic approach. Thoughtful preoperative planning and intraoperative vigilance are essential to optimizing outcomes.

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Footnote

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