Editorial

Tackling MAC and other complex mitral valve repair scenarios through the lens of robotics

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In the spectrum of degenerative mitral valve (MV) diseases, mitral annular calcification (MAC) can manifest as the primary and sole cause of MV stenosis, or as one of several lesions, such as those found in Barlow's disease, leading to MV regurgitation. The first scenario offers bleak chances of repair due to insufficient pliable leaflet tissue. Moreover, MAC extending to the leaflets and left ventricular (LV) wall may reduce both the MV orifice and the LV cavity size. MV replacement often necessitates MAC removal to create adequate space for implanting a typically small prosthetic valve. The second scenario is significantly more favorable for achieving MV repair. The deciding factor for proceeding with MV repair is not the mere presence of MAC, but the quantity of pliable leaflet tissue remaining after the removal of the most dystrophic portion of the valve. The inherent increase in leaflet size found in Barlow's valves usually allows enough tissue for MV repair. Complete MAC excision and proper atrioventricular (AV) groove reconstruction are essential for achieving a secure zone for annuloplasty device attachment, resolving MV orifice distortion, and terminating further calcification growth and extension. These are important considerations for the quality and durability of MV valve repair. Due to the increased complexity of MV surgery in the presence of MAC, we believe robotics is "the right tool for the right job" (1,2).

While complete MAC resection and AV groove reconstruction have become our standard approach, a few MV repair or replacement techniques that involve leaving MAC in place and working around it have been developed in the past and used again recently (3). The understandable rationale behind these techniques is to keep surgery simple and avoid the risk of postoperative AV groove disruption. To perform proper MAC removal and AV groove reconstruction, we abide by ten technical principles:

(I) Unobstructed visualization of the calcific bar, including its extension along the annulus, onto the leaflets, the LV wall, and the left atrium (LA), is required during valve analysis.

(II) The calcium bar is typically surrounded by a reactive fibrous layer. The ideal dissection plane lies between the calcification and the fibrous layer. Electrocautery, as a dissection tool, allows for the preservation of as much fibrous tissue as possible on the myocardial side to reinforce the suturing zone and preserve the base of the posterior leaflet (PL). En bloc resection of the MAC is preferable to minimize the risk of debris dispersion.

(III) The PL tertiary chordae are excised, and the papillary muscle attachments to the myocardium are divided. This facilitates repositioning the PL against the interventricular septum with a dual-blade retractor, thereby enhancing visualization of the AV groove and the posterior wall of the LV.

(IV) AV groove dissociation is diagnosed when the epicardium is visible between the LA and LV myocardial edges. For narrow defects with good myocardial edges, primary repair with horizontal mattress sutures on a pledget is appropriate. Otherwise, the use of a patch is recommended

when the myocardial edges are separated by more than 10 mm, appear fragile, or when the LV cavity or MV orifice dimensions are small.

(V) Precision is paramount when placing stitches on the LV edge for either primary or patch repair of the AV groove. We consistently use 2-0 Ethibond horizontal mattress sutures with pledget. These sutures should be placed deep enough to engage compact muscle without becoming transmural or including the AV groove epicardium. We do not rely on myocardial trabeculations.

(VI) To ensure proper patch attachment to the LV edge using the Cor-Knot system, the bedside surgeon must individually visualize each knot as the console surgeon simultaneously holds the patch firmly against the LV edge during tightening. This process is essential to achieve sufficient compression of the patch on the myocardial edge without tearing it.

(VII) When performing a direct closure of the AV groove, the mattress sutures placed at the LV edge are also passed through the LA edge and then reserved for anchoring the annuloplasty device. Thus, AV groove closure becomes effective when the annuloplasty stitches are tied. To avoid any tearing on the LV side when tightening the annuloplasty knots, the console surgeon holds and pushes the annuloplasty device deep towards the LV base to release tension on the LV edge.

(VIII) When performing patch closure of the AV groove, a second line of mattress sutures (2-0 Ethibond without pledget) is needed to attach the patch to the LA edge. The distance between the LA and LV suture lines should be kept proportional to the AV dissociation; however, this distance should be kept as small as possible to avoid a postoperative drop in LV ejection fraction, since patches do not contract. The LA sutures will be reserved for anchoring the annuloplasty device.

(IX) The rim of the patch left above the LA suture line is used to reattach the PL. This rim can be made higher in areas where the height of the PL is considered too small.

(X) The successful conduct of this process depends on the presence of more than one experienced surgeon, each critically analyzing and approving the repair strategy and its execution.

While complex MV surgical techniques, including MAC excision and AV groove reconstruction, are performable via a sternotomy approach, we believe that robotics facilitates their execution according to the principles stated above. The near-microscopic visualization and superior dexterity offered by robotics make it the ideal tool for effectively performing complex techniques. Based on comprehensive valve analysis, the surgical sequence is collaboratively planned and agreed upon by the console and patient-side surgeons. The AV groove defect is visualized and assessed with unparalleled clarity, enabling collaborative reconstruction between both surgeons. Avoiding transmural stitches or LV edge tearing during AV groove repair is critical for successful outcomes. The ability of robotic instruments to achieve the balance between depth and careful tissue handling contributes to the overall safety and effectiveness of the procedure. This approach should be reserved for a dedicated team with advanced experience in robotics and MV surgery (1,2,4,5).

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Footnote

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