Masters of Cardiothoracic Surgery

Extensive posterior bar decalcification with novel calcific emulsification to enable endoscopic minimally invasive mitral valve repair

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Keywords: Mitral annular calcification (MAC); ultrasonic emulsification; mitral valve repair

Submitted Apr 10, 2025. Accepted for publication Jun 04, 2025. Published online Aug 11, 2025.
doi: 10.21037/acs-2025-mac-10
View this article at: https://dx.doi.org/10.21037/acs-2025-mac-10

Clinical vignette

Mitral annular calcification (MAC) is associated with increased perioperative risks and can require conversion to valve replacement. A 67-year-old male with New York Heart Association (NYHA) class 2 dyspnea was found to have severe mitral regurgitation (MR) secondary to P2 leaflet prolapse. He had a history of hypertension, scleroderma, left below knee amputation, and gastrointestinal bleeding. Echocardiography & computed tomography (CT) imaging revealed a flail posterior leaflet with severe anteriorly directed jet of MR and severe posterior MAC (*Figure 1*). His ejection fraction was 60–65% with trace aortic and tricuspid insufficiency and no significant coronary artery disease. A minimally invasive mitral valve repair using a novel ultrasonic emulsification and aspiration technique using the Sonopet device (Stryker, Michigan) was planned.

Surgical technique

Preparation and cannulation

The patient was placed in the left lateral decubitus position. Under ultrasound guidance, a percutaneous 16-French right internal jugular superior vena cava (SVC) drainage catheter was placed. Femoral cutdown was performed to expose the right femoral artery and vein. After systemic heparinization, an 8 mm Dacron graft was sewn to the right common femoral artery. Then, the right common femoral vein was cannulated with a 25-French multiport venous drainage catheter and guided up to the cavoatrial junction under transesophageal echocardiography (TEE) guidance. Cardiopulmonary bypass (CPB) was initiated once activated clotting time was >480 seconds.

Cross-clamp and mitral valve exposure

A vented cardioplegia needle was placed in the aortic root. Transthoracic aortic cross-clamp was applied, followed by antegrade cold del Nido cardioplegia to achieve diastolic arrest. After cardioplegic arrest, the mitral valve was exposed through a transverse left atriotomy with a 5 mm endoscope. A flail posterior leaflet was easily identified; however, there was significant calcification of the posterior mitral valve annulus subtending P2 and P3.

Decalcification of the mitral valve annulus and mitral valve repair

After careful inspection of the valve, decalcification was clearly required to enable successful repair. However, challenges include the completeness of decalcification with traditional scalpel techniques and difficulties manipulating the calcium with long-shafted instruments. Thus, the Sonopet device was used to decalcify, emulsify, and aspirate the calcium entirely down to the myocardium (*Figure 2*). After careful decalcification, the atrioventricular (AV)

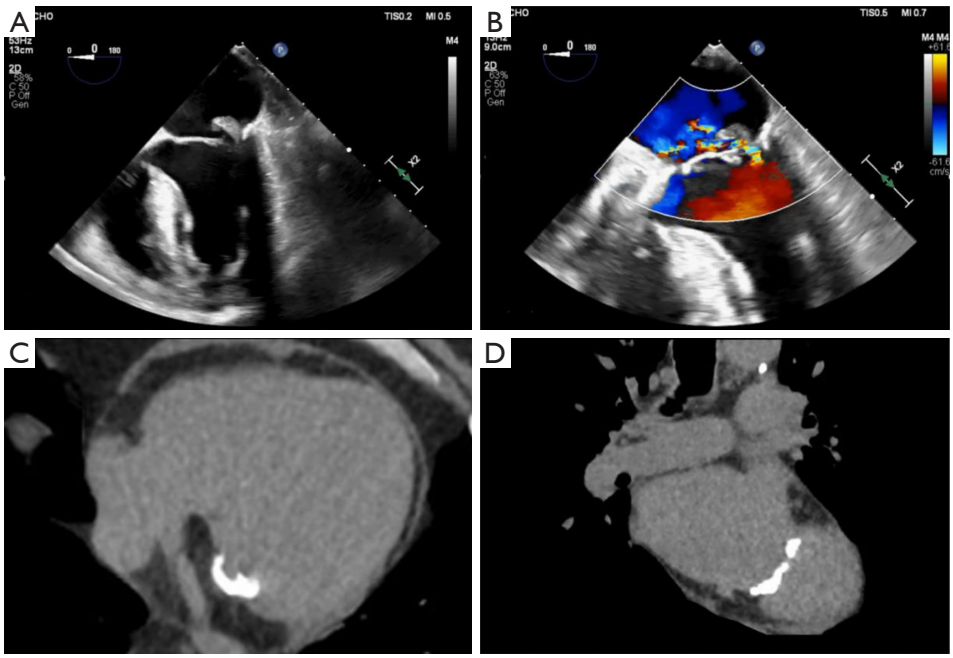

Figure 1 Preoperative images. (A,B) TEE demonstrating flail P2 posterior leaflet with severely dilated left atrium and severe anteriorly directed jet of MR. (C,D) CT heart demonstrating severe posterior mitral annular calcification. CT, computed tomography; MR, mitral regurgitation; TEE, transesophageal echocardiography.

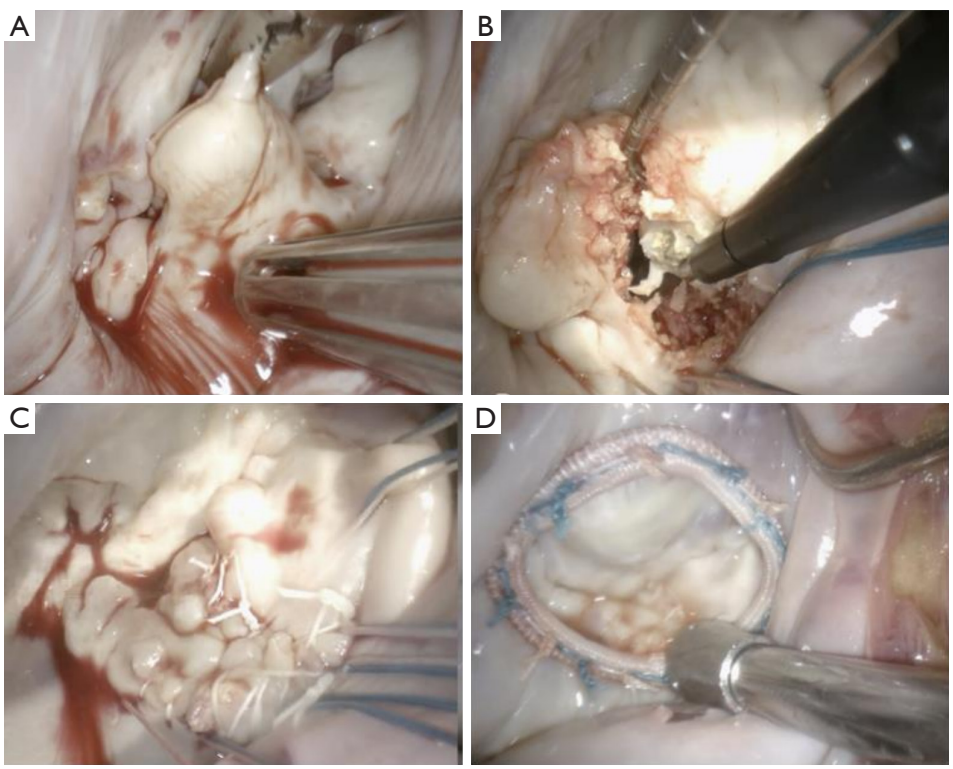

Figure 2 Intraoperative images. (A) Prolapsed P2 segment. (B) Decalcification of the posterior bar using Sonopet device. (C,D) Mitral valve repair and final result with annuloplasty ring.

groove was reapproximated with plegeted 2-0 Ethibond sutures. A quadrangular resection was completed with a limited sliding plasty to address the remaining P2 prolapse. The leaflet margins were reapproximated with 4-0 polytetrafluoroethylene sutures. Annuloplasty sutures were placed circumferentially around the annulus to accommodate a 32 mm Medtronic Simuform remodelling annuloplasty ring. The sutures were tied, and a final saline test demonstrated no significant residual leaks. We then proceeded to flood the surgical field with CO_2 and closed the left atrium with two layers of running 3-0 Prolene suture.

Weaning from CPB and final result

The patient was easily weaned from CPB on low dose inotropes and did not require any blood products. Postoperative TEE demonstrated excellent mitral valve reconstruction with no MR, mean/peak gradients of 3/7 mmHg respectively, and a height of coaptation of 12 mm with preserved biventricular function. Total cross-clamp and CPB times were 111 and 153 minutes, respectively. The patient had an unremarkable postoperative course and was discharged four days after surgery. At one-year follow-up, the patient is doing very well, functioning at NYHA class 1. His echocardiogram demonstrated no significant MR.

Comments

Severe MAC poses challenges during mitral valve surgery, as it is independently associated with increased risks such as mitral repair failure, AV groove disruption, paravalvular leak, calcific embolization, stroke and increased operative mortality (1,2). Mitral valve repair remains the gold standard. However, severe MAC can compromise valve repairability and require replacement. Techniques vary, from posterior bar resection and reconstruction with pericardium to more conservative approaches like partial annular decalcification to seat a bioprosthetic valve, or avoidance of MAC altogether by suturing around the calcium bar (1,2). Other alternatives for severe MAC include hybrid transatrial mitral valve replacement (MVR) and transcatheter MVR for high-risk patients. Thus far, hybrid and transcatheter based approaches have been associated with impaired survival and significant risks of paravalvular leak, stroke, and risk of left ventricular outflow tract obstruction (1,3).

Ultrasonic emulsification for annular decalcification in MVR was initially described by Brescia and colleagues as a safer approach (1). Their study included 15 patients with severe MAC who underwent MVR with the Sonopet device and 164 patients who had MVR without the Sonopet device. The Sonopet group had no operative mortalities or postoperative strokes, whereas the non-Sonopet group had a 10.3% mortality rate and 7.3% of postoperative strokes (1). They hypothesized that the Sonopet device for MAC reduces the risk of AV groove rupture and calcium embolization by providing controlled emulsification of MAC while minimizing annular trauma, although they only reported use in MVR. The Sonopet device has the advantage of calcific emulsification and aspiration which likely reduces any residual retained fragments that commonly occurs with more traditional decalcification techniques, especially when performed using minimally invasive techniques. We find that the Sonopet device instrument tip enabled relatively fine sculpting of the MAC resection in a controlled manner that would also allow more preserved leaflet tissue than more traditional scalpel techniques, which facilitated mitral repair. Stryker reports that the Sonopet cavitation targets calcium, and anhydrous tissue such as muscle and blood vessels are unaffected by the device, although this remains completely theoretical. Although the device was able to be passed through the 3-cm port, the handle remains somewhat bulky and requires visualization with the endoscope to guide decalcification. Further investigation is required; however, we do believe this technology holds significant potential as it provides a targeted technique of MAC decalcification which can be performed using minimally invasive techniques and can preserve MV reconstruction, avoiding the deleterious consequences of replacement.

Acknowledgments

None.

Footnote

Funding: None.

Conflicts of Interest: M.W.A.C. is supported as the Ray and Margaret Elliott Chair in Surgical Innovation and has received Speaker's honoraria from Medtronic, Edwards Lifesciences, Terumo Aortic and Artivion. The other author has no conflicts of interest to declare.

Ethical Statement: The patient provided written informed consent for publication of their study data.

Cite this article as: Rheault-Henry M, Chu MWA. Extensive posterior bar decalcification with novel calcific emulsification to enable endoscopic minimally invasive mitral valve repair. Ann Cardiothorac Surg 2025;14(6):504-507. doi: 10.21037/acs-2025-mac-10

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