

VALVULAR HEART DISEASE MINI-FOCUS ISSUE

ADVANCED

CASE REPORT: CLINICAL CASE

Hybrid Mitral Valve Replacement

A Heart-Team Approach to Severe Mitral Annular Calcification



Javier G. Castillo, MD, Gilbert H.L. Tang, MD, David H. Adams, MD, Ahmed El-Eshmawi, MD

ABSTRACT

Mitral annular calcification tends to be significant in patients of advanced age or with underlying processes such as increased mechanical stress. When severe, it can significantly affect perioperative outcomes, especially if mitral decalcification is required for success. This report describes a versatile heart-team approach to a very complex condition. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2019;1:495-9) © 2019 Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

HISTORY OF PRESENTATION

The patient was an active 68-year-old woman who presented to a local emergency department with worsening dyspnea and very limited ambulatory capacity. Additional symptoms included easy fatigue, occasional palpitations, and orthopnea.

MEDICAL HISTORY

Medical history included hypertension, hyperlipidemia, type 2 diabetes mellitus on oral medication, and morbid obesity (weight 102 kg, height 154 cm, body mass index 42.6 kg/m²). On examination, she was normotensive (125/83 mm Hg), with a regular pulse of 62 beats/min, with no significant findings other than jugular venous distention and peripheral edema. Cardiac auscultation revealed a regular rate and rhythm, a faint first heart sound, a loud second heart

sound, and a classic mid-diastolic rumbling murmur with pre-systolic accentuation best heard over the apex. Pulmonary auscultation revealed bilateral rales.

DIFFERENTIAL DIAGNOSIS

Although our patient had a very straightforward diagnosis, particularly after echocardiography, the differential diagnosis can include prosthetic valve obstruction, large left atrial myxoma, or, in very rare occasions, cor triatriatum.

SEE PAGE 500

INVESTIGATIONS

Echocardiography showed severe mitral valve stenosis (mitral valve area 1.1 cm², diastolic pressure half-time 157 ms), moderate mitral valve regurgitation (type IIIA dysfunction secondary to bileaflet restriction), and severe left atrial enlargement (area 30 cm²). There was severe mitral annular calcification (MAC), which completely engulfed the posterior leaflet, thus freezing the leaflet hinge. The anterior leaflet was partially pliable, with concentrated calcification foci. Of note, the areas of calcification (pebble-like shape) protruded into the left ventricular outflow tract. The posteromedial commissure was severely fibrotic and

LEARNING OBJECTIVES

- Operators should be able to plan therapeutic strategies in patients with severe MAC.
- Operators should understand the role of a hybrid approach in surgical patients requiring high-risk techniques.

From the Department of Cardiovascular Surgery, The Mount Sinai Hospital, New York, New York. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Informed consent was obtained for this case.

Manuscript received July 1, 2019; revised manuscript received August 7, 2019, accepted August 14, 2019.

**ABBREVIATIONS
AND ACRONYMS**

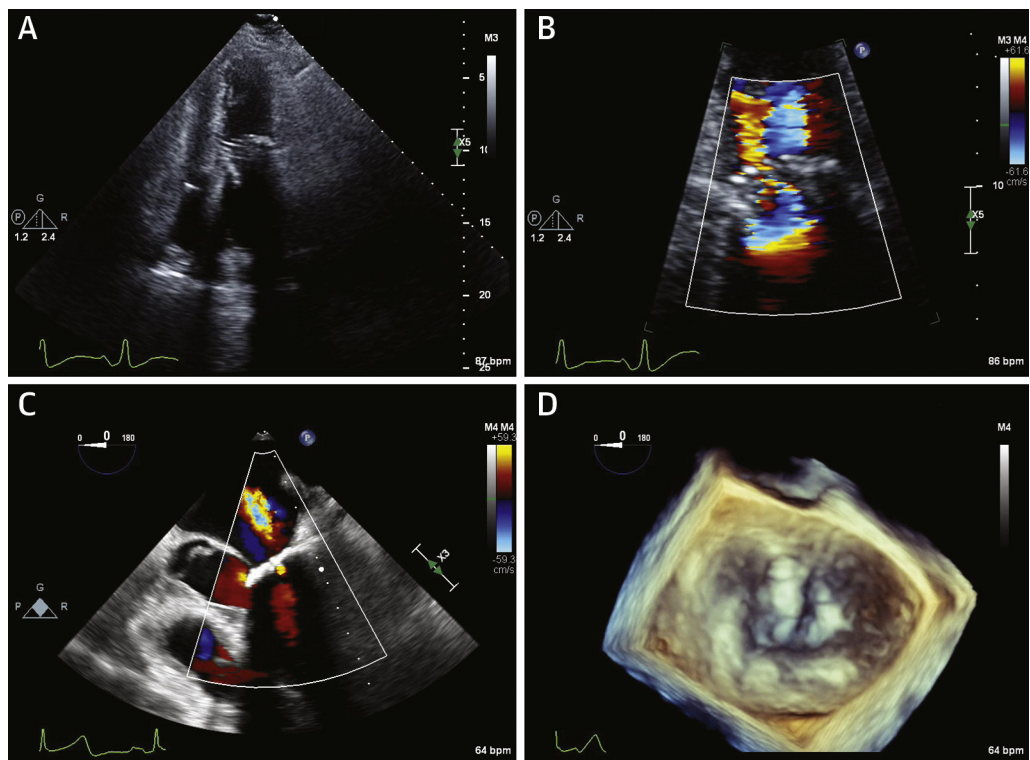
MAC = mitral annular
calcification

fused. Left and right ventricular function and dimensions were preserved. Narrowing of the left ventricular outflow tract was seen, due to a small left ventricular cavity and extensive calcification of the aortomitral curtain. A large pericardial effusion was noted (Figures 1A to 1D, Videos 1, 2, and 3). Computed tomography confirmed echocardiographic findings. The coronary calcium score was found to be 2 (representing the 53rd percentile adjusted for age, sex, and ethnicity). The maximal pulmonary artery diameter was 3.1 cm (Figures 2A to 2F). Cardiac catheterization demonstrated right dominance, nonobstructive coronary artery disease (30% stenosis of the left anterior descending coronary artery), and moderate pulmonary hypertension (mean pulmonary artery pressure 41 mm Hg).

MANAGEMENT

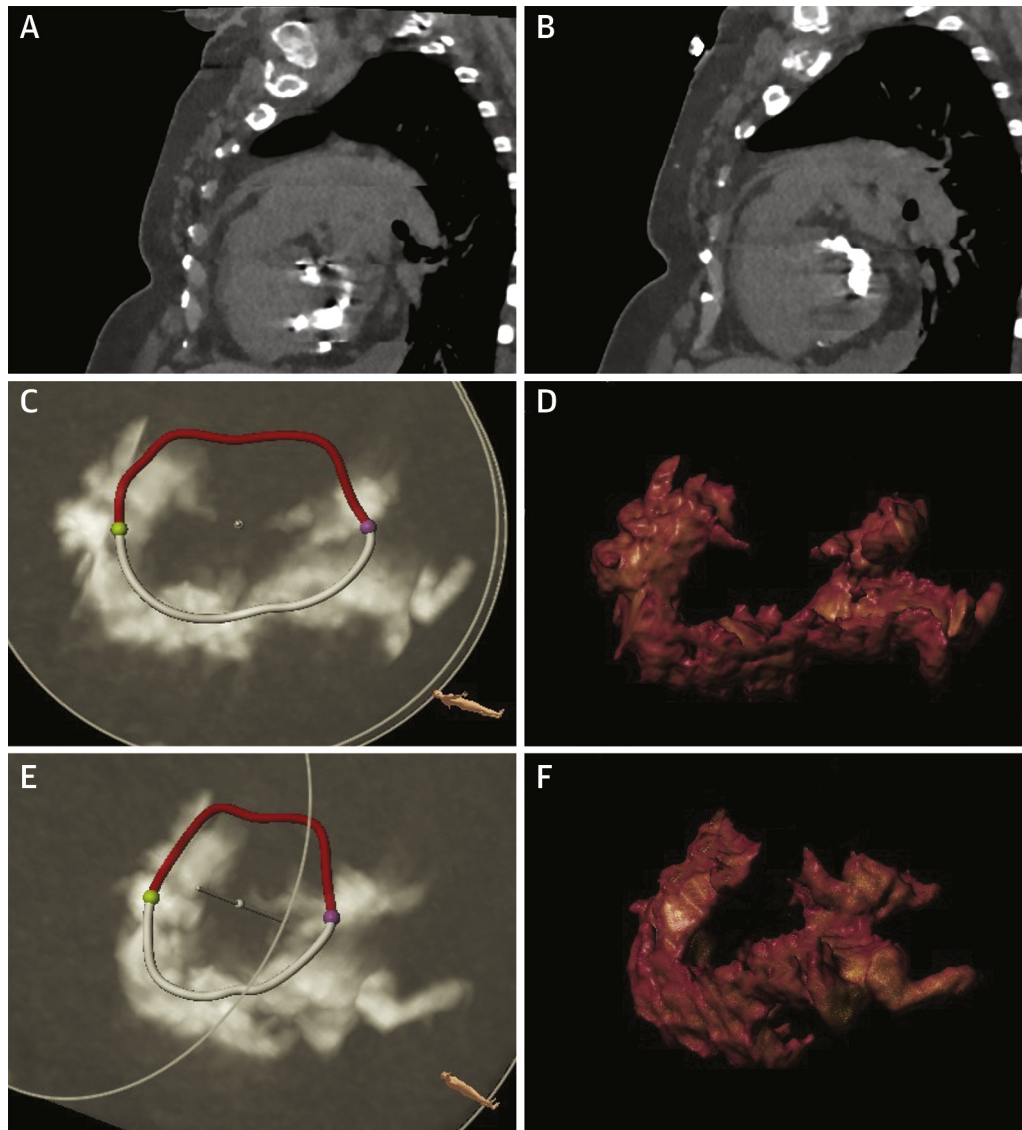
According to current guidelines, the severity of disease, the presence of symptoms and moderate mitral regurgitation, a nonfavorable valve morphology (Wilkins score 14) for percutaneous mitral balloon commissurotomy, and the relative absence of surgical risk represent a Class I indication for surgical intervention. At surgery, a mini-sternotomy was performed to open the chest, and the heart was arrested using antegrade and retrograde cold blood cardioplegia. The mitral valve was exposed through Sondergaard's groove. Valve analysis revealed a chronic severe calcification of the posterior annulus that engulfed the leaflet hinge and extended toward the posterior leaflet and the subvalvular apparatus (Figure 3A). Given the impossibility of driving needles

FIGURE 1 Transthoracic and Transesophageal Echocardiograms



(A) Severe left atrial enlargement, mitral calcification with reduced valve area, and small ventricular capacity. **(B)** Doppler imaging shows near critical mitral stenosis and moderate mitral regurgitation. **(C)** Severe mitral annular calcification along the posterior mitral annulus extending to the posterior leaflet and commissures. Calcification of the anterior leaflet and mitroaortic curtain leads to a pebble-like deposit or shelf of calcium protruding into the left ventricular outflow tract. **(D)** Three-dimensional echocardiography shows massive calcification of the posterior leaflet and 2 areas of calcification along the anterior leaflet. See Videos 1, 2, and 3.

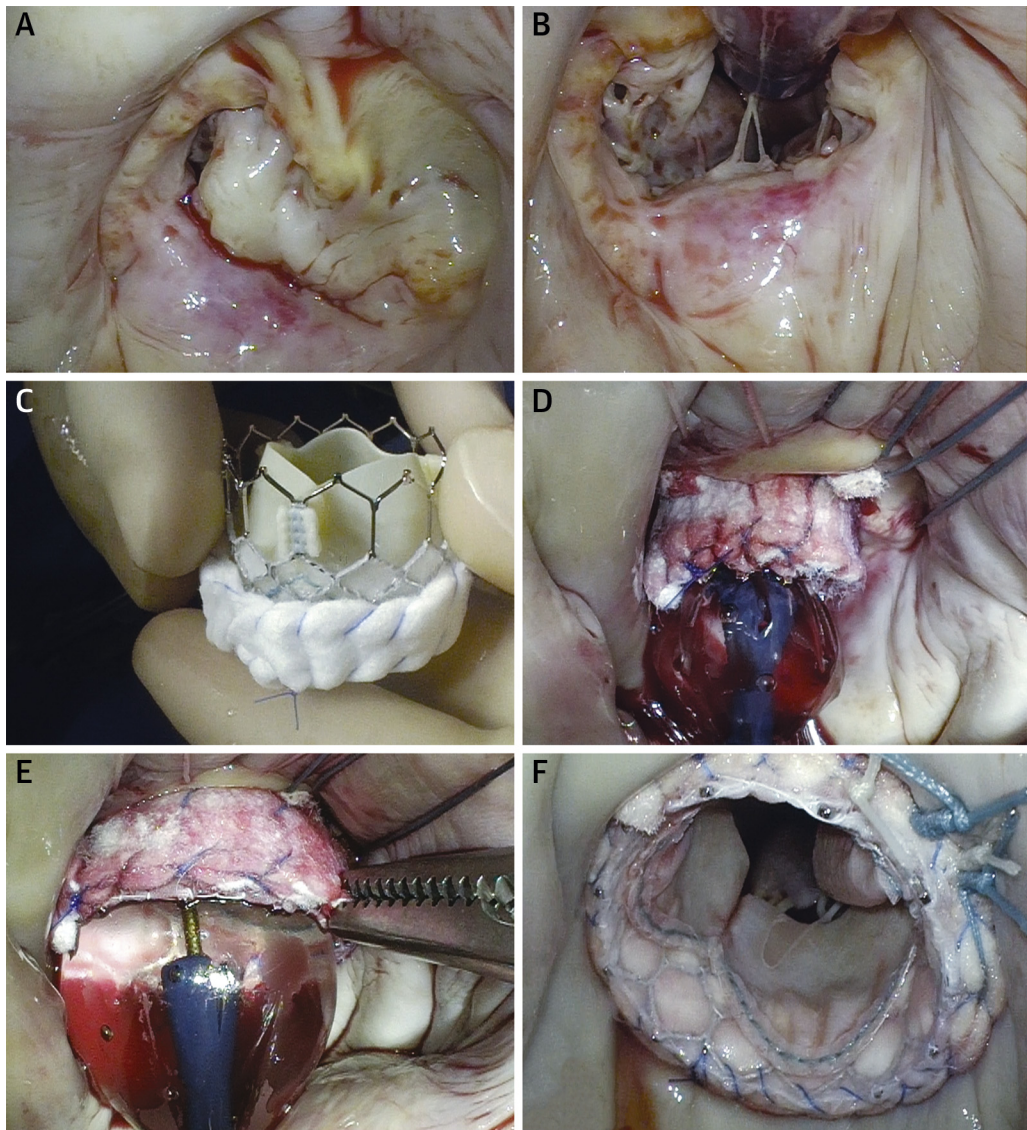
FIGURE 2 Computed Tomography



(A,B) Severe left atrial enlargement, mitral calcification with reduced valve area, and small ventricular capacity. **(B)** Doppler imaging shows severe mitral stenosis with almost critical mitral stenosis and moderate mitral regurgitation. **(C,D)** Severe mitral annular calcification along the posterior mitral annulus extending to the posterior leaflet and commissures. **(E)** Calcification of the anterior leaflet and mitroaortic curtain leads to a pebble-like deposit or shelf of calcium protruding into the left ventricular outflow tract. **(F)** Three-dimensional echocardiography shows massive calcification of the posterior leaflet and 2 areas of calcification in the anterior leaflet.

through the annulus (even when trying deep infra-annular ventricular bites), the only option was annular en bloc decalcification and ventriculoplasty, which may carry up to 5% mortality in very expert hands. After a rapid heart-team discussion, a decision was made to assess hybrid options. Using standard Epic valve sizers (Abbott-St. Jude Medical, Minneapolis, Minnesota) with 120° markings, a 26-mm

Edwards SAPIEN 3 Ultra valve (Edwards Lifesciences, Irvine, California) was chosen. The anterior leaflet was partially resected, sparing calcified areas to facilitate prosthetic anchoring. In addition, 4 pledgeted sutures (2-0 polyethylene terephthalate) were placed along the anterior mitral annulus (Figure 3B). The percutaneous valve was prepared with 2 long Teflon felt strips (Figure 3C). The valve

FIGURE 3 Surgical Analysis and Procedure

(A) Massive mitral annular calcification of both mitral valve leaflets with a pebble-like shelf of calcium protruding into the left ventricular outflow tract. (B) The anterior leaflet has been partially excised. (C) Two strips of Teflon felt are sewn to the sealing skirt with a running 5-0 polypropylene suture. (D,E) The valve is expanded. (F) Sutures are passed through the Teflon felt strips to further anchor and secure the valve.

was crimped on a deflated balloon following standard techniques and then deployed (Figure 3D). Subsequently, sutures were passed through the Teflon felt strips to further secure the valve (Figure 3E). Intraoperative echocardiography off bypass did not reveal perivalvular leaks or significant left ventricular tract obstruction (Figure 3F). Recovery was uneventful, and the patient was discharged on post-operative day 6. Pre-discharge echocardiography showed a valve

gradient of 3 mm Hg, no paravalvular leaks, and no significant left ventricular tract obstruction. Findings on follow-up echocardiography at 3 months were unchanged.

DISCUSSION

About 10% of patients 70 years of age or older may present with a significant degree of MAC (1). Without

question, this represents a very technically demanding challenge because of significant risk for atrioventricular disruption, which in turn may be associated with reported operative mortality as high as 75%. Although conventional surgery can be successfully performed with mild degrees of MAC, circumferential or advanced degrees of MAC frequently require adjunct techniques or procedures, and outcomes are exponentially worse (2). In this context, transcatheter approaches have been increasingly proposed in patients with severe MAC and a high surgical risk profile. However, severe limitations, including potential left ventricular tract obstruction and difficulties to securely anchor the prosthesis, have led to important increased periprocedural morbidity and mortality (3). Therefore, a hybrid approach to severe MAC, open implantation of a balloon-expandable valve, has recently emerged, whether as a planned procedure or as a bailout solution (4). Russell et al. (4) provided a detailed description of hybrid transatrial mitral valve replacement using a balloon-expandable valve that served well as a scaffold for surgical and procedural variations for the heart team. This series not only demonstrated that open delivery of a balloon-expandable prosthesis in the mitral position can be achieved safely with similar hemodynamic results but also served as a proof that very high risk surgical patients with challenging lesions can be successfully treated. However, unlike in our current case, the investigators were able to place sutures circumferentially with Teflon felt pledgets on the atrial side. In the present case, as shown, the calcium was left behind and used as an anchor for the prosthesis.

The following are key considerations for the heart team. 1) Excise the anterior leaflet completely or partially (only the ventricular end to avoid obstruction of the left ventricular outflow tract), depending on the degree of calcification. Calcium is often preferred to securely anchor the percutaneous valve if sutures cannot be placed because of severe circumferential MAC. 2) Although size can be

determined using pre-operative computed tomography, we recommend intraoperative sizing with standard valve sizers. Mark the commissures 120° apart with a surgical marking pen so that 2 of these subtend the left ventricular outflow tract. 3) If there is no fusion of at least 1 of the commissures, posteromedial commissural closure is advised to achieve a more circumferential geometry of the mitral valve and avoid potential paravalvular leaks. 4) Pledged annular sutures should be placed wherever possible to further secure the valve. 5) The Edwards SAPIEN 3 Ultra transcatheter valve is prepared by applying 2 long Teflon felt strips around the sealing skirt with a running 5-0 polypropylene suture. 6) The commissures of the valve are marked over the Teflon felt strip 120° apart with a surgical marking pen. 7) Crimp the valve and lower it into position, considering potential foreshortening. 8) After expanding the valve, pass previously placed annular sutures through the Teflon felt strips.

FOLLOW-UP

Findings on follow-up echocardiography at 3 months were unchanged.

CONCLUSIONS

As transcatheter valve therapies continue to expand, hybrid solutions will be increasingly proposed as optimal in high-risk patients with challenging lesions or disease processes. Hybrid mitral valve replacement with a SAPIEN 3 Ultra transcatheter valve in patients with very severe MAC can be safely performed despite challenging anatomy or a high-risk patient profile. A systematic heart-team approach is crucial in such scenarios to achieve success.

ADDRESS FOR CORRESPONDENCE: Dr. Javier Castillo, The Mount Sinai Hospital, 1190 Fifth Avenue, GP2W, Box 1028, New York, New York 10029. E-mail: javier.castillo@mountsinai.org.

REFERENCES

1. Fox CS, Vasan RS, Parise H, et al. Mitral annular calcification predicts cardiovascular morbidity and mortality: the Framingham Heart Study. *Circulation* 2003;107:1492-6.
2. Saran N, Greason KL, Schaff HV, et al. Does mitral valve calcium in patients undergoing mitral valve replacement portend worse survival? *Ann Thorac Surg* 2019;107:444-52.
3. Guerrero M, Urena M, Himbert D, et al. 1-Year outcomes of transcatheter mitral valve replacement in patients with severe mitral annular calcification. *J Am Coll Cardiol* 2018;71:1841-53.
4. Russell HM, Guerrero ME, Salinger MH, et al. Open atrial transcatheter mitral valve replacement in patients with mitral annular calcification. *J Am Coll Cardiol* 2018;72:1437-48.

KEY WORDS hybrid, mitral annular calcification, mitral valve disease, mitral valve replacement, transcatheter valve replacement

APPENDIX For supplemental videos, please see the online version of this paper.