



Case Report

Right Mini-Thoracotomy Beating-Heart Mitral Valve Replacement With a SAPIEN 3 Valve for Severe Circumferential Mitral Annular Calcification

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ABSTRACT

Mitral annular calcification (MAC) is a degenerative process that can cause mitral valve stenosis. Conventional surgical mitral valve replacement (MVR) for MAC with mitral stenosis can be challenging and associated with significant risk. Open surgical MVR with a transcatheter valve can offer an alternative in select situations. When such a strategy is not feasible, a beating-heart, mini-thoracotomy MVR with a SAPIEN 3 transcatheter heart valve can be considered. The novel teaching point of this case is use of an alternative approach for managing severe mitral stenosis secondary to MAC, when conventional surgical and transcatheter strategies are not safe or possible.

RÉSUMÉ

La calcification de l'anneau mitral (CAM) est un processus dégénératif qui peut causer la sténose mitrale. Le remplacement valvulaire mitral (RVM) par intervention chirurgicale traditionnelle lors de CAM associée à la sténose mitrale peut être complexe et est associé à un risque important. Le RVM à cœur ouvert par cathéter peut être une solution dans certaines situations. Lorsque cette stratégie n'est pas faisable, le RVM à cœur battant par mini-thoracotomie à l'aide d'une valve cardiaque SAPIEN 3 par cathéter peut être envisagé. Le nouveau point à retenir de ce cas est l'utilisation d'une autre approche pour prendre en charge la sténose mitrale grave secondaire à la CAM, lorsque les stratégies d'intervention chirurgicale traditionnelle et de cathétérisme ne sont pas sûres ou possibles.

Mitral annular calcification (MAC) is a degenerative process that is present in approximately 10% of the population.¹ Conventional surgical mitral valve replacement (MVR) for MAC can be challenging, with the potential for atrioventricular dissociation related to decalcification of the annulus. Transcatheter MVR (TMVR) may be a good option for the treatment of MAC in the future, but it is presently associated with a high rate of complications.¹ Although outcomes of the transcatheter approach likely will improve with time, currently, open surgical implantation of transcatheter valves can offer a lower-risk option for patients.²⁻⁴ Recent studies have reported outcomes of open surgical implantation of a transcatheter heart valve (THV) in the mitral position in high-risk patients with severe MAC and mitral stenosis.⁵⁻⁸ In some cases, such as porcelain aorta, application of a cross-clamp is not safe. For those patients, a beating-heart, minimally

invasive MVR with a SAPIEN 3 THV (Edwards Lifesciences, Irvine, CA) is an option.

Case

A 79-year-old woman was admitted to the hospital with refractory congestive heart failure from severe mitral stenosis (MS; mean gradient of 29.7 mm Hg on catheterization, and 15 mm Hg on echocardiography) due to circumferential MAC (Fig. 1). She was frail, had a porcelain aorta, had chronic kidney disease, and had had prior breast cancer. After multidisciplinary discussion, consensus was reached that conventional surgical MVR via sternotomy with aortic cross-clamping was associated with prohibitive risk. The decision was made that a minimally invasive, beating-heart, right mini-thoracotomy approach was the only surgical option. To avoid the risks associated with en bloc removal of MAC, a plan was made for an inverted SAPIEN 3 valve to be implanted within the circumferential MAC. A preoperative computed tomography scan was obtained to determine the dimensions of the mitral valve apparatus. Measurements were performed at 70% of the cardiac cycle, where the annulus area was 9.92 cm², the average diameter was 35.5 mm, the perimeter was 114 mm, the intercommissural distance was 37 mm, the septal-lateral distance was 32 mm, and the trigone-trigone distance was 20 mm.

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Ethics Statement: The patient provided informed consent for the preparation of this report.

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Novel Teaching Points

- Mitral valve stenosis secondary to severe MAC can be difficult to manage through conventional surgical or emerging transcatheter approaches.
- In challenging cases in which an aortic cross-clamp cannot be applied, a beating-heart MVR can be performed.
- Minimally invasive mitral valve surgery can be performed safely via a right mini-thoracotomy approach in appropriate patients.
- In select cases, when other options are not safe or feasible, a THV can be deployed in the mitral position through a minimally invasive incision and while the heart is beating.

The patient was positioned supine on the operating table. Transesophageal echocardiography (TEE) confirmed only trace aortic regurgitation; the beating-heart procedure should not be attempted with more than mild aortic regurgitation. Peripheral vessels were cannulated, and cardiopulmonary bypass (CPB) was initiated, with the patient maintained at normothermia. In the right 4th intercostal space, a 5-cm mini-thoracotomy incision was made. The lungs were then deflated, and the pericardium was opened and retracted. Excellent venous drainage is critical to minimize blood in the field, and this was achieved with a vacuum assist on a 25-Fr multi-sideport venous cannula, positioned with its tip at least 3 cm into the superior vena cava. With the heart continuing to beat, and CO₂ insufflated, the left atrium (LA) was opened, and 2 sump suckers were used to manage blood in the atrium. One of these was passed across the valve and into the left ventricle.

Valve inspection found a heavily calcified mitral valve. The valve orifice was small, and complete decalcification of the annulus would have been necessary to allow placement of an acceptably-sized bioprosthesis. Instead, the MAC was left intact, and only the anterior leaflet was resected. A stepwise description of the open SAPIEN 3 implantation procedure

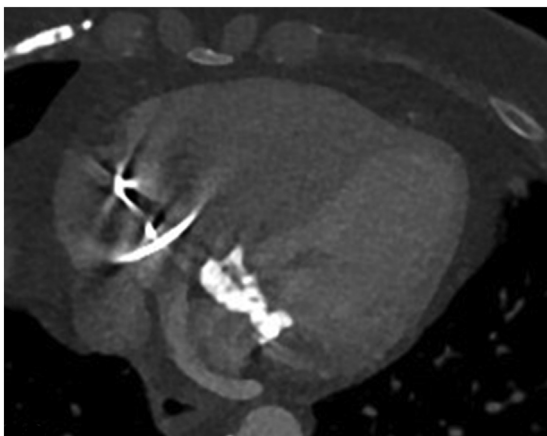


Figure 1. An axial computed tomography scan showing circumferential mitral annular calcification.

has been given previously.² The same sequence of steps was used, via the minimally invasive beating-heart approach.

As shown in [Video 1](#) (view video online), 3 pledgeted valve sutures were placed at the commissures to act as guiding sutures for delivery of the valve. Additional pledgeted sutures were placed in the annulus anteriorly for hemostasis. A 29-mm SAPIEN 3 THV was opened, and felt was sewn circumferentially to the outer skirt. The valve was then crimped and placed on the delivery system. The sutures placed at the commissures were passed through a rim of felt, and the valve was delivered through the mini-thoracotomy incision and positioned at the level of the annulus ([Fig. 2](#)). Using long instruments and video assistance, the position of the valve was verified, the balloon was inflated, and the valve sutures were tied. The sump suckers were gradually withdrawn as the LA was closed, to allow filling of the ventricle and LA as residual air was displaced. With adequate de-airing confirmed on TEE, the patient was weaned from CPB. Post-CPB echocardiogram imaging suggested a moderate-severe paravalvular leak posteriorly. This leak was believed to be secondary to incomplete expansion of the SAPIEN THV. Back on CPB, the valve was re-exposed, and the balloon was reinserted and inflated an additional 5 mL (total of 8 mL). The patient was weaned from CPB with a better result. The TEE revealed mild paravalvular leakage, that the valve leaflets opened well, and a mean gradient of 2 mm Hg. CPB time was 184 minutes, and there was no cross-clamp. At 6-months follow-up, the patient was asymptomatic and living independently at home with no readmissions for heart failure. Echocardiography revealed normal biventricular function, a well-functioning SAPIEN THV with mild-moderate paravalvular leakage, and a mean gradient of 6 mm Hg. The right ventricular systolic pressure was 52 mm Hg. No evidence was seen of left ventricular outflow tract obstruction.

Discussion

The treatment of MAC-associated MS can be difficult and high risk. Conventional surgical strategies, involving removal of MAC with valve implantation, have been the mainstay of surgical treatment. Open surgical implantation of transcatheter aortic valve prostheses in the mitral position for patients with severe MAC has been reported recently.⁸ The majority of these case reports and series have been done through a conventional full median sternotomy on an arrested heart.

This case describes the surgical management of a patient in refractory heart failure with severe mitral valve stenosis secondary to MAC. With the presence of the high-risk features of frailty and a porcelain aorta, conventional sternotomy, cross-clamping, removal of MAC, and valve replacement were deemed to pose prohibitive risk. A percutaneous TMVR using a SAPIEN 3 valve or a dedicated prosthesis, such as Tendyne, was not available at our centre. Instead, a minimally invasive beating-heart MVR was performed through a right mini-thoracotomy with a SAPIEN 3 valve. This case is unique, as it describes the steps of beating-heart MVR performed through a right mini-thoracotomy, using an aortic THV. The left atrial approach facilitated excellent native valve exposure, which we believe would not have been accomplished through a trans-septal incision. A beating-heart strategy was chosen

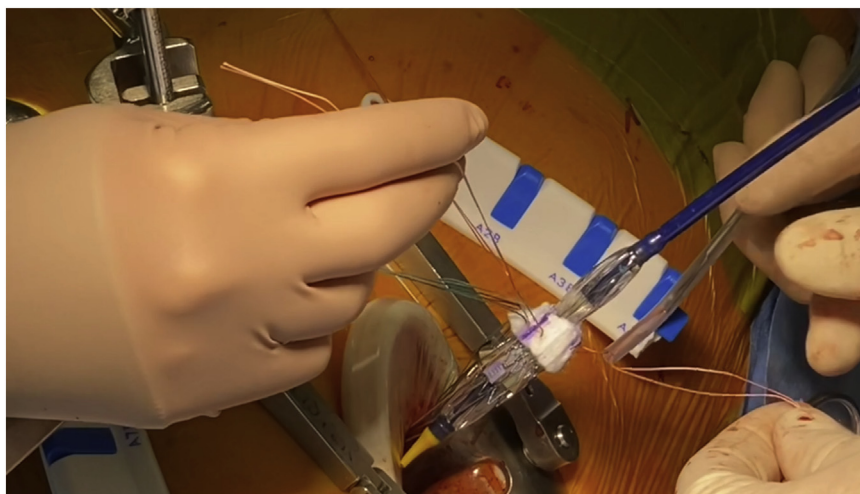


Figure 2. The deployment of a SAPIEN 3 transcatheter heart valve (Edwards Lifesciences, Irvine, CA) through a right mini-thoracotomy to treat mitral stenosis secondary to severe mitral annular calcification.

because, compared with fibrillatory arrest, it is associated with a shorter CPB time, a lower rate of transfusion, and a shorter period of invasive ventilation postoperatively.

As noted above, some groups have used a THV to address severe MS in the past. To our knowledge, this is the first case that describes the successful combination of deploying a SAPIEN 3 THV through a minimally invasive incision while the heart was beating, in order to manage MS in the context of severe MAC. Our approach may be an option for select, high-risk patients for whom conventional surgical and transcatheter strategies are not safe or possible.

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Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

To access the supplementary material accompanying this article, visit *CJC Open* at <https://www.cjopen.ca/> and at <https://doi.org/10.1016/j.cjco.2022.03.012>.