Texas Heart Institute Journal

Case Reports

Minimally Invasive Beating Heart Mitral Valve Repair in a Patient With Connective Tissue Disease at Prohibitive Risk for Redo Sternotomy

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Sternal reentry when the ascending aorta is adherent to the posterior table of the sternum is associated with substantial risk. A minimally invasive right thoracotomy beating heart approach is an alternative when the aorta cannot be cross-clamped. This report details this technique for a complex reoperative mitral valve repair procedure performed in a patient with connective tissue disease who had required multiple aortic operations and presented with heart failure and severe functional mitral regurgitation. ***(Tex Heart Inst J. 2022;49(6):e217699)***

Citation:
Fatehi Hassanabad A, Svystonyuk DA, Kent WDT. Minimally invasive beating heart mitral valve repair in a patient with connective tissue disease at prohibitive risk for redo sternotomy. *Tex Heart Inst J.* 2022;49(6):e217699. doi:10.14503/THIJ-21-7699

Keywords:
Mitral valve; minimally invasive surgical procedures; connective tissue diseases

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Redo mitral valve (MV) surgery is becoming more common.[1] Although it was previously considered very high-risk, with a perioperative mortality rate greater than 20%, some reports have suggested that the mortality risk is 4% to 7%.[2-5] The 2 most common strategies for reoperative MV surgery are resternotomy and anterolateral thoracotomy. For patients with brachiocephalic vein, aorta, right ventricle, or bypass grafts adjacent to the undersurface of the sternum, the risk of reoperation can be mitigated with a right chest approach.

Minimally invasive right thoracotomy is a less-invasive alternative to full thoracotomy. Evidence suggests that it is associated with less bleeding, less postoperative pain, earlier extubation, and earlier mobilization.[6,7] When the aorta cannot be safely clamped, a beating or fibrillating heart strategy with no cross-clamp is an option. Comparisons of beating heart and arrested heart techniques have found both to be safe.[4,8-11] There is also evidence of reduced operative times, quicker extubation, shorter intensive care unit (ICU) and total hospital length of stay, less ischemia-reperfusion injury, and reduced postoperative bleeding and blood transfusion needs with the beating heart technique.[8]

Case Report

A 76-year-old man with undifferentiated connective tissue disease complicated by extensive aortopathy presented with congestive heart failure. His surgical history was significant for multiple aortic root and ascending aorta reconstructions, transverse arch reconstruction with subsequent endovascular repair and debranching, and total thoracic aneurysm repair extending to the infrarenal aorta with bilateral popliteal endovascular reconstruction. Recent surveillance transthoracic echocardiography found new severe mitral regurgitation (MR) with flow reversal in the pulmonary veins, severe left atrial enlargement, and moderate left ventricular dilation.

With a history of permanent, rate-controlled atrial fibrillation, preoperative transesophageal echocardiography determined the pathology to be primarily annular dilation, with a dominant central jet, consistent with atrial functional MR (Fig. 1). There was also an eccentric component to the jet, with evidence of mild anterior leaflet prolapse at A2. Preoperative chest computed tomography demonstrated extensive postsurgical changes related to the multiple prior median sternotomies. Importantly, the ascending aortic graft, right coronary artery, and anterior right ventricle had all

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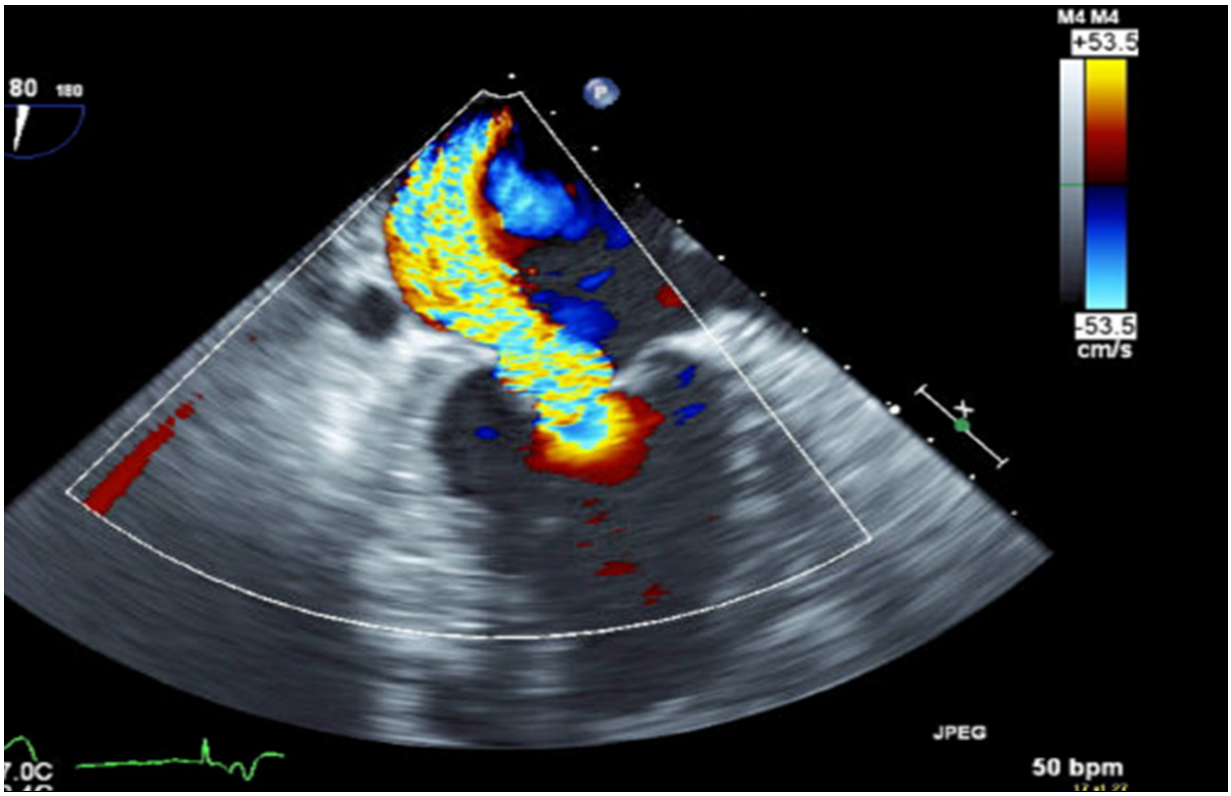

Fig. 1 *A preoperative transesophageal echocardiogram shows a regurgitant jet that was primarily central and secondary to a dilated annulus. This was addressed with an annuloplasty. There was also a smaller eccentric jet at A2 and P2 as a consequence of mild anterior leaflet prolapse, which was addressed with an edge-to-edge stitch.*

adhered to the posterior table of the sternum (Fig. 2). The risk of a fourth sternotomy was deemed prohibitive, and a mini–right thoracotomy approach was chosen for MV repair. In this case, a MitraClip (Abbott) was considered, but it was a poor option because the annulus was dilated and an annuloplasty was required.

Operative Strategy

Using the Seldinger technique and transesophageal echocardiographic guidance, a 25F multisideport venous cannula was inserted through a small right groin cutdown. Because of pacemaker leads and chronic thrombosis, the cannula could not be passed into the superior vena cava, and percutaneous access was obtained via the right jugular vein, where a 17F drainage cannula was placed into the superior vena cava for bicaval drainage. A 19F arterial cannula was inserted in the right common femoral artery. In the right fourth intercostal space, a 5-cm lateral minithoracotomy was performed, and a soft tissue retractor was placed. On cardiopulmonary bypass, the patient was cooled to 32 °C, the right lung was dropped, and an additional port was placed for the camera. The operation was done under video assistance using long instruments. Carbon dioxide was administered into the right pleural space. Adhesions were encountered from the right upper lobe to the mediastinum. These were taken down carefully with cautery, taking care to preserve the phrenic nerve.

Very limited intrapericardial dissection is required with this approach, which minimizes the risk of bleeding, and the pericardium is opened only enough to identify the right superior pulmonary vein and the interatrial groove. In this case, dissection of the aorta for cross-clamping was not possible, so a beating heart technique was used. Excellent drainage was achieved, and with a mechanical prosthetic aortic valve in situ, there was no aortic regurgitation. The left atrium was then opened through the interatrial groove, and a minimally invasive self-retaining retractor was used for exposure. The valve was then assessed with the heart beating. Blood return through the pulmonary veins was controlled with 2 sump suckers.

On valve analysis, it became evident the pathology was Carpentier classification type 1 with annular dilation resulting in central MR. This was consistent with atrial functional MR resulting from the patient's long-standing atrial fibrillation. To address the annular dilation, annuloplasty was performed with a 34-mm Memo 3D annuloplasty ring (Corcym). Sutures were placed circumferentially around the annulus, where the annuloplasty ring was seated, and the

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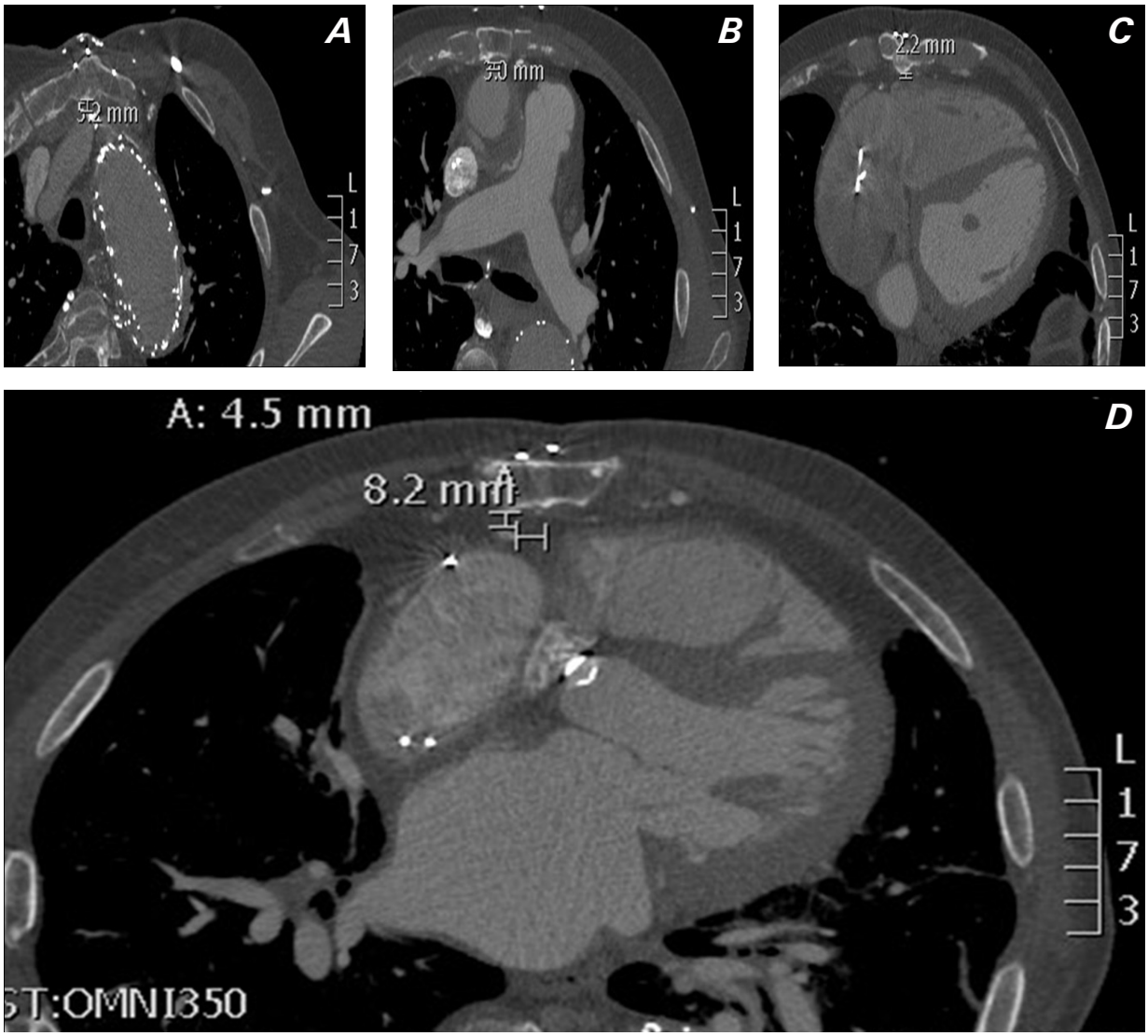

Fig. 2 *A computed tomography scan showing cardiac structures and prosthetic grafts from previous aortic surgeries adhered to the posterior table of the sternum.* ***A****) A chronically thrombosed left brachiocephalic vein containing pacing leads lies 5 mm below the manubrium.* ***B****) The ascending aortic graft lies 3 mm below the upper third of the sternal body.* ***C****) The anterior free wall of the right ventricle lies 2 mm below the suprasternal junction.* ***D****) The right coronary artery lies 5 mm below the inferior third of the sternum and 8 mm to the right of the sternal midline.*

sutures were secured (Fig. 3). There was mild prolapse of the anterior leaflet at A2, which was then managed with an edge-to-edge stitch placed at A2/P2. This resulted in a satisfactory appearance of the valve with no residual leak on saline test. The left atrium was closed in a single-layered running fashion.

The patient was weaned from cardiopulmonary bypass. The echocardiogram suggested good function of the valve with trivial residual MR and a mean gradient of 1 mm Hg. The cannulae in the groin were removed, and the femoral vessels were repaired. Hemostasis in the chest was achieved, and 2 drains were left. Two pericostal stitches were placed, and the thoracotomy incision was closed in layers. The patient remained hemodynamically stable and was transferred to the cardiovascular ICU. Cardiopulmonary bypass time was 110 minutes. The patient was extubated on postoperative day 1. He was discharged home on postoperative day 8. At a 1-year follow-up, the patient had no recurrent episodes of heart failure. His most recent transthoracic echocardiogram found his valve repair intact with mild MR.[4]

Discussion

This case highlights the utility of a minimally invasive right minithoracotomy approach used for a patient at prohibitive risk for redo sternotomy. The details are helpful, as they outline a surgical approach for a patient with severe MR who had multiple ster-

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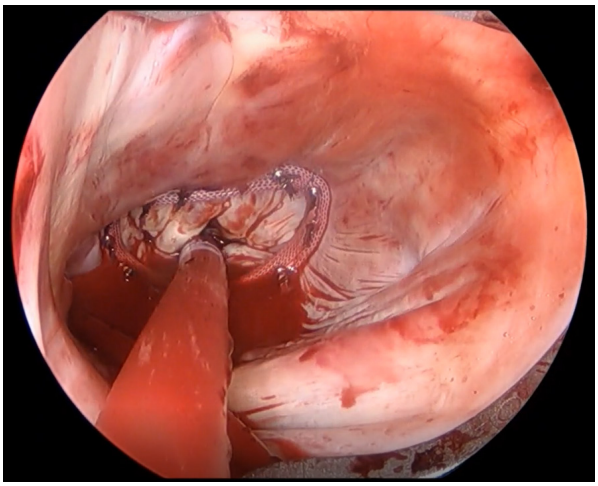

Fig. 3 *Mitral valve annuloplasty, which was performed on a beating heart through a right minithoracotomy approach, is shown. The supplemental motion image shows the intraoperative steps.*

Supplemental motion image is available for Figure 3.

notomies in the past to treat complications associated with aortic aneurysmal disease resulting from connective tissue disease. With multiple previous proximal aortic reconstructions and adherence of the ascending aorta to the sternum, cross-clamping the aorta was not feasible, so a beating heart MV repair was performed through a right minithoracotomy.

The risk of cardiovascular injury is substantial during reoperative cardiac surgery and is greatest among patients with multiple previous sternotomies.[9] The presence of connective tissue disorders can further compromise outcomes, given their impact on vascular integrity. Compared with redo median sternotomy, minimally invasive MV surgery via right minithoracotomy has been documented as safe, reproducible, and associated with fewer perioperative complications.[10] In the context of connective tissue disorders, Helder et al[11] found that the durability of mitral repair did not differ between patients with Marfan syndrome or myxomatous MV disease.

The presence of dense adhesions, patent coronary grafts, or hostile anatomy may preclude the aorta from being safely clamped. In such cases, repair can be performed with a beating heart or under fibrillatory arrest. Several studies comparing beating heart and fibrillatory-arrested heart techniques have found both to be safe.[3,8,12,13] Some evidence suggests there are shorter surgical and ventilator times as well as less postoperative bleeding with a beating heart strategy, and length of ICU and total hospital stay may be shorter, with less ischemia-reperfusion injury.[12] In contrast, others suggest that the use of fibrillatory arrest for right minithoracotomy is preferred because a beating heart approach can obscure visualization of the MV, especially in the presence of aortic valve incompetence, and the strategy can increase the risk of air embolization.[14] More studies may be helpful to further compare the outcomes of beating heart vs fibrillatory-arrest redo MV surgery. Following a review of current evidence, the physicians in this case preferred to arrest the heart with direct aortic cross-clamping using a Chitwood clamp. They only use the beating heart approach for cases in which the aorta cannot be clamped, such as in the present case with previous proximal aortic reconstruction, or for a porcelain aorta. Also, if faced with aortic insufficiency that is more than mild, a beating heart strategy cannot be used and an aortic endo-balloon is a good alternative.

Conclusion

This case adds to the growing body of knowledge that supports a minimally invasive right thoracotomy approach for reoperative MV surgery. For patients at prohibitive risk for redo sternotomy, who cannot safely undergo cross-clamping, a right minithoracotomy with either beating heart or fibrillatory arrest strategy is safe and facilitates good exposure of the MV for repair or replacement.

Published: 9 December 2022

Conflict of Interest Disclosures: None

Funding/Support: None

Ethical Statement: Informed consent was obtained from the patient to publish this case report.

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