

# Robot -Assisted Mitral Valve Repair via Right Mini-Thoracotomy in a Patient with a History of Cardiac Surgery via Median Sternotomy: A Case Report and Technical Considerations

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## Case Report

**Keywords:** Reoperative cardiac surgery, Robotic mitral valve surgery, Minimally invasive cardiac surgery

**Posted Date:** September 30th, 2026

**DOI:** <https://doi.org/10.21203/rs.3.rs-10951665/v1>

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**Additional Declarations:** No competing interests reported.

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# Abstract

## Background:

Reoperative mitral valve surgery after prior median sternotomy is challenging because of retrosternal adhesions and the risk of cardiac injury during resternotomy.

## Case Presentation:

A 75-year-old woman with a history of atrial septal defect closure via median sternotomy 30 years earlier presented with congestive heart failure. Echocardiography showed moderate mitral regurgitation and severe tricuspid regurgitation caused by annular dilatation. Computed tomographic angiography confirmed the feasibility of a right thoracic approach and peripheral cannulation. Robot-assisted mitral and tricuspid valve repair was performed using the da Vinci Xi system. Following limited adhesiolysis, the ascending aorta was cross-clamped and antegrade cardioplegia administered. Mitral and tricuspid annuloplasty were completed successfully without major complications.

## Conclusions:

Robot-assisted reoperative mitral and tricuspid valve repair after prior sternotomy is feasible in selected patients. Careful preoperative imaging, minimal adhesiolysis, and secure myocardial protection are essential for favorable outcomes.

# Background

Reoperative cardiac surgery after prior median sternotomy carries an increased risk of injury to the heart and great vessels arising from the presence of dense retrosternal adhesions. Therefore, previous sternotomy has traditionally been considered a relative contraindication for minimally invasive approaches. However, in recent years, right thoracotomy has emerged as a viable alternative for reoperative mitral valve (MV) surgery because it avoids the need for resternotomy and its associated risks [1, 2].

Here, we report a case of robot-assisted MV repair via right mini-thoracotomy in a patient with prior atrial septal defect closure. The technical feasibility of this approach is discussed.

# Case Presentation

A 75-year-old woman was referred to our institution for treatment and examination of congestive heart failure. She had a history of atrial septum defect closure via median sternotomy at an external institution 30 years earlier. Upon referral, an electrocardiogram demonstrated persistent atrial fibrillation. Transthoracic echocardiography revealed moderate mitral regurgitation and severe tricuspid regurgitation, both attributed to annular dilatation without leaflet prolapse. Preoperative computed tomographic angiography showed no contraindications for a right thoracic approach or peripheral

cannulation. Based on these findings, we selected robot-assisted MV and tricuspid valve (TV) surgery, anticipating that the regurgitation could be managed by ring annuloplasty. Regarding the patient's persistent atrial fibrillation, we planned to perform left atrium appendage closure without Maze procedure because the atrial fibrillation had been present for 10 years.

## Surgical Technique

### Cardiopulmonary Bypass Establishment

During anesthesia induction, a venous cannula was inserted into the right internal jugular vein under fluoroscopic guidance. After systemic heparinization, arterial cannulation was performed via the femoral artery, and an additional venous cannula was advanced from the femoral vein into the right atrium under fluoroscopic guidance.

### Cannula Selection

The cannula sizes were determined according to the body surface area (BSA). The criteria for the internal jugular venous cannula were as follows: a 17-Fr cannula for BSA < 1.7 m<sup>2</sup> and a 19-Fr cannula for BSA ≥ 1.7 m<sup>2</sup>. For the present patient, a 17-Fr venous cannula was selected. An additional 21-Fr cannula was selected for femoral venous drainage. For arterial cannulation, the selection criteria were as follows: an 18-Fr cannula for BSA < 1.7 m<sup>2</sup> and a 20-Fr cannula for BSA ≥ 1.7 m<sup>2</sup>. For the present patient, an 18-Fr cannula was selected.

### Robotic Approach

The da Vinci Xi Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA, USA) was used. An approximately 5-cm skin incision was made in the third intercostal space, and three da Vinci ports were placed for the left arm, the atrial retractor arm, and the right arm. An additional port for the flexible vent tube was inserted into the same intercostal space as the port for the right arm (Figure).

After careful and minimal adhesiolysis was conducted around the ascending aorta, the right atrium, and the right side of the left atrium, the ascending aorta near the brachiocephalic artery was cross-clamped (Video 1). Cardioplegia was delivered via an antegrade cardioplegia/vent catheter. During cardiopulmonary bypass, the patient's body temperature was maintained at 30°C to prevent re-expansion lung edema.

As shown in Video 2, the MV demonstrated annular dilatation without leaflet prolapse, along with a dilated left atrial appendage. The left atrial appendage was closed with a CV-4 Gore-Tex running suture. MV repair was performed by ring annuloplasty using a 28-mm Physio Flex ring (Edwards Lifesciences, Irvine, CA, USA) and secured with a CV-4 Gore-Tex running suture.

Subsequently, the superior vena cava and inferior vena cava were occluded using bulldog clamps. TV repair was performed by ring annuloplasty using a 30-mm Tri-Ad ring (Medtronic, Minneapolis, MN, USA)

and secured with a CV-4 Gore-Tex running suture.

The operative time was 291 minutes, the cardiopulmonary bypass time was 197 minutes, and the aortic cross-clamp time was 90 minutes. The estimated blood loss was 140 mL, and the patient received intraoperative blood transfusions consisting of 6 units of red blood cell concentrate, 6 units of fresh frozen plasma, and 20 units of platelet concentrate. Intraoperative transesophageal echocardiography demonstrated trivial residual mitral regurgitation and tricuspid regurgitation. The procedure was completed uneventfully.

### Postoperative Course

The total postoperative ventilation time was 15 hours, and the intensive care unit stay was 2 days. Postoperative echocardiography confirmed mitral and tricuspid regurgitation below the mild range. The patient was discharged home without complications on postoperative day 15.

## Discussion

The present case demonstrates the feasibility of robot-assisted reoperative MV and TV repair in a patient with a history of median sternotomy. Resternotomy is associated with an increased risk of injury to the heart and great vessels because of the presence of dense retrosternal adhesions. Therefore, right thoracotomy approaches have been increasingly utilized for reoperative MV surgery to avoid these potential injuries [1, 2]. Meanwhile, advances in three-dimensional videoscopes and suture devices have led to an increase in surgical procedures performed via right mini-thoracotomy. Besides the conventional right mini-thoracotomy approach, several studies have demonstrated favorable outcomes of robotic MV surgery in selected reoperative patients [3, 4]. Nevertheless, reports describing robotic reoperative valve surgery in Japan remain limited.

Similar to the case for the right mini-thoracotomy approach, there are some noteworthy points regarding cerebral complications and myocardial protection in robotic surgery [3]. Preoperative computed tomography should be performed routinely to assess the presence of aortic atherosclerosis and intrathoracic adhesions, as well as the feasibility of peripheral cannulation. Patients with a shaggy aorta or other conditions that may increase the risk of cerebral embolization should be considered unsuitable candidates for a robot-assisted approach. During surgery, the use of CO<sub>2</sub> is a simple and effective method for reducing air embolisms. Venting into the left atrium or left ventricle, as well as venting into the aortic root after declamping, are also considered effective.

Myocardial protection is another important consideration. Although adhesions are commonly present around the ascending aorta after previous sternotomy, our experience suggests that the distal ascending aorta near the brachiocephalic artery is often less affected. The enhanced visualization provided by the robotic system facilitates safe dissection and aortic cross-clamping. Furthermore, when antegrade cardioplegia infusion is insufficient, robotic surgery enables the performance of a right atrial incision and retrograde cardioplegia infusion because it provides clear visualization. In such cases, vacuum-assisted

drainage during cardiopulmonary bypass allows a right atrial incision to be created without occlusion of the superior vena cava and inferior vena cava.

Pulmonary complications should be considered in patients undergoing a robot-assisted approach. In cardiac reoperation cases, intrathoracic adhesions are sometimes observed, even if the patient has not undergone a previous thoracotomy. However, in robot-assisted surgery, unless there are extensive adhesions, lung adhesions near the pericardium can be easily dissected once the camera and arms have been inserted. Regarding the prevention of re-expansion pulmonary edema, Irisawa et al. [5] reported that 2.1% of patients who underwent cardiac surgery via right mini-thoracotomy suffered from re-expansion lung edema postoperatively. Moreover, the re-expansion pulmonary edema group had a longer initial ventilation time, as well as prolonged intensive care unit and postoperative hospital stays. Inoue et al. [6] reported that re-expansion pulmonary edema can be prevented by maintaining intraoperative hypothermia. We managed the patient's body temperature at 30°C during cardiopulmonary bypass. In the present case, although mild pulmonary adhesions were observed and the cardiopulmonary bypass time was prolonged, no pulmonary complications were noted.

## Conclusions

The present case demonstrates that robot-assisted MV and TV repair after previous median sternotomy is a safe and feasible treatment option in carefully selected patients. Comprehensive preoperative imaging, meticulous and minimal adhesiolysis, and appropriate myocardial, cerebral, and pulmonary protection strategies are critical for achieving successful outcomes in reoperative robotic cardiac surgery.

## List of abbreviations

MV, mitral valve; TV, tricuspid valve; BSA, body surface area;

## Declarations

### **Ethics approval and consent to participate**

In accordance with institutional policy, this study is an anonymized case report of a single patient and was therefore exempt from ethical review.

### **Consent for publication**

Written informed consent was obtained from the patient for the publication of this case report and the accompanying images.

## Competing interests

The authors declare that they have no competing interests

## Funding

The authors received no specific funding for this work

## Author Contribution

TK; Conception and design, Collection and assembly of data, Manuscript writing All authors read and approved the final manuscript

## Acknowledgement

The authors thank Alison Sherwin, PhD, from Edanz (<https://jp.edanz.com/ac>) for editing a draft of this manuscript.

## Availability of data and materials

No new data were created or analyzed in this study. Data sharing is not applicable to this article.

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## Figures

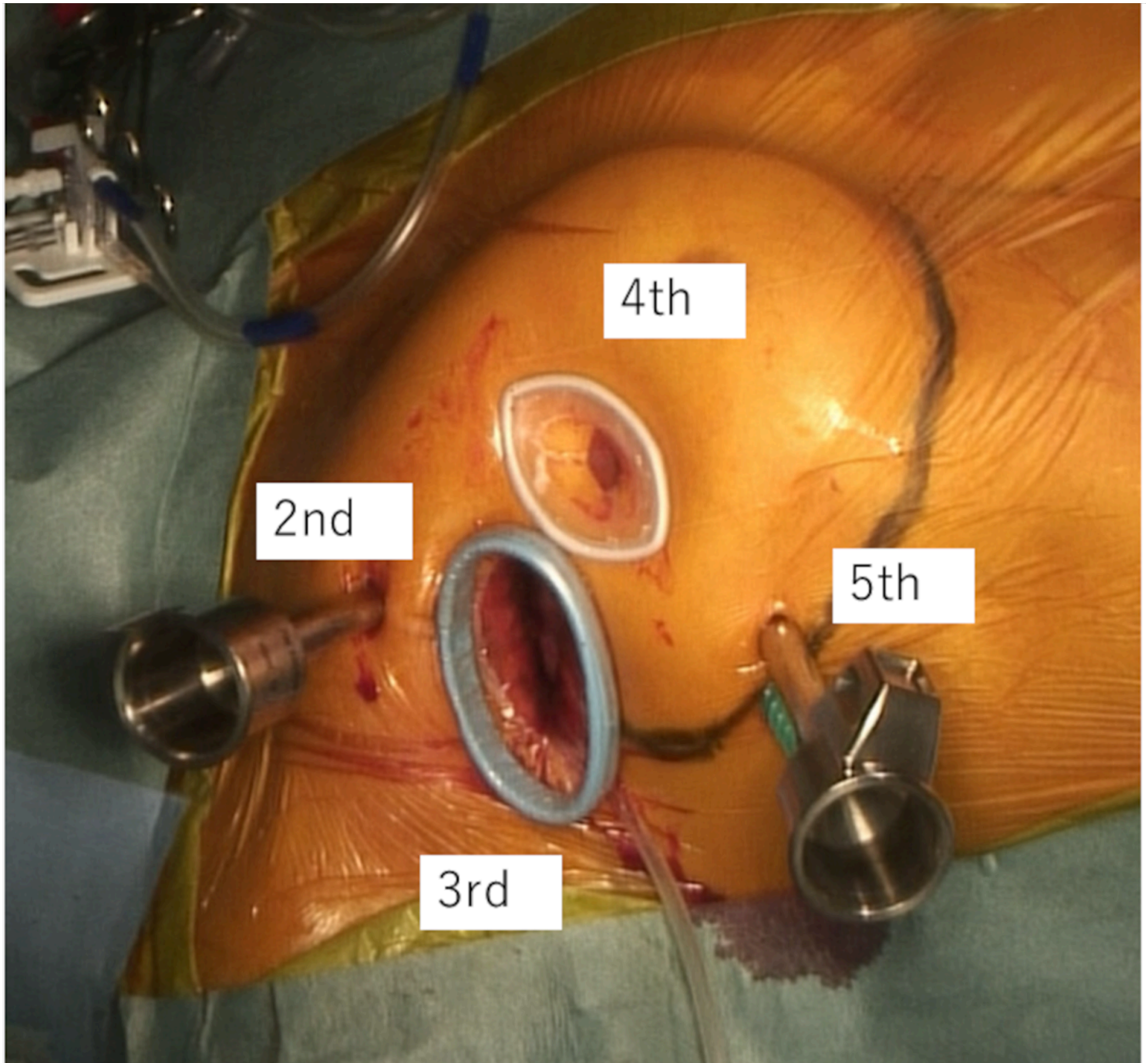


**Figure 1**

Port configuration for the da Vinci Surgical System;

The main working incision was placed in the third intercostal space, with the left robotic arm in the second intercostal space, the atrial retractor arm in the fourth intercostal space, and the right robotic arm and flexible vent tube in the fifth intercostal space.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Video1.mp4](#)
- [Video2.mp4](#)