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CASE REPORT

INTERMEDIATE

CLINICAL CASE

A Rare Case of Radiation-Associated Aortic and Mitral Valve Stenosis Treated With Transcatheter Valve Replacements

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ABSTRACT

Radiation therapy is the standard of care for achieving cure for many thoracic malignancies, but it can result in long-term cardiovascular sequelae such as valve disease. We describe a rare case of severe aortic and mitral stenosis due to prior radiation therapy for giant cell tumor treated successfully with percutaneous aortic and off-label mitral valve replacements. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2023;8:101672) © 2023 The Authors. 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 a 49-year-old man presenting with dyspnea on exertion (New York Heart Association functional class III). Vital signs included a temperature of 36.6 °C, heart rate of 91 beats/min, blood pressure of 111/57 mm Hg, and saturation of 97% on room air. Physical examination was significant for a grade II/VI systolic ejection murmur loudest at the left upper sternal border and grade I/IV diastolic murmur loudest at the apex. Electrocardiography revealed sinus rhythm with left atrial enlargement, left ventricular hypertrophy, right-axis deviation, and no significant conduction abnormalities (**Figure 1**).

LEARNING OBJECTIVES

- To describe a rarely documented case of severe aortic and mitral stenosis due to prior radiation therapy for giant cell tumor with the hallmark imaging feature of calcification of the aortomitral curtain.
- To illustrate the unique challenges and risks of a surgical approach and to describe a successful management approach with percutaneous transaortic and off-label transmitral valve replacements.

PAST MEDICAL HISTORY

He reported a history of diabetes mellitus, hypertension, hyperlipidemia, tobacco, and methamphetamine use. He took no home medications. He presented to our echocardiography laboratory for evaluation of murmurs found during an urgent care visit. On careful questioning, he reported a history of giant cell tumor located in the thoracic spine diagnosed 25 years earlier and treated with chest wall radiation of unknown dosage or duration. He reported no history of chemotherapy. He was referred to our center for further evaluation and management.

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ABBREVIATIONS AND ACRONYMS

AV = aortic valve

CT = computed tomography

LVOT = left ventricular outflow tract

MV = mitral valve

TAVR = transcatheter aortic valve replacement

TMVR = transcatheter mitral valve replacement

TTE = transthoracic echocardiography

DIFFERENTIAL DIAGNOSIS

The differential diagnosis included rheumatic heart disease, endocarditis, and congenital heart disease.

INVESTIGATIONS

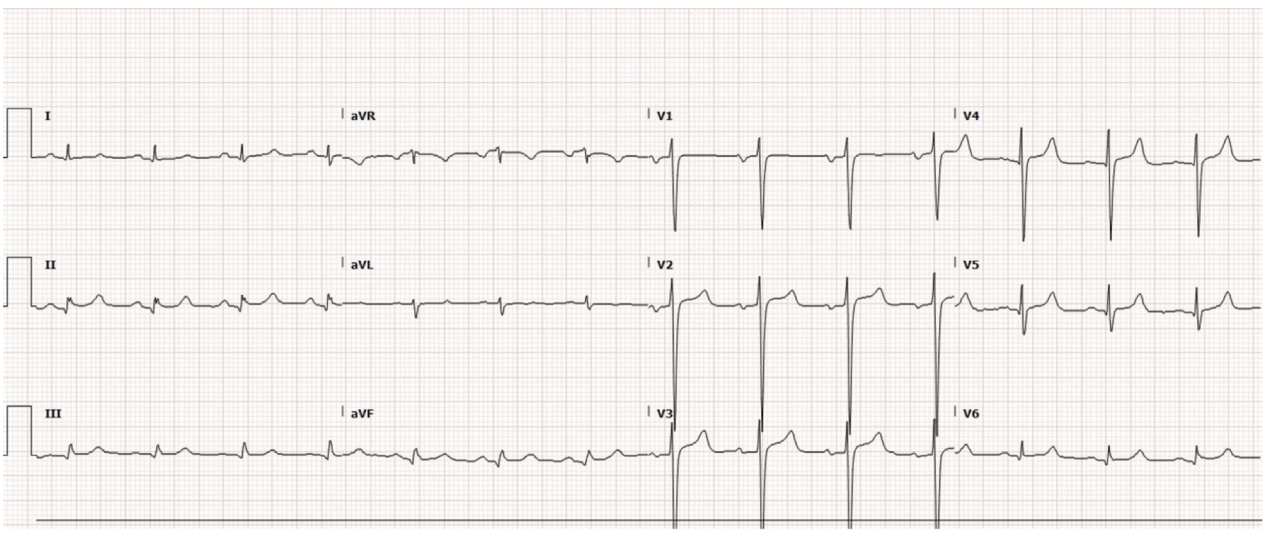
Initial transthoracic echocardiography (TTE) revealed normal left and right ventricular sizes and systolic function and left atrial enlargement. The mitral valve (MV) was heavily calcified, notably involving the aortomitral curtain, leading to severe mitral stenosis with a mean gradient of 16 mm Hg (**Figure 2,** Video 1). The aortic valve (AV) was also heavily calcified, causing severe aortic stenosis with a peak velocity of 4.1 m/sec, mean gradient of 42 mm Hg, and AV area of 0.9 cm^2 (Video 1). The inferior vena cava was small and collapsible. No findings were present to suggest pericardial disease.

Cardiac computed tomography (CT) was performed for anatomic planning and confirmed the presence of extensive calcification of the AV and MV involving the aortomitral curtain (**Figure 3A**). The CT provided important information regarding the AV annulus for transcatheter atrial valve replacement (TAVR) sizing and the left ventricular outflow tract (LVOT) for mitral valve deployment (**Figures 3B and 4**). Pulmonary function testing demonstrated mild restrictive lung disease. Invasive angiography showed mild nonobstructive coronary disease of the left anterior descending, ramus, and circumflex arteries and moderate (40%) disease of the proximal right coronary artery.

MANAGEMENT

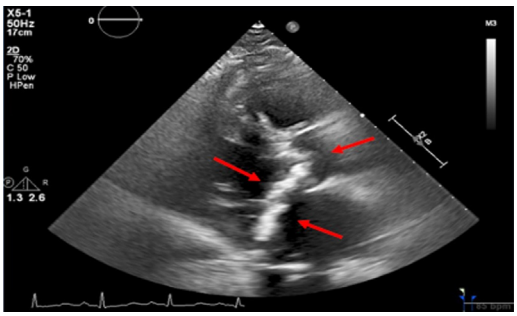
The patient was evaluated by a multidisciplinary heart team, including cardiac imaging, interventional cardiology, and cardiothoracic surgery. Despite relatively low surgical risk scores (European System for Cardiac Operative Risk Evaluation II: 4.9%; Society of Thoracic Surgeons Score: 3.2%), surgical valve replacement via a Commando procedure was foregone owing to the extent of aortomitral curtain and anterior mitral leaflet calcification, in addition to the patient's underlying morbid obesity, restrictive lung disease, and active methamphetamine use. Therefore, a nonsurgical treatment option with TAVR and off-label transcatheter MV replacement (TMVR) via a transapical approach was pursued. Real-time 2D and 3D transesophageal echocardiography and fluoroscopy was used for procedural guidance (**Figure 5,** Videos 2 and 3). Access was obtained via a left lateral thoracotomy to expose the left ventricular apex. The TAVR was implanted first, followed by the TMVR, each using a 29 mm Sapien3 valve (Edwards Lifesciences) (**Figure 6,** Video 4). Both valves were implanted successfully with normal hemodynamics,

FIGURE 1 Index Electrocardiography



The index electrocardiogram revealed sinus rhythm with left atrial enlargement, left ventricular hypertrophy, right-axis deviation, and no significant conduction abnormalities.

FIGURE 2 **Index Transthoracic Echocardiography**



Parasternal long-axis view showing calcification of the aortic and mitral valves with the hallmark feature of extension to the aortomitral curtain **(arrows)**, consistent with radiation-associated valve disease.

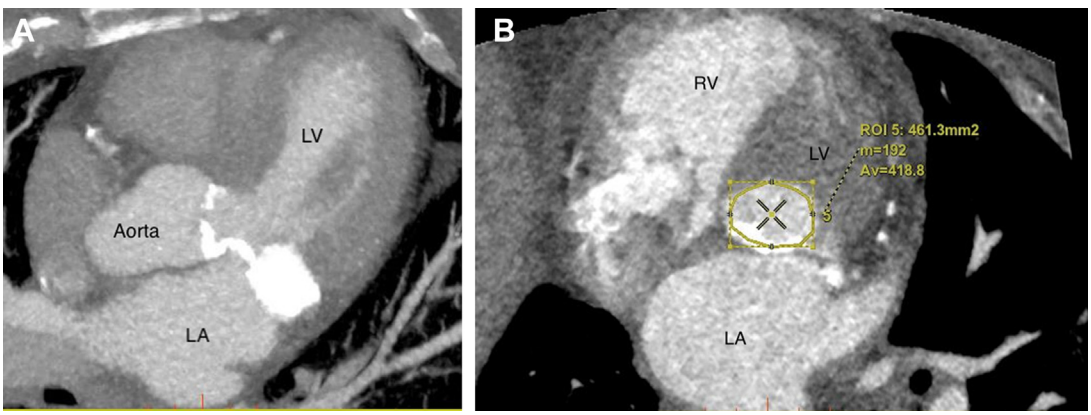
mild mitral paravalvular leak, and no significant gradient across the LVOT (Video 5).

DISCUSSION

Radiation therapy is the standard of care for many thoracic malignancies. Long-term cardiovascular sequelae of thoracic radiation exposure include mediastinal adhesions, pulmonary fibrosis with restrictive lung disease, conduction system disease, aortic and valvular calcifications, pericardial constriction, and coronary artery disease.[1,2] Radiation-associated valve disease has an extended latency interval, occurring 10 to 20 years after radiation therapy, and can cause fibrosis, calcification, and thickening, predominantly of the left-side valves leading to stenosis and/or regurgitation.[1,2] Surveillance is critical and should include an annual history and physical examination to assess for cardiovascular symptoms and screening TTE every 5 to 10 years.[3] The latency interval in our case was 25 years, and the exposure to radiation was not originally known to the medical team until careful interpretation of the TTE was performed that led to focused questioning of the patient's medical history.

The hallmark imaging feature of radiation-associated valve disease is calcification of the aortomitral curtain, which poses a technical challenge for valve replacement surgery and is associated with increased mortality.[2,4,5] Commonly used perioperative risk scores do not account for features such as a hostile chest, pulmonary fibrosis, calcification of the aorta, conduction disease, coronary disease, and pericardial involvement, factors that must be considered before determining the management approach in this unique population.[6] In the setting of prohibitive surgical risk, a transcatheter approach for dual valve replacement is a viable management option. A multimodality approach to diagnostic imaging for valve assessment and procedural planning including echocardiography and cardiac CT is

FIGURE 3 **Cardiac Computed Tomography**



(A) Multiplanar reconstruction demonstrating severe calcification of the aortic and mitral valves with concomitant aortomitral curtain calcification. **(B)** Multiplanar reconstruction of left ventricular outflow tract (LVOT) dimension in short-axis view is important to position the mitral valve and minimize the risk of developing an outflow tract gradient. The interventional team deployed the transcatheter aortic valve replacement because the struts of the transcatheter mitral valve replacement may land within the LVOT. LA = left atrium; LV = left ventricle; RV = right ventricle.

FIGURE 4 Cardiac Computed Tomography

Volume-rendering 3-dimensional reconstruction with the use of cardiac computed tomography demonstrating aortomitral calcification.

essential.[7,8] There remains higher than normal all-cause morbidity and mortality among TAVR patients with a history of chest wall radiation compared with those without.[8] When comparing patients with prior chest wall radiation for surgical AV replacement vs TAVR, patients undergoing TAVR had significant reduction in 30-day mortality, postoperative atrial fibrillation, and hospitalization duration.[9] There is limited evidence for the use of isolated TMVR or TMVR with TAVR in this setting, but it appears to be a potential solution when operative risk is prohibitive.

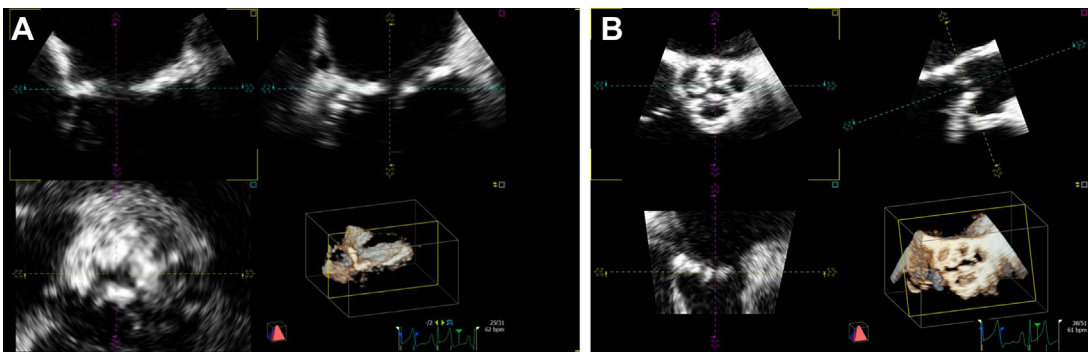
FOLLOW-UP

The patient was discharged on aspirin and warfarin for 3 months, followed by aspirin and clopidogrel indefinitely. The post-procedure TTE showed normal hemodynamics for both valves and no significant gradient across the LVOT. His symptoms improved through the 1-, 3-, and 6-month visits, and serial TTE monitoring remained stable. Unfortunately, the patient was lost to follow-up at our institution after the 6-month visit.

CONCLUSIONS

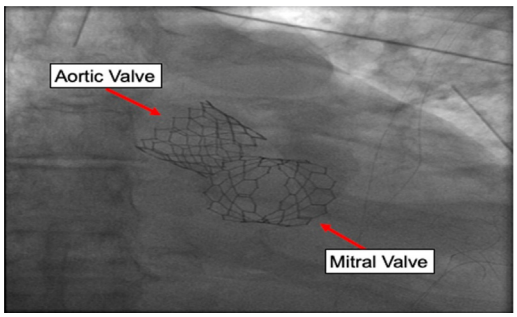
We describe a rare case of severe aortic and mitral stenosis due to thoracic radiation therapy for giant

FIGURE 5 Pre-Implantation Transesophageal Echocardiography



(A) Multiplanar imaging of the mitral valve revealed a mitral valve area of 1.0 cm^2 by 3-dimensional planimetry. There is heavy calcification of the annulus, leaflets, and aortomitral curtain. **(B)** Multiplanar imaging of the aortic valve shows a trileaflet valve with severe cusp calcification, consistent with transthoracic echocardiography finding of severe aortic stenosis.

FIGURE 6 Postimplantation Fluoroscopy



Transcatheter atrial valve replacement and off-label transcatheter mitral valve replacement deployed via a transapical approach using a transcatheter heart valve in both positions.

cell tumor. We provide a successful management approach using multimodality imaging and percutaneous TAVR and TMVR implantation resulting in symptomatic improvement for our patient.

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The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS aortomitral curtain, radiation therapy, valve stenosis

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