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CASE REPORT

ADVANCED

CLINICAL CASE

Infectious Endocarditis of a Heterotopic Caval Valved Stent

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ABSTRACT

Right-sided infective endocarditis (IE) accounts for 5% to 10% of all IE cases. Compared with left-sided IE, it is more often associated with intravenous drug abuse and intracardiac devices, whereas the latter has become more prevalent in recent decades. The authors report the first case of IE in a heterotopic caval valved stent used for treating torrential tricuspid regurgitation. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2023;11:101761) © 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

A 85-year-old female patient known for long-standing valvular heart disease and sick sinus syndrome with atrial fibrillation was admitted because of altered mental state, nonproductive cough during the preceding 10 days, and new-onset fever (38.8 °C). The clinical examination did not reveal any significant pathologies. Her blood pressure was 110/90 mm Hg, heart rate was 95 beats/min, and oxygen saturation was normal (96%).

LEARNING OBJECTIVES

- To apply a multimodality imaging approach to confirm device-associated endocarditis.
- To highlight the complexity of the management of device-related endocarditis in inoperable patients with valvular heart disease.

Laboratory analysis revealed increased inflammatory parameters, mild anemia and thrombocytopenia, and elevated N-terminal pro-brain natriuretic peptide (6,429 pg/mL). Chest radiography showed right pleural effusion, potentially masking a pulmonary infiltrate (**Figure 1**). After blood sampling, antibiotic therapy (ceftriaxone and clarithromycin) was initiated for suspected pneumonia, and the patient was referred to the internal medicine ward.

Two days later, blood cultures were all positive (4 of 4) for viridans streptococci. Because one major Duke criterion was fulfilled, device-related infective endocarditis (IE) was suspected, and further investigations, in particular cardiac multimodality imaging, were performed.

MEDICAL HISTORY

The patient was treated 3 years prior to this admission for severe lead-induced symptomatic tricuspid regurgitation (TR) leading to dyspnea on exertion

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

CAVI = caval valve implantation

IE = infective endocarditis

RV = right ventricle/ventricular

TR = tricuspid regurgitation

(New York Heart Association functional class III) and recurrent hospitalizations for severe right heart failure, elevated liver enzymes, and anasarca.

After interdisciplinary discussion, uneventful pacemaker explantation followed by ablation of the atrioventricular node and leadless pacemaker implantation (Micra, Medtronic) (pace-and-ablate strategy) were performed, as atrial fibrillation was seen as a possible contributing factor to recurrent cardiac decompensations because of tachy-brady syndrome. However, TR remained severe, and the patient continued to be admitted for recurrent right heart failure decompensations poorly responsive to oral diuretic agents. Since the patient was deemed inoperable by the Heart Team because of advanced age and comorbidities, various interventional treatment strategies of TR were evaluated. Both tricuspid transcatheter edge-to-edge repair and direct annuloplasty were considered technically not possible because of the wide coaptation gap (17 mm) and severe tethering of the valve leaflets (tenting distance 24 mm and tethering area 883 mm^2 on 4-dimensional cardiac computed tomography) (**Figure 2**). Transcatheter valve replacement was not available at that time but would certainly have been considered today.

Thus, transfemoral venous implantation of a bicaval valved stent (Tricento, Medira) was proposed to alleviate congestive symptoms. The procedure was performed without complications (**Figure 3**, Video 1). At 60 days of follow-up, the patient reported clinical improvement with weight loss of 7 kg and decrease of exertional dyspnea (New York Heart Association functional class II). Compared with baseline, a second magnetic resonance imaging examination revealed slightly increased cardiac output (cardiac index from 3.4 to 3.9 L/m^2) and decreased right ventricular (RV) volumes (indexed RV end-diastolic volume from 187 to 177 mL/m^2), ascites, and pleural effusion, as well as nearly normalized liver enzymes and a marked decrease of N-terminal pro-brain natriuretic peptide (from 7,373 to 3,497 pg/mL). No cardiac rehospitalizations have occurred since device implantation.

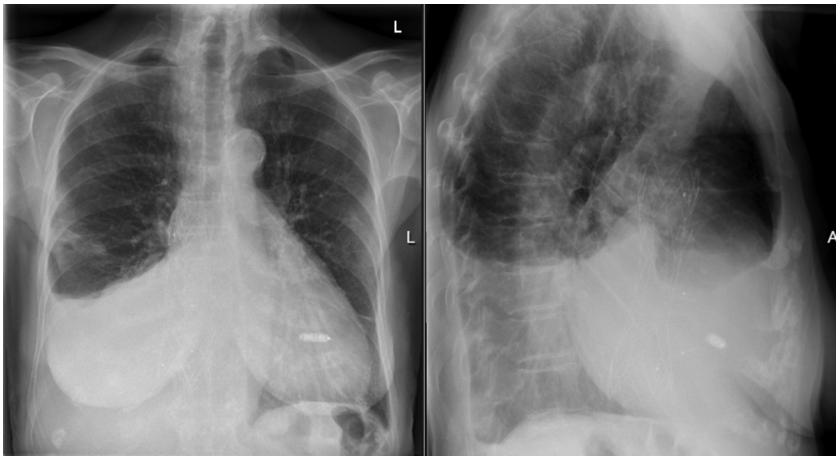
DIFFERENTIAL DIAGNOSIS

IE was strongly suspected given the results of the blood cultures and the presence of right heart devices. The differential diagnosis included a another focus of infection, such as pneumonia or the presence of thrombotic material on the device, which was rather unlikely given continuous oral anticoagulation.

INVESTIGATIONS AND MANAGEMENT

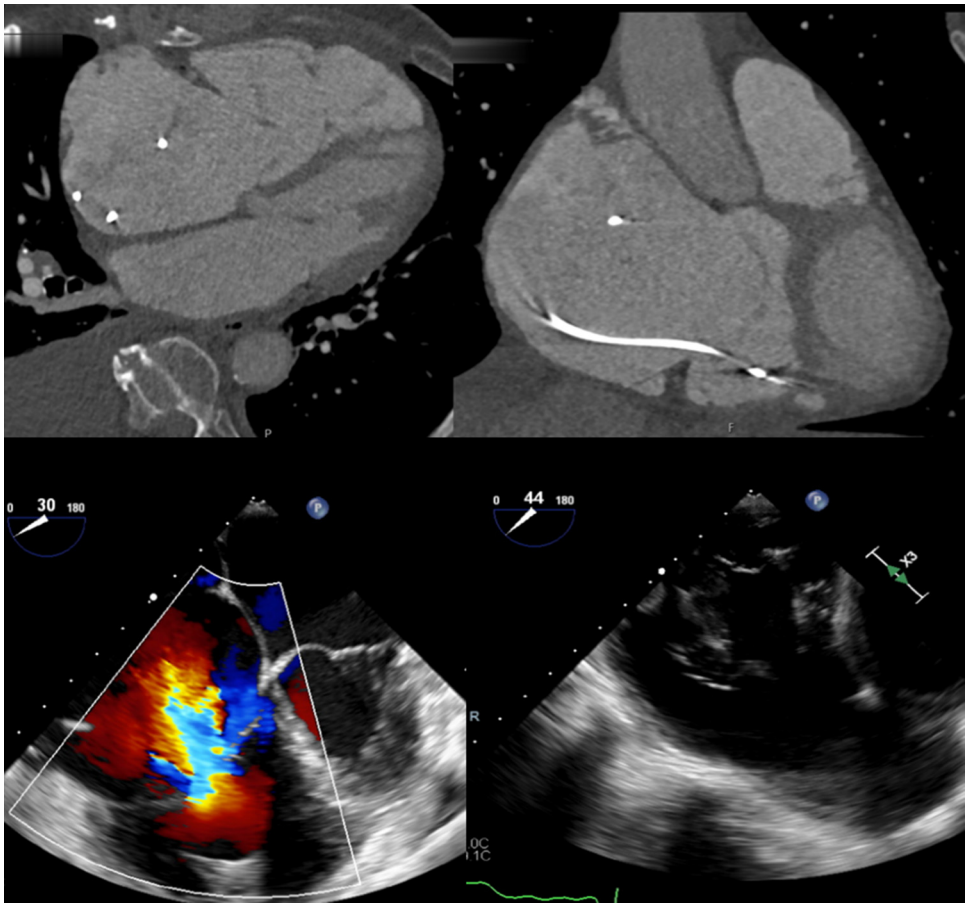
Following suspicion of IE, transthoracic echocardiography was performed, showing native severe TR with correct position of the caval valve implantation (CAVI) device visualized using different views.

FIGURE 1 Radiography of the Chest (Anteroposterior and Lateral Views) at Admission



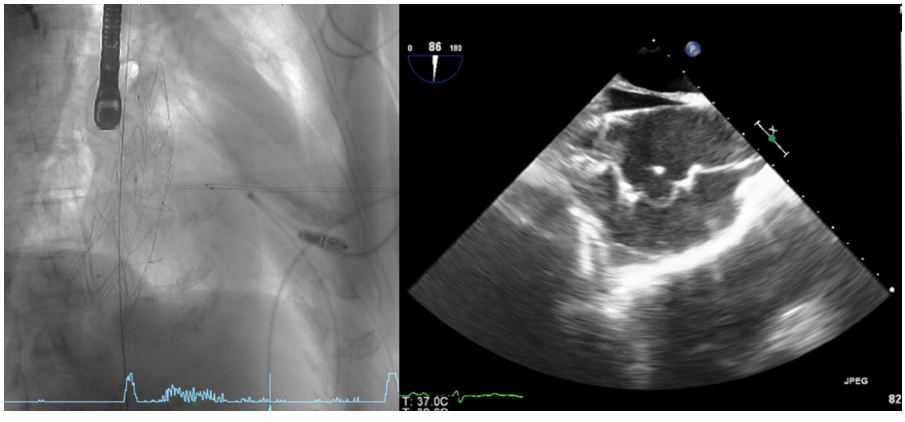
Radiography of the chest showing right pleural effusion with adjacent compression atelectasis potentially masking an associated infiltrate.

FIGURE 2 **Transesophageal Echocardiography and 4-Dimensional Computed Tomographic Scan of the Heart**



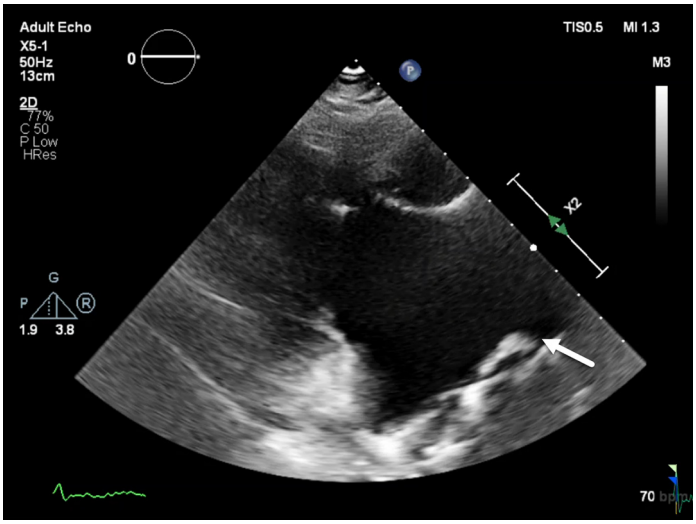
Various planar reconstructions, showing a severely dilated right ventricle, severe valve tethering, and interaction of the right ventricular lead with the tricuspid valve.

FIGURE 3 **Peri-Interventional Fluoroscopy and Transesophageal Echocardiography**



The **left image** shows a right anterior oblique 45° view after successful device implantation. The **right image** shows a bicaval transesophageal echocardiographic view showing the valve element **(arrow)** correctly positioned in the right atrium.

FIGURE 4 Right Ventricular Inflow on Transthoracic Echocardiography

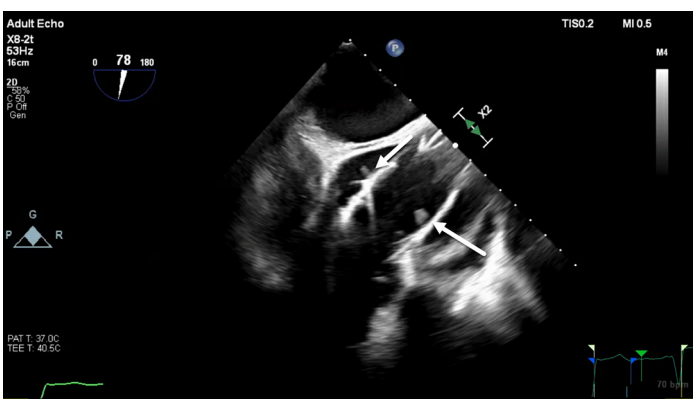


The caval valved stent can be partly visualized with a thickened valve leaflet **(arrow)**.

Thickened valve leaflets and small floating structures were evident during the examination (**Figure 4**, Video 2). Transesophageal echocardiography was recommended and showed an 11 × 8 × 6 mm floating structure within the CAVI valved stent in the right atrium, as well as prosthetic leaflet thickening (**Figure 5**, Videos 3 and 4), fulfilling the second major Duke criterion for the diagnosis of IE. Valve thrombosis was unlikely because of continuous therapy with rivaroxaban. The antibiotic regime was adapted according to local guidelines. The initial therapy with clarithromycin was stopped, and high-dose ceftriaxone was maintained. Orthopantomography did not show evidence of an oral infectious focus. No other clear point of entry could be identified.

Further treatment of the patient was discussed at our endocarditis board, consisting of a heart surgeon, a cardiologist, an imaging specialist, and a specialist in infectious diseases. Because of the nature of the device, surgical repair or explantation was not an option. Intravenous antibiotic therapy during 6 weeks followed by long-term oral suppression with doxycycline was decided upon. For this purpose, a peripherally inserted central catheter line was installed.

FIGURE 5 Transesophageal Echocardiographic Modified Bicaval View



The caval valved stent is visualized at the level of the vena cava inferior. Small floating structures are visible **(arrow)**.

DISCUSSION

TR is a common valvular heart disease that has been related to higher morbidity and mortality rates.[1] When TR is severe, the pressure in the right atrium and the caval veins rises, and backflow during systole, the so-called v wave, occurs. In this situation, congestion leads to edema, ascites, and finally impaired function of the organs including liver and kidneys.[2]

Following the success of transcatheter treatment of aortic and mitral valve disease, a number of devices have been developed for the treatment of TR. However, the tricuspid valve poses many challenges, such as complex variable anatomy, often severely dilated annuli, and associated poor RV function. Therefore, a relevant proportion of patients are unsuitable for valve repair or replacement strategies. Alternative catheter-based concepts such as CAVI or bicaval valve implantation have been used (**Figure 6**) and are still under clinical development.[3-5] The aim of CAVI is to reduce backflow into the caval veins and treat associated congestion of the organs and heart failure symptoms.[6] In a previous study by our group, functional improvement, as well as positive RV remodeling, was described using the CAVI device, despite detected device fractures that led to design modification and adaptation of the criteria for patient selection.[4]

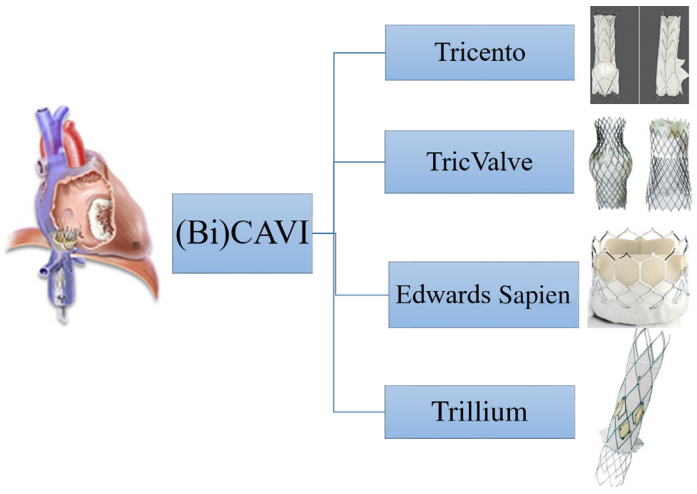
With the emergence of various devices for the treatment of valvular heart disease and heart failure in sick patients, more complex cases of IE may appear.[7] Currently, right-sided IE represents 5% to 10% of all IE cases. Current guidelines recommend

treating patients with IE with antibiotic therapy, while early surgery is indicated in patients with complications, including persistent infection, right-sided heart failure, recurrent emboli or persistent vegetations despite antibiotic therapy, and vegetations larger than 10 to 20 mm.[8,9] As in our case, open heart surgery is not always feasible, because of comorbidities and the nature of the device complicating explantation. Thus, a conservative approach was proposed to control chronic prosthesis infection.

FOLLOW-UP

After an initially favorable course, the patient was referred again 1.5 months later by her general practitioner because of recurrent fever episodes most likely due to bacterial dissemination. Laboratory analysis revealed stable inflammatory parameters. Blood cultures remained negative. Follow-up transesophageal echocardiography showed a decrease in vegetation mass but persistent leaflet thickening (Video 5). For further assessment of the extent of the vegetations, four-dimensional cardiac computed tomography was performed (**Figures 7 and 8,** Videos 6 and 7) confirming the persistence of vegetational material located mainly around the valve element. Positron emission tomography/computed tomography performed during follow-up after completion of antibiotic treatment showed residual circumferential enhancement around the prosthesis, as well as lymph node uptake, suggesting a controlled infection with low-grade activity (**Figure 9**). Alternative sources of infection were not detected. No therapy changes were made, and the permanent antibiotic therapy regime was continued.

FIGURE 6 **CAVI Systems**

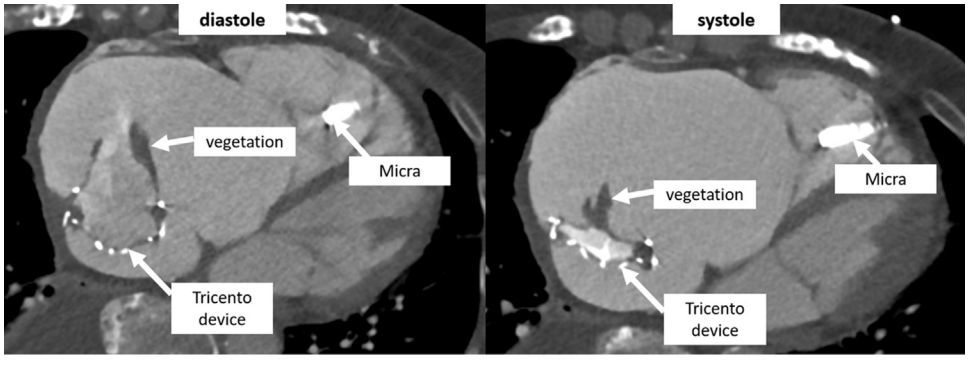


The different caval valve implantation (CAVI) devices used for treatment of severe tricuspid regurgitation. Reproduced with permission from manufacturers' websites.

CONCLUSIONS

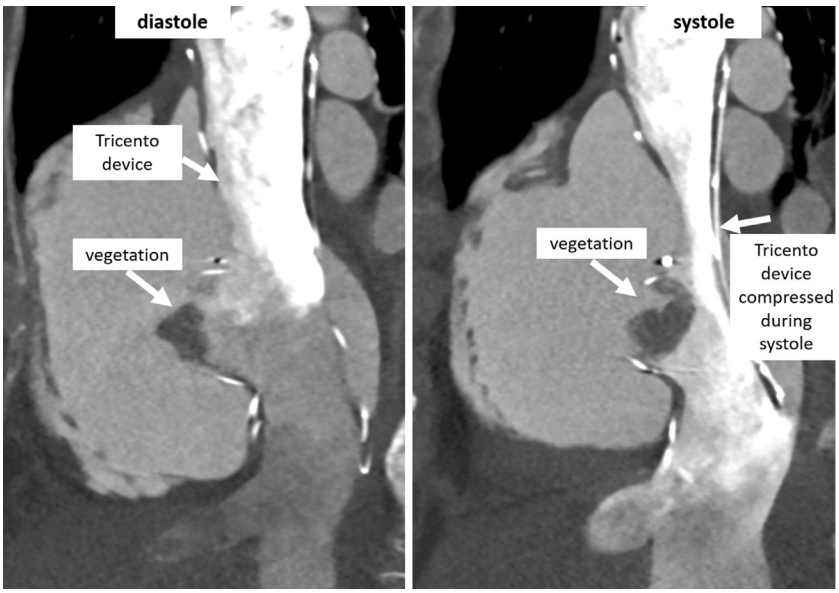
With an increasing number of procedures performed on the right side of the heart, in particular for the treatment of severe TR, device-related IE is expected

FIGURE 7 **Computed Tomographic 4-Chamber View**



Computed tomographic 4-chamber views show the caval valve implantation device in systole and diastole. The valve element is thickened, with floating vegetations. In addition, the leadless pacemaker (Micra, Medtronic) is visualized.

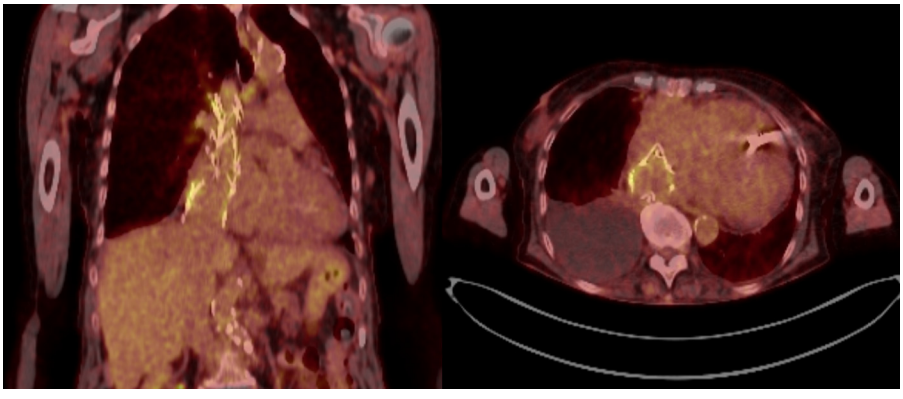
FIGURE 8 Computed Tomographic Bicaval Views



Bicaval views show the caval valve implantation device in its length with mobile vegetations on the valve element.

to become more common. A multimodality imaging approach helps evaluate right-sided device-associated IE. Its treatment is complex, particularly in inoperable patients with previous transcatheter treatment. As device explantation may not always be possible, conservative treatment options should be considered, and interdisciplinary case-by-case discussion helps tailor optimal therapy.

FIGURE 9 Positron Emission Tomography/Computed Tomography Frontal and Axial Views



Follow-up positron emission tomography/computed tomography shows circumferential, moderate grade enhancement around the prosthesis, suggesting either low-grade infection or healing lesions.

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KEY WORDS heterotopic caval valve, infective endocarditis, multimodality imaging, Tricento, tricuspid regurgitation

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