

# Transesophageal Echocardiographic Evaluation of Novel Extracellular Matrix Valve for Tricuspid Valve Endocarditis



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## INTRODUCTION

Right-sided infective endocarditis (IE), specifically tricuspid valve (TV) endocarditis, is a rare occurrence, accounting for <10% of IE cases. The vast majority of cases of TV endocarditis result from intravenous drug use. Risk factors for the development of endocarditis include a history of IE, prosthetic valves, intracardiac devices, valvular or congenital heart disease, chronic intravenous catheters, immunosuppression, and recent dental procedure.<sup>1</sup> Although medical management with antibiotics is generally successful, a subset of patients will require surgical intervention. Furthermore, there is evidence suggesting that early surgical intervention can reduce embolic events as well as mortality in this patient population.<sup>2</sup> Echocardiography remains the primary imaging modality for detecting vegetations and abscesses,<sup>3</sup> with transesophageal echocardiographic (TEE) imaging having a reported sensitivity of >90%.

Because of the unique anatomic and functional features of the TV, there are no ideal prosthetic valves designed for the TV.<sup>4</sup> Mechanical or bioprosthetic replacement may be complicated by thrombosis, degenerative calcification, heart block, and residual or recurrent infection.<sup>5</sup> However, new technology has made it possible to undertake TV replacement with unstented valve material constructed from extracellular matrix (ECM). The CorMatrix ECM TV (CorMatrix Cardiovascular, Roswell, GA) is designed to function as a competent heart valve immediately after implantation. In addition, it serves as a biological scaffold that may enable native cells to migrate and grow,<sup>6</sup> resulting in a remodeled TV with the patient's own tissue. This case exemplifies a comprehensive echocardiographic evaluation of this new valve and highlights its unique appearance and function.

## CASE PRESENTATION

A 43-year-old man with a history of polysubstance drug abuse presented with productive cough, nocturnal diaphoresis, weight loss,

chills, dyspnea, pleuritic chest pain, and nausea. He was diagnosed with bibasilar pneumonia and multiple pulmonary septic infarcts, as well as methicillin-sensitive *Staphylococcus aureus*/*Enterococcus faecalis* bacteremia and TV endocarditis. He later presented to the operating room for TV replacement.

Preoperative TEE imaging revealed severe tricuspid regurgitation and a large burden of mobile vegetations on all three TV leaflets, which made TV repair not feasible (Figure 1, Video 1).

The tricuspid annular diameter was measured intraoperatively at 33 mm. The decision was made to replace and remove the native TV leaflet tissue using ECM with the CorMatrix ECM valve. A piece of CorMatrix ECM was cut to 5 cm and wrapped around a 33-mm sizer. The sheet was cut to fit and sutured to create a 33 × 50 mm cylinder of its own making. Three fixation points for neochoords were selected within the right ventricle. The valve was then secured to the annulus with a running suture. No annuloplasty ring was necessary (Figure 2).

Following separation from cardiopulmonary bypass, the newly implanted CorMatrix TV was evaluated using two-dimensional and three-dimensional (3D) imaging as well as color flow and spectral Doppler evaluation. Examination revealed mild residual tricuspid regurgitation, a mean inflow gradient of 1.0 mm Hg, and normal right ventricular function (Figures 3-5, Videos 2 and 3). The postoperative course was unremarkable, and the patient was discharged on postoperative day 14.

## DISCUSSION

Comprehensive intraoperative TEE examination in patients with valvular endocarditis provides valuable information regarding the feasibility for repair. Currently available materials for valve repair (e.g., patch repair) or replacement are synthetics such as woven nylon (Dacron), expanded polytetrafluoroethylene, and glutaraldehyde-cross-linked biological membranes such as bovine pericardium. Although such materials perform adequately as patch material, they have no capacity for bioresorption, they may become incorporated by fibrotic encapsulation, and they cannot restore regional tissue functionality.<sup>7</sup>

ECM such as the CorMatrix ECM has recently been used for valve replacements in both the tricuspid and mitral positions.<sup>8-13</sup> ECM is the material surrounding cells in all tissues and is composed mainly of proteoglycans, forming a 3D, hydrated gel in the extracellular interstitial space, and fibrous proteins (elastins, fibronectins, and laminins). The composition of the main components varies depending on the function of the tissue or organ. Besides functioning as a passive support structure, it serves as a biological scaffold for regulation of cell adhesion, cell differentiation, cell division, and cell migration. CorMatrix ECM is derived from porcine small intestinal submucosa composed of four major types of molecules: structural proteins, adhesion

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**VIDEO HIGHLIGHTS**

**Video 1:** Two-dimensional TEE imaging shown in mid-esophageal four-chamber and mid-esophageal bicaval views demonstrating preprocedural mobile TV vegetations.

**Video 2:** Two-dimensional TEE imaging shown in mid-esophageal four-chamber and mid-esophageal right ventricular inflow-outflow views with color flow Doppler demonstrating laminar flow and trace tricuspid regurgitation after TV replacement with CorMatrix valve.

**Video 3:** Two-dimensional TEE imaging shown in transgastric right ventricular basal short-axis and transgastric RV inflow demonstrating valve motion. Three-dimensional TEE imaging of CorMatrix valve seen en face from right atrial and right ventricular perspective. Three-dimensional with color flow Doppler demonstrating competent valve.

View the video content online at [www.cvcasejournal.com](http://www.cvcasejournal.com).

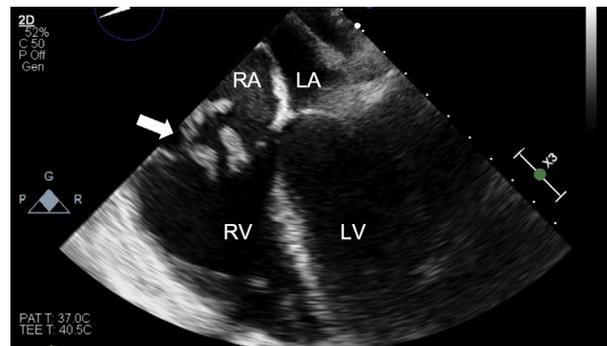
glycoproteins, glycosaminoglycans, and matricellular proteins. The ECM is then fashioned into a simple tubular valve, inspired by tubular

aortic valves and the theory of “form follows function.”<sup>8,14</sup> The hypothesis behind this principle is that native cardiac valves function as if they were simple tubes with sides that collapse when subjected to external pressure, and their form is dictated by the natural anatomic restraints placed on that tube (i.e., form follows function).<sup>14</sup> The valve competency and mechanical characteristics are similar to a Heimlich valve. Depending on the pressure gradients and direction of flow, the valve cylinder either closes or opens with a windsock-like motion.

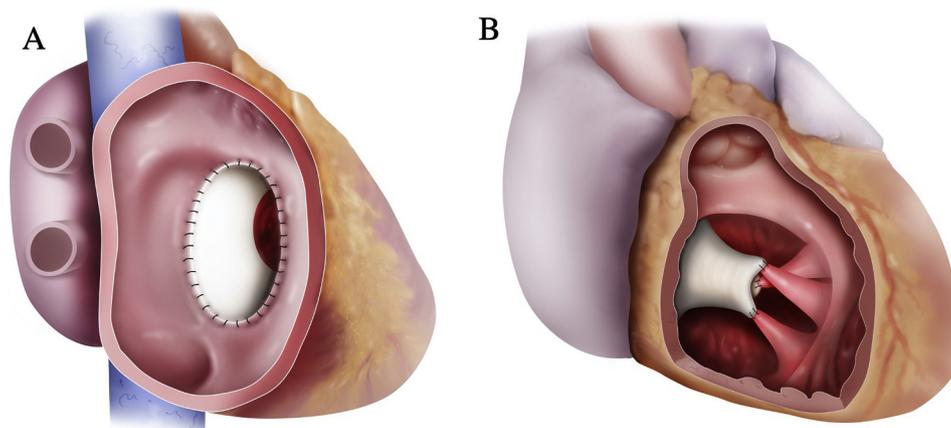
Evaluation of the ECM valve should be performed in all mid-esophageal and transgastric views used for evaluation of the native TV. Color flow Doppler, spectral Doppler, and 3D imaging techniques should be used. The valve competency and mechanical characteristics windsock-like motion and should be observed. Possible reported complications include annular ring disruption, papillary disruption, right ventricular dysfunction, residual tricuspid regurgitation, right ventricular outflow tract obstruction, pulmonary embolism, and recurrent endocarditis.<sup>8-13,15</sup>

**CONCLUSION**

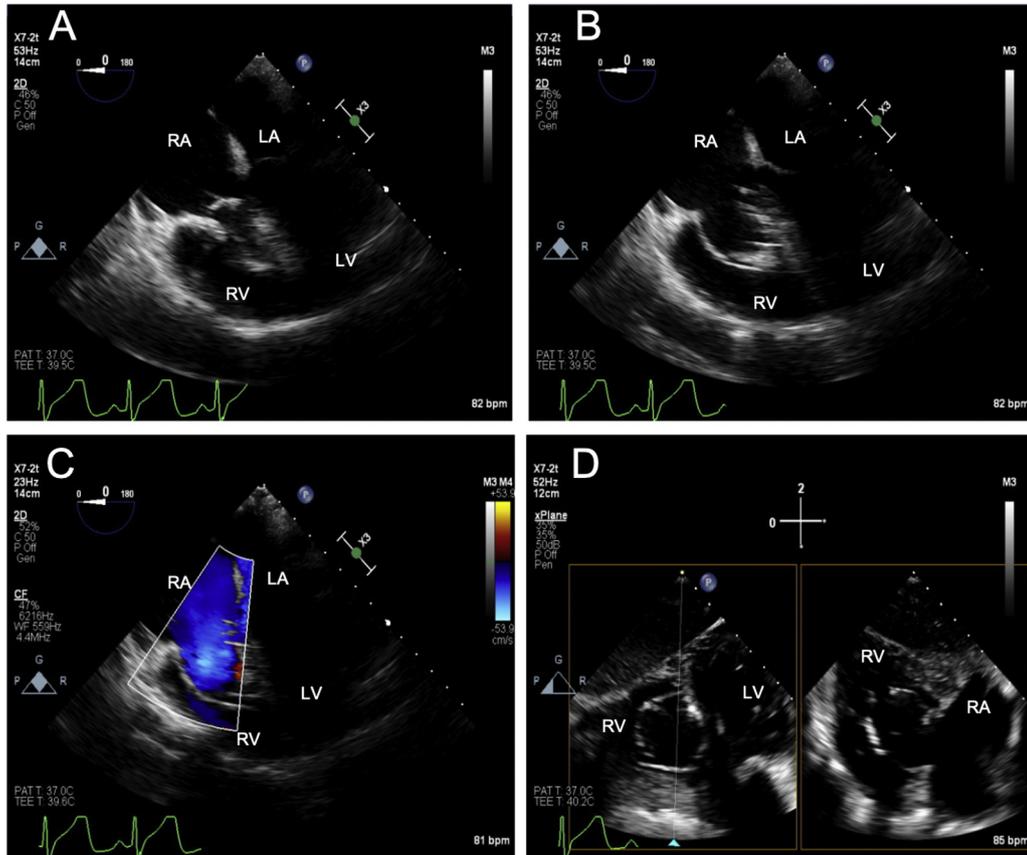
Echocardiographic evaluation of this novel valve implantation technique is important for the proper assessment of valve function. ECM valve replacements have unique mechanics and echocardiographic appearance. The absence of an annuloplasty ring plus its tube-like structure attached by neochords to the right ventricle are the main



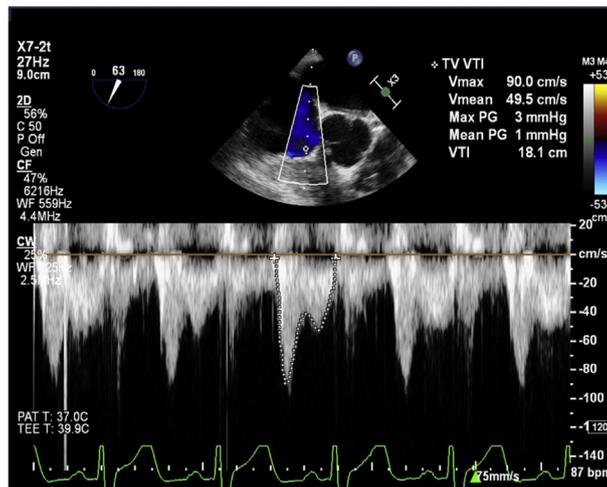
**Figure 1** Midesophageal four-chamber view demonstrating multiple TV vegetations (white arrow). LA, Left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.



**Figure 2** (A) Illustration of valve CorMatrix ECM viewed from right atrium. (B) Illustration of CorMatrix ECM valve viewed from right ventricle. Medical illustration by Stan Coffman/Medmedia Solutions.



**Figure 3** Intraoperative postprocedural evaluation of the new CorMatrix ECM TV. **(A)** Midesophageal (ME) four-chamber view demonstrating TV during systole. **(B)** ME four-chamber view demonstrating TV during diastole. **(C)** ME four-chamber view with color flow Doppler demonstrating laminar flow during diastole. **(D)** Biplane imaging of the TV starting from transgastric right ventricular basal view as a reference view. LA, Left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

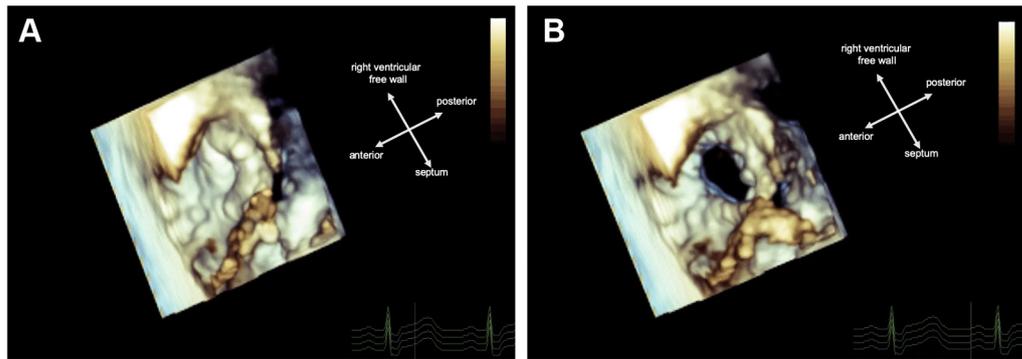


**Figure 4** Postprocedural spectral Doppler interrogation of the TV demonstrating a mean gradient of 1 mm Hg. PG, Pressure gradient; VTI, velocity-time integral.

unique characteristic features of this novel valve. Echocardiographers performing examinations should be familiar with common complications and comprehensive evaluation techniques, including two-dimensional and 3D imaging.

#### SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.05.018>.



**Figure 5 (A)** Three-dimensional assessment of the TV seen en face from the right atrial perspective during systole demonstrating complete TV closure. **(B)** Three-dimensional assessment of TV seen en face from the right atrial perspective during diastole.

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