

MINI-FOCUS ISSUE: TRANSCATHETER INTERVENTIONS

ADVANCED

HEART CARE TEAM/MULTIDISCIPLINARY TEAM LIVE

A Complex Tricuspid Clip

Bridging the Decision



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ABSTRACT

We present this case of a 22-year-old woman with congenital heart disease as the youngest reported patient, to the best of our knowledge, to successfully undergo treatment of medically refractory torrential tricuspid regurgitation with the MitraClip system as an adjunct to guideline directed therapy. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2020;2:1089-92) © 2020 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/>).

A 22-year-old woman with Turner syndrome who had 3 previous cardiac surgeries and a balloon valvuloplasty for recurrent aortic stenosis and repaired aortic coarctation presented with an out-of-hospital cardiac arrest secondary to atrial flutter in the setting of restrictive cardiomyopathy. Before presentation, she had ongoing right-sided heart failure symptoms necessitating hospital admission and escalation of oral diuretics. Although there was improvement in her right-sided volume overload with inotrope-augmented diuresis (bumex infusion,

intermittent diuretic, spironolactone 100 mg daily, and dobutamine 3 to 5 $\mu\text{g}/\text{kg}/\text{min}$), she continued to experience persistent ascites and pedal edema after 5 weeks of aggressive medical management. Attempts to wean to intermittent intravenous diuretics or wean the dobutamine dose were limited by worsening volume overload and low-output state.

Besides her congenital cardiac surgical repairs, she also had implantation of a dual-chamber epicardial pacemaker for heart block. Her last aortic valve intervention was a Konno procedure to enlarge the left ventricular outflow tract to allow implantation of a 21-mm St. Jude mechanical aortic valve 3 years before presentation. This was complicated by restrictive physiology of both ventricles and torrential tricuspid regurgitation (TR). From a noncardiac perspective, she was treated for depression.

At this stage, her physical examination was notable for heart rate 70 beats/min, blood pressure 96/53, and O_2 saturation 97%. Her current weight was 55 kg, which was 15 kg less than her admission weight. Cardiac auscultation revealed a normal S1 with a crisp, mechanical S2, and a grade 3/6 holosystolic murmur at the left lower sternal border. Her jugular

LEARNING OBJECTIVES

- To recognize the noninvasive imaging modalities to assess the mechanism and severity of tricuspid regurgitation.
- To identify the hemodynamic and clinical benefits of reducing the degree of tricuspid regurgitation in patients with right-sided heart failure.
- To illustrate the therapeutic role of tricuspid clip in patients with ongoing heart failure despite optimal medical therapies.

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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 *JACC: Case Reports* [author instructions page](#).

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ABBREVIATIONS AND ACRONYMS

RV = right ventricle

TR = tricuspid regurgitation

venous pressure was elevated to the angle of the jaw with a prominent CV wave. Additional evidence of right heart failure included a pulsatile liver, prominent ascites, and 2+ pedal edema bilaterally. Transthoracic echocardiography demonstrated left ventricular ejection fraction of 40% to 45%, normally functioning mechanical aortic valve, normal right ventricular (RV) systolic function with restrictive RV physiology, and torrential functional TR (Video 1). Right-heart catheterization demonstrated elevated right- and left-sided filling pressures without significant pulmonary hypertension (right atrium mean, 16 mm Hg; pulmonary artery 33/13, mean 23 mm Hg; pulmonary capillary wedge pressure, 20 mm Hg), and borderline cardiac output (cardiac index, 2.6 l/min/m²) while on dobutamine 3 µg/kg/min.

QUESTION 1: WHAT TREATMENT OPTIONS COULD BE CONSIDERED AT THIS STAGE?

Potential strategies beyond a goals of care discussion for this critically ill patient included heart transplantation, mechanical circulatory support, and tricuspid valve intervention to reduce the degree of TR. Mechanical circulatory support was limited by biventricular dysfunction. Heart transplantation was believed to be the most definitive strategy, although urgent transplant was limited by severely elevated levels of preformed antibodies (Class I, 80%; Class II, 100%) requiring desensitization and further reassessment. Her ability to tolerate desensitization from a hemodynamic perspective was also uncertain. Given the family and patient's desire to pursue active interventions, we then focused on interventions to reduce the degree of TR and improve her right-sided heart failure symptoms along with ongoing evaluation of desensitization therapy.

QUESTION 2: WHAT OPTIONS WERE CONSIDERED FOR REDUCING THE TR?

Both surgical and percutaneous options were considered. Although percutaneous repair is typically considered in older patients with high surgical risk the heart team favored a percutaneous approach given her high risk of surgical repair (3 previous cardiac surgeries, inotrope-dependent). We also anticipated that repeat surgical intervention could contribute to further sensitization. While there are many devices at various stages of clinical use for percutaneous repair, our local experience has focused on using the MitraClip in the tricuspid position as the preferred option. Although a dedicated tricuspid clip delivery system is under development

(1), transcatheter tricuspid valve repair using the MitraClip XTR system has been previously reported for native tricuspid valves (2,3). With these considerations in mind, we then performed further investigations to assess the anatomic suitability of a tricuspid clip.

QUESTION 3: WHAT FEATURES WERE USED TO DETERMINE IF THE ANATOMY WAS SUITABLE FOR A TRICUSPID CLIP?

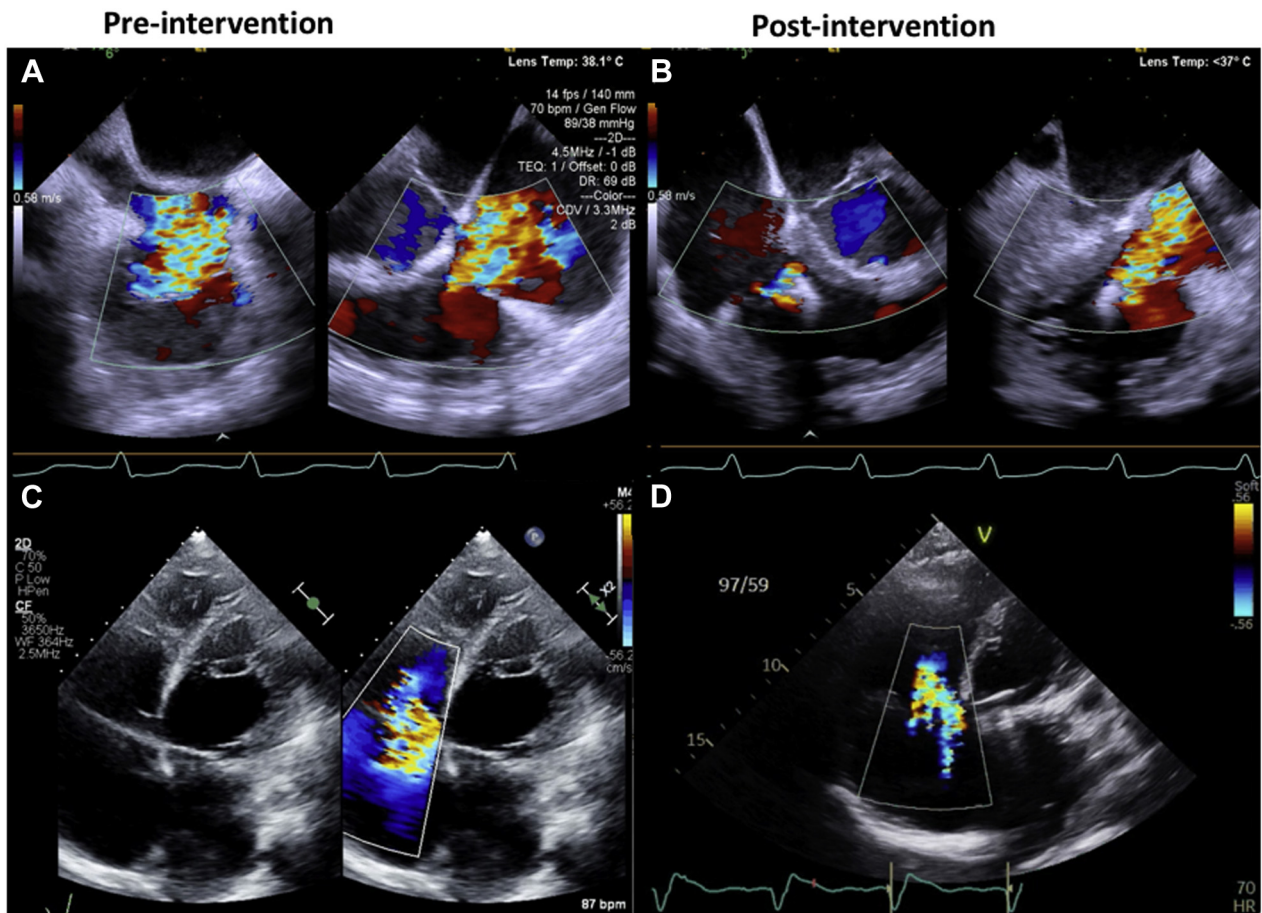
We carefully rereviewed the transthoracic echocardiogram images to determine to the origin of the TR jet using described protocols (4,5). The TR was most likely functional in etiology as noted by the central direction of the jet and the annular dilation. The predominant jet originated from between the septal and anterior leaflets (Video 1); however, a smaller jet was also noted originating from between the anterior and posterior leaflets (Video 2). Further imaging with transesophageal echo including 3-dimensional acquisitions was requested to further assess the tricuspid valve anatomy. The predominant jet was originating between the anterior and septal leaflets with smaller jets noted between the other leaflets (Videos 3, 4, and 5). The 3-dimensional images provided incremental value in demonstrating a central coaptation gap between all 3 leaflets. Our patient had epicardial pacing leads, which would not impose the technical challenges of performing a tricuspid clip in a patient with transvenous pacing leads.

QUESTION 4: HOW WAS THE PATIENT MANAGED?

The patient underwent successful clipping of the tricuspid valve under general anesthesia. Baseline hemodynamics revealed right atrium mean, 21 mm Hg; pulmonary artery 43/18 mean, 29 mm Hg; pulmonary capillary wedge pressure, 21 mm Hg; and normal cardiac output (cardiac output 5.5 l/min; cardiac index 3.9 l/min/m²) on dobutamine 5 µg/kg/min.

The MitraClip device was used to access the tricuspid valve through the right femoral vein. The grasping view on transesophageal echocardiogram was suboptimal necessitating use of intracardiac echocardiography (Video 6) to guide the clip delivery system between the septal and anterior tricuspid leaflets. After both leaflets were captured, the MitraClip was closed and deployed, leading to a reduction in the degree of TR from torrential to moderate-to-severe (Figure 1, Video 7) with an acceptable gradient (4 mm Hg). The mean right atrium pressure decreased to 15 mm Hg following implantation of the tricuspid clip. Notably, our intention was to reduce the degree

FIGURE 1 Pre- and Post-Transcatheter Tricuspid Valve Repair With the MitraClip System



(A) TEE before intervention demonstrating torrential TR. **(B)** TEE following intervention demonstrating moderate-to-severe TR. **(C)** TTE before intervention demonstrating torrential TR. **(D)** TTE following intervention demonstrating moderate-to-severe residual TR through the posterior and septal leaflets. TEE = transesophageal echocardiogram; TR = tricuspid regurgitation; TTE = transthoracic echocardiogram.

of TR rather than completely eliminating all TR. Implantation of a second clip was not pursued given the risk of tricuspid stenosis and concerns of whether the dysfunctional RV would tolerate further acute reduction in the degree of TR.

QUESTION 5: WHAT WAS THE PATIENT'S CLINICAL COURSE FOLLOWING THE PROCEDURE?

Over the subsequent 48 h, she was successfully weaned off inotropes, transitioned to oral diuretics, and discharged home on post-operative day 9. At 30-day follow-up, she reported significantly improved symptoms (New York Heart Association functional class I) and transthoracic echocardiogram demonstrated a persistent reduction in the degree of TR with a residual jet originating between the posterior

and septal leaflets (Figure 1D, Video 8). The RV dimensions had decreased from a basal diameter of 55 mm to 47 mm, and the RV systolic function (as assessed by fractional area of change) remained similar at 50%. She has not had any further hospitalizations post-procedure. In subsequent multidisciplinary discussions, the heart team determined that the risks of desensitization outweighed any benefits.

QUESTION 6: ARE THERE ANY GAPS IN THE GUIDELINES FOR TRICUSPID CLIP?

Although preliminary data on clinical outcomes following tricuspid clip continue to be published, there are insufficient data to inform guideline recommendations on indications for tricuspid clip and patient factors associated with favorable clinical

outcomes following tricuspid clip to guide patient selection at present time. The technical aspects of the procedural technique continue to evolve, including the optimal number of clips and position of clips and the optimal imaging modality to guide the procedure.

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KEY WORDS cardiomyopathy, chronic heart failure, echocardiography, restrictive, tricuspid valve, valve repair

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



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