

Edge-to-edge tricuspid valve repair for severe tricuspid regurgitation 20 years after cardiac transplantation

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Abstract

Tricuspid valve regurgitation in orthotopic heart transplant recipients is common. Surgical corrections have been the mainstay of the treatment for diuretic-refractory heart failure due to severe tricuspid regurgitation. However, post-transplant patients inherently carry higher surgical risk owing to previous sternotomy and immunocompromised state. We report a case of successful percutaneous edge-to-edge tricuspid valve repair for severe tricuspid regurgitation after cardiac transplantation. A 27-year-old man with a history of idiopathic restrictive cardiomyopathy status after orthotopic heart transplant presented with severe right-sided heart failure symptoms. A transthoracic echocardiogram showed bi-atrial enlargement and moderate-to-severe tricuspid regurgitation, and an increase to the severe range with exercise. Percutaneous edge-to-edge tricuspid valve repair was performed. The patient's symptoms improved, and follow-up echocardiogram showed mild tricuspid regurgitation. Percutaneous tricuspid valve repair can be considered as an alternative option to conventional surgery for symptomatic severe tricuspid regurgitation in orthotopic heart transplant recipients with suitable anatomy.

Keywords Tricuspid regurgitation; Percutaneous tricuspid repair; Cardiac transplantation

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Introduction

Tricuspid valve regurgitation in orthotopic heart transplant recipients is common.¹ Although the large majority of patients tolerate mild-to-moderate tricuspid regurgitation well, severe tricuspid regurgitation may lead to right-sided heart failure symptoms and significantly impact the quality of life after otherwise successful transplant.² Surgical corrections by either repair or replacement have been the mainstay of the treatment for diuretic-refractory heart failure.³ However, post-transplant patients inherently carry higher surgical risk owing to previous sternotomy and immunocompromised state. Thus, a percutaneous approach is an attractive alternative to surgery. In the mitral field, percutaneous options have expanded in the last two decades. Percutaneous edge-to-edge mitral valve repair has been shown to be a suitable alternative approach to conventional surgery for primary mitral regurgitation and also superior to medical therapy alone for selected cohort of functional mitral regurgitation.^{4,5}

There has also been a recent growing interest in percutaneous tricuspid intervention. In general non-transplant cohorts, percutaneous tricuspid repair has been shown to have a reasonable overall procedural success rate and lead to significant clinical improvement in early case series.^{6,7} To date, no cases of percutaneous tricuspid repair after cardiac transplantation have been reported. Here, we report a case of successful percutaneous edge-to-edge tricuspid valve repair using MitraClip system for severe tricuspid regurgitation 20 years after cardiac transplantation.

Case report

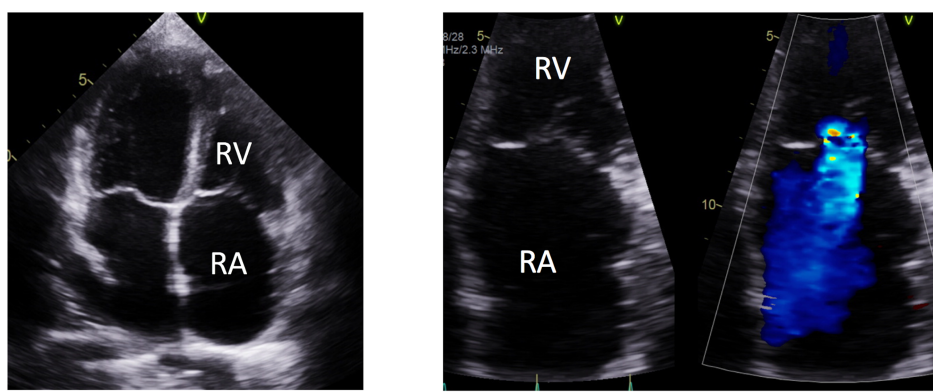
A 27-year-old man with a history of idiopathic restrictive cardiomyopathy status after orthotopic heart transplant 20 years prior (after tricuspid valve repair at age of 4) presented with worsening exertional dyspnoea, fatigue, and progressive

lower extremity oedema. Physical examination revealed a well-nourished man with severely elevated jugular venous pressure with prominent v wave and rapid y descents noted. Cardiac examination revealed a 1+ right ventricular lift, widely split S2, and a prominent right-sided S3 gallop. There was a 1/6 high-pitched systolic murmur at the left lower sternal border increasing with inspiration. Abdominal examination revealed mild hepatomegaly, and lower extremities were

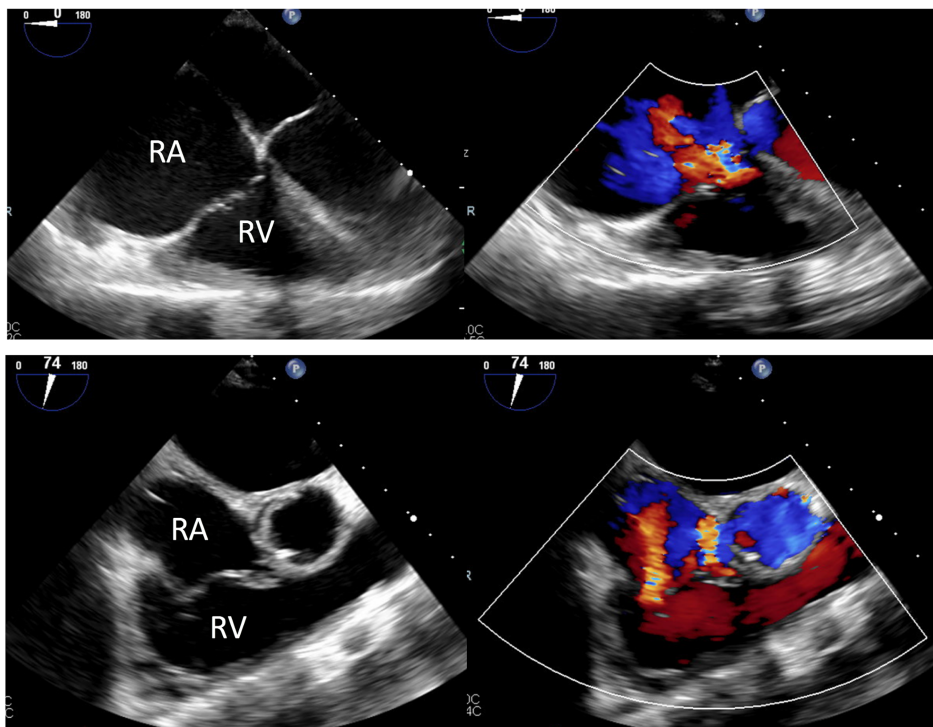
notable for 1+ pitting oedema. Laboratory test showed elevated NT-pro BNP of 1257 pg/mL. Exercise oxygen consumption testing demonstrated a severely reduced peak VO_2 of 18 mL/kg/min (30% predicted). A transthoracic echocardiogram showed bi-atrial enlargement, moderate-to-severe tricuspid regurgitation due to tricuspid annular dilatation, mild right ventricular enlargement, and moderate right ventricular systolic function (*Figure 1*). The left ventricular ejection

Figure 1 Baseline transthoracic and transesophageal echocardiogram. (A) Baseline transthoracic echocardiogram showed moderate bi-atrial enlargement, right ventricular enlargement, and moderate–severe tricuspid valve regurgitation. (B) Baseline transesophageal echocardiogram showed moderate–severe tricuspid valve regurgitation.

A Baseline TTE



B Baseline TEE



fraction was normal at 57%, and there was no other valvular heart disease. The patient was evaluated by cardiothoracic surgery team. Owing to multiple previous sternotomies, consideration was given to percutaneous edge-to-edge tricuspid valve repair using MitraClip system on a compassionate-use basis.

Right and left heart catheterization was performed to evaluate the aetiology of dyspnoea. Haemodynamic tracings are shown in *Figure 2*. At baseline, the right atrial pressure was severely elevated (mean 26 mmHg) with prominent y descent and prominent c–v wave. The pulmonary capillary wedge pressure was moderate–severely elevated at 22 mmHg. The right ventricle waveform was notable for a dip and plateau morphology and a reduced dp/dt with severely elevated right ventricle end-diastolic pressure of 22 mmHg. The pulmonary artery pressure was mildly elevated (mean 28 mmHg). The left ventricle waveform was notable for a dip and plateau morphology with elevated left ventricle end-diastolic pressure (21 mmHg). The cardiac index was normal at 2.8 L/min/m² with normal pulmonary vascular resistance of 1.2 Woods Unit. On simultaneous left ventricle–right ventricle assessment, there was occasional enhanced ventricular interdependence but primarily concordant pressures with the respiratory cycle. During inspiration, right ventricular diastolic pressure exceeded the left ventricular diastolic pressure. There was no intrathoracic intracardiac pressure dissociation on left ventricular–wedge assessment. We performed supine bicycle exercise haemodynamic study to further investigate the contribution of tricuspid regurgitation in the setting of underlying restrictive physiology. With exercise, there was a severe increase in right-sided filling pressures (mean 40 mmHg, v wave 47 mmHg) and left-sided filling pressures

increased severely (mean wedge 32 mmHg, v wave 45 mmHg). The cardiac index increased to 4.4 L/min/m² (only 75% of the expected increase in cardiac output expected for increase in VO₂).⁸ With exercise, simultaneous transthoracic echocardiography demonstrated an increase in tricuspid regurgitation severity to the severe range (*Figure 3*). Overall, the findings were consistent with significant tricuspid regurgitation that worsens with exercise and underlying restrictive cardiomyopathy.

After right and left heart catheterization, we proceeded to percutaneous edge-to-edge tricuspid valve repair with MitraClip system (Abbott Vascular, Santa Clara, CA, USA). The procedure was performed under general anaesthesia with transesophageal echocardiography guidance. Access was obtained through the right common femoral vein. After serial dilatation, the MitraClip delivery sheath was advanced into the right atrium over a stiff wire. The XTR MitraClip was then introduced with conventional guide-clip alignment. The clip was further advanced and positioned over the area of anterior and septal leaflets, where the most prominent regurgitant jet originated from, by adding plus knob on the guide and rotating the guide anteriorly. Three-dimensional transesophageal echocardiography confirmed correct clip orientation in relation to the tricuspid valve leaflets. The clip was then advanced into the right ventricle, and anterior-septal leaflets were successfully grasped (*Figure 4*). There was a significant reduction in the degree of tricuspid regurgitation into mild range (*Figure 4*), and the resting mean right atrial pressure lowered from 20 to 14 mmHg with a reduction in the v wave (*Figure 2*). We considered the procedure successful based on significant reduction in the degree of tricuspid regurgitation, and mild persistent

Figure 2 Haemodynamic tracing at baseline, peak exercise, and post tricuspid valve repair.

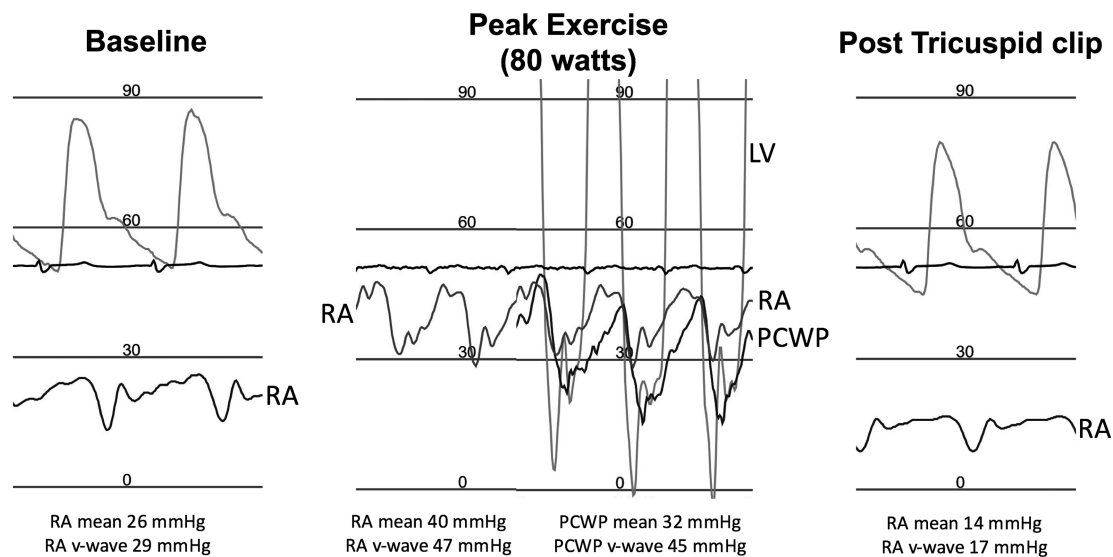
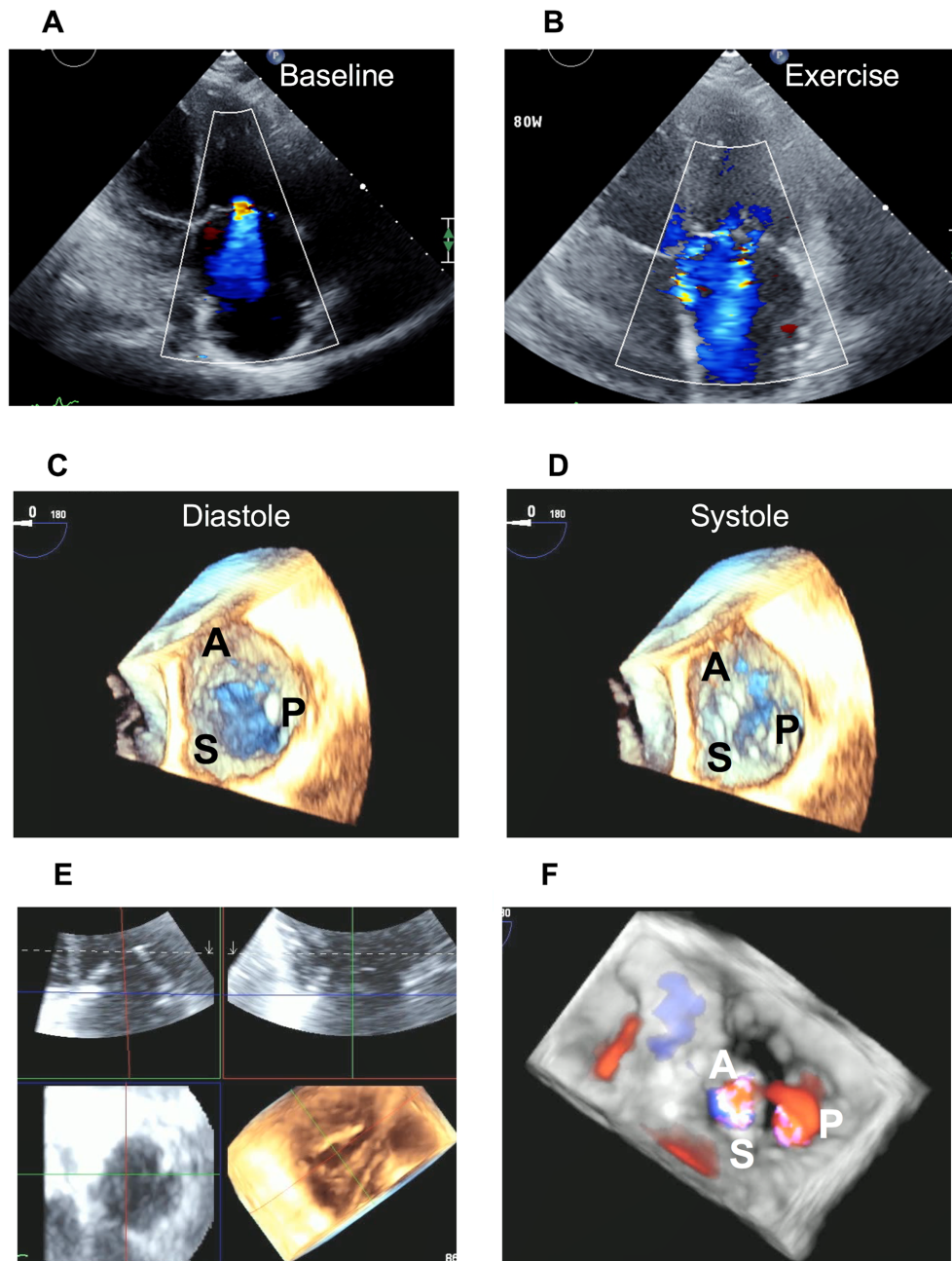


Figure 3 Intraoperative transthoracic and transesophageal echocardiogram. (A, B) Apical four-chamber with colour view demonstrating moderate–severe tricuspid regurgitation at baseline and severe tricuspid regurgitation during exercise. (C, D) Transesophageal echocardiography three-dimensional full images of the tricuspid valve anatomy during diastole and systole demonstrating three distinct tricuspid leaflets (A; anterior, P; posterior, S; septal). (E) Transesophageal echocardiography multiplanar reconstruction images of the tricuspid valve in diastole demonstrating anterior and septal leaflet lengths are adequate for edge-to-edge repair without excessive chordal bundles present. (F) Three-dimensional colour images demonstrating the primary jet of tricuspid regurgitation is between the anterior and septal leaflets.



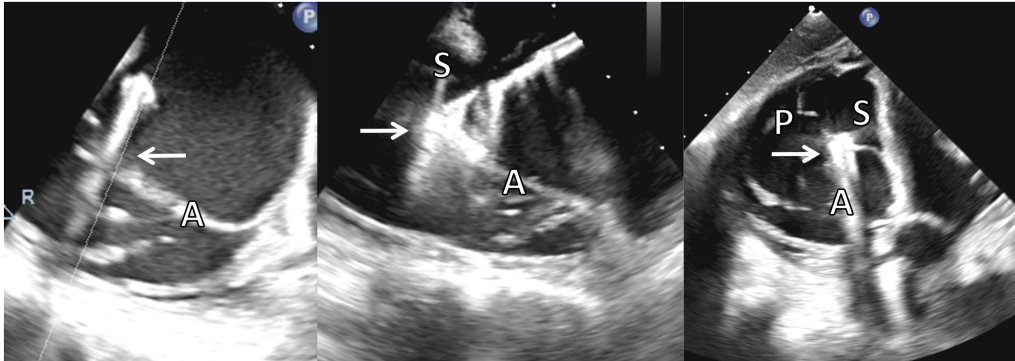
elevation of right atrial pressure was thought to be related to underlying restrictive physiology.

Post-procedural course was uneventful, and the patient was discharged home on the following day. Two weeks after the procedure, the patient's symptoms improved down to

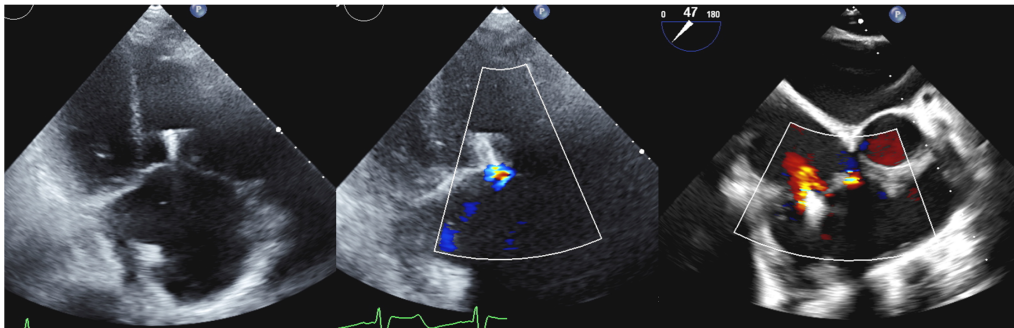
New York Heart Association Class II. Transthoracic echocardiogram showed mild tricuspid regurgitation with tricuspid gradient of 3 mmHg with normalized right ventricular size and systolic function. These findings were unchanged at 6 month follow-up.

Figure 4 Percutaneous edge-to-edge tricuspid valve repair. (A) MitraClip was deployed between anterior and septal leaflets. A, anterior; S, septal; P, posterior; white arrow, MitraClip device. (B) Tricuspid regurgitation was decreased to mild range after successful tricuspid valve repair.

A Clipping procedure



B Post procedure



Discussion

We report a case of successful percutaneous edge-to-edge tricuspid valve repair using MitraClip system for severe tricuspid regurgitation 20 years after cardiac transplantation. Tricuspid valve regurgitation in orthotopic heart transplant recipients is common.^{1,2} Severe tricuspid regurgitation is associated with significant morbidity and mortality.^{2,9} The aetiology of tricuspid regurgitation in the present case was thought to be tricuspid annular dilatation likely related to bi-atrial anastomosis, leading to functional tricuspid regurgitation. The very late presentation of severe tricuspid regurgitation was consistent with this aetiology, whereas early presentation is associated with allograft rejection or injury from myocardial biopsy.¹⁰ Bi-atrial anastomosis, especially when placed in close proximity to the atrioventricular groove, can geometrically distort the tricuspid valve annulus. Although bicaval technique lowers the risk of post-transplant tricuspid regurgitation, many other factors contribute to post-transplant tricuspid regurgitation.¹¹ Severe tricuspid regurgitation becomes more common over time: 7.8% of surviving patients at 5 years and 14.2% at 10 years.² Tricuspid

regurgitation remains one of the major aetiologies leading to heart failure in transplant recipients. Surgical corrections by either repair or replacement have been the mainstay of the treatment for diuretic-refractory cases.³ Although successful surgical repair or replacement can lead to significant improvement in heart failure, tricuspid surgery after heart transplant is associated with high morbidity and mortality.¹²

The experience in percutaneous tricuspid valve repair has been accumulating. A recent multicenter observational study reported 97% procedural success rate of percutaneous tricuspid valve repair using MitraClip system as well as improvement in heart failure symptoms in non-surgical candidates with severe tricuspid regurgitation.⁶ The majority of the clips were placed in anterior-septal commissure, due to the typically large size of the anterior leaflet and also related to the fact that tricuspid annular dilatation is typically most pronounced at the anterior-septal region.⁶ We believe that edge-to-edge repair in the septolateral dimension may translate to better annular size reduction in patients with tricuspid annulus dilatation. Specific challenges for percutaneous tricuspid intervention lie in a difficulty in obtaining optimal images for precise clip positioning. Nevertheless, with the use

of advanced imaging techniques as well as accumulated experiences, these difficulties can be mitigated.^{13,14}

A unique aspect of the present case was underlying restrictive physiology. Exercise haemodynamics were used to differentiate the relative contribution of tricuspid regurgitation in the setting of restrictive cardiomyopathy. Based on the increased severity of tricuspid regurgitation as well as right heart filling pressure exceeding left side pressures during exercise, we concluded that significant improvement could be achieved with successful tricuspid valve repair despite persistent underlying restrictive physiology. Tricuspid repair led to improvement in haemodynamics and symptoms, successfully deferring surgery. We plan to closely monitor the progression of restrictive physiology.

In summary, we report a case of successful percutaneous edge-to-edge tricuspid valve repair using MitraClip system for severe tricuspid regurgitation 20 years after cardiac transplantation. Percutaneous tricuspid valve repair can be considered as an alternative option to conventional surgery for selected cases of symptomatic severe tricuspid regurgitation in orthotopic heart transplant recipients with suitable anatomy.

Conflict of interest

None declared.

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