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**CASE REPORT**
*Structural intervention*

# Tailored pre-procedural management and four-clip trans-catheter edge-to-edge repair procedure to efficiently treat torrential tricuspid regurgitation: a case report

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**Background** The use of trans-catheter treatment for tricuspid regurgitation (TR) is currently increasing, especially trans-catheter edge-to-edge repair (TEER). However, patients with very large coaptation gaps are usually considered not eligible for this treatment.

**Case summary** We present the case of an 87-year-old man with symptomatic [New York Heart Association (NYHA) functional Class IV, right-sided heart failure signs] isolated torrential TR due to chronic atrial fibrillation who was initially considered not eligible for a tricuspid valve (TV) TEER because of a very large coaptation gap. A leadless pacemaker was implanted, and the patient received high doses of intravenous diuretics at home during 2 months. After heart team discussion, he was then considered suitable for a TEER procedure. A 'zipping' technique was performed, with the implantation of four TriClip devices, based on the anatomy of the TV and guided by fluoroscopy and bi- and tri-dimensional trans-oesophageal echocardiography, allowing an excellent procedural result (mild TR and mean TV gradient = 1 mmHg). At 6 months, TR was still mild, the patient reported a remarkable improvement (NYHA I, no heart failure signs), and 6-min walk test increased from 260 to 375 m.

**Discussion** This case underscores the need for heart valve centres with dedicated and experienced teams and networks of care to adequately manage patients with severe TR from pre-procedural choice of cardiac pacing type and optimization of diuretic therapy to customized interventions with appropriate number and location of clips according to the anatomy of the valve and the mechanism of TR, guided by high-quality bi- and tri-dimensional echocardiography.

**Keywords** Tricuspid regurgitation • Percutaneous valve repair • Management • Case report

**ESC curriculum** 2.2 Echocardiography • 4.5 Tricuspid regurgitation

## Learning points

- Diuretic therapy should be optimized before trans-catheter tricuspid valve edge-to-edge repair.
- Trans-catheter tricuspid valve edge-to-edge repair should be customized with the appropriate number and location of clips according to the anatomy of the valve and the mechanism of tricuspid regurgitation.

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## Introduction

Severe tricuspid regurgitation (TR) is frequent and its prevalence increases with age.[1,2] Tricuspid regurgitation is mostly functional, frequently related to atrial fibrillation,[3] and associated with a dismal outcome (altered quality of life, heart failure, and death), especially as TR grade increases.[4–6] A curative treatment for TR is seldom performed and most often late in the course of the disease. Nowadays, the use of trans-catheter treatment for TR is increasing, especially trans-catheter edge-to-edge repair (TEER).[7] However, patients with very large coaptation gaps are usually considered not eligible for this treatment.[8]

## Summary figure

| Date | Events |
|---|---|
| December 2021 | Hospitalization for right-sided heart failure related to a torrential functional TR |
| Late June 2022 | First assessment of the patient in our heart valve centre<br>Implantation of a leadless pacemaker |
| July to August 2022 | High doses of intravenous diuretics at home during 2 months |
| Early September 2022 | New assessment of the patient in our heart valve centre |
| Late September 2022 | Trans-catheter edge-to-edge tricuspid valve (TV) repair with implantation of four TriClips and excellent procedural result |
| Mid-March 2023 | 6-month follow-up |

## Case presentation

An 87-year-old man with a history of permanent atrial fibrillation presented with right-sided heart failure signs related to a torrential (5/5)[9] functional TR to another tertiary hospital centre. He was medically treated with diuretics, denied curative surgical treatment, deemed high surgical risk (TRI-SCORE was 6, meaning a predicted in-hospital mortality rate after isolated TV surgery of 22%),[10] and denied TEER because of a very large coaptation gap (>8.5 mm).[8] As the patient remained severely symptomatic [New York Heart Association (NYHA) functional class IV and right-sided heart failure signs] with a very altered quality of life (asthenia, anorexia, and depression) despite high doses of diuretics (furosemide 250 mg/day and spironolactone 12.5 mg/day), he was referred to our heart valve centre. At admission, vital signs were normal, with no heart murmur, and no pulmonary rales, but there was jugular venous distension, hepatojugular reflux, and lower limb oedema. Trans-thoracic echocardiography showed massive TR [proximal isovelocity surface area (PISA) radius = 10 mm, vena contracta = 10 mm, effective regurgitant orifice area = 74 $mm^2$, regurgitant volume = 47 mL, and maximal gap size = 9 mm] due to tricuspid annulus dilatation (54 mm), with significant enlargement of both right ventricle (RV) and right atrium (RA) (RA indexed volume = 172 $mL/m^2$ and RV end-diastolic area = 35 $cm^2$), dilated and not compliant inferior vena cava, and hepatic vein systolic flow reversal. There was no RV dysfunction [tricuspid annular plane systolic excursion (TAPSE) = 20 mm, systolic annular velocity = 13 cm/s, and RV fractional area change = 41%] (*Figure 1*). Left ventricular size and function were normal, and there was no aortic or mitral valve disease. As the patient presented episodes of bradyarrhythmia, the heart team decided to implant a leadless pacemaker to avoid a permanent lead through the TV that may preclude a trans-catheter TV intervention. As the coaptation gap was too large (9 mm) to consider a TEER procedure, a peripherally inserted central venous catheter was implanted, and the patient received high doses of intravenous diuretics (furosemide 250 mg/day over 1 h) at home during 2 months (home hospitalization with clinical and biological monitoring to ensure safety and efficiency).

Trans-thoracic echocardiography performed 2 months later showed a decrease of TR from massive (4/5) to severe (3/5) (PISA radius = 8 mm, vena contracta = 9 mm, effective regurgitant orifice area = 50 $mm^2$, regurgitant volume = 30 mL, and maximal gap size = 4 mm) (*Figure 2*). Bi- and tri-dimensional trans-oesophageal echocardiography (TEE) revealed a three-leaflet TV with two scallops for both anterior and posterior leaflets[11] (*Figure 3*). Six-minute walk test (6MWT) was 260 m, and blood work revealed an N-terminal pro-B–type natriuretic peptide (NT pro-BNP) of 4470 pg/mL, a liver cholestasis without cytolysis, and a glomerular filtration rate of 40 mL/min. There was no coronary stenosis, and right heart catheterization showed normal pulmonary pressure (systolic/mean pulmonary artery pressure = 21/10 mmHg, pulmonary wedge pressure = 5 mmHg, and RA pressure = 3 mmHg).

After heart team discussion, the patient was now considered suitable for a TV TEER procedure. A 'zipping' technique was performed, with the implantation of four TriClips XTW devices (Abbott Medical) (one antero-septal at the level of the commissural anterior scallop, one antero-septal at the level of the central anterior scallop, one postero-septal at the level of the commissural posterior scallop, and one postero-septal at the level of the central posterior scallop), based on the anatomy of the TV and guided by fluoroscopy and TEE, using bi-and tri-dimensional modes, biplane mid/distal oesophageal, and trans-gastric views, allowing an excellent procedural result. Indeed, both leaflets were successfully captured by each of the four clips, the mean TV gradient was 1 mmHg, and the residual TR was mild (1/5) (*Figure 4*). The patient was discharged on Day 4 without any complications with the same oral diuretic treatment.

At 6 months, the patient reported a remarkable improvement with no more depression, asthenia, or anorexia, a NYHA Class I functional status, no signs of right-sided heart failure, and a 6MWT of 375 m. Trans-thoracic echocardiography showed good leaflet attachment to the four clips, a mean TV gradient of 1 mmHg and mild TR (1/5), with a significant remodelling of the right cavities (tricuspid annulus = 44 mm, RA indexed volume = 81 $mL/m^2$, and RV end-diastolic area = 21 $cm^2$) and a preserved RV systolic function (TAPSE = 16 mm, systolic annular velocity = 10 cm/s, and RV fractional area change = 37%), and inferior vena cava was not dilated and compliant (*Figure 5*).

## Discussion

This is an educational case report of tailored management of a patient with a torrential TR in whom a prolonged administration of intravenous diuretics at home followed by a four-clip TEER procedure based on the anatomy and guided by bi- and tri-dimensional TEE enabled an excellent echocardiographic result and a remarkable functional improvement.

As our goal is to perform a curative procedure that would be both safe and efficient, aiming for a none or mild TR after the intervention,[12] a huge coaptation gap is usually considered as a 'red flag' to perform TEER.[8] Thus, we should work on strategies to decrease this coaptation gap with the aim of making the patient eligible for this procedure. For this purpose, we have developed a network of care allowing prolonged and optimized intravenous diuretics at home (hospital-at-home care)

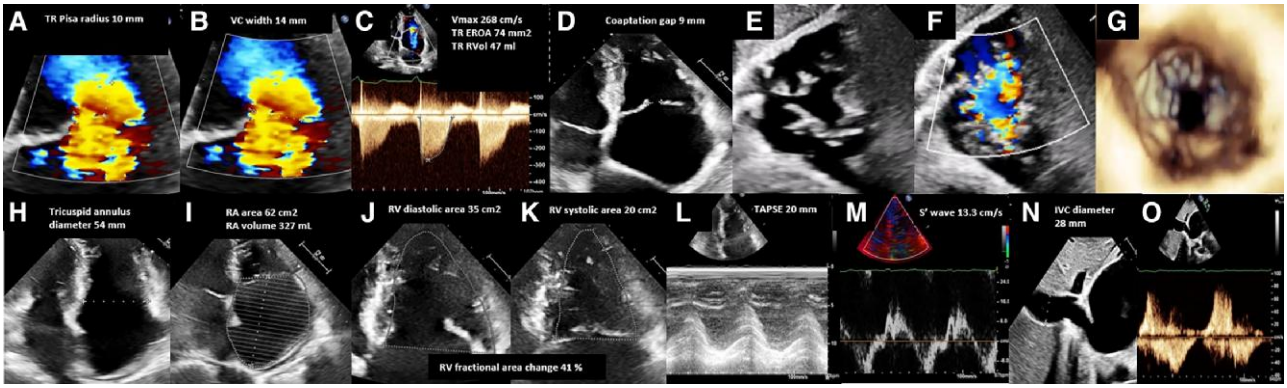


**Figure 1** Trans-thoracic echocardiography at baseline. Assessment of tricuspid regurgitation severity grade and mechanism (*A*–*H*), right atrial and ventricular size and function (*I*–*M*), and impact on inferior vena cava and hepatic vein (*N* and *O*). EROA, effective regurgitant orifice area; IVC, inferior vena cava; PISA, proximal isovelocity surface area; RA, right atrium; RV, right ventricle; RVol, regurgitant volume; TAPSE, tricuspid annular plane systolic excursion; TR, tricuspid regurgitation; VC, vena contracta.

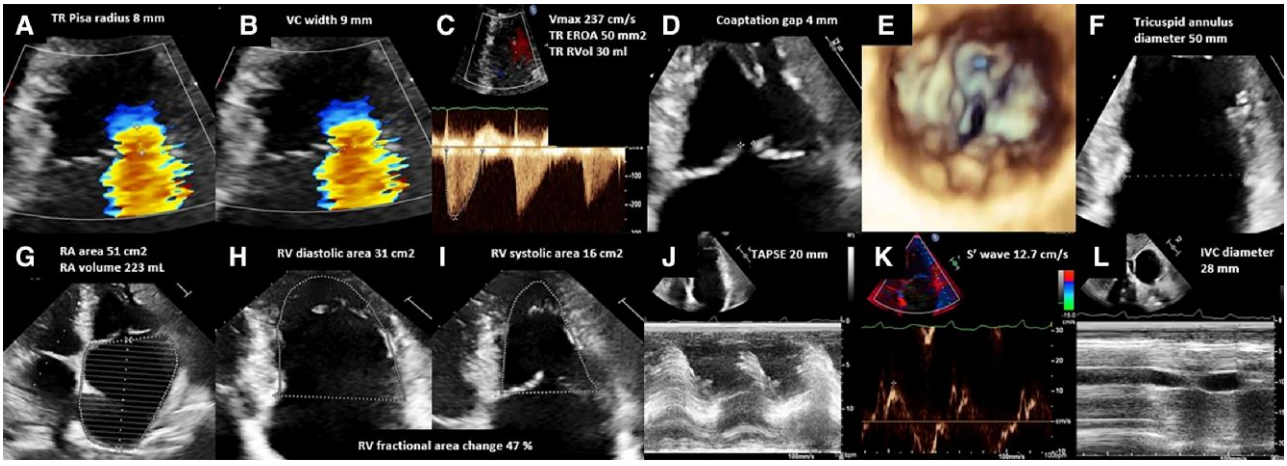


**Figure 2** Trans-thoracic echocardiography after prolonged high doses of intravenous diuretics. Assessment of tricuspid regurgitation severity grade and mechanism (*A*–*F*), right atrial and ventricular size and function (*G*–*K*), and impact on inferior vena cava (*L*). EROA, effective regurgitant orifice area; IVC, inferior vena cava; PISA, proximal isovelocity surface area; RA, right atrium; RV, right ventricle; RVol, regurgitant volume; TAPSE, tricuspid annular plane systolic excursion; TR, tricuspid regurgitation; VC, vena contracta.

to significantly decrease the gap size in order to bring the patient for a successful TEER procedure. Ultrafiltration or the use of drugs such as levosimendan may be other interesting strategies.[13,14]

As TEER is a challenging and customized procedure, procedural success requires an experienced team and a good understanding of the anatomy and the mechanism of TR, which are unique for each patient. Thus, high-quality imaging is critical for such intervention, and tri-dimensional TEE (including multi-planar reconstructions), additionally to bi-dimensional mode, should be used more frequently as it is very helpful to understand the mechanism of TR and treat it adequately.

The best timing to perform a curative intervention is not clearly defined, but patients should be referred to expert centres for a curative intervention earlier in the course of the disease, before irreversible organ damage, to improve outcome.[7,12]

## Conclusion

This educational case shows the need for heart valve centres, with dedicated and experienced teams, to successfully manage patients with severe TR, from pre-procedural choice of cardiac pacing type and optimization of diuretic therapy, if needed through hospitalization at home, to adequate number and location of clips based on high bi- and tri-dimensional TEE quality imaging and a good understanding of anatomy and mechanism of TR.

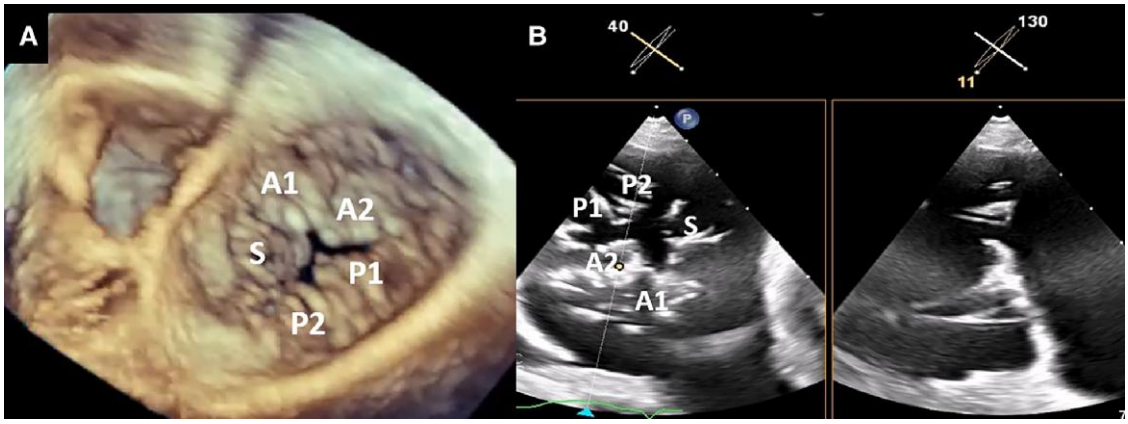


**Figure 3** Analysis of the tricuspid valve leaflets using trans-oesophageal echocardiography, with tri-dimensional (*A*) and biplane bi-dimensional trans-gastric views (*B*). A1, anterior scallop close to the antero-septal commissure; A2, anterior scallop close to the antero-posterior commissure; P1, posterior scallop close to the antero-posterior commissure; P2, posterior scallop close to the postero-septal commissure; S, septal leaflet.

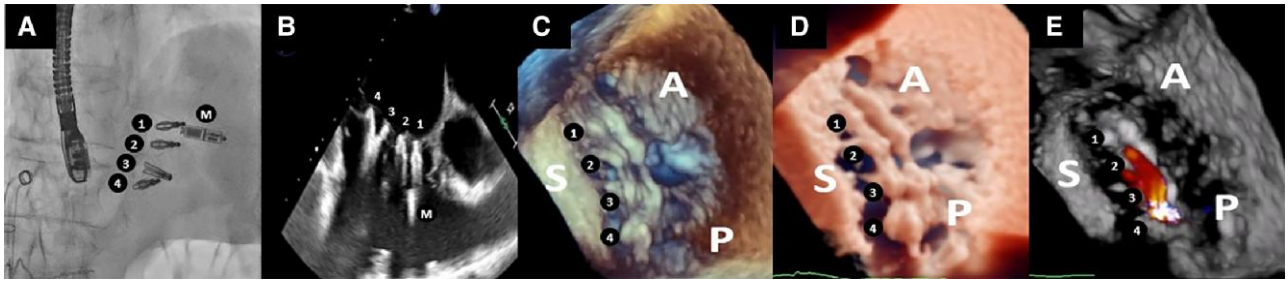


**Figure 4** Immediate post-procedural result after implantation of four TriClips during a tricuspid valve trans-catheter edge-to-edge repair, assessed by fluoroscopy (*A*) and trans-oesophageal echocardiography using bi-dimensional and tri-dimensional views Doppler (*B*–*E*), showing the four TriClips (1–4) and the leadless pacemaker (*M*).

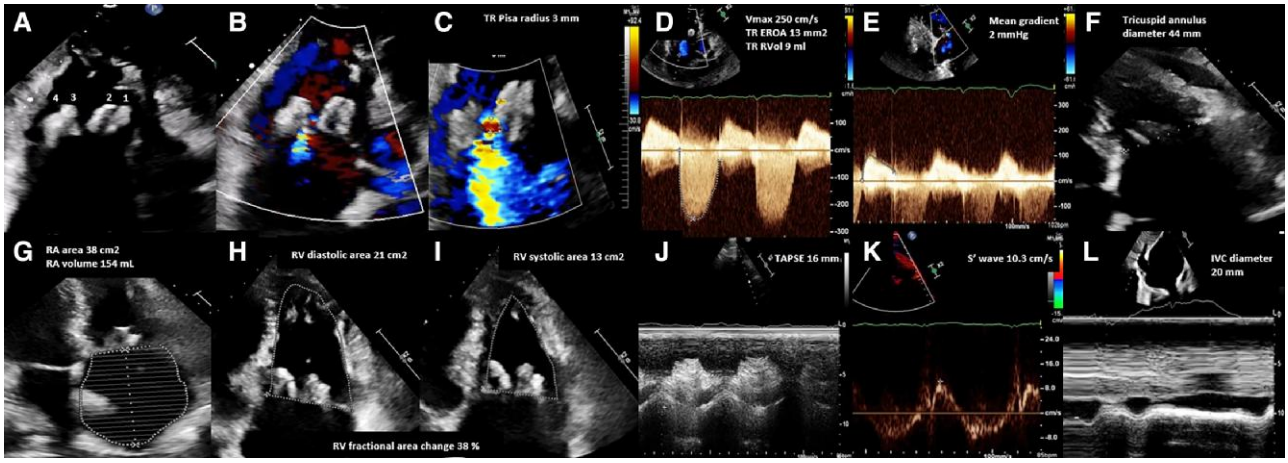


**Figure 5** Trans-thoracic echocardiography 6 months after edge-to-edge tricuspid valve repair. Assessment of clips attachment to leaflets (*A*), tricuspid regurgitation severity grade (*B*–*D*), mean gradient (*E*), right atrial and ventricular size and function (*F*–*K*), and impact on inferior vena cava (*L*). EROA, effective regurgitant orifice area; IVC, inferior vena cava; PISA, proximal isovelocity surface area; RA, right atrium; RV, right ventricle; RVol, regurgitant volume; TAPSE, tricuspid annular plane systolic excursion; TR, tricuspid regurgitation; VC, vena contracta.

## Lead author biography

Julien Dreyfus is a senior cardiologist at Centre Cardiologique du Nord in France, highly committed to the assessment andmanagement of tricuspid regurgitation, both in clinical practice and research (PhD on this topic).

## Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.


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### Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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