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CASE REPORT
Cardiac imaging

Transthoracic guidance of percutaneous tricuspid valve repair: a case report

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Background Percutaneous tricuspid valve (TV) repair for tricuspid regurgitation (TR) is arising as a viable treatment option in high-risk patients and can lead to symptom control an improvement in quality of life (QoL). Newest devices have greatly increased safety and efficacy of interventional TR therapy. However, as with any emerging medical procedure, safety aspects need to be considered and procedural risks gradually reduced.

Case summary We present the case of an 87-year-old woman with massive TR despite successful percutaneous mitral valve repair. The patient was turned down for surgery and eventually underwent percutaneous TV repair using the TriClip™ (Abbott Medical) device. Significant TR reduction with sustained procedural success at 30-day follow-up were associated with functional and clinical improvement. Transthoracic echocardiographic guidance of the procedure, thanks to excellent parasternal TV visualization, is highlighted, while the complex anatomy of the TV is pointed out.

Discussion Tricuspid regurgitation is an individual predictor of morbidity but frequently found in elderly patients who are deemed very high risk for surgical treatment. This case underscores the use of modern interventional techniques and devices for addressing TR and improving QoL, whether as a stand-alone procedure or as part of complete interventional therapy of the atrioventricular valves.

Keywords Case report • Tricuspid regurgitation • Percutaneous valve repair

ESC Curriculum 2.2 Echocardiography • 4.5 Tricuspid regurgitation • 6.7 Right heart dysfunction • 4.9 Multivalvular disease

Learning points

- Percutaneous tricuspid valve repair in high-grade tricuspid regurgitation is a safe option in high-risk patients and can improve quality of life.
- Complete interventional treatment of the atrioventricular valves is emerging as a new therapeutic concept in elderly patients turned down for surgery.
- Transthoracic echocardiographic guidance, in conjunction with fluoroscopy, is possible in selected patients with very good acoustic window and can eliminate the need for transoe sophageal echo probe placement and general anaesthesia.

Introduction

Severe tricuspid valve regurgitation (TR) is a common finding in elderly patients, with an incidence of 5.6% after the age of 70 years, according to the Framingham Heart Study.[1] Over 90% of cases are secondary TR due to annulus dilatation often attributed to left-sided heart disease, e.g. mitral valve regurgitation (MR). Tricuspid regurgitation is an independent predictor for adverse prognosis.[2] Successful treatment, therefore, appears of great importance but, until recently, is limited to the use of diuretics and high-risk surgical procedures.[3]

Thanks to recent technological advances, percutaneous therapies are emerging as a viable treatment option for high-risk patients. Last

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year the first TR dedicated device (TriClip™, Abbott Medical) has been approved (CE mark) with good feasibility, safety, and effectiveness.[4] The lack of need for transseptal puncture improves safety of the procedure. However, the risks associated with general anaesthesia remain, due to the necessity of the transoesophageal echo (TOE) probe for guidance during the lengthy procedure and the ventilator mediated breath holding during Clip placement.

Timeline

Date	Events
July 2015, April 2016, June 2017, July 2018	Hospitalizations for acute heart failure Medical therapy
August 2018	Tachycardia-bradycardia syndrome Placement of single-chamber pacemaker (VVI)
October 2018	Refractory supraventricular tachycardias Atrioventricular node ablation
December 2018	Hospitalization for acute heart failure Severe mitral (III/IV) and tricuspid valve (TV) regurgitation (III/V)
January 2019	Percutaneous mitral valve repair
October 2019, January 2020, December 2020	Hospitalizations for acute heart failure Trivial mitral valve regurgitation; massive TV regurgitation (IV/V)
December 2020	Percutaneous TV repair
February 2021	Follow-up Moderate TV regurgitation (II/V) Successful symptom control; considerable increase in quality of life

Case presentation

An 87-year-old Caucasian female with massive functional TR (grade IV/V)[5] was referred for percutaneous tricuspid valve (TV) repair, based on multiple hospitalizations with right-sided acute heart failure, poor response to diuretic therapy, and high surgical risk (EUROSCORE[6] 11.46%, Clinical Risk Score for Mortality 35%,[7] Clinical Risk Score for Morbidity 59%[7]).

Her medical history included permanent atrial fibrillation, single-chamber pacemaker implantation, and percutaneous repair of severe MR, 2 years prior. Despite successful MR reduction, no effect on the severity of TR was observed. Since the pacemaker lead was not attached to any leaflet and did not interfere with the closure of the TV, the pathogenesis of TR was attributed to annular dilatation. Due to several comorbidities including stage 3B chronic kidney disease, type 2 diabetes, and frailty, she was deemed very high risk. The heart team suggested percutaneous TV repair.

Upon admission, physical examination showed marked peripheral oedema, jugular venous distension, and an irregular heartbeat. The patient complained of shortness of breath on minimal exertion, had a low Kansas City Cardiomyopathy Questionnaire (KCCQ) Score of 21.9, a 6-min walk distance (6MWT) of 275 m and NT-proB-type natriuretic peptide (NTproBNP) of 2082 pg/mL.

Transthoracic echocardiography (TTE) and TOE confirmed massive TR (*Figure 1*), as measured by biplane vena contracta of 16 mm and regurgitant orifice area of 82 mm^2. Regurgitation volume amounted to 82 mL. The right chambers were significantly enlarged [right atrial indexed volume 66.4 mL/m^2; right ventricular (RV) basal diameter 48 mm], whereas TV annulus was dilated (38 mm). Furthermore, RV function was impaired [tricuspid annular plain systolic excursion (TAPSE) 10 mm, fractional area change 30%, lateral wall tissue Doppler 8.5 cm/s], and RV systolic pressure considerably increased (50 mmHg) (*Figure 1*). Left ventricular function was normal.

The low body mass index of 20.1 was attributed to cardiac cachexia and further increased the procedural risk, but made for a good echo window in TTE. Particularly the parasternal long-axis RV inflow view and the short-axis 'aortic' view best depicted TV anatomy with visualization of all three leaflets upon gentle tilting of the probe (*Figure 2*).

Therefore, we decided to use TTE as the main guiding method of percutaneous TV repair, complementary to fluoroscopy. As both methods were used in alternation, the echocardiographer was not exposed to unnecessary radiation. Considering that it was our first procedure with transthoracic guidance, we still opted for general anaesthesia and placement of a TOE probe, which only served as bail-out in case of imaging difficulties, and result confirmation. In hindsight, the TOE images proved to be inferior to the aforementioned TTE views, as especially the transgastric window was of poor quality. In view of the good long-time result after percutaneous mitral valve repair using the MitraClip™ system (Abbott Medical) in this patient and local expertise, a decision was made to use the recently approved[4] TriClip™ XT device (Abbott Medical) (*Figure 3*).

After cannulation of the right femoral vein, the steerable guide catheter was advanced into the right atrium under fluoroscopic guidance. Then, by using bi-plane parasternal views, the TriClip™ delivery system was advanced into the right ventricle (*Figure 3*) and the clip was positioned and released between the anterior and septal (SL) leaflets (*Figure 4*), where the main body of TR jet was present. As the big coaptation gap of 7 mm could not be covered with one clip, a second clip was implanted and successfully placed between the medial scallop of the posterior leaflet (PL) and the SL (*Figure 4*) and led to a reduction to moderate TR (II/V), while the TV pressure gradient only rose to 2 mmHg. During these movements, we paid attention to the pacer lead position and avoided dislodgement. The patient was extubated in the cath lab. The reminder of her hospital stay was uneventful with considerable diuretic dose reduction at discharge.

One month follow-up confirmed successful downgrading from massive (IV/V) to moderate (II/V) TR (*Figure 5*), with improvement of RV systolic pressure (50–42 mmHg), RV function (TAPSE 10–17 mm), and decrease in right atrium (66.4–58.9 mL/m^2) and TR volume (82–23 mL). More importantly, the patient reported improvement of symptoms (New York Heart Association class III-II) and quality of life (QoL) (6MWT 275–360 m, KCCQ Score 21.9–36.1).

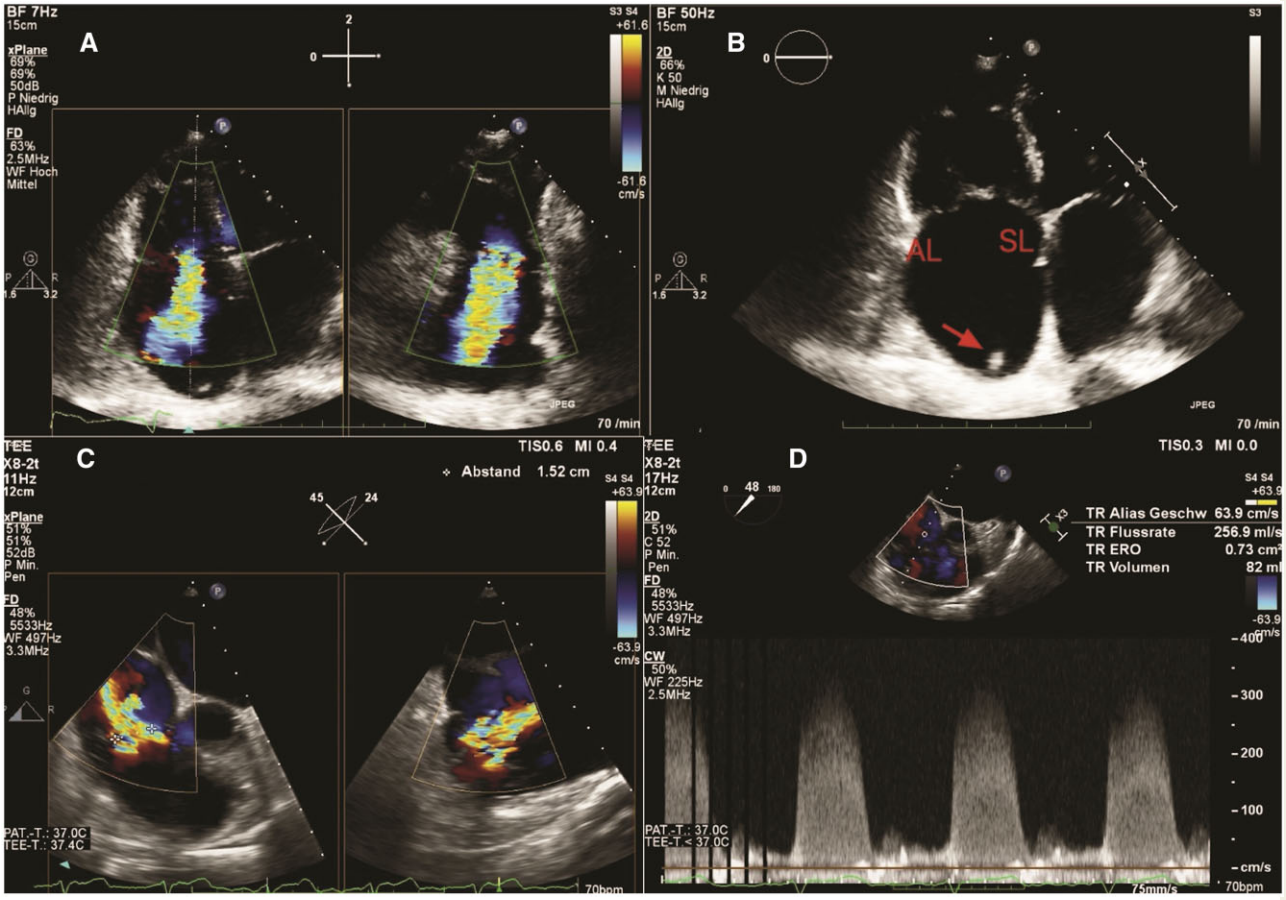

Figure 1 Preprocedural echocardiographic evaluation showing massive tricuspid regurgitation. (*A*) Transthoracic echocardiography bi-plane, colour flow Doppler, four- and two-chamber view of the right heart. (*B*) Four-chamber view. AL, anterior leaflet; Arrow, pacemaker lead; SL, septal leaflet. (*C*) Transoesophageal echo bi-plane views of tricuspid valve. (*D*) Continuous wave Doppler assessment of tricuspid regurgitation.

Interestingly enough, liver and kidney values also improved and NTproBNP dropped to 1483 pg/mL.

Discussion

We report the case of percutaneous TV repair of massive TR by mainly using TTE guidance in a high-risk patient. Despite successful interventional repair of MR, TR remained unchanged, probably due to longstanding progressive right heart and TV ring enlargement. The patient was turned down for surgery and experienced poor QoL due to right-sided heart failure symptoms. Considering recently shown safety and efficacy of the TriClip™ (Abbott Medical) system,[4] interventional treatment is emerging as a possible solution for decreasing morbidity in similar patients. Even though this percutaneous procedure does not imply higher risk gestures like e.g. arterial puncture, rapid ventricular pacing, or trans-septal puncture, operators still need to consider even further diminishing procedural risks.

Due to the fact that patients suffering from high-grade TR often have associated cardiac cachexia,[8] we have frequently experienced paradoxical good acoustic echo window for proper anatomical evaluation of TV and have assumed that TTE procedural guidance is possible in selected patients, thus eliminating the need for TOE and, in turn, general anaesthesia. As a proof of concept, in our first patient exposed to this 'TTE approach', we still went through the usual protocols, respectively endotracheal intubation, general anaesthesia and TOE probe placement, but guided the procedure solely by TTE, while using TOE only as back-up and result confirmation. After this experience, we feel comfortable in applying an exclusive TTE approach in similar future patients, provided that little to no doubt exists about TV anatomy.

This case report also highlights the arising therapeutic option of complete interventional repair of the atrioventricular (AV) valves in patients turned down for surgery, as both mitral[9] and TV repair[10] have separately proved to be viable and safe option with significant impact on QoL.

In conclusion, percutaneous repair of TV is a safe and valuable treatment option in high-risk symptomatic patients suffering from high-grade TR, can be part of a complete interventional approach for treatment of AV valves in selected patients, and can sometimes be even guided by TTE only.

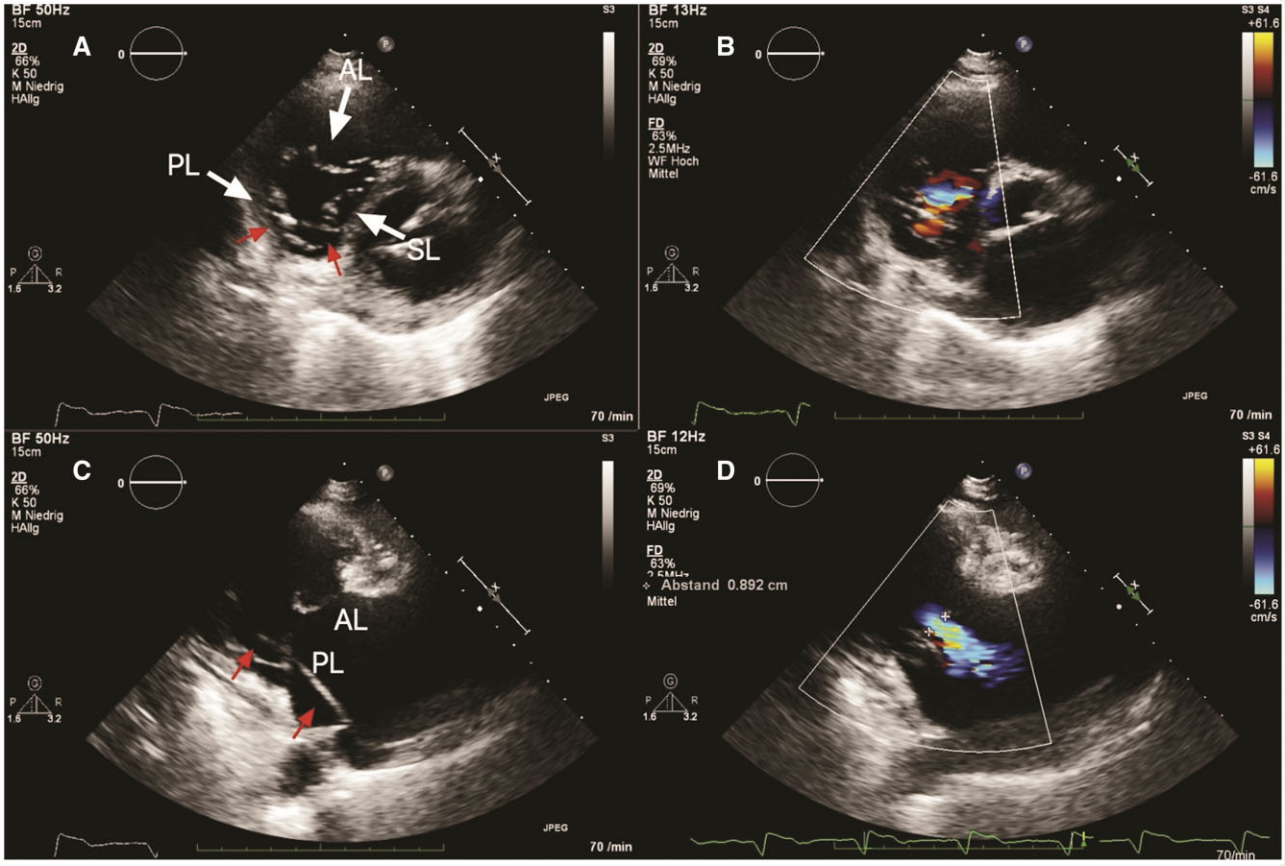

Figure 2 Transthoracic assessment of tricuspid valve anatomy depicting all leaflets and pacemaker lead position. (*A*) Transthoracic echocardiography parasternal short-axis view; red arrows → pacemaker lead; white arrows → tricuspid valve leaflets. AL, anterior leaflet; PL, posterior leaflet; SL, septal leaflet. (*B*) Colour flow Doppler of the same view. (*C*) Transthoracic echocardiography parasternal long-axis (right ventricular inflow) view; red arrows → pacemaker lead. (*D*) Colour flow Doppler of the same view.

Lead author biography

Alexandru Patrascu is a 37-year-old interventional cardiologist working as an attending doctor at the Helios Hospital in Pforzheim, Germany. After completing his training in general cardiology in Robert Bosch Hospital, Stuttgart, Germany, he was awarded the EAPCI grant and started his interventional career in Georges Pompidou, Paris, France. After a second fellowship in interventional and structural cardiology at the Andreas Gruentzig Heart Cath Laboratories, Zurich, Switzerland, he joined the interventional team of the academic hospital in Pforzheim. His research interests include the percutaneous treatment of valvular heart disease as well as the pathophysiology of the Tako-Tsubo syndrome.

Supplementary material

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

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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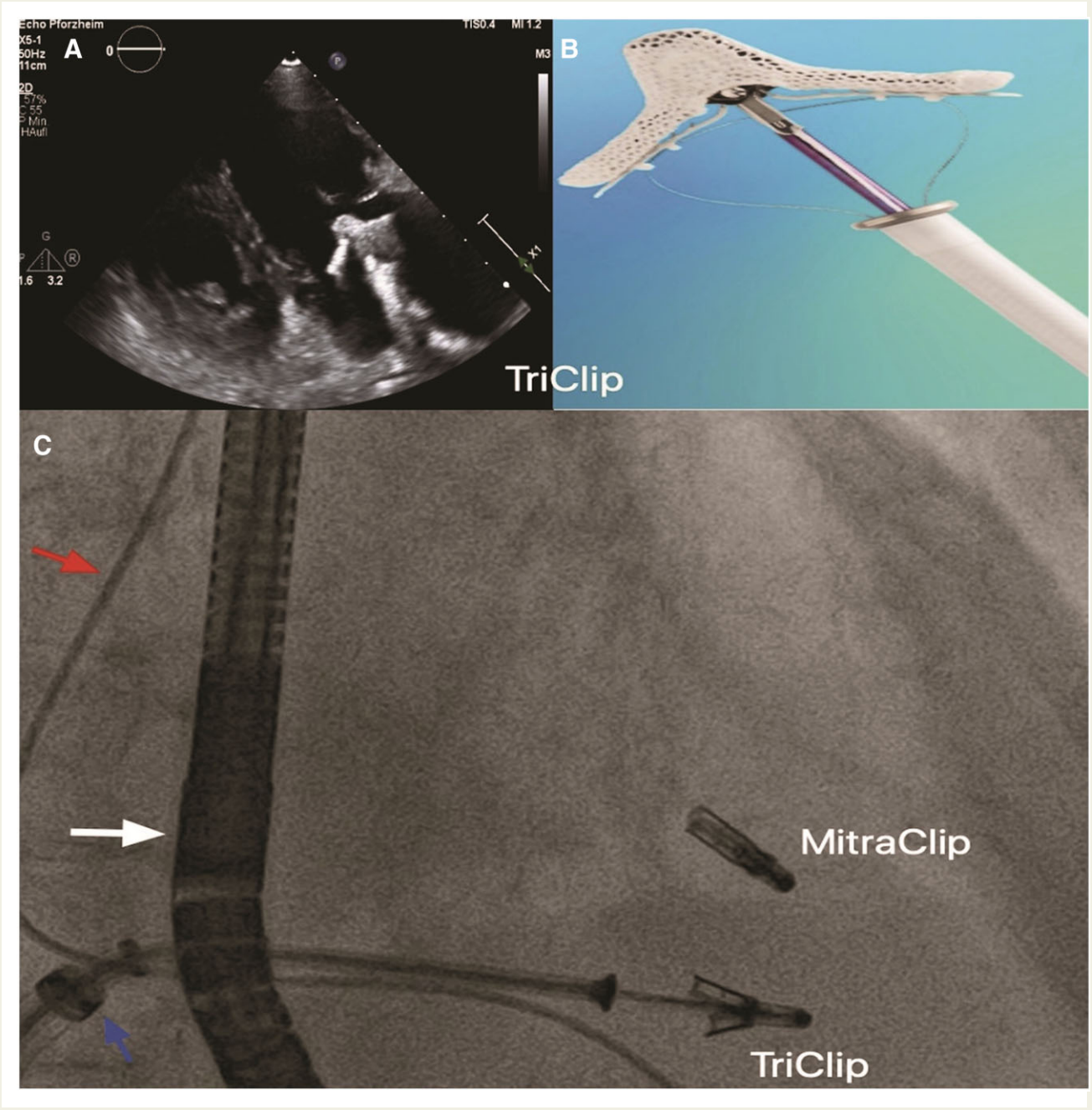

Figure 3 Combined transthoracic echocardiography and fluoroscopy procedural guidance showing advancement of TriClip system through tricuspid valve. (*A*) Transthoracic echocardiography parasternal long-axis right ventricular inflow view. (*B*) TriClip XT device (image courtesy of Abbott). (*C*) Fluoroscopy; red arrow → pacemaker lead; white arrow → transoesophageal echo probe; blue arrow → guide catheter.

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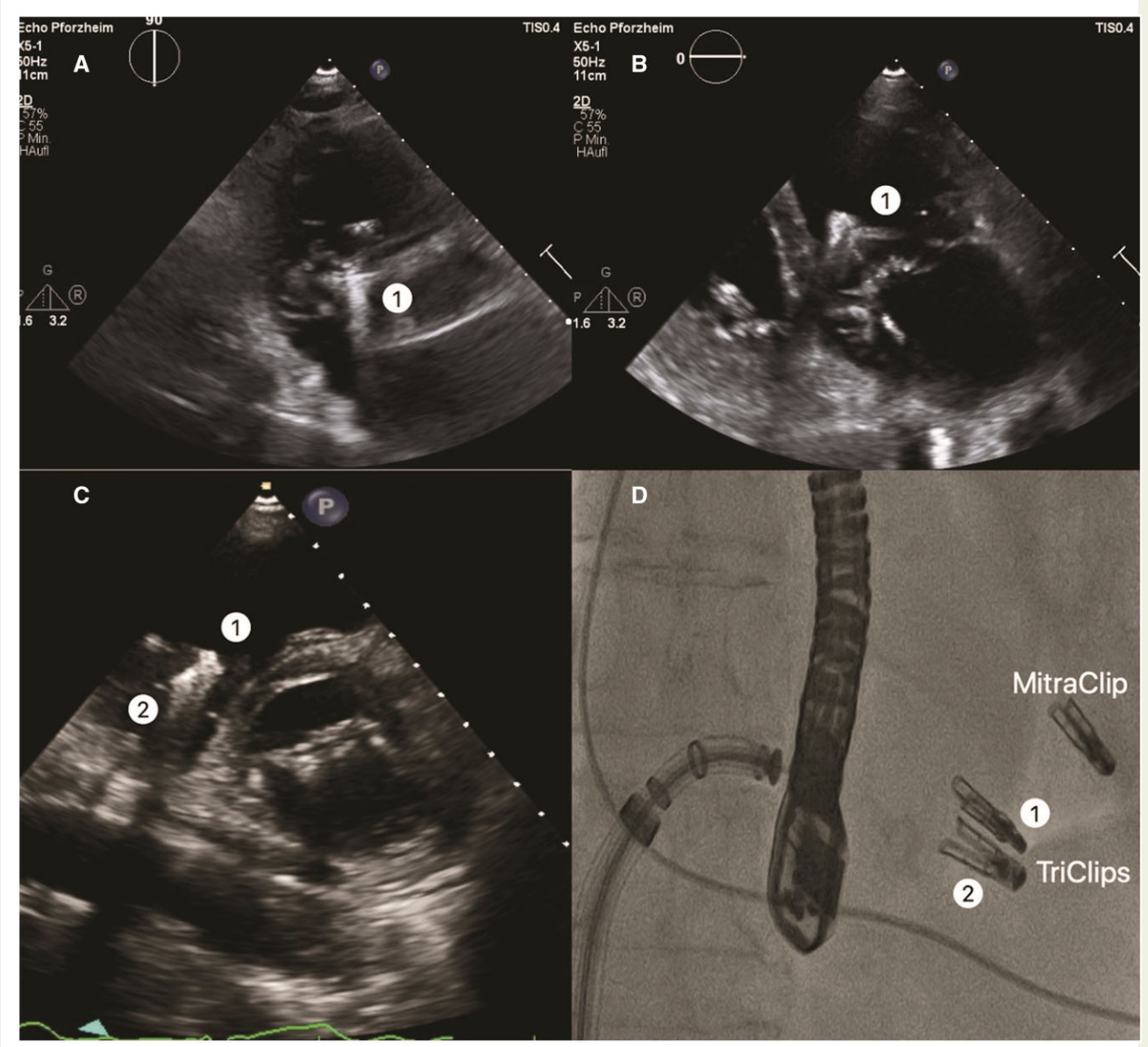

Figure 4 Periprocedural imaging of 1st clip during release and final position confirmation of both clips. (*A*) Transthoracic echocardiography parasternal short-axis view. (1) First TriClip between septal and anterior leaflet. (*B*) Transthoracic echocardiography parasternal long-axis right ventricular inflow view. (*C*) Transthoracic echocardiography parasternal short-axis view after implantation of two Clips. (2) Second TriClip between septal and posterior leaflets. (*D*) Fluoroscopic view of all clips, including MitraClip.

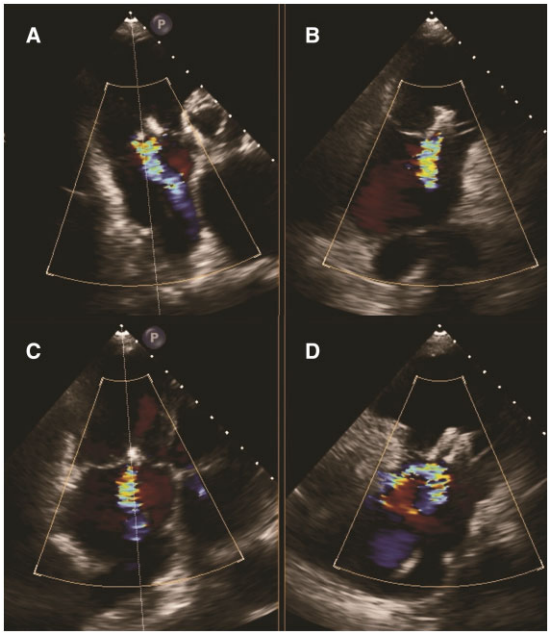

Figure 5 Thirty-day transthoracic echocardiography follow-up showing marked tricuspid regurgitation reduction (*A* and *B*) bi-plane colour flow parasternal views. (*C* and *D*) Four- and two-chamber views of the right heart.