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CASE REPORT
Other

Transcatheter valve-in-ring and para-ring vascular plug implantation for severe tricuspid regurgitation following annuloplasty ring failure: a case report

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Background Moderate or severe tricuspid regurgitation (TR) recurs in up to one-third of patients within 8 years of surgical annuloplasty repair. Reoperation often carries high risk with poor outcomes. Transcatheter valve-in-ring repair is an emerging alternative treatment. However, residual regurgitation is frequent and may necessitate further procedures.

Case summary A 52-year-old female was diagnosed with severe rheumatic valvular heart disease. The patient underwent mechanical aortic and mitral valve replacement. Additionally, tricuspid repair was performed using a semi-rigid annuloplasty ring (28 mm Edwards Physio Tricuspid). Within 2 years, the patient developed recurrent, isolated severe symptomatic TR, with progressive right ventricular dilatation. The patient was considered prohibitive risk for redo surgery and unsuitable for cardiac transplantation. She underwent percutaneous valve-in-ring transcatheter heart valve (THV) implantation using a 29 mm Sapien S3 (Edwards Lifesciences, CA, USA) valve. Persistent severe residual para-ring TR warranted a further procedure to deploy vascular plugs, significantly reducing the TR to a mild jet with symptomatic improvement.

Discussion Valve-in-ring THV implantation for failed surgical tricuspid annuloplasty repair is a rare procedure reserved for symptomatic patients at high or prohibitive risk for reoperation. Significant residual TR is a commonly encountered problem with incomplete annuloplasty rings following valve-in-ring procedures and may occur either intra-ring between the THV and the ring or para-ring. Implantation of vascular occlusion devices can be used to successfully treat residual TR at either location with good outcomes at 6-month follow-up. Further work is required to determine the longevity of this treatment.

Keywords Transcatheter tricuspid valve implantation • Tricuspid regurgitation • Valve-in-ring • Case report

ESC Curriculum 4.5 Tricuspid regurgitation • 2.2 Echocardiography

Learning points

- Implantation of an Edwards Sapien 3 valve into a Capentier-Edwards Physio tricuspid annuloplasty ring is technically feasible but para-ring regurgitation is frequently observed, particularly on the septal side.
- Para-ring regurgitation can be effectively treated by staged implantation of vascular plugs, with good short-term echocardiographic results.

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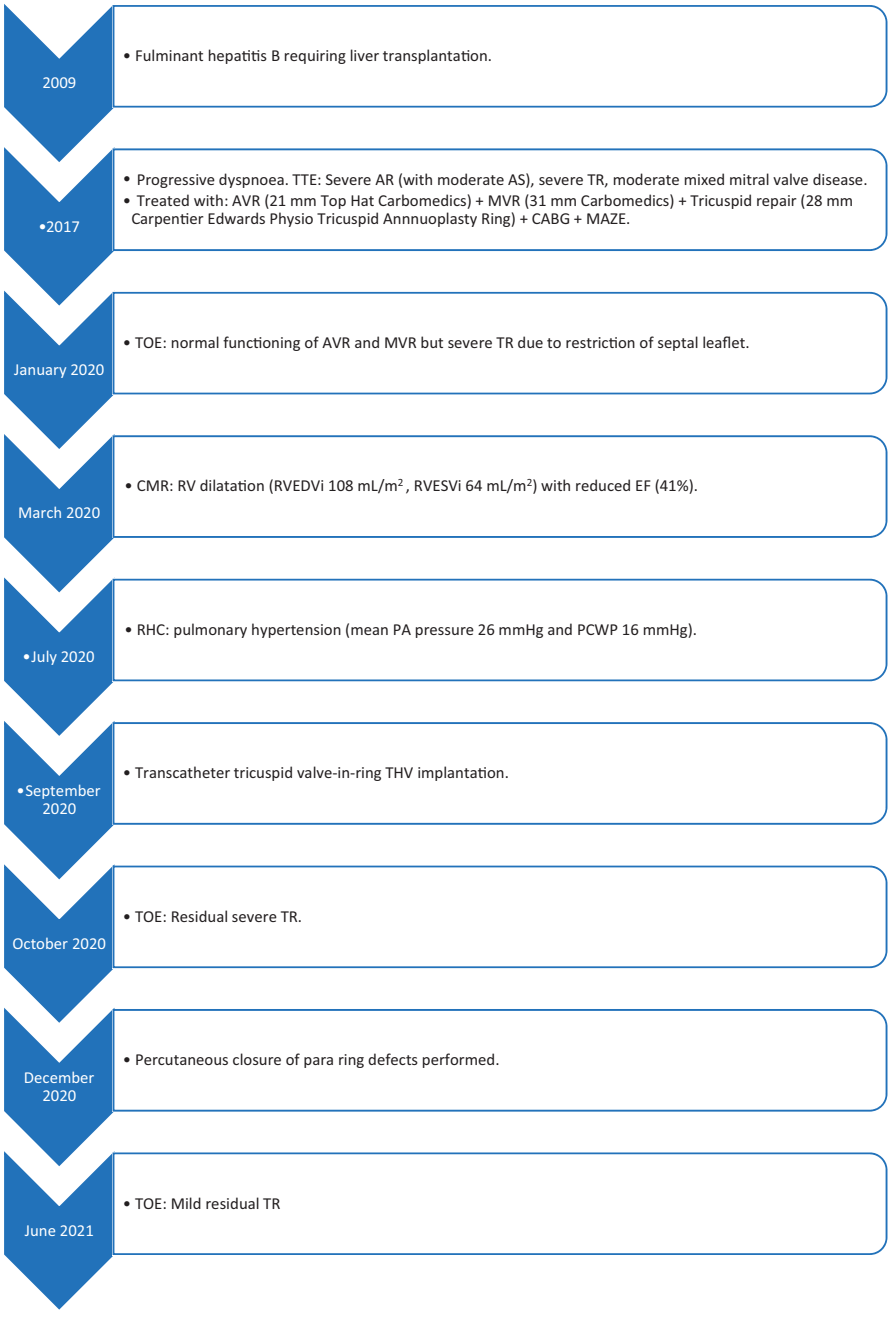
Introduction

Tricuspid regurgitation (TR) is observed in 80–90% of individuals undergoing echocardiography.[1] While mild TR is a benign finding, 16% have moderate or severe TR which carries a significantly worse prognosis, independent of right ventricular (RV) function or pulmonary hypertension.[2] Tricuspid surgery is the first-line treatment for such patients in the presence of symptoms, RV dysfunction, or if undergoing left-sided surgery.[3,4] Tricuspid repair using an annuloplasty ring is preferred to valve replacement in 90% of cases.[5] However, significant recurrence occurs in 25–33% within 5 years and 8 years, respectively.[6] Re-operation carries a high risk of mortality.[6] An emerging alternative treatment involves the implantation of a transcatheter heart valve (THV)[7–11] but is often complicated by significant residual regurgitation. This report details the implantation of a 29 mm THV in a new-to-market 28 mm semi-rigid incomplete annuloplasty ring (Edwards Physio Tricuspid), describing the mechanisms and percutaneous management of residual regurgitation.

Timeline

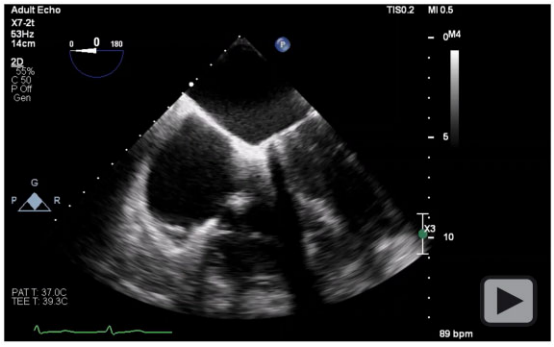


Case presentation

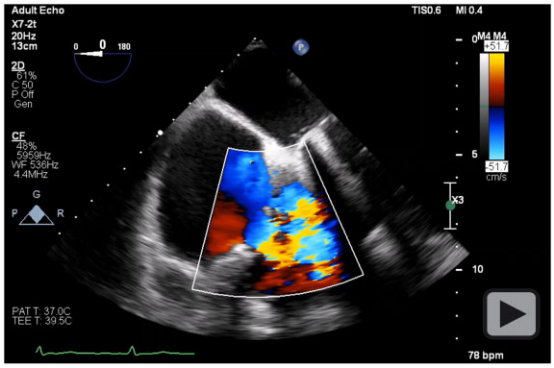
A 52-year-old female with a history of liver transplant in 2009, Stage 3 chronic kidney disease, ischaemic heart disease, and rheumatic valvular disease developed severe symptomatic aortic and mitral regurgitation.

In 2017, the patient underwent surgery to implant a mechanical aortic and mitral valve [21 mm Top Hat Carbomedics (LivaNova, London, UK) and 31 mm Carbomedics (LivaNova, London UK)], a 28 mm Edwards Physio Tricuspid annuloplasty ring (Edwards Lifesciences, CA, USA) and coronary grafting.

Three years later (January 2020), she developed progressive dyspnoea and peripheral oedema. Transoesophageal echocardiography (TEE) now identified severe trans- and para-ring TR (*Figure 1*, *Videos 1* and *2*). Cardiovascular magnetic resonance (CMR) (March 2020) showed RV dilatation [RV End-Diastolic Volume index (RVEDVi) 108 mL/m^2; RV End-Systolic Volume index (RVESVi) 64 mL/m^2] and reduced ejection fraction (EF: 41%) compared to 2017 (RVEDVi 72 mL/m^2; RVESVi 30 mL/m^2; EF 59%). Liver function tests such as bilirubin (9 µmol/L), alkaline phosphatase (95 units/L), alanine transaminase (15 units/L), and albumin (38 g/L) were within the normal range, however, hepatic veins were dilated on CMR suggesting elevated venous pressure as a result of TR. Right heart catheterization demonstrated mild pulmonary arterial (PA) hypertension (mean PA pressure 26 mmHg and pulmonary capillary wedge pressure 16 mmHg). The Heart Team agreed intervention was warranted but redo surgery was considered prohibitive risk (EuroSCORE II 5.75%) and cardiac transplantation was deemed unsuitable. Risk factors for adverse outcomes from further surgery or transplantation included previous cardiac surgery with patent grafts, liver transplant surgery, chronic kidney disease (estimated glomerular filtration rate 40 mL/min/1.73 m^2), obesity (body mass index 38kg/m^2), and immunosuppressant medication. Accordingly, a valve-in-ring THV procedure was performed 9 months later (September 2020) under conscious sedation via transfemoral venous access. A 29 mm Sapien S3 valve



Video 1 Two-dimensional transesophageal echocardiography demonstrating restriction of the septal leaflet.



Video 2 Two-dimensional colour Doppler transesophageal echocardiography demonstrating severe eccentric tricuspid regurgitation.

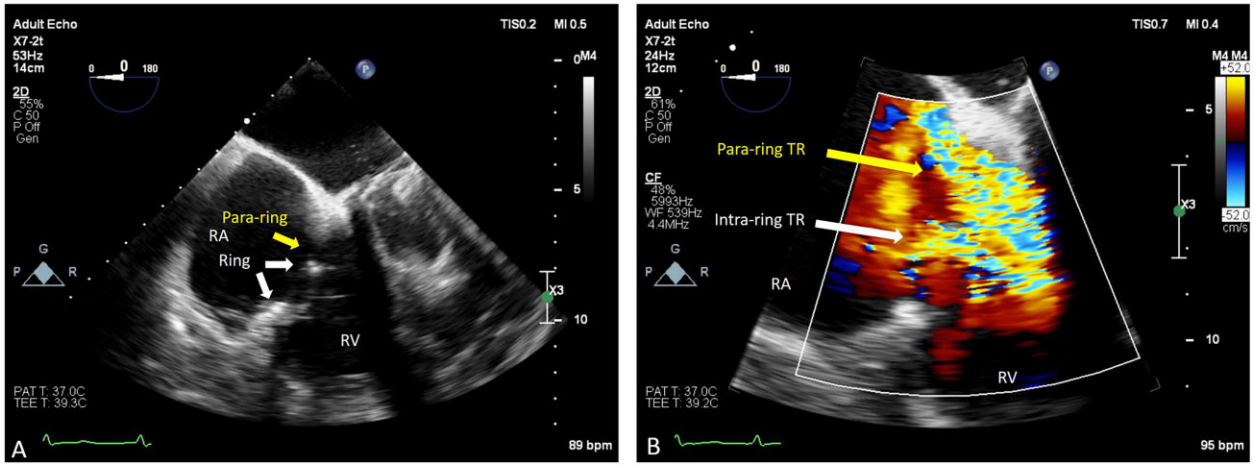


Figure 1 Two-dimensional transesophageal echocardiography demonstrating restriction of the septal leaflet (*A*) resulting in severe intra-ring and para-ring tricuspid regurgitation on colour Doppler (*B*).

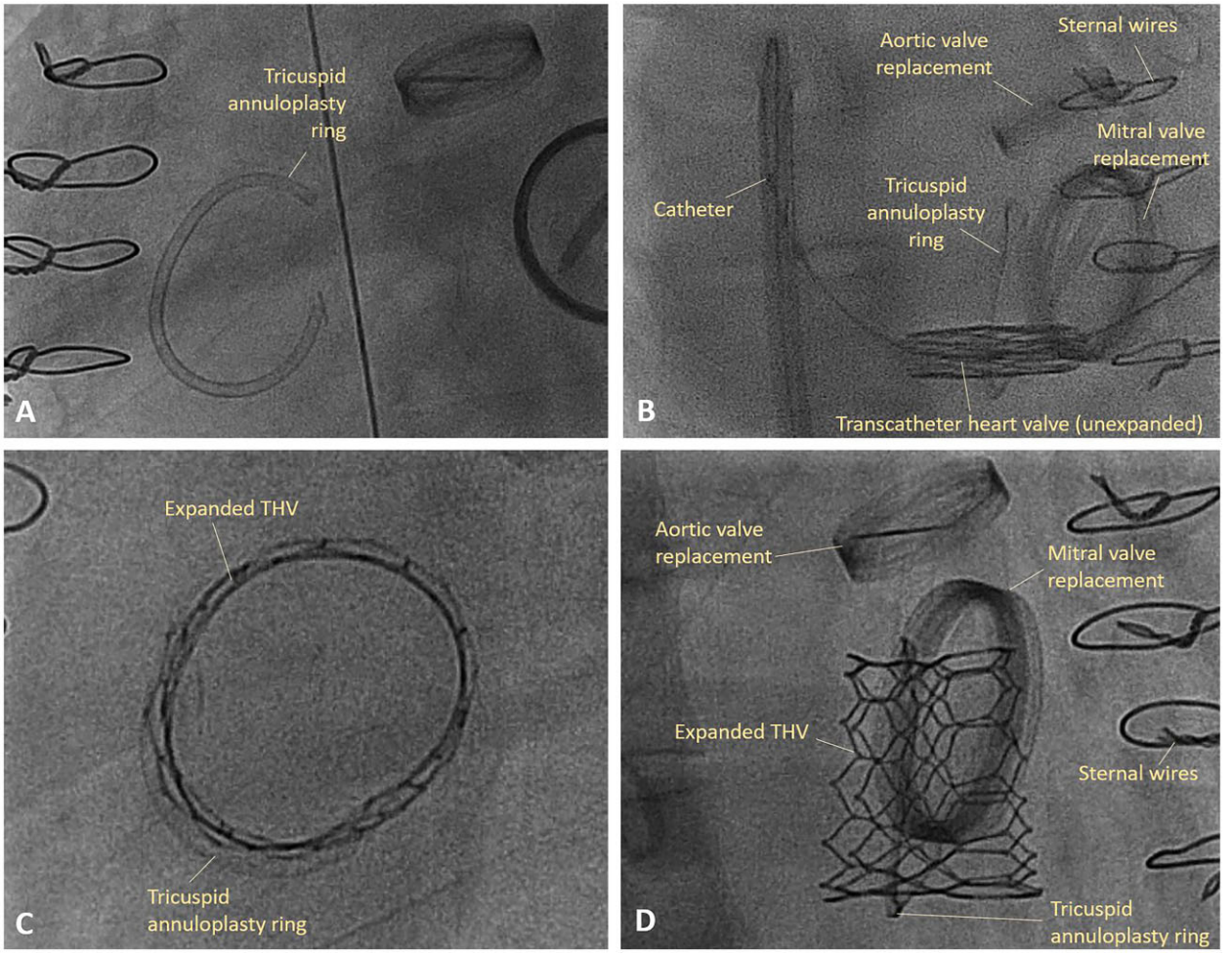


Figure 2 Fluoroscopy demonstrating the tricuspid annuloplasty ring (*A*), transcatheter heart valve positioning within the ring (*B*), and final expansion (*C* and *D*) in the left anterior oblique (*C*), and right anterior oblique (*D*) views.

(Edwards Lifesciences, CA, USA) was sized on minimum and maximum internal diameters of the annuloplasty ring (19.7 mm × 28.5 mm) determined from gated computed tomography (Supplementary material online, *Figure S1*) and delivered inside the annuloplasty ring over a super stiff Amplatz wire placed in the PA (*Figure 2A* and *B*). Transcatheter heart valve orientation on the deployment balloon was reversed compared to retrograde transcatheter aortic valve implantation. The wire and THV were well centred within the continuous part of the ring and away from the open section (*Figure 3A*) and the THV was slowly deployed without pacing, with 2 ml overfilling. Fluoroscopy confirmed good circumferential THV apposition within the ring (*Figure 2C* and *D*). However, at follow-up, the patient remained breathless and TEE subsequently confirmed severe residual para-ring TR arising from the septal side of the tricuspid annulus through a large (12 × 16 mm) defect (*Figure 4A* and *B*, *Video 3*, Supplementary material online, *Video S1*). In December 2020 (4 months after THV implantation), a subsequent procedure under general anaesthesia was undertaken to close the defect using vascular plugs (VPs). The defect was crossed with two 9-French guide sheaths via two separate punctures in the right femoral vein. Separate punctures were used to reduce interaction between the guide catheters and devices and to reduce bleeding at the access site. Two (20 and 22 mm) Amplatzer Vascular Plug II duct occluders (Abbot, IL, USA) were positioned and deployed under TEE and fluoroscopic guidance (*Figure 4C* and *D*) reducing the TR to a mild jet. There were no intraprocedural complications and in particular no development of atrioventricular (AV) node block. The patient was discharged the next day. The patient's symptoms improved with a reduction in ankle swelling and improvement in exertional dyspnoea. At 6-month follow-up, the patient was asymptomatic with no development of atrioventricular node block, endocarditis or haemolysis. A TEE 6 months post-device closure, confirmed no VP migration and mild

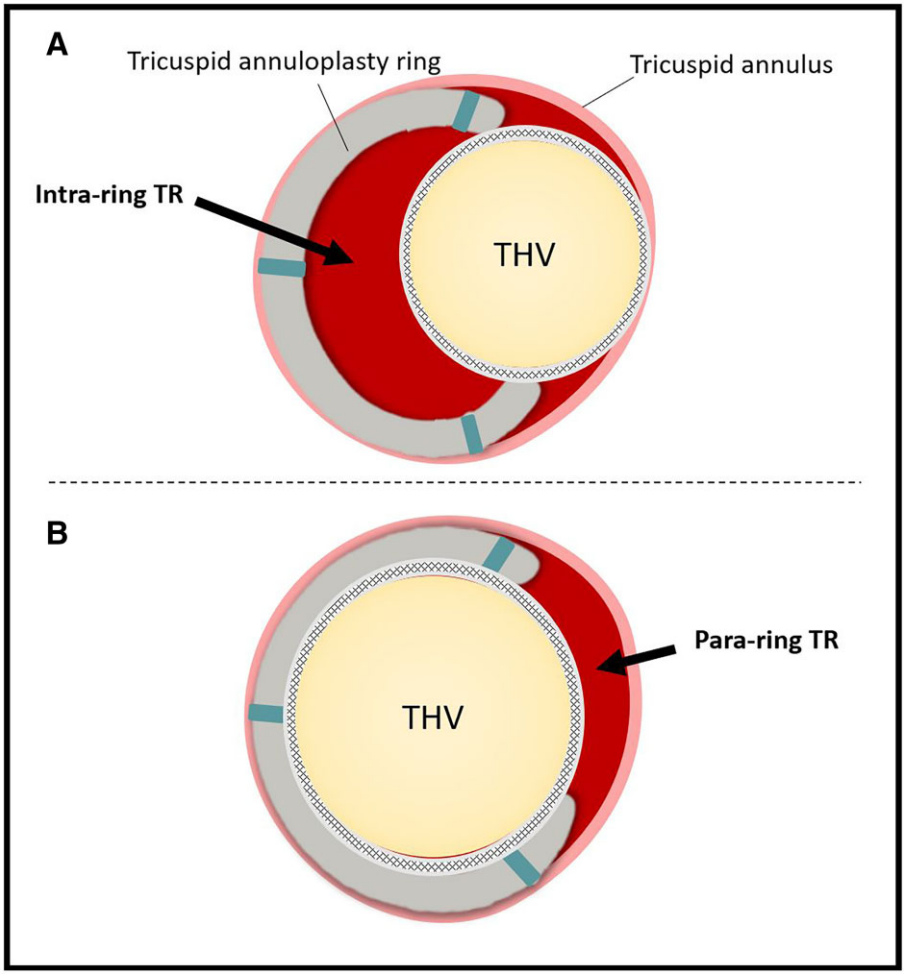


Figure 3 A demonstration of the malplacement (*A*) of the transcatheter heart valve which can occur if the balloon expandable valve becomes 'wedged' in the open segment of the annuloplasty ring. (*B*) Demonstrates the correct transcatheter heart valve positioning within the ring, with para-ring tricuspid regurgitation frequently a complication.

residual TR between the occlusion devices (*Figure 5*, Supplementary material online, *Videos S2* and *S3*). Right ventricular dilatation persisted but systolic function was improved and hepatic veins were less dilated compared with pre-intervention studies.

Discussion

Valve-in-ring THV implantation for failed surgical tricuspid annuloplasty repair is a rare procedure reserved for patients at high risk for reoperation. Case reports have demonstrated feasibility, but complications include leaflet entrapment (requiring further THV implantation[10]) distal wire perforation,[11] residual severe TR necessitating vascular occlusion devices,[7,8,10] or emergency open heart surgery.[12]

This case report uniquely describes outcomes following implantation of a 29 mm Sapien S3 valve within a 28 mm Edwards Physio Tricuspid ring. This ring has an elliptical morphology with an opening on the anteroseptal commissure. The open arms are flexible in the long axis (to preserve natural annular movement), while the remaining ring is rigid. Careful positioning of the THV on deployment is paramount to avoid 'wedging' in the open segment of the ring causing malplacement and severe intra-ring regurgitation (*Figure 3A*). Even with correct placement, severe residual para-ring TR between the THV, septum, and open part of the ring may persist (*Figures 3B* and *4A* and *B*). The largest registry of tricuspid valve-in-ring cases ($n = 20$) found that paravalvular leak (PVL) occurs in 75% of cases with 78% of PVLs located on the medial aspect of the ring, adjacent to the septum. Percutaneous device closure was required in 6/20 cases for moderate to severe regurgitation.[7] Data on the efficacy and outcomes of percutaneous treatment of tricuspid PVL following valve-in-ring procedures is limited. The benefit of PVL closure has to be weighed against the potential procedural complications, which include endocarditis, incomplete closure, THV embolization, and THV migration producing *transvalvular* regurgitation, heart block, and septal perforation. Nevertheless, several authors have published good outcomes following PVL closure,[7,8,10] typically using the Amplatzer Vascular Plug II or III or Amplatzer muscular ventricular septal defect occluder

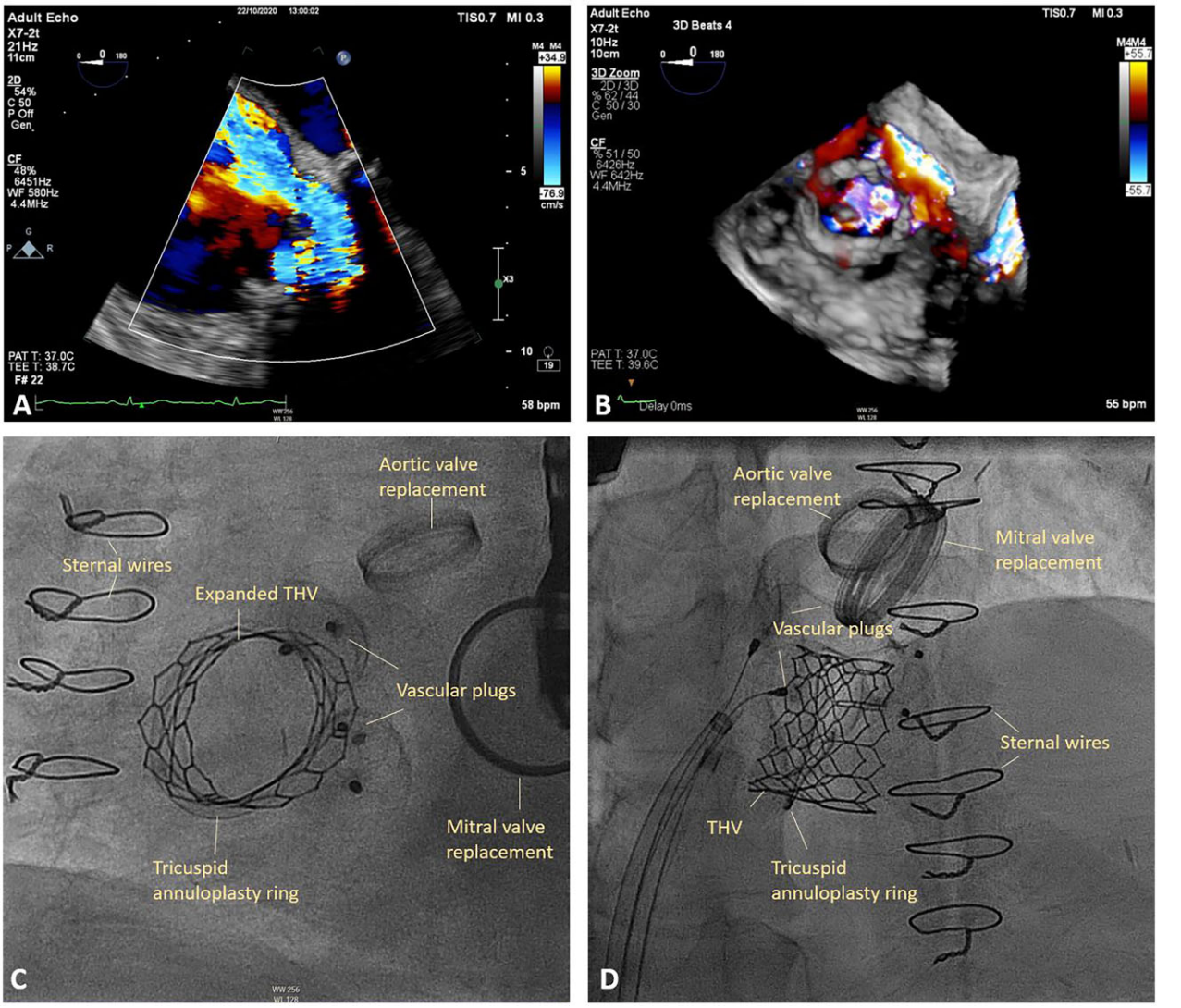
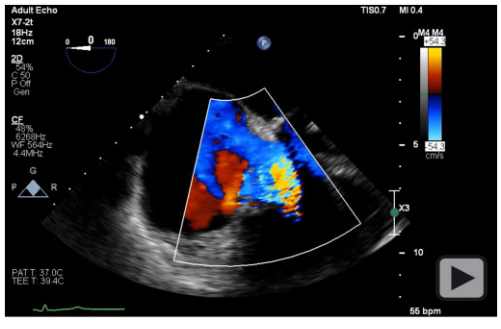


Figure 4 Colour Doppler demonstrating severe residual para-ring tricuspid regurgitation on two-dimensional (*A*) and three-dimensional (*B*) transesophageal echocardiography between the open section of the ring and septum. (*C* and *D*) Fluoroscopy showing the implantation of vascular plugs for severe residual para-ring tricuspid regurgitation in the left anterior oblique (*C*) and right anterior oblique (*D*) views.



Video 3 Two-dimensional colour Doppler transesophageal echocardiography demonstrating severe residual tricuspid regurgitation following implantation of the transcatheter heart valve.

(Abbot, IL, USA). As in our case, the PVL may necessitate rather large devices but appear to be well anchored between the THV and septal tricuspid annulus. Despite implantation against the septum and proximity to the AV node, there have been no reports to date of subsequent conduction disturbance. Heart block would be expected to occur during or early post-procedure and it is prudent to maintain continuous heart rhythm monitoring overnight. Although septal perforation is a theoretical risk, to date, no instances have been reported in the large published series and case reports.

As this case demonstrates, vascular occlusion devices can be used to successfully treat even large residual para-ring defects with good echocardiographic and clinical outcomes at 6-month follow-up. It is currently unclear whether this should be performed at the time of valve implantation or as a staged procedure. Further work is required to assess long-term outcomes from this treatment.

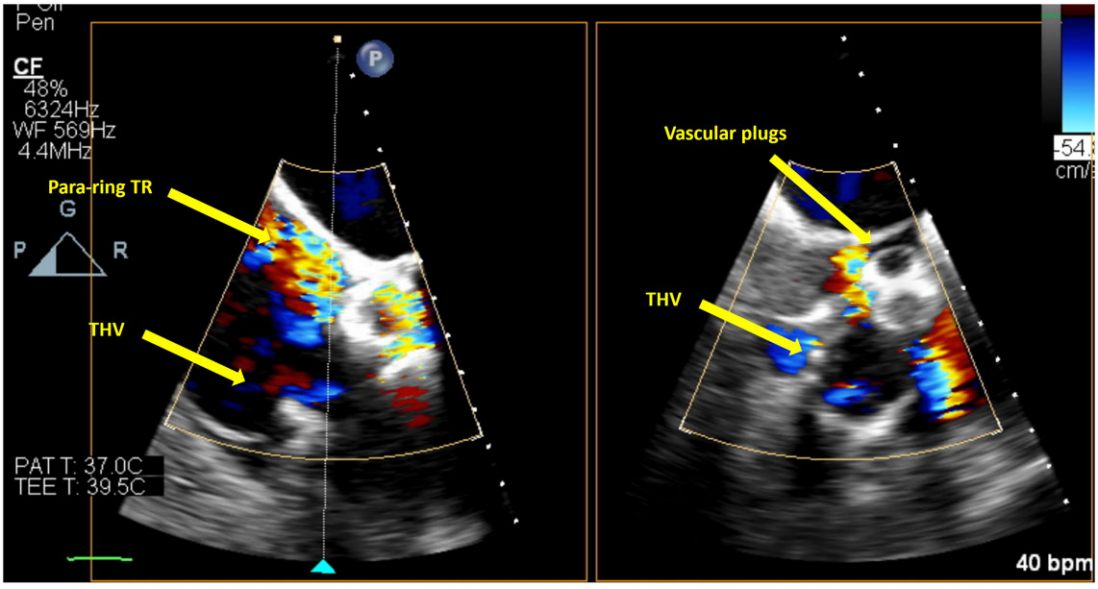


Figure 5 Biplane transesophageal echocardiography demonstrating mild residual tricuspid regurgitation on the septal aspect of the tricuspid annulus.

Lead author biography

Dr Harish Sharma is a Cardiology registrar and PhD research fellow with an interest in structural intervention and cardiac imaging.

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: S.N.D. is a proctor for Edwards LifeSciences. None of the other authors have any disclosures.

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