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CASE REPORT
Structural intervention

Trans-oesophageal echocardiography-guided implantation of a cardiac resynchronization therapy pacemaker and successful ablation of the atrioventricular node after TriClip: case report

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Background Edge-to-edge intervention is the most common trans-catheter procedure performed for isolated severe tricuspid regurgitation in high-surgical-risk patients. However, it creates an obstacle for future right ventricular (RV) procedures such as implantation of cardiac implantable electronic devices (CIEDs). Reports of the management of CIED implantation after tricuspid edge-to-edge therapy are scarce.

Case summary A 76-year-old woman suffered from severe tricuspid regurgitation with New York Heart Association three symptoms despite optimal medical therapy. After a thorough evaluation, the heart team recommended the TriClip procedure as the treatment of choice. However, 12 months after a successful TriClip procedure, rapid atrial fibrillation needed to be addressed with CIED implantation and atrioventricular (AV) node ablation. Pre-procedural planning included the intended posterior location of the CIED to avoid interference with the implanted clip and future AV node ablation. With an additional left ventricular lead positioned anteriorly to the RV lead, the posterior position of the RV lead was secured. Under peri-procedural trans-oesophageal echocardiography (TEE), the planned procedures were performed successfully.

Discussion A blind manoeuvring of the RV lead may damage the edge-to-edge tricuspid device. In addition, friction due to an overly close contract between the RV lead and the edge-to-edge device may damage the RV lead. A successful and safe CIED implantation and atrioventricular node ablation can be performed after tricuspid edge-to-edge therapy with careful planning and its precise execution under TEE surveillance.

Keywords TriClip • Cardiac implantable electronic device • Cardiac resynchronisation therapy • Ablation • Tricuspid regurgitation • Atrial fibrillation • Case report

ESC curriculum 2.2 Echocardiography • 4.5 Tricuspid regurgitation • 5.3 Atrial fibrillation • 5.9 Pacemakers

Learning points

- Tricuspid edge-to-edge therapy may create an obstacle for future cardiac implantable electronic device (CIED) interventions.
- Blind manoeuvring of the pacemaker lead may damage the implanted tricuspid edge-to-edge device.
- Safe CIED implantation can be performed under echocardiography guidance.

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Introduction

Severe tricuspid regurgitation is not rare problem, with a reported 4% prevalence in the elderly population.[1] Most commonly, symptoms related to severe tricuspid regurgitation develop slowly over several years, and at the time of diagnosis, patients often suffer from symptoms such as severe oedema, renal and liver failure, ascites, malnutrition, and exercise intolerance.[2,3] Systemic manifestations along with other comorbidities increase the surgical risk, and until recently, patients were often declined invasive treatment.[2,4]

New trans-catheter treatment options have changed the outlook for carefully selected patients with severe tricuspid regurgitation.[4] The most common intervention is leaflet approximation with the edge-to-edge technique.[5] A significant reduction in tricuspid regurgitation can be achieved in 72–78% of patients, and the majority of patients have symptom improvement after the procedure.[6,7] However, placing one or more clips between the tricuspid leaflets creates a valvular obstacle that might obstruct the route where the right ventricle (RV) or pulmonary arteries need be reached for future interventions, such as right heart catheterization, endomyocardial biopsies, or cardiac implantable electronic devices (CIEDs) implantation.

There is also a concern that RV lead manipulation may disturb or even damage the implanted tricuspid edge-to-edge device and thus worsen tricuspid regurgitation. Reports of CIED implantation after tricuspid edge-to-edge procedures are scarce, and they emphasize echocardiography-guided procedures to avoid dismal results.[8,9]

Summary figure

Time	Events
3 months before TEER	Patient was evaluated for torrential secondary tricuspid regurgitation at HUS. Blood pressure 93/57 mmHg. LVEF 45-50%.
1 month before TEER	After OMT patient has still NYHA 3 symptoms and ERO 0.76cm^2. ProBNP 3722 ng/l. Heart Team decision: TriClip.
TEER procedure	1 TriClip implanted successfully. ERO 0.31cm^2.
1 month after TEER	NYHA 1, ERO 0.20cm^2. ProBNP 2239 ng/l. Blood pressure 110/78 mmHg.
3 months after TEER	NYHA 1, ERO 0.23cm^2. ProBNP 3100 ng/l.
12 months after TEER	NYHA 3, ERO 0.15cm^2. ProBNP 5775 ng/l. Holter with tachycardic atrial fibrillation.
15 months after TEER	OMT (bisoprolofumarate 20 mg DD and digoxin 0.625 mg every other day) insufficient for tachycardic atrial fibrillation. LVEF 45-50%.
17 months after TEER	Pacemaker implantation under TEE guidance.
19 months after TEER	AV node ablation.
22 months after TEER	Resolution of tachycardia-related symptoms. LVEF 50%. Blood pressure 124/80 mmHg. Tricuspid ER0 0.20 cm^2. ProBNP 3373 ng/l.

TEER; tricuspid edge-to-edge repair; HUS, Helsinki University Hospital, tertiary center; proBNP, pro-brain natriuretic protein; OMT, optimal medical therapy; NYHA, New York Heart Association grading of symptoms; ERO, effective regurgitant orifice; TEE, trans-oesophageal echocardiography

Case presentation

A 76-year-old woman was referred to our tertiary unit (Heart and Lung Center, Helsinki University Hospital, Finland) for treatment of tricuspid regurgitation trans-catheter in March 2020. The patient had severe exercise dyspnoea with a walking distance of 10 m (NYHA Class 3). Patient had enlarged and pulsating liver, elevated vena jugularis pressure along with severe pitting oedema and ascites as clinical sings of severe tricuspid regurgitation. The atrial functional tricuspid regurgitation was considered massive with an antero-septal location (*Figure 1*). The patient's other comorbidities included permanent atrial fibrillation, previous cerebral infarction, pleural fibrosis, and asthma. Other aetiologies for the patient's symptoms were excluded with multiple testing.

Hospital's Heart Team concluded that the patient was at an increased surgical risk. The TriClip procedure was the treatment of choice as intensive medical therapy had not alleviated the symptoms. The TriClip procedure was performed in January 2021 with one clip positioned antero-septally. There was good anatomical and symptomatic relief with reduction of the tricuspid regurgitation from massive to mild and NYHA class improved from Class 3 to Class 2 and Class 1 after discharge and 1- and 3-month post-procedure, respectively (*Figure 1*). The results of the 6-min walking test (6MWT) improved from 210 to 402 m during the follow-up. However, at the 12 months of visit, the patient complained of recurrence of exercise dyspnoea with NYHA Class 3. Since the anatomical result of the TriClip procedure was adequate with an ERO of 0.15 cm^2 and mean gradient of 2 mmHg, other aetiologies for symptoms were sought.

Holter monitoring revealed rapid atrial fibrillation, which did not respond to medical treatment. As the next treatment option, CIED implantation combined with atrioventricular (AV) node ablation was considered. As the TriClip was located in the middle of the tricuspid valve, the planned RV lead would either run antero-superior or infero-posterior to the implanted clip. The antero-superior course would be unfavourable because of the planned ablation near the antero-septal commissure. Therefore, it was important to secure the posterior course of the RV lead. As the left ventricular (LV) function was borderline (LV ejection fraction 45–50%), there was a concern of causing RV pacing-induced LV dyssynchrony and further decline of LV function.[10] Therefore, implantation of a biventricular pacemaker with both RV and LV leads was chosen as the optimal treatment.

Pacemaker implantation was performed under general anaesthesia with trans-oesophageal echocardiography (TEE) guidance in June 2022. The key TEE views were trans-gastric 40 degree *en face* and 3D views. During the implantation, the RV lead initially took an antero-superior course in relation to the implanted clip. The course was corrected to a postero-inferior course with the aid of TEE (*Figure 2*). After RV lead implantation, the LV lead was implanted via the coronary sinus to a lateral coronary vein. Near the tricuspid valve orifice, the LV lead's course was positioned anterior to the RV lead (*Figure 3*). The procedure was completed uneventfully, and at the follow-up visits, the pacemaker functioned flawlessly.

In August 2022, ablation of the AV node was performed successfully via the right femoral vein using an irrigated radiofrequency catheter (*Figure 3*). Tachycardia-related symptoms were resolved with the procedure. Echocardiography showed a good, unchanged TriClip result.

Discussion

As the elderly population continues to grow, there will be an increasing number of patients with a need for CIED implantations in the future.[11] As trans-catheter tricuspid interventions increase in number especially in septuagenarians and octogenarians, the need for CIED after the tricuspid edge-to-edge procedure will be more frequent. In such cases, the RV lead can damage the implanted clip or create a new regurgitation by compressing the valve elsewhere. In addition, the insulation of the pacemaker lead could be damaged by friction caused by close contact with the clip.

Other pacing methods can be considered to avoid the harmful effects of the RV lead. Epicardial leads are not a feasible alternative for these high-risk patients, but LV pacing only via the coronary sinus or leadless RV pacing could offer an alternative for patients with normal systolic LV function.[12,13] Bundle of His pacing and left bundle branch area pacing (LBBAP) are appealing novel techniques to stimulate the heart providing good left ventricular synchrony and thus offering an alternative to cardiac resynchronization therapy pacemaker (CRT-P).[14]

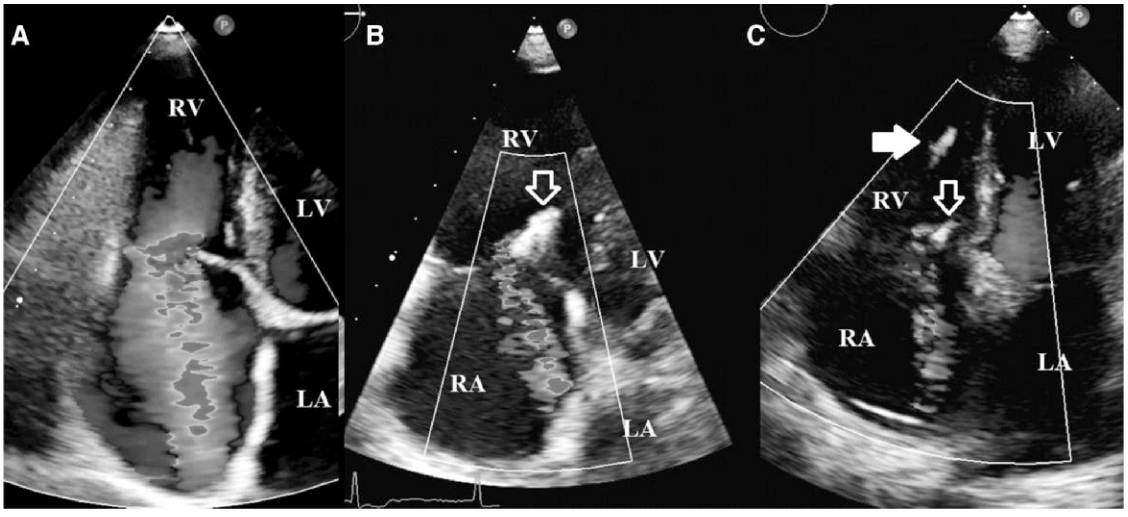

Figure 1 Tricuspid regurgitation. The image on the left side (*A*) demonstrates the patient's massive tricuspid regurgitation prior to TriClip treatment. After the TriClip procedure (Image *B*) regurgitation was reduced; the open arrow indicates the TriClip. The image on the right side (*C*) is taken after cardiac resynchronization therapy pacemaker (CRT) implantation and shows unchanged mild tricuspid regurgitation, with the TriClip in unchanged position. The solid arrow points to the right ventricular lead. LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

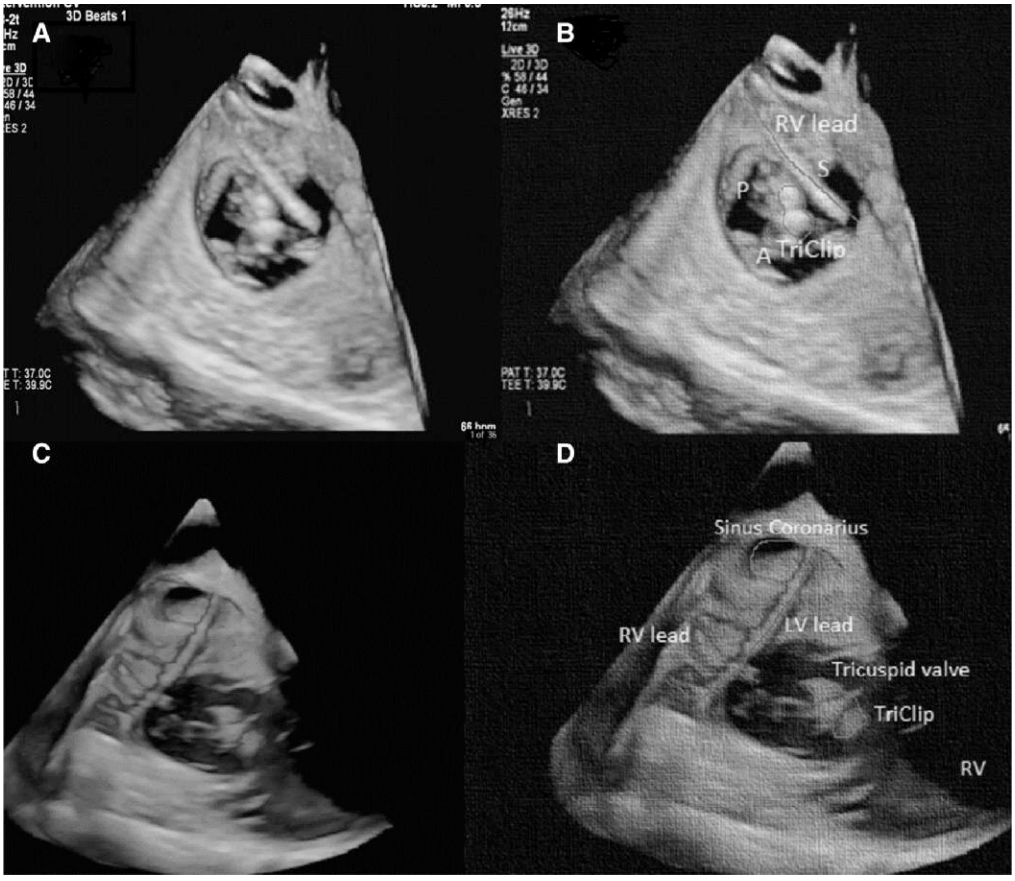

Figure 2 3D echocardiography during pacemaker implantation (trans-gastric and deep oesophageal 3D images). Images *A* and *B* present the initial situation with the right ventricular lead spontaneously taking an anterior path in trans-oesophageal 3D images. As this would interfere with the previously implanted TriClip, and would complicate later AV node ablation, the right ventricular lead was repositioned in the postero-septal commissure. The left ventricular lead was advanced via the coronary sinus to its final position (trans-oesophageal 3D images *C* and *D*). As the left ventricular lead was positioned anterior to the right ventricular lead, the left ventricular lead pushed the right ventricular lead closer to the postero-septal commissure, securing the right ventricular lead's position.

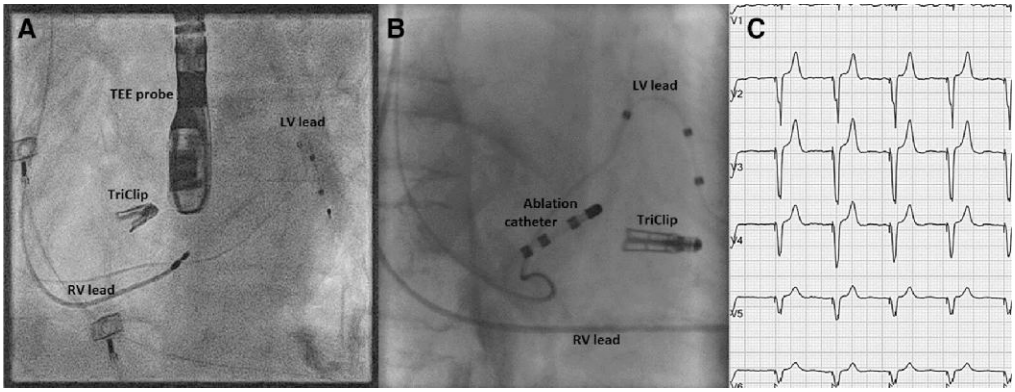

Figure 3 Fluoroscopy during pacemaker insertion and electrocardiogram (ECG) after electrophysiology treatment. Image *A* shows the relationships between the pacemaker leads and the TriClip in the left anterior oblique fluoroscopy image taken during the pacemaker implantation. In Image *B*, the position of the ablation catheter is shown in relation to the TriClip and pacemaker leads. Image *C* shows patient's ECG (25 mm/s) taken immediately after atrioventricular node ablation showing simultaneous right ventricular and left ventricular pacing with a QRS duration of 122 ms.

However, LBBAP requires implantation of a lead through the tricuspid valve, and ablation of the AV node may result in increased capture thresholds for bundle of His pacing.

Our patient was scheduled for AV node ablation, and therefore, she would be permanently pacemaker-dependent. Using LV lead alone currently presents an off-label use and may not offer secure enough pacing long term. Leadless pacing was considered and rejected due to possible deleterious effects of RV pacing on LV function. Moreover, steering the delivery catheter through the neo-orifice may have been a challenge.[8] Left bundle branch area pacing was considered as an option, but was not supported by the current guidelines.[15]

For our patient, CRT-P including a trans-valvular RV lead was considered the best option prior to AV node ablation. Careful procedural planning and precise execution of the plan with TEE guidance were of crucial importance for the safety and success of the procedures in this case. A blind RV lead placement would have resulted in antero-superior positioning of the lead that would press the implanted TriClip device and interfere with the planned AV node ablation. Instead, the RV lead was repositioned posteriorly under TEE guidance. Furthermore, placing the LV lead anteriorly to the RV lead offered an additional advantage—the horizontally running LV lead secures the posterior RV lead position, so future anterior dislodgement of the RV lead with possible friction between the lead and TriClip device is avoided.

Our case is consistent with previous case reports indicating that CIED implantation is feasible and safe after the TriClip procedure when performed under echocardiography guidance. Detailing our experience may be helpful to others with similar cases.

Lead author biography

Suvi Tuohinen is imaging cardiologist at Heart and Lung Center in Helsinki University Hospital (Finland) with responsibility of trans-catheter tricuspid interventions.

Supplementary material

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

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance. The patient has given a written consent for the publication according to COPE guidelines.

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Data availability

The data underlying this article are available in the article and in its online supplementary material.

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