Implantation of right ventricular endocardial pacing lead via paravalvular leak and subsequent paravalvular leak closure in a patient with mechanical tricuspid valve

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Introduction

Transvalvular right ventricular (RV) endocardial pacing is contraindicated in patients with mechanical tricuspid valve (TV) owing to the mutual damage between prosthetic TV and pacing lead. For these patients, implantation of epicardial lead through surgery or left ventricular (LV) lead via coronary sinus (CS) have been reported.[1,2] In this report, we present a successful implantation of RV endocardial lead via tricuspid paravalvular leak (PVL) and subsequent PVL closure in a rare case with mechanical TV, mechanical mitral valve (MV), and CS ostium on the ventricular side of mechanical TV.

Case report

A 72-year-old woman was transferred to our hospital owing to Adams-Stokes attack. Cardiac arrest of 15 seconds was recorded by electrocardiogram monitoring. She had undergone 3 open heart surgeries for rheumatic heart disease. A failed mechanical MV replacement was carried out 28 years ago and was re-performed the next year. The third surgery was a mechanical TV replacement 11 years ago. Atrial fibrillation had been documented for 20 years. She had recurrent lightheadedness and shortness of breath for 1 year. Before the procedure, the body temperature, leukocyte count, and the level of C-reactive protein were within the normal range. Repeated cardiac pauses were documented in 24-hour Holter monitoring (Figure 1A). Transthoracic echocardiogram (TTE) revealed well-functioning mechanical TV and MV, normal LV diameter with LV ejection fraction of 61%, enlarged left atrium (LA) and inferior vena cava, significantly dilated right atrium (RA), and an unusual suture position of prosthetic TV sewing ring with the CS ostium on the ventricular side of the mechanical TV (Figure 1B). In particular, a 6-mm tricuspid paravalvular defect in the posterior portion of the mechanical TV sewing ring with moderate-to-severe regurgitation was demonstrated in subxiphoid 4-chamber view (Figure 1C). Pulmonary artery systolic pressure was estimated to be 42 mm Hg.

Owing to Adams-Stokes attack, recurrent lightheadedness, and repeated cardiac pauses, permanent pacing was

KEY TEACHING POINTS

- Transvenous right ventricular (RV) endocardial pacing is contraindicated in patients with mechanical tricuspid valve (TV). The appropriate implantation approach needs to be considered prior to the procedure.
- In the rare case with mechanical TV and coronary sinus ostium on the ventricular side of the TV, the tricuspid paravalvular leak (PVL) provides an unusual but feasible approach for RV endocardial pacing.
- Implantation of RV lead via tricuspid PVL and simultaneous percutaneous PVL closure is feasible and safe. The appropriate occlusion device should be selected to reduce the mechanical stress on the pacing lead.

KEYWORDS Mechanical tricuspid valve; Paravalvular leak; Permanent pacing; Right ventricular pacing; Tricuspid valve replacement
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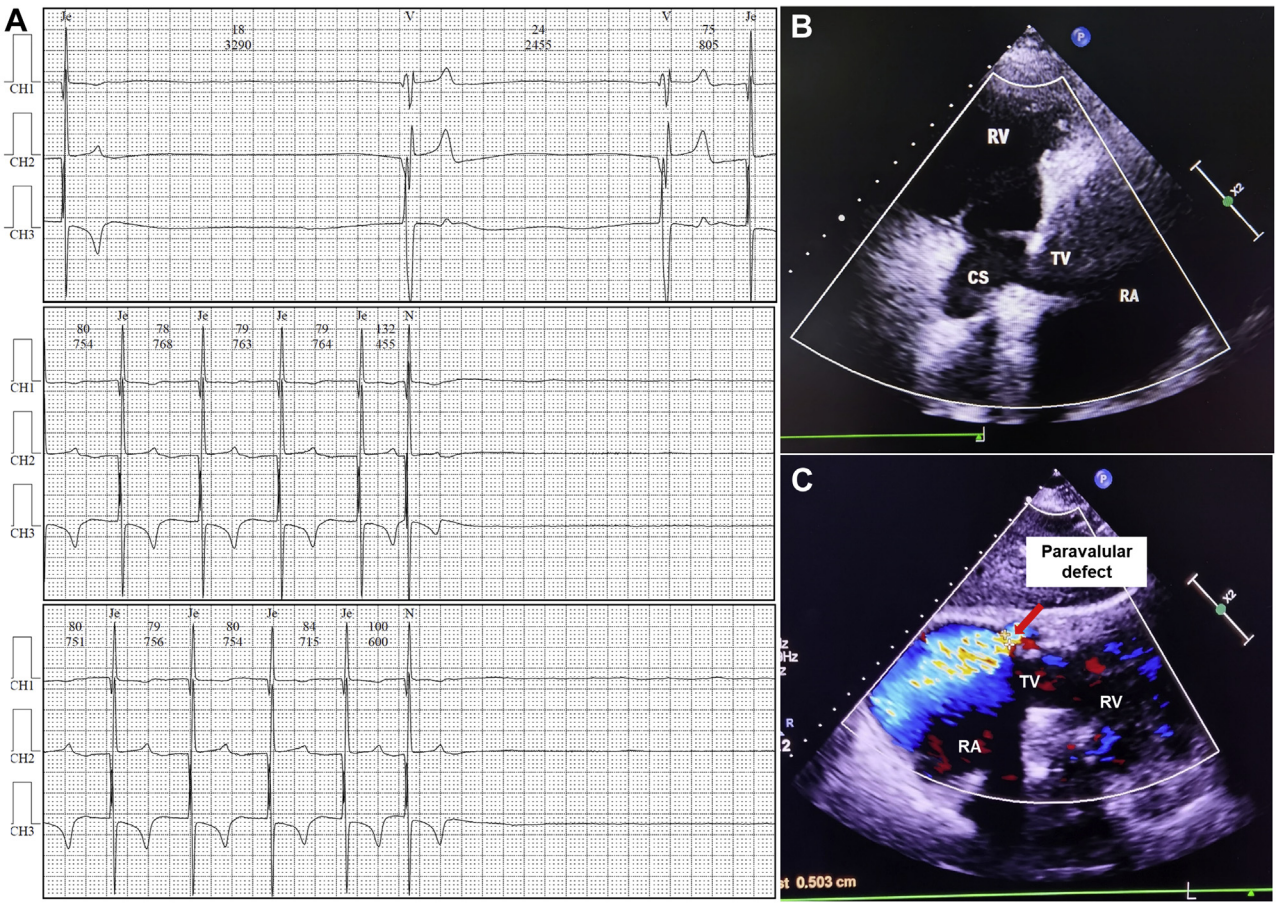

Figure 1 Dynamic electrocardiogram and transthoracic echocardiogram before the procedure. **A:** Repeated cardiac pauses were recorded by 24-hour Holter monitoring. **B:** An unusual suture position of prosthetic tricuspid sewing ring with the posterior portion attached to the ostium of the coronary sinus (CS), and CS ostium on the ventricular side of mechanical tricuspid valve (TV). **C:** A tricuspid paravalvular defect (*arrow*) and moderate-to-severe regurgitation with the area of regurgitant color flow approximately 2.3 cm^2 in subxiphoid 4-chamber view. RA = right atrium; RV = right ventricle.

highly recommended for this patient, and implantation of RV lead via the tricuspid PVL was chosen as the most feasible approach. Subsequent percutaneous closure of the PVL was also recommended because of moderate-to-severe paravalvular regurgitation and signs of right heart failure.

Under local anesthesia, the access from the right subclavian vein to the pulmonary artery was established via PVL (Figure 2A). Mean pulmonary arterial pressure, RA pressure, and pulmonary wedge pressure measured by right cardiac catheterization were 24 mm Hg, 12 mm Hg, and 11 mm Hg, respectively. Then 2 pacing leads (SelectSecure 3830; Medtronic Inc, Minneapolis, MN), which were delivered through 2 fixed-curve sheaths (C315His; Medtronic Inc), were screwed into the interventricular septum; 1 of the leads was used as a backup (Figure 2B). The pacing thresholds of the 2 leads were 0.7 V / 0.4 ms and 0.6 V / 0.4 ms, with lead impedance of 490 Ω and 480 Ω and R-wave amplitudes of 21 mV and 22.3 mV, respectively. Next, a 20 mm vascular plug (Shanghai Shape Memory Alloy Co, Ltd, Shanghai, China) with the delivery system was positioned and deployed at the paravalvular leak via the guidewire (Figure 2C). The TTE monitor showed only trivial residual regurgitation post device implantation and no influence on mechanical TV function. Fluoroscopic imaging showed appropriate tension of pacing leads. The pacing parameters of the 2 pacing leads were stable. After that, the occlusion device was released under fluoroscopy. A dual-chamber rate-adaptive pacemaker (model G70A1; Vitatron Holding B.V., Arnhem, Netherlands) was implanted with the 2 pacing leads inserted to the RA IS-1 and RV IS-1 connector port, respectively, and programed to ventricular rate adaptive (VVIR) pacing mode (Figure 2D). Postprocedure, pacing electrocardiograms of the 2 pacing leads were recorded (Figure 3A). Before discharge, TTE demonstrated reduced size of RA (from 80 × 60 mm to 74 × 58 mm) and LA (from 53 mm to 48 mm) with only trivial tricuspid paravalvular regurgitation. Warfarin, diuretics, and digoxin were prescribed at discharge.

At 3-month follow-up, the pacing parameters of the 2 pacing leads were stable. Chest radiography showed satisfactory tension of the 2 pacing leads (Figure 3B). TTE demonstrated trivial tricuspid paravalvular regurgitation (Figure 3C) and the sizes of the LA and RA were similar to that before discharge. At 1-year follow-up, device interrogation showed excellent pacing parameters of the 2 leads with pacing thresholds 0.5 V / 0.4 ms and 0.5 V / 0.4 ms, lead impedance 398 Ω and 362 Ω, and R-wave amplitudes 9.8 mV and 7.8 mV,

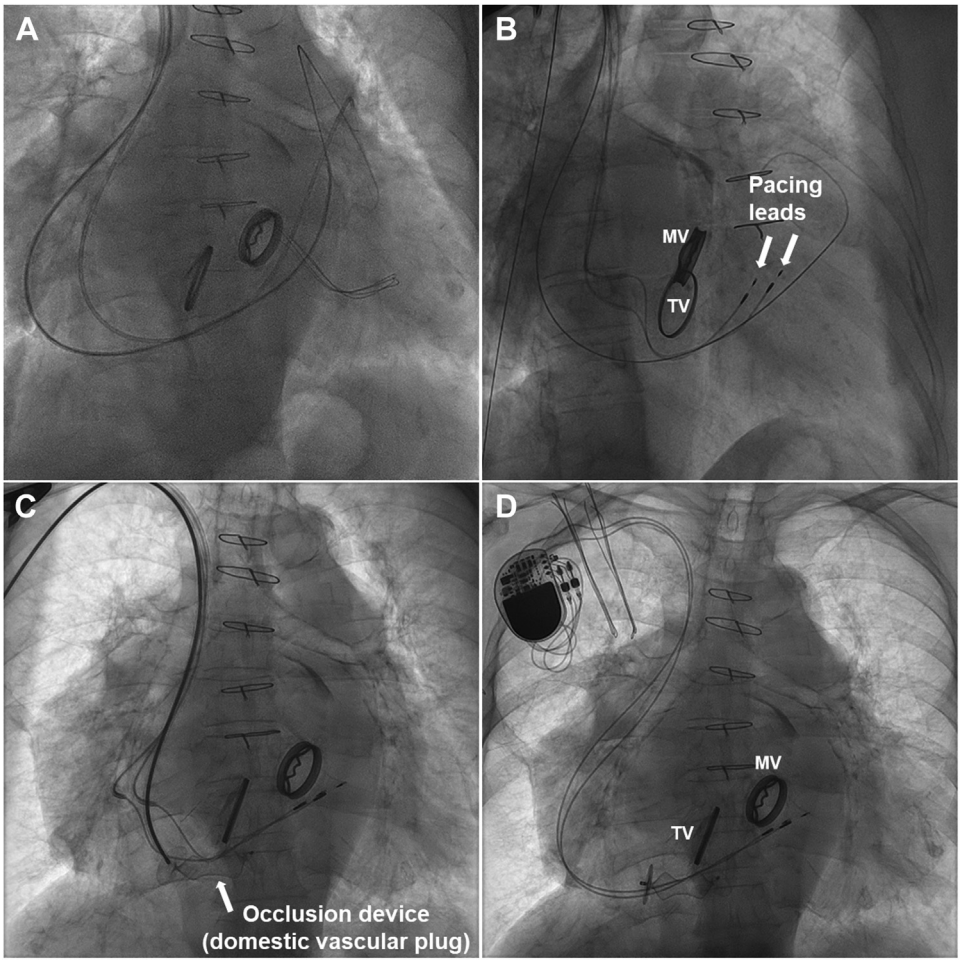

Figure 2 Fluoroscopic imaging records during the procedure. **A:** Under anterior posterior fluoroscopic view, angiographic catheter and angiographic guide wires were used to explore paravalvular leak and establish the access from the right subclavian vein to the pulmonary artery. **B:** Two pacing leads (*arrows*) were screwed into the interventricular septum under the right anterior oblique (RAO) 30° fluoroscopic view. **C:** A 20 mm vascular plug (*arrow*) was positioned and deployed in the paravalvular defect. **D:** Imaging record at the end of the procedure. MV = mitral valve; TV = tricuspid valve.

respectively. TTE at the local hospital showed trivial tricuspid paravalvular regurgitation. Chest radiography showed similar tension of the 2 pacing leads as before (Figure 3D). During the follow-up, the patient had no recurrence of syncope and partial relief of the shortness of breath.

Discussion

This was a rare case with mechanical TV, MV, and abnormal CS ostium, which brought challenge to the implantation of pacing lead. Owing to the preexisting mechanical TV and MV, transvalvular RV endocardial pacing and LV endocardial pacing through atrial septum puncture were contraindicated. In particular, because of the abnormally sutured TV sewing ring, the CS ostium, which was normally in the RA, was on the ventricular side of the mechanical TV. Thus, implantation of LV lead via CS was also infeasible. Owing to previous multiple surgeries, the risk of epicardial pacing through another surgery was high. However, the tricuspid PVL discovered by TTE provided an unusual but minimally invasive approach for RV endocardial pacing.

PVL is a common complication after prosthetic valve replacement, and significant tricuspid PVL is rare.[3] Limited data suggest that significant paravalvular regurgitation with progressive right heart failure warranted surgical or transcatheter treatment.[4] In addition, the pacing lead going through the paravalvular defect might worsen paravalvular regurgitation. Therefore, simultaneous percutaneous closure of the PVL was performed. The right subclavian venous approach was preferred for percutaneous closure of the tricuspid PVL. Considering that the patient was not engaged in physical labor or vigorous exercise, the right subclavian vein instead of the left was chosen for the procedure. The vascular plug was chosen to close the tricuspid PVL because of its small profile and its suitability for the small and flexible delivery system. Meanwhile, the plug is relatively soft, which could minimize the abrasion on the pacing lead.

In case of pacing lead dysfunction, a second pacing lead was implanted in the same manner, considering the difficulty of another RV pacing lead implantation after PVL closure. If pacing lead dysfunction occurs during follow-up, lead abandonment instead of lead removal would be chosen, unless

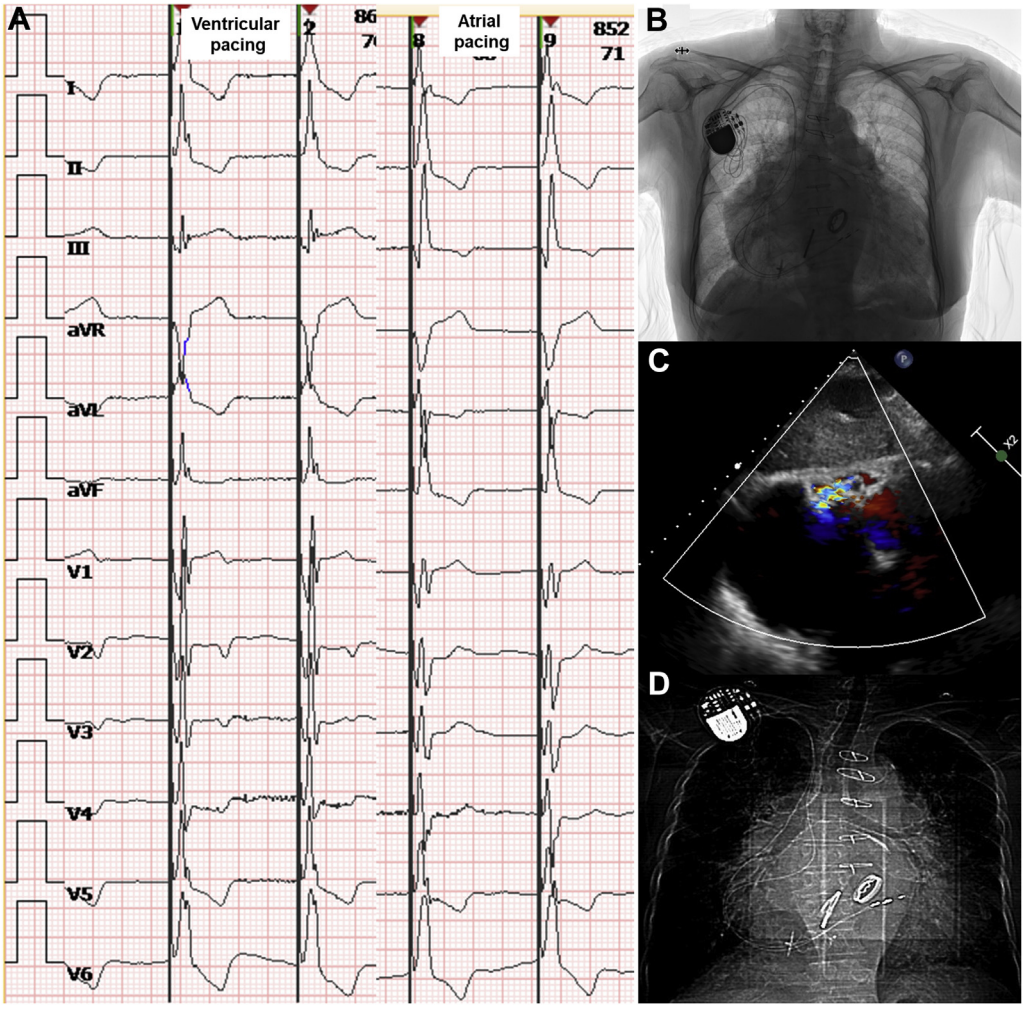

Figure 3 Follow-up images. **A:** Postprocedure, the pacing electrocardiograms of the 2 leads (ventricular pacing and atrial pacing) were recorded. **B, C:** At 3-month follow-up, chest radiography showed satisfactory tension and no displacement of the 2 pacing leads. Transthoracic echocardiogram demonstrated only trivial paravalvular regurgitation. **D:** At 1-year follow-up, chest electrocardiogram at local hospital showed similar tension and position of the 2 pacing leads as before.

there is cardiovascular implantable electronic device infection or vascular complications. Manual traction or mechanical extraction tools could be used according to the reported data on the extraction of the 3830 lead.[5–7]

According to the literature review, this is the first report of successful implantation of RV pacing lead via tricuspid PVL and subsequent percutaneous closure of PVL. One-year follow-up demonstrated satisfactory lead performance and clinical outcomes. Long-term follow-up is still needed.

Conclusion

Tricuspid PVL provides a feasible approach to implant an RV endocardial lead. The need for subsequent closure of the PVL depends on the severity of paravalvular regurgitation and RV dysfunction. Implantation of an RV lead via tricuspid PVL and subsequent percutaneous closure of the PVL is feasible and safe.

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