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CASE REPORT
Arrhythmias / electrophysiology

A case report of pulmonary vein isolation with radiofrequency catheter using superior vena cava approach in patient with paroxysmal atrial fibrillation and inferior vena cava filter

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Background Transseptal puncture and pulmonary vein isolation (PVI) in patients with atrial fibrillation (AF) are generally performed via the inferior vena cava (IVC). However, in cases where the IVC is inaccessible, a specific strategy may be needed.

Case summary An 86-year-old woman with paroxysmal AF and an IVC filter *in situ* was referred to our hospital for ablation therapy. An IVC filter for pulmonary embolism and deep venous thrombosis had been implanted 15 years prior, therefore we selected a transoesophageal echocardiography (TOE)-guided transseptal puncture using a superior vena cava (SVC) approach. After the single transseptal puncture, we performed fast anatomical mapping, voltage mapping by multipolar mapping catheter, and then PVI by contact force-guided radiofrequency catheter using a steerable sheath. Following the ablation, bidirectional conduction block between the four pulmonary veins and the left atrium was confirmed by both radiofrequency and mapping catheter. No complications occurred and no recurrence of AF was documented in the 12 months after the procedure.

Discussion When performing a transseptal puncture during AF ablation, an SVC approach, via access through the right internal jugular vein, enables the sheath to directly approach the left atrium without angulation and improves operability of the ablation catheter. Combining the use of general anaesthesia, TOE, a steerable sheath, and contact force-guided ablation may contribute to achieving minimally invasive PVI with a single transseptal puncture via an SVC approach.

Keywords Case report • Pulmonary vein isolation • Superior vena cava approach • Inferior vena cava filter

Introduction

Pulmonary vein isolation (PVI) using radiofrequency ablation is recommended as appropriate therapy in patients with symptomatic atrial fibrillation (AF).[1]

The standard procedure of radiofrequency ablation for PVI is performed through the inferior vena cava (IVC) via a femoral vein approach. However, there is difficulty in approaching the heart in patients with implanted IVC filters.

We performed PVI in a patient with an implanted IVC filter with a single transseptal puncture through the superior vena cava (SVC) supported by general anaesthesia, transoesophageal echocardiography (TOE), a steerable guiding sheath, and a contact-force sensing ablation catheter.

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Learning points

- When performing atrial fibrillation ablation, if the inferior vena cava approach is inaccessible, transoesophageal-guided single transseptal puncture via superior vena cava approach may be enough to perform minimally invasive pulmonary vein isolation (PVI).
- General anaesthesia to ensure stable respiratory movement is useful to facilitate a complex procedure when performing PVI.

Timeline

Time	Description of events
June 2018	Diagnosis for atrial fibrillation and prescribed anti-arrhythmic medication
December 2018	Decided to receive the ablation therapy and discontinued anti-arrhythmic medication
Admission (February 2019)	Elective hospitalization
Admission Day 1	Transoesophageal echocardiography to check the intra-cardiac thrombus
Admission Day 2	Ablation under general anaesthesia
Every 2 months after ablation	12 lead electrocardiogram (ECG): sinus rhythm
1 year after ablation	12 lead ECG: sinus rhythm

Case presentation

An 86-year-old woman with symptomatic paroxysmal AF was referred to our hospital for possible catheter ablation therapy. She had a history of hypertension, chronic kidney disease, acute pulmonary embolism, and deep venous thrombosis. She had an IVC filter (Günther Tulip®) implanted 15 years prior because of sub-massive pulmonary embolism with reiterative venous thrombosis. CHADSVASC score was 4 points. At the time of admission, she was taking atenolol, amlodipine besilate, azosemide, edoxaban, and aspirin. From 8 months before the admission, this patient also received an antiarrhythmic drug (pilsicainide 25 mg twice daily) to treat paroxysmal AF but despite ongoing treatment with antiarrhythmic medication, she had ongoing symptoms of intermittent palpitations. The patient was provided with two potential treatment options; alternative antiarrhythmic drug therapy or catheter ablation therapy. Following discussion with her family, the patient decided on catheter ablation therapy. On the admission, the patient's oxygen saturation was 99% on room air, blood pressure was 120/70 mmHg, with a heart rate of 75 beats per minutes, regular. Physical examination revealed a 1/6 systolic murmur in the left sternal border. Lab work showed elevated creatinine at 1.12 mg/dL (0.46–0.79 mg/dL), D-dimer at 0.95 mg/L (0.0–0.7 mg/L), haemoglobin of 9.3 g/dL (11.6–14.8 g/dL), platelet count of 462 (158–348), and white blood cell count of 6.4 (3.3–8.6). Thyroid function was within the normal range. Electrocardiography on admission showed normal sinus rhythm, but AF had previously been documented during palpitations experienced by the patient. Transthoracic echocardiography showed that the left ventricular ejection fraction was 77%, the left atrium was slightly dilated (42.3 × 52.6 mm), and mild aortic valve stenosis was present.

Because delivery of a long sheath via the IVC carries a risk of dislodgement or fracture of the IVC filter and perforation of the IVC, we planned to perform PVI via an SVC approach. To minimize haemorrhagic complications for this elderly patient, a right internal jugular and left subclavian approach was selected.

First, a deflectable 20-pole 6-Fr catheter (BeeAT®; Japan Lifeline, Tokyo, Japan) was placed into the coronary sinus from a 7-Fr straight sheath (Terumo Medical, Tokyo, Japan) via the left subclavian vein. A Brockenbrough needle was placed into the right atrium from an 8.5-Fr steerable sheath (Agilis®; Terumo Medical) via the right internal jugular vein. Both venous access points were obtained using ultrasound guidance. The procedure was performed under general anaesthesia to regulate the respiratory function, and TOE was used when performing the transseptal puncture. Although intracardiac echocardiography (ICE) would also provide anatomical details of the interatrial septum during the transseptal puncture, ICE requires additional vascular access. Therefore, to minimize the amount of vascular access, we performed transseptal puncture assisted by TOE (*Figure 1*). After the single transseptal puncture, we performed anatomical 3D mapping and myocardial potential mapping using a multipolar mapping catheter (PentaRay®; Biosense Webster, CA, USA) on the display of an electroanatomical mapping system (CARTO®; Biosense Webster) and then PVI by radiofrequency catheter using a steerable sheath (*Figure 2*). We used a contact force-guided ablation catheter (THERMOCOOL SMARTTOUCH D-F curve®; Biosense Webster), and the ablation index (automatically calculated value by computer programming) was monitored continuously to maintain adequate radiofrequency ablation. Target ablation index was 450 on the left atrial (LA) anterior wall and 350–400 on the LA posterior wall. Bidirectional conduction block between the four pulmonary veins (PVs) and the left atrium was confirmed following the ablation by both the radiofrequency catheter and mapping catheter (*Figure 3*). Total patient time in catheterization laboratory was 6 h, the duration of general anaesthesia was 5 h 17 min, procedural time (from puncture to removal of sheath) was 3 h 54 min and time from first ablation to isolation of all four PVs was 1 h 33 min. No complications occurred and recurrence of AF was not documented in the 12 months after the procedure by every 2 months 12 lead electrocardiogram.

Discussion

We reported a rare approach from the internal jugular vein for PVI in a patient with AF and an IVC filter. Radiofrequency ablation strategies for patients with interrupted IVC or implanted IVC filter have been reported. Masaki *et al.*[2] described two cases of radiofrequency ablation for AF using a trans-filter procedure for a patient with another type of IVC filter (OptEase®). They checked the diameter of the

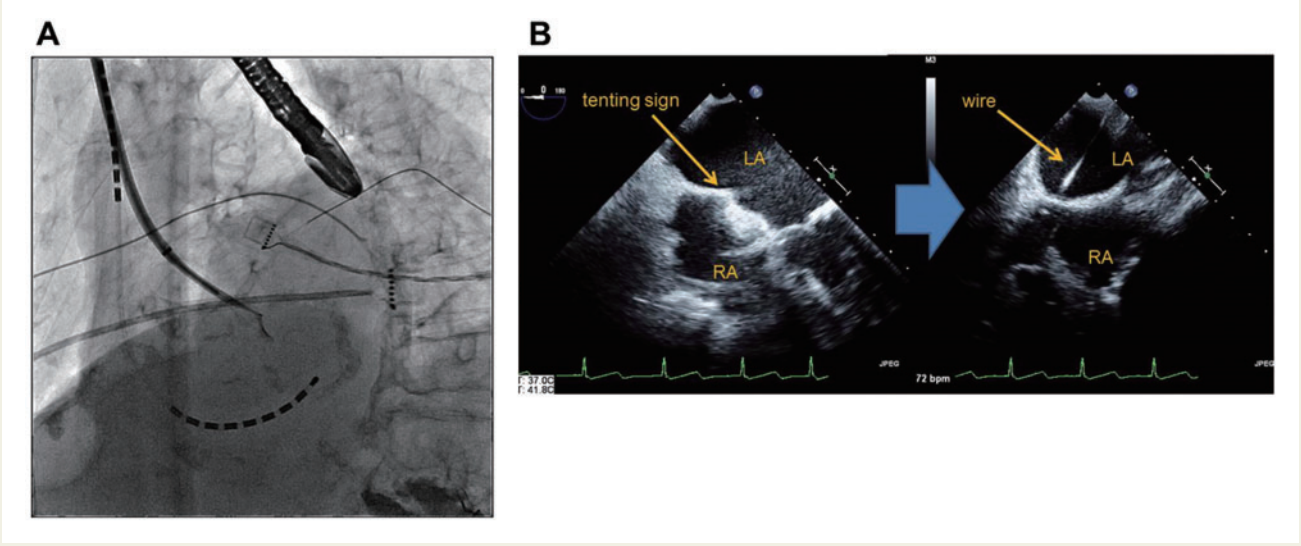

Figure 1 (*A*) Radiography of the transseptal puncture. (*B*) Transoesophageal echocardiography of the transseptal puncture. LA, left atrium; RA, right atrium.

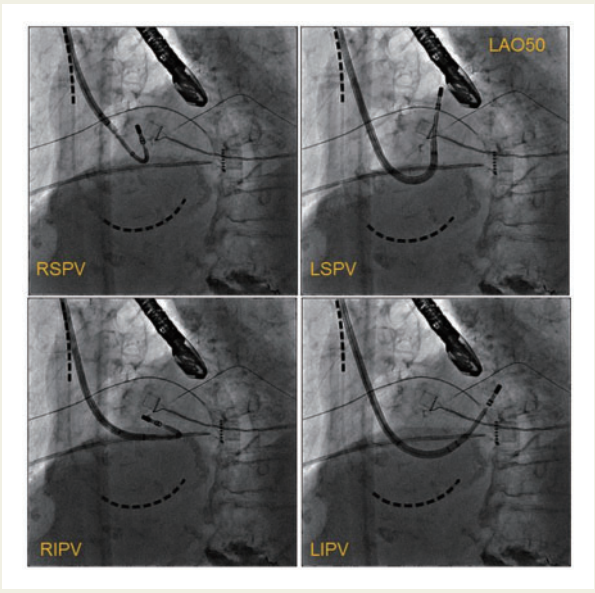

Figure 2 Radiography of isolation of the four pulmonary veins by radiofrequency catheter. LIPV, left inferior pulmonary vein; LSPV, left superior pulmonary vein; RIPV, right inferior pulmonary vein; RSPV, right superior pulmonary vein.

struts of the OptEase and the absence of thrombus formation in the filter, and then inserted a single steerable sheath through the IVC filter. Since the OptEase has a relatively wider gap than the Günter Tulip that had been implanted in this case, the insertion of a long sheath across the Günter Tulip was expected to be difficult. In another patient with complete occlusion of the IVC due to a permanent IVC filter (OptEase), Usman *et al.*[3] performed PVI via a dual approach from the right subclavian vein and the left axillary vein. They used a specially designed Baylis needle and an SVC approach, but the advance of the sheath through the atrial septum was difficult. Eventually, they were able to advance only the ablation catheter through the atrial septum and performed PVI with ablation catheter inside a steerable sheath placed in the right atrium. Passing the straight sheath through to the left atrium is difficult from a left-side approach, and the stability of the ablation catheter seems to decrease without the support of a steerable sheath. In contrast, our approach from the right internal jugular vein offered some advantages for advancing the sheath into the left atrium and provided high flexibility for the use of the ablation catheter. Kato *et al.*[4] demonstrated PVI via a single sheath in the internal jugular vein and double sheaths in the subclavian vein in a patient with congenital interruption of the IVC. They used ICE for the transseptal puncture and inserted two long sheaths into the left atrium for monitoring PV potential during the ablation. In our case, TOE under general anaesthesia ensuring controlled respiratory movement, allowed safe transseptal puncture and avoided additional sheath placement. General anaesthesia may also attribute to maintaining the catheter stability, suppressing patient movement, and shortening overall procedural time.

In an SVC approach, puncture from the right internal jugular vein enables the sheath to approach the left atrium linearly and improves operability of the ablation catheter. General anaesthesia also seems to facilitate performing TOE and ablation. Recently, a steerable sheath and contact force-guided ablation permitted precise PVI without monitoring the PV potential via electrode catheter.[5] Combining the use of general anaesthesia, TOE, a steerable sheath, and contact force-guided ablation may contribute to achieving minimally invasive PVI with a single transseptal puncture via an SVC approach.

Transseptal puncture under TOE monitoring and insertion of steerable sheath to left atrium was the most difficult and important part of this PVI through SVC approach. In the process of insertion of steerable sheath, which is large diameter and high friction, from right

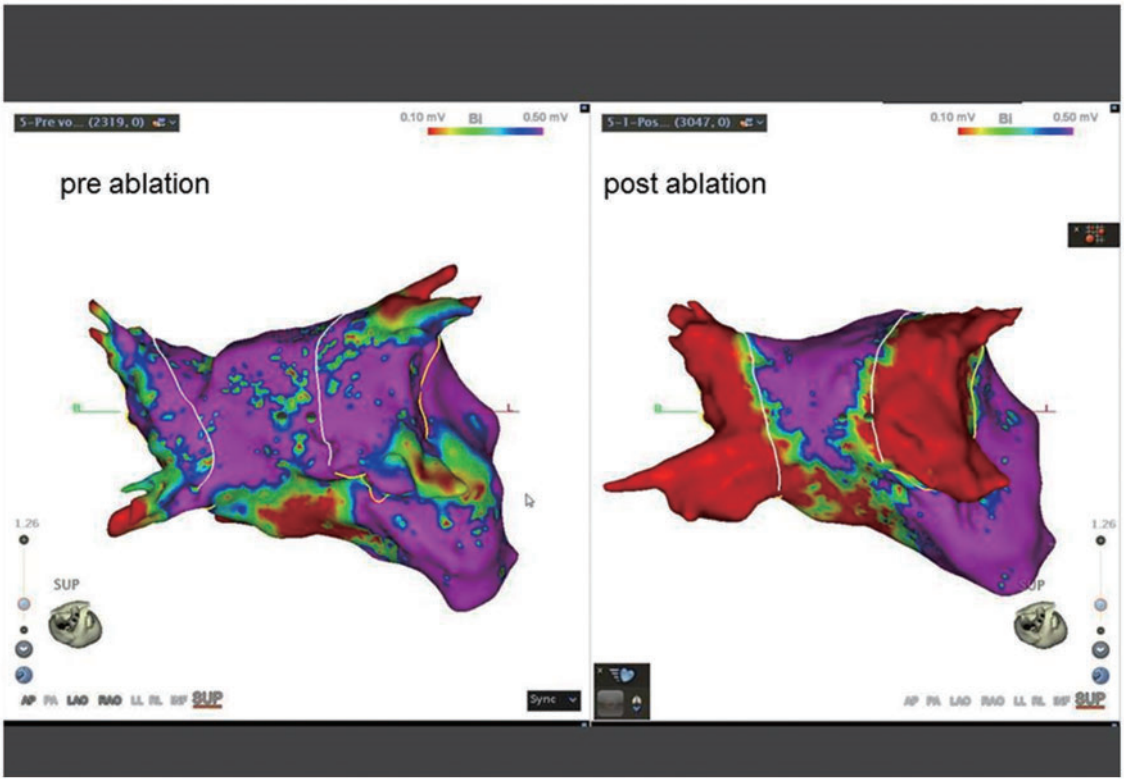

Figure 3 Voltage mapping of the left atrium pre- and post-ablation (anteroposterior view).

atrium to left atrium, rigid wire support is required. In the case of conventional approach from IVC, steerable sheath can be linearly advanced to left atrium from IVC. However, the insertion of steerable sheath from SVC to left atrium was difficult due to large bend angle. To overcome this problem, we advanced an 0.035-inch wire to left ventricle and linearly inserted steerable sheath to left atrium and dilated the site of transseptal puncture.

Conclusion

In cases involving a restricted IVC approach, TOE-guided single transseptal puncture using an SVC approach may allow for successful PVI.

Lead author biography

Dr Masatoshi Narikawa is a cardiologist in Yokohama City University School of Medicine, Yokohama, Japan. He graduated from the Cardiovascular Research Institute, Yokohama City University of Japan, in 2018 and obtained the PhD degree. He is working in arrhythmia team at Yokohama City University School of Medicine.

Supplementary material

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

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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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