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Case Report

Radiofrequency catheter ablation of atrial fibrillation through an implanted inferior vena cava filter

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ABSTRACT

Pulmonary vein isolation (PVI), which creates electrical blocks between pulmonary veins and left atrium, is an established way of catheter ablation for atrial fibrillation (AF). PVI is usually performed via the femoral vein access, using two or three long preshaped sheaths, followed by atrial-septal puncture to approach the left atrium.

Here, we treated an AF patient with a permanently implanted inferior vena cava filter (IVC-F) due to deep venous thrombosis (DVT) and pulmonary thromboembolism (PTE). The patient had symptomatic paroxysmal AF for over a decade, which was not controlled under antiarrhythmic drugs including beta-blockers. Therefore, we recommended PVI to treat the AF.

However, as the IVC-F was an obstacle to perform conventional PVI, we changed the combination of vascular access sites and devices to perform it safely. Notably, insertions of a single steerable sheath through IVC-F and an intracardiac ultrasound catheter from the right internal jugular vein were useful for the successful completion of the procedure.

<**Learning objective:** Pulmonary vein isolation through an implanted inferior vena cava filter (IVC-F) for an atrial fibrillation patient with IVC-F can be completed by changing the combination of vascular access sites and devices. Notably, insertions of a single “steerable” sheath through IVC-F from the femoral vein and an intracardiac ultrasound catheter from the internal jugular vein are useful for the successful completion of the procedure. Precise evaluation and careful preparation including contrast-enhanced computed tomography are mandatory for this unusual procedure.>

Introduction

Pulmonary vein isolation (PVI), which is an effective and established therapeutic modality to eliminate atrial fibrillation (AF), is usually performed through the inferior vena cava (IVC) via femoral vein access, using two or three long preshaped sheaths followed by atrial-septal puncture to approach the left atrium.

Because of this procedure, we may hesitate to perform PVI for AF patients with a permanently implanted inferior vena cava filter (IVC-F). As easily imagined, an IVC-F may disturb preshaped long sheaths advancing through the IVC, and cause complications such as filter migration or dislodgment, venous perforation, pulmonary embolism, and guidewire entrapment during the procedure. But we might be able to provide PVI for them and relieve their symptoms more safely than imagined. To the best of our knowledge, this case report includes an originality in terms of the establishment of the reproducible method to perform PVI through an IVC-F systematically describing the details.

Case report

A 77-year-old woman was referred to our hospital because of symptomatic AF. Her medical history was insignificant other than implantation of a permanent IVC-F (OptEase®; Cordis, Milpitas, CA, USA) for deep venous thrombosis (DVT) and pulmonary thromboembolism 11 years previously. Her AF had been controlled by antiarrhythmic drugs (AAD) over the course of a decade, and PVI had been deferred thus far because her IVC-F might present an obstacle to complete conventional PVI typically performed through the IVC. However, her AF gradually became uncontrollable, causing palpitations and impairing her activities of daily life

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frequently despite being on AAD. Therefore, we decided that AF should be eliminated to relieve her symptoms. Her IVC-F was OptEase®, which had been placed about a decade before and computed tomography (CT) images revealed penetration of the filter strut through the IVC wall. According to the instructions for use, removal of OptEase® can be achieved within 12 days of implantation. However, Ashley et al. reported that it should not be removed after an extended time because of filter protrusion through the IVC [1]. We thus decided to perform PVI using an alternative approach and devices without removing the IVC-F. Radiofrequency catheter ablation for AF patients with an IVC-F had not yet been reported when we performed the procedure. However, Haman et al. reported passing multiple electrode catheters and long sheaths through an IVC-F, and Kanjwal et al. reported a case of cavo-tricuspid isthmus catheter ablation through an IVC-F [2,3], which are similar in the procedure to inserting devices through the IVC-F. We therefore considered that PVI across the IVC-F was feasible.

First of all, we analyzed whether long sheaths and catheters could cross the IVC-F. In this patient, the OptEase was fully expanded with a maximum diameter of around 30 mm (Fig. 1), with a minor diameter of the large cells in a diamond shape of around 7.5 mm.

In conventional PVI, we advance an 8.5–9 Fr long sheath above the renal veins through the IVC. The outer diameter of the 9 Fr sheath is 4 mm, which is smaller than the minor diameter of the large cell of OptEase (7.5 mm). For this case, we checked that another 9 Fr sheath could pass another OptEase expanded to maximum diameter ex vivo. Moreover, we confirmed the patency of the IVC-F because the contrast-enhanced CT images did not show contrast defect, suggesting thrombus formation in the IVC.

Next, we changed the combination of vascular access sites and devices. In conventional PVI we usually use three vascular access sites, namely the femoral vein, internal jugular vein, and radial artery. Three sheaths are inserted from the femoral vein and then advanced through the IVC. One 8.5 Fr sheath (LAMP45; St. Jude Medical, St. Paul, MN, USA) is used to place an ablation catheter (ThermoCool SmartTouch®; Biosense Webster, Irvine, CA, USA) in the left atrium, one 8.5 Fr sheath (SL-1) is used to place a multi-electrode mapping catheter (PentaRay®; Biosense Webster) in the left atrium, and a third 9Fr sheath is used to place alternately an intracardiac echo (AcuNav®; Siemens, Erlangen, Germany) catheter to monitor the procedure of atrial-septal puncture and a right ventricle (RV) electrode catheter for back-up pacing to prepare for bradycardia such as complete atrioventricular block during the procedure. A coronary sinus (CS)-high right atrium (HRA)-superior vena cava (SVC) electrode catheter (BeeAT®; Japan Lifeline, Tokyo, Japan) is inserted from the internal jugular vein, and a radial artery sheath is used to monitor systemic blood pressure and the hemodynamic status (Fig. 2A).

In this case, notably, we inserted the AcuNav from the internal jugular vein to minimize the risk of complications associated with the IVC-F. Then we placed the BeeAT in CS-HRA-SVC after the atrial-septal puncture. We did not put a pacing catheter in the RV and planned to place an BeeAT in the RV when we needed back-up pacing. Furthermore, both ThermoCoolSmartTouch and PentaRay were inserted via the same femoral sheath by exchanging them according to their use. This alternative approach was able to reduce the number of femoral access sites from three to one (Fig. 2B).

For insertion of the long sheath through the IVC-F, we took advantage of a steerable sheath (Guidee; Japan Lifeline), which can be kept straight while crossing the IVC-F and bent during the atrial-septal puncture, thus reducing the risk of the filter-related complications.

Immediately after the femoral puncture, we confirmed the patency of the IVC-F by contrasting the IVC (Fig. 3A). We then crossed a 0.035-mm J-shaped-tip guidewire through the IVC-F. When the wire crosses through the filter, it is preferable that it passes linearly through both the ipsilateral distal and proximal cells of the filter to avoid IVC-F-related complications. A 9 Fr-long sheath was used to ensure that it passed through the IVC-F, after which the sheath was exchanged for the Guidee whose tip was

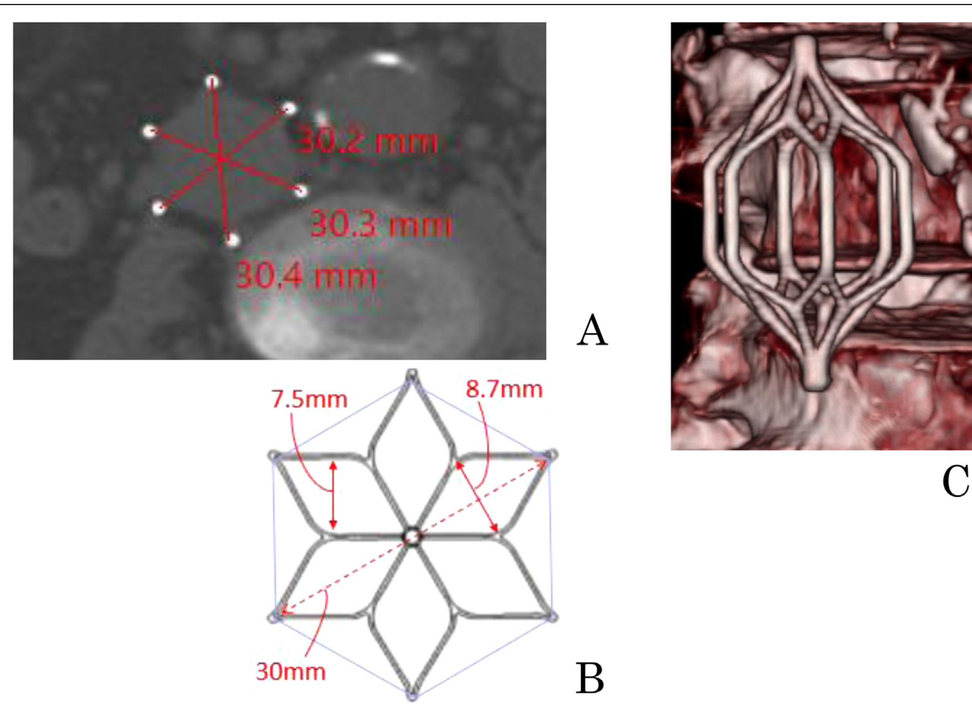

Fig. 1. (A) Computed tomography image (CT) showing the OptEase fully expanded with maximum diameter. (B) Estimating the minor diameter of the large cells as 7.5 mm when the OptEase is fully expanded. (C) 3D reconstruction CT image of inferior vena cava filter implanted in this case.

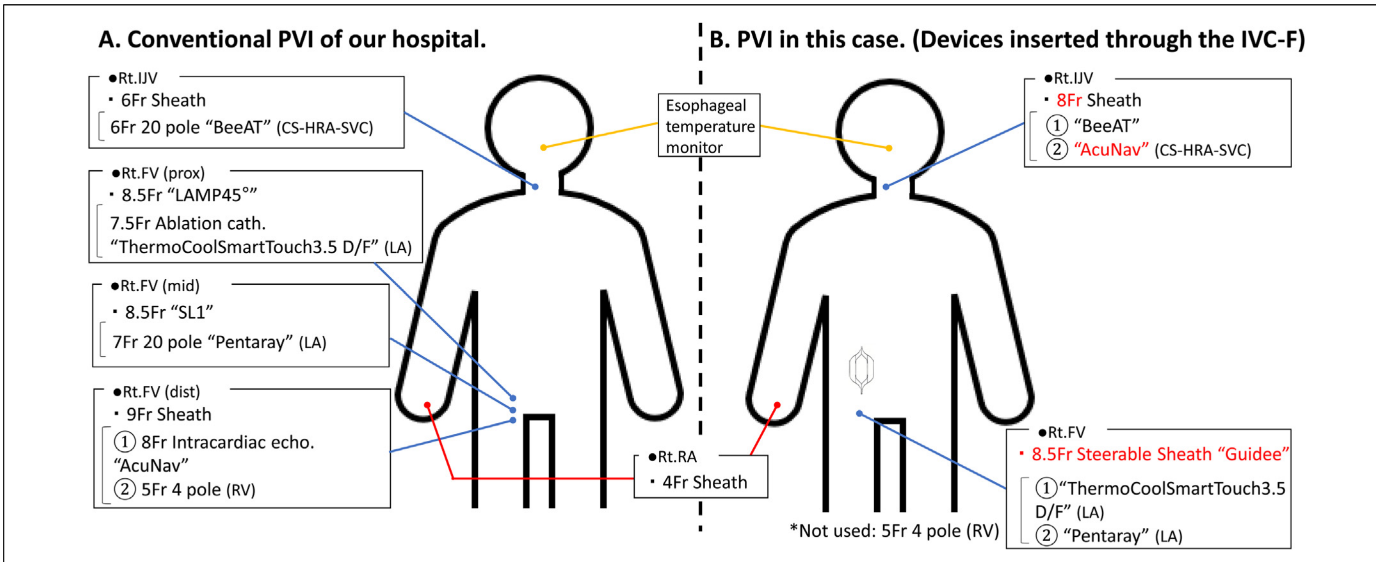

Fig. 2. (A) Conventional Pulmonary vein isolation (PVI) approach used in our hospital. (B) PVI approach in this case. We reduced the number of long sheaths via femoral access sites from three to one.
Rt. = right, IJV = internal jugular vein, FV = femoral vein, RA = radial artery, prox = proximal, mid = middle, dist = distal, CS = coronary sinus, HRA = high right atrium, SVC = superior vena cava, LA = left atrium, RV = right ventricular, cath. = catheter.

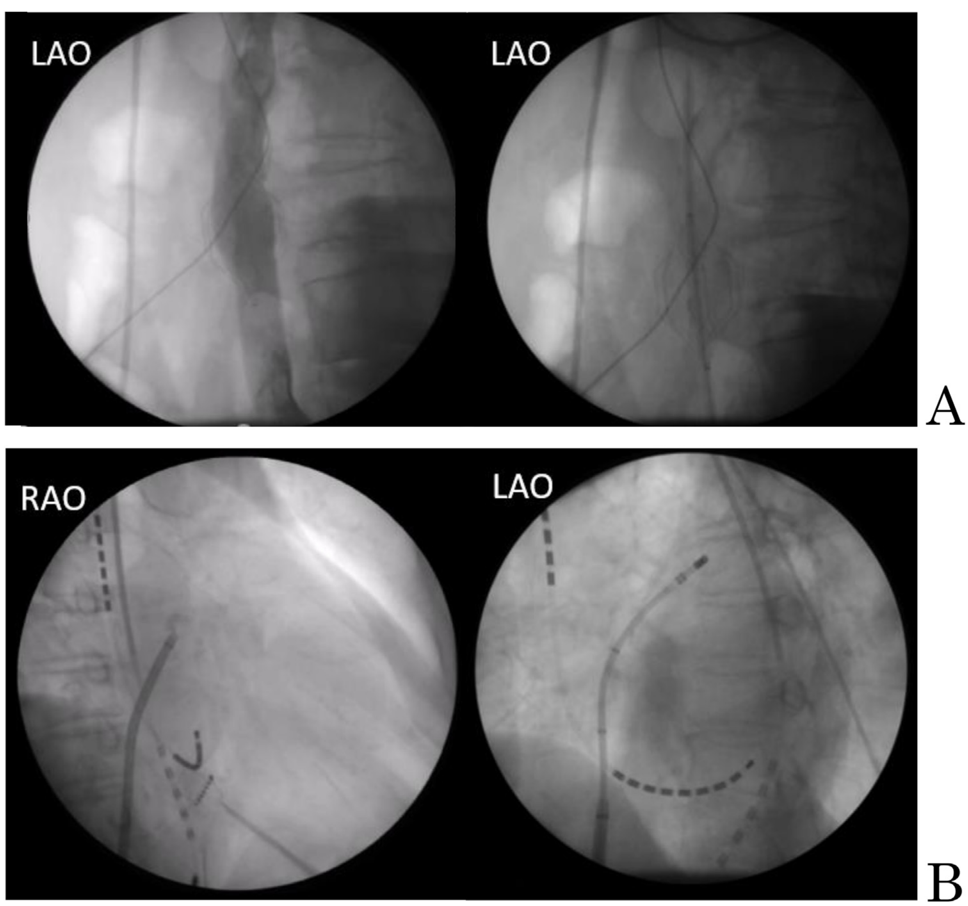

Fig. 3. (A) Checking the patency of the inferior vena cava (IVC) filter by contrasting the IVC, and then crossing 9Fr-long sheath followed by exchanging the Guidee whose tip was kept straight. (B) Atrial-septal puncture by bending the tip of the Guidee and completing Pulmonary vein isolation.
LAO = left anterior oblique, RAO = right anterior oblique.

adjusted to remain straight while crossing the filter. We then made the atrial-septal puncture by bending the tip of the steerable sheath and using a transseptal needle (RF Needle; Japan Lifeline). After the puncture, firstly we inserted the multi-electrode mapping catheter in the left atrium via the sheath, and performed electrical mapping to confirm its shape and voltages. Thereafter, we completed PVI after exchanging the mapping catheter for the radiofrequency ablation catheter. Control of the ablation catheter via the steerable sheath through the IVC-F was broadly no different from that of the conventional PVI (Fig. 3B).

Discussion

There has been only one report of radiofrequency catheter ablation procedures across an IVC-F, in which the details of the filter were not mentioned [4]. We considered various options to complete PVI without complications associated with the IVC-F. One possible option is transseptal left atrial puncture using a non-femoral approach, such as via the internal jugular vein or the hepatic vein [5]. However, we have no experience in such an approach, and a hepatic vein approach may be riskier than others. Moreover, combinations of transseptal left atrial puncture and PVI using the femoral vein approach is preferred because of the anatomical relationship between the left atrium and the IVC. All things considered, we finally decided to perform PVI across the IVC-F using the femoral vein approach.

Besides the vascular access, the structure of the IVC-F should be considered. The characteristics of the filter, OptEase, include a double-basket, self-centering design with six vertical struts contracting the IVC wall, which may contribute to lowering the risk of filter migration and dislodgment. In fact the filter in this case had remained in a stable position for over a decade and was firmly fixed with struts penetrating the IVC wall, thus being suitable for trans-filter procedures.

Following this case, we experienced a similar drug-resistant AF case of a 52-year-old man with an OptEase and also were able to complete the PVI using the same method without any complications. Which suggests reproducibility of the PVI procedure through the same type of IVC-F.

Above all, precise evaluation and careful preparation are mandatory for these unusual procedures. Contrast-enhanced CT is valuable for collecting any information regarding the IVC-F and the anatomical relationship between the filter and the IVC wall. Careful attention while crossing the IVC-F is mandatory. Finally, a cautious approach with flexible modifications of the routine procedure might provide optimal results. More reports about PVI for AF patients with an IVC-F are necessary in order to verify the safety and certainty of our strategy.

Conclusion

We completed PVI through an IVC-F by changing the combination of vascular access sites and devices, including the steerable sheath.

Conflict of interest

The authors declare that there is no conflict of interest.

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