Cryoballoon ablation for atrial fibrillation in a patient with esophageal dilatation due to achalasia

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Introduction

Collateral damage is one of the crucial risks in catheter ablation for atrial fibrillation (AF). In particular, owing to its close proximity to several ablation lines, the esophagus may be prone to injury.[1] A recent study[2] has shown that esophageal injury was observed in up to 43% of patients undergoing catheter ablation for AF. Esophageal injury can lead to severe complications, such as atrial–esophageal and pericardial-esophageal fistulas.[3]

Esophageal achalasia is a neurodegenerative disorder characterized by failure of lower esophageal sphincter relaxation and loss of peristalsis to the distal esophagus, frequently leading to the marked dilatation of the esophagus. The dilatation of the esophagus may increase the risk of esophageal injury in AF ablation; however, the outcome after AF ablation in patients with esophageal achalasia has not been fully described.

KEY TEACHING POINTS

- Collateral damage of the esophagus is one of the significant risks in catheter ablation for atrial fibrillation, as it can lead to atrial-esophageal and pericardial-esophageal fistulas.
- Esophageal achalasia is a neurodegenerative disorder characterized by failure of lower esophageal sphincter relaxation and loss of peristalsis to the distal esophagus, which may increase the risk of esophageal injury by causing marked dilatation of the esophagus.
- Cryoballoon ablation may be a safe ablation approach for patients with a dilated esophagus due to esophageal achalasia.

Case report

A 44-year-old man sought medical consultation at another hospital owing to the onset of palpitations regardless of type of activity, such as exercise or food intake. The patient was referred to our facility because paroxysmal AF was documented during follow-up. The electrocardiogram showed a type 3 Brugada pattern in lead V_1 and type 2 Brugada pattern in lead V_2 (Figure 1), but he did not have a history of syncope or a family history of sudden death. Although catheter ablation was planned, the procedure was deferred because of the markedly dilated esophagus noted during the preoperative magnetic resonance imaging. The patient was diagnosed with esophageal achalasia after a series of detailed examinations, including an esophageal motility study. The patient underwent peroral endoscopic myotomy; however, in computed tomography imaging after the surgery, the esophagus remained dilated and in contact with the entire posterior wall of the left atrium (Figure 2). With the risk of esophageal injury, catheter ablation was postponed until pulsed-field ablation is available. Conservative therapy was started with antiarrhythmic drugs, including bepridil and quinidine; however, no drug effectively suppressed the AF. Since the patient's AF was severely symptomatic, we proceeded to perform catheter ablation after discussing the risks and benefits with the patient.

A proton pump inhibitor was administered before the ablation procedure. We performed pulmonary vein (PV) isolation with a cryoballoon approach. A steerable esophageal thermometer (Esophastar; Japan Lifeline Co, Ltd, Tokyo, Japan) was used to cover the entire area of the dilated esophagus.[4] Under fluoroscopic guidance, we positioned it on the opposite site of the cryoballoon. We planned to interrupt cooling when the esophageal temperature decreased to below 20°C.[5] Sheath introducers were inserted through the right femoral vein under local anesthesia and sedation with propofol. Following transseptal puncture, a cryoballoon was advanced into the left atrium. PV occlusion was verified using selective contrast injection before each application (Figure 3A–3D). The left superior PV, left inferior PV, and

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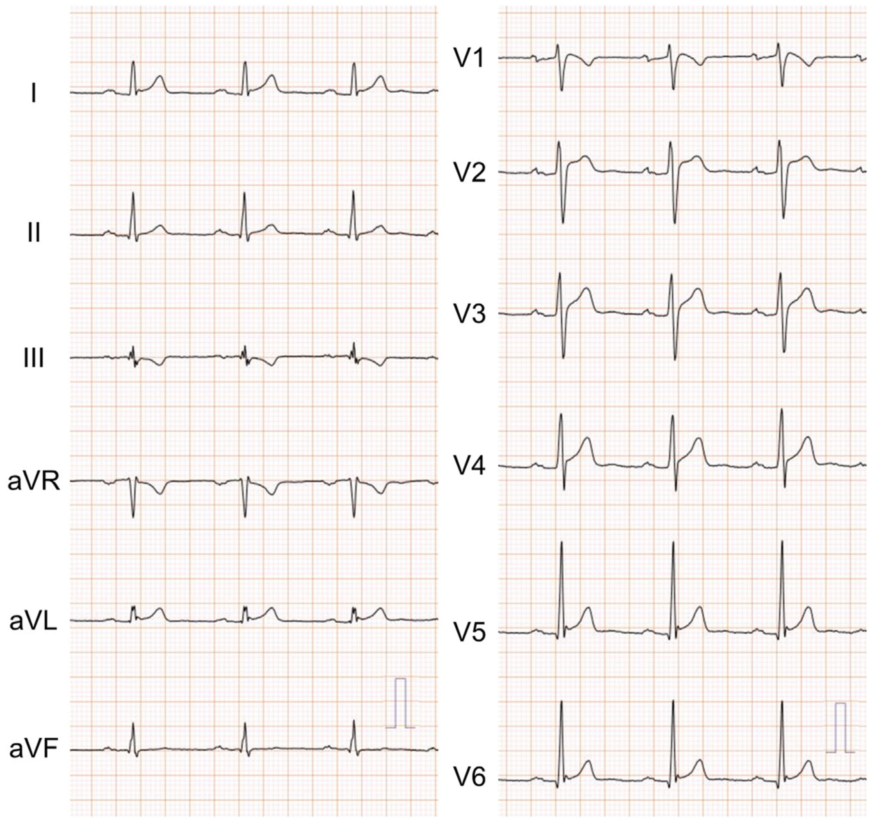

Figure 1 Preprocedural surface electrocardiogram.

right inferior PV required 2 applications to achieve the entrance block, while the right superior PV required 1 application (all applications were performed for 180 seconds). The exit block was demonstrated through PV pacing in all PVs. The time to isolation in the left superior PV and left inferior PV was 100 seconds and 25 seconds, respectively. The time to isolation was not available in the right superior PV and right inferior PV because PV potentials were unclear during freezing. Nadir temperature was -59°C in the left superior PV and left inferior PV and -65°C and -57°C in the right superior PV and right inferior PV, respectively. The time to thaw in each PV was 25 seconds, 27 seconds, 42 seconds, and 23 seconds, respectively. Although esophageal temperature decreased to a minimum of 28°C during the application to the left inferior PV, no esophageal temperature drop below 20°C was noted during the procedure. The patient fasted for 1 week after the procedure. Esophageal endoscopy was performed 2 days and 1 week after the procedure, but no remarkable evidence of esophageal injury was observed (Figure 3E and 3F). A proton pump inhibitor was continued for 2 months after the ablation procedure. During the 5-month follow-up, no AF recurrence was observed even without any intake of antiarrhythmic drugs, and no perioperative complication occurred.

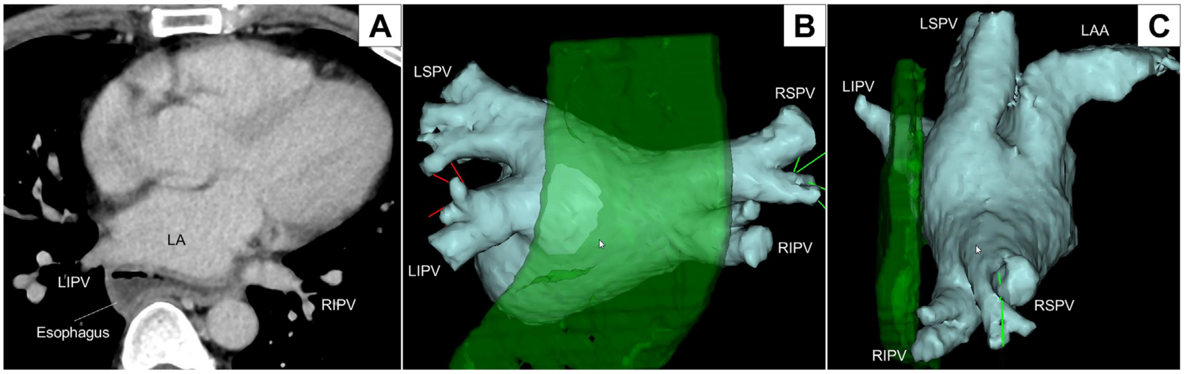

Figure 2 Preprocedural computed tomographic (CT) images. **A:** Two-dimensional CT image at the level of inferior pulmonary veins. **B:** A posterior view of a 3-dimensional CT image. **C:** A modified right lateral view of a 3-dimensional CT image. LAA = left atrial appendage; LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

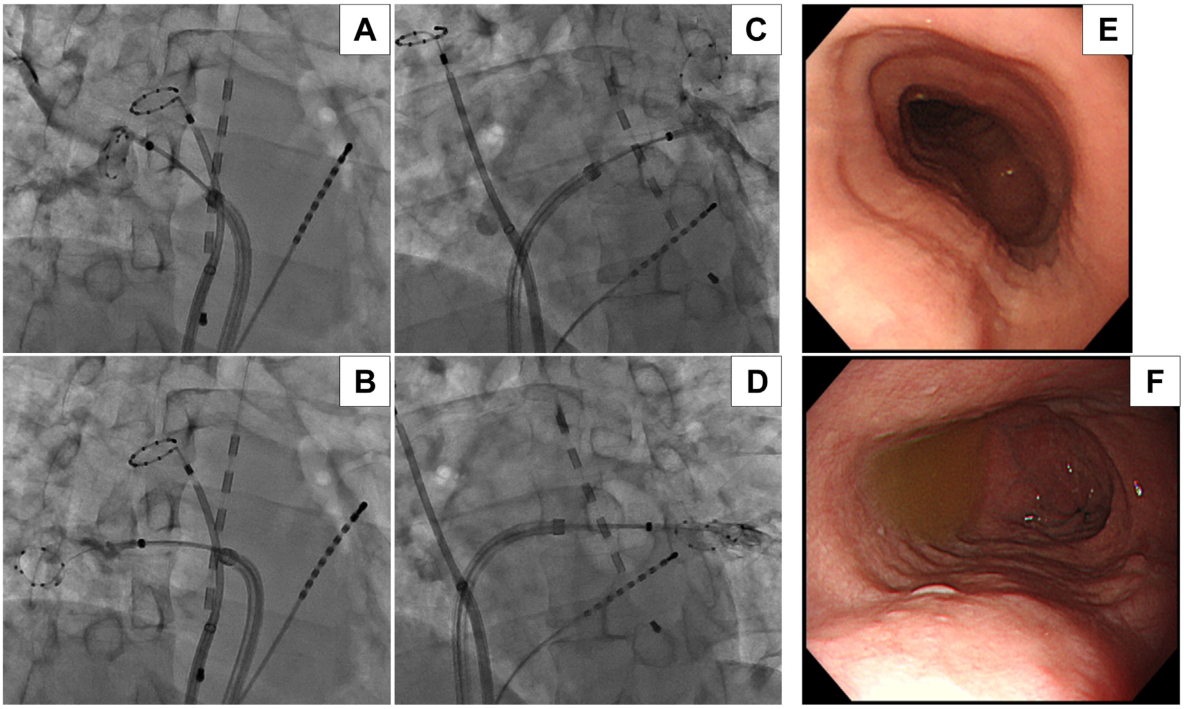

Figure 3 Intraprocedural fluoroscopy images and postprocedural esophageal endoscopic images. **A, B:** Right anterior oblique 35° views during contrast injection to the right superior pulmonary vein (**A**) and right inferior pulmonary vein (**B**). **C, D:** Left anterior oblique 45° views during contrast injection to the left superior pulmonary vein (**C**) and left inferior pulmonary vein (**D**). **E:** An esophageal endoscopic image obtained 2 days after the procedure. **F:** An image obtained 1 week after the procedure. No abnormal finding was observed in the esophageal mucosa in both images.

Discussion

Several reports suggest a close relationship between AF and esophageal achalasia. Owing to the collateral injury to the vagus nerve supplying the lower esophageal sphincter, AF ablation can cause secondary esophageal achalasia.[6] Inversely, esophageal achalasia can cause AF owing to left atrium compression by the dilated esophagus.[7] In this case, AF occurs regardless of food intake and did not improve after peroral endoscopic myotomy. Therefore, we considered that the patient's AF was not associated with mechanical stimulation from the dilated esophagus.

Despite the development of techniques to prevent esophageal injury, esophageal injury is still a concern in AF ablation. The severity of the injury can range from mild inflammation or erythema to more serious complications such as atrial-esophageal fistula. Although atrial-esophageal fistula has been reported to occur in $<0.1\%$ of cases, it is associated with a high mortality rate of $>50\%$.[8] Esophageal achalasia may increase the risk of esophageal injury owing to the proximity of the dilated esophagus to the posterior wall of the left atrium. Furthermore, a deranged esophageal tissue structure may lead to mechanical injury vulnerability. Of note, esophageal achalasia can cause atrial-esophageal fistula regardless of AF ablation.[9] There are only a few case reports of AF ablation performed in a patient with esophageal achalasia. Fukaya and colleagues[4] reported a case where radiofrequency ablation was performed with precise temperature monitoring using the steerable esophageal thermometer. We used the steerable esophageal thermometer according to this report. Conversely, Dale and Nazer[10] chose a cryoablation approach with conservative thresholds for nadir esophageal temperature. Based on the previous study[11] that revealed a low incidence of atrial-esophageal fistula after cryoballoon ablation, a cryoballoon approach was opted for in this case. However, whether data from usual AF patients can be applied to patients with esophageal achalasia remains unclear. Therefore, serial esophageal endoscopic examinations were conducted to assess changes in esophageal mucosa, which fortunately revealed no abnormal findings.

High-power, short-duration radiofrequency ablation has been proposed as a potential method to shift from conductive heating to resistive heating, which may reduce the risk of esophageal injury.[12] However, it is unclear whether this approach is effective for patients with esophageal achalasia, given the potential risk for resistive heating of the esophagus owing to the close proximity between the esophagus and the left atrium. Pulsed-field ablation is a nonthermal ablative modality in which high-voltage ultrashort pulses are applied to target tissue. Owing to its tissue selectivity, pulsed-field ablation is less likely to cause esophageal injury in PV isolation.[2] Although pulsed-field ablation is unavailable in our country at present, this novel ablative modality may contribute to a safer ablation in patients with esophageal achalasia.

In consultation with a gastroenterologist, we decided to have the patient fast for 1 week. We chose this duration because we had no prior experience with AF ablation in patients with esophageal achalasia. Although the patient was accustomed to fasting owing to previous surgery for esophageal achalasia, this approach may be challenging for typical patients. Further discussion is necessary to determine the optimal duration of the fasting period.

To the best of our knowledge, this is the first report that verified the safety of a cryoballoon approach with serial esophageal endoscopic examinations in a patient with esophageal achalasia. However, the outcome of AF ablation should be assessed in more patients with esophageal achalasia, as the risk of esophageal injury may be affected by several factors, such as the severity of the disorder.

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