

# Hemoptysis after five months of cryoballoon ablation: What is the relationship?



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## Introduction

Cryoballoon ablation with pulmonary vein isolation is a novel technology for the treatment of atrial fibrillation. Its efficacy was established after the introduction of the second-generation cryoballoon (CB-2).<sup>1</sup> Cryothermal energy is known to be safer than other energy sources.<sup>2</sup> However, some reports have shown an increasing rate of phrenic nerve palsy and elevated myocardial biomarker levels after CB-2 ablation compared with ablation using the first-generation cryoballoon (CB-1).<sup>3,4</sup> The long-term safety of the CB-2 is not well known. We report a patient with atrial fibrillation treated by CB-2 with subsequent hemoptysis associated with pulmonary vein stenosis 5 months after the procedure.

## Case report

A 63-year-old man underwent catheter ablation for drug-refractory symptomatic paroxysmal atrial fibrillation. Pulmonary vein (PV) isolation was performed successfully using a 28-mm second-generation cryoballoon (Arctic Front Advance; Medtronic, Minneapolis, MN). The procedure was performed successfully without additional ablation. The structures of the left atrium and PV were not specific. The diameter of each PV was 20.1 mm × 8.6 mm in the left superior PV, 18.2 mm × 9.4 mm in the left inferior PV, 18.1 mm × 12.7 mm in the right inferior PV, and 19.4 mm × 14.8 mm in the right superior PV. Cryoballoon application was performed once for each PV for 180 seconds. The balloon nadir temperature reached −65°C in the left superior PV, −37°C in the left inferior PV, −59°C in the right inferior PV, and −59°C in the right superior PV. Occlusion at the ostium was difficult in the left superior PV but was performed successfully by strong

push with deep engagement (Figure 1A and B). The temperature decreased immediately (Figure 2). After the procedure, atrial fibrillation was absent and anticoagulation therapy (apixaban 10 mg/day) was discontinued 3 months after ablation.

Five-and-a-half months after the procedure, the patient suddenly experienced hemoptysis. The origin of the bleeding was not identified on esophagogastroduodenoscopy or laryngofibroscope. Chest computed tomography (CT) did not show a pulmonary infiltrative shadow. After admission, bronchofibroscope showed considerable coagulation in the left lower trachea. Fresh bleeding with coughing was observed at segment 4–5 of the left lung (Figure 1C). Hemoptysis did not improve following angiographic bronchial artery obstruction via the aorta. More than 100 mL of hemoptysis was seen many times during 1 day and the blood oxygen saturation level decreased. The serum hemoglobin level was decreased by 2 mL/dL at 2 days after admission. After 3 days of hospitalization, the cause of hemoptysis was not clear and the bleeding was uncontrollable. Because a large amount of hemoptysis might induce suffocation, the patient was transferred for surgery.

Intraoperatively, we found abnormal development and dilatation of the bronchial artery. Extraction of the left lung lingular segment was performed, which improved hemoptysis. After surgery, the patient had mild dyspnea but hemoptysis was not evident. Severe stenosis of the left superior PV and complete occlusion of the PV from the lingular segment (Figure 3) were revealed when a 3-dimensional CT image was constructed and then evaluated by cardiologists after surgery. Therefore, PV stenosis caused by cryoballoon ablation and hemoptysis was suggested.

**KEYWORDS** Atrial fibrillation; Hemoptysis; Second-generation cryoballoon; Pulmonary vein isolation; Pulmonary vein stenosis (Heart Rhythm Case Reports 2017;3:357–359)

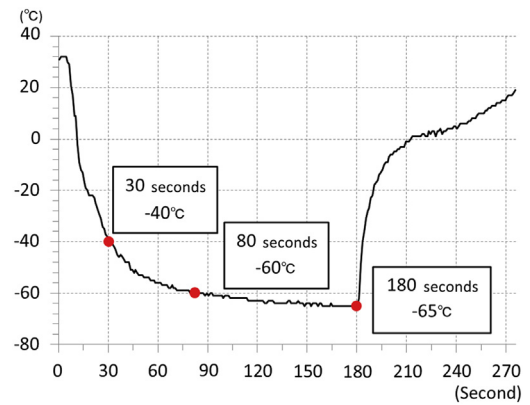
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## Discussion

To our knowledge, this is the first report to use extraction of the lung to treat uncontrolled hemoptysis after cryoballoon ablation. Hemoptysis after PV isolation with a cryoballoon can be classified into 2 groups according to the time period: acute-phase or

### KEY TEACHING POINTS

- If hemoptysis occurs long after cryoballoon ablation, pulmonary vein stenosis and occlusion must be suspected.
- An excessive decrease in temperature and deep balloon engagement should be avoided to prevent complications such as pulmonary vein stenosis.
- The proximal seal technique is useful for avoiding a deep balloon position.



**Figure 2** Temperature trend of the left superior pulmonary vein. At 30 seconds, the temperature was  $-40^{\circ}\text{C}$ . The balloon temperature reached  $-60^{\circ}\text{C}$  at 80 seconds. The nadir temperature was  $-65^{\circ}\text{C}$ .

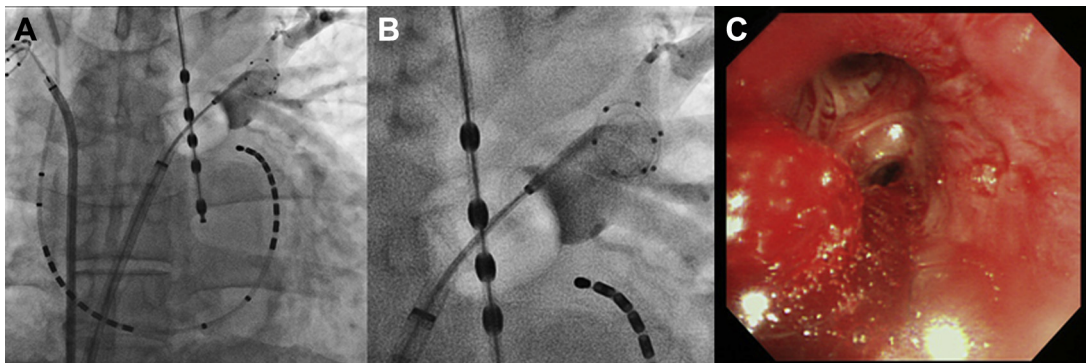
chronic-phase hemoptysis. During the acute phase, hemoptysis that occurs soon after the procedure is frequently reported as the result of anticoagulation therapy or direct injury of the bronchus by extremely low balloon temperature. This type of hemoptysis can be improved gradually without additional treatment.<sup>5-7</sup> On the other hand, hemoptysis that occurs several months after the procedure has been rarely reported. There was 1 report of hemoptysis that occurred 3 months after the procedure; this case suggested an association between PV stenosis and hemoptysis.<sup>8</sup> Our case also suggested an association between severe stenosis and occlusion of the PVs.

When the cause of hemoptysis is considered, abnormal development and dilatation of the bronchial artery among the surgical findings might be important. The suspected mechanism of hemoptysis is described here. In general, the lung itself is dominated by both the pulmonary and bronchial arteries. PV stenosis and obstruction induce lung circulatory stagnation and pulmonary artery dysfunction. This stagnation causes ischemia of the lung. This ischemia leads to overgrowth and abnormal development of the bronchial artery, which eventually dominates the ischemic lung and causes congestion in the lung because blood cannot flow to the left atrium. Finally, this rapidly developed fragile artery induces hemoptysis. Hemoptysis occurs in the chronic phase after the procedure because time is required for the artery to grow. This case indicates a possible causative mechanism for hemoptysis after atrial fibrillation ablation. Based on the results, we can suggest

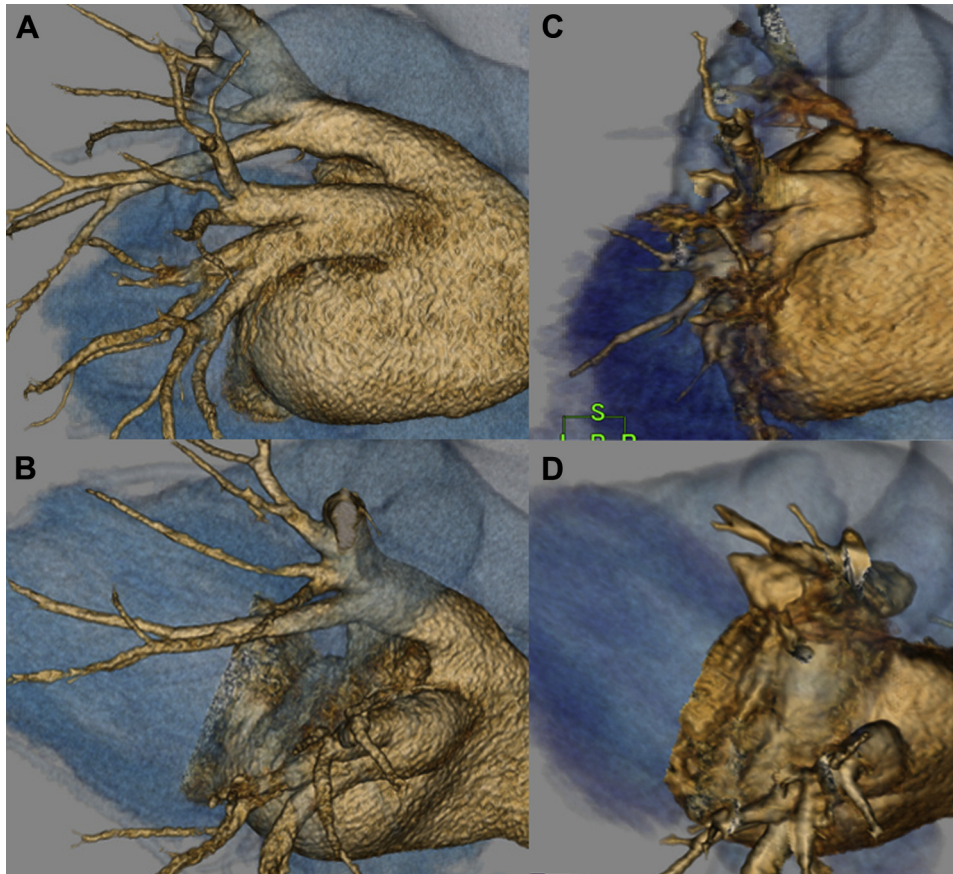
that PV stenosis should be considered when hemoptysis is discovered in the chronic phase after ablation.

PV stenosis is an uncommon complication with cryoballoon ablation. Although cryothermal energy is known to be safe compared with other energy sources,<sup>2</sup> PV stenosis associated with cryoballoon ablation has been reported.<sup>9</sup> Because a systematic investigation of asymptomatic patients with PV stenosis was not performed, the risk factors for stenosis are not clear. In this case, the deep position of the balloon was considered the main cause. The balloon might have been positioned deeper more easily because the left superior PV branched from the center of the left atrium and the long PV had a constant thickness throughout. Although the balloon was not out of the cardiac shadow on angiography, it was not a complete circle (Figure 1B). In fact, the temperature at 30 seconds was  $-40^{\circ}\text{C}$ ; this rapid decrease in temperature has been suggested to cause deep positioning of the balloon. Furthermore, the temperature reached  $-60^{\circ}\text{C}$  at 80 seconds and the balloon stayed below  $-60^{\circ}\text{C}$  for 100 seconds (Figure 2). The proximal seal technique is very useful for avoiding deep positioning.<sup>10</sup>

An accurate diagnosis might be difficult for our patients because of the longer interval between cardiac ablation and the occurrence of hemoptysis. If the relationship between PV stenosis and hemoptysis is considered before surgery,



**Figure 1** A, B: The deep position and incomplete circle of the balloon in the left superior pulmonary vein can be seen in angiography. C: Considerable blood volume in the left lower trachea and coagulation and blood outflow with coughing was observed on bronchofibroscopy at segment 4-5 of the left lung.



**Figure 3** No pulmonary vein stenosis was observed on contrast-enhanced computed tomography (A, B; preablation). Five-and-a-half months after ablation, severe stenosis of the left superior pulmonary vein and complete occlusion of the pulmonary vein for the lingular segment were observed (C, D).

then the decision to use catheter dilatation for extensive PV stenosis and occlusion might be considered the primary treatment. Construction of a 3-dimensional CT image might be useful to evaluate the stenosis after catheter ablation.

## Conclusions

In conclusion, an excessive decrease in temperature and deep balloon engagement should be avoided to prevent the aforementioned complications and PV stenosis. We should consider PV stenosis when hemoptysis or other pulmonary symptoms occur long after cryoballoon ablation.

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