

# Severe sphincter of Oddi spasm after cryoballoon ablation: a case report of an unusual complication after atrial fibrillation ablation

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## Background

Perioesophageal vagal nerve (VN) injury after atrial fibrillation (AF) ablation remains an important complication. The VN provides parasympathetic innervation to the majority of the abdominal organs—including the stomach and the sphincter of Oddi (SO)—and regulates smooth muscle contraction. We present an unusual case of SO spasm induced by VN injury after cryoballoon ablation (CBA).

## Case summary

A 71-year-old woman presented to our institution with paroxysmal AF. The patient had a history of cholecystectomy and SO dysfunction. She had undergone CBA for AF. Immediately after the procedure, the patient developed epigastric pain. Computed tomography showed dilation of the intra- and extrahepatic bile ducts, with the diameter of the common bile duct measuring ~15.6 mm. Blood tests on postoperative Day 1 revealed severely elevated aminotransferase levels (aspartate aminotransferase, 3156 U/L; alanine aminotransferase, 2084 U/L; lactate dehydrogenase, 2279 U/L; total bilirubin 1.7 mg/dL).

## Discussion

It is known that VN denervation induces SO spasms. The right and left vagal trunks descend alongside the oesophagus, forming a perioesophageal plexus and innervating most of the gastrointestinal organs. In our case, SO spasm was induced as a result of the perioesophageal plexus injury caused by CBA. Underlying SO dysfunction and post-cholecystectomy also played an important role. Coupled with the absence of the gallbladder, which is the reservoir of bile juice and coordinator of SO, SO spasm caused severe elevation of the bile duct pressure. Care should be taken when performing AF ablation with regards to the stomach and the SO.

## Keywords

Cryoballoon ablation • Atrial fibrillation • Vagal nerve injury • Sphincter of Oddi • Cholecystectomy • Epigastric pain • Case report

## ESC Curriculum

5.3 Atrial fibrillation • 5.4 Atrial flutter

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## Learning points

- The vagal nerve and its branches are anatomically closely proximal to the posterior wall of the left atrium and innervate most of the upper gastrointestinal system, such as the stomach, gallbladder, and sphincter of Oddi (SO).
- Sphincter of Oddi spasm induced by perioesophageal vagal nerve injury after cryoballoon ablation provoked severe epigastric pain.
- When a patient is suffering from epigastric pain and a computed tomography scan shows a distended bile duct without any obstructive lesions, we should suspect SO spasm.

## Introduction

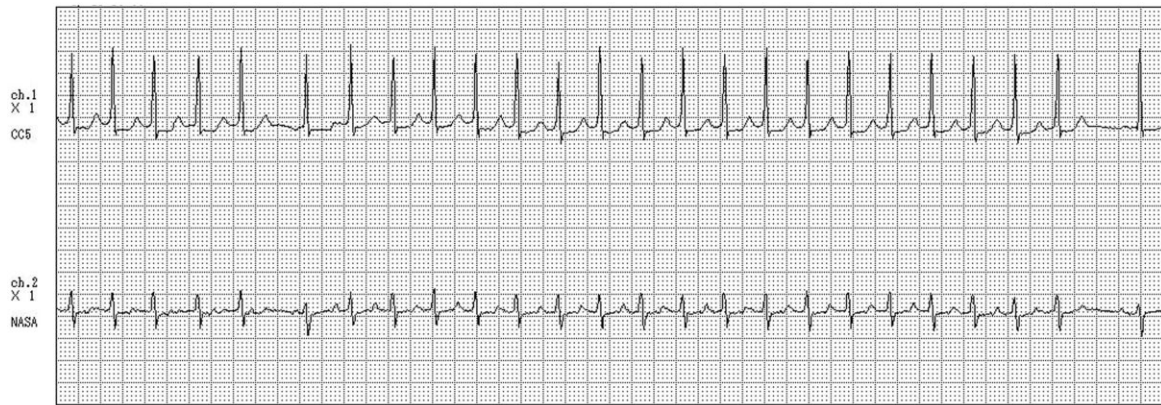
Atrial fibrillation (AF) is the most common type of cardiac arrhythmia. Pulmonary vein isolation (PVI) is widely accepted as the cornerstone of AF ablation procedures. While the overall complication rates for AF ablation are acceptably low, the development of oesophagus-related collateral damage, such as perioesophageal vagal nerve (VN) injury, remains an important complication.<sup>1</sup> Anatomically, the VN and its branches are closely proximal to the posterior wall of the left atrium (LA) and innervate most of the upper gastrointestinal system, such as the stomach, gallbladder, and sphincter of Oddi (SO).<sup>2,3</sup> We present an unusual case of SO spasm induced by VN injury after cryoballoon ablation (CBA), causing severe epigastric pain and elevated aminotransferases.

## Timeline

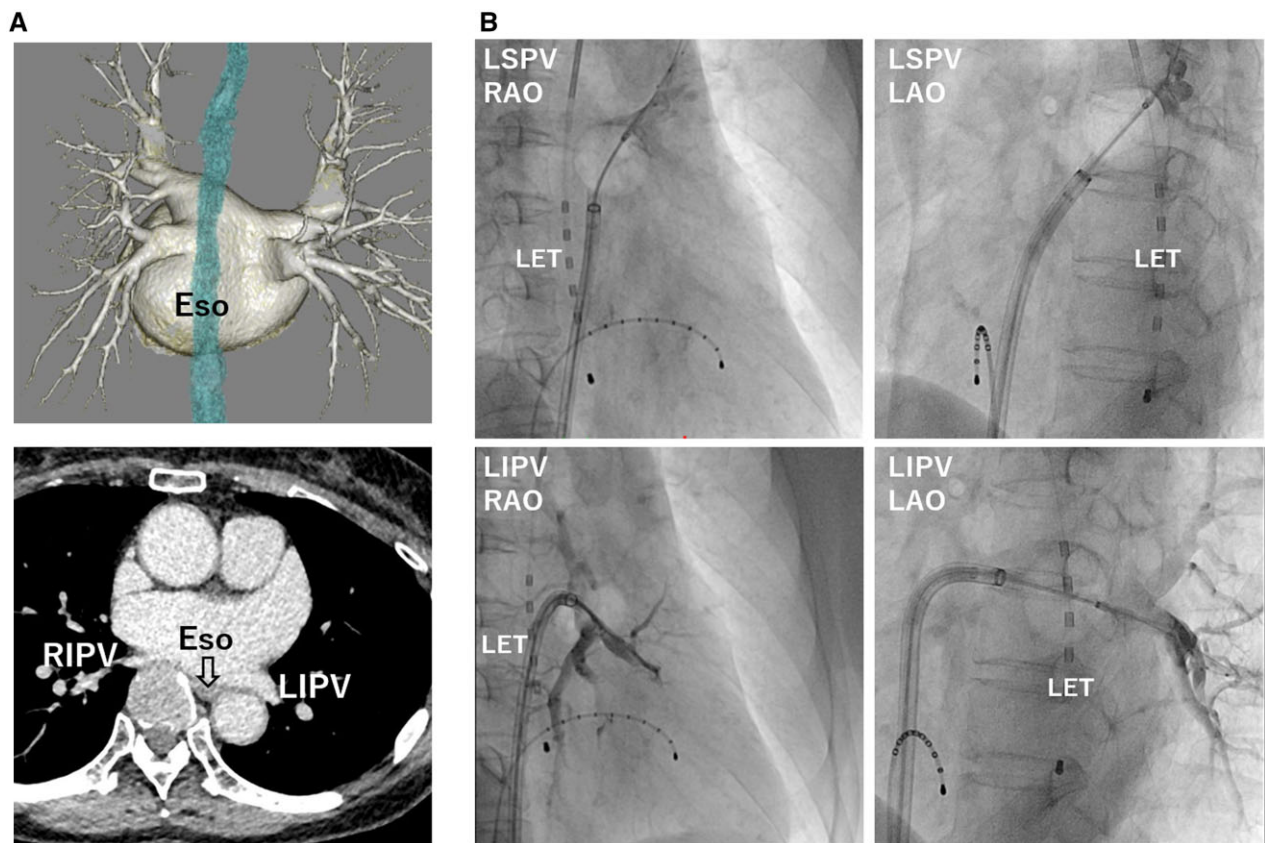
Time	Events
30 years prior	Underwent cholecystectomy for cholelithiasis
145 days prior	Presented to our institution with paroxysmal atrial fibrillation. The patient also reported experiencing recurrent epigastric pain after cholecystectomy, which was relieved with nitrates
90 days prior	Coronary angiography revealed moderate (FFR negative), mid-segment left anterior descending artery stenosis
Day 0	
13:40	Patient was transferred to the operating room for cryoballoon ablation for atrial fibrillation
14:00	Ablation initiated
14:30	Cryoballoon ablation of the left pulmonary vein
15:03	Ablation completed and intravenous anaesthesia stopped
15:20	The patient experienced epigastric pain
16:05	Computed tomography scan showed distended common bile duct due to the sphincter of Oddi spasm
16:30	Intravenous nitroglycerine administration relieved her symptom
Day 1	Blood tests on postoperative Day 1 revealed severely elevated aminotransferase levels. However, patient's symptoms were completely relieved
Day 5	Patient's liver enzyme levels were almost normalized
Day 6	The patient was discharged on postoperative day 6

## Case presentation

A 71-year-old Japanese woman presented to our institution with highly symptomatic paroxysmal AF refractory to antiarrhythmic drugs (Figure 1). The patient had a history of cholecystectomy. She reported experiencing recurrent epigastric pain after cholecystectomy, which was relieved with nitrates. Coronary angiography revealed moderate (fractional flow reserve negative), mid-segment left anterior descending artery stenosis. Magnetic resonance cholangiopancreatography showed no obstructive lesions, such as stones or tumours in the biliary tract. The patient was diagnosed with SO dysfunction. Apixaban 5 mg twice daily and cibenzoline 50 mg thrice daily were prescribed. Her blood pressure was 130/55 mmHg, and physical examination revealed normal heart sounds, no jugular venous distention, or pedal oedema. Transthoracic echocardiography revealed normal biventricular function with an LA diameter of 33 mm and LA volume index of 16 mL/m<sup>2</sup>. The preprocedural computed tomography (CT) scan is shown in Figure 2A, and left atrial appendage thrombus was not detected with the delayed phase acquisition protocol. The patient underwent CBA for AF with the procedure as follows: PVI was performed under deep sedation. Midazolam (4 mg bolus), thiopental (100 mg bolus), and propofol (170 mg) were continuously infused. Luminal oesophageal temperature was monitored. A 28-mm cryoballoon (CB) (Arctic Front Advance; Medtronic, Inc., Minneapolis, MN, USA) was applied for 180 s to the right superior, right inferior, and left superior pulmonary vein (PV) and for 150 s to the left inferior PV. During right PV ablation, the phrenic nerve was paced at 50 b.p.m. from the superior vena cava while recording diaphragmatic compound motor action potentials (CMAPs). Cryoablation was immediately interrupted if a 30% reduction in CMAP amplitude was observed, or if the oesophageal temperature was below 15°C. The fluoroscopic images are shown in Figure 2B and the details of the procedure are presented in Table 1. All PVs were successfully isolated after single application. Transient phrenic nerve injury was observed during right superior PV ablation at 83 s. After complete recovery of diaphragmatic movement, an additional CB application was delivered to the right superior PV for 90 s. Vital signs were stable during the procedure, and the procedure time was 63 min. Approximately 15 min after the procedure, the patient experienced epigastric pain. Electrocardiogram monitoring was consistent with sinus tachycardia without ST-T segment changes. Transthoracic echocardiography demonstrated that her cardiac wall motion was normal and no evidence of pericardial effusion, which excluded the possibility of coronary spasm, coronary air embolism, and cardiac tamponade. An immediate CT scan of her abdomen ruled out acute pyloric spasm, but surprisingly, dilation of the intra- and extrahepatic bile duct, with the diameter of the common bile duct (CBD)



**Figure 1** Holtter electrocardiogram showing paroxysmal atrial fibrillation.



**Figure 2** (A) Volume renderings and axial view of the left atrium, pulmonary vein, and oesophagus. The oesophagus located between the left inferior pulmonary vein and vertebra. (B) The positional relationship between the oesophagus and cryoballoon during the procedure.

measuring ~15.6 mm, was observed (Figure 3A). Intravenous nitroglycerine administration successfully relieved her symptoms. Blood tests on postoperative day 1 revealed severely elevated aminotransferase levels [aspartate aminotransferase, 3156 U/L (normal value 8–38); alanine aminotransferase, 2084 U/L (normal value 4–44); lactate

dehydrogenase, 2279 U/L (normal value 106–211); total bilirubin 1.7 mg/dL (normal value 0.2–1.2)]. However, her symptoms were completely relieved on post-operative day 1, without any additional treatment. On post-operative day 5, her liver enzyme levels were almost normalized (aspartate aminotransferase, 86 U/L; alanine

**Table 1** Procedure-related data

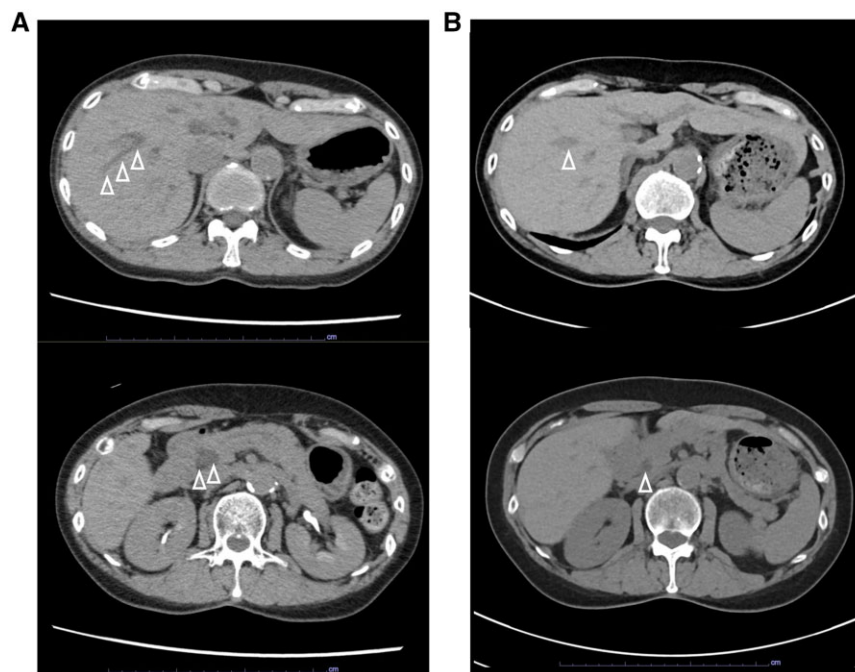
Variables	LSPV	LIPV	RSPV	RIPV
Minimal temperature (°C)	-56	-42	-48	-43
Occlusion grade	4	4	4	4
Total freezing duration (s)	180	150	174	180
Minimal oesophageal temperature (°C)	33	22	36	36
Number of applications	1	1	2	1

LIPV, left inferior pulmonary vein; LSPV, left superior pulmonary vein; RIPV, right inferior pulmonary vein; RSPV, right superior pulmonary vein.

aminotransferase, 403 U/L; lactate dehydrogenase, 175 U/L; total bilirubin 1.0 mg/dL) (Table 2), and a CT scan revealed that the bile duct distension had improved (Figure 3B). The patient was discharged on postoperative day 6. During a follow-up period of 12 months, the patient remained free of any AF episodes without the need for antiarrhythmic drugs.

## Discussion

We report the first case of SO spasm after CBA for AF. Two important nerve injuries are associated with AF ablation: phrenic- and peri-oesophageal VN injury. The phrenic nerve originates from the



**Figure 3** Computed tomography images immediately after ablation procedure (A), and 5 days after the procedure (B). White triangles indicate dilated intra and extrahepatic bile duct. The bile ducts were distended, and the diameter of common bile duct was ~15.6 mm post-procedure. The distension of the bile ducts notably improved 5 days after the procedure and the diameter of common bile duct was reduced to ~6.5 mm. CT, computed tomography; CBD, common bile duct.

**Table 2** Trend of laboratory data

	1 day prior to ablation	Day 1	Day 2	Day 5	Day 20	Reference range
AST	20	3156	807	86	23	8–38 U/L
ALT	19	2084	1206	403	28	4–44 U/L
LDH	183	2279	339	175	161	106–211 U/L
TBIL	1.1	1.7	1.3	1.0	0.9	0.2–1.2 mg/dL
AMY	74	NA	NA	68	40	41–112 U/L
GGT	23	NA	NA	180	82	16–73 U/L

ALT, alanine transferase; AMY, amylase; AST, aspartate transferase; GGT, gamma-glutamyltranspeptidase; LDH, lactate dehydrogenase; NA, not available; TBIL, total bilirubin.

cervical spinal roots C3, C4, and C5. The right phrenic nerve descends along the pericardium of the right atrium and innervates the diaphragm. The phrenic nerve is anatomically close to the right PV; therefore, right PV CBA could result in right phrenic nerve palsy (2.7–11.2%).<sup>4,5</sup> In contrast, the VN originates from the medulla of the brainstem. In the thorax, the right and left vagal trunks descend alongside the oesophagus, forming a perioesophageal plexus. The VN provides parasympathetic innervation to the majority of abdominal organs and regulates smooth muscle contraction. Phrenic nerve injury is more common in case of CBA than in radio-frequency ablation. Further, gastrointestinal complications (which are the result of perioesophageal VN injury) are similar in CBA and radio-frequency ablation.<sup>4</sup> Perioesophageal VN injury is a widely recognized complication after PVI and commonly manifests as gastric hypomotility.<sup>6</sup> However, it is known that coeliac VN denervation induces SO spasm. Several animal studies have reported that the stimulation of the VN inhibits the electrical activity of the SO.<sup>7,8</sup> There are variations in the anatomy of the perioesophageal plexus: anterior plexus only (34%), posterior plexus only (19%), both anterior and posterior plexus (43%), and no communicating fibres (4%). The perioesophageal plexus forms the anterior and posterior vagal trunk in the abdomen. In general, the anterior vagal trunk is a continuation of the main fibres of the left vagal trunk and innervates the stomach and liver. On the other hand, the posterior vagal trunk, which mainly comes from the right vagal trunk, innervates the stomach and forms the coeliac plexus, the branch of which innervates the sphincter of Oddi, gallbladder, pancreas, and intestine.<sup>9</sup> In the present case, CB attached left-sided PVs approximate the anterior and left side of the oesophagus. Therefore, left vagal trunk (which is the upper part of the anterior vagal trunk) denervation should mainly occur in theory. However, the patient's symptoms were associated with posterior vagal trunk denervation. Variations in the perioesophageal plexus can explain this paradoxical response. If the patient had an anterior perioesophageal plexus, CBA to the left-sided PVs will approximate the anterior and left side of the oesophagus, affecting both the anterior and posterior vagal trunk.

Underlying SO dysfunction and post-cholecystectomy also played an important role in our case. The diagnostic criteria for SO dysfunction are as follows: recurrent epigastric pain lasting more than 30 min and no evidence of structural abnormalities. Cholecystectomy has been suggested as a risk factor for SO spasm in humans.<sup>10</sup> There is evidence that sphincter dynamics are altered after cholecystectomy. Animal studies have shown a cholecystosphincteric reflex with distention of the gallbladder that results in SO relaxation. Interruption of this reflex could affect SO behaviour by an altered response to cholecystokinin, or because the loss of innervation unmasks the direct contractile effects of cholecystokinin on smooth muscle.<sup>11</sup> The activity of the SO is controlled by multiple neurotransmitters, hormones and dysregulation can result in the elevation of the bile duct pressure.<sup>3</sup> In the absence of the gallbladder, morphine, fentanyl, codeine, and pentazocine increase the contraction of SO and elevate the biliary pressure.<sup>10,12,13</sup> These medications were not used in the present case.

In our case, coupled with the absence of the gallbladder, which is the reservoir of bile juice and coordinator of SO, SO spasm induced by VN injury after CBA greatly elevated the bile duct pressure. Although VN injury after CBA has been widely reported, its

mechanism and true prevalence, including those of asymptomatic cases, are still unknown. As the VN innervates most of the upper gastrointestinal system, care should be taken when performing AF ablation with regards to the stomach, gallbladder, and SO. Computed topography and magnetic resonance cholangiopancreatography are useful tools for the diagnosis of SO spasm. Once the imaging scan reveals a distended bile duct without an obstructive lesion, medical therapy, such as nitrates, calcium-channel blockers, and glucagon, should be administered for pain relief.<sup>10</sup>

## Conclusions

Here, we report the first case of SO spasm induced by VN injury after CBA. Physicians who perform AF ablations should recognize this rare complication and what is known about its postulated mechanism.

## Lead author biography



Dr Yusuke Hayashi completed his medical degree in Japan in 2007. He specializes in interventional electrophysiology and device therapy. He graduated from a doctoral course in Osaka City University Graduate School of Medicine in 2017. He is now working as a medical director in Cardiovascular Medicine at Osaka City General Hospital.

## Supplementary material

[Supplementary material](#) is available at *European Heart Journal - Case Reports* online.

**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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