Near-Fatal Coronary Artery Spasm During Cryoballoon Pulmonary Vein Isolation
An Unreported Complication

Heiko Lehrmann, MD; Clemens Potocnik, MD; Thomas Comberg, MD; Wolfgang Peck, MD; Alaa Salama, MD; Jens Schneider, Tech; Chan-il Park, MD; Amir S. Jadidi, MD; Reinhold Weber, MD; Thomas Arentz, MD

Case Report
A 50-year-old nonsmoker with paroxysmal atrial fibrillation was referred to our hospital for pulmonary vein isolation (PVI). He had a known 1-vessel coronary artery disease. Because of stable angina, a drug-eluting stent had been implanted into the midportion of the left anterior descending artery in 2010. Otherwise he was healthy. His medical treatment included warfarin, sotalol, an angiotensin-converting enzyme-inhibitor and a statin. Cryoballoon-PVI (Arctic Front Advance 28 mm; Medtronic) was scheduled under general anesthesia (international normalized ratio, 2–9; minimal activated clotting time, 300 s). After transseptal access, the left PV were targeted first, followed by the right inferior PV and right superior PV, respectively. PVI of all PVs could be visualized in real-time and gained within 40 s. Two freeze–thaw cycles were used for each PV, except for the left superior PV, which had to be treated 3x, because of an initially ineffective freeze (Table I in the Data Supplement ). The procedure had been uneventful, until a sudden blood pressure drop occurred (70/40 mmHg), immediately after the second right superior PV-freeze. Cardiac tamponade was excluded. Twelve-lead ECG revealed global ST-depression and progressive ST-elevation in aVR, consistent with coronary main stem occlusion (Figure 1). Pulseless electric activity developed rapidly, necessitating cardiopulmonary resuscitation. Coronary angiography showed a severe spasm of the left coronary main stem, without evidence for air- or thromboembolism (Figure 2A), which could be completely reverted by balloon dilatation and intracoronary nitroglycerine administration (Figure 2B). The right coronary artery showed a less severe spasm, which was treated by nitroglycerine alone (Figure 3A and 3B). Immediately after coronary reperfusion, ventricular fibrillation occurred, affording several direct current shocks. Because of severe global myocardial stunning, without effective myocardial contractions, an extracorporeal cardiac life support system (veno-arterial extracorporeal cardiac life support system) had to be implanted. Myocardial stunning reverted completely during the following 5 days, and the patient could be weaned from the extracorporeal cardiac life support system. He survived without any major focal neurologic deficit, but impairment of short-term memory was apparent during follow-up. Predischarge echocardiography showed normal biventricular function without wall motion abnormalities. About the used cryoballoon device, the manufacturer excluded a technical malfunction.

Discussion
In this case report, to date, we describe an unreported serious complication of a near-fatal coronary artery main stem spasm during cryoballoon-PVI. We suspect cryoenergy-induced blood cooling, as the most likely trigger, rather than a direct ablation effect, given the distance between the pulmonary veins and the left main stem (Figure 1 in the Data Supplement). Further evidence for this theory is provided in Figure 1, which retrospectively showed progressive development of T wave inversion and ST depression in the 12-lead ECG, already starting after the first cryoenergy application. These changes were not noticed earlier because the procedure was performed using only a limited number of real-time monitored ECG leads (I, III, aVF, V1, V6). Furthermore, the Manufacturer and User Facility Device Experience-database of the US Food and Drug Administration (FDA MAUDE-database), lists 4 additional adverse events related to ST-segment changes with hemodynamic deterioration during cryoballoon-PVI.1 Noteworthy, only 2 of these 4 patients survived. Despite scarce details, a coronary vasospasm (left anterior descending and right coronary artery, respectively) occurred in ≥2 of these cases. Therefore, we suspect cold-induced coronary vasospasm as the unifying mechanism in susceptible patients, analogous to the formerly used cold pressure test to induce coronary vasospasm.2

As a consequence, cryoballoon-PVI should not be performed in patients with known or suspected coronary artery...
vasospasm. In addition, the 12-lead ECG should be continuously monitored throughout the procedure with special attention to ischemic changes. This case report also stresses the need for an onsite surgical support to prevent fatality in such cases. Additional studies will be needed to assess the incidence of this potentially fatal complication and to guide proper patient selection for cryoballoon PVI.

Disclosures

None.

References

1. www.fda.gov/MedicalDevices/Safety.

KEY WORDS: ablation techniques ■ coronary vasospasm

![Figure 1](http://circrg.ep.ahajournals.org/)

**Figure 1.** Progressive ECG changes during cryoballoon-pulmonary vein isolation (PVI). ECG tracings during the procedure are shown in chronological order. **Left,** The resting ECG at the beginning of the procedure. The following panels depict progressive ECG changes after ablation of the respective PVs (minor changes are marked with an arrow). **Right,** The ECG directly before cardiac arrest. CPR indicates cardiopulmonary resuscitation; LIPV, left inferior pulmonary vein; LSPV, left superior pulmonary vein; RIPV, right inferior pulmonary vein; and RSPV, right superior pulmonary vein.

![Figure 2](http://circrg.ep.ahajournals.org/)

**Figure 2.** Left main stem spasm. **A,** Coronary angiography detects severe left main stem spasm as the cause of cardiac arrest. Of the contrast-filled aorta, a filiform left main stem originates (white circle). The left anterior descending and circumflex artery are nearly invisible. The white arrow shows a stent in the anterior descending artery. **B,** Coronary angiography after balloon dilatation of the left main stem and intracoronary nitroglycerine injection shows normal left coronary arteries.

![Figure 3](http://circrg.ep.ahajournals.org/)

**Figure 3.** Less severe spasm in the right coronary artery. **A,** Coronary angiography of the right coronary artery also shows minor spasm. **B,** After intracoronary injection of nitroglycerine the spasm resolves completely.
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SUPPLEMENTAL MATERIAL

Video Legend:

Video 1: Left main stem spasm. 
Coronary angiography during cardiac arrest illustrates severe left main stem spasm. Importantly, there is no evidence of thrombo- or airembolism to the coronary arteries. Of note, resuscitation was only shortly paused during contrast injection.

Video 2: Restored blood flow to the left coronary arteries. 
Coronary angiography during cardiopulmonary resuscitation shows restored coronary blood flow after balloondilatation of the left main stem and intracoronary injection of nitroglycerine.

Tables

Table 1: Procedural Details

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LIPV = left inferior pulmonary vein, LSPV = left superior pulmonary vein, RIPV = right inferior pulmonary vein, RSPV = right superior pulmonary vein.
Supplemental Figure

Supplemental Figure 1: Distance between left main stem and LSPV.

Computed tomography scan depicting the anatomic relation between the left main stem, the adjacent left atrial appendage (LAA) and the left superior pulmonary vein (LSPV).