Left Main Coronary Spasm During Cryoballoon Ablation for Atrial Fibrillation: A Case Report and Literature Review

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Abstract

Well known adverse effects of cryoablation are phrenic nerve and esophageal injury. (1, 2) However, there is very little literature about coronary artery spasm (CAS), a life-threatening complication of cryoablation. We report a case of a 68-year-old Caucasian female, who developed left main coronary spasm (CAS) with significant hemodynamic compromise during cryoablation. Although rare, this complication can be life threatening. Prompt recognition and appropriate intervention is critical for good patient outcome.

Introduction

Pulmonary vein isolation is a common procedure to treat atrial fibrillation. Well known adverse effects of cryoablation are phrenic nerve injury and esophageal ulceration. (1, 2) There have been very few reports of coronary artery spasm (CAS), which could potentially be a life-threatening complication, as an adverse outcome of cryoablation. (3) The few available reports have been mostly in Japanese patients, who are known to have a higher prevalence of vasospastic angina (VSA) when compared to other ethnic groups. (4-6) To our knowledge, there has been only one case report of CAS in a Caucasian male patient following radiofrequency catheter ablation and no case reports of periprocedural coronary artery spasm in a Caucasian female patient undergoing cryoablation. (7) Here, we report a case of a 68-year-old Caucasian female, who while undergoing catheter cryoablation for persistent atrial fibrillation, developed severe left main coronary spasm with significant hemodynamic compromise.

Case Report

A 68-year-old Caucasian woman with a history of hyperlipidemia, hypertension and symptomatic persistent atrial fibrillation who had failed cardioversion was brought in for catheter ablation. She has no history of coronary artery disease. Transeptal puncture was performed, and the patient was properly anticoagulated. The left superior pulmonary vein (LSPV) which was the first vein to be ablated. The cryoballoon was inflated for 3 minutes and the lowest temperature achieved was 48°C the patient developed severe hypotension (systolic BP in the 50s mmHg) and profound bradycardia with heart rate down to the 20’s. Patient required temporary pacing after failure to respond to atropine (figure 1A). Cardiac tamponade was excluded. Twelve lead ECG revealed global ST segment elevation (figure 1B). Immediate coronary angiography revealed significant spasm of the left main coronary artery with no signs of air embolism (figure 2A). The right coronary artery showed no evidence of spasm. After nitroglycerine administration, the vasospasm completely resolved (figure 2B) with improvement of the patient’s clinical condition. Blood pressure returned to baseline and EKG showed resolution of the ST elevation and bradycardia (figure 1C). The procedure was resumed with no further complications.

Discussion
In this report, we describe the case of a Caucasian female patient who developed a left main CAS during cryoablation of the left superior pulmonary vein for the treatment of persistent atrial fibrillation. CAS during cryoablation-PVI was described in several cases reports, mostly in Asian population. (8, 9) To the best of our knowledge, this is the first reported case in a Caucasian female. Additionally, most of the coronary spasms were reported in the right coronary artery and very few cases described left main coronary spasms with such severe hemodynamic effects.

Lehrmann et. al was the first to report a case of CAS in a Caucasian male from Germany. In his report, EKG showed a pattern of left main stem occlusion while performing right superior pulmonary vein cryoablation. (3) A multicenter large-scale study in the Japanese population by Nakamura et al on CAS related to atrial fibrillation ablation reported a higher prevalence of CAS in cryoablation-PVI (0.34%) compared to the radiofrequency, hot balloon, or laser balloon PVI ablation (0.04%, 0%, 0% respectively). The same study reported LSPV as the most common site of ablation (64% in cryoablation and 75% in RF ablation) right before spasms happened. (5) Interestingly in this study, 100% of patients with ST-elevation during LSPV cryoablation showed EKG changes in inferior leads and 98% of all CAS cases related to all AF ablation approaches were male.

There are two possible mechanisms for a CAS during AF ablation. The first possible mechanism is that the application of a cryoablation catheter may have caused direct cooling injury to the adjacent coronary arteries. (8, 11) This is supported by the fact that CAS has been reported to occur near the cooling site after the application of a cryoablation catheter. (9, 12) There is also available data revealing the occurrence of CAS during hypothermia therapy with ice packs and chilled intravenous infusion after successful cardiopulmonary resuscitation, which supports the first mechanism. (13) It is possible that blood cooled by the cryoballoon in the left atrium flows through the coronary arteries and stimulates the coronary endothelium causing CAS.

Alternatively, the second possible mechanism, which was proposed in radiofrequency ablation, is a possible autonomic nerve activity imbalance leading to CAS. Epicardial sites near the right inferior pulmonary vein are associated with a ganglionated plexus (GP), the so-called right lower GP. Endocardial RF ablation can affect the epicardial GP through a thermal injury that may cause an imbalance in autonomic nervous activity, frequently stimulating the parasympathetic nerve, which could, in turn, induce vasospasm of the coronary artery. (14) The latter theory was used to describe the CAS happening far from the site of ablation in the Asian population. (15)

Since STE happened when we delivered cooling energy adjacent to the LSPV and responded immediately to IC nitroglycerine, we believe that the mechanism causing the severe coronary artery spasm was most probably a cryoenergy-induced blood cooling, causing transient constriction in the left coronary artery. Lehrmann et al. suggested that there might be a racial difference in the pathophysiology of CAS happening during cryoablation between the Asian and Caucasian ethnicities. Although the case by Lehrmann et al. presented with a near-fatal CAS induced by CBA(3), the patient in the present case was diagnosed in the early phase, which enabled us to proceed with CBA after CAS.

Conclusion

It is important to immediately recognize the possible occurrence of this complication during cryoballoon ablation for atrial fibrillation and take prompt actions to treat it. A thorough preoperative history should be taken to determine history suggestive of vasospastic angina. The administration of a calcium channel blocker and education on smoking cessation before ablation should be considered in these circumstances. When vagal suppression is predicted, atropine (a vagal nerve blocker) may be useful. Given that the ST changes on ECG during CBA may reflect CAS, it is necessary to carefully monitor the ECG during CBA. Additionally, we should consider performing coronary angiography when persistent ST changes with significant hemodynamic effects are observed during CBA.

References


Figure 1A: Twelve lead electrogram (ECG) showing bradycardia initially followed by ventricular paced rhythm

Figure 1B: ECG showing global ST segment elevation

Figure 1C: ECG showing resolution of ST segment elevation after nitroglycerin administration.
Figure 2: Left heart coronary angiogram showing significant spasm of the left main coronary artery intracoronary nitroglycerin (NTG).

Figure 3: Left heart coronary angiogram showing resolving of the spasm after intracoronary nitroglycerin (NTG).