Right coronary artery occlusion after radiofrequency catheter ablation of a posteroseptal accessory pathway: Lessons to avoid it

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Introduction

Radiofrequency (RF) catheter ablation is a safe and effective therapy for the treatment of most patients with recurrent atrioventricular reentrant tachycardia (AVRT).[1] In such procedure, RF is delivered on the annulus of tricuspid and mitral rings aiming to eliminate accessory pathways (AP), which can be in almost any site along the valvular rings. Despite the relative proximity to the epicardial coronary arteries (CA), coronary occlusion has been rarely reported using the conventional techniques.[2] A higher risk for this complication, however, has been reported when a high-power RF energy is delivered during cavotricuspid isthmus (CTI) ablation for typical atrial flutter,[3–5] or during AP ablation inside the coronary sinus (CS), because of the closer anatomic proximity to epicardial CA.[6] The occlusion may occur immediately during the procedure or within weeks and it is related to the extension and intensity of coronary thermal injury.[7]

We report a case of right coronary artery (RCA) thrombosis and myocardial infarction that occurred 12 hours after a redo ablation of a right posteroseptal AP.

Case report

An 18-year-old male patient without structural heart disease, with a history of recurrent episodes of severely symptomatic AVRT with frequent visits to the emergency department, despite treatment with different drugs, including class IC and III antiarrhythmics. He had been previously exposed to 4 unsuccessful RF ablations of a posteroseptal AP causing orthodromic AVRT and was referred to our institution for catheter ablation. Baseline surface electrocardiogram (ECG) showed a sinus rhythm with a PR interval of 92 ms, QRS interval of 108 ms, and corrected QT interval of 440 ms. There was evidence of preexcitation with a delta wave polarity suggestive of a right posteroseptal AP (Figure 1C and 1D). The procedure was performed after informed consent under general anesthesia by right femoral access puncture. Intravenous unfractionated heparin (5000 IU) was administered through the sheaths. An electrophysiology study was performed, and the AP was identified in the right posteroseptal region related to the CS ostium, based on the fusion of atrial and ventricular potentials with earliest activation found in the CS ostium (Figure 1A and 1C). RF energy was applied with an externally irrigated-tip 3.5 mm catheter (EP Technologies, Inc, Sunnyvale, CA) with impedance of 90–110 ohms, maximum temperature set to 43°C, and a maximum power of 30 W, in the right posteroseptal region, at the CS ostium and in the paraseptal region of the CTI. A long nonsteerable sheath (Schwart SL1 8F 2.6 mm, 63 cm; St Jude Medical, Saint Paul, MN) for catheter stabilization was necessary. After several attempts (RF application delivery for 10–15 seconds) without disappearance of the conduction by the AP, we decided to change to the right jugular vein approach. Mapping was then repeated within the CS and fusion of atrial and ventricular potentials with earliest activation was found close to the CS ostium at the proximal third of the median cardiac vein (MCV) (Figure 1B). In this region RF energy was applied in the CS ostium at 20 W for 60 seconds, finally abolishing AP conduction (Figure 1D and 1E). The procedure was terminated after 30 minutes (Figure 1F) without recovery of AP conductions (anterograde and retrograde) tested by atrial and ventricular pacing and adenosine infusion.

Twelve hours after the ablation, the patient presented with chest pain, and ST-segment elevation in the inferior ECG leads was noted without ventricular preexcitation

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KEY TEACHING POINTS

- Whenever performing accessory pathway (AP) mapping and ablation, limit test applications for a maximum of 10 seconds, and avoid extensive and repetitive radiofrequency (RF) applications when inside the coronary sinus (CS) and their ramifications.
- Previous RF ablation procedures of the inferior vena cava–tricuspid isthmus can make the local tissue thinner and leave the right coronary artery more exposed to the risk of thermal injury.
- When performing a redo RF ablation procedure, imaging studies are essential to evaluate the integrity of cardiac structures approached in previous RF ablations. A CS angiography should be performed before posteroseptal AP ablation, and a coronary computed tomography angiography in redo cases.
- If a higher risk for coronary injury is anticipated owing to coronary proximity to CS and branches in imaging exams, consider using safer energy sources such as cryoablation.
- Performing a 12-lead electrocardiogram is essential to rapidly detect abnormalities in the next minutes or hours after the ablation procedure, especially in patients with a chest pain complaint.

(Figure 2A). A coronary angiography was immediately performed and showed total occlusion of the distal portion of the RCA, just before the bifurcation to the posterior descendent artery and the atrioventricular branch, before the crux cordis, with negative image suggesting intracoronary thrombus (Figure 2B). Coronary angioplasty of this artery was performed with a conventional REBEL® (Boston Scientific, Marlborough, MA) stent, followed by TIMI III distal flow (Figure 2C), with complete resolution of pain. Aspirin, clopidogrel, and tirofiban were given after the procedure. There was a rise in creatine kinase-MB to a peak of 99.6 ng/mL (upper threshold of normality, 4.4 ng/mL) and troponin I to a peak of 21.1 ng/mL (upper threshold of normality, 0.04 ng/mL). The following ECG showed a q wave and a mild persistent ST-segment elevation in the inferior leads. A subsequent transthoracic echocardiogram demonstrated a normal left ventricular ejection fraction (LVEF) with a small region of akinesia in the left ventricle inferior wall. Coronary computed tomography angiography (CCTA) after the procedure showed the stent in the distal RCA lumen; the distance of the CA to the CTI was 2.7 mm at the lateral tricuspid annulus and 5.7 mm at the septal tricuspid annulus (Figure 3A). Magnetic resonance imaging demonstrated a normal LVEF with an area of fibrosis in the inferior wall (Figure 3B).

The patient had a good evolution. He was also diagnosed with a femoral access–related deep vein thrombosis and a minor subsegmental pulmonary embolism after a chest pain while still in-hospital and was discharged 6 days after the RCA angioplasty with dual antiplatelet therapy and anticoagulation for 1 month, and after that only clopidogrel and a new oral anticoagulant for 12 months. His last outpatient visit was in April 2021, and he was asymptomatic; the ECG showed no evidence of preexcitation, but q waves in inferior leads persisted. The follow-up transthoracic echocardiogram did not show any improvement in LVEF and still presented left ventricular inferior wall motion abnormalities. A summary investigation to exclude thrombophilia was performed and the results were all negative.

Discussion

We report a case of acute RCA thrombosis and ST-segment elevation myocardial infarction (STEMI) that occurred 12 hours after a redo RF catheter ablation of a posteroseptal AP, which was successfully treated with immediate coronary intervention, in a patient with four previous attempts of ablation of the AP.

The incidence of coronary thermal injury secondary to RF catheter ablation procedures in adult patients with atrial arrhythmias is extremely low, from 0.06 to 0.1%.[7] CA occlusion is rare, and during a posteroseptal AP ablation only isolated cases have been reported,[8–11] mostly attributing RCA occlusion to RF applications inside the CS or middle cardiac vein. When high-power RF energy is delivered during CTI ablation for typical atrial flutter, RCA occlusion has also been documented.[3–5] Cryoablation may be safer than RF energy regarding CA injury,[12] an alternative approach that can be utilized for such cases.

Mao and colleagues[6] reported 427 patients that underwent catheter ablation of supraventricular tachycardia, of whom 105 (aged 28 ± 17 years, 60% male) had AP-mediated tachycardia. Of these, 23 patients had AP close to the CS, and 60% (n = 14) underwent concurrent coronary angiography. In 4 patients, the posterolateral (inferolateral) branch of the RCA was in close proximity to the CS, and 2 patients (18%) had stenosis of the posterolateral (inferolateral) branch at the level of the ablation.

In our case, although the ablation was succeeded in the region close to the CS ostium at the proximal third of the median cardiac vein, RCA obstruction occurred in the paraseptal CTI region, where RF ablations were also performed before achieving the site of success.

Cabrera and colleagues[13] examined 30 formalin-fixed hearts from patients who died of noncardiac causes with the heart in attitudinal orientation and identified and measured the lengths of 3 levels of isthmus: paraseptal (24 ± 4 mm), central (19 ± 4 mm), and inferolateral (30 ± 3 mm). Comparing the 3 levels revealed that the central isthmus had the thinnest muscular wall and the paraseptal

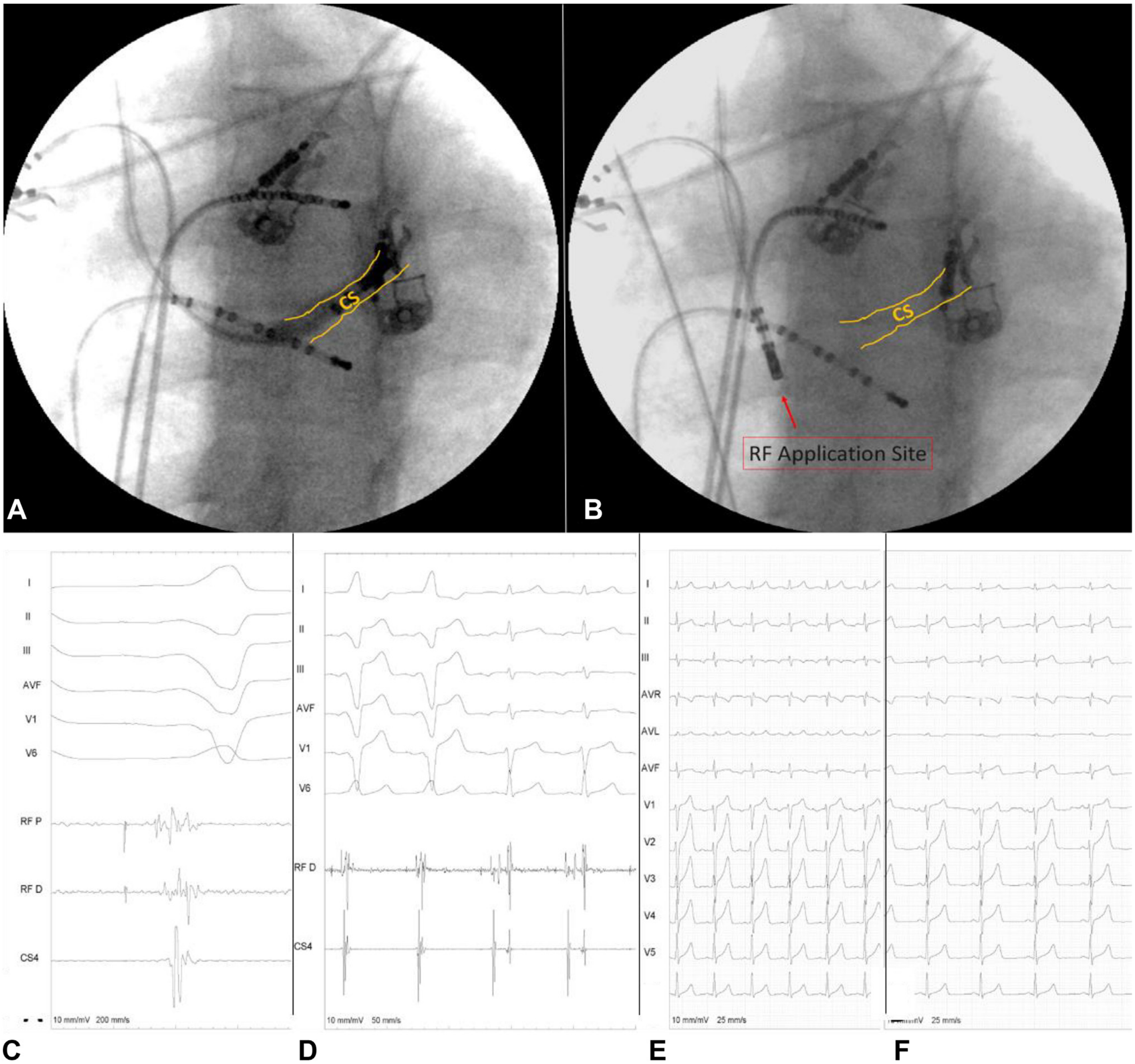

Figure 1 Fluoroscopy and electrograms at the site of radiofrequency (RF) applications. **A,B:** Left anterior oblique (LAO) views of the catheters (upper left: high right atrium [HRA]; lowermost: right ventricle [RV]; upper right: His; coming from top to the bottom: mapping catheter) during catheter mapping inside the coronary sinus (CS) (**A**) and near the CS ostium (**B**). **C, D:** Electrograms with continuous AV signals (**C**), and interruption of the accessory pathway (AP) conduction during RF application (**D**). **E, F:** Electrocardiogram immediately after (**E**) and 30 minutes after AP ablation (**F**) are shown. Minor ST-T changes are visualized that could be explained by cardiac memory after AP ablation or intermittent right coronary artery spasm

isthmus the thickest wall. At all 3 levels, the anterior part was consistently muscular, whereas the posterior part was composed of mainly fibrofatty tissue in 63% of hearts. The RCA could be found less than 4 mm below the endocardial surface of the inferolateral isthmus in 47% of the hearts. This anatomical relationship suggests that, while delivering RF applications in the CTI, care should always be taken regarding the RCA. While mapping for the target site, limiting test applications to a maximum of 15 seconds is also encouraged, to prevent incomplete AP lesion, tissue swelling, and inadvertent collateral damage.

Convective cooling is attributed as a protective factor for epicardial CA injury during RF ablation, an effect that may be lost among thinner luminal diameters, usually less than 3–5 mm, either because of vessel diameter or because of atherosclerotic plaques. It is not clear whether the patient in this case had underlying atherosclerotic disease in the RCA, but no other lesions were found on coronary angiography. Possible pathophysiological explanations for the adverse event include CA spasm, direct vessel trauma, or RF-induced endothelial lesions leading to acute or subacute thrombus. Spasm has been attributed as the most common

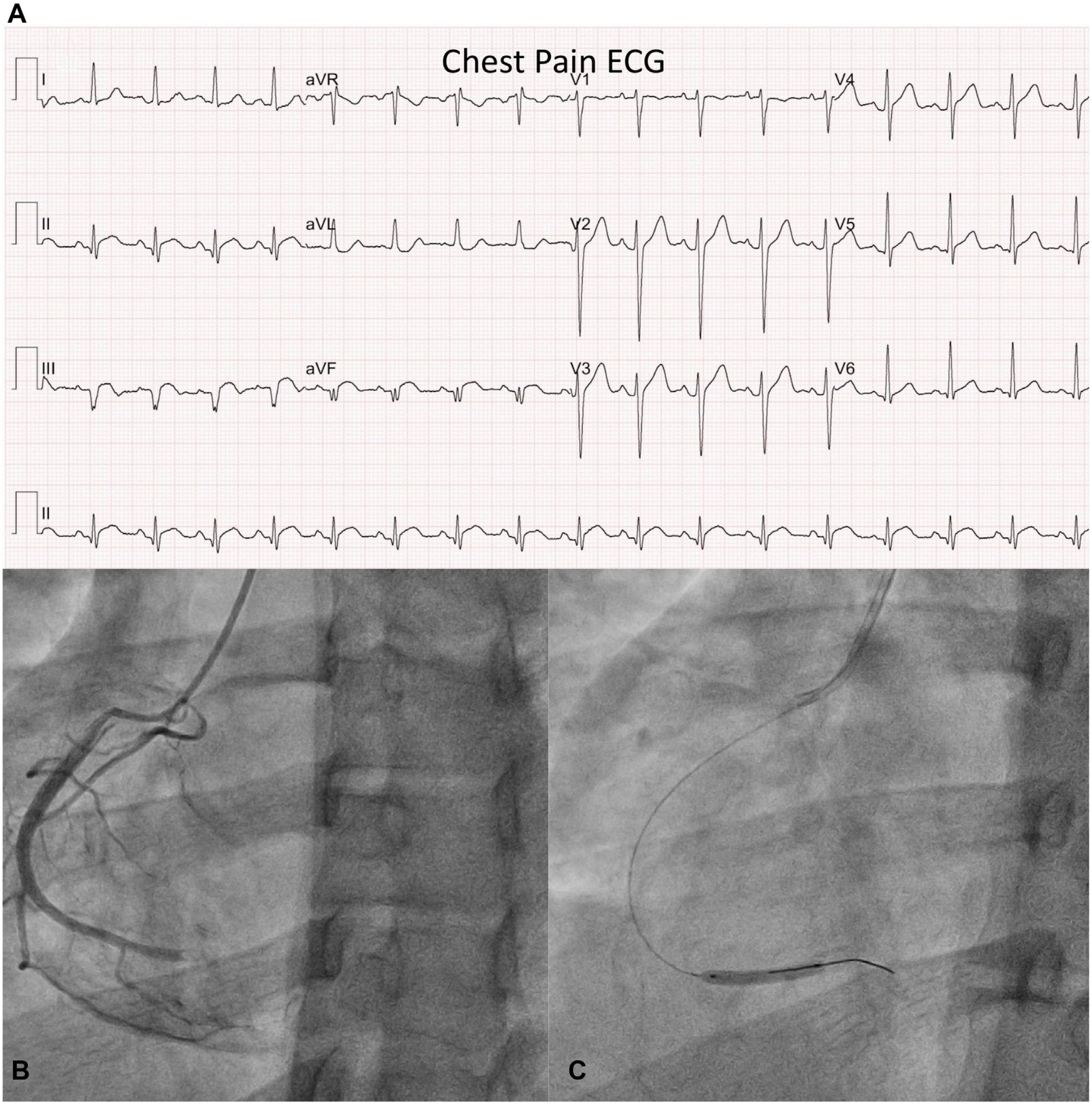

Figure 2 Electrocardiogram (ECG) during chest pain and coronary angiography showing distal right coronary artery (RCA) occlusion. **A:** ECG shows an inferior wall (leads II, III, and aVF) ST-segment elevation acute myocardial infarction, together with q waves. **B:** Right coronary angiography showing distal RCA occlusion at the level of the crux cordis. Note the negative image suggestive of a thrombus. **C:** A 0.014-inch guidewire and RCA angioplasty with a stent.

mechanism.[14] In our case, we suppose that a delayed coronary spasm with further prothrombotic effect could be the best mechanistic explanation.

Moreover, the exact moment that the RCA occluded is not clear, although the chest pain only started 12 hours after the procedure and ECG immediately after ablation was normal. The ECG during chest pain, however, already presented with pathologic q waves, suggesting a more prolonged time course to the STEMI, although q waves may appear up to 1 hour after the beginning of symptoms of a STEMI.[15] Physicians should always be aware of this type of complication, even in patients without known CA disease. Monitoring the 12-lead electrocardiogram during and after the procedure is important, especially in complex cases in which extensive ablation was necessary. Another aspect of recognizing the anatomy is that posteroseptal pathways could be related to CS abnormalities such as diverticulum; knowing the anatomy by CCTA could aid in the success of the ablation.

Assessing the anatomic proximity of the RCA to the CTI and CS ostium with a CCTA could add safety when applying

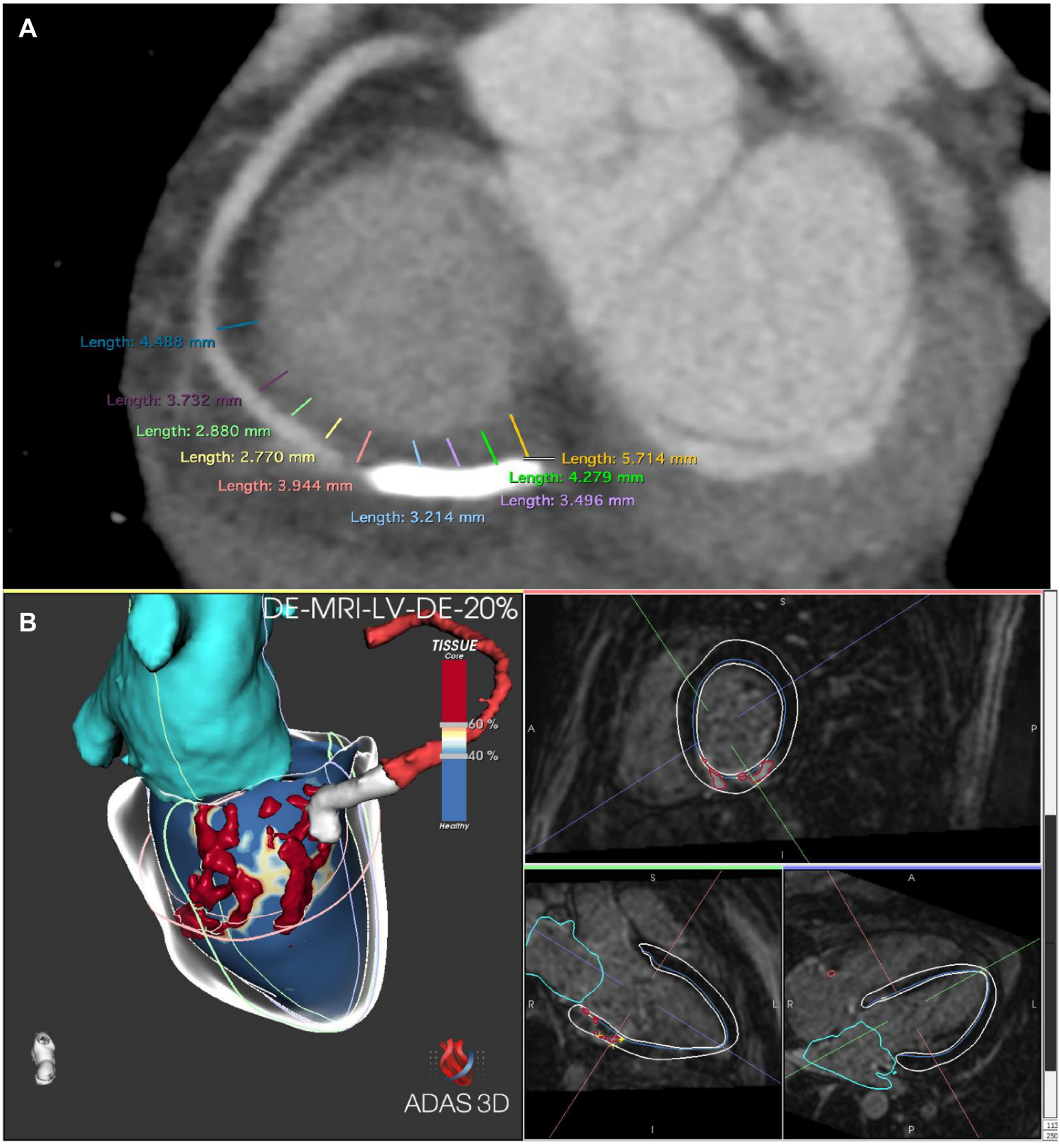

Figure 3 **A:** Coronary computed tomography angiography showing the relationship between the stent placed and right atrial wall. Note that the distance may be as short as 2.7 mm at the lateral tricuspid annulus (TA) to 5.7 mm at the septal TA. **B:** Magnetic resonance imaging with 3D reconstruction after 3 days of angioplasty showing left ventricle (LV) inferior basal scar derived from the ST-segment elevation acute myocardial infarction. Note the right coronary artery shown in light red, the stent shown in white, and the scar shown in dark red over the LV surface in dark blue.

RF energy in this location, as well as a CS angiography, especially when it comes to a redo procedure, to avoid this rare but serious complication.

Conclusion

Although AP catheter ablation is a low-risk procedure, injury to the RCA can exceptionally occur. In this report we present a case of RCA occlusion following posteroseptal AP ablation, related to the proximity of the area to the CA after an extensive ablation.

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