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Right Coronary Artery Occlusion After Radiofrequency Catheter Ablation of a Posteroseptal Accessory Pathway: Lessons to avoid it.

Short Title: Right coronary occlusion post AP ablation

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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 postero-septal 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 four unsuccessful RF ablations of a postero-septal AP causing orthodromic AVRT and was referred to
our institution for catheter ablation. Baseline surface electrocardiogram (EKG) showed a sinus rhythm with a PR interval of 92 msec, QRS interval of 108 msec, and corrected QT interval of 440 msec. There was evidence of preexcitation with a delta-wave polarity suggestive of a right posteroseptal accessory pathway (Figure 1, panels C and D). The procedure was performed after informed consent under general anesthesia by right femoral access puncture. Intravenous unfractionated heparin (5,000 IU) was administered access through the sheathes. An EPS was performed, and the accessory pathway 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 1, panels A and C). 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 ostium CS and in the paraseptal region of the CTI. A long non-steerable sheath (St Jude Medical®, Schwart SL1 8F 2,6mm, 63 cm) for catheter stabilization was necessary. After several attempts (RF applications delivery for 10 to 15 sec) without disappearance of the conduction by the accessory pathway, 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 1, panel B). In this region RF energy was applied in the CS ostium at 20 W for 60 sec, finally abolishing AP conduction (Figure 1, panels D and E). The procedure was terminated after 30 min (Figure 1, panel F) 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 pre-excitation (Figure 2, panel A). 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 atroventricular branch, before the crux cordis, with negative image suggesting intracoronary thrombus (Figure 2, panel B). Coronary angioplasty of this artery was performed with a conventional stent REBEL®, followed by TIMI III distal flow (Figure 2, panel C), 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 EKG showed a q wave and a mild persistent ST-segment elevation in the inferior leads. A subsequent transthoracic echocardiogram (TTE) demonstrated a normal left ventricular ejection fraction 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 coronary artery to the CTI was 2.7 mm at the lateral tricuspid annulus (TA) and 5.7 mm at the septal TA (Figure 3, panel A). Magnetic resonance imaging (MRI) demonstrated a normal left ventricular ejection fraction with an area of fibrosis in the inferior wall (Figure 3, panel B).

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 six days
after the RCA angioplasty with dual antiplatelet therapy and anticoagulation for
one month, and after that only clopidogrel and a new oral anticoagulant (NOAC)
for twelve months. His last outpatient visit was in April 2021, and he was
asymptomatic, the EKG showed no evidence of pre-excitation, but q waves in
inferior leads persisted. The follow-up TTE did not show any improvement in
LVEF, and still presented LV 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 re-do 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. Coronary artery occlusion is rare, and during a posteroseptal AP ablation,
only isolated cases have been reported8–11, 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 documented3–5. Cryoablation may be safer than RF energy regarding
coronary artery injury12, an alternative approach that can be utilized for such
cases.
Mao et al. reported 427 patients that underwent catheter ablation of supraventricular tachycardia, of whom 105 (age 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 (PLA) of the RCA was in close proximity to the CS, and two patients (18%) had stenosis of the PLA 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 MCV, RCA obstruction occurred in the paraseptal CTI region, where RFA were also performed before achieving the site of success.

Cabrera et al. 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 three levels of isthmus: paraseptal (24±4 mm), central (19±4 mm), and inferolateral (30±3 mm). Comparing the three levels, the central isthmus had the thinnest muscular wall and the paraseptal isthmus the thickest wall. At all three levels, the anterior part was consistently muscular whereas the posterior part was composed of mainly fibro-fatty 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 with and inadvertent collateral damage.
Convective cooling is attributed as a protective factor for epicardial coronary artery 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 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 coronary artery spasm, direct vessel trauma or RF induced endothelial lesions leading to acute or subacute thrombus. Spasm has been attributed as the most common mechanism\textsuperscript{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 twelve 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\textsuperscript{15}. Physicians should always be aware of this type of complication, even in patients without known coronary artery 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 help to succeed in the ablation.

To assess the anatomic proximity of the RCA to the CTI and CS ostium with a CCTA could add safety when applying RF energy in this location, as well
as a CS angiography, especially when it comes to a re-do procedure, to avoid
this rare but serious complication.

Conclusions:

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 accessory pathway ablation, related to the proximity of
the area with coronary artery after an extensive ablation.
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Figure 1

Fluoroscopy and electrograms at the site of radiofrequency (RF) applications. 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) (panel A) and near the CS ostium (panel B). Electrograms with continuous AV signals (panel C), and interruption of the accessory pathway (AP) conduction during RF application (panel D). Electrocardiogram immediately after AP ablation (panel E) and thirty minutes after (panel F) are shown. Minor ST-T changes are visualized that could be explained by cardiac memory after AP ablation or intermittent RCA spasm.
Figure 2

Electrocardiogram (ECG) during chest pain and coronary angiography showing distal right coronary occlusion. Panel A: ECG shows an inferior wall (Leads II, III and aVF) ST-segment elevation acute myocardial infarction (STEMI), together with q waves. Panel B: Right coronary angiography showing distal RCA occlusion at the level of the crux cordis. Note the negative image suggestive of a thrombus. Panel C: A 0.014-inch guidewire and RCA angioplasty with a stent.
Figure 3

Panel A: Coronary computed tomography angiography (CCTA) 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. Panel B: Magnetic Resonance Imaging (MRI) with 3D reconstruction after three days of angioplasty showing left ventricle (LV) inferior basal scar derived from the STEMI. Note the right coronary shown in light red, the stent shown in white and the scar shown in dark red over the LV surface in dark blue.
Key Teaching Points

- Whenever performing AP mapping and ablation, limit test applications for a maximum of 10 seconds, and avoid extensive and repetitive radiofrequency applications when inside the CS and its ramifications.
- Previous RF ablation procedures of the IVC-TI 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 due to coronary proximity to CS and branches in imaging exams, consider using safer energy sources such as cryoablation.
- Performing a 12-lead-EKG is essential to rapidly detect abnormalities in the next minutes or hours after the ablation procedure, especially in patients with a chest pain complain.

AP: accessory pathway; RF: radiofrequency; IVC-TI: inferior-vena-cava-tricuspid istmus; CS: coronary sinus; EKG: electrocardiogram