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CASE REPORT

INTERMEDIATE

CLINICAL CASE

# Paroxysmal Atrial Fibrillation With Both Triggers and Rotational Drivers Within the Right Atrial Appendage

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## ABSTRACT

A 48-year-old woman with paroxysmal atrial fibrillation (AF) underwent an electrophysiology study after 2 previous failed ablations. Noninvasive mapping suggested AF initiation from the right atrial appendage (RAA) with rotational drivers of AF in the RAA. Invasive mapping confirmed these findings. The patient was successfully treated with cryoballoon RAA isolation. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2019;1:607–11) © 2019 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

## HISTORY OF PRESENTATION

A 48-year-old woman with ischemic cardiomyopathy (ejection fraction: 30%; left atrial diameter: 4.5 cm) and symptomatic paroxysmal atrial fibrillation (AF) with a history of 2 previous ablation procedures presented to the emergency department after receiving multiple inappropriate implantable cardioverter-defibrillator (ICD) shocks for recurrent, rapidly conducting AF. She was symptomatic with palpitations and dyspnea.

## MEDICAL HISTORY

Previous ablations included cavotricuspid isthmus ablation, pulmonary vein isolation, and posterior wall isolation, all of which were unsuccessful in decreasing the patient's AF burden, despite treatment with antiarrhythmic agents, including sotalol and dofetilide. In addition, provocative maneuvers with isoproterenol, adenosine, and programmed stimulation failed to identify extrapulmonary triggers. Cardiac catheterization 6 months before presentation was negative for presence of obstructive coronary lesions.

### LEARNING OBJECTIVES

- Body surface potential mapping systems (noninvasive mapping) can aid in the localization of AF triggers and rotational drivers.
- The cryoballoon ablation system can be used to effectively treat AF originating from the RAA.

## DIFFERENTIAL DIAGNOSIS

Differential diagnosis for inappropriate ICD shocks for rapidly conducting atypical atrial flutter or organized AF included atrial arrhythmia due to gaps in previously placed linear ablation sets, reconnection of previously isolated pulmonary veins, or presence of new or extrapulmonary triggers.

## INVESTIGATION

Interrogation of the patient's single ICD revealed rapidly conducting AF with a ventricular rate of 215

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Informed consent was obtained for this case.

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**ABBREVIATIONS AND ACRONYMS**

**AF** = atrial fibrillation

**ICD** = implantable cardioverter-defibrillator

**NIEAM** = noninvasive electroanatomic mapping

**RAA** = right atrial appendage

beats/min despite treatment with metoprolol succinate 200 mg/day. The authors decided to first proceed with noninvasive electroanatomic mapping (NIEAM) (Cardioinsight, Medtronic, Minneapolis, Minnesota) to possibly localize rotational drivers while the patient was in AF and/or had spontaneous triggers before proceeding with a third invasive procedure. NIEAM was performed in the waiting area while the patient was in AF and suggested the presence of rotational activity within the right atrial appendage (RAA) with passive activation of the entire left atrium (Figure 1). The authors then decided to bring the patient to the laboratory to target the right atrial driver.

Invasive mapping (Carto3, Biosense Webster, Diamond Bar, California) confirmed organized activation of the left atrium with isolated pulmonary veins and posterior wall. Interrogation of the RAA with a multipolar catheter (Pentaray, Biosense Webster) revealed high-frequency, low-amplitude endocardial electrograms (Figure 2).

After termination of AF via cardioversion, spontaneous initiation of AF was documented to originate from the RAA by both invasive and noninvasive mapping (Figure 1). The preceding observation was reproducible with spontaneous paroxysms of AF during the case.

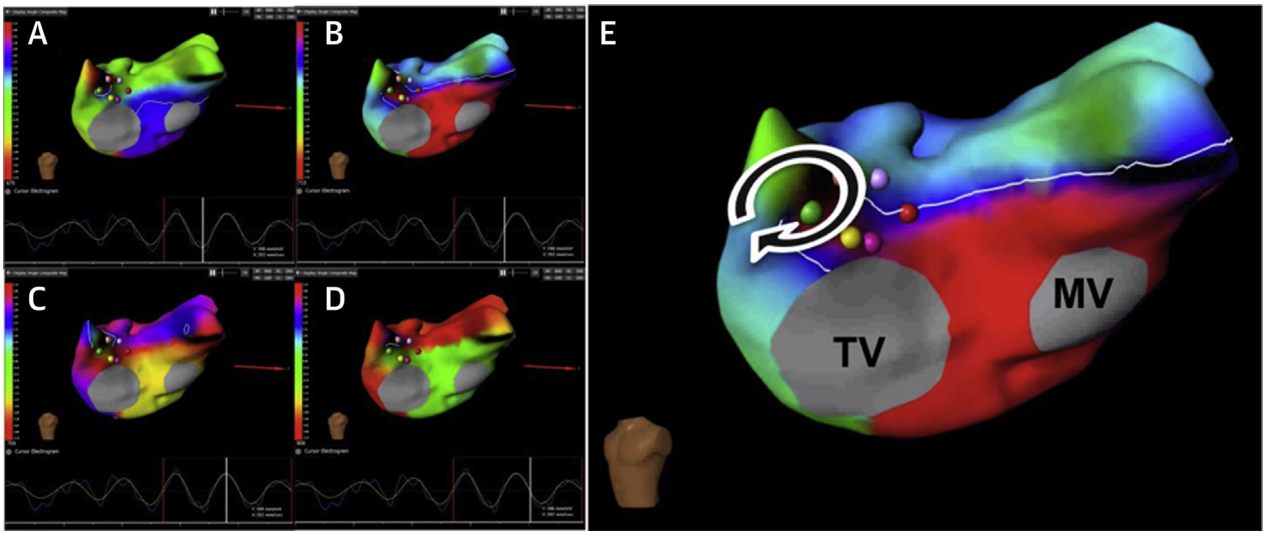
## MANAGEMENT

An attempt was made to isolate the RAA with radiofrequency energy but was unsuccessful. The authors then proceeded with cryoballoon ablation of the RAA. The Achieve mapping catheter was placed in the RAA and a 23-mm Arctic Front Advance (Medtronic) cryoballoon catheter was advanced over the Achieve catheter (Medtronic) to the RAA. Contrast injection into the RAA verified occlusion (Figure 3). Intracardiac echocardiography in conjunction with the Cartosound 3-dimensional mapping system verified close apposition of the cryo-balloon and the RAA ostium. During application of the first freeze, spontaneous fibrillatory activity within the appendage drastically diminished. A total of 5 freezing applications were performed for a total of 960 s of cryoballoon therapy. Following ablation, the patient was cardioverted to normal sinus rhythm and had no further spontaneous conversions to AF for the remainder of the case.

## DISCUSSION

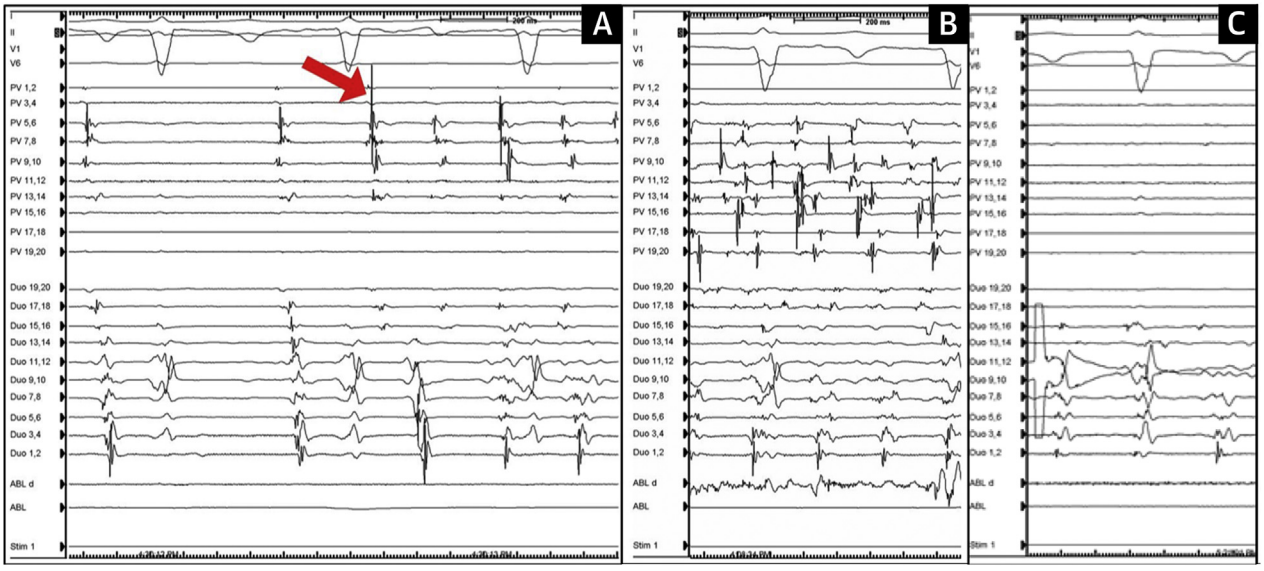
A common initial approach for catheter ablation of paroxysmal AF involves wide area circumferential ablation of the pulmonary veins to achieve electrical isolation of potential pulmonary vein triggers (1). In the event of recurrent AF, a repeat attempt at ablation usually involves verification that the previously

**FIGURE 1 Noninvasive Activation Map of the Atria in a LAO Caudal Perspective Showing a Spontaneous AF Trigger in the RAA**




**(A to D)** The sequence of 1 rotor cycle from the right atrial appendage (RAA). **(E)** An enlarged activation map (CardioInsight, Medtronic) with an **arrow** depicting the sequence of activation around the base of the RAA. AF = atrial fibrillation; LAO = left anterior oblique; MV = mitral valve; TV = tricuspid valve.

**FIGURE 2** **Spontaneous Electrical Activity in the RAA Initiating AF**




**(A)** A Pentarray mapping catheter (PV) placed within the RAA demonstrates spontaneous fibrillatory activity within the RAA **(red arrow)**, which initiates AF as seen in the later portion of the tracing. A 20-polar catheter (Duo) is positioned with distal poles in the coronary sinus and mid-proximal poles, looping in the posterolateral right atrium. **(B)** High-frequency fragmented signals in the RAA (PV) passively activate the left atrium as seen by the lower frequency signals on the distal coronary sinus (Duo) catheter. **(C)** Entrance block within the RAA post-cryo applications. Exit block was confirmed with pacing after restoring sinus rhythm. Abbreviations as in Figure 1.

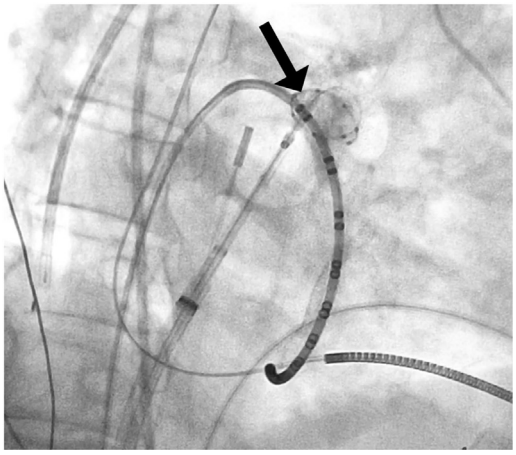
isolated veins remain electrically isolated, as well as a search for extrapulmonary AF triggers as a target for ablation (2). A main challenge in identifying AF triggers invasively is the limited number of possible sites that can be monitored with electrographic recordings.

Evidence has shown that rotational drivers may be important for arrhythmia perpetuation, and therefore, ablation of these rotors may be helpful in the treatment of persistent AF (3,4). In this case, isolation of the RAA failed to terminate AF, which suggested that rotational activation in the RAA was not the sole mechanism of arrhythmia perpetuation. However, studies have suggested long-term benefit of targeting rotational drivers in AF, even if this practice does not always lead to termination of acute AF. The atrial appendages, especially the left, are known potential sites for extrapulmonary AF triggers, but their participation in the perpetuation of AF has not been clearly described (3). In this particular case, the RAA was not only the triggering site but also the structure that harbored the only identified rotational driver.

Historically, radiofrequency energy has been used either to target spontaneous atrial triggers within the appendage or to isolate the appendage via a circumferential approach. Despite multiple radiofrequency ablation applications with a contact force–irrigated catheter (SmartTouch SF, Biosense Webster), the authors were unable to isolate the RAA and decided to use cryoablation. Currently, there are 3 cases in the literature that demonstrated the effective use of a cryoballoon catheter to entrap and treat a focal atrial tachycardia that originated from within the RAA (5–8). The authors report the first case in the literature of a patient with AF that originated within the RAA that was successfully treated with cryoballoon isolation. Potential complications of this practice include RAA perforation (especially from the tip of the cryo-balloon), complete heart block, and phrenic nerve injury. The authors used intracardiac echocardiography to visualize the balloon and its tip while positioning the balloon in the RAA; the His location was tagged in the mapping system, and a safe distance was maintained fluoroscopically.

This case illustrated the usefulness of noninvasive mapping in designing a successful ablation strategy in cases in which AF triggers cannot be identified with conventional invasive methods. The use of noninvasive mapping to simultaneously evaluate both atria was crucial in redirecting attention to the right atrium (specifically, the RAA), where it confirmed the presence of the AF trigger with a multipolar catheter. Noninvasive mapping suggested the presence of

**FIGURE 3 RAO Fluoroscopy Projection Showing the Cryoballoon Catheter and the Achieve Spiral Mapping Catheter Positioned Within the RAA**



Contrast was injected and can be seen filling the RAA and identifying the osteal location of the cryoballooon **(arrow)**. RAO = right anterior oblique; other abbreviation as in Figure 1.

rotational fibrillatory activation in the RAA, despite the apparent organized activation of the left atrium as a result of multiple previous ablations. The recognition of the RAA as the trigger source and culprit in the perpetuation of AF obviated the need for unnecessary mapping and possible ablation in the left atrium, which was passively activated. The RAA is a known source of up to 2% to 3% of atrial tachycardia triggers, and, as demonstrated in this case, the RAA can also serve to maintain AF as a rotational driver (2,6). The authors believe that noninvasive mapping could have a role in selective cases of AF when conventional ablation strategies fail; however, lack of literature data and high cost prevent the widespread use of the technology.

Positioning a traditional radiofrequency catheter in the RAA via a femoral venous access site is likely to direct the point of contact superiorly against the thin atrial myocardium with a small footprint of contact force at the region of ablation. This catheter orientation and force vector increases the risk of perforation. The authors believe that the larger surface area of the cryoballoon may decrease the risk of perforation. Furthermore, the cryoballoon allows for a greater area of contact during ablation, which appears to be an advantage when targeting a nonfocal tachycardia within the appendage, as was the situation in this case. The authors used intracardiac echocardiography to continuously monitor the location of the cryoballoon, in particular, its tip. It remains unknown whether ablation with a cryoballoon confers any safety advantage when used in the RAA compared with a traditional radiofrequency ablation catheter due to the larger footprint of contact. Variability of RAA anatomy affects whether the cryoballoon is a suitable tool for RAA isolation in other patients. In this case, the RAA anatomy was amenable to isolation because satisfactory occlusion could be achieved with the balloon in the RAA ostium.

**FOLLOW-UP.** After 18 months of follow-up, the patient has remained in normal sinus rhythm without antiarrhythmic medications, and she has not received any further ICD shocks.

## CONCLUSIONS

Noninvasive mapping can be a useful tool for the identification of AF triggers and rotational drivers, especially when conventional ablation strategies have failed. The cryoballoon ablation catheter can be considered for treatment of AF originating from the RAA. At present, there is a paucity of literature on the use of the cryoballoon in the RAA; therefore, the safety profile remains uncertain.

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**KEY WORDS** **atrial fibrillation, cardioversion, cryoballoon ablation, electroanatomic mapping, electrophysiology, noninvasive mapping, right atrial appendage, rotors, triggers**