Cryoablation of distal right atrial appendage tachycardia focus using intracardiac echocardiography and no fluoroscopy: Improved outcomes with modern technology

Abdul Q. Haji, MD, FHRS,* Joseph C. Lee, MD†

*From the *Cardiac Electrophysiology Service, Martinsburg VA Medical Center, Martinsburg, West Virginia, and †Walter Reed National Military Medical Center, Bethesda, Maryland.*

Introduction

Focal atrial tachycardias (ATs) arising from the right atrial appendage (RAA) are unusual, constituting an estimated 3.8% of focal ATs.[1,2] They can pose significant challenges to management because they can be incessant and result in tachycardia-induced cardiomyopathy, among other complications.[3] Over the past decade, work has been performed to delineate the different anatomies of the atrial appendage, recognize activation sites of incessant RAA tachycardias, identify the need for irrigated radiofrequency (RF) catheters, and report the use of cryotechnology (balloons and catheters) to achieve success in these difficult cases.[1,2,4,5] RAA tachycardia arising from the distal half of the appendage has been associated with the need for surgical excision to cure the arrhythmia.[1] However, technology continues to improve, and the management approach to such cases has evolved over time.[5–7]

We report the case of an active-duty military soldier with incessant distal RAA tachycardia who presented with long-standing persistent atrial fibrillation. The condition was successfully treated with no fluoroscopy or contrast, using real-time intracardiac echocardiographic (ICE) imaging, 3-dimensional (3D) electroanatomic mapping, and both contact force–sensing catheters and cryocatheters to achieve success. This case demonstrates how current technology can make complex procedures safer for patients and avoid open surgical interventions and the risks of long-term antiarrhythmic drug therapy in the management of these difficult arrhythmias.

Case report

A 42-year-old man was referred by his cardiologist for consideration of ablation of long-standing persistent atrial fibrillation because of symptoms of continued exertional dyspnea and fatigue that were limiting his service in the United States military. He had been treated unsuccessfully with multiple antiarrhythmic drugs, including sotalol, flecainide, dofetilide, and amiodarone, with multiple cardioversions and early return of atrial fibrillation. He was then left in atrial fibrillation with rate control for several years until he was referred for catheter ablation. Echocardiography revealed he had no coronary artery disease and a structurally normal heart. Polysomnography for evaluation of sleep apnea was normal. Twelve-lead electrocardiography (ECG) demonstrated atrial fibrillation (Figure 1).

He subsequently underwent circumferential pulmonary vein antral isolation for persistent atrial fibrillation as well as cavo-tricuspid isthmus ablation. Direct-current cardioversion was required to achieve sinus rhythm during this procedure, and he felt better for several weeks postablation. However, the tachycardia returned, and the patient was noted to be in suspected atrial flutter on 12-lead ECG (Figure 2A). The ECG characteristics included negative P waves on leads V_1 and V_2, a transition to positivity in the rest of the precordial leads, and positive P waves in the inferior leads. However, on repeat electrophysiology study, a comprehensive biatrial activation map of the tachycardia confirmed focal activation arising from the RAA. The CARTO 3D electroanatomic mapping system (Biosense Webster, Diamond Bar, CA) and a decapolar coronary sinus catheter were used for this study. Three-dimensional reconstruction of the right atrium and the RAA as seen in the anteroposterior and left anterior oblique views demonstrated the early activation was confined to the RAA (Figure 2B and C). The initial mapping was performed using a 4-mm NaviStar D/F mapping and ablation catheter (Biosense Webster), which was changed to a 3.5-mm SmartTouch ST/SF contact force–sensing catheter (Biosense Webster) for ablation because of concerns of low-power heating, complex anatomy, and perforation of the RAA. Detailed activation mapping of the RAA was performed, with signal as early as 30 ms before the surface P wave was identified. RF application at this

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Address reprint requests and correspondence: Dr Abdul Q. Haji, Martinsburg VA Medical Center, 510 Butler Ave, Martinsburg, WV 25405. E-mail address: Abdul.haji@va.gov.

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KEY TEACHING POINTS

- Right atrial appendage tachycardias can be difficult to ablate, so use of irrigated, contact force–sensing technologies should be considered.
- Intracardiac echocardiography can be useful in supporting catheter ablation in this challenging structure, particularly with assessment of the actual position and stability of the catheter.
- Cryocatheter technology can be useful in the appendage where stability can be difficult to achieve, particularly if the initial ablation is successful but not durable, which suggests migration of the radiofrequency ablation catheter off the target lesion site.

site led to termination of tachycardia within 500 ms to 3 seconds; however, tachycardia resumed before a full 60-second lesion could be completed. RF energy was delivered using a Stockert 70 RF generator (Biosense Webster) delivering 20–30 W of power. Higher powers were not used because of concerns of perforation in the distal appendage.

After several lesions, we realized there were likely issues with maintaining RF ablation contact, so we scheduled a subsequent procedure with a cryocatheter (Freezor Xtra, Medtronic Inc, Minneapolis, MN). On the second AT ablation attempt, we remapped the appendage initially with a SmartTouch catheter to localize the best site for ablation. We then used a 6-mm cryocatheter via an 8.5F Agilis steerable sheath (St. Jude Medical, St. Paul, MN) for cryoablation, which led to termination of tachycardia in 35 seconds. After termination, the tachycardia would not restart despite attempts to remap the site. Unable to reinitiate tachycardia, we placed a series of insurance cryolesions. Again, the patient felt well for approximately 6 weeks, but then returned with recurrent tachycardia. On the third ablation attempt, we performed a detailed ICE interrogation of the RAA. We created a 3D image using the CartoSound module (Biosense Webster), which showed a pyramidal shaped RAA anatomy (Figure 3). Using ICE, we noted that the SmartTouch RF catheter had a tendency to eject from the contracting appendage to the tricuspid side of the appendage base. However, even the contact force sensors did not pick up on this well as the pressure vector would quickly recover. We initially remapped with a SmartTouch ST/SF catheter and noted that the RAA AT focus was likely 1–2 mm away from the previous ablation site. We used an 8-mm cryocatheter through a 10F SR0 sheath (St. Jude Medical), and the cryolesions placed then terminated the tachycardia in <1 second (Supplemental Video).

At 6-month follow-up, the patient remained in sinus rhythm with no antiarrhythmic therapy. All of the RAA AT ablation procedures were completed with no fluoroscopy or use of contrast.

Discussion

Focal AT arising from the RAA is uncommon but can pose a significant challenge at ablation.[2] ATs originating from the distal portion of the atrial appendage have been noted to be refractory to RF ablation and require surgical excision in one-third of cases.[1] This report illustrates the utility of real-time visualization by ICE of the RAA lumen during catheter manipulation and ablation. ICE also allows for direct visualization of the degree of contact within the RAA that otherwise is not possible because of lack of contact force technology in cryocatheters.[8,9] Three-dimensional reconstruction using CARTO imaging in conjunction with ICE provides additional anatomic detail and is critical when ablating within the complex atrial anatomic confines. The Freezor ablation catheter is less costly than cryoballoon

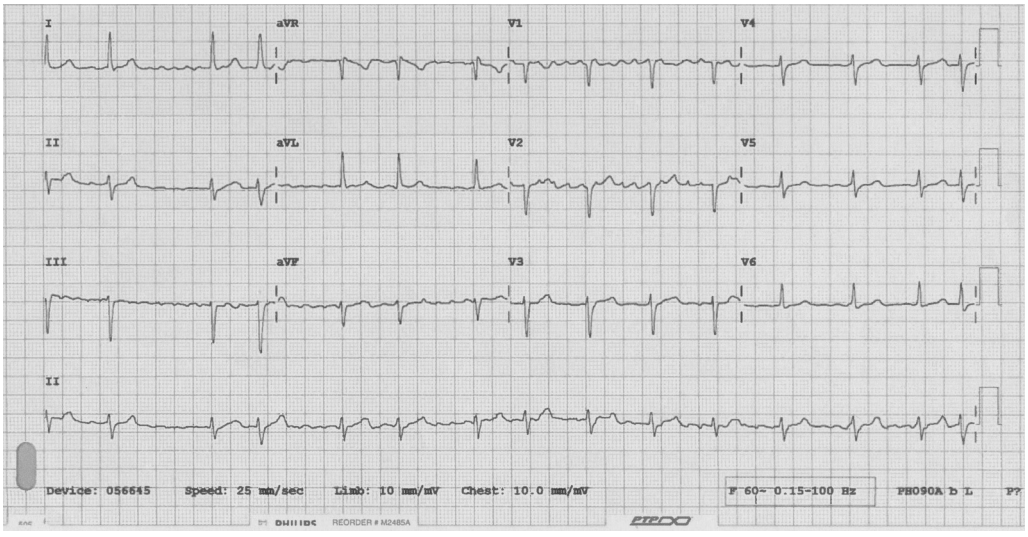

Figure 1 Twelve-lead electrocardiography on presentation is consistent with long-standing persistent atrial fibrillation.

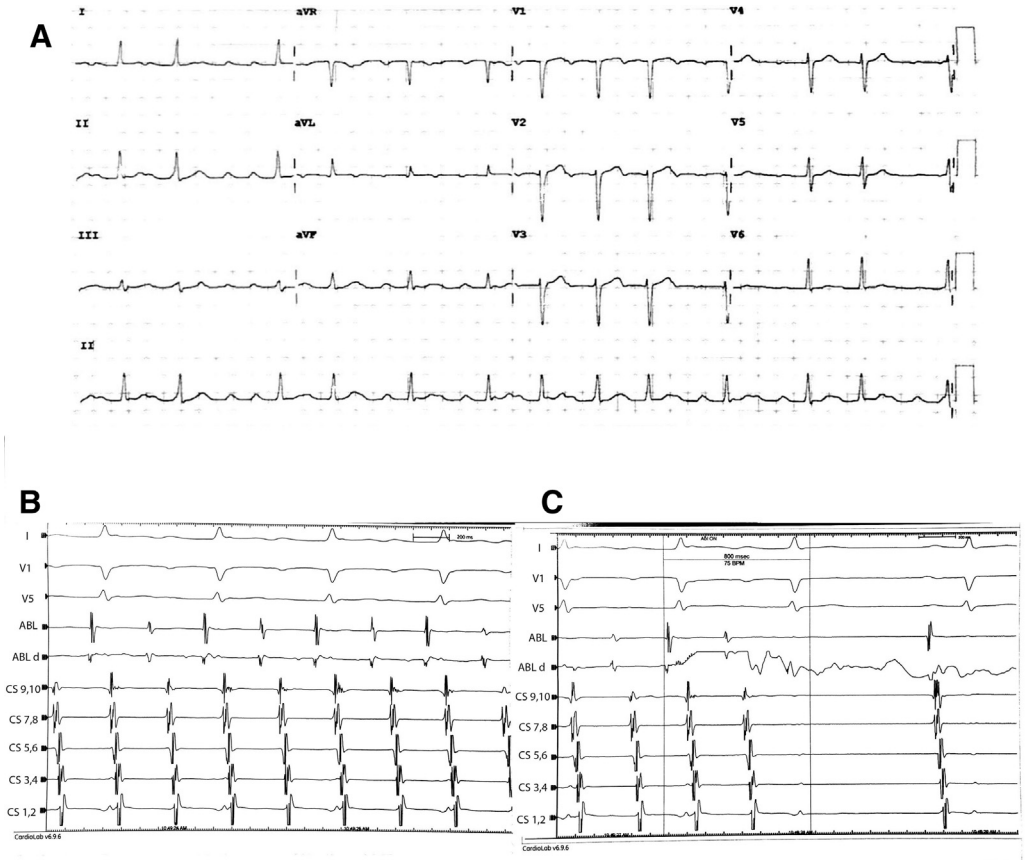

Figure 2 **A:** Electrocardiography after pulmonary vein isolation and cavo-tricuspid isthmus ablation suspected to be atrial flutter. **B:** Right atrial appendage (RAA) atrial tachycardia intracardiac electrograms. **C:** RAA termination within 800 ms of radiofrequency application in the distal RAA appendage. ABL = ablation proximal electrodes; ABL d = ablation distal electrodes; CS = coronary sinus electrodes.

ablation, which have been used in previous reports,[5] and does not risk complete electrical isolation of the RAA. It also likely minimizes risk of inadvertent damage to surrounding structures such as the right coronary artery. Cryoablation provides additional stability and eliminates the "painting effect" of RF energy as well as the inherent difficulty of catheter stability in the mobile RAA.[4,5] Abolition of tachycardia was instrumental to allowing the patient continue his professional military career and for his long-term quality of life without antiarrhythmic or rate controlling drugs.

In our review of the literature, traditional imaging of the RAA is typically accomplished using contrast injection/fluoroscopic imaging.[1] However, we believe that detailed ICE and fast anatomic mapping of the RAA provides equivalent/better information to assist with ablation targeting and planning. The patient had no exposure to fluoroscopy or contrast agents, thereby avoiding the risks of those treatments. Reports of incessant RAA tachycardia with tachycardia-induced cardiomyopathy in pregnant women represent cases that could be conducted with a fluoroless

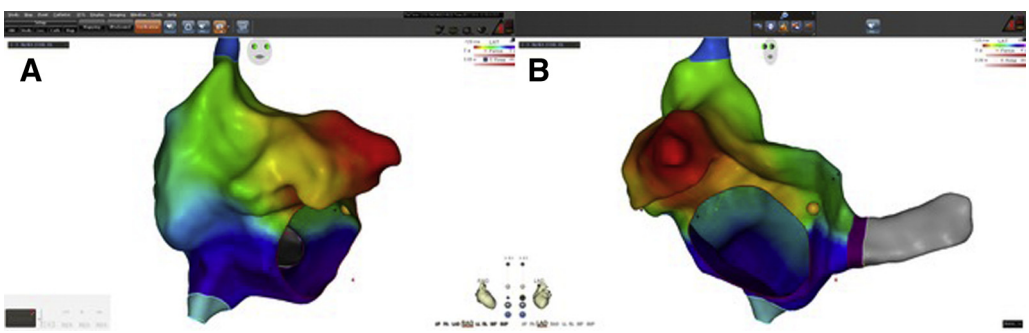

Figure 3 Three-dimensional reconstruction of the right atrium and appendage using the CartoSound module (Biosense Webster, Diamond Bar, CA) and fast anatomic mapping techniques in the anteroposterior (**A**) and left anterior oblique (**B**) projections. On right atrial appendage atrial tachycardia activation map, *red color* indicates the earliest activation site and *dark blue-green* indicates the later activation sites.

technique without delay and exposure of the patient and unborn child to antiarrhythmic medications.[10,11] In difficult cases such as the patient reported here, a multimodality approach can improve procedural outcomes and optimize patient safety.

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Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2018.05.002.

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