Successful Ablation of Roof Dependent Left Atrial Tachycardia Using Cryoballoon After Pulmonary Vein Isolation.

Kudret Aytemir[1], Burak Sezenoz[2], Ugur Canpolat[3], and Hikmet Yorgun[3]

[1]Hacettepe University Medical Faculty
[2]Gazi University
[3]Hacettepe University Faculty of Medicine

December 20, 2020

Abstract

Cryoballoon technology is a well-established method to provide pulmonary vein isolation in the treatment of atrial fibrillation. Additional lesions such as roof line, posterior wall isolation or left atrial appendage isolation also possible with the same technique. We report a case with roof dependent atrial tachycardia successully terminated by using cryoballoon following pulmonary vein isolation.

Introduction

Since the first application of cryoballoon technologies for catheter ablation of atrial fibrillation (AF), its efficacy and safety were shown in numerous studies. Although pulmonary vein isolation (PVI) is the mainstay of AF ablation, the formation of additional lesions to improve long-term arrhythmia-free survival, especially in patients with persistent AF, is an ongoing debate. However, even though the cryoballoon (CB) technique has some procedural limitations, there is emerging data about the utilization of CB regarding ablation of non– pulmonary vein sources such as the posterior wall, left atrial appendage,and roof isolation.[1-3] Here, we reported a case of AF organized into roof dependent left atrial tachycardia following PVI, which subsequently terminated after left atrial roof ablation using CB.

Case

A 61-year-old male patient was admitted to our outpatient clinic with palpitations despite metoprolol 50 mg bid and propafenone 150 mg bid. He had a diagnosis of early persistent AF for three months, and surface ECG was also AF with a ventricular rate of 110 bpm. Transthoracic echocardiography revealed dilated left atrium (45 mm) and concomitant moderate mitral regurgitation with preserved left ventricular systolic function. As a result, the patient was scheduled for CB ablation. Cardiac computed tomography was unremarkable and showed four separate pulmonary veins. The baseline rhythm at the beginning of the procedure was AF. After femoral vein punctures, a single transseptal puncture was performed. A fourth-generation 28-mm CB (Arctic Front Advance Pro^{TM}, Medtronic, Minneapolis, MN, USA) was placed into the left atrium with the circular mapping catheter (Achieve^{TM}, Medtronic, Minneapolis, MN, USA). Initially, all PVs were isolated successfully with a single freeze (240 s for each PV with a time to isolation period of < 60 s). Following right upper PV isolation baseline rhythm and atrial activity recorded in the superior vena cava by coronary sinus (CS) catheter revealed organized atrial activity with a stable tachycardia cycle length. After placement of the catheter into the CS again, atrial activation was stable with a cycle length of 215 ms and 'reverse chevron pattern' appearance (Figure 1).

Then roof-line was targeted (180 ms in each position) with CB application by the aid of anchoring method to provide complete elimination roof dependent conduction. Roof isolation was started from the right side with an each application time of 120 ms after placing the Achieve catheter deep into the right superior PV with a slight counterclockwise rotation. After two applications from the right side, left-sided roof lesions were created by placing the Achieve catheter deep into the left superior PV and CB catheter apart from the PV ostium with clockwise rotations. A gradual increase in the tachycardia cycle length was observed from 215 ms to 254 ms. Besides, the "reverse-chevron" CS activation pattern, in the beginning, changed into a "proximal-distal" pattern after completion of the first left-sided roof isolation (Figure 2).

Moreover, far-field left atrial appendage recordings remain in the first half of the tachycardia cycle length when surface P wave in the V1 lead is used as the reference, implying earliest activation in the anterior wall. AT was terminated during the final CB application, and sinus rhythm was restored (Figure 1). After ablation, the roof's electrical activity was checked using a circular mapping catheter (Achieve Advance, Medtronic), which revealed double potentials at the roof (Figure 3). No periprocedural complication occurred, and the patient was discharged uneventfully. During the follow-up of 3-months, the patient was free from any atrial arrhythmias.

Discussion

This case report highlights the effectiveness of CB for roof isolation by terminating –left atrial tachycardia. Although the feasibility of roof isolation using second-generation CB was demonstrated previously, our case is the first one reporting terminating roof-dependent AT using fourth-generation CB.[3]

PVI is the cornerstone of AF ablation procedure, and besides the paroxysmal AF patients, CB can be used as a first-line approach in persistent AF.[4-6] Unlike paroxysmal AF, long-term outcomes of PVI in persistent AF are moderate, which paved the way for additional lesion formation in such a group of patients. However, previous randomized studies did not benefit from additional lesion formation, including linear lesion formation or complex fractionated atrial electrogram ablation compared to the PVI-only approach.[7, 8] Traditionally, radiofrequency ablation is used to create additional lesions beyond PVI. However, several recent studies demonstrated the safety and efficacy of CB for isolating several non-PV sources such as superior vena cava, posterior wall, and left atrial appendage as well as roof isolation[2, 9, 10] But, data regarding the use of CB for left atrial linear lesion formation is scarce.

As CB is primarily designed as a single shot device for circumferential lesion formation after engagement to the ostium of related veins, additional lesion formation – especially at linear surfaces like the roof or posterior wall- is challenging. Moreover, reliance on fluoroscopic guidance during the procedure is a hurdle to evaluate effective lesion formation in anatomical locations, where CB engagement to the ostium of the anatomical structure is not the case. Despite these limitations, previously, Kuniss et al. demonstrated the feasibility of roof line formation using second-generation CB among patients with persistent AF.[3] The broader and more homogenous lesion formation can be achieved using novel CB due to hemispheric and more uniform cooling properties. Moreover, in a recent report, a mitral isthmus line was created using second-generation CB with the guidance of a novel 3-D mapping system that allows contiguous lesion deployment to the desired area.[11]

In our patient, conversion to atrial tachycardia from AF was evident after completing the right superior PVI and roof line formation with 4 CB applications. Atrial tachycardia cycle length progressively increased with each application and terminated with the last application at the roof's mid-portion. The change in the atrial activation sequence in the CS catheter from the "reverse chevron" pattern to "proximal-distal" was indirect evidence of roof-dependent AT. Moreover, far-field left atrial appendage signals remain in the first half of the tachycardia cycle length, implying descending activation at the anterior wall. However, entrainment maneuvers were not performed to prevent degeneration of AT into another tachycardia. The voltage map was not created using a 3-D mapping system; only CB was the planned strategy. The ablation line was checked using Achieve circular mapping catheter and double potentials were demonstrated along the line to evaluate the lesion contiguity.

To the best of our knowledge, this is the first case showing successful treatment of roof dependent AT by using CB. CB technology can be effectively applied for roof isolation selected patients with persistent AF when needed. Since CB ablation provides durable lesions, this technology may be a reasonable option to perform additional lesions and PVI, especially when linear lesion formation is necessary, in patients who underwent AF ablation procedure.

Funding: None

Conflict of Interest: None

References

1. Yorgun H, Canpolat U, Kocyigit D, Coteli C, Evranos B, Aytemir K: Left atrial appendage isolation in addition to pulmonary vein isolation in persistent atrial fibrillation: one-year clinical outcome after cryoballoon-based ablation. *Europace* 2017, 19(5):758-768.

2. Aryana A, Baker JH, Espinosa Ginic MA, Pujara DK, Bowers MR, O'Neill PG, Ellenbogen KA, Di Biase L, d'Avila A, Natale A: Posterior wall isolation using the cryoballoon in conjunction with pulmonary vein ablation is superior to pulmonary vein isolation alone in patients with persistent atrial fibrillation: A multicenter experience. *Heart Rhythm* 2018, 15(8):1121-1129.

3. Kuniss M, Greiss H, Pajitnev D, Akkaya E, Deubner N, Hain A, Bodammer L, Berkowitsch A, Chierchia GB, Hamm CW *et al* : Cryoballoon ablation of persistent atrial fibrillation: feasibility and safety of left atrial roof ablation with generation of conduction block in addition to antral pulmonary vein isolation. *Europace* 2017, 19(7):1109-1115.

4. Kuck KH, Brugada J, Furnkranz A, Metzner A, Ouyang F, Chun KR, Elvan A, Arentz T, Bestehorn K, Pocock SJ *et al* : Cryoballoon or Radiofrequency Ablation for Paroxysmal Atrial Fibrillation. *N Engl J Med* 2016, 374(23):2235-2245.

5. Aytemir K, Gurses KM, Yalcin MU, Kocyigit D, Dural M, Evranos B, Yorgun H, Ates AH, Sahiner ML, Kaya EB *et al* : Safety and efficacy outcomes in patients undergoing pulmonary vein isolation with second-generation cryoballoon. *Europace* 2015, 17(3):379-387.

6. Koektuerk B, Yorgun H, Hengeoez O, Turan CH, Dahmen A, Yang A, Bansmann PM, Gorr E, Hoppe C, Turan RG *et al* : Cryoballoon Ablation for Pulmonary Vein Isolation in Patients With Persistent Atrial Fibrillation: One-Year Outcome Using Second Generation Cryoballoon. *Circ Arrhythm Electrophysiol* 2015, 8(5):1073-1079.

7. Verma A, Jiang CY, Betts TR, Chen J, Deisenhofer I, Mantovan R, Macle L, Morillo CA, Haverkamp W, Weerasooriya R *et al* : Approaches to catheter ablation for persistent atrial fibrillation. *N Engl J Med* 2015, 372(19):1812-1822.

8. Vogler J, Willems S, Sultan A, Schreiber D, Luker J, Servatius H, Schaffer B, Moser J, Hoffmann BA, Steven D: Pulmonary Vein Isolation Versus Defragmentation: The CHASE-AF Clinical Trial. *J Am Coll Cardiol* 2015, 66(24):2743-2752.

9. Yorgun H, Canpolat U, Oksul M, Sener YZ, Ates AH, Crijns H, Aytemir K: Long-term outcomes of cryoballoon-based left atrial appendage isolation in addition to pulmonary vein isolation in persistent atrial fibrillation. *Europace* 2019, 21(11):1653-1662.

10. Iacopino S, Osorio TG, Filannino P, Artale P, Sieira J, Stroker E, Bala G, Overeinder I, Hacioglu E, Calburean PA *et al* : Safety and feasibility of electrical isolation of the superior vena cava in addition to pulmonary vein ablation for paroxysmal atrial fibrillation using the cryoballoon: lessons from a prospective study. *J Interv Card Electrophysiol* 2020.

11. Badertscher P, Wissner E: Case report: Cryoballoon ablation of the mitral isthmus using a novel mapping system. *Pacing Clin Electrophysiol* 2019, 42(10):1414-1417.

Figure legends:

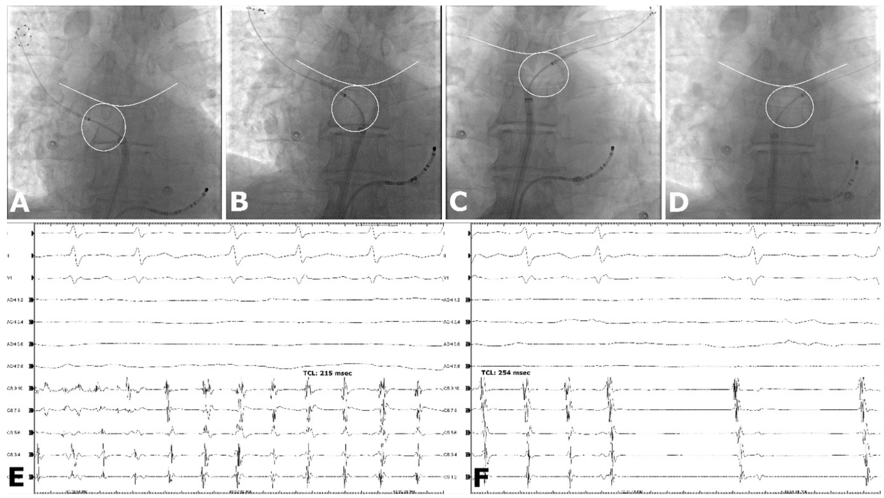

Figure 1. Fluoroscopic images of roof isolation start from the right to left side and end in the roof's mid-portion (A-D). Atrial tachycardia with a cycle length of 215 ms was recorded after the right superior PV isolation (E). After completion of the roof line, AT was terminated, and sinus rhythm resumed (G).

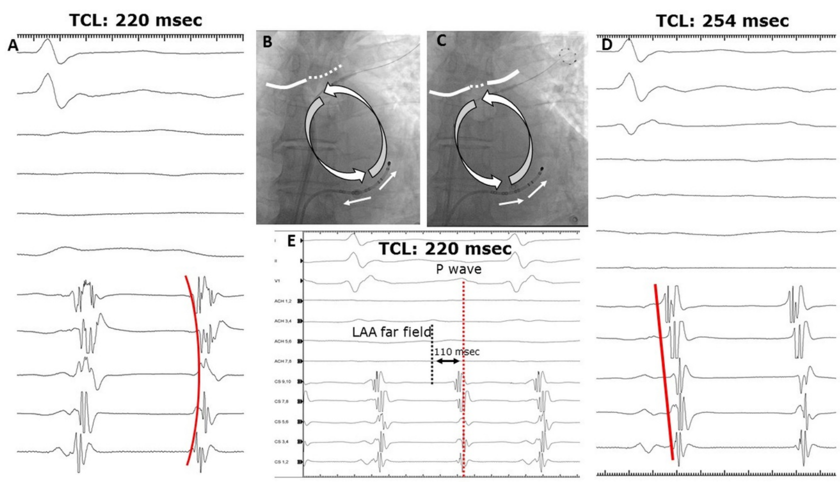

Figure 2. Atrial activation sequence in the CS demonstrated a "reverse chevron" pattern compatible with roof dependent tachycardia (A). Fluoroscopic image of CB at the right side at the beginning of roof line formation. Dashed curve demonstrating the non-ablated roof area (B). Fluoroscopic image of CB in the middle of roof line at the last CB application before AT termination. The dashed line was the only area without cryo energy application (C). Before AT termination, atrial activation in the CS catheter turned into a "proximal-distal" pattern due to the roof's left side (D). Far-field left atrial appendage signals recorded in Achieve 3-4 is 110 ms earlier than surface P wave, implying descending activation at the anterior wall.

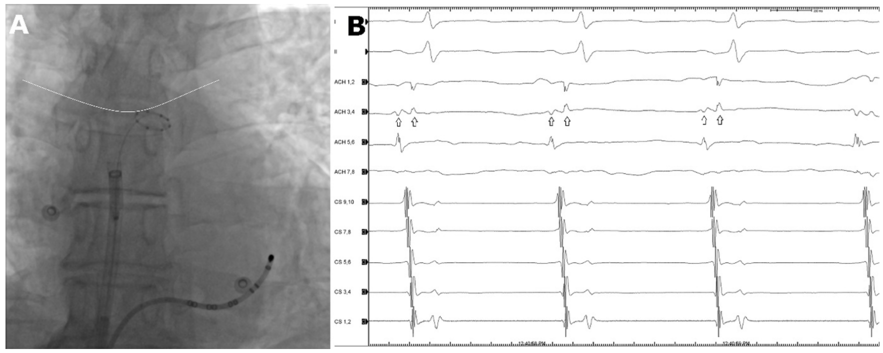

Figure 3. Achieve catheter at the roof after deflation of CB (A), demonstrating double potentials (B).