Pulsed-field ablation using pentaspline catheter as a bail-out strategy for perimitral flutter related to the left atrium anterior wall scar

Piotr Gardziejczyk, MD, PhD,* Ewa Wlazłowska-Struzik, MD,*
Marta Skowrońska, MD, PhD,* Jakub Baran, MD, PhD*†

*From the *Division of Clinical Electrophysiology, Department of Internal Medicine and Cardiology, Medical University of Warsaw, Warsaw, Poland, and †Division of Clinical Electrophysiology, Department of Cardiology, Centre of Postgraduate Medical Education, Grochowski Hospital, Warsaw, Poland.*

Introduction

The relationship between perimitral flutter and previously performed atrial fibrillation ablation is well known. The event rate ranges from 5% to 25% depending on the complexity of catheter ablation procedures.[1] The perimitral flutters are one of the most challenging arrhythmias owing to complex anatomic relationships.[2] Attempts to interrupt the perimitral circuit at different locations, such as anterior, medial, or lateral lines, have individual challenges.[1,3] The ablation strategy should be carefully chosen based upon previously performed lines in the left atrium (LA), low-voltage areas in the LA, and the ability to adapt various energy sources, such as radiofrequency (RF) energy, cryoablation, and alcohol ablation.

Case report

A 61-year-old patient was referred to our electrophysiology lab after 2 left atrial ablation procedures. The patient underwent pulmonary vein isolation for persistent atrial fibrillation with cryoablation (Arctic Front; Medtronic, Minneapolis, MN) in 2016 and subsequently, in 2022, a re-do RF ablation procedure with pulmonary vein reisolation and posterior wall isolation owing to abnormal, heterogenous low-voltage areas between the left and right pulmonary veins. Several months later the patient developed highly symptomatic atrial tachycardia. The ablation procedure was performed under general anesthesia owing to the unpleasant experience of pain referenced by the patient during previous procedures despite conscious sedation with midazolam and fentanyl. Vascular access was obtained under ultrasound assistance. The intracardiac echocardiography (ICE)-guided transseptal puncture was performed after administration of a full dose of unfractionated heparin intravenously. The electrophysiologic study and electroanatomic mapping (CARTO 3 System; Biosense Webster, Irvine, CA) was performed with a high-density diagnostic catheter (PentaRay; Biosense Webster, Irvine, CA). Pulmonary veins and posterior wall remained isolated and low-voltage areas in the anterior wall were noted (Figure 1). Macroreentrant left atrial tachycardia was revealed with a cycle length (CL) of 240 ms, related to a scar at the higher aspect of the anterior wall of the LA. Using the ripple mapping module, we depicted the critical isthmus in that location (Supplemental Video 1). In that area near-field fractionated electrograms were recorded. Entrainment maneuver from the target area was performed with postpacing interval – tachycardia CL less than 10 ms and stim to P longer than 70% of the CL (Supplemental Figure 1),

KEY TEACHING POINTS

- Perimitral flutter is a challenging arrhythmia with recurrences after catheter ablation owing to inability to create durable transmural lesions that are associated with individual anatomical relationships.
- Pulsed-field ablation can be associated with more consistent scar formation, which can be crucial in terms of difficult atrial tachycardia ablation. There are preclinical reports on better energy penetration through scar and fatty tissue in comparison to radiofrequency energy.
- It seems reasonable to use pulsed-field ablation in other regions than pulmonary veins and posterior wall of the left atrium with caution, and its use should be limited as a bail-out strategy until collection of more clinical data.

KEYWORDS Pulsed-field ablation; Perimitral flutter; Catheter ablation; Atrial tachycardia; Radiofrequency energy
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Address reprint requests and correspondence: Dr Piotr Gardziejczyk, Division of Clinical Electrophysiology, Department of Internal Medicine and Cardiology, Medical University of Warsaw, Lindleya 4, 02-005 Warsaw, Poland. E-mail address: piotrgardziejczyk@gmail.com.

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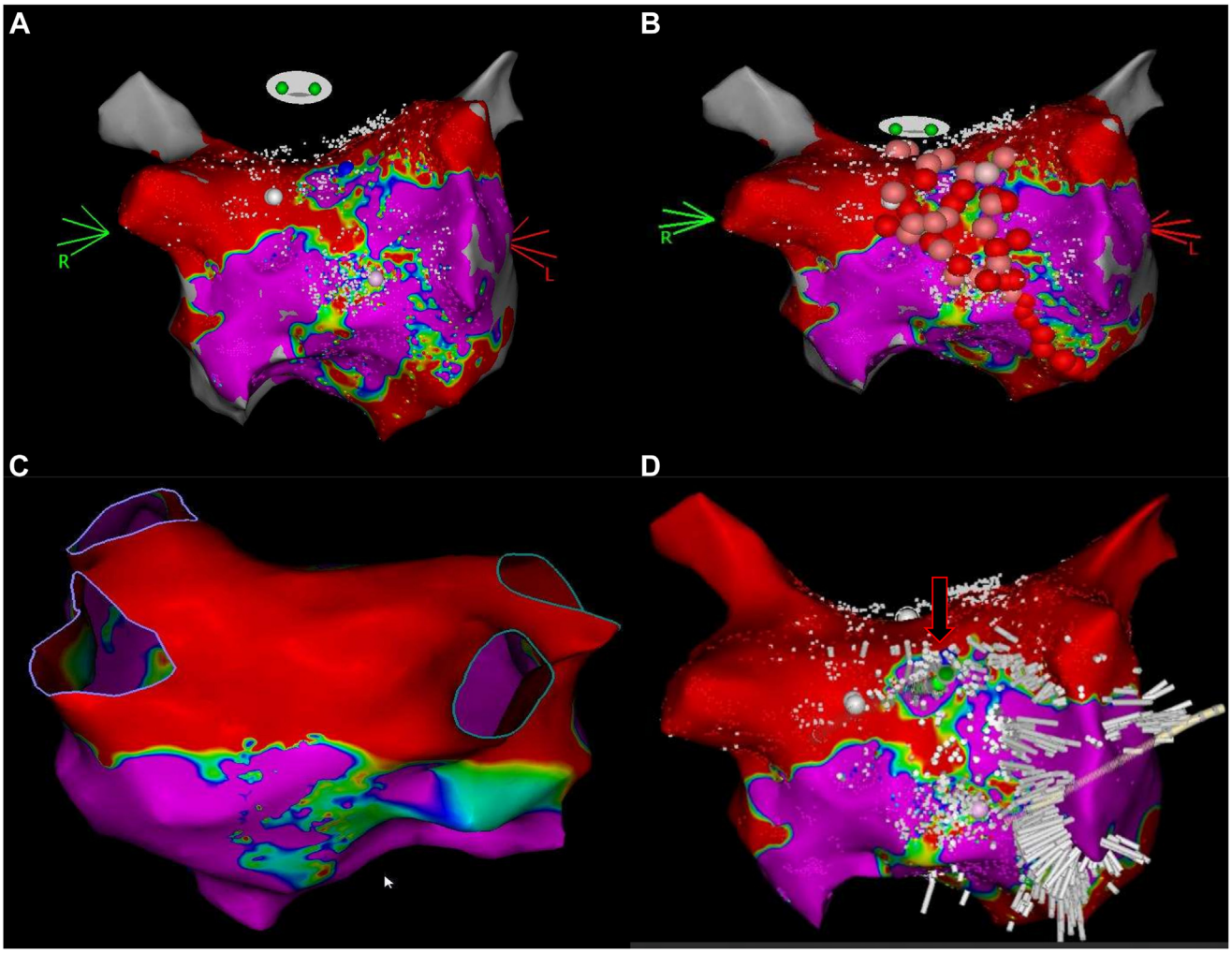

Figure 1 **A:** Left atrium (LA) bipolar map (0.1–0.3 mV) with isolated pulmonary veins and posterior wall with low-voltage areas in the anterior wall. **B:** Radiofrequency lesion sets in the anterior and roof line. **C:** Posteroanterior 3-dimensional map of LA. **D:** Ablation catheter localization (*black arrow*) in the critical isthmus area; green arrow represents the direction of the main force vector of the ablation catheter.

suggesting the catheter was in an inner loop close to the critical isthmus. An additional map from the left pulmonary artery was also performed to confirm the arrhythmia localization solely in the endocardial aspect of the LA. In the first step, an anterior line through the patchy scar was ablated using point-by-point RF applications (QDOT Micro catheter; Biosense Webster, Irvine, CA) (Figure 1B). It was possible only to achieve a prolongation of CL by 20 ms, but arrhythmia was still ongoing. Unfortunately, despite prolonged RF applications with different energy settings (35–50 W) with an ablation index up to 700 in the target area, we were unable to terminate the arrhythmia (Figure 1C). ICE showed thickness of the left atrial wall in this region of 4–5 mm. As a next step we decided to cross over to pulsed-field ablation (PFA) instead of ineffective RF energy during the same procedure. We introduced the pentaspline PFA catheter (FaraWave; Farapulse-Boston Scientific Inc, Marlborough, MA) through a dedicated 13F steerable sheath with a transparent shaft (FaraDrive; Farapulse-Boston Scientific Inc, Marlborough, MA) into the LA. As visualization of the FaraWave catheter in the CARTO 3D mapping system is not possible, the target area was annotated in fluoroscopy with the RF ablation catheter in different projections (left anterior oblique, right anterior oblique) (Figure 2). Being aware that PFA might cause coronary vasospasm, especially on the anterior LA wall, where in front of the LA the aortic root is located with the orifice of the left main coronary artery, we used ICE visualization to ensure the proper distance from the left coronary artery and device location (Supplemental Video 2). Once we achieved the higher portion of the anterior wall with the PFA catheter in the "flower" configuration, the arrhythmia was terminated with the first pulse of the energy application. Additional pulses were delivered to ensure proper scar development in that area (Figure 3). Anterior line block was confirmed by pacing maneuvers from decapolar and ablation catheters. No more near-field electrograms were recorded with the ablation catheter in the ablated area and we were not able to capture atrial tissue with high output pacing. Despite a high dose of the isoproterenol challenge and very aggressive atrial burst pacing from the decapolar

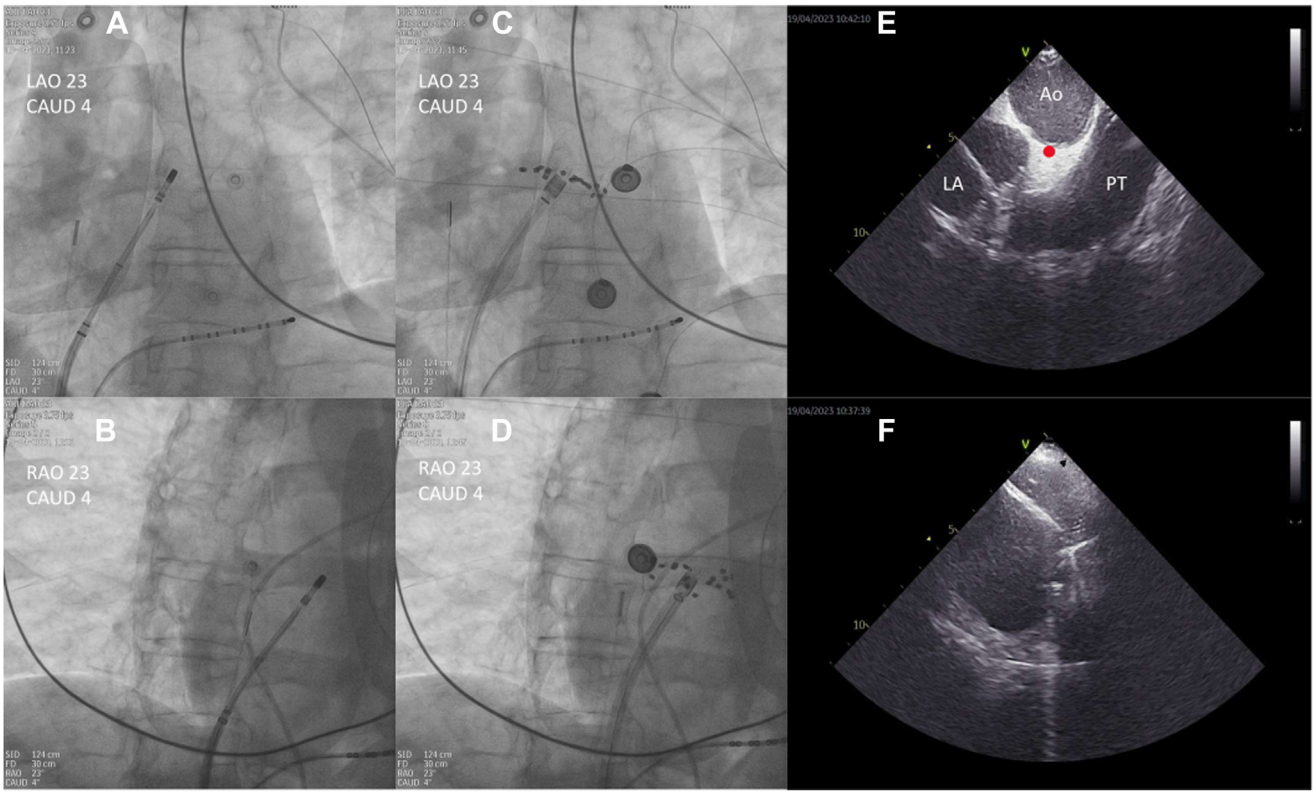

Figure 2 **A, B:** Fluoroscopy shows the location of the ablation catheter in left anterior oblique (LAO) (**A**) and right anterior oblique (RAO) (**B**). **C, D:** Pulsed-field ablation (PFA) catheter is shown in LAO and RAO, respectively. **E, F:** Intracardiac echocardiography imaging shows the location of PFA catheter in the target location with proper tissue contact and a safe distance from the coronary arteries; red dot represents the expected location of the left main coronary artery. Ao = aorta; LA = left atrium; PT = pulmonary trunk.

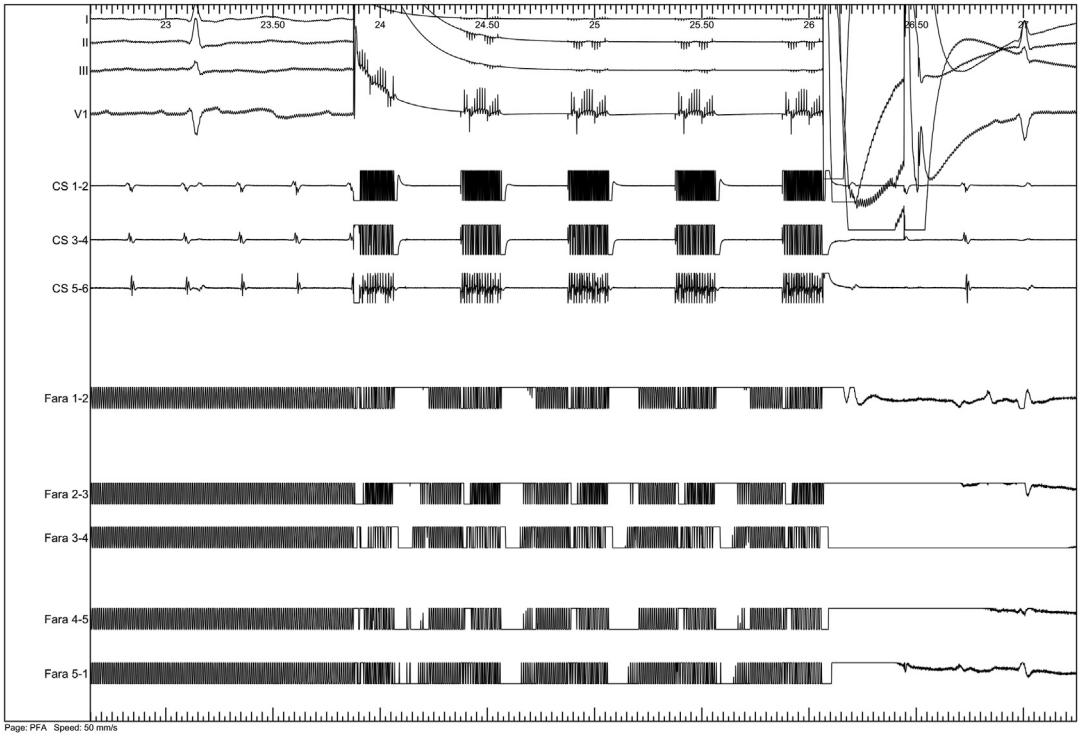

Figure 3 Electrocardiogram and intracardiac electrograms recordings during pulsed-field ablation application with termination of the perimitral flutter.

diagnostic catheter up to 200 ms CL, it was not possible to induce any arrhythmia afterwards. It seems that the acute effect was satisfactory. During 3 months of follow-up, the patient remains asymptomatic and 12-lead electrocardiogram registration and 24-hour Holter electrocardiogram showed sinus rhythm. There was no episode of symptoms related to atrial tachycardia, and daily measurements of resting heart rhythm were within 50–70 beats/min. However, we must wait until long-term follow-up to completely recognize the effect of the PFA in that location.

Discussion

This case presents the powerful impact of a hybrid strategy with PFA and RF energy on perimitral atrial tachycardia related to a scar area on the LA anterior wall that was resistant to a standard approach. The best entrainment maneuver from the endocardial aspect of the LA with post-pacing interval – tachycardia CL less than 10 ms and stim to P longer than 70% of the CL was performed in the upper part of the LA anterior wall. The PFA catheter was able to create a larger lesion that affected the critical isthmus, which was not reached by RF ablation. This novel type of energy is mainly used for pulmonary vein isolation, with a high efficacy and satisfactory safety profile consistent with preferential tissue ablation.[4–6] There are also clinical reports on the possibility and efficacy of PFA in ablation in the posterior wall of the LA. However, there are some concerns regarding vasospasm of coronary arteries, which can be reversed by the administration of nitroglycerin.[7,8] There are also some animal studies that confirm better penetration of PFA into scar and fatty tissue compared to RF energy.[9] At present, PFA should remain a bail-out strategy in other regions than pulmonary veins and posterior wall of LA and may be considered an option in highly symptomatic patients with arrhythmias refractory to standard approach. We believe that when focal catheter ablation will become more available, PFA will be an interesting option for difficult macroreentrant atrial tachycardia ablation within the left and right atrium.[10]

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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.2023.09.016.

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