Rotors in Patients with Persistent Atrial Fibrillation

Case Report of a Left Atrial Appendage Rotor Identified by a Novel Computational Mapping Algorithm Integrated into 3-Dimensional Mapping and Termination of Atrial Fibrillation with Ablation

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KEYWORDS

• Persistent atrial fibrillation • Panoramic AF mapping • Left atrial appendage • Ablation

KEY POINTS

- The cornerstone for catheter-based approaches to treat symptomatic paroxysmal atrial fibrillation (PAF) has historically been based on circumferential pulmonary vein isolation (PVI).
- The role of PVI in patients with persistent AF (PsAF) and long-standing PsAF (LsPAF) typically requires extensive ablation with a variety of approaches and techniques.
- Recent imaging modalities have been developed with the use of intracardiac baskets and high-density body surface electrodes allowing AF to be imaged in a panoramic field of view. These tools have provided insight into the mechanisms that maintain AF in patients with PsAF and LsPAF and identified AF drivers in the form of rotors and focal impulses.
- Targeting AF drivers using these technologies has recently been shown to reduce procedure times and improve outcomes in patients with PsAF and LsPAF.
- The left atrial appendage (LAA) has been shown to be an extrapulmonary source of AF; targeting sources within/around the LAA has resulted in termination of AF and improved AF outcomes.

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INTRODUCTION

Atrial fibrillation (AF) is the most common cardiac arrhythmia worldwide and is associated with increased risks of stroke, heart failure, hospitalizations, and mortality.[1,2] Catheter-based treatment has been historically based on targeting the triggers of AF, which are thought to be mainly located within the pulmonary veins (PVs).[3] This approach has had success in the treatment of paroxysmal AF (PAF); however, its role in persistent AF (PsAF) and long-standing PsAF (LsPAF) has been limited, largely because of poorly understood mechanisms of the driving influences that maintain AF.[4]

Recent technological advancements have provided further insight into mechanisms driving PsAF and LsPAF with the use of intracardiac baskets and high-density body-surface electrodes, creating an opportunity for panoramic imaging to elucidate the mechanism that maintain AF in patients.[5,6] Using these novel technologies, AF drivers have been identified and described as rotors and focal Impulses. With a panoramic field of view of human AF, drivers of AF can be targeted with catheter ablation. Using these technologies, an AF driver-directed approach guiding ablation in PsAF and LsPAF has produced promising initial results potentially reducing procedure times and improving outcomes in this difficult-to-treat patient population.[7,8]

The left atrial appendage (LAA) is traditionally thought of as the major source of thromboembolism in patients with AF, which can result in disabling strokes.[9] In addition, recent studies have revealed the LAA to be a source contributing to the initiation and possible maintenance of AF.[10]

CASE REPORT

Clinical History

Here we describe a 66-year-old white man with a history of hypertension, diabetes mellitus, and obstructive sleep with PsAF who underwent ablation with pulmonary vein isolation (PVI) and Linear Ablation. He was noted to have depressed left ventricular function by transthoracic echocardiography revealing an ejection fraction of 45%. Despite adequate rate control, he continued to report symptoms of fatigue and dyspnea on exertion, which he correlated with the onset of his AF. He initially underwent antiarrhythmic drug load with dofetilide and cardioversion but was noted to have early recurrence of AF (ERAF). Given his symptoms, he was offered a catheter-based ablation approach with PVI and linear ablation using radiofrequency ablation. Transesophageal echocardiography before the procedure was noted for a mildly dilated left atrium (LA) with a septal to lateral wall dimension of 4.9 cm.

Research Protocol

This patient was a participant in an Institutional Review Board–approved study at Mercy Heart and Vascular Hospital (St Louis, MO) evaluating a novel computational mapping algorithm (CMA; CardioNXT, Westminster, CO) that recreates 3-dimeniional (3D) panoramic unipolar maps with the collection of local near-field electrograms with circular mapping catheters (LASSO, Biosense Webster, Diamond Bar, CA) in a sequential fashion during LA geometry creation while the patient is in AF. A novel pattern-recognition algorithm derived from the CMA analyzed local near-field and far-field signals and detected correlations in AF allowing for the recreation of 3D panoramic unipolar AF maps.

Local unipolar signals were then evaluated in the context of their identified and reassigned locations within the 3D LA geometry created during the procedure and analyzed with conduction vector analyses. Conduction vectors in AF were created based on the relationship between identified unipolar signals obtained with the circular duodecapolar catheters and integrated within the 3D LA map. Local unipolar signals were then filtered and processed with CMA to identify the drivers of AF in the form of rotors and focal impulses.

In addition, further evaluation of local electrograms was performed, including continuous fractionated atrial electrogram (CFAE) analysis and mean voltage in AF. CFAE and mean voltage in AF were subsequently correlated in the context of identified AF drivers. Analysis was performed off-line after the procedure, with rhythm changes that were noted during the case evaluated in relation to the (1) CMA-identified drivers and (2) incidental ablation during the procedure with standard PVI and linear ablation.

Procedural Details

The patient was brought to the electrophysiology laboratory in a fasting state, intubated, and sedated under general anesthesia. Catheters were introduced via the femoral veins. Double transseptal access was guided by intracardiac ultrasound and fluoroscopy. Heparin was administered to maintain an ACT greater than 350 throughout the case once transseptal access was obtained. Standard catheters were placed, including a linear decapolar catheter in the coronary sinus (Inquiry, St Jude Medical, St Paul, Minnesota) and a circular duodecapolar catheter (LASSO) in the LA. Detailed 3D electroanatomic