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Case Report

Dual loop reentrant tachycardia with a combination of a localized reentry and a macro-reentry

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ABSTRACT

A 78-year-old woman presented 2 years after mitral valve replacement for rheumatic mitral stenosis with cardioversion-resistant atrial tachycardia (AT). Dual-loop AT was identified by activation mapping with the Rhythmia™ system (Boston Scientific, Marlborough, MA, USA) and confirmed by entrainment-mapping; one circuit with localized re-entry turned around the scar on the posterior left atrium and the other circuit, which was macro re-entrant, turned around the left superior pulmonary vein (LSPV) using the PV-carina, the ridge beween the left atrial appendage and the LSPV, and the roof. The two wavefronts fused on the posterior wall close to the LSPV. Radiofrequency ablation of an area of slow conduction on the posterior wall changed the tachycardia to roof-dependent AT which was then terminated by completion of a roof line.

<**Learning objective:** In this case report, we demonstrate the importance of using both conventional entrainment mapping methods and a novel ultra-high density mapping system to precisely understand the mechanism and appropriately terminate the complex atrial tachycardia in patients with prior atrial fibrillation ablation.>

Introduction

Entrainment mapping and activation mapping are the fundamental techniques for identifying the critical path of the re-entrant circuit [1,2]. However, after multiple atrial fibrillation (AF) procedures, tachycardia circuits frequently follow a complicated course between prior ablation scars or fibrotic areas, and it is not always possible to demonstrate the entire circuit of atrial tachycardia (AT) with only entrainment mapping. Furthermore, even with conventional 3D mapping systems, manual annotation is often required to create a reasonable activation map, and it is sometimes impossible to display the entire circuit of the complex AT due to the low resolution of the mapping system. The Rhythmia™ mapping system with the 64-electrode Orion™ basket catheter (Boston Scientific, Marlborough, MA, USA) may make it feasible to rapidly map the complicated circuits with sufficient spatial resolution and electrogram quality to elucidate the entire circuit and critical isthmus of these ATs after AF ablation.

Case report

A 78-year-old woman was referred for radiofrequency ablation of a cardioversion-resistant AT. Two years previously, she had undergone a mitral valve replacement with pulmonary vein isolation for rheumatic mitral stenosis. On arrival in the electrophysiology laboratory, the patient presented with clinical tachycardia with a cycle length (CL) of 235 ms. The AT was mapped with the Orion™ multipolar basket catheter and Rhythmia™ system. A total of 17,699 mapping points were obtained in 15 min to cover the left atrium with the Orion™ catheter (64 electrodes, area 0.4 mm^2; 2.5 mm spacing) using continuous automated acquisition and standard beat acceptance criteria. These were: (i) CL variation <10 ms, (ii) activation time difference variations between the coronary sinus electrograms <5 ms, (iii) catheter motion <1.0 mm per beat, (iv) catheter tracking uncertainty <3 mm, and (v) confidence mask ≤0.03 mV. The activation map without any manual annotation was displayed by the Rhythmia mapping system, allowing identification of a dual loop re-entrant AT, which was confirmed by post-pacing interval (PPI) mapping; as

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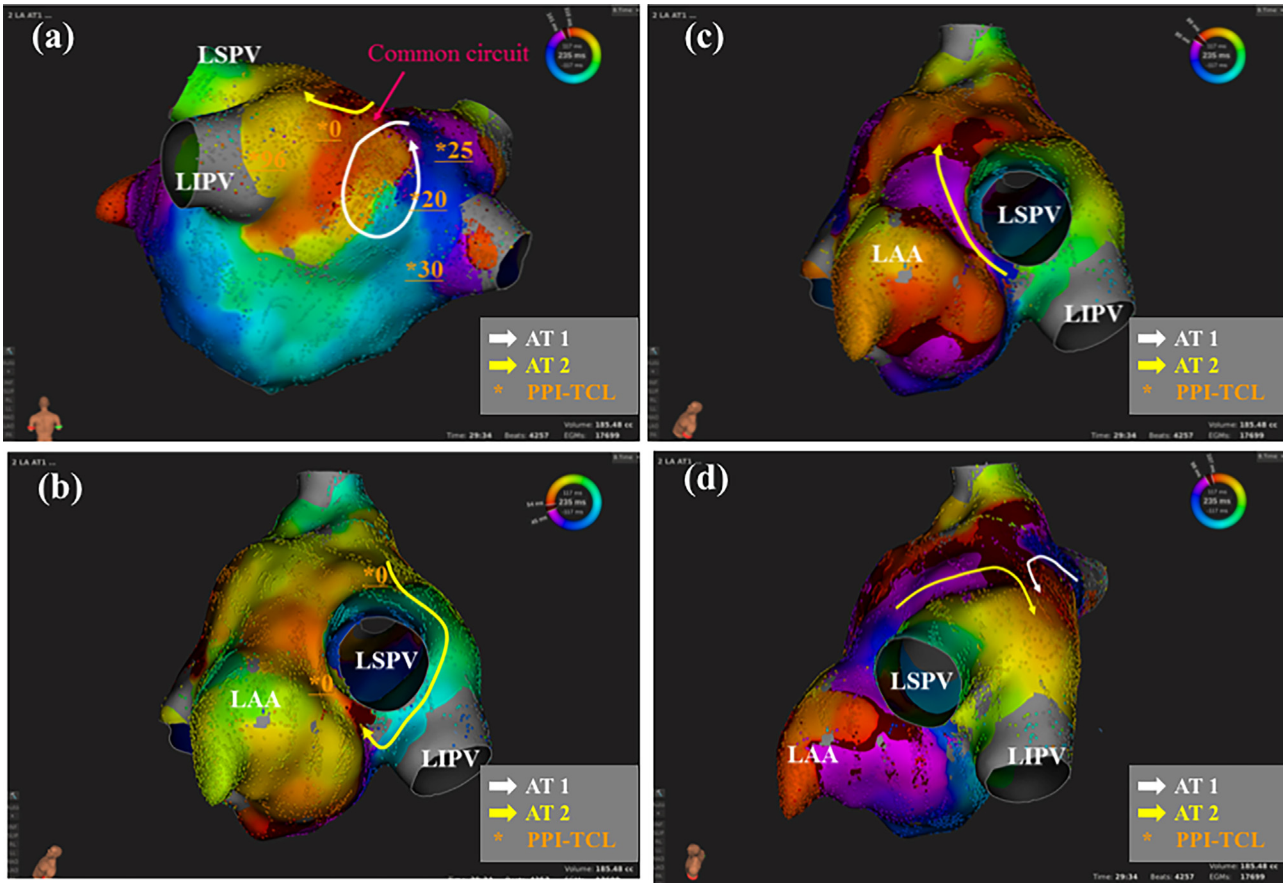

Fig. 1. Detailed activation map of the initial dual loop re-entrant tachycardia (a–d). The common isthmus in the posterior LA is shown with re-entry around an area of posterior scar and around the LSPV. Involvement of both circuits is confirmed by entrainment mapping.
AT, atrial tachycardia; LA, left atrium; LIPV, left inferior pulmonary vein; LSPV, left superior pulmonary vein; PPI, post-pacing interval; TCL, total cycle length.

shown in Fig. 1a–d. One circuit (AT1) turned locally around a small scar (black dots in Fig. 2) on the low posterior left atrium and the other (AT2) around the left superior pulmonary vein (PV) using the PV carina, the ridge between the left atrial appendage (LAA) and the left superior PV, and the roof. The two wavefronts fused on the posterior wall, close to the left superior pulmonary vein, which was used as a common path. Although the PPI on this critical site was equal to the tachycardia CL, we decided to treat these two ATs separately because this critical location was on the esophagus. To terminate AT1, the right PV was re-isolated and the gap between the right PV posterior-line and posterior scar, which exhibited fragmented slow conduction potentials (0.188 mV, 143 ms, was ablated) (Fig. 2). The CL gradually increased to 305 ms during ablation. Following the applications, a PPI during entrainment was still equal to tachycardia CL (TCL) on the posterior wall. However, entrainment at the ridge between the LAA and the left superior PV demonstrated a PPI-TCL of 100 ms, indicating that this site was no longer part of the re-entrant circuit. Subsequently, a second map created with the Rhythmia system with 13,434 mapping points in 11 min without any manual annotation displayed a typical roof-dependent AT (AT3). This tachycardia was terminated with a roof line (Fig. 3). Procedure and fluoroscopy time was 200 min and 36 min, respectively. Afterwards no AT was inducible.

Discussion

In the present study, we demonstrate the ability of a new high-density mapping system 'Rhythmia' to identify the activation pattern and critical isthmus of a dual loop tachycardia. We also demonstrate the importance of conventional entrainment mapping. Even if the activation map with the Rhythmia system clearly displays both circuits, it is mandatory to perform entrainment mapping [1,2]. This maneuver rules out passive activation of one of the circuits.

In this case, the Rhythmia mapping system successfully demonstrated dual-loop circuits with a localized re-entrant AT and a macro re-entrant AT. Dual-loop ATs with two macro re-entrant circuits, particularly after cardiotomy, are well described [3]. However, dual-loop AT consisting of a localized- and a macro re-entrant circuit has not been often reported. As substrate modification is increasingly performed to treat persistent AF, this type of dual-loop re-entry in the left atrium should have frequently occurred, but may have not been visualized with the previous 3D mapping system with a low-density mapping. Ultra-high-density mapping with multiple electrodes may make it easier to visualize this type of circuit and diagnose the mechanism of a complicated AT than is possible with other 3D mapping systems. In the present case, the common isthmus of the dual loop was not targeted in order to avoid radiofrequency applications on the esophagus, but under other circumstances detailed mapping would allow targeting of a single critical isthmus for both loops of the AT. In the current case, the dual loop AT, which was electrophysiologically confirmed by entrainment mapping, changed to a different circuit when one circuit was broken. Theoretically, AT2 should be persistent following the termination of AT1 by radiofrequency applications at the critical site for AT1. But, in reality, the activation