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CASE REPORT

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Effective and fast characterization of a complex atrial flutter in patient with previous atrial surgery and ablation procedure: The importance of new ultra–high-density mapping tools

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Abstract

New tools of mapping systems may allow to detect residual conduction around the atriotomy and could eliminate the subjectivity of the human eye, analyzing thousands of electrograms in a matter of seconds and providing a clear and fast identification.

KEYWORDS

arrhythmic substrate, atrial flutter, mitral valve surgery, ultra–high-density mapping

1 | INTRODUCTION

Atriotomies could be extremely pro-arrhythmic, allowing for areas of conduction through incisions and potentially leading to atrial arrhythmias. In this case, we describe the importance of new tools in ultra–high-density mapping procedures that may help to quickly identify and target the correct arrhythmic substrate.

Atriotomies provide direct visualization of the mitral valve, and surgical exposure through the transseptal approach may be favored in some instances, particularly for reoperations in which the anatomic landmarks can be obscured by fibrosis, and dissection of the posteriorly located left atrium may be complex.[1] This approach could be extremely pro-arrhythmic, potentially allowing for unpredictable areas of conduction through incisions with significant slowing. Not by chance, areas of slow conduction between the atriotomy and other structures are typical finding during atrial arrhythmias after previous cardiac surgery.[2] In this case report, we describe the use of recent automated tools in ultra–high-density mapping procedures that can help the physician to quickly identify and target the correct substrate.

2 | CASE DESCRIPTION

A 55-year-old man was seen for symptomatic persistent atrial flutter (AFL). Reconstructive mitral valve surgery in 2004 and mechanical surgical valve replacement after 15 years had been previously performed. Particularly, an extended vertical transatrial septal approach to the mitral valve was performed in order to provide better exposure[1]: The right atrium was opened along its anterolateral aspect extending it across the base of the right atrial appendage to the superior aspect of the interatrial septum. In 2019 after second surgery, the patient had developed new episodes of suspected right AFL, at first requiring multiple electrical cardioversions to restore sinus rhythm. An ablation procedure in a different hospital had been attempted, reporting a complete cavotricuspid-isthmus isolation. However, at admission in May 2020 the AFL was still persistent, and an atrioventricular 2:1 conduction was documented. Pharmacological therapy was warfarin 5 mg and sotalol 80 mg. Echocardiogram revealed a normal left ventricle global contractility (ejection fraction, EF: 55%), with residual mild mitral valve regurgitation. We decided to perform a new ablation attempt. Forty-eight-hours washout from sotalol was planned, before the ablation procedure.

2.1 | Procedure

A concentric coronary sinus activation (proximal to distal, 375 ms atrial cycle length) was documented; the electrocardiogram (ECG) confirmed incessant atrial flutter with negative inferior leads together with V1 (Figure 1). Activation map during arrhythmia was created, and a safe landmark, like the His position, was placed. Mapping points were collected from the Rhythmia mapping system and the Orion multipolar basket catheter (Boston Scientific) with a unique flat printed electrode technology (64 electrodes of 0.4 mm^2 area; 2.5 mm interelectrode spacing). In particular, due to sophisticated hardware designed to produce high-quality signals, it could result in a 0.01 mV noise floor. More than 11 000 intracardiac electrograms (EGMs) were collected. The activation map revealed localized conduction within the right atrium, along the previous right atriotomy scar (Video S1). At this point, we used the new Lumipoint™ algorithm,[3] rapidly allowing identification of a specific EGM characteristic such as double potentials (Figure 2) and visualizing it within thousands of EGMs available. This tool clearly shows previous atriotomy points (gray tags, Figure 2). The high-density mapping system also documented a complete cavotricuspid-isthmus isolation, due to previous ablation procedure (Figure 3). The radiofrequency ablation was then performed by means of a 4.5-mm-tip catheter (Intella NAV MIFI OI; Boston Scientific) from the pre-existent right atriotomy to the tricuspid valve (Figures 4 and 5). The line of ablation was performed in order to avoid any risk of damage to the normal conduction pathway. Power was adjusted between 35 and 40 W (power control mode) and ablation was continued for 30 to 60 seconds at each site, unless a local drop in impedance occurred (15-20 Ohm). The ablation phase was guided by DirectSense Technology, a feature based on local impedance, in order to guide the ablation phase according to the tissue response. AFL was rapidly interrupted (Figure 6) with creation of double potential, spaced 120 ms along the line of ablation, and the remap obtained with the Orion catheter during pacing from the coronary sinus catheter clearly showed the complete block line. Furthermore, a severe induction test was performed and the tachycardia was no more inducible. After 4 months of follow-up, sinus rhythm persists.

3 | DISCUSSION

In this case, the identification of circuit was crucial for successful ablation, especially if P-wave morphology and intracardiac EGM activation could potentially suggest typical cavotricuspid-isthmus–dependent AFL, as shown in Figure 1. The high-resolution mapping catheter allowed us to detect residual slow conduction between the right atriotomy

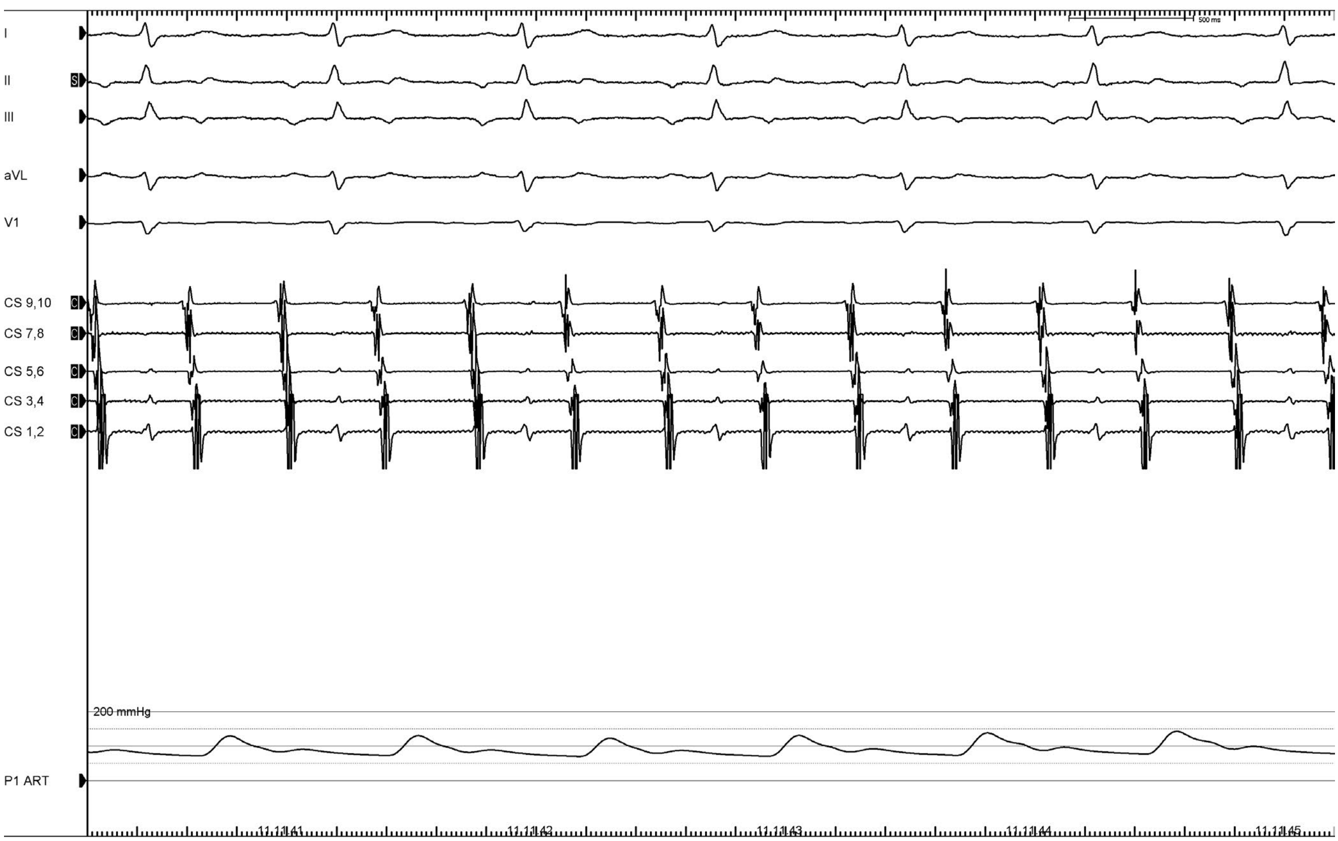


FIGURE 1 Persistent atrial flutter with concentric coronary sinus activation (375 ms atrial cycle length)

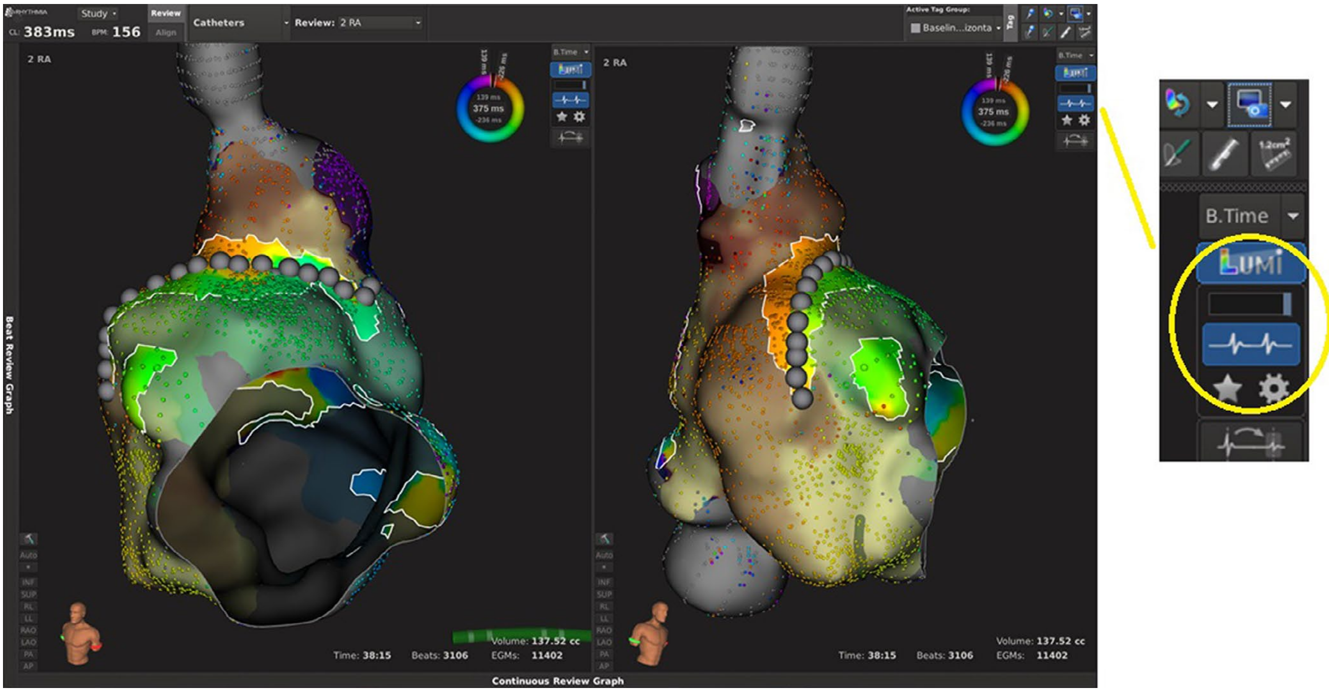
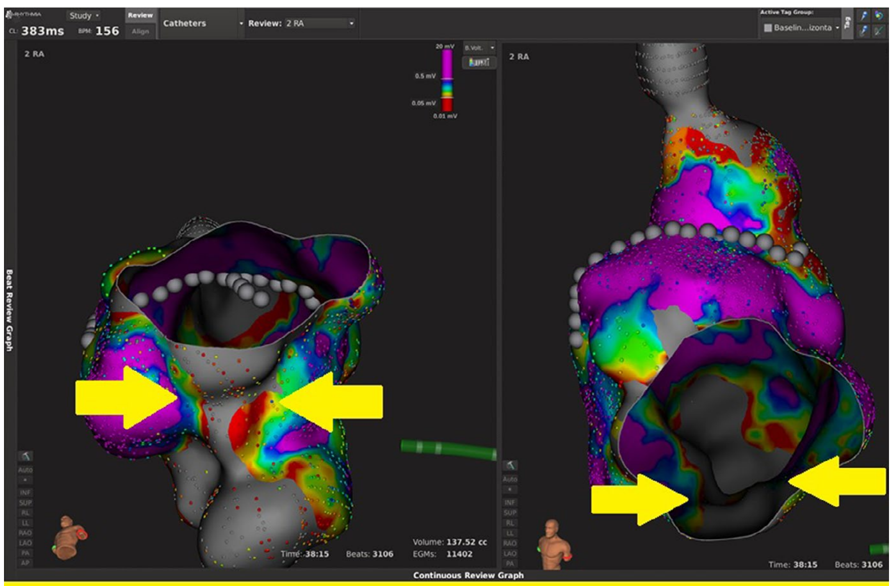


FIGURE 2 Lumipoint™ algorithm allows identification of a specific electrogram (EGM) characteristic such as double potentials (yellow circle), visualizing it within thousands of EGMs available. Gray tags identify previous atriotomy points

FIGURE 3 Previous complete cavotricuspid-isthmus isolation



and the tricuspid valve,[4] and was extremely fast and accurate in order to define the scar. The Lumipoint™ software, a new automated algorithm, was actually very effective since it could eliminate the subjectivity of the human eye analyzing thousands of EGMs in a matter of seconds.[3] In this case, the Lumipoint tool was as fast as effective to find the line due to previous cardiac surgery: The highlighted area in Figure 2 demonstrates the presence of double potential, representing the surgery line. Also in Figure 5, the presence of double potentials is well represented in the orange graph (trend tool): This important tool shows the summary of the potentials around the probe (round white shape in the figure). The extreme accuracy was determined by the combination of ultra–high-definition mapping system (Rhythmia HDx) and the Orion multipolar basket catheter (64 electrodes of 0.4 mm^2 area; 2.5 mm interelectrode spacing) allowing to detect even the smallest EGMs.[5]

The high-density mapping system also showed a complete cavotricuspid-isthmus isolation. In the supplementary attached Video S1, the red wave propagation crossing all the

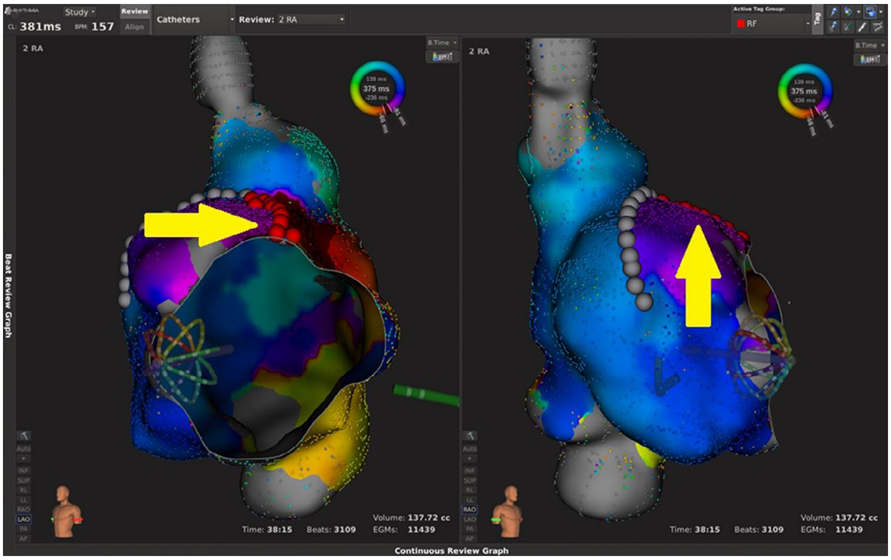


FIGURE 4 The radiofrequency ablation points (red tags) performed from the pre-existent right atriotomy to the tricuspid valve

surface of the right atrium is documented: starting from the posterolateral wall (in inferior direction) and then around the lateral scar, the wave front reach the upper side of the right atrium. This change of direction is due to an important area of dense scar (as shown in Figure 3), potentially related to the previous ablation of cavotricuspid isthmus. Figure 3 confirms the voltage map of the right atrium: The range is very low (between 0.05 and 0.5 mV), and the suspected previous cavotricuspid-isthmus isolation line is even below the red threshold (below 0.05 mV). Actually, the isolation line was large due to two previous ablation sessions, with no evidence of double potentials (dense scar with no detectable signals even below the confidence mask of 0.03 mV, Figure 3).

Therefore, although the arrhythmia circuit may frequently involve predictable anatomic landmarks, such as a known postsurgical atriotomy and a previous ablation, the precise critical isthmus is finally difficult to predict. Moreover, it is well known that a particular operative approach to the mitral valve, the transseptal incision, may result in very complex patterns of right atrium activation during arrhythmia; however, despite the modern introduction of high-density mapping systems, it is still time-consuming in daily practice. The ultra–high-density mapping tools, such as Lumipoint™ software in this case, rapidly elucidated the circuit in a complex scenario.

4 | CONCLUSIONS

The use of recent automated tools in ultra–high-density mapping procedures helped to quickly identify and target the circuits in a very complex anatomy, with a previous unsuccessful ablation procedure, allowing successful treatment with minimal lesion set.

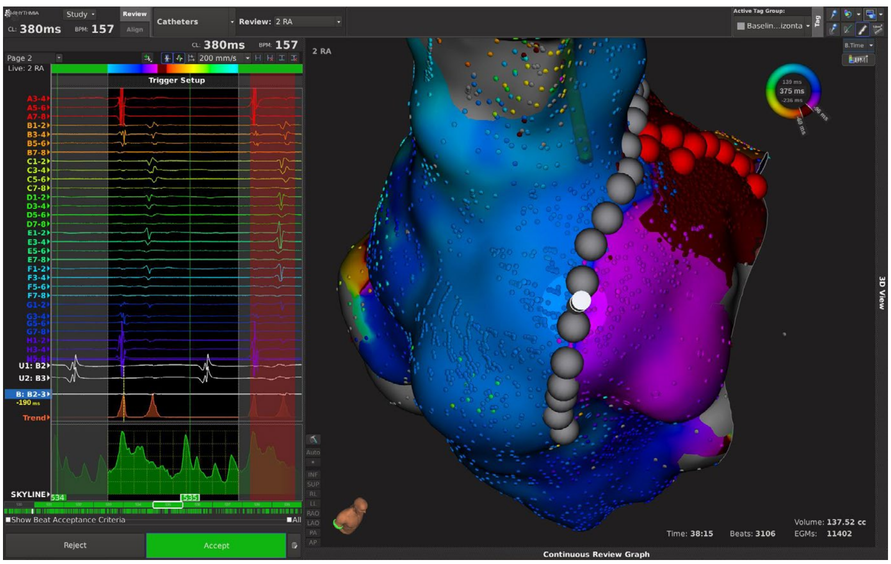


FIGURE 5 The presence of double potentials represented in the orange graph (trend tool)

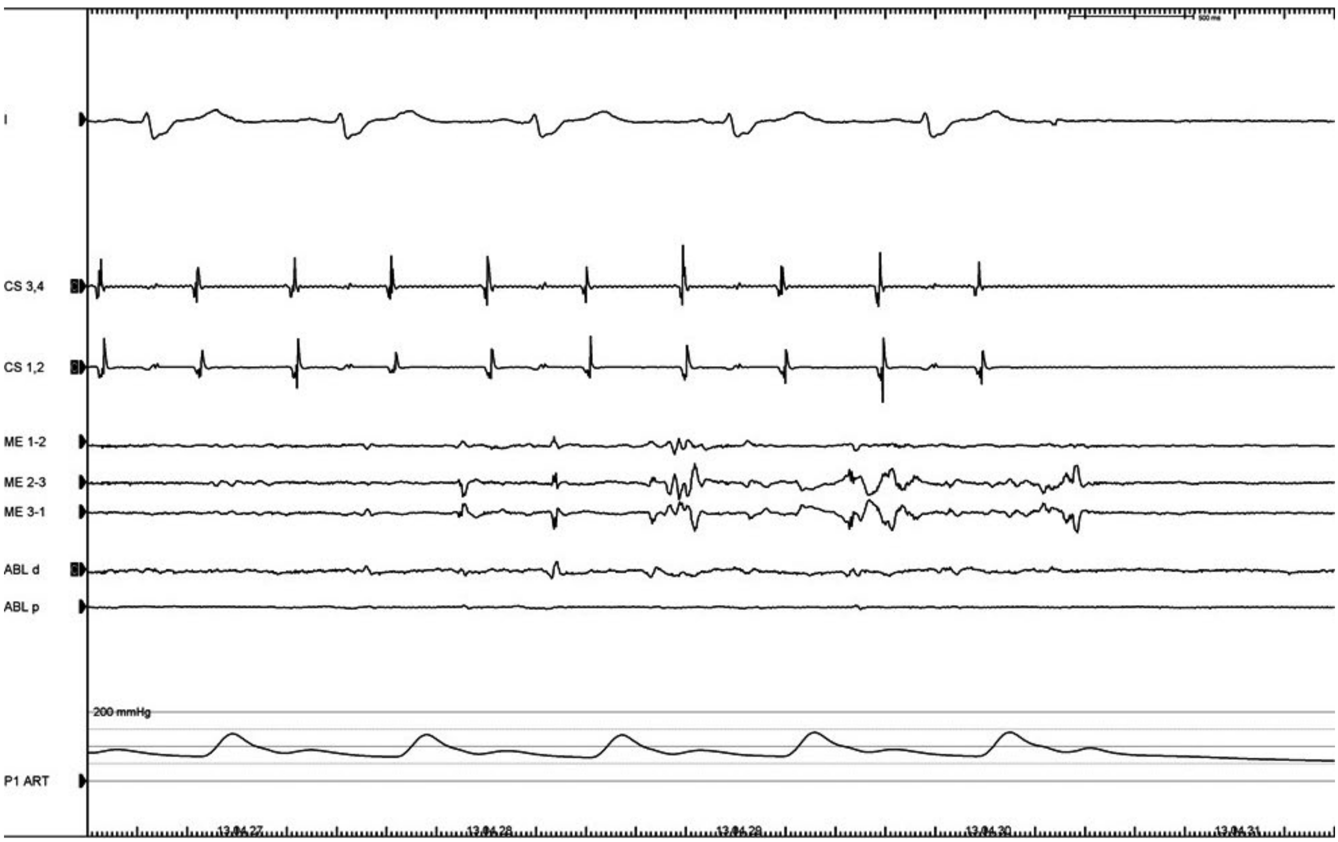


FIGURE 6 Atrial flutter interruption during radiofrequency catheter ablation

ACKNOWLEDGMENTS
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CONFLICT OF INTEREST
Nothing to declare.

AUTHOR CONTRIBUTIONS
GM and PS: performed the procedure. GM and IP: equally contributed to the paper and critically revised the manuscript.

ETHICAL APPROVAL
The procedure was approved by the ethical committee.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section.

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