USEFULNESS OF HIGH RESOLUTION MAPPING WITH MINI-ELECTRODES TO SELECT ABLATION SITE IN COMPLEX ARRHYTHMIAS

A CASE REPORT.

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ABSTRACT

A 62-year-old woman, with recent sinus venosus atrial septal defect correction surgery, developed a persistent macroreentrant atrial tachycardia and was scheduled for ablation. Right atrial high-resolution electroanatomical map (RHYTHMIA™ navigation system) showed a macroreentrant circuit with a broad slow conduction area in the lateral wall of the right atrium, between the two cavotomy scars performed at surgery for extracorporeal cannulation. Phrenic capture was patent in most of the slow conduction area. High-resolution mapping of this area using the mini-electrodes embedded in the IntellaTip MIFI™ open-irrigated catheter allowed precise location of the critical isthmus of the tachycardia. Focal ablation was sufficient to terminate it, avoiding linear ablation, which may have induced phrenic nerve injury.

CASE REPORT

We present a case of macroreentrant atrial tachycardia (MAT) ablation in a 62-year-old woman with a surgically corrected sinus venosus atrial septal defect. The diagnosis of this congenital heart defect was done in a cardiac magnetic resonance imaging performed after an uneventful percutaneous atrial fibrillation ablation performed in another center. The patient underwent then open-heart sinus venosus defect closure. Early after cardiac surgery, the patient developed an atrial tachycardia (Figure 1). An ablation procedure was scheduled.

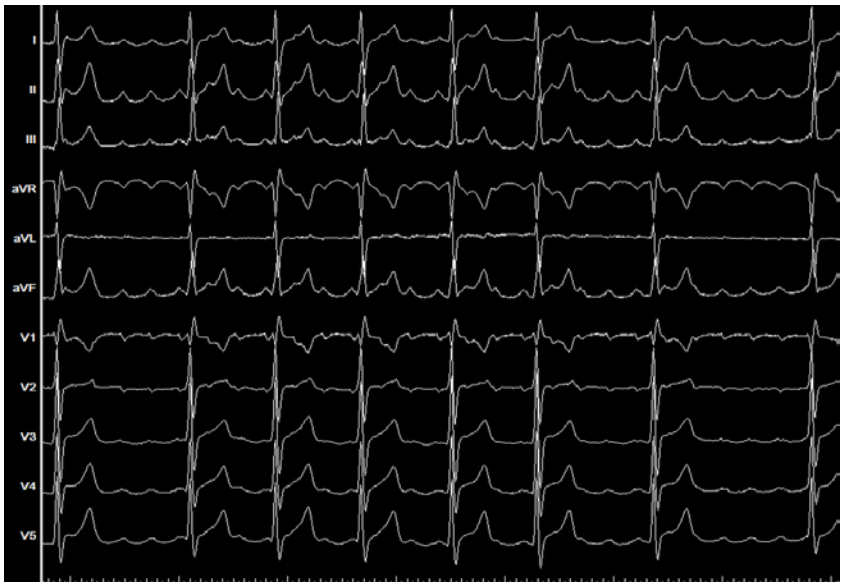

Figure 1. *ECG in atrial tachycardia. Macroreentrant mechanism is highly probable due to nearly-continuous atrial activity, and right atrial origin is suspected due to negative F waves in V1.*

A 24-pole catheter (**ORBITER®;** Bard Medical) was placed around the tricuspid annulus with its distal part within the coronary sinus. Post-pacing intervals at the coronary sinus and right atrium were consistent with right atrial origin of the tachycardia. Right atrial high-resolution activation map performed with the **INTELLAMAP ORION™** 64-poles catheter and **RHYTHMIA™** navigation system (Boston Scientific, Inc.) showed a **macroreentrant circuit with a figure-of-eight involving a broad slow conduction area in the lateral wall of the right atrium** (Figure 2): clockwise rotation around the superior vena cava, and counter-clockwise rotation around the inferior vena cava.

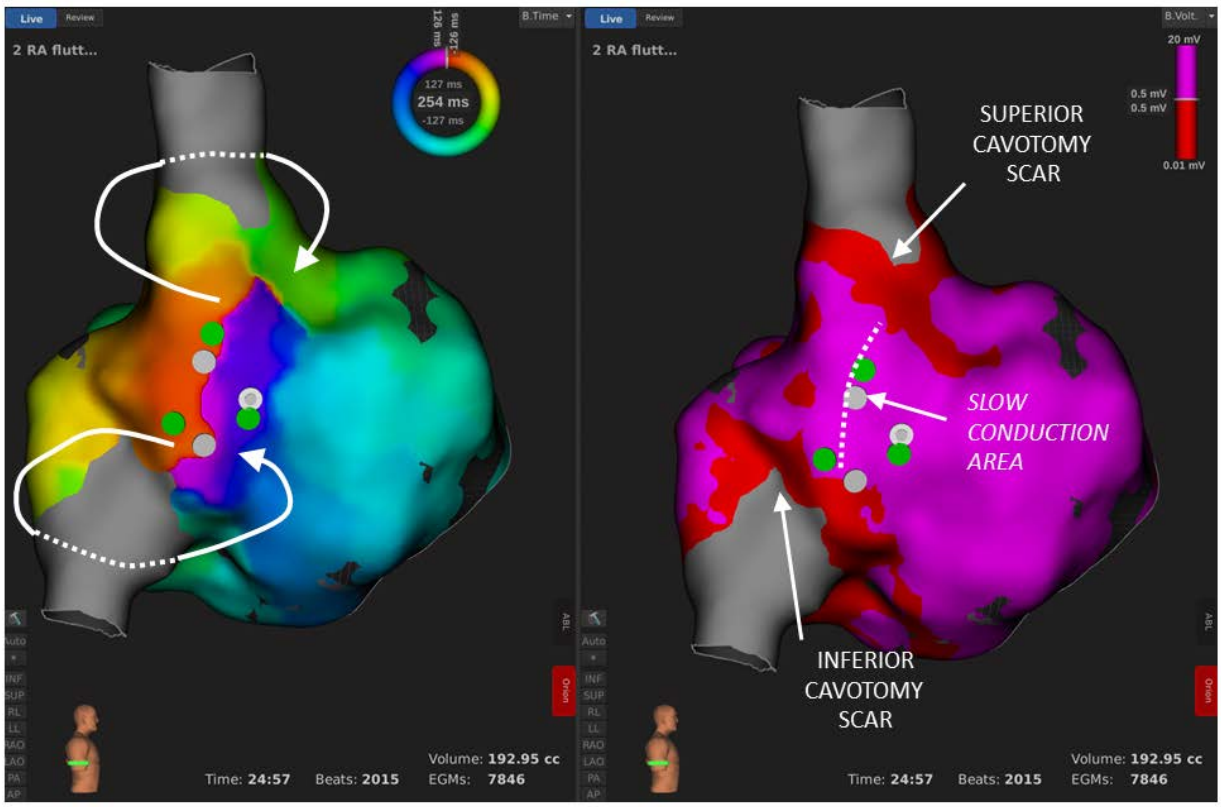

Figure 2. *High-density electroanatomical map of the tachycardia (lateral view of the right atrium), on RHYTHMIA™ mapping system. Left panel: Activation map showing a macroreentrant circuit with a figure-of-eight between the two cavotomy scars: clockwise rotation around the superior vena cava, and counter-clockwise rotation around the inferior vena cava. Right panel: Bipolar voltage map (scar threshold: 0.5 mV). In both panels, white dots represent fragmented local electrograms, and green dots (in the same positions) represent pacing sites with post-pacing intervals that matched tachycardia cycle length with concealed fusion.*

The **area of slow conduction was located between the two pericaval scars** performed at cardiac surgery for extracorporeal circulation, showing phrenic nerve capture along the majority of the line (Figure 3).

Linear ablation between the two cavotomy scars would have been sufficient to terminate the tachycardia, but that would have implied a high risk of phrenic nerve injury. Hence, high-resolution mapping of this area (previously located with the INTELLAMAP ORION™ catheter), was done using **IntellaTip MIFI™ open-irrigated** ablation catheter (Boston Scientific, Inc.) in order to localize the critical isthmus of the tachycardia and attempt focal ablation. Spots with most fragmented signals within the area of slow conduction in the distal dipole of the IntellaTip MIFI™ catheter (i.e. potential targets for ablation) were marked in the electroanatomical map (white spots in Figure 2); concealed entrainment with post-pacing intervals that matched tachycardia cycle length was observed from all three locations (green spots in Figure 2).

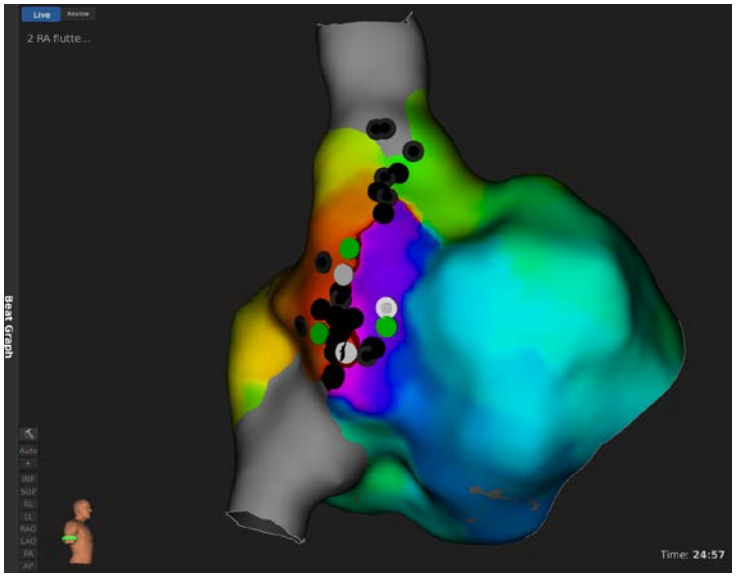

Figure 3. *Activation map of the tachycardia (RHYTHMIA™ mapping system, same view as in Figure 2). Spots with phrenic capture (black dots) were located nearly all along the slow conduction area in the lateral wall of the right atrium, between the two cavotomy scars.*

Mini-electrode signals from these three spots permitted exclusion of *false* isthmuses (i.e. **fragmented electrograms in the distal dipole of the ablation catheter and no fragmented signals in the mini-electrode dipoles, meaning fragmentation at the distal dipole was near-field but not *local* signal**) and selection of the *true* critical isthmus of the tachycardia (i.e. fragmented electrograms in both the distal dipole of the ablation catheter and the mini-electrode dipoles, meaning local fragmentation at the tip of the ablation catheter) (Figure 4).

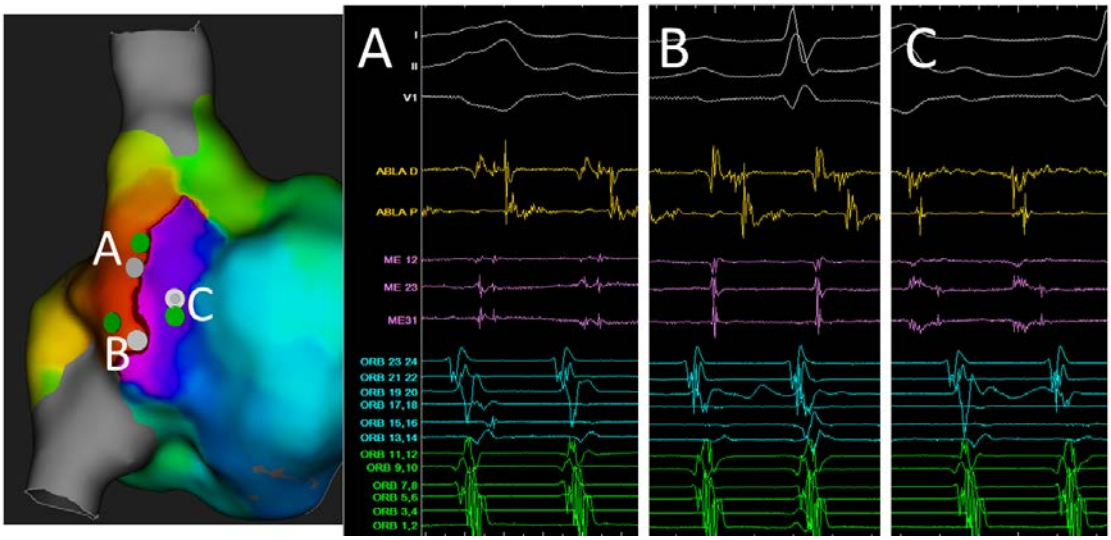

Figure 4. *Local EGMs on the distal dipole (ABLA D), proximal dipole (ABLA P) and mini-electrode (ME 12, ME 23 and ME 31) of the IntellaTip MIFI™ open-irrigated ablation catheter in locations A, B and C. ORB: Orbiter® catheter (dipoles in the right atrium colored in blue; dipoles in the coronary sinus in green). A: fragmented EGMs on ABLA D and ABLA P, but double potentials on mini-electrode dipoles. B: fragmented EGMs on ABLA D and ABLA P, but single non-fragmented signal on mini-electrode dipoles. C: fragmented EGMs on ABLA D and on the mini-electrodes dipoles, which means true local fragmentation at the tip of the ablation catheter.*

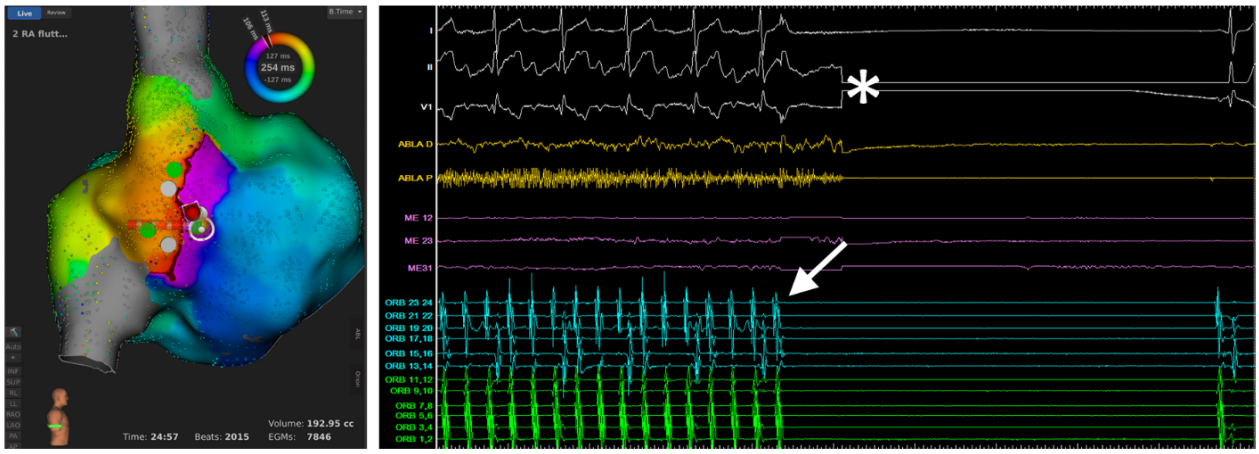

Figure 5. *A single radiofrequency application (40W) at the critical isthmus of the circuit (red spot in left panel) terminated the tachycardia (white arrow in right panel). ABLA D: local electrograms on the distal dipole of the ablation catheter; ABLA P: local electrograms on the proximal dipole; ME 12, ME 23 and ME 31: local EGMs on the mini-electrode dipoles (IntellaTip MIFI™ open-irrigated ablation catheter); ORB: local EGMs on Orbiter® catheter (dipoles in the right atrium colored in blue; dipoles in the coronary sinus in green). Electrical interference seen soon after tachycardia termination (asterisk) was due to a steam pop, which had no repercussions.*

DISCUSSION

MAT incidence is increasing, especially after other ablation procedures or cardiac surgery[1]. High-resolution electroanatomical mapping systems are a useful tool to understand complex reentrant circuits and may facilitate their ablation, even after unsuccessful procedures guided by conventional mapping systems[2]. Nevertheless, MAT ablation remains a challenge and its success rates are not as good as in other tachyarrhythmias[3]. In this context, **ablation catheters with embedded mini-electrodes might permit high-resolution mapping during ablation and improve its success**, as preliminary reports on common atrial flutter ablation have shown[4].

IntellaTip MIFI™ open-irrigated ablation catheter has three mini-electrodes within the distal electrode that allows visualization of the local electrograms at the catheter tip whilst avoiding near-field signals, which cannot be sometimes distinguished using only the *conventional* distal dipole signal. Concretely, in the field of MAT, precise location of slow conduction spots is of paramount importance as critical isthmuses that perpetuate the tachycardia usually display slow conduction, represented by fragmented electrograms**. If the distal dipole of the catheter is located onto a spot with slow conduction, fragmented electrograms will be seen in both distal dipole and mini-electrogram dipoles** (Figure 6, panel A). On the contrary, **if the distal dipole of the catheter is located *near* a spot with slow conduction but not right onto it, the distal dipole may display fragmented electrograms (as the mapped area is bigger than the catheter tip area) but the mini-electrode dipoles will not show those electrograms, meaning that point is not a valid target for ablation** (Figure 6, panel B). Finally, **if the distal dipole of the catheter is far enough from a spot with slow conduction, no fragmented electrograms will be seen neither at the distal dipole nor at the mini-electrode dipole**s (Figure 6, panel C).

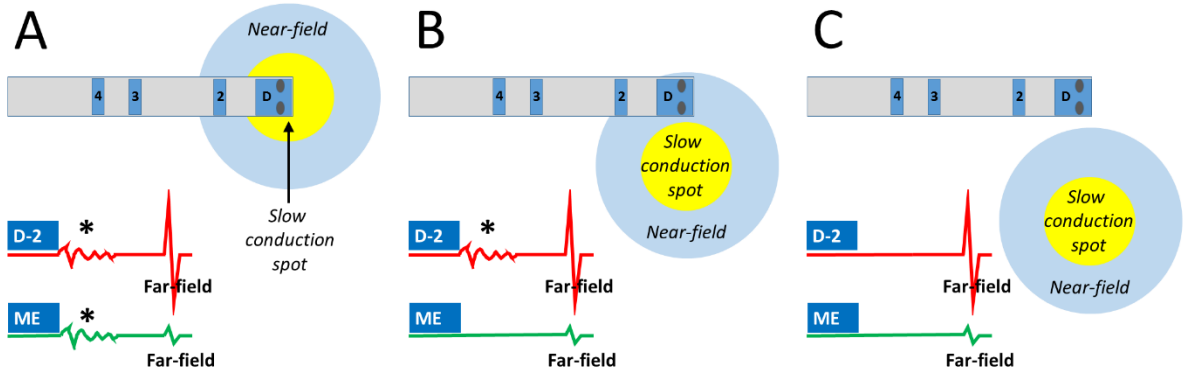

***Figure 6**. Diagrams representing local electrograms on distal dipole (D-2) and a mini-electrode dipole (ME) of a IntellaTip MIFI™ open-irrigated ablation catheter located onto a spot of slow conduction (panel A), near a spot of slow conduction (panel B) and far from that spot (panel C). Catheter electrodes are represented as D (distal), 2, 3 and 4. Mini-electrodes are represented as grey spots onto the distal electrode of the catheter. Panel A: fragmented electrograms (asterisks) can be seen on both distal and mini-electrode dipoles. Panel B: fragmented electrograms can be seen only on the distal dipole. Panel C: no fragmented electrograms can be seen if the distance from the slow conduction spot is big enough.*

CONCLUSION

High-density mapping with INTELLAMAP ORION™ 64-pole catheter and RHYTHMIA™ system permits precise documentation of reentrant circuits. Mini-electrodes embedded within the IntellaTip MIFI™ open-irrigated ablation catheter allow distinguishing between local, near-field and far-field signals. This may help to select the target for focal ablation in complex tachyarrhythmias.

DISCLOSURES

Dr. Eduardo Franco and Dr. Javier Moreno have received consulting fees from Boston Scientific. The rest of authors declare no conflicts of interest.

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