# Cavotricuspid isthmus high-density mapping

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## Introduction

Typical atrial flutter (AFL) is a common arrhythmia that is responsible for about 10% of all hospitalizations for supraventricular tachycardia in adults.[1] The reentrant circuit through the cavotricuspid isthmus is located in the right atrium, and the left atrium is then activated passively.[2] Cavotricuspid isthmus radiofrequency (RF) ablation is considered a first-line therapy to achieve rhythm control in patients with typical AFL.[3] A variety of techniques are applicable, including various catheter types, energy-delivery systems, and mapping and visualization tools; generally, success depends on the creation of a complete line of block and permanent interruption of conduction across the cavotricuspid isthmus. We report a case of cavotricuspid isthmus ablation guided by a novel mapping system capable of rapid- and high-resolution electroanatomical and activation mapping.[4]

## Case Report

A 66-year-old woman presented for RF ablation of common AFL. The AFL was mapped using the Orion multipolar basket catheter and Rhythmia mapping system (Boston Scientific, Marlborough, MA). Mapping points were obtained from the basket catheter (64 electrodes of 0.4 $mm^2$ area; 2.5-mm spacing) using continuous (automated) acquisition over 9 minutes, with standard beat acceptance criteria: (i) variation of cycle length $<13$ milliseconds, (ii) variation of activation time difference between coronary sinus electrograms $<5$ milliseconds, (iii) respiration phase gated within 13.6 microvolts, (iv) catheter motion $<1.7$ mm per beat, and (v) catheter tracking uncertainty $<3$ mm. The activation map revealed localized counterclockwise reentry within the right atrium, along the tricuspid annulus. The reentry circuit presented the site of markedly slowed conduction located typically at the cavotricuspid isthmus. We assessed it by inspecting the propagation wavefront map. In this kind of map, a dark red area displays the amount of tissue activated within 10 milliseconds in a specific portion of the mapping window. If this dark red area remains very close to the cavotricuspid isthmus in a large portion of the mapping window, it is reasonable that the cavotricuspid isthmus is located inside an area of slowed conduction.

The RF ablation was performed by means of a 10-mm-tip catheter (Blazer, Boston Scientific), achieving the interruption of the AFL and the creation of double potential, spaced 120 milliseconds, along the line of ablation (Figure 1A). The remap obtained with the Orion catheter during pacing from the coronary sinus showed a highly slowed conduction through the cavotricuspid isthmus without a full block (Figure 1B to 1G). Fractionated signals, with a third distinct potential, were observed with the Orion catheter at the sites of slowed conduction (Figure 2A and 2B), whereas only 2 split atrial electrograms were discernible with the ablation catheter (Figure 2C). This result may be ascribed to the lower spatial resolution achievable with larger electrode size and spacing. Therefore, we applied 2 additional RF pulses at the site of slow conduction, where fractioned potentials were detected by the Orion catheter. Then a new remap, performed during coronary sinus pacing, showed a complete block along the cavotricuspid isthmus and the disappearance of the previously detected second component of the fractioned potential (Figure 3).

## Discussion

In this patient, we were not able to precisely identify the gap in the cavotricuspid isthmus using a standard ablation catheter, due to absence of a detectable local signal. Achieving a $>110$ milliseconds separation between the double atrial potentials along the ablation line was not associated with complete cavotricuspid isthmus block, and only with a high-density and high-resolution mapping catheter we were finally able to detect residual slow cavotricuspid isthmus conduction.[5,6] The small, close, and low-noise minielectrodes of the Orion catheter may be advantageous for mapping areas of scar tissue, including acutely ablated tissue. They provide higher mapping resolution, potentially allowing the identification of surviving

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## KEY TEACHING POINTS

- Cavotricuspid isthmus radiofrequency ablation is considered a first-line therapy to achieve rhythm control in patients with typical atrial flutter. Success depends on the creation of a complete line of block and permanent interruption of conduction across the cavotricuspid isthmus.
- In some cases, achieving a >110-millisecond separation between the double atrial potentials along the ablation line is not associated with complete cavotricuspid isthmus block. The use of a high-density and high-resolution mapping catheter allows the detection of residual slow cavotricuspid isthmus conduction.
- The small, close, and low-noise minielectrodes of the Orion catheter may be advantageous for mapping areas of scar tissue, including acutely ablated tissue. They provide higher mapping resolution, potentially allowing identification of surviving bundles that may correspond to gaps in the ablation line.

bundles that may correspond to gaps in the ablation line. Moreover, small electrodes with close interelectrode spacing produce less signal averaging and cancellation effects, and thus they return signals with higher bipolar voltage amplitude.[7,8] This characteristic explains the higher sensitivity of the minibasket catheter in detecting, after RF ablation, low and fractioned potentials that are not revealed by an ablation catheter. In our case, additional RF delivery at the identified linear gap allowed the achievement of a complete cavotricuspid isthmus block. Finally, the high number of electrodes (64) and the continuous, automated acquisition allowed fast geometrical and electrical reconstruction of the area of interest during mapping, ablation, and postablation remapping. Some disadvantages should be considered in using this system over other systems for cavotricuspid isthmus ablation. In particular, the higher cost of the Orion catheter, the need for an higher activated clotting time value (>300 seconds) during the procedure, and the potential higher sensitivity to far-field signals.

## Conclusion

In our case, a new high-density and high-resolution mapping catheter was useful in detecting residual slow conduction along the cavotricuspid isthmus and facilitated the ablation procedure.

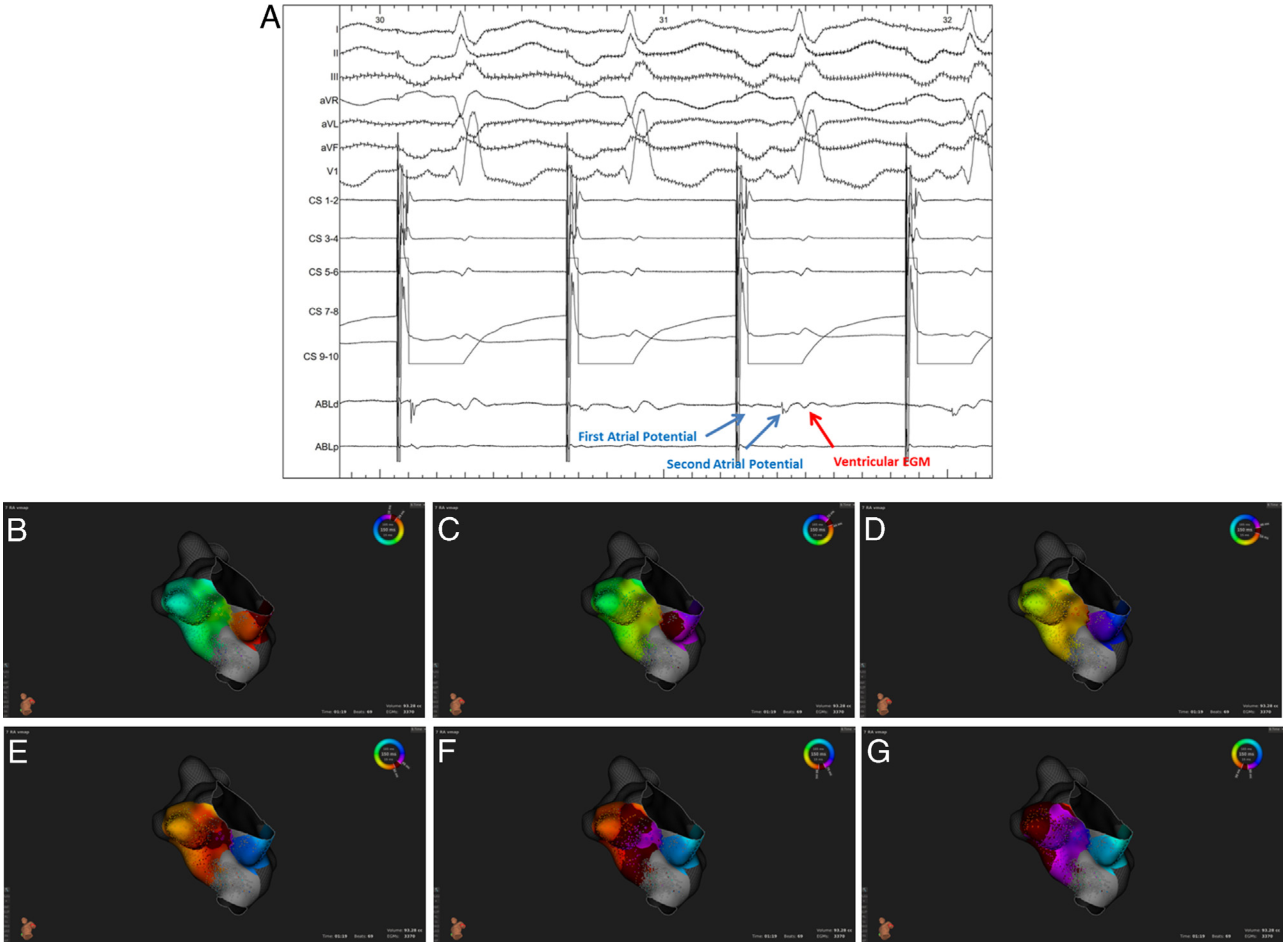


**Figure 1** **A:** The ablation catheter records split electrograms all along the ablation line. The interval between electrogram components is 120 milliseconds. **B–G:** Propagation map in the right atrium during coronary sinus (CS) pacing after the presumed cavotricuspid isthmus (CTI) block. The dark red area shows the portion of the right atrium that is activated within 10 milliseconds in various portions of the mapping window, which are labeled from B to G. Its extension gives an idea of how fast the wavefront is propagating inside the cardiac chamber **B:** The wavefront propagated from the CS ostium toward the CTI (since we were pacing from the CS ostium). **C:** The wavefront reached the CTI area (where the ablation line had been performed). **D:** The propagation wavefront was still at the isthmus area. However, the narrowing of the dark red area indicated the presence of a very slow conduction at this area. **E:** The propagation wavefront was able to cross the isthmus area activating a portion of the lateral wall. **F:** A larger portion of the lateral wall was activated by the propagation wavefront (resulting in a greater dark red area). **G:** The upper lateral wall was activated.

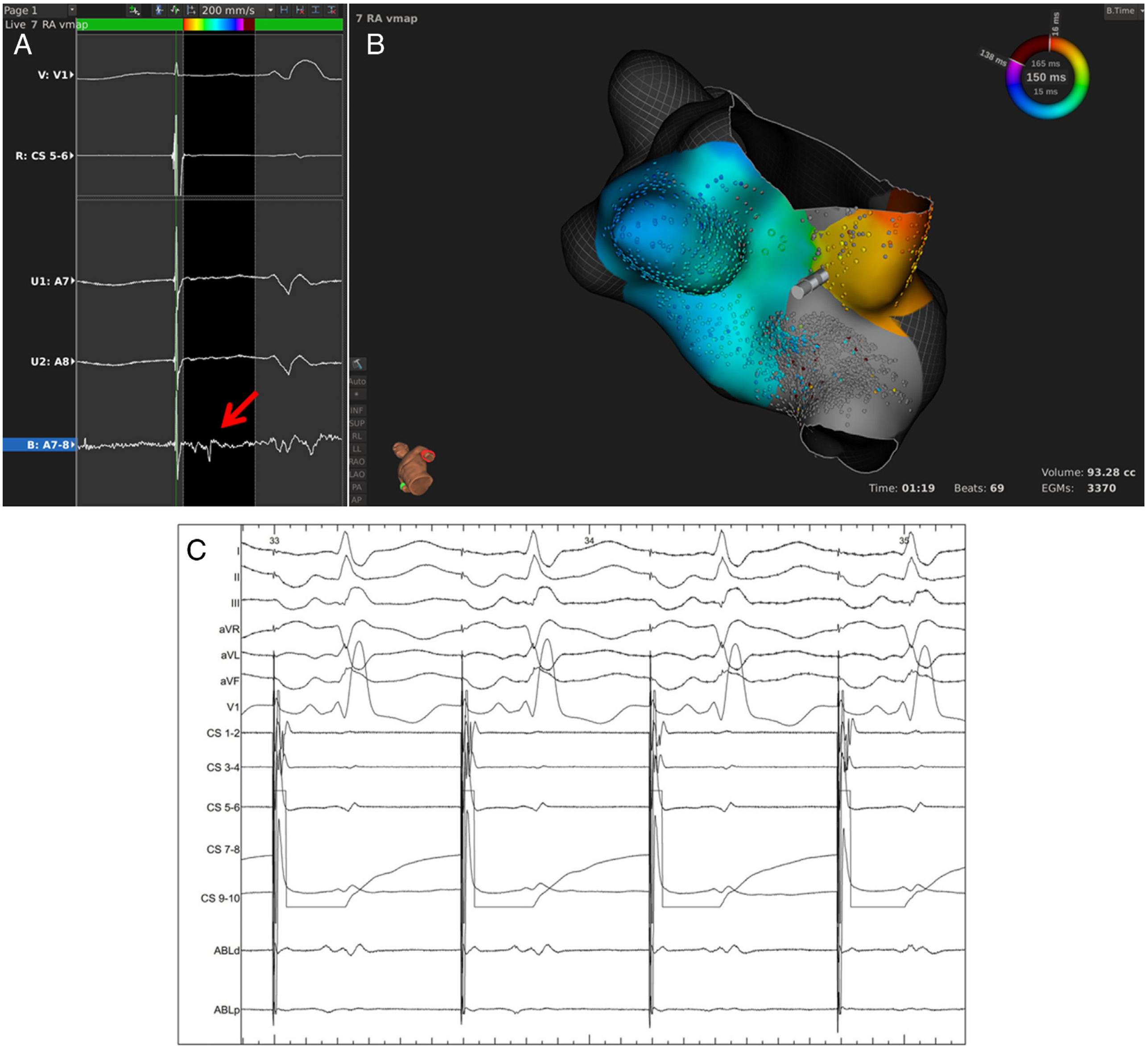


**Figure 2** **A:** The electrical signals detected by the Orion catheter along the ablation line during the remap of the right atrium while pacing from the coronary sinus with **B:** the roving probe. Fractionated signals, with a third distinct potential (arrow) were observed at this spot of slowed conduction. **C:** In the same spot indicated by the roving probe in **B**, the ablation catheter displays 2 atrial split components, completely filtering out the high-frequency multicomponent signals detected by the Orion catheter.

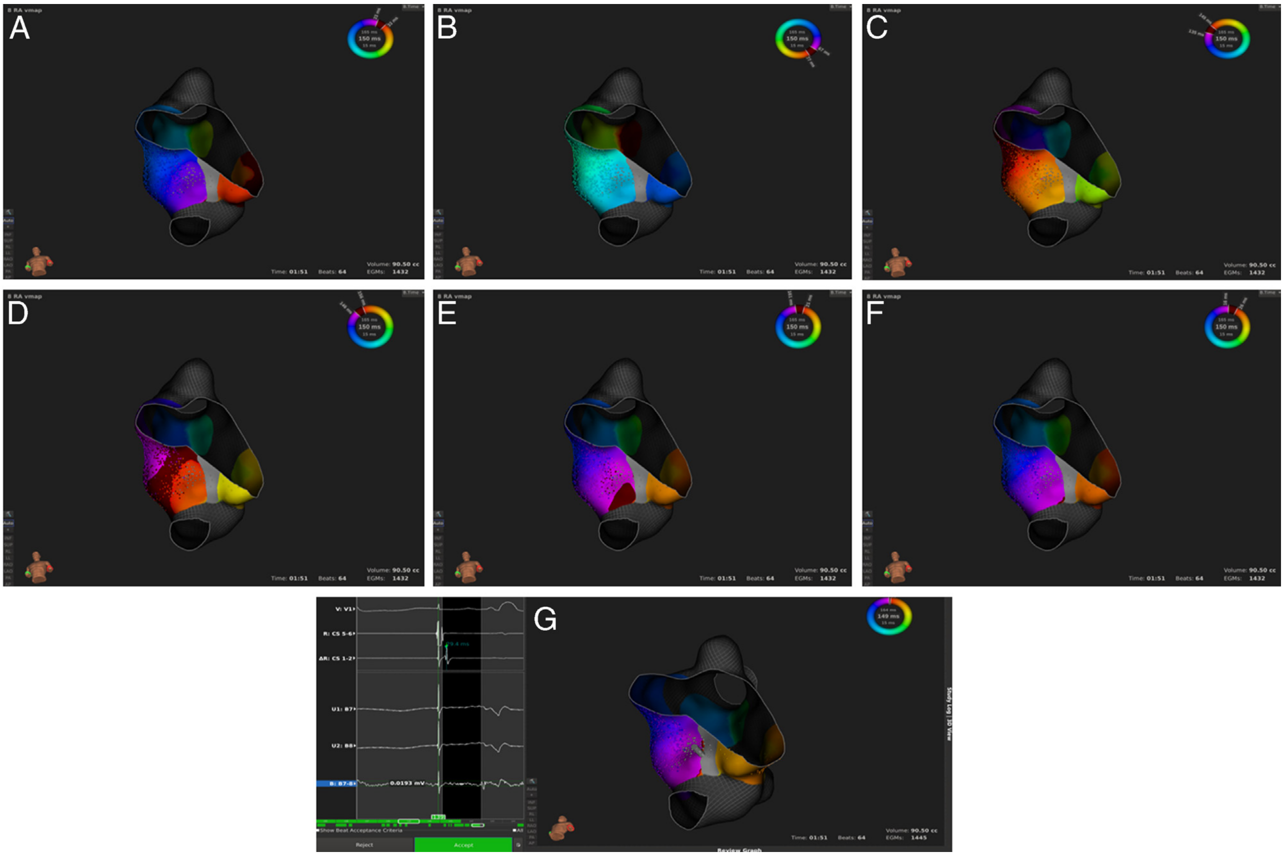


**Figure 3** A propagation map in the right atrium during coronary sinus pacing after 2 additional radiofrequency pulses. The propagation of the wave front from **A** to **F** shows that complete cavotricuspid isthmus block is achieved. **G**: The disappearance of the second potential of the fractioned potential was recorded in the same spot indicated by the roving probe in Figure 2.

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