MINIMAL FLUOROSCOPIC APPROACH TO CAVO-TRICUSPID ISTHMUS ABLATION USING THE INTELLANAV™ MIFI XP CATHETER

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INTRODUCTION

Fluoroscopically guided procedures such as cardiac radiofrequency (RF) catheter ablation provide a definitive treatment of typical atrial flutters and are widely used in clinical practice. A major disadvantage associated with these procedures is the risk of radiation damage that can be described in terms of both stochastic and deterministic effects. Exposure to ionizing radiation is known to affect human biology at a cellular level, with cancer risk associated with both high and low dose. These considerations highlight the importance of minimizing radiation exposure in cardiac electrophysiology practice. In the following discussion I present the approach that I have been using in my lab for typical atrial flutter with the Rhythmia™ HDx (Boston Scientific, Massachusetts) mapping system and IntellaNav™ MiFi XP (Boston Scientific, Massachusetts) catheter making the procedure safe and effective with minimal fluoroscopic guidance

APPROACH

Large tip ablation catheters (8mm, 10mm) are considered the gold standard in the treatment of cavo-tricuspid isthmus (CTI) dependent flutter. Catheters with large distal electrodes create larger lesions due to the greater tip surface area in contact with tissue. Higher powers are required as a larger area of the tip is frequently not in contact with tissue allowing power to be lost to the blood pool. This results in an augmented convective cooling effect on tissue.

Larger tip RF ablation catheters, dampen the local electrogram reducing the resolution of mapping and potentially misleading applications of radiofrequency energy. In our experience, the addition of 3 mini-electrodes (~1mm diameter with 2.5mm separation, positioned ~2mm from the distal tip)

the large tip of the IntellaNav™ MiFi XP catheter improves the quality of mapping identifying exact locations to ablate.

Coronary Sinus cannulation using fluoroscopy

Firstly, we place either a quadripolar or decapolar Dynnamic XT catheter (Boston Scientific, Massachusetts) in the coronary sinus (CS) as our atrial reference. This catheter is advanced under fluoroscopic guidance either through a subclavian approach (a fixed curve catheter is used) or through a femoral approach (a deflectable curve catheter is used) and usually takes no more than two minutes of X-ray exposure even during complex CS cannulation. The placement and stability of this catheter is very important to build the field map that the Rhythmia system uses to track non-navigationally enabled catheters that are advanced in the right atrium using the impedance tracking capability of the Rhythmia ™ HDx system.

Right atrium reconstruction

From this point on, fluoroscopic guidance is minimal. The IntellaNav™ MiFi XP 8mm tip catheter is advanced into the right atrium and a detailed anatomy of the right atrium is collected. The Rhythmia ™ HDx system enables simultaneous collection of anatomic and activation points. The IntellaNav™ MiFi XP enables detailed anatomy and high-density activation map creation in only a few minutes. The RA map below has ~1000 map points collected within 5 minutes (Figure 1).

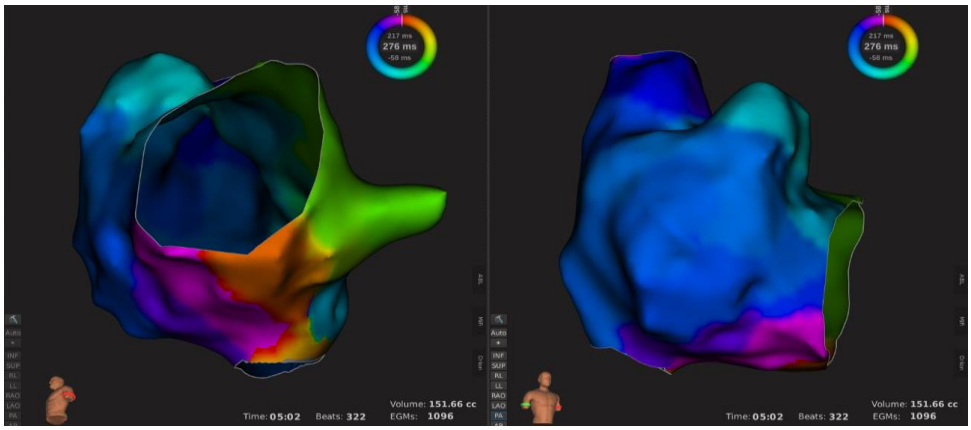

Figure 1: Activation map of the RA during a typical counter clockwise atrial flutter using the IntellaNav™ MiFi XP catheter. 1000 points collected in five minutes without using fluoroscopy

Acceptance criteria chosen for mapping are: variation of cycle length < 20 ms, propagation reference (time difference between two coronary sinus electrograms < 10 ms), catheter motion < 1,7 mm per beat, respiration gating and tracking.

Once the activation map of the RA is completed and a detailed anatomy of the CTI is reconstructed, we can use the impedance tracking capabilities of Rhythmia ™ HDx to position and visualize any additional impedance based catheter without fluoroscopic guidance. CTI block can quickly be confirmed using vmap created with the IntellaNav™ MiFi XP catheter.

Using mini-electrodes to improve ablation lesions

At this point we place the ablation catheter on the CTI. During ablation the micro-fidelity (MiFi) mini-electrodes are used to identify high frequency atrial EGMs. Targeted ablation is delivered at these locations until the flutter terminates. Figure 2 shows the high quality mini-electrode tracings during ablation. EGM amplitude reduction is clearer with mini-electrodes (blu arrow in figure) when compared with the conventional bipoles (red arrow in figure)

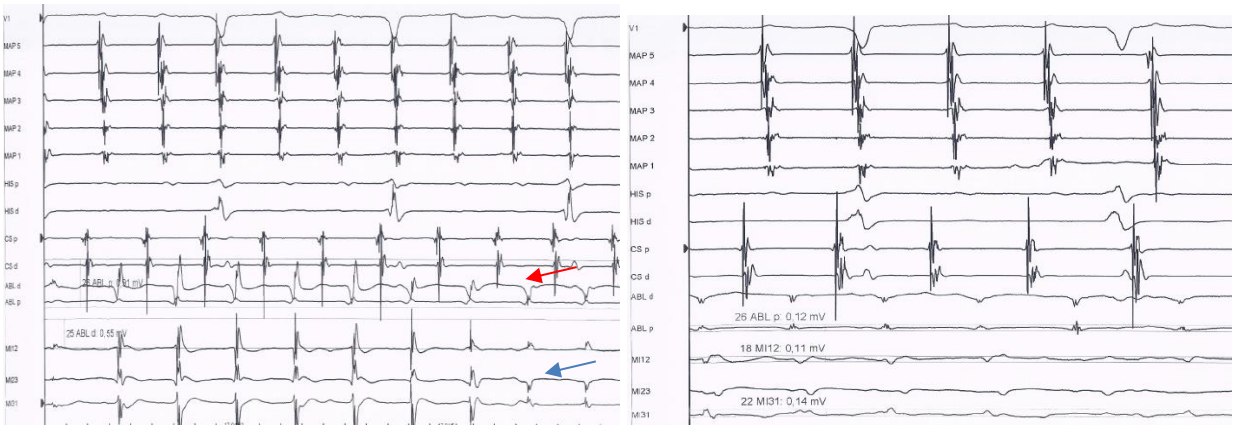

Figure 2: RF application leading to flutter termination. Mini-electrodes demonstrate significant amplitude reduction and signal clarity compared with conventional signals

Frequently, CTI block is not fully achieved when the arrhythmia is terminated. To fully complete the CTI line, we pace from the coronary sinus using MiFi signals to identify exact locations to ablate. In some cases, there is a mismatch between MiFi and bipole signals – where a sharp signal is seen on the bipole but no signal is observed on MiFi and vice-versa. In the following discussion we provide some clear examples showing how mini-electrodes are used to guide ablation.

Tricuspid Valve pullback

CTI ablation is started at the anterior edge, close to the tricuspid valve. At this location, conventional traces detect a small atrial EGM and a large ventricular signal indicating that the tip is correctly located at the CTI anterior border. In figure 3, the mini-electrodes clearly show that the ablation tip is beyond the CTI since only a large ventricular EGM is detected. There is no atrial component on the EGM. The ablation tip is not actually located on the anterior edge of the isthmus. This catheter position is confirmed using the accuracy of Rhythmia navigation

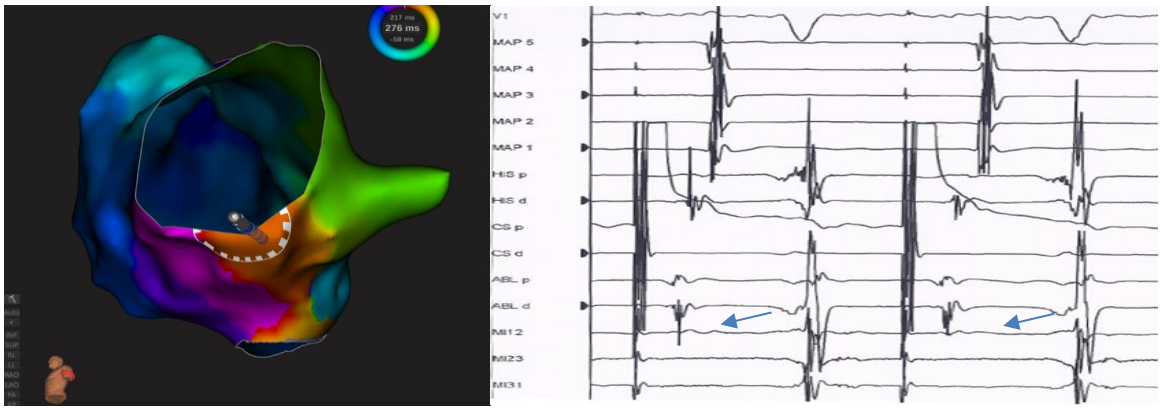

Figure 3: Rhythmia geometry showing the ablation catheter tip beyond the CTI where mini-electrodes detect a large ventricular component without any atrial EGM. By contrast the conventional bipole traces show both V and A signals giving the false impression that the catheter tip is on the CTI anterior edge

The catheter is withdrawn until the tip is located on the isthmus (Figure 4). The position is confirmed as the mini-electrode traces show a clear atrial component. Ablation can be started.

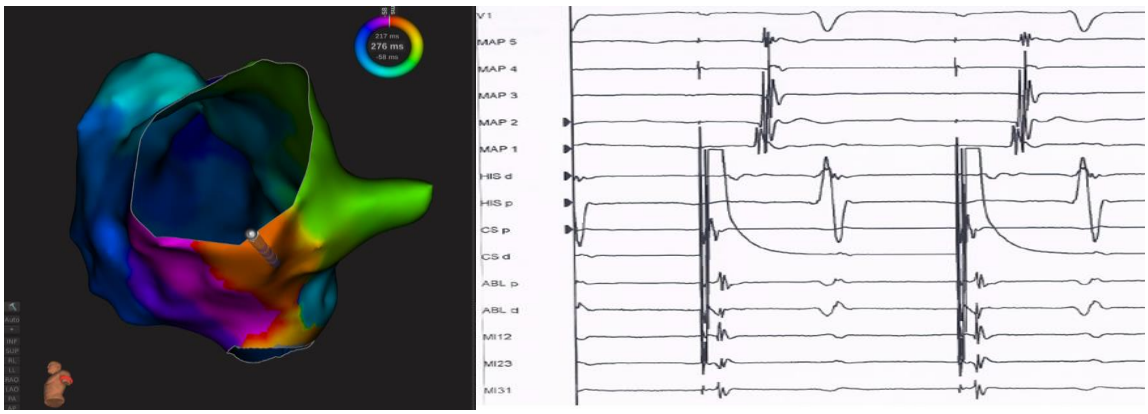

Figure 4: When the catheter is pulled back onto the CTI, mini-electrode traces show a clear atrial component indicating that ablation can be started

MiFi and conventional bipole signal mismatch on CTI line

In our experience signal mismatch between MiFi and conventional bipole traces is not uncommon. Figure 5 shows a typical situation where this mismatch occurs. The upper panel of Figure 5 shows black tags where RF ablation has already been delivered. The anterior CTI line has already been ablated, and the catheter tip is positioned on a black tag where the lesion has been effective. Two types of signal mismatch can occur as illustrated on the lower panel of figure 5. On the left lower panel, we can see that no clear atrial component is visible on the mini-electrode since the tip is facing a portion of the isthmus that has been effectively ablated (large atrial EGM amplitude reduction). While the larger conventional bipoles pick up signal from the proximal healthy tissue that has not been ablated yet and show a large atrial EGM. In this situation, the catheter tip should be pulled back proximally until the mini-electrodes detect the atrial EGM before starting ablation. On the right lower panel of figure 5 we see the second type of signal mismatch that can occur when the tip of the catheter is on a previously ablated location. This second type of mismatch happens when the CTI line is almost blocked. There are only one or two gaps remaining. The upper green traces on the right lower panel of figure 5 show mini-electrode recordings where atrial components are split indicating that the tip of the ablation catheter is on a blocked portion of the line. By contrast, the lower green traces on the right lower panel of figure 5 are conventional bipole recordings showing a single fused atrial component indicating a more proximal gap in the line. In this situation, the catheter tip should be pulled back proximally until the mini-electrodes detect the fused atrial EGM before starting ablation.

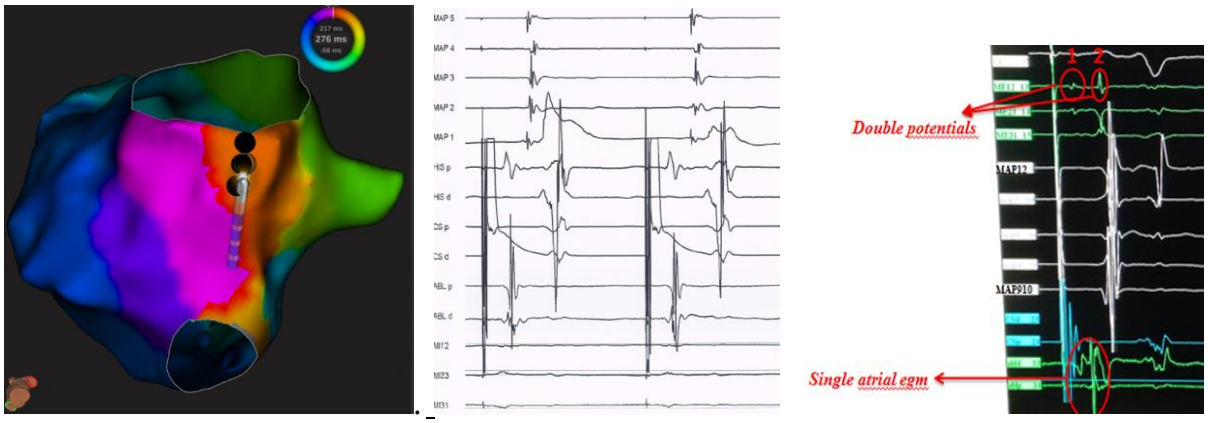

Figure 5 Rhythmia map: the catheter tip is on a previously ablated location where RF application has been effective. In this situation two kinds of signal mismatch between minis and conventional bipole signals can occur as illustred in the right hand panels of the figure.

MiFi and conventional bipole signal mismatch during drag lesion ablation

In our experience, mini-electrode signals provide useful information when performing a CTI line by dragging the catheter back during continuous RF delivery. Frequently, during RF, the atrial component starts splitting on mini traces faster than on conventional bipole signals indicating that the lesion at the tip is effective and the catheter should be dragged more proximally.

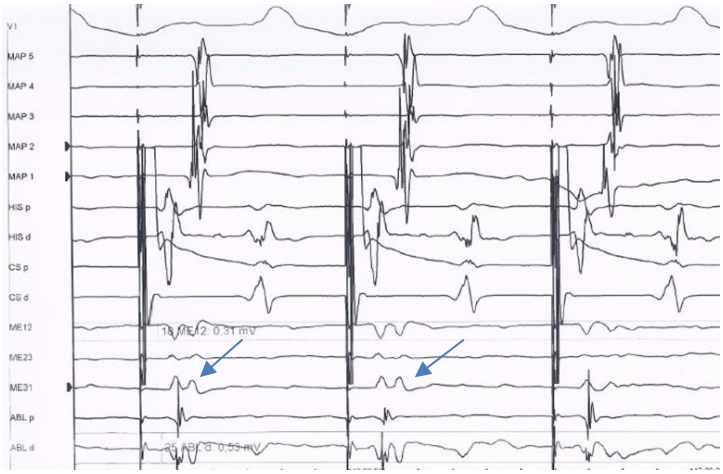

Figure 6: Atrial EGM starts splitting on mini traces indicating that the catheter can be dragged more proximally

CTI Block validation

A quick remap with the IntellaNav^{TM} MiFi XP proves the line of block.

Figure 7 shows an example of a fast validation map (680-point map of the RA in 3 mins 52 s) during CS pacing indicating CTI block. Acceptance criteria chosen for mapping are: propagation reference (time difference between the pacing spike and a coronary sinus electrogram) < 10 ms, catheter motion < 1,7 mm per beat, respiration gating and tracking.

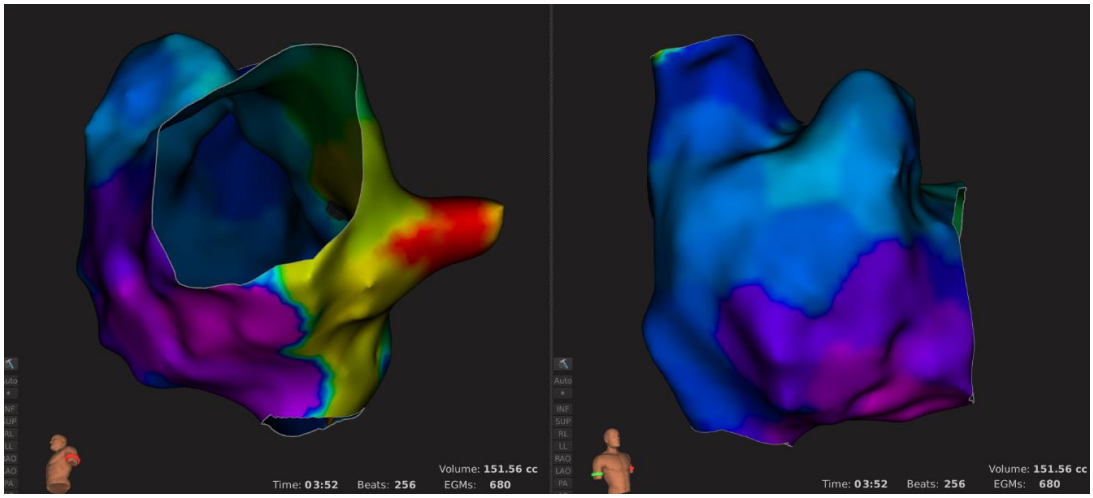

Figure 7 validation map (680-point map of the RA in 3 mins 52 s) during CS pacing indicating CTI block

Using validation maps (vmap), atrial activation close to the stimulation spike is displayed in red, while progressive later activations are displayed in ascending order of colors following this legend: yellow-green-cyan-blue-purple. In figure 7 the propagation map shows a wavefront spreading from the septum that activates the RA lateral wall in a cranio-caudal fashion confirming CTI block.
At the location where, previous ablation lesions have been placed, the propagation map shows a color "jump" meaning that early (yellow) and late (purple) are detected across the ablation line. If CTI block had not been achieved we would have seen a gradual "progression" of colors (without any jump) along the ablation line meaning that the wave front spreads through the CTI line from its septal side to the RA lateral wall (caudo-cranial direction).

Vmap is a very accurate way to detect CTI block as it unmasks patterns of pseudo-conduction along the line that can be mistakenly diagnosed when conventional criteria are used. Placing a decapolar Viking catheter along the RA lateral wall would show a cranio-caudal activation along the catheter if CTI block exists. If CTI block is achieved but the RA lateral wall is first activated by a posterior wave front, we can have caudo-cranial activation along the RA lateral wall despite CTI block giving the false appearance that the isthmus is conducting. Vmaps rapidly demonstrate this.

Conclusion

This case report shows how conventional bi-pole signals can be misleading. The high-resolution signals on mini-electrodes guide the ablation strategy with greater accuracy by reducing far field interference and focus on target near field at the ablation catheter tip. The sensor enabled IntellaNav™ MiFi XP catheter enables us to build accurate, detailed cardiac geometries with Rhythmia™ very quickly to guide ablation and confirm success. Importantly this approach using electro-anatomically guided ablation for flutter minimizes radiation exposure for the patient and operator.

Dr Ducceschi was compensated by Boston Scientific for their time in drafting this case report. F Maddaluno is an employee of Boston Scientific.