High density mapping in atrial fibrillation

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Disclosure

• none
Difference of Resolution
Emergence of Multielectrode Mapping

On the Road to Higher Resolution

• In 1999, single-point catheter-based mapping was first validated using the CARTO system with 75 endocardial points.

• Seventeen years later, the validation of an automated mapping system (Rhythmia; Boston Scientific) with microelectrodes on a miniature basket catheter was demonstrated with an average of >8000 mapping points.
Problem in mapping

- Spatial averaging
- Ringing artifact
• Smaller electrode catheters increase the sensitivity to identify normal surviving bundles of myocardium, relative to large tipped catheters.

• A smaller interpolation distance requires a greater number of points to be mapped, but provides more accurate mapping.

Electrode size and spacing on a ThermoCool SF Ablation Catheter.
## Catheter profiles

**Table. Summary of Various Electrode Configurations, Sizes, and Relative Spacing With Commonly Used Catheters**

<table>
<thead>
<tr>
<th>Model</th>
<th>Manufacturer</th>
<th>Electrodes</th>
<th>Tip Electrode Size, mm</th>
<th>Ring Electrode Size, mm</th>
<th>Spacing (Edge-to-Edge)</th>
<th>Spacing Recorded (Center-to-Center)</th>
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<tbody>
<tr>
<td>Ablation catheters</td>
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<tr>
<td>ThermoCool ST</td>
<td>Biosense Webster</td>
<td>4</td>
<td>3.5</td>
<td>1</td>
<td>1-6-2</td>
<td>3.25</td>
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<tr>
<td>ThermoCool SF</td>
<td>Biosense Webster</td>
<td>4</td>
<td>3.5</td>
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<td>4.25</td>
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<td>Navistar</td>
<td>Biosense Webster</td>
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<td>4/8</td>
<td>1</td>
<td>1-7-4</td>
<td>3.50</td>
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<tr>
<td>CoolFlex</td>
<td>St. Jude Medical</td>
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<td>2</td>
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<td>IntellaMap Orion</td>
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</table>
INTELLAMAP ORION™ HIGH-RESOLUTION MAPPING CATHETER

The IntellaMap Orion is a 64-electrode catheter designed to safely measure signals from all cardiac chambers.

- 8.5F, bi-directional steerability
- 64-electrodes, 8 splines
- Variable deployment, 3-22mm diameter
- Deployment control located on handle – no long sheath required
- Connects to the Signal Station with a single connector
Annotation criteria

- Two reference electrograms (EGM; one main [R] and one additional [ΔR]) were chosen on the decapolar catheter.

- Cardiac beats were automatically selected for inclusion in the map based on cycle length (CL) stability, stable relative timing of 2 reference EGM, electrode location stability, and respiratory gating.

- The window of interest is automatically set by the system at the CL value and centered on the main reference EGM.

- For annotation of the local activation time of each acquired bipolar EGM, the system combines unipolar (maximum negative dV/dt) and bipolar (maximum amplitude) EGM.
EGM fractionation over areas of interest was defined as ≥4 deflections, lasting more than 40msec

1) Slow conduction (SC);
2) lines of block (LB)
3) pivot site (PS)
4) wavefront collision (WFC) and
5) gap
1. Finding gap and confirming PV isolation.
2. Mapping the AT after PV isolation and define the exact mechanism of AT, eg, focal Vs microreentrant.
3. Confirming the line of block, showing the small channel in the ablation line or epicardial breakthrough.
Gap detection and PVI

Identification of pulmonary vein reconnection gaps with high-density mapping in redo atrial fibrillation ablation procedures

Ignacio García-Bolao\textsuperscript{1*†}, Gabriel Ballesteros\textsuperscript{1†}, Pablo Ramos\textsuperscript{1}, Diego Menéndez\textsuperscript{1}, Ane Erkiaga\textsuperscript{2}, Renzo Neglia\textsuperscript{1}, Marta Jiménez Martín\textsuperscript{1}, and Enrique Vives-Rodríguez\textsuperscript{1}

\textsuperscript{1}Department of Cardiology and Cardiovascular Surgery, Clínica Universidad de Navarra, Avenida Pío XII, 36 (31008) Pamplona, Spain; and \textsuperscript{2}Boston Scientific Corporation

- Comparing HD mapping and conventional 3D mapping with circular catheter
Gap detection and PVI
Successful recognition of the reconnection gap

The HDM group (86 of 141; 60.99%) the control group (48 of 121; 39.66%; P=0.001).
Micro-reentrant tachycardia

Micro-reentrant tachycardia: circuit size < 2 cm


Localized Atrial Reentrant Tachycardia in Tetralogy of Fallot

Adam Lee, et al. Heart Rhythm 2017
Micro-reentrant tachycardia

Characterizing localized reentry with high-resolution mapping: Evidence for multiple slow conducting isthmuses within the circuit

Antonio Frontera, MD, Rajiv Mahajan, MD, PhD, Corentin Dallet, PhD,
Konstantinos Vlachos, MD, Takeshi Kitamura, MD, Masateru Takigawa, MD, PhD,
Ghassen Cheniti, MD, Claire Martin, MD, Josselin Duchateau, MD, Anna Lam, MD,
Felix Bourier, MD, Arnaud Denis, MD, Thomas Pambrun, MD, Meleze Hocini, MD,
Frederic Sacher, MD, PhD, Nicolas Derval, MD, Michel Haïssaguerre, MD,
Remi Dubois, MD, PhD, Pierre Jais, MD

From the *Hôpital Haut Leveque, Pessac, France, †LIRYC Institute, Pessac, France, and ‡Lyell McEwin and Royal Adelaide Hospitals, South Australian Health and Medical Research Institute and University of Adelaide, Adelaide, Australia.
Two forms of localized reentrant circuits.

A: Lines of block delimitate the circuit.
B: A central area of scar around which the localized reentrant circuit turns around.
ORIGINAL ARTICLE

Pseudoblock of the Posterior Mitral Line With Epicardial Bridging Connections Is a Frequent Cause of Complex Perimital Tachycardias
Line of block

Pseudoblock across a posterior mitral line with residual endocardial conduction.

Anatomic distribution of the bridging endocardial-epicardial connections.
(A) Confidence mask: 0.04mV

(B) Confidence mask: 0.2mV
Limitation of HD mapping

- Noise problem
- Setting of WOI
- Relative prolonged mapping
- EP knowledge and experience
A secondary wavefront (labeled 2) travelling toward this area of low voltage collided with the head of the primary wavefront (starred—site 7) and advanced activation around (site 1–2) creating the impression of reentry.
Carousel activation can be seen from just 3 closely spaced points with different annotation of local activation timing across the window of interest.

Carousel was seen within an area of low-voltage signal rotating around a pinwheel. Removing the noise signal, carousel activation was no longer evident.

Circulation AE 2017
Conclusion

- Ultra–high electro-anatomic density mapping (10 000 points per map) improved electrogram resolution for activation mapping.

- This has enabled a better understanding of different tachycardia mechanism, especially within low voltage myocardium.

- However, the effects of HD mapping would largely depend on physician’s knowledge and experience.