Future directions in mapping complex arrhythmias

EP MASTERCLASS - Heart Rhythm Congress

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Future directions in mapping complex (organised) arrhythmias

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Innovations in arrhythmia mapping

CARTO COHERENT MAPPING

ACUTUS AcQMAP

CardioInsight Phase Mapping

Anter et al, Circ AE 2018

Courtesy of Dr Claire Martin

Courtesy of Cheng Yao, Medtronic
Complex organised arrhythmia

- Complex arrhythmias ≠ Failure to diagnose
- Complex arrhythmias = long-term recurrence
Complex organised arrhythmia

• Complex arrhythmias ≠ Failure to diagnose

• Complex arrhythmias = long-term recurrence

• **Future directions** in mapping should focus on reducing long-term recurrence

• Understand the scar electro-architecture

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Kalmann et al, Circ 1996  
Oral et al, Circ 2003  
Tung et al, Circ 2011
Current mapping approaches

Bipolar EGM
Electro-architecture mapped in ultra-high density

Integrating structure and function on the same display
Current mapping approaches
Active tissue voltage thresholding

Atrial substrate based ablation – a method to reduce future atrial arrhythmia recurrence?
Scar/Low Voltage Areas – homogenisation

Mapping the VT substrate

VT Diastolic Channel

Sinus Rhythm Late potential channel

Tung et al, Circ 2011

Berruezo et al, Circ AE 2015
Ventricular substrate ablation – a method already in practice

<table>
<thead>
<tr>
<th>Substrate Ablation Target</th>
<th>Reference</th>
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<tbody>
<tr>
<td>Scar Homogenisation</td>
<td>Di Biase, JACC 2012</td>
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<td>Scar border-zone ablation</td>
<td>Tilz, Europace 2014</td>
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<td>Voltage gradient channels</td>
<td>Arenal, Circ 2004</td>
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~70% freedom from VT recurrence at 6 months to 1 yr
After spending 40 years looking at substrates and activation...I’ve come to the conclusion that the understanding of VT is relatively naïve...Everyone is focused on scar, and we assume that the isthmus is bounded by fixed scar...the barriers of conduction are really functional, because they are not there in sinus rhythm.

A more accurate analysis of the functional characteristics responsible for creating and maintaining the VT circuit is needed before we can move on
Bipolar voltage defined scar

Tung et al, HRJ 2011
Low voltage bipolar EGMs ≠ Scar

1) Catheter construct (electrode tip & inter-electrode spacing)
Low voltage bipolar EGMs ≠ Scar

2) Electrode orientation

Electrodes orientated perpendicular to activation wave
= low amplitude EGM

Electrodes orientated parallel to activation wave
= large amplitude EGM

Low voltage bipolar EGMs ≠ Scar

3) Activation direction

Saghy et al, HRJ 2012
Low voltage bipolar EGMs ≠ Scar

4) Tissue refractoriness

Bradfield...Shivkumar et al. *Heart rhythm*. 2013
Low voltage bipolar EGMs ≠ Scar

- AT1: Median 3 isthmuses per map
- ~1 ablated
- 88% residual isthmus concordance between AT1 and Map2

Voltage Map independent - ILAM

Tung et al, Circ AE 2016

Isochronal crowding/ deceleration zones during NSR = critical isthmus sites during VT

Ensite Precision™:
Last deflection
Voltage Map independent – SAG mapping

VT1

VT2

0.5-1.5mV

0.1-0.5mV

Anter et al, JACC EP 2018
The Re-entry Vulnerable zone

Steep activation gradient and high curvature = critical isthmus sites during VT

Anter et al, JACC EP 2018
Ripple Mapping conduction channels

DeEP Mapping
(Decrement Evoked Potential Mapping)

Jackson, Nathankuma et al, Circ AE 2016
But what if we wanted to go back to the voltage map?

**HD WAVE SOLUTION**

= Electrode orientation independent mapping

Courtesy of Dr Kim Rajappan
Atrial substrate

HD Wave Configuration  Standard Map Configuration

Courtesy of Dr Kim Rajappan
Ventricular substrate

HD Wave Configuration

Standard Map Configuration

Courtesy of Dr Kim Rajappan
Considering activation direction

MAP 1

Regions of high bipolar voltage concordance

Pace from LAA

MAP 2

Pace from CS Prox
Omnipolar Mapping

- Omnipole = assess signals from all possible bipoles around the mapping location (in space and time).
  - Activation direction
  - Conduction velocity
  - Maximal voltage, independent of electrode orientation AND wavefront direction

Massé, Nathankumar et al, Circ AE 2016
Summary:

• Acute success rates in complex organised arrhythmia ablation are high, but this does not translate to long-term freedom from arrhythmia.

• Future directions should aim to better our understanding of the underlying scar electro-architecture.
  – Catheter construct (inter-electrode spacing)
  – Electrode orientation
  – Activation direction
  – Tissue refractoriness