Role of Entrainment in the Era of High-Density Activation Mapping

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**Presenter Disclosure Information**

Within the past 12 months, the presenter has received financial support from the organizations identified below for the relationships listed.

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<thead>
<tr>
<th>Company Name</th>
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<tr>
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*No organization has prepared, altered or influenced content of any lecture material*
What is the Holy Grail for VT Ablation?

0.03-0.8 mV
What is the Holy Grail for VT Ablation?
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76 consecutive patients with well-tolerated VT

- 64/76 mappable VT
- 12/76 with only unmappable VT
  - 44/64 also had unmappable VT
  - 74%: At least 1 unmappable VT

ThermoCool VT Ablation Trial (231 pts)

- 31%: only mappable VT
- 69% at least 1 unmappable VT
  - 54% VTs unmappable
    - 22% non-inducible/changing
    - 78% unstable hemodynamics

Callans et al. AJC 1998;82:429-432
Stevenson et al. Circulation 2008;118:2773-2782
Ability to Map VT
Arrhythmia Specific and Patient Specific Factors

2,063 patients with scar-related VT

<table>
<thead>
<tr>
<th>PAINESD RISK SCORE</th>
<th>VARIABLE</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary disease [COPD]</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Age &gt;60 years</td>
<td>3</td>
<td></td>
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<tr>
<td>Anesthesia [general]</td>
<td>4</td>
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<tr>
<td>Ischemic cardiomyopathy</td>
<td>6</td>
<td></td>
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<tr>
<td>NYHA class III or IV</td>
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<td></td>
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<tr>
<td>Ejection fraction &lt;25%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Storm [VT]</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>3</td>
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</tbody>
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Acute Hemodynamic Decompensation (AHD)*

*Sustained hypotension (SBP<80-90 mmHg) despite increasing doses of vasopressors and requiring mechanical hemodynamic support or procedure discontinuation.

Santangeli et al. JACC 2017;69:2105-2115
Santangeli et al. Circulation A&E 2015;8:68-75
Mappable VTs – Preferred Strategy?

High-Density Activation Mapping vs. Entrainment Mapping

- 62 yo M h/o CAD (inferior MI), HTN, mild CKD.
- 8 ICD shocks – incessant stable MMVT at 140 bpm.
- TTE: Severe LV dysfunction (EF = 35%), inferior-lateral akinesis.
- SPECT: Large fixed defect in the inferior-lateral wall base to apex. EF = 30%.
Substrate

0.03-0.8 mV

12-Lead ECG of VT
High-Density Activation Map

Infero-lateral wall

Mitral valve

Infero-septal wall
Where Would You Ablate?

- Site #1
- Site #2
- Site #3
- Site #4

Voltage Scale 0.03 to 0.5 mV
High-Density Activation Map vs. Entrainment
Critical Site of VT Termination
Visual Reentry Can Be Passive
15 pts w/ 27 RA reentrant circuits
Visual Reentry Can Be Passive

None of the entrainment runs resulted in termination of AT or change to a different AT

Pathik et al. Heart Rhythm 2017;14:1541-49
Activation Mapping to Define VT Mechanism?

42 yo F w/ ARVC and Incessant VT
Quick Definition of VT Mechanism w/ Pacing

42 yo F w/ ARVC and Incessant VT
Unequivocal Definition of Critical Diastolic Components w/ Entrainment
Unequivocal Definition of Critical Diastolic Components w/ Entrainment
High-Density Activation Mapping

Limitations

• Highly dependent on sampling bias (full chamber/cycle length needs to be represented)
• Unable to reliably differentiate passive diastolic activity from diastolic activity participating to VT.
• Unable to differentiate true reentry from focal origin adjacent to a line of block (anatomical or functional).
• Only adequate to define circuits when reentry is confined within a fully mappable chamber/structure (2-D/surface reentry).
Reentry *Is Not* Necessarily Confined to Mappable Surface

52 yo M with Antero-Lateral MI

Courtesy of Drs. Paolo Della Bella and Caterina Bisceglia
Entrainment Mapping *Is Not* Perfect!

- Unable to reliably capture with a fixed relationship of stimulus to EGMs.
- Non-local recording and non-local stimulation – particularly with large interelectrode distance and/or large tip electrode.
- Contact with tissue generating signal.
- Obscuring EGM by pacing artifact.
- Termination/change during pacing.
- High current produces non-local stimulation (enlarged virtual electrode).
Failure to Capture
Need **Perfect ECG Match** – **RF Failed to Terminate**
Good Entrainment Map – 12/12 Perfect Match

420 ms  420 ms  450 ms  450 ms
Good Entrainment Map – $PPI-TCL=0$
Failure to Terminate VT at a Single Site Despite *Apparent* Perfect Entrainment Map

- Inadequate map
- Inadequate lesion
  - Clot/Fat/Scar
  - Deep location of VT (intramural)
  - Width of isthmus exceeds RF point lesion
Conclusions

- When a stable monomorphic VTs is present use of responses to pacing, based on *physiologic principles*, can define critical sites in the circuit (i.e. a protected isthmus).

- Although high-density activation mapping may be helpful to identify reentrant excitation and *visually define* regions of diastolic activity, it is unnecessary (and possibly misleading) in identifying critical diastolic sites at which RF lesions can terminate VT.