Ablation of Ventricular Tachycardia in Non-Ischemic Cardiomyopathy

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• Nothing to disclose
• No conflict of interest
2 Years living with EHRA/HRS consensus document on VT ablation: need for an update?

- VT in Dilated Cardiomyopathy
- 20 minutes
- Important recent advances in an emerging field of catheter ablation for ventricular tachycardia
VT Ablation in Non-ischemic CM

- Endocardial substrate
  - Septal substrate
- Epicardial substrate
  - What is normal?
  - What is abnormal?
  - When to suspect epicardial origin
    - ECG
    - Imaging
    - Unipolar voltage mapping
  - Outcome
VT Ablation in Non-ischemic CM

- **Endocardial** substrate
  - Mechanism of VT: reentry
  - Less than 25% of endocardial surface
  - Abnormal endocardial EGM is basal and perivalvular
  - Epicardial venous mapping suggested epicardial substrate

Circulation 2003;108:704-710
JACC 2000;35:1442-1449
VT Ablation in Non-ischemic CM

• *Endocardial* substrate- What is new?
Non Ischemic VT **Septal Substrate**

- Normal voltage anterior, lateral, inferior walls
- Abnormal LV septum 22/31 (71%)
  - Dense scar
    - $28 \pm 23 \text{ cm}^2$
    - $11 \pm 8 \%$
  - Abnormal substrate –low voltage/frac
    - $63 \pm 41 \text{ cm}^2$
    - $26 \pm 13 \%$
- Normal Voltage in 9/31 (29%)
- RV voltage 9/31 abnormal
- Epi 5/31 small area (12 ± 6 cm²)

VT Ablation in Non-ischemic CM

- Endocardial substrate
  - Septal substrate
- Epicardial substrate
Non Ischemic CM
Epicardial Substrates

N=192

- CAD: 6
- HOCM: 40
- IDCM: 94
- ARVC/D: 36
- Sarcoid: 12
- Focal/Normal: 4

Update 1/1/11
VT Ablation in Non-ischemic CM

- Endocardial substrate
  - Septal substrate

- Epicardial substrate
  - What is normal epicardial voltage?
Epicardium Normal Heart (8pts)

- Rare Wide Egs > 80mS – 2.2%
- Split Egs - 0.9%
- Late Potentials – 0%
- Wide, Split or Late - >2.3%

95% of signals >1.0mV from rest of EPI – voltage cutoff for normal RV/LV EPI

From Fat/Coronaries or Normal RV/LV

Cano et al JACC 2009
VT Ablation in Non-ischemic CM

• Endocardial substrate
  – Septal substrate

• Epicardial substrate
  – What is normal epicardial voltage?
  – What is abnormal epicardial voltage?
**LVCM and EPI VT ORIGIN** (18pts)

EPI Scar \( = 56.7 \pm 33.1 \text{ cm}^2 \) (Basal-lateral)

VS

ENDO scar \( = 22.9 \pm 32.4 \text{ cm}^2 \)

**Abnormal EGM Characteristics**

\(< 1.0 \text{ mV}\)

- Wide Egs > 80ms - 27.5%
- Split Egs – 33.0%
- Late Potentials – 25.8%
- Wide, Split or Late - 50%

Cano et al JACC 2009
Abnormal Epicardial Substrate RVCM/D


Late and Fractionated RV Epicardial Electrograms
Non Ischemic CM Substrate Abnormalities

- More extensive epicardial than endocardial voltage abnormalities
- Thicker walls and more dense/fibrotic tissue is abnormal area
- VT circuits are protected from endocardial approach
- *Early* epicardial approach in non ischemic cardiomyopathies

Cano O, et al. JACC 2009
VT Ablation in Non-ischemic CM

- **Endocardial substrate**
  - Septal substrate

- **Epicardial substrate**
  - What is normal?
  - What is abnormal?
  - When to suspect epicardial origin
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Interval Criteria for EPI origin

- Pseudodelta wave ≥ 34 ms
- Intrinsicoid deflection time ≥ 85 ms
- Shortest RS complex ≥ 121 ms
- Maximum Deflection Index ≥ 0.55
- May be less reliable in structural heart disease (endocardial delay)

Daniels DV: Circulation 2006;113:1659-66
ECG Morphology clues for EPI origin

Q waves in focus leads

- **BASAL SUPERIOR LV:**
  - Q wave lead I
  - No Q wave II-III-aVF

- **BASAL INFERIOR LV:**
  - Q wave II-III-aVF
  - aVR/aVL < 1

- **APICAL SUPERIOR LV:**
  - Q wave lead I

- **APICAL INFERIOR LV:**
  - Q wave II-III-aVF

- **LV EPICARDIUM:**

- **LV ENDOCARDIUM:**

- **LV APEX:**
  - Q wave lead V2

Bazan V: Heart Rhythm 2007;4:1403–1410
Bazan V: Heart Rhythm 2007;4:1403–1410
Valles E: Circ Arrhythm Electrophysiol 2010;3:63-71
Limitations

- Not perfect
- Site dependent
- Affect of antiarrhythmic drugs?
- Individual patients may have VT morphologies best approached from both ENDO and EPI
- Intramural VT substrate?
Mapping Clues From Venous Circulation

Is it EPICARDIAL?

VT

NOT EPICARDIAL!!
Pericardium

Endocardial voltage map

>1.5 mV

<0.5 mV

Epicardial voltage map

>1.0 mV

<0.5 mV

Epicardial scar

LV

Bala et al. ACC Sessions 2009

Fractionated and split late potential

Fractionated and isolated late potential
Non Ischemic VT Septal Substrate
Use of MRI and PET scan

Septal mid-myo DE

Inferior epi DE

Normal ENDO
LV and RV

>1.5 mV

<0.5 mV
ENDO **Unipolar** EGM to Identify **EPI** Scar LVCM

- Normal
- Endocardium Bipolar
- **NICM**
- **ENDO**
- Unipolar EGM to Identify EPI Scar LVCM

*Hutchinson et al. Circ EP 2011*
ENDO Unipolar EGM to Identify EPI Scar RVCM

Endocardial Bipolar

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40 ms presystolic + Endo Late (30 sec) termination with RF

EPI early activation, good entrainment and prompt termination

Successful EPI ablation is opposite to abnormal ENDO
VT LV-NICM

Entrance

Isthmus

Exit
Isthmus

Entrance

Exit
Isthmus

Entrance

Exit
ARVC - Epicardial Ablation Targets

1) Late Potentials and 2) Pacemap Match of VT

Garcia et al. Circulation 2009
Outcome with VT Ablation in ARVC/D

- **N = 23 pts**
  - Ave F/U – 33 mos

- **Epi ablation 22 pts**
  - Irrigated Ablation
  - Substrate ablation

Adapted and updated from Garcia et al Circulation 2009, Haqqani et al Cardiac Clinic in EP 2011

VT Ablation in Non-ischemic CM
Updating Guidelines

• Epicardial Substrate typically greater than endocardial
  – Identify fat/coronaries versus VT substrate (Use electrogram width and late potentials)
  – Identify epi substrate/VT origin? (Q waves in VT, imaging, Endo Unipolar EGM’s)

• Ablation Strategies
  – Mappable/Unmappable VT (pacemapping/Late potentials (clusters on epicardium)
  – Avoid Complications phrenic nerve / coronaries
  – Surgical ablation in selected patients (protect coronaries/bipolar ablation intramural scar)