Epicardial Approaches for Ablation of VT:
When, Pitfalls, Perils

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Mapping and RF Ablation of Sustained VT
- Methods, Strategies, and Techniques -

- Mapping Systems
  - Electrograms based mapping
  - Electro anatomic based mapping
  - Simultaneous multi electrode mapping

- Mapping Strategies
  - During sinus rhythm
  - During VT
  - Trigger that initiates polymorphic VT

- Mapping Approaches
  - Endocardial (aortic retrograde / transeptal)
  - Epicardial (surgical / transvenous / percutaneous)

- Ablation Systems
  - RF energy (4-mm / 8-mm / irrigated tip catheters)
  - Cryo, Ultra sound, Microwave and Laser energies

Subendocardial myocardial fibers
Subepicardial myocardial fibers

MI Related Scar
- Endocardial RF Ablation -

Stevenson – NASPE 2003
Irrigated Radiofrequency Catheter Ablation Guided by Electroanatomic Mapping for Recurrent Ventricular Tachycardia After Myocardial Infarction

The Multicenter Thermocool Ventricular Tachycardia Ablation Trial

Circulation. 2008

N = 231; post MI patients
EF = 0.25
N of VT in 6 m = 11 (median)
N of VT/ patient = 03 (median)
Mappable VT = 31%
Unmappable = 31%
Both = 38%

Acute success = 49%
Hospital mortality = 3%
53% of patients were free of ICD Shocks in 6 months

Catheter Ablation of Recurrent Scar-Related Ventricular Tachycardia Using Electroanatomical Mapping and Irrigated Ablation Technology

Results of the Prospective Multicenter Euro-VT-Study

JCE. 2009

N = 63; post MI patients
EF = 0.30 ± 0.13%
VT in 6 m = 1 – 380 (17 median)
N of VT/ patient = 03 (median)
Incessant VT = 14 (22%)
Unmappable = 14 (22%)

Acute success = 51 (81%)
No mortality in the hospital
VT recurrence in 12 months = 49%

Epicardial and endocardial mapping of ventricular tachycardia in patients with myocardial infarction


Five types of activation patterns

- Complete mapped circuits
  - A: subendocardial reentry circuits 07 VTs (15%)
  - B: subepicardial reentry circuits 04 VTs (9%)
- Incompletely mapped circuits
  - C: Endo preceding the EPI breakthrough 25 VTs (53%)
  - D: EPI preceding the ENDO breakthrough 03 VTs (6%)
  - E: EPI breakthrough suggesting deep septal reentry 08 VTs (17%)
Epicardial and endocardial mapping of ventricular tachycardia in patients with myocardial infarction. Is the origin of the tachycardia always subendocardially localized?

- Epicardial and endocardial isochronal maps: 47 VTs; 28 patients; MI (inferior: 14; anteroseptal: 14)

<table>
<thead>
<tr>
<th>VTs (%)</th>
<th>Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left ventricular endocardial reentry substrates</td>
<td>68</td>
</tr>
<tr>
<td>Subepicardial reentry substrates</td>
<td>15</td>
</tr>
<tr>
<td>Deep septal layers</td>
<td>17</td>
</tr>
</tbody>
</table>


Chagas VT Epicardial Circuit

Effectiveness of Epicardial VT Ablation

Related to:
- Prevalence and anatomical characteristics of the epicardial circuits in a given population
- Epicardial barriers for epicardial ablation
  - Coronary vessels distribution
  - Fat tissue
  - Pericardial adhesions
- Risks of pericardial puncture and contiguous tissue injury during RF ablation:
  - Coronary arteries, Phrenic nerve, Lung, Parietal Pericardium
Monomorphic Ventricular Tachycardia
InCor - São Paulo - Brazil
(n: 598)

**VT Etiology**

- **Ischemic**
  - 130 - (22%)
- **Non-ischemic**
  - 194 - (32%)
- **Chagas**
  - 274 - (46%)

**Idiopathic**
- Dilated Cardiomyopathy
- Right Ventricular Dysplasia
- Surgical: (Fallot; Batista's)
- Valvular Heart Disease
- Hypertrophic Cardiomyopathy
- Tumor

**Endocardial and Epicardial Ablation with regular 4mm catheter**

- Recurrence in 257 patients

Prevalence of Mappable Epicardial VTs in Structural Heart Disease - n: 257

- **Endocardial VT**
- **Epicardial VT**

- **Inferior MI**
  - Post-MI*: n: 60
  - Chagas: n: 172
  - DCM: n: 24

**Suggestive Findings of Epicardial VT**

- **Intracardiac recording**
  - Absence of early endocardial activation site
  - Diffuse area of earliest endocardial activation
  - Poor endocardial pace maps
  - Failed ablation at best endocardial sites
Epicardial and Endocardial Substrate Mapping in Chagas’ Heart Disease

Electrocardiographic Recognition of the Epicardial Origin of Ventricular Tachycardias

- Pseudo-delta wave > 34 ms
  - Sensitivity 83%; specificity 95%
- Intrinsicoid deflection time in V2 > 84 ms
  - Sensitivity 87%; specificity 90%
- The shortest RS complex >121 ms
  - Sensitivity 76%; specificity 85%

Berruezo et al. Circulation. 2004

Epicardial Accesses for Epicardial Mapping

Techniques
- Surgical
  - Open chest
  - Video thoracoscopy
- Non surgical
  - Coronary venous system
  - Subxiphoid percutaneous

Epicardial Techniques in the EP Lab

Techniques
- Surgical
  - Open chest
  - Thoracoscopy
- Non surgical
  - Coronary venous system
  - Subxiphoid percutaneous
Subxyphoid Access to the Pericardial Space

Subxyphoid Access to the Pericardial Space

Subxyphoid Access to the Pericardial Space

Subxyphoid Epicardial Approaches

Subxyphoid Epicardial Approaches

A

B

contrast

wire guide

needles
Subxyphoid Pericardial Approach
- anterior access -

Right lateral view of the Heart

Subxyphoid Pericardial Approach
- posterior access -

Left lateral view of the Heart
Pericardial puncture with the Tuhoy needle

Guidewire insertion through the Tuhoy needle

Introducing the sheath in the pericardial space

Intrapericardial catheter positioning
**Epicardial VT Ablation**

**N = 373**

**Risks**
- Pericardial puncture
  - Megacolon = 0
  - Stomach = 0
  - Liver = 0

**Epicardial VT Ablation**

**N = 373**

**Risks**
- Pericardial bleeding
  - “dry RV puncture” = 5%
  - drained > 50cc = 10%
  - surgical correction = 0.8%
- Intraperitoneal bleeding = 0.3%

**Epicardial VT Ablation**

**N = 373**

**Risks**
- Epicardial Ablation
- Coronary artery Damage
  - Coronary artery spasm = 0
  - Coronary occlusion = 0.3%
Catheter Ablation of Ventricular Epicardial Tissue
A comparison of Standard and Cooled-Tip Radiofrequency Energy

<table>
<thead>
<tr>
<th></th>
<th>Cooled-tip</th>
<th>Standard RF</th>
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<tbody>
<tr>
<td>N</td>
<td>47</td>
<td>33</td>
</tr>
<tr>
<td>Fat</td>
<td>2.6±1</td>
<td>3.1±1</td>
</tr>
<tr>
<td>Power</td>
<td>45W</td>
<td>16W</td>
</tr>
<tr>
<td>T°C</td>
<td>40°C</td>
<td>69°C</td>
</tr>
<tr>
<td>Depth</td>
<td>4.1±2</td>
<td>NOT SEEN</td>
</tr>
</tbody>
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**Effects of RF Pulses Delivered in the Vicinity of the Coronary Artery**

CA diameter: 0.8±0.4 mm

CA diameter: 1.8±0.8 mm

**Before the procedure**

**During the procedure**

Epicardial VT ablation
Coronary Vessel Relationship with the Target

D'Avila et al - Circulation - 2004

D'Avila - PACE 2000; 25: 1488
**Epicardial VT Ablation**

*Coronary Vessel Relationship with the Target*

- **Risks**
  - Phrenic nerve damage = 3 (0.8%)
    - Transitory = 1
    - Permanent = 2

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**Cryotermia vs. Radiofrequency Catheter Ablation within the Canine Coronary Sinus Close to the Left Circumflex Coronary Artery**

- RF = 30 – 50 W, irrigated tip; Cryo: -70°C for 4 min

**Phrenic Nerves**

- Aoyama H et al. JCE. 2005
- Quintana et al. JCE. 2005;16:309
Epicardial Ablation Close to the Phrenic Nerve

Epicardial VT Ablation: A Multicenter Safety Study

Epicardial VT Ablation: A Multicenter Safety Study


Methods and Results

Acute Adverse events

N = 22 / 156 (14%)

Epicardial RF Application was necessary in 121/156 (78%) cases

Long-term evolution

Follow-up: 23±21 months

Epicardial bleeding: 08 (>100cc)
RV perforation: 03
Coronary occlusion: 01 (transitory)

Delayed complications:
- Important pericardites = 1
- Cardiac tamponade = 1 (10d)
- Coronary occlusion = 1 (2 wks)

Sacher F et al. HRS 2009

Buch et al. Heart Rhythm 2007

Jais P. Circulation 2008

Sacher F et al. HRS 2009
Summary

• The percutaneous and transvenous epicardial approaches can be performed safely in the EP lab and might improve the results of endocardial ablation in selected patients.

• Electrophysiological and electrocardiographic signals are useful methods to predict epicardial origin of a VT circuit and for scheduling an epicardial procedure.

• Pericardial bleeding is the most frequent complication related to the percutaneous pericardial puncture, but it does not preclude performing the procedure in most patients.

• Irrigated tip catheters are the more effective alternative to ablate subepicardial fibers due to the epicardial fat; however, it might increase coronary artery damage. Cryoablation seems to be a safer alternative when ablating close to the coronary arteries.

• The phrenic nerve position should be identified before RF delivering and some protection might be necessary to prevent its damage.