Useful Tips for Successful Ablation of Epicardial Idiopathic VT

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Outlines

• Definitions and clinical implications
• Patient selection
• Anatomic structures
• Preparation and the procedures
• Complications
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Definitions

• “Endocardium”
  - Reachable via systemic venous or arterial access

• “Epicardium”
  - Potentially approach through epicardial coronary vein and aortic sinuses of Valsalva
  - Requires percutaneous and/or surgical pericardial access
Example of ARVC VT requiring epicardial ablation
Ablation outcome-Epicardial era (ARVD)

87 patients, 175 RFA procedure

49 patients, 23 endo; 26 endo+epi


Rong Bai et al. Circ AE. 2011;4:478-485
Idiopathic VA

Tanawuttiwat T et al. Eur Heart J 2016
Clinical implication of epicardial ablation

Epicardial ablation in Taipei VGH

- ARVC: 43%
- Brugada syndrome: 20%
- IDC: 16%
- Idiopathic: 14%
- ICM: 5%
- Other NICM: 3%

Lin CY, Chung FP, Lin YJ et al. ACS 2017
Outlines

• Definitions and clinical implications
• Patient selection
  ✓ Disease characteristics
  ✓ ECG
  ✓ Endocardial substrates
  ✓ Imaging study
• Anatomic structures
• Preparation and the procedures
• Complications
Possible Access Combinations

• **Situations of only epicardial access**
  - LV organized mural thrombus
  - Mechanical AVR.MVR (can consider transapical access in the context)

• **Situations of only endocardial access**
  - Prior CABG
  - Dense adhesions from prior radiation, surgery, pericarditis, ablation etc.

• **Situations of likely only endocardial ablation**
  - Post-infarct VT
  - Idiopathic VT

• **Situations of mainly epicardial ablation**
  - ARVD, BrS, Chagas disease, NIDCM, post-myocarditis
  - Epicardial criteria
ECG suggestions of LV epicardial exit

• Slurring in the initial portion of the QRS and delayed activation
  – Pseudodelta wave ≥ 34 ms
  – Intrinsicoid deflection ≥ 85 ms
  – Shortest RS complex in precordial leads ≥ 121 ms
  – Maximum deflection index > 0.55
  – Increase QRS by >20 ms compared to comparable endocardial pacing site

• Q wave where they do not belong
2. Daniels DV et al. Circulation. 2006;113:1659-1666
Hayashi T. J Cardiovasc Electrophysiol. 2017

Precordial transition break → Epicardial origin

Proximity to LAD precludes ablation in about half.
ECG favored of RV epicardial exit

- Q wave in I
- Q wave in V2
  - Anterior RV
  - P<0.001

- Q wave in II
- Q wave in III
- Q wave in aVF
  - Inferior RV
  - P<0.001
  - P<0.001
  - P<0.01

ECG favored of RV epicardial exit

Special Consideration “LV submit”
ECG algorithm for LVS approaches

A

ROC for GCV/AIV lesion (AUC=0.982)
ROC for Subvalvular lesion (AUC=0.980)
ROC for ASV lesion (AUC=0.998)

Sensitivity

1-Specificity

ASV
Cut-off: 1.415
Sensitivity: 95.7%
Specificity: 100.0%

Subvalvular
Cut-off: 1.535
Sensitivity: 96.8%
Specificity: 97.1%

GCV/AIV
Cut-off: 1.740
Sensitivity: 93.3%
Specificity: 96.1%

B

ASV
Yes (n=22)
No (n=44)

Q aVL/aVR ≤ 1.415

Subvalvular
Yes (n=13)
No (n=31)

Q aVL/aVR 1.416-1.535

GCV/AIV
Yes (n=16)
No (n=15)

Q aVL/aVR 1.536-1.740

Epicardium*

13/15

Lin CY, Chung FP et al. Heart Rhythm revision
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Sagittal Sections

- Sternum
- RV
- Pericardial Space
- Needle direction
- Diaphragm
- Inferior
- Anterior
- Liver
- RV
- Liver
Foramen of Morganni (Space of Larrey)
Anterior vs. Inferior Epicardial Puncture
Pushing Down on the Abdomen
Pushing Down on the Abdomen
Outlines

• Definitions and clinical implications
• Patient selection
• Anatomic structures
• Preparation and the procedures
  ✓ Tuohy needles; Micropuncture needles
  ✓ Puncture procedures
  ✓ Mapping and ablations
  ✓ Special considerations
• Complications
Epicardial Puncture Sets in TVGH

- Epicardial Puncture Set
  - Tuohy Needle (18G ARROW)
  - 0.032 guidewire/Sheath (Cordis)
  - Agilis Sheath (St. Jude Medical)
Epicardial Puncture Sets in TVGH

Abdominal compression
The “Needle-In-Needle” Technique

Micro puncture needle

Micropuncture through a standard 18 G needle

# “Sosa” vs. “Needle-in-Needle” Technique


<table>
<thead>
<tr>
<th></th>
<th>Sosa technique (n = 291 patients, 316 procedures)</th>
<th>Needle-in-needle technique (n = 23 patients, 23 procedures)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>56 ± 15</td>
<td>58 ± 17</td>
<td>.6</td>
</tr>
<tr>
<td>Male gender (%)</td>
<td>78</td>
<td>65</td>
<td>.2</td>
</tr>
<tr>
<td>Etiology of HD (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idiopathic</td>
<td>23</td>
<td>26</td>
<td>.4</td>
</tr>
<tr>
<td>Ischemic</td>
<td>25</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Nonischemic</td>
<td>53</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Left ventricular ejection fraction (%)</td>
<td>40 ± 16</td>
<td>43 ± 17</td>
<td>.4</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>28 ± 5</td>
<td>30 ± 7</td>
<td>.2</td>
</tr>
<tr>
<td>Procedural indication, as percent of procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>93.8</td>
<td>65.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Premature ventricular contractions</td>
<td>2.1</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>Left atrial appendage closure</td>
<td>1.7</td>
<td>17.3</td>
<td></td>
</tr>
<tr>
<td>Phrenic nerve displacement (atrial arrhythmias)</td>
<td>2.1</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>Supraventricular tachycardia</td>
<td>1.7</td>
<td>17.4</td>
<td></td>
</tr>
<tr>
<td>Prior cardiac surgery (no.)</td>
<td>4.5</td>
<td>4.3</td>
<td>1</td>
</tr>
<tr>
<td>Successful epicardial access</td>
<td>297/316 procedures (94%)</td>
<td>23/23 procedures (100%)</td>
<td>.4</td>
</tr>
<tr>
<td>Any pericardial bleeding &gt; 80 mL</td>
<td>28/316 procedures (8.9%)</td>
<td>2/23 procedures (8.7%)</td>
<td>1</td>
</tr>
<tr>
<td>Estimated pericardial blood loss (mL) [median (range)]</td>
<td>160 (80–300)</td>
<td>170 (100–240)</td>
<td></td>
</tr>
<tr>
<td>Need for emergent cardiac surgery for pericardial bleeding</td>
<td>5/297 patients (1.7%)</td>
<td>0/24 patients (0%)</td>
<td>.7</td>
</tr>
<tr>
<td>Other complications related to pericardial access</td>
<td>8/316 procedures (2.5%)</td>
<td>0 (0%)</td>
<td>1</td>
</tr>
<tr>
<td>Procedure-related mortality</td>
<td>3/291 (1%)</td>
<td>0/23 (0%)</td>
<td>1</td>
</tr>
</tbody>
</table>
Before Puncture...

- History of cardiac surgery? Pericarditis? Pericardial instruments?
- Coagulation parameters?
- Image study: TTE? TEE? ICE?
- Blood type
- Strong CVS backup
Needle Pressure Monitoring (Typical)
Needle Pressure Monitoring (RV)
Step 3
Epicardial fluid matter?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>5 mL/min</th>
<th>No IPF (B)</th>
<th>15 mL/min</th>
<th>No IPF (D)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IPF (A)</td>
<td></td>
<td>IPF (C)</td>
<td></td>
<td>A vs B</td>
</tr>
<tr>
<td>Ablation parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact force (g)</td>
<td>9.1 ± 2.7</td>
<td>9.8 ± 2.1</td>
<td>8.9 ± 1.9</td>
<td>9.3 ± 2.3</td>
<td>.490</td>
</tr>
<tr>
<td>Power (W)</td>
<td>38.9 ± 0.5</td>
<td>38.8 ± 0.9</td>
<td>39.1 ± 0.9</td>
<td>38.9 ± 0.9</td>
<td>.892</td>
</tr>
<tr>
<td>RF duration (s)</td>
<td>59.9 ± 0.5</td>
<td>59.8 ± 0.6</td>
<td>59.9 ± 0.5</td>
<td>59.8 ± 0.6</td>
<td>.866</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>34.6 ± 1.7</td>
<td>35.4 ± 2.2</td>
<td>27.9 ± 2.7</td>
<td>29.1 ± 2.4</td>
<td>.267</td>
</tr>
<tr>
<td>Impedance ∆ (%)</td>
<td>17.4 ± 4.5</td>
<td>19.8 ± 6.3</td>
<td>17.0 ± 6.6</td>
<td>18.8 ± 6.4</td>
<td>.651</td>
</tr>
<tr>
<td>Lesion dimensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface diameter (mm)</td>
<td>6.07 ± 0.92</td>
<td>8.07 ± 2.03</td>
<td>5.88 ± 0.20</td>
<td>6.72 ± 0.67</td>
<td>.003*</td>
</tr>
<tr>
<td>Maximum diameter (mm)</td>
<td>7.21 ± 0.91</td>
<td>9.48 ± 2.24</td>
<td>7.18 ± 0.77</td>
<td>9.09 ± 1.61</td>
<td>.008*</td>
</tr>
<tr>
<td>Depth (mm)</td>
<td>4.46 ± 0.82</td>
<td>5.59 ± 0.83</td>
<td>4.53 ± 0.59</td>
<td>5.55 ± 0.52</td>
<td>.003*</td>
</tr>
<tr>
<td>Volume (mm³)</td>
<td>102.4 ± 30.7</td>
<td>245.1 ± 145.2</td>
<td>100.7 ± 26.0</td>
<td>177.7 ± 42.7</td>
<td>.002*</td>
</tr>
</tbody>
</table>

Aryana et al. Heart Rhythm 2016; 13:1602
Intrapericardial corticosteroid instillation

Chest pain
  - NSAID
    - Look carefully at the ECG, TnI may be difficult to interpret
Post-Procedure
Inflammation/Chest pain

- Intrapericardial corticosteroid instillation
  - Triamcinolone 2mg/kg intrapericardially

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<table>
<thead>
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<th>Complications Related to Epicardial Approach</th>
<th>Other Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major complications</strong></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td></td>
</tr>
<tr>
<td>Intrapericardial bleeding (&gt;80 cm³)</td>
<td>7 (4.5%)</td>
</tr>
<tr>
<td>Coronary artery stenosis (PL br of RCA; asymptomatic)</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td><strong>8/156 (5%) major complications acutely</strong></td>
<td></td>
</tr>
<tr>
<td>Delayed (&gt;48 h)</td>
<td></td>
</tr>
<tr>
<td>Major pericardial reaction</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>Delayed tamponade</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>23 ± 21 month F/U</td>
<td></td>
</tr>
<tr>
<td>Delayed tachyphylaxis</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>Total</td>
<td>11 (7%)</td>
</tr>
<tr>
<td><strong>Minor complications</strong></td>
<td></td>
</tr>
<tr>
<td>RV puncture without consequence</td>
<td>23/136 percutaneous approach (17%)</td>
</tr>
<tr>
<td>Pleural catheterization with guidewire</td>
<td>2/136 (1.5%)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>Almost all patients</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6 (4%)</td>
</tr>
</tbody>
</table>

AV = atrioventricular; RV = right ventricular; VT = ventricular tachycardia.
### Experience in Taipei VGH

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<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrapericardial bleeding (&gt; 80 cm³)</td>
<td>5 (6.3%)</td>
<td></td>
</tr>
<tr>
<td>Intra-thoracic bleeding</td>
<td>1 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Intra-abdominal bleeding</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Delayed (&gt;48 h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major pericardial reaction</td>
<td>1 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Delayed tamponade</td>
<td>1 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8 (10.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Minor complications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RV puncture without consequence</td>
<td>6 (7.5%)</td>
<td></td>
</tr>
<tr>
<td>Subxyphoid hematoma</td>
<td>1 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Prolonged pleuritic pain &gt; 3 days</td>
<td>4 (5.0%)</td>
<td></td>
</tr>
<tr>
<td>Transient acute coronary syndrome</td>
<td>3 (3.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14 (17.5%)</td>
<td></td>
</tr>
</tbody>
</table>
RV Pseudoaneurysm after Epicardial Puncture

RV PSA = 13 x 10 x 9 mm

Pericardial Bleeding Requiring Surgery

- Loculated pericardial effusion
  - Intra-pericardial adhesions
  - Localized bleeding
  - Inaccessible percutaneously

- Pericardial clot formation
Bleeding at the end of Procedure

- Injury of subcutaneous vessels causing bleeding from the tract
- Double RV puncture

Double RV puncture
RV Puncture

• Incidence: 1:6 attempts
• Needle: usually no major sequelae
• Management
  – Slightly withdraw the needle (1-2 mm)
  – Withdraw the guidewire and re-advance to pericardium as possible
• Bleeding: Usually stop within 30 mins without anticoagulation
• Prevention: ICE!
Minimize the attempts of Epicardial Puncture
Unprotected sheath inside pericardium

65-year-old man underwent an epicardial catheter ablation

PL branch of CS
Liver Puncture during pericardial approaches

ICE may show intra-abdominal fluid & ascites

53-y-o woman with WPW (RPS AP), AF and VF arrest – ↓ in BP

Epicardial Mapping & Ablation

Coronary vessel

- **Coronary artery damage**
  - Left coronary vasospasm and VF
  - Coronary artery stenosis/thrombosis
    - 0.8% of epicardial ablation
  - Animal study:
    - Replacement of the media with extracellular matrix
    - Internal perimeter of the vessel associated with severe arterial damage
    - No coronary artery lesion if RF > 1 cm from the vessel
    - Consensus Document: ≥ 5 mm

Koruth JS et al. Circ A&E 2011
Sacher F et al. JACC 2010
D’Avila A et al. PACE 2002
Conclusions

• Epicardial ablation is reasonably safe
  – When potential complications are known
  – With acute major complications occurring in 5% of patients and delayed major complications in 2%
  – Disease preferences (ARVD/C, Brugada syndrome, DCM, post-myocarditis, sarcoidosis...etc), ECG morphology in idiopathic VT

• Key-points for a safe epicardial ablation
  – Availability of angiography and cardiac surgery on site
  – Patients’ selection (previous cardiac surgery)
  – Access (before anticoagulation, tuohy needle, X-ray profile, guidewire throughout the cardiac silhouette)
  – Epicardial Mapping and ablation
  – Adequate follow-up
Useful Tips for Successful Ablation of Epicardial Idiopathic VT

Thanks for your attention