Tips for LV Fascicular VT

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Classification of Idiopathic VT

I. Non-life-threatening (typically monomorphic)
   A. Outflow tract
      - Right ventricular outflow
      - Left ventricular outflow
      - Aortic sinus of Valsalva
      - Peri His bundle
   B. Idiopathic left ventricular tachycardia
      - Left posterior fascicle
      - Left anterior fascicle
      - High septal fascicle
   C. Other
      - Mitral annulus
      - Tricuspid annulus
      - Papillary muscle
      - Perivascular epicardial

Fascicular VT

• RBBB with LAD, Verapamil-sensitive VT
  - Reentrant excitation
  - Anatomic variants

• Focal fascicular (Purkinje) VT
  - Abnormal automaticity

• Interfascicular reentry
  - Reentrant excitation
  - Structural heart disease always present
Verapamil-Sensitive VT

Response of recurrent sustained ventricular tachycardia to verapamil

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A patient is described with no demonstrable organic heart disease and episodes of sustained ventricular tachycardia. Lignocaine and ajmaline failed to control the episodes. A bolus injection of verapamil succeeded. This drug was subsequently administered intravenously, with a slow titration, and each of the eighth, ninth, and tenth episodes of ventricular tachycardia was terminated. During electrophysiological study of the eighth attack, slow ventricular pacing was performed and induced sustained tachycardia. After verapamil, repeated attempts to induce ventricular tachycardia by a burst of ventricular pacing were unsuccessful. Paper speed is 25 mm/s.

Fig. 1 Effects of a bolus injection of verapamil during ventricular tachycardia in October 1977. (A), (B), (C), show lead III trace and (D) shows lead II. (A) Ventricular tachycardia at a rate of 150 beats/min. (B) One minute after a bolus of intravenous verapamil 7.5 mg. Slowing of the ventricular rate to 125 beats/min is noted with sinus capture and fusion beats. (C) 30 seconds later; ventricular rate at 115 beats/min. (D) Conversion to sinus rhythm two minutes after verapamil.

Fig. 3 Top: A burst of ventricular pacing (180 beats/min) induces and terminates the ventricular tachycardia. Bottom: After verapamil, repeated attempts to induce ventricular tachycardia by a burst of ventricular pacing were unsuccessful. Paper speed is 25 mm/s.
Left Posterior Fascicular VT

Clinical Presentation

- Male predominance
- Teenagers and young adults (15-50 years)
- Paroxysms of sustained VT, often exercise-related
- Symptom: palpitation, pre-syncope, syncope
- Termination: verapamil, not adenosine
- Sometimes associated with SVTs
- Occasionally seen in patients with prior inferior MI

Left Posterior Fascicular VT

Mechanism and Substrate

• Reentry

• Inducible, terminable, entrainable (atrium or ventricle)

• Ca dependent portion: partially depolarized Purkinje cells

• Antegrade: slow conduction portion on septum

• Retrograde: rapid conduction portion – fascicle

• False tendon or fibromuscular band ??

Pathophysiology of Fascicular VT

Classification of idiopathic VT

I. Left fascicular VT (reentry)
   1. Left posterior fascicular VT
      i. Proximal type (mid-septum)
      ii. Distal type (apical-inferior septum)
   2. Left anterior fascicular VT
      i. Proximal type (mid-septum)
      ii. Distal type (antero-lateral wall)
   3. Left upper septal fascicular VT (upper septum)

II. Left outflow tract VT (triggered activity, reentry, and automaticity)
   1. Endocardial origin
      i. Medio-superior aspect of mitral annulus (Aorto-mitral continuity)
      ii. Anterior mitral annulus
      iii. Superior basal septum (His-bundle area)
   2. Coronary cusp “origin”
      i. Left coronary cusp
      ii. Right coronary cusp
      iii. Noncoronary cusp
   3. Epicardial origin (direct approach)
Left Posterior/Anterior Fascicular VT

# Differential Diagnosis of RBBB WCT

<table>
<thead>
<tr>
<th></th>
<th>Verap. Sens. LPF VT</th>
<th>SVT + Aberration</th>
<th>Focal Fascicular VT</th>
<th>Papillary Muscle VT</th>
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<tbody>
<tr>
<td>QRS duration</td>
<td>Rel. narrow</td>
<td>Rel. narrow</td>
<td>Rel. narrow</td>
<td>Wider</td>
</tr>
<tr>
<td>Q in lead 1</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Q in lead V1</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>AV relationship</td>
<td>Variable</td>
<td>1:1</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Adenosine effect</td>
<td>None</td>
<td>Termination</td>
<td>Termination</td>
<td>None</td>
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<tr>
<td>HV interval</td>
<td>~20 ms</td>
<td>45 ms</td>
<td>~15 ms</td>
<td>~10 ms</td>
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<tr>
<td>Earliest Purkinje</td>
<td>(throughout)</td>
<td>After His</td>
<td>Before His</td>
<td>Before His</td>
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<tr>
<td>Overdrive pacing</td>
<td>Constant return</td>
<td>Variable</td>
<td>Overdrive suppress</td>
<td>Overdrive suppress</td>
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<tr>
<td></td>
<td>cycle</td>
<td>effects</td>
<td>suppress</td>
<td>suppress</td>
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<tr>
<td>Pacemapping</td>
<td>Not helpful</td>
<td>Not helpful</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

# Fascicular VT vs. Papillary m. VT

**Table 1** Comparison of characteristics of patients with idiopathic fascicular VT and arrhythmias originating from the papillary muscles

<table>
<thead>
<tr>
<th>Patients (n)</th>
<th>IFVT</th>
<th>Papillary muscle</th>
<th>P value</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>31 ± 7</td>
<td>57 ± 9</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Gender (female/male)</td>
<td>3/5</td>
<td>4/5</td>
<td>.6</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>0.6 ± 0.07</td>
<td>0.49 ± 0.13</td>
<td>.04</td>
</tr>
<tr>
<td>VT (n)/PVCs (n)</td>
<td>7/1</td>
<td>2/8</td>
<td>.01</td>
</tr>
<tr>
<td>Structural heart disease</td>
<td>0/8</td>
<td>4/9</td>
<td>.2</td>
</tr>
<tr>
<td>ECG (per arrhythmia)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RB SA</td>
<td>6/8</td>
<td>9/11</td>
<td>.9</td>
</tr>
<tr>
<td>RB IA</td>
<td>2/8</td>
<td>2/11</td>
<td>.9</td>
</tr>
<tr>
<td>Axis RBSA (°)</td>
<td>-87 ± 16</td>
<td>-76 ± 31</td>
<td>.4</td>
</tr>
<tr>
<td>Axis R gia (°)</td>
<td>135 ± 21</td>
<td>120 ± 0</td>
<td>.4</td>
</tr>
<tr>
<td>rs' pattern in V1</td>
<td>8/8</td>
<td>0/11</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Q in limb leads</td>
<td>8/8</td>
<td>1/11</td>
<td>.0001</td>
</tr>
<tr>
<td>Notches in precordial leads</td>
<td>4/8</td>
<td>7/11</td>
<td>.9</td>
</tr>
<tr>
<td>QRS width during arrhythmia</td>
<td>127 ± 11</td>
<td>150 ± 15</td>
<td>.001</td>
</tr>
<tr>
<td>Pleomorphic ectopy</td>
<td>0/8</td>
<td>4/9</td>
<td>.2</td>
</tr>
<tr>
<td>PP at effective site (per arrhythmia)</td>
<td>8/8</td>
<td>5/11</td>
<td>.01</td>
</tr>
<tr>
<td>PP-QRS interval (msec) during SR</td>
<td>-29 ± 5</td>
<td>+10 ± 17</td>
<td>.002</td>
</tr>
<tr>
<td>S-RQS interval at effective site</td>
<td>34 ± 5</td>
<td>44 ± 5</td>
<td>.4</td>
</tr>
<tr>
<td>RF delivered (min)</td>
<td>7 ± 5</td>
<td>24 ± 12</td>
<td>.003</td>
</tr>
<tr>
<td>Procedure time (min)</td>
<td>214 ± 50</td>
<td>368 ± 76</td>
<td>.0004</td>
</tr>
<tr>
<td>Activation time at effective site (msec)</td>
<td>45 ± 14</td>
<td>34 ± 15</td>
<td>.4</td>
</tr>
<tr>
<td>Matching pace map at effective site</td>
<td>0/8</td>
<td>10/11</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Amplitude of ventricular EGM in SR(mA) at effective site</td>
<td>6.2 ± 3.0</td>
<td>1.1 ± 0.8</td>
<td>.0001</td>
</tr>
</tbody>
</table>

*° = degree of axis; EGM = electrogram; ILVT = idiopathic fascicular ventricular tachycardia; PP = Purkinje potentials; PP-QRS interval = interval between the Purkinje potential and the onset of the QRS complex; PVC = premature ventricular complex; Q = Q wave; RBIA = right bundle branch block inferior axis morphology; RBSA = right bundle branch block superior axis morphology; RF = radiofrequency energy; SR = sinus rhythm; VT = ventricular tachycardia.

Good E et al., Heart Rhythm 2008
Left Posterior Fascicular VT
Mapping and Ablation

- LV septal endocardium
- Circuit:
  - antegrade diastolic pathway (? false tendon; septal fascicle)
  - retrograde posterior fascicle
- Purkinje potential (left posterior fascicle) – sinus and VT
- Sensitive to mechanical effects (bump)
Left Posterior Fasicular VT
Mapping and Ablation

• Diastolic potential
  - Prior to Purkinje potential in VT
  - Following local ventricular electrogram in sinus
• Activation mapping superior to pace mapping
• Acceleration often with RF application
• Acute success rate: more than 90%, recurrence rate 7-10%
Recordings at Successful Ablation Site

Ventricular Tachycardia

P1 -75
P2 -70
P1 -60
P2 -5

100 ms

Successful Ablation Sites during SR

(A) Before Ablation

(B) After Ablation

Successful Ablation Sites with P1 & P2 Potential
Termination at 6 sec after RF delivery
Acceleration with Additional Ablation
Successful Ablation Sites with P1 & P2 Potential
Diastolic Potential at Success Site
Diastolic Potentials in Sinus Rhythm
P1 & P2 Potentials in Sinus Rhythm
LV Cartosound Map
Activation Mapping
Mapping: LV-mid septum
Ablation Site
Ablation with Cartosound
VT Ablation with Cartosound
High-Resolution Multipolar Mapping

Multipolar Mapping with Pentaray Catheter
<table>
<thead>
<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to induce VT</td>
<td>Adrenergic dependency</td>
<td>Use isoproterenol</td>
</tr>
<tr>
<td></td>
<td>Insufficient slow conduction</td>
<td>Give small dose of class Ia drug</td>
</tr>
<tr>
<td></td>
<td><em>Bump</em> phenomenon during mapping</td>
<td>Find ventricular echo beat with a similar QRS morphology as that observed during the VT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use pace mapping and the anatomic (linear) approach</td>
</tr>
<tr>
<td>Unable to find a good electrogram</td>
<td>Poor catheter contact</td>
<td>Improve the contact with a different catheter or approach, use multipolar mapping catheter</td>
</tr>
<tr>
<td>Unable to find a diastolic potential during VT</td>
<td>Unknown</td>
<td>Use pace mapping and the anatomic (linear) approach</td>
</tr>
<tr>
<td>Poor catheter stability</td>
<td>Excessive heart motion during the VT</td>
<td>Ablate during sinus rhythm or overdrive pacing, change catheter reach and stiffness, use cryoablation</td>
</tr>
<tr>
<td></td>
<td>Frequent ventricular premature beats during the RF application</td>
<td>Use verapamil IV (after which the noninducibility of VT becomes invalid as an end point), use cryoablation or overdrive pacing</td>
</tr>
</tbody>
</table>

_Huang SK et al: Catheter ablation of cardiac arrhythmias, 3rd ed. 2015_
A Stepwise Approach to the Induction of VT

Ablation Strategies for Non-inducible Cases

- Target earliest diastolic potentials during SR
- Create ablation line along inferior LV septum that should transect diastolic pathway
- Ablate left posterior fascicle
Linear Ablation Strategy

Pacemap at Exit site
Pacemap with PASO
Ablation Strategies for Fascicular VT

- Transect diastolic pathway
- Ablate posterior fascicle
- Ablate along diastolic pathway
- Ablate diastolic pathway-LPF connection

Focal Fascicular (Purkinje) VT

- Characteristic surface ECG appearance
  - RBBB and either a left or right-axis deviation

- Mechanism: abnormal automaticity
  - Induction by exercise and that is catecholamines
  - Unable to induce or entrain by ventricular stimulation
  - Transient suppression by adenosine and with overdrive pacing or faster supraventricular rhythm

- Often incessant, relatively slow

- May result in cardiomyopathy

- Response to lidocaine, Beta-blockers, and class Ia drugs

- No response to verapamil (verapamil insensitive)

- Negative HV interval in tachycardia

*Huang SK et al. Catheter ablation of cardiac arrhythmias, 2nd edition. 2011*
Ablation for Focal Fascicular VT

Distal/Peripheral Site
- No effect on VT
- No effect in SR

Proximal Site
- No effect on VT
- LAFB in SR

At Focus
- Terminates VT
- No effect in SR

Site on Other Fascicle
- No effect on VT
- LPFB in SR

77 Y.O. Male. Palpitation
No response to multiple DCC and AAD

DC 200J

Lidocaine IV bolus
Tachycardia Induced Cardiomyopathy
Focal Fascicular VT
VT termination after RF energy delivery
Pre and Post Ablation
Summary: Tips for LV Fascicular VT

- Induce ventricular tachycardia before LV mapping
  - Watch out for bump
- Activation mapping is superior to pace mapping
- Target diastolic and Purkinje potentials
- Transect the presumed location of the diastolic pathways
- Intracardiac echo (Cartosound)
Thanks for your attention !!