Uncommon type AVNRT

강동경희대학교병원
심장혈관내과
진은선
Embarrassing things during AVNRT ablation

• When slow pathway ablation doesn’t work
  – Both in typical and atypical AVNRT
  – Then, where to ablate next?

• Earliest retrograde A activation is at CS os (5~7%) or inside CS
Postulated Pathways

A. rFP
B. rRIE
C. rLIE
D. rIL-LA

Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed
Mapping of RIE

Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed
During Sinus Rhythm

Postulate No. 1

Postulate No. 2

Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed
Most Common Form; Typical Slow-Fast AVNRT

RIE Slow/Fast AVNRT

LAO projection

Earliest RA activation
FP
ToT
HB
RIE
RA activation
LA activation
Activation of CS myocardium
Ablation region
Ablation will fail
Ablation region
Ablation will fail

LIE Slow/Fast AVNRT

LAO projection

Earliest RA activation
FP
ToT
HB
LIE
RA activation
LA activation
Activation of CS myocardium
Ablation region
Ablation will fail

IL-LA Slow/Fast AVNRT

LAO projection

Earliest RA activation
FP
ToT
HB
IL-LA
RA activation
LA activation
Activation of CS myocardium
Ablation region
Ablation will fail

Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed
Delineation of Circuit

* Reset of next H by delivering late APC

Yamabe, Circulation 1999;100:621-7
Slow-Slow & Fast-Slow AVNRT

Hypothesis for Slow/Slow and Fast/Slow AVNRT

RIE/LIE AVNRT (usually Slow/Slow AVNRT)

LIE/LIE AVNRT (usually Fast/Slow AVNRT)

Lockwood, Jackman, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed
Different Stories
Variable Retrograde Activation Pattern; Fast Pathway

Atrial activation during atrioventricular nodal reentrant tachycardia: Studies on retrograde fast pathway conduction

Demosthenes G. Katritsis, MD, PhD,* Kenneth A. Ellenbogen, MD,† Anton E. Becker, MD, PhD‡

- Earliest Retrograde A
  - During AVNRT (17pts)
    - L; 53%
    - R; 17%
    - Both L&R; 29%
  - During Vp
    - Lt septum 71%
  - Concordance; 57%
Proposed AVNRT Circuit; Previously by Katritsis

Slow-fast AVNRT

Katritsis, Heart Rhythm 2007;4:1354
Proposed AVNRT Circuit; Previously by Katritsis
Atypical atrioventricular nodal reentrant tachycardia: prevalence, electrophysiologic characteristics, and tachycardia circuit

Demosthenes G. Katritsis\textsuperscript{1*}, Ali Sepahpour\textsuperscript{2}, Joseph E. Marine\textsuperscript{3}, George D. Katritsis\textsuperscript{4}, Tanyanan Tanawuttiwat\textsuperscript{3}, Hugh Calkins\textsuperscript{3}, Edward Rowland\textsuperscript{2}, and Mark E. Josephson\textsuperscript{5}
Fast-Slow & Slow-Fast AVNRT does NOT Use Same Pathway

Table 1: Tachycardia types and conduction intervals

<table>
<thead>
<tr>
<th>AVNRT type</th>
<th>n</th>
<th>Age</th>
<th>Sex (F/M)</th>
<th>CL (ms)</th>
<th>AH (His) activation</th>
<th>HA (His) activation</th>
<th>HA (pCS) activation</th>
<th>Earliest retrograde atrial activation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast–slow</td>
<td>44</td>
<td>50.7 ± 19.3</td>
<td>23/21</td>
<td>379.1 ± 68.5</td>
<td>99.7 ± 40.5</td>
<td>251.7 ± 76.4</td>
<td>251.5 ± 77.2</td>
<td>pCS (59%)</td>
</tr>
<tr>
<td>Slow–slow</td>
<td>9</td>
<td>45.6 ± 20.0</td>
<td>7/2</td>
<td>476.4 ± 137.9</td>
<td>286.0 ± 83.2</td>
<td>163.3 ± 60.5</td>
<td>171.0 ± 60.9</td>
<td>His (67%)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>6</td>
<td>52.5 ± 13.7</td>
<td>4/2</td>
<td>395.8 ± 105.5</td>
<td>197.0 ± 31.1</td>
<td>176.0 ± 72.9</td>
<td>173.8 ± 66.7</td>
<td>His/pCS (50%)</td>
</tr>
<tr>
<td>Slow–fast</td>
<td>34</td>
<td>39.0 ± 7.5</td>
<td>22/12</td>
<td>331.1 ± 46.8</td>
<td>270.4 ± 44.3</td>
<td>45.8 ± 7.7</td>
<td>51.4 ± 7.5</td>
<td>His (85%)</td>
</tr>
</tbody>
</table>

Fast–slow type: AH < 200 ms and AH < HA; slow–slow type: AH > 200 ms and AH > HA; intermediate: all other patterns.

CL, tachycardia cycle length; AH tachy, atrial to His interval during tachycardia; HA tachy, His to right atrium interval during tachycardia.
Classification of electrophysiological types of atrioventricular nodal re-entrant tachycardia: a reappraisal

Demosthenes G. Katritsis¹* and Mark E. Josephson²

¹Athens EuroClinic, 9 Athanassiadou Street, Athens 11521, Greece; and ²Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

Table 1 Classification of AVNRT types

<table>
<thead>
<tr>
<th>Type</th>
<th>HA</th>
<th>VA (His)</th>
<th>AH/HA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical AVNRT</td>
<td>≤70 ms</td>
<td>≤60 ms</td>
<td>&gt;1</td>
</tr>
<tr>
<td>Atypical AVNRT</td>
<td>&gt;70 ms</td>
<td>&gt;60 ms</td>
<td>Variable</td>
</tr>
</tbody>
</table>

Fast-Slow AH/HA < 1
Slow-Slow AH/HA > 1, AH > 200 ms
Target for AVNRT ablation

• Jackman/Haissaguerre potential

Editorial

The “Slow Pathway” Potential: Fact or Fiction?

Joseph J. Gard, MD; Samuel J. Asirvatham, MD, FACC
Ablation of Atypical AVNRT

Catheter Ablation of Atypical Atrioventricular Nodal Reentrant Tachycardia

113 pts, 75.2% fast-slow, 8.9% had both typical and atypical AVNRT
- All but 3 pts, conventional right-sided ablation was successful
Lt Inferior Nodal Extension is Anatomical Substrate of SP
Lt Inferior Nodal Extension is Anatomical Substrate of SP

Hucker WH, Anat Rec 2008;291:204-15
Lt Inferior Nodal Extension is Anatomical Substrate of SP?

Kurian T, PACE 2010;33(6):754-62
Left Septal Slow Pathway Ablation for Atrioventricular Nodal Reentrant Tachycardia
Better Results in Lt Septal SP Ablation

Table. Electrophysiology and Ablation Characteristics of Patients Subjected to Left Septal Slow Pathway Ablation

<table>
<thead>
<tr>
<th></th>
<th>R+L Group (n=15)</th>
<th>L Group (n=11)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atypical AVNRT, %</td>
<td>4 (26.7%)</td>
<td>0 (0%)</td>
<td>0.113</td>
</tr>
<tr>
<td>Female sex, %</td>
<td>9 (60%)</td>
<td>8 (73%)</td>
<td>0.683</td>
</tr>
<tr>
<td>Age, years</td>
<td>53±12.7</td>
<td>43±10.7</td>
<td>0.045</td>
</tr>
<tr>
<td>Tachycardia cycle length, ms</td>
<td>370.7±59.7</td>
<td>359.0±37.1</td>
<td>0.573</td>
</tr>
<tr>
<td>AH, ms</td>
<td>317.0 (213.5–349.5)</td>
<td>288.0 (254.0–340.0)</td>
<td>0.649</td>
</tr>
<tr>
<td>HA, ms</td>
<td>63.0 (42.5–106.0)</td>
<td>48.0 (32.0–59.0)</td>
<td>0.106</td>
</tr>
<tr>
<td>Fluoroscopy time, min</td>
<td>30.5 (21.0–44.0)</td>
<td>20.0 (17.0–25.0)</td>
<td>0.061</td>
</tr>
<tr>
<td>RF delivery time, min</td>
<td>11.3 (5.0–19.1)</td>
<td>10.0 (7.0–12.0)</td>
<td>0.897</td>
</tr>
<tr>
<td>Postablation dual AV nodal conduction, %</td>
<td>2 (13.3%)</td>
<td>0 (0%)</td>
<td>0.492</td>
</tr>
<tr>
<td>Tachycardia recurrence, %</td>
<td>1 (6.7%)</td>
<td>0 (0%)</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Katritsis, Circ Arrhythm Electrophysiol 2018;11:e005907
When Rt sided ablation fails

• Targeting earliest retrograde activation?
  – NOT in typical AVNRT
  – Could be attempted in atypical AVNRT; targeting Lt inferior nodal extension

• Lt inferior extension vs LA septal ablation
  – LIE ablation from CS os; risk of AVN damage
  – Junctional rhythm
When LA approach is needed

- **Anterograde Limb**: Slow/Fast or Slow/Slow
- **Retrograde Limb**: Slow/Slow or Fast/Slow
  - **Targeting earliest retrograde A**

![Diagram showing retrograde conduction over the Leftward Inferior Extension (LIE) of the AV node.](Image)

**Para-Hisian Ventricular Pacing**

- II
- V1
- RAA
- HB
- CS
- CS Floor
- RVPH

Earliest Retrograde Activation at Roof of Proximal CS (3-4 cm from CS Ostium)

4 cm from CS Os

Jackman WM, HRS 2017
When LA approach is needed

- **Retrograde Limb**: Slow/Slow or Fast/Slow

Ablation of “Inferolateral Left Atrial” Slow Pathway
When LA approach is needed

**Slow/Fast AVNRT**

3 Forms

- All use Fast Pathway for Retrograde Limb
- 3 Different Slow Pathways for Antegrade Limb
  1. Rightward Inferior Extension of AV Node (most common)
  2. Leftward Inferior Extension of AV Node (uncommon)
  3. Inferolateral Left Atrial Slow Pathway (rare)

Sometimes Ablate the LIE or IL-LA by Delivering RF Progressively Higher in Triangle of Koch

*Ideal Target: Atrial End of LIE or IL-LA Slow Pathways*

**Techniques for Differentiating Antegrade Pathway**

- Ablation Site of Antegrade Slow Pathway
- Resetting Response (Single Atrial Extrastimulus)

Jackman WM, HRS 2017
Use of Resetting to Identify Antegrade Limb (Slow Pathway) of Reentrant Circuit

RAO Projection

- Fast Pathway
- Tendon of Todaro
- RA Activation
- CS

LAO Projection

- Fast Pathway
- ToT
- RA Activation
- IVC

Late Extrastimulus at
- Inferior Triangle of Koch
- Roof of Proximal CS

Site Where Latest Extrastimulus Advances Next H - Closest to Antegrade Slow Pathway

Jackman WM, HRS 2017
Use of Resetting to Identify Antegrade Limb (Slow Pathway) of Reentrant Circuit

RAO Projection

- Fast Pathway
- Tendon of Todaro
- RA Activation
- CS

LAO Projection

- Fast Pathway
- ToT
- HB
- IVC
- Inferolateral Left Atrial Slow Pathway

Late Extrastimulus at
- Inferior Triangle of Koch
- Roof of Proximal CS

Late Extrastimulus at Inferolateral LA, Close to Mitral Annulus (4:30-5:00)
Case

• Prior failed AVNRT ablation x 2
  – Vigorous accelerate junctional rhythm in usual SP region

• Resetting Response
  – ToK: failed to advance H
    • RIE is not a limb of reentry
When Rt sided ablation fails

Ablation at Roof of CS

Failed to Terminate AVNRT

Ablation at Resetting Site

Resetting Sites in LA

Near Inferolateral MA (IL-LA)

Prior Resetting Site in CS

Near Inferior MA (LIE)

LAO Projection

Ablation in LA Required for 25% of LIE

Jackman WM, HRS 2017
Take Home Message

• Simplified Dx criteria for typical/atypical AVNRT

• AVNRT circuit
  – Variable retrograde fast pathway conduction
  – RIE, LIE, IL-LA

• Stepwise approach in ablation
  – Rt sided posterior septal ablation
  – LIE vs LA septal ablation, IL-LA SP ablation
    • Earliest retrograde A for retrograde pathway
    • Reset response for anterograde pathway