Interpreting EP signals
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British Heart Rhythm Society Certification: Core
HRC 2017
15:15 – 16:00
Why are electrograms useful?

How are they obtained?

How are they similar/different to what you are used to?

Is it “A” or “V”

Normal sinus rhythm

Programmed stimulation

Anterograde conduction:
  – Accessory pathways
  – Decrementation, fast and slow pathways

AVNRT

Retrograde conduction
Holter report: 25 yr old female, history of palpitations.

Normal sinus rhythm, with periods of sinus arrhythmia.

Three episodes of VT, longest 12 beats.
Single, paired and also one VE triplet.

Episodes of a narrow complex tachycardia, longest episode 9.53 min with a mean HR 202 bpm. Frequent AE's including singles, pairs, triplets and atrial runs.

Episodes of bradycardia and tachycardia.
Min HR 42 bpm / Max HR 173 bpm

No patient diary submitted.
21:50:47 VT; Number of QRS = 12; Duration = 3.61s; Mean HR = 183 min⁻¹
21:50:51 VT changes to Narrow Complex Tachycardia
Introduction

• Interpretation of EGMs is fundamental

• EGMs are created by the interaction of a propagating wavefront with electrodes and electronic amplifiers

• They can be modified, enhanced or distorted
Electrograms

• Generated by potential differences at two recording electrodes

• Clinical EGMs are **differential** recordings:
  
  – one source connected to the anodal (positive) input of the recording amplifier
  
  – second source connected to the cathodal (negative) input
Differential amplifier

- Electronic amplifier that does not amplify the particular voltages but the *difference* between the two

Vs+ and Vs− are the power supply voltages
**Unipolar**

- Exploring electrode in the heart, second electrode distant from the heart (indifferent)

- Exploring electrode connected to positive input

**Bipolar**

- Both electrodes exploring the area of interest
Unipolar (1)
Unipolar (3)
Bipolar (1–2)
Bipolar (3–4)
Bipolar (1–6)

Issa ZF, Miller JM, Zipes DP; Clinical Arrhythmology and Electrophysiology
CS catheter in coronary sinus
LAO view
Coronary sinus
Intracardiac signals: pacemakers and ICDs
Intracardiac signals: EP study
The His Bundle Electrogram (HBE)
Paper speed: surface ECG

- P wave
- QRS complex
- T wave
Is it an “A” or a “V”

- What does it line up with on the ECG?
- Where is the catheter?
- Near field of far field?
- Big or small?
Tachycardia

• Which A goes with which V?
Atrial activation: lines up with p wave
His bundle electrogram (HBE): iso-electric interval
Ventricular activation: Lines up with QRS
Normal sinus rhythm
Intra-cardiac Intervals
Abnormal H-V interval
P.E.S.

Sensed $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_2$

Sense-$S_1$ Interval

DRIVE TRAIN

$S_1$-$S_2$ Interval

PAUSE

S1 S1 S1 S1 S1 S1 S1 S1 S2
Decremental Conduction
After, Cardiac Arrhythmia, mechanisms, diagnosis & Management, by Podrid & Kowey, Lippincott
The AV node consists of a complex of fibres interposed between true atrial fibres and the His bundle.

Two types of fibres known as the fast pathway and the slow pathway are responsible two modes of AV transmission.
- Fast pathway
  - Fast conduction, long refractory period

- Slow Pathway
  - Slow conduction, short refractory period.
Dual AV nodal physiology

- Atrial premature stimuli conduct first via the fast pathway but then switch to the slow pathway when very premature.

- Known as **dual AV nodal physiology**

- The fast and slow fibres form the circuit for AVNRT
AV nodal “Jump”

- The switch from fast to slow is known as a “jump” and is identified by a dramatic lengthening of the AH interval.
The UK’s first Academic Health Science Centre delivering breakthroughs in medical research directly to its patients
AV nodal echo

- Under the right conditions an impulse conducted via the slow pathway may retrogradely enter the fast pathway and re-activate the atria.

- This represents half a circuit of AVNRT and is known as an echo.
Typical AVNRT: The complete circuit

- A premature atrial beat **blocks in the fast pathway** but is conducted toward the compact AV node by the slow pathway.

- The impulse emerges from the compact node via the His bundle to activate the ventricles.

- **Simultaneously** activates the atria via the fast pathway and completes the circuit by re-entering the slow pathway.
atrium

av-node

His

slow

fast

ECG: atrial echo
Table I.

Six Features of SVT to Consider before Considering a Diagnostic Pacing Maneuver

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
<th>SVT Mechanism(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. VA relationship</td>
<td>V = A</td>
<td>AVNRT, AVRT, AT</td>
</tr>
<tr>
<td></td>
<td>V &gt; A ± AV dissociation</td>
<td>ONVRT, ONFRFT, AVNRT</td>
</tr>
<tr>
<td></td>
<td>V &lt; A</td>
<td>AVNRT, AT</td>
</tr>
<tr>
<td>2. VA interval</td>
<td>VA &gt; 70 ms</td>
<td>aAVNRT, AVRT, AT</td>
</tr>
<tr>
<td></td>
<td>VA ≤ 70 ms</td>
<td>tAVNRT, AT</td>
</tr>
<tr>
<td></td>
<td>VA &gt; AV</td>
<td>aAVNRT, AT, AVRT using slowly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>conducting AP</td>
</tr>
<tr>
<td>3. Atrial activation sequence</td>
<td>High to low</td>
<td>AT</td>
</tr>
<tr>
<td></td>
<td>Concentric</td>
<td>AVNRT, AVRT, AT</td>
</tr>
<tr>
<td></td>
<td>Eccentric</td>
<td>AVRT, AT*</td>
</tr>
<tr>
<td>4. Spontaneous termination</td>
<td>Ends with an “A”</td>
<td>AVNRT, AVRT</td>
</tr>
<tr>
<td></td>
<td>Ends with a “V”</td>
<td>AVNRT, AVRT, AT</td>
</tr>
<tr>
<td>5. HH changes precede and predict AA changes</td>
<td>Yes</td>
<td>AVNRT, AVRT</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>AVNRT, AVRT, AT</td>
</tr>
<tr>
<td>6. VA increase &gt; 30 ms with functional BBB</td>
<td>Yes</td>
<td>AVRT with free wall AP ipsilateral to</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>BBB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AVNRT, AVRT, AT</td>
</tr>
</tbody>
</table>

*aAVNRT = atypical AVNRT; tAVNRT = typical AVNRT; ONVRT = orthodromic nodoventricular reciprocating tachycardia; ONFRFT = orthodromic nodofascicular reciprocating tachycardia. *AVNRT with a leftward atrionodal exit is uncommon but still possible. AT is most likely, but AVNRT and AVRT are theoretically still possible.*
Retrograde conduction
P.E.S.

Sensed $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_1$  $S_2$

Sense-$S_1$ Interval

DRIVE TRAIN

$S_1$-$S_2$ Interval

PAUSE
Normal VA sequence: concentric atrial activation
Normal VA sequence: concentric atrial activation
Abnormal VA sequence: eccentric conduction
VA decrementation