VARIANTS OF AV JUNCTIONAL RHYTHMS

1. Typical AVNRT
2. Atypical AVNRT
3. Septal A.P.
4. Nodo-fascicular pathway
5. Focal junctional tachycardia
   (J.E.T., A.J.T.)

Anatomic Site of Slow Pathway

B. Medkour et al. (Circ 98:164, 1998) (rabbit heart)
1. PNE - bundle of specialized cells between CS and compact node (no distinct separation)
2. Found distinct electrophysiologic differences between PNE and compact node.
3. PNE - slower conduction with shorter refractory period.
4. Critically timed APCs - blocked in transitional cells, could propagate through PNE and produce an echo beat.
What is the AV Node?

The AV node cannot be defined as the region in which AN- and N-type action potentials are found because cells with similar action potentials are found around the entire mitral and tricuspid valve annuli. Moreover, the cells with nodal-type action potentials in the tricuspid annulus (and possibly those in the mitral annulus) appear to be contiguous and continuous with cells with nodal-type action potentials in the anatomic region of the traditional AV node.

McGuire, MA. Circ 1996;94:571

AVNRT Possible Circuits

1. Solely RA
2. LA with typical SP involvement
3. LA involving LA or CS muscle without involvement of SP
4. H-A fibers
5. Involves both inferior extensions
Types of AVNRT

1. Classic slow-fast
2. Atypical fast-slow
3. Slow-slow
Ablation of Slow Pathway

1. Atypical AVNRT
2. Atrial tachycardia
3. Septal AP
4. N-F tachycardia

Mid-Long RP Tachycardia

- Atypical AVNRT
- Atrial tachycardia
- Septal AP
- N-F tachycardia

Usefulness of the $\Delta$ HA to accurately distinguish AVNRT from septal ORT

$\text{HA}_{\text{pace}} - \text{HA}_{\text{SVT}} > -10\text{ ms in AVNRT}$

Response to VOD during ORT

- VI
- I
- II
- III
- HRA
- HBl
- RVA

- a. $SA - VA < 85\text{ ms}$
- b. $PPI - TCL < 115\text{ ms}$

$\text{HA}_{\text{pace}} - \text{HA}_{\text{SVT}} > -10\text{ ms in AVNRT}$

$\text{Michaud et al., J Am Coll Cardiol 2001;38:1163-7}$
Para-Hisian pacing demonstrating retrograde conduction over the slow AV nodal pathway

Para-Hisian pacing demonstrating retrograde conduction over Anteroseptal AP

A on V Tachycardia

1. Slow-fast AVNRT
2. Atrial tachycardia
3. Focal junctional tachycardia
4. Concealed nodofascicular
Characteristics of S-F AVNRT

1. Dual pathways with critical AH for echo beats
2. Usually induced by atrial pacing
3. VA is hooked, ∆ H-H drives ∆ AA
4. Spontaneous termination with A block in slow pathway
5. VAV response after entrainment
6. (PPI- TCL >115 ms)
7. Premature V terminates tachycardia without affecting A

Characteristics of Atypical AVNRT

1. Negative P waves in 2,3,F and V₅, positive in V₁ (short duration)
2. Usually initiated by ventricular pacing
3. PPI-TCL > 115 ms, S-VA-VAT => 85 ms
4. V on His no effect on succeeding A
5. Parahisian pacing (SVT) to exclude septal AP
Identification of concealed Kent pathways by comparison of VA intervals from apical and posterobasal RV sites

- $VA_{\text{Apical}} - VA_{\text{postbasal}} > 10\text{ ms in posteroseptal AP}$
- $VA_{\text{Apical}} - VA_{\text{postbasal}} \text{ negative in AVNRT}$

Martinez-Alday et al. Circulation 1994;89:1060-1067

DIFFICULT AVNRT ABLATION

Start low (level of CS os/stay septal)

1. Ablation dangerously close to His bundle. Use cryoaolation
2. Slow Pathway only (retrograde fast pathway ablation)
3. Look for potentials in the CS.
4. Look for eccentric CS atrial activation.
Successful ablation site at the Mitral Annulus (transeptal)

AVNRT via Left Posterior Extension
AVNRT Requiring Ablation in the CS or Left Atrium (1.8%)

- AVNRT requiring ablation in the CS or at the MA should be suspected by eccentric atrial activation during tachycardia (earliest A within the CS) as well as recording a discrete potential within the CS (that is a critical part of the retrograde limb and serves as an excellent target for ablation).
- Variable successful ablation sites were noted to be in the proximal CS, at the posteroseptal MA and at the anterior MA.
- In patients with AVNRT resistant to standard SP ablation one should consider ablation within the CS or at the MA rather than risking ablation close to the compact node.

<table>
<thead>
<tr>
<th>Age/sex</th>
<th>AVNRT type</th>
<th>VA coordination</th>
<th>TSL (ms)</th>
<th>Cs potential</th>
<th>JT at SP/PF site</th>
<th>Successful RF site</th>
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Narrow complex tachycardia with VA block

AV nodal reentrant tachycardia  Junctional tachycardia  Concealed nodofascicular tachycardia

Concealed nodofascicular tachycardia

- SVT initiated with atrial programmed stimulation (often with dual response) or ventricular extrastimuli
- Evidence of AV dissociation during SVT or A on V TACH. SVT (rules out extranodal AP)
- PVC on His during SVT advances the next His / V or terminates SVT
- Bundle branch block leads to prolongation of VA interval or tachycardia cycle length
Spontaneous PVC

Ablator signal within CS in sinus rhythm

Successful ablation site in the CS

Proposed circuit for left sided concealed nodofascicular tachycardia
**Electrophysiologic Characteristics**

<table>
<thead>
<tr>
<th>Initiation</th>
<th>Baseline HV interval</th>
<th>TCL</th>
<th>SVT</th>
<th>Adenosine</th>
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<td>380</td>
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<td>2 VES</td>
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<td>3 AES/VES</td>
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<td>WCT with VA block term</td>
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<td>WCT with VA block No termination</td>
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<td>250</td>
<td>NCT with VA block term</td>
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AES= Atrial extrastimuli, VES= Ventricular extrastimuli, Iso= isoproterenol

**Focal Junctional Tachycardia**

- Narrow complex tachycardia with AV dissociation
- Catecholamine stimulation (abnormal automaticity)
- Initiation with atrial and ventricular overdrive pacing (triggered)
- Termination with adenosine (triggered)
- Earliest retrograde A preceded or buried in the QRS

**Initiation with atrial overdrive pacing**

- Dual AV node
- AV dissociation
- BBB ↑ Tach CL
- V on His

1 N Atrial pacing RBBB no effect Term SVT
2 Y Spont Y Term SVT
3 N VA block Y Advanced next his, V
4 Y Spont Not seen Advanced next his, V
5 N VA block RBBB, LBBB no effect Advanced next his, V
6 Y (double fire) VA block RBBB no effect Delayed next his, V

BBB= Bundle branch block
Single PVC to reveal the site of earliest retrograde atrial activation

Single PAC terminates SVT without affecting the V

Focal Junctional Tachycardia
1. Initiates spontaneously or with ventricular pacing
2. Starts de novo without critical AH
3. Frequently has episodes of AV dissociation
4. APC from CS does not advance the His
5. APC on His never terminates
Para-Hisian entrainment

Comparison of Atrial-His interval during tachycardia and atrial pacing in patients with long RP tachycardia

Focal Junctional Tachycardia
1. Initiates spontaneously or with ventricular pacing
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Initiation with atrial overdrive pacing

Single PAC terminates SVT without affecting the V

Carto activation map of JT

AT: Diagnosis

- Surface P wave & intracardiac atrial activation sequence during AT different from that in sinus rhythm
- AH interval with atrial pacing same as AH during AT
- Initiation independent of a critical AV nodal or AV conduction delay
- AA drives VV during Tachycardia
- A and V not hooked
- Initiation from ventricles alone excludes AT
- Single V terms without change in A excludes A
- AV dissociation
  - Spontaneous
  - Pharmacologically-induced
  - Pacing-induced
  - V-A-A-V response to ventricular extrastimulus
Characteristics of A Tach
1. No critical AH
2. Usually from atrial pacing (not solely from V pacing)
3. Warm up phenomenon
4. Adenosine-induced AV block
5. VAAV or AV dissociation with ventricular overdrive

Concealed Nodo-Fascicular Tachycardia
1. May start with dual response
2. AV block common
3. Some have prolonged HV
4. V on His advances next His or may terminate tachycardia
5. BBB ipsilateral to site of N-F will prolong tachycardia cycle length

Ablator in CS recording discrete potential
Successful ablation site

Ablation site: His bundle position
Focal AT ablation in the non coronary cusp

AT: Intracardiac electrograms

Proposed circuit for concealed right sided nodofascicular tachycardia
**AT: 3 mg adenosine (contd)**

- **Successful Site of Ablation**
  - **Cs potential**
  - **RF site**
  - **JT at RF site**
  - **Successful long term follow up (mths)**
  - **Complications**

<table>
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<tr>
<th></th>
<th>Cs potential</th>
<th>RF site</th>
<th>JT at RF site</th>
<th>Successful long term follow up (mths)</th>
<th>Complications</th>
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**Patient Characteristics**

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**Mean+SD**: 50±25

**Concealed nodofascicular tachycardia**

- Evidence of AV dissociation during SVT (rules out extranodal AP)
- PVC on His during SVT advanced / delayed the next His and V or terminated SVT
- Bundle branch block leads to prolongation of VA interval or tachycardia cycle length
Septal AVRT vs Atypical AVNRT

- Response to VOD during SVT
- RV pacing at TCL during sinus
- HA during RV pacing and SVT
- Pace from RVA and RVS
- Para hisian pacing / entrainment
- Change in HA with change in HV
- VA change with BBB during SVT
- Compare HRA AH with that of AH in SVT

Concealed nodofascicular tachycardia

- Critical infranodal delay often needed for SVT
- SVT easily initiated with atrial programmed stimulation and ventricular extrastimuli
- Proximal end of tract (perinodal or within CS) targeted for RFA
Usefulness of the $\triangle$ HA to accurately distinguish AVNRT from septal ORT

Miller et al, Am J Cardiol 1991;68:1037-1044