Differential Diagnosis of SVT & It's Mapping Techniques

Classification of SVT

- Atrial

1. A Fib
2. A Flu
3. AT

1) focal
2) reentry

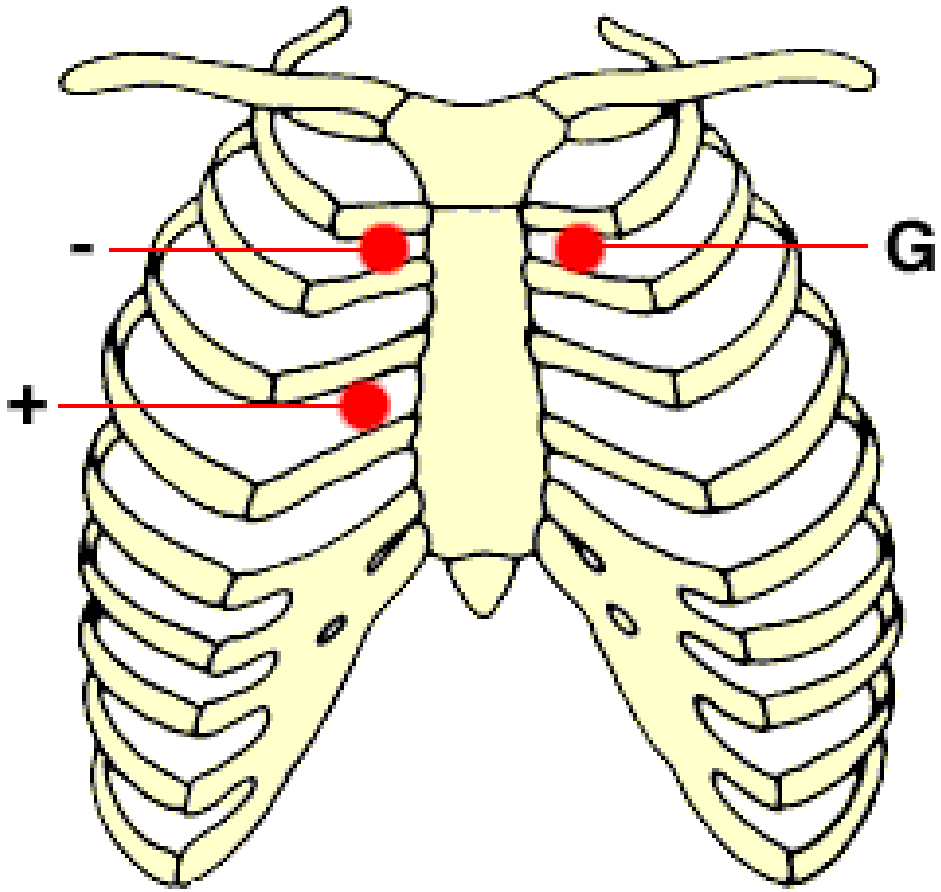
- atrial
- sinoatrial

- AV junction

1. AVNRT
2. AVRT
3. PJRT

Carotid sinus massage

- Termination(AV junction dependent)
  - AVNRT
  - AVRT
- Slowing
  - A Flu
  - AT



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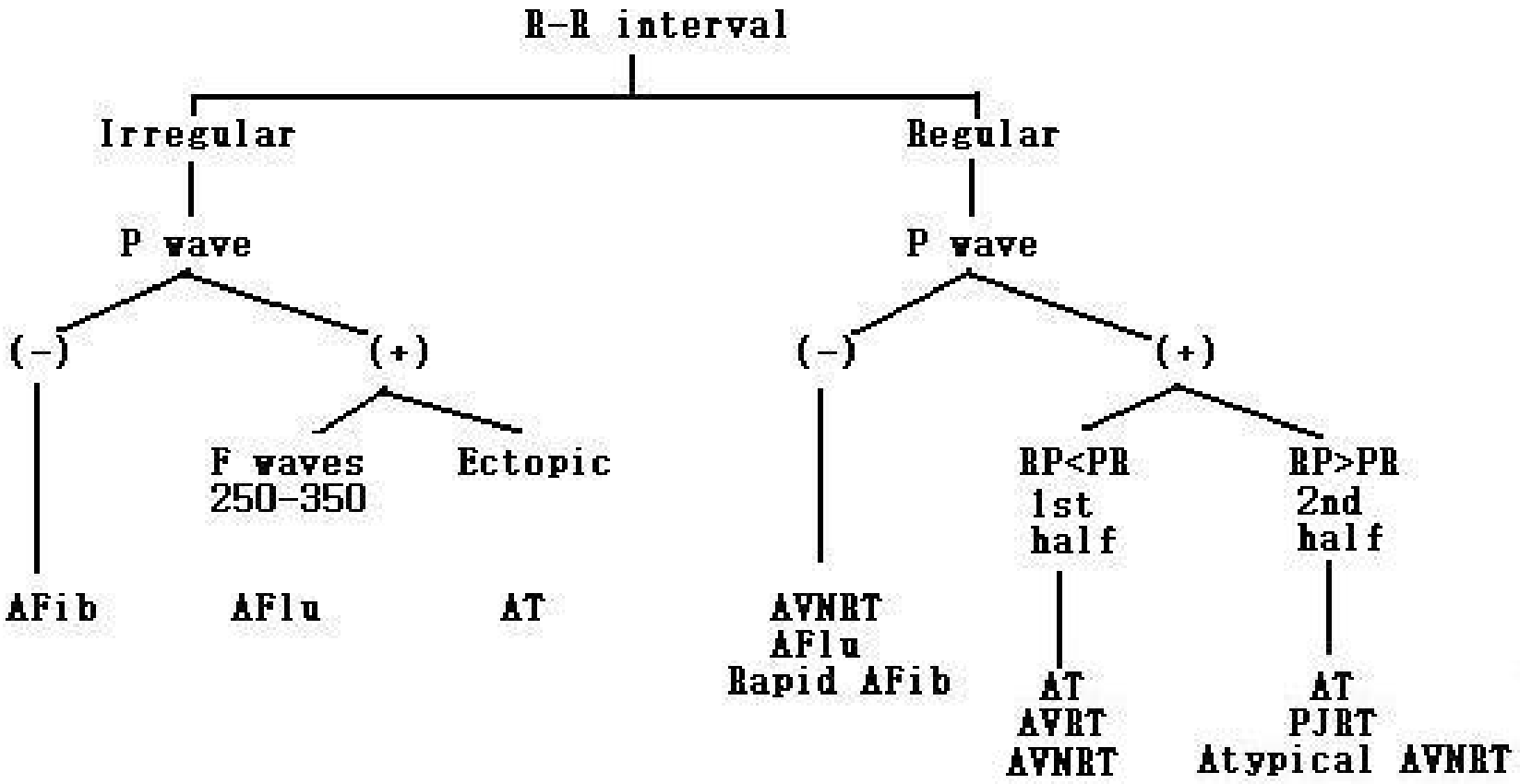
ECG

1. Onset
2. Position of P wave in R-R interval during SVT
3. P wave morphology
4. Pseudo R' in V1
5. QRS alternans
6. Cycle length variation
7. Effects of bundle branch block(BBB)
8. Ventricular preexcitation

Onset

- AVNRT
  - APB with marked ↑P-R
- Triggered/reentrant AT
  - APB without marked ↑P-R
- Automatic AT
  - gradual acceleration
- AVRT
  - by APB/VPB

Position of P wave in R-R



P wave Morphology

1. (+) in aVL, (−) in V1: right AT
   (−) in aVL, (+) in V1: left AT
2. (−) in inferior leads: inferior AT
   (+) in inferior leads: superior AT
3. (−) in aVR: along crista terminalis
4. MAT: varying
5. SART: similar to sinus P

Psedo R’ in V1

- more frequen in AVNRT than in AVRT/AT

QRS Alternans

- usually AVRT
- depends on Abrupt onset & more common in Rapid tachycardia
  - 27~38% in orthodromic AVRT
  - 13~23% in AVNRT
  - much less in AT

Rate & Cycle Length Alternans

- Rate
  - marked overlap
- Cycle length variation
  - relatively uncommon in Reentry
  - orthodromic AVRT+Dual AVN pathway

Effect of BBB

- BBB ipsilateral to accessory pathway
  - ↑cycle length(circuit)
  - ↓heart rate

Preexcited Tachycardias

- Antidromic AVRT
  - 1:1 VA conduction
- A Fib/AT conducting over AP
  - irregular rate
  - R-R shorter than 220~250 ms
- Tachycardia by Mahaim fiber
  - QRS≤150 ms
  - LBBB+LAD(QRS axis 0°~-75°)
  - Transition in V4-6

Patterns of Ventricular Preexcitation(1)

- Left: Rs, (+)δ wave in V1

1. Posterior: QS, (−)δ wave in inferior leads
2. More anterior-laterally:

- QS, (−)δ wave in aVL,
- (+)δ wave in inferior leads

Patterns of Ventricular Preexcitation(2)

- Posterior septum:
  - (−)δ wave in inferior leads
  - R/S abrupt transition in V1(rS), V2(Rs)
  - Subepicardial: (−)δ wave in II in the first 20 ms
- Middle to anterior septum
  - (+)δ wave in inferior leads, (−)δ wave in V1
  - Anteroseptal: Rs in III
  - Midseptal: R/S in III=1

Patterns of Ventricular Preexcitation(3)

- Right: rS in V1, delayed δ wave progression

1. Posterior: (−)δ wave in inferior leads
2. More anterior: (+)δ wave in inferior leads

Irregular R-R interval

- A Fib
- A Flu
- AT

Right Atrial Flutter

ECG Lead	Clockwise	Counterclockwise
II, III, aVF	(+/–)	(–)
I	(+)	Biphasic/isoelectric
aVL	biphasic/isoelectric	(+)
V1	(–/biphasic)	(+)
V6	(+)	(–)

Atrial Tachycardia

- 130~240 bpm

1. Enhanced automaticity

- warming up & cooling down, incessant

2. Triggered activity

3. Intra-atrial microreentry

4. Macroreentry: after surgery

- 130~170/m, longer P-R

Regular R-R interval

- P wave: presence, morphology, position

1. Site of origin
2. Mechanism

No P wave

- Typical AVNRT: RSR’ in V1
- D/D

1. A Flu with 2:1 AV conduction(150/min)
2. Rapid A Fib

P wave in 1st half of R-R

- Orthodromic AVRT

– P(–) in I,(+) in V1: left-sided AP

– Ipsilateral BBB: longer cycle length

– QRS alternans

- D/D

1. AVNRT
2. AT
3. A Fib/A Flu with 1:1 AV conduction

P wave in 2nd half of R-R interval

- Permanent Junctional Reciprocating Tachycardia(PJRT)

- Incessant, often irregular R-R
- Antegrade AV nodal conduction
- Retrograde decremental AP conduction

P wave in 2nd half of R-R interval

- D/D

1. Atypical AVNRT
2. AT: different P

- Ectopic : inferior atrium near CS ostium
- IART

3. SART: similar to sinus P
4. Sinus tachycardia: same P

- Appropriate
- Inappropriate: exaggerated acceleration of rate

Regular wide QRS tachycardia

- Aberrant conduction
- Fixed BBB
- Accessory pathway(AP)

Preexcited QRS tachycardia

- A Fib with AP
- A Flu with AP: 250~300/min
- Tachycardia with Mahaim fiber

– LBBB+LAD

- Antidromic AVRT
- Tachycardia using 2 APs
- AVNRT with bystander AP

Conventional Contact Catheter Mapping

- Preprocedural ECG
- Diagnostic procedure
- Operator experience
- Coordination with imaging

Diagnostic procedure

- Quadripolar electrode catheters

1. high RA(HRA)
2. His bundle
3. RV apex(RVA)
4. coronary sinus

- Basic intervals in sinus rhythm
- Programmed stimulation at RVA & HRA

1. Eight-beat drive train at two cycle lengths
2. Extrastimulus decremented by 10~20 ms

- Decremental pacing

Fluoroscopic Views

- Frontal

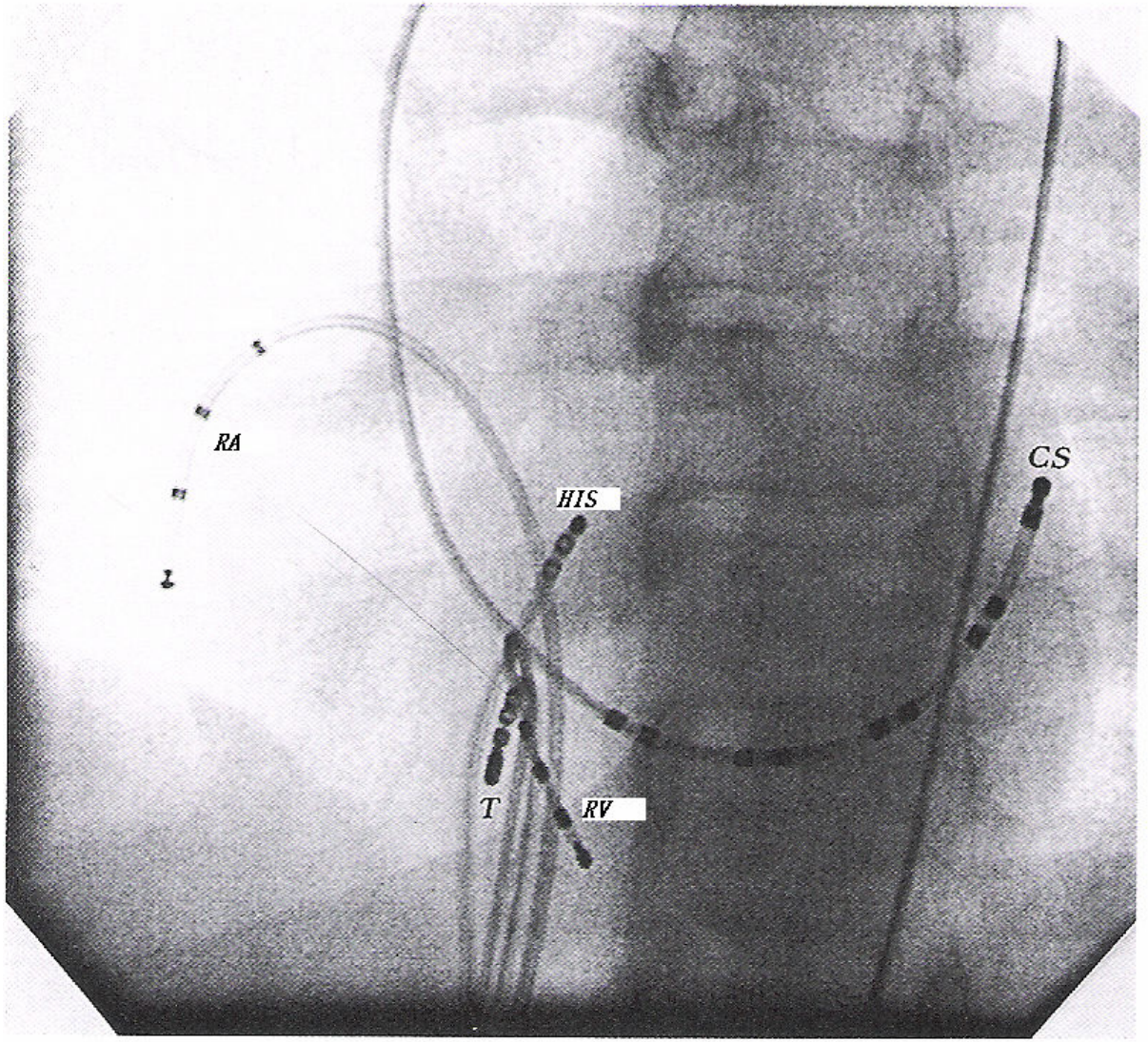
1. Advancing to heart
2. RVOT

- RAO

1. Valves: mitral, tricuspid, aortic
2. His bundle

- LAO

1. Valve annuli: mitral, tricuspid
2. Septum
3. LV: septal, lateral, basal
4. Coronary sinus


RA
HIS
CS
T
RV

Catheter Mapping

- Recording
- Analysis

1. Determine activation timing
2. Create a mental map of activation sequence

- Electrophysiological & Anatomic targets

Conventional Mapping Methods

- Main methods

1. Activation sequence mapping
2. Pace mapping
3. Entrainment mapping

Activation Sequence Mapping

- During tachycardia

1. Electrogram from roving catheter
2. Comparing with reference signal

- Earliest signal/progression of activation around macroreentrant circuit

Activation Sequence Mapping

- Focal tachycardias in normal structure

1. Focal AT
2. Focally initiated A Fib

- For reentrant circuits

– complemented by pace mapping

Pace Mapping

- Focal tachycardia
- Pace match: cardiac activation sequence/surface ECG of arrhythmia

– reproduced by pacing at its focal origin, at similar cycle length

Entrainment Mapping

- Macro-reentrant tachycardia
- Merely confirms reentrant mechanism

1. Stimuli from sites within/outside circuit

– reset tachycardia

2. A train of stimuli fall within excitable gap

– continuously reset(entrain) tachycardia

Entrainment Mapping

- Criteria for confirming pacing within circuit

1. Concealed entrainment
2. Identical interval between pacing site & fixed reference point during pacing & tachycardia
3. Post-pacing interval after entrainment

– return cycle generated by last pacing stimulus is equal within 30 ms to TCL

AVNRT

- Concept of Dual AVN Pathway

- Discontinuity in AVN function curve

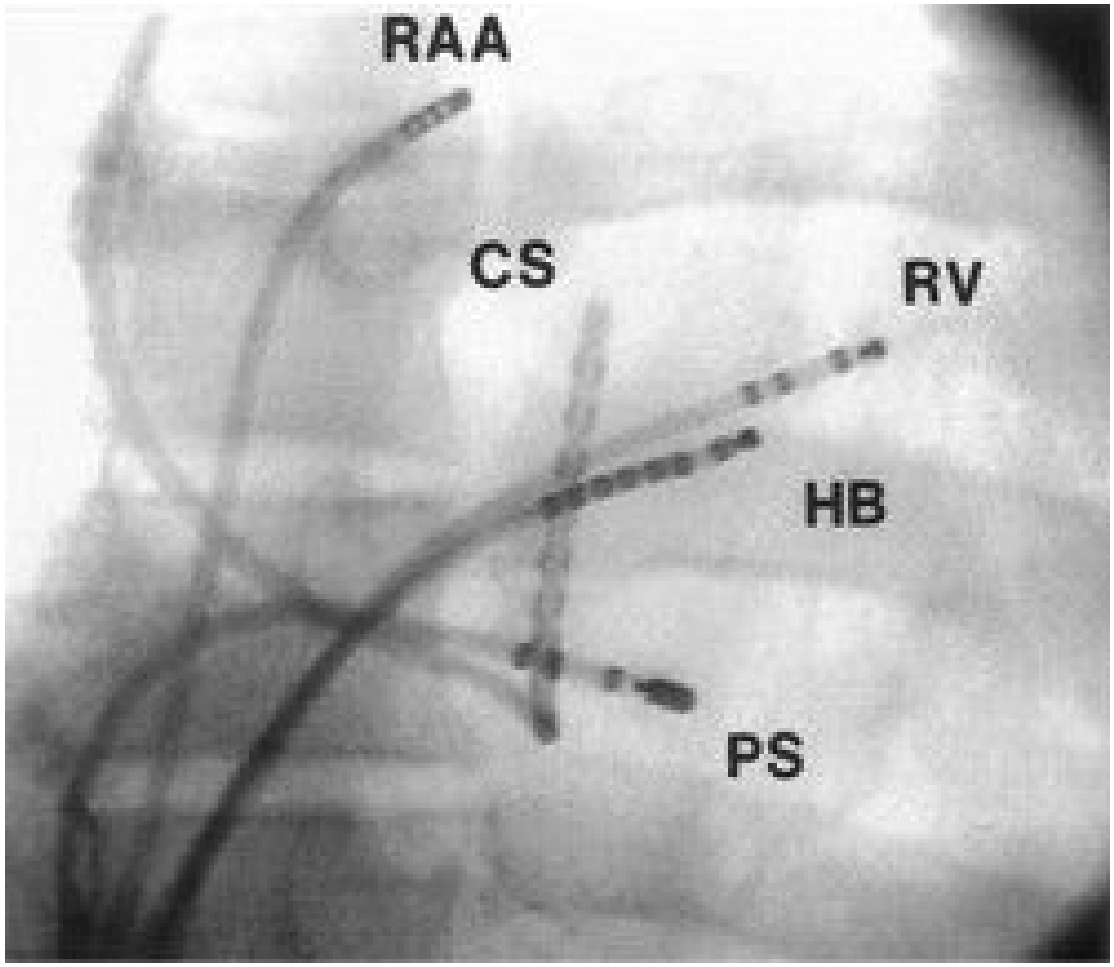
- Unusual Physiology of Dual AVN pathways

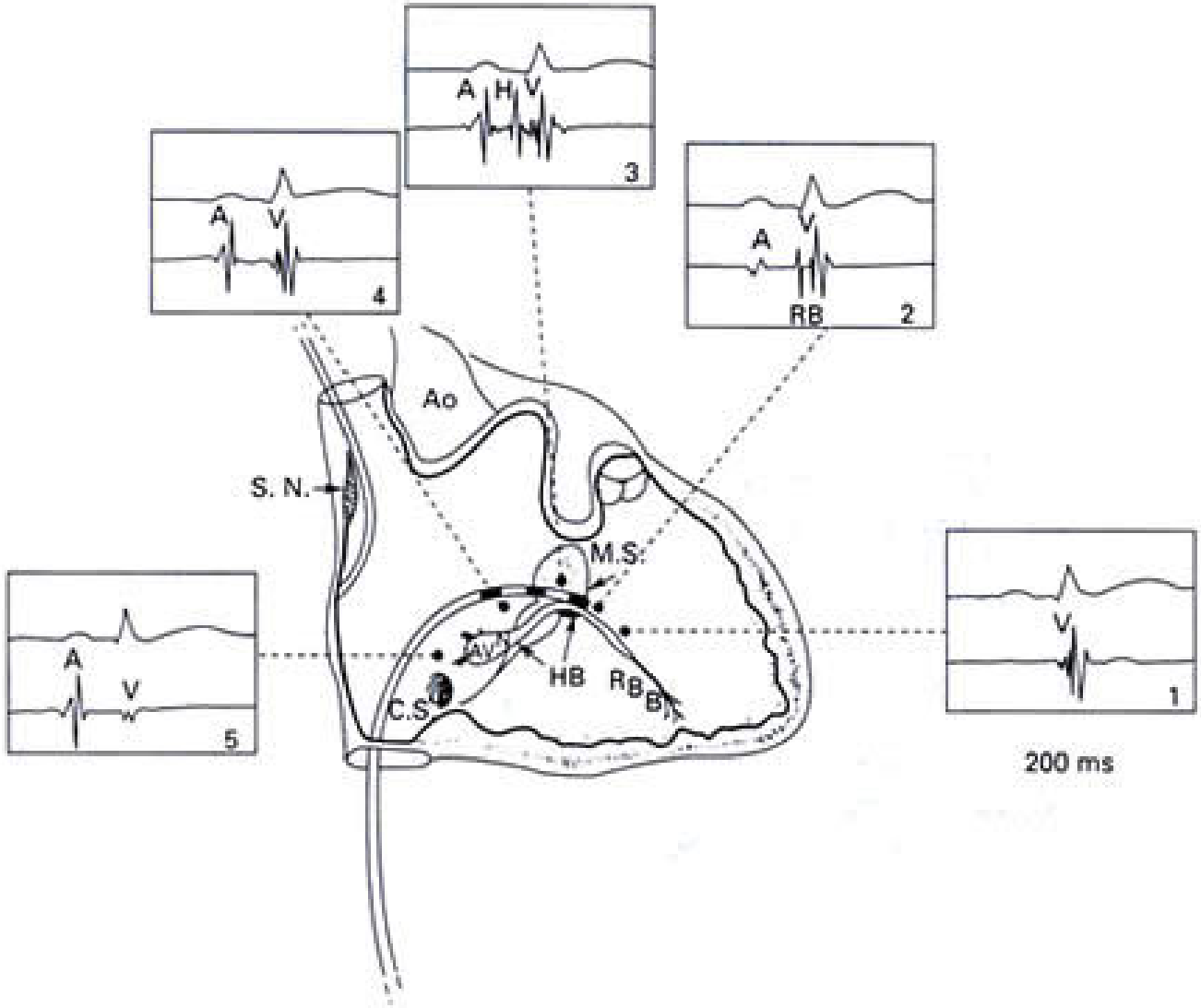
- Multiple antegrade & retrograde AVN pathway

1. Slow-slow
2. Slow-intermediate
3. Fast-intermediate

Mapping of AVNRT

- Dual AVN physiology
- >50 ms ↑ in A-H after 10~20 ms shortening in A1-A2
- Typical: long A-H & short H-A'
- Atypical: short A-H & long H-A'(long RP)


RAA
CS
RV
HB
PS


A
H
V
3
A
V
4
A
RB
2
Ao
S. N.
M.S.
A
V
5
AVJ
HB
RBB
C.S.
V
1
200 ms

Mapping of AVNRT

- Anatomic approach

1. AP: floor of coronary sinus os
2. LAO: inferior tricuspid annulus(6-o'clock) to 4-o'clock

Mapping of AVNRT

- Based on electrogram

1. RAO: inferior tricuspid annulus near coronary sinus os
2. Slow pathway potential

1) single or multiple
2) usually high frequency
3) follow or fuse with local atrial electrogram
4) Usually posterior or midseptum, usually anterior to coronary sinus os

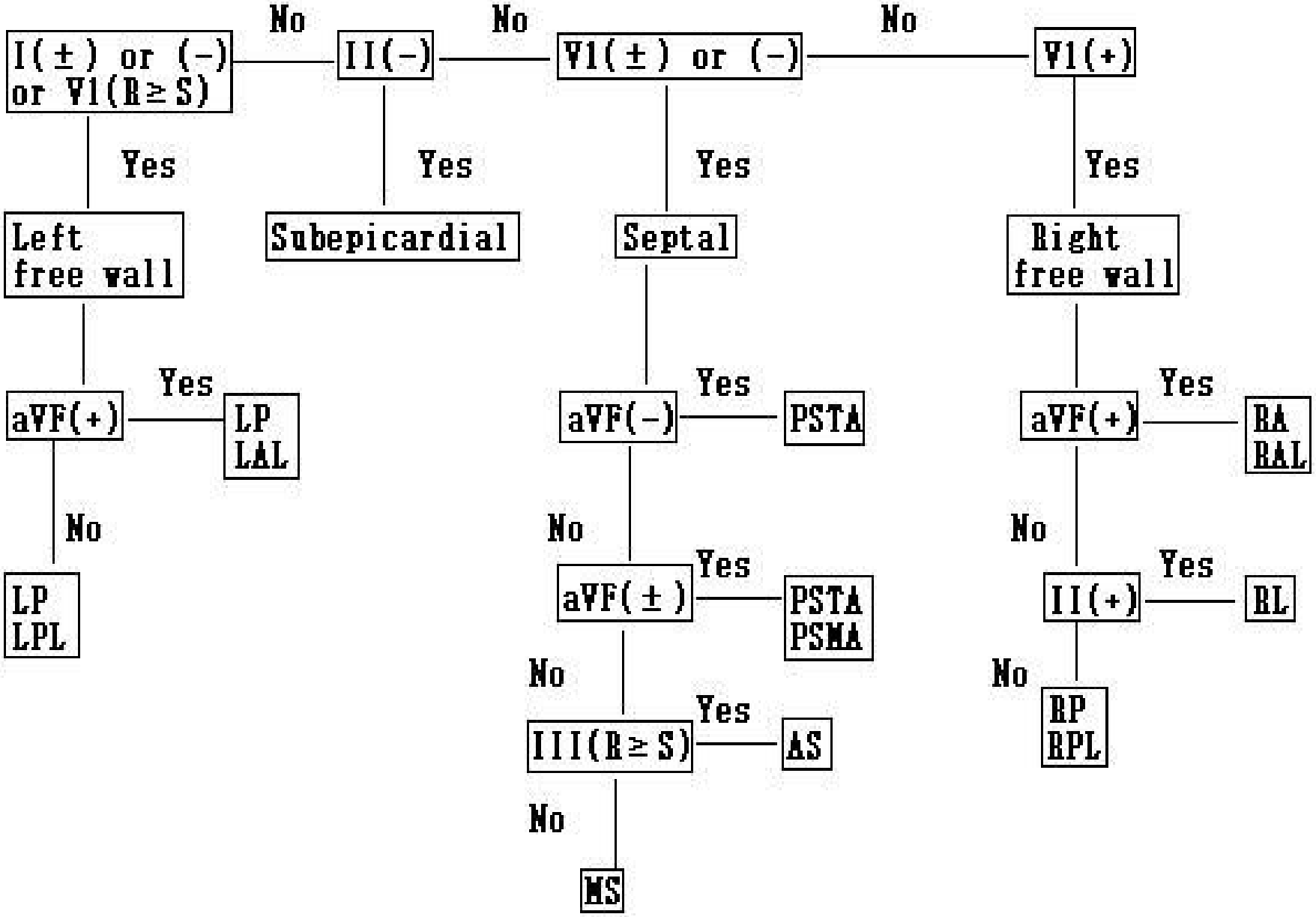
- Combined approach

WPW Syndrome & Concealed Accessory Pathways

- ECG algorithms
- Pre-excitation maximized by rapid atrial pacing

1. Planning for procedure
2. Guide mapping
3. Identify target area for ablation

ECG algorithms



Anatomy & Electrophysiolgy of AP

- Anatomic & functional dissociation of AP

– Atrial & ventricular insertion

– Antegrade & retrograde component

- Conduction properties

1) Fast(90%)

2) Decremental(10%)

– Right free wall, posteroseptal

– Mahaim: atriofascicular/nodoventricular, close to RBB

– Sensitive to verapamil, adenosine

AVRT

- Antidromic AVRT
- Multiple AP: 5~20%
- Mahaim tachycardia(LBBB+LAD)
  - VA dissociation: nodofascicular
- AVNRT with innocent bystander AP

AT

- Dx criteria

1. Atrial activation sequence different from that during sinus rhythm or ventricular pacing
2. Changing P-R & R-P interval related to changing of tachycardia rate
3. AV block without affecting tachycardia

Mapping of Focal AT

- Atrium

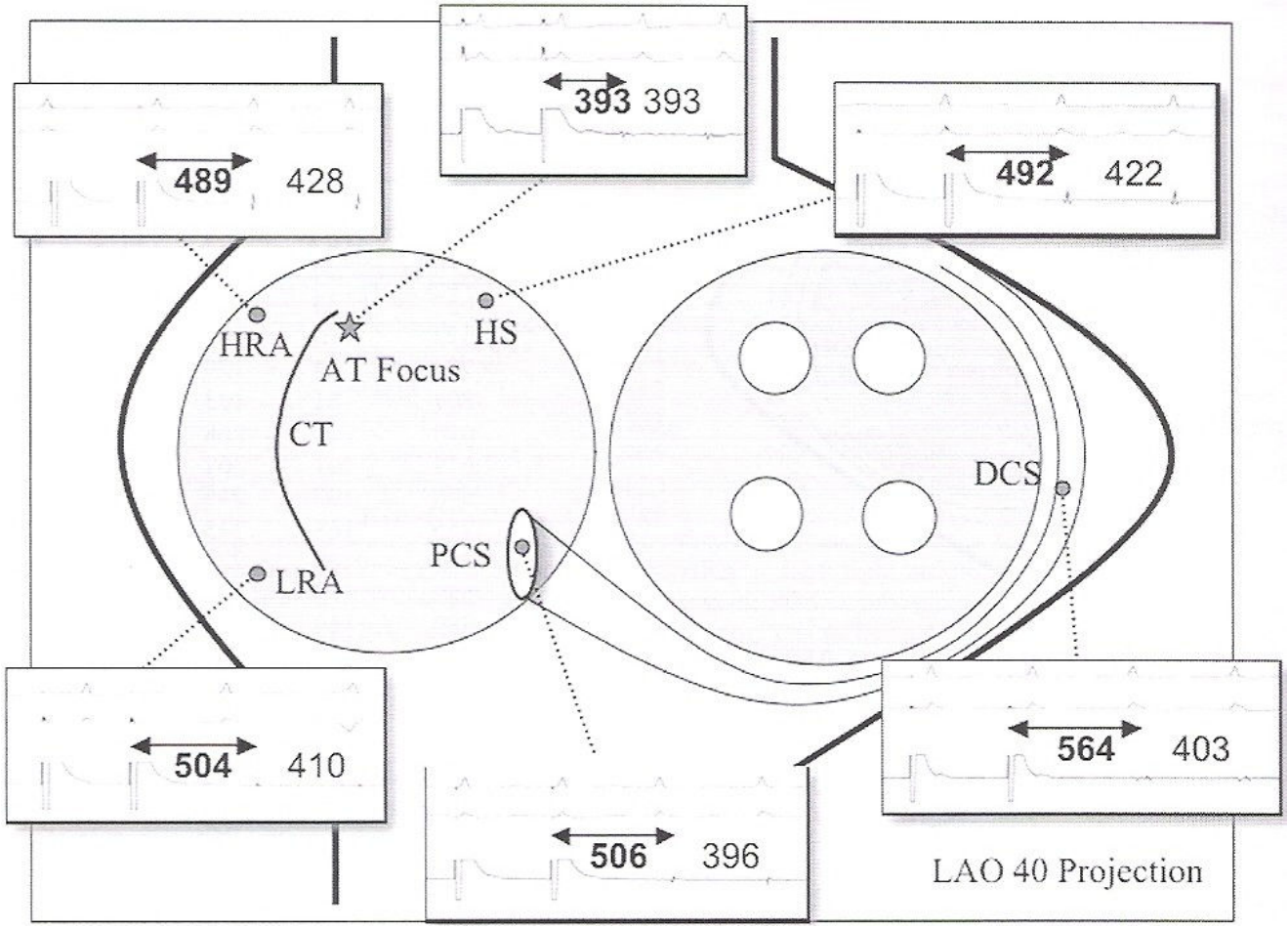
1. Crista terminalis
2. Atrial septum
3. Koch's triangle
4. Atrial appendage
5. AV annulus

- Thoracic veins with atrial connection

1. SVC
2. IVC
3. CS
4. PV

Mapping of focal AT

- Sequential point-by-point during stable tachycardia: earliest activation relative to P wave or reference atrial electrogram
- Simultaneous mapping: electrogram timing & color maps
- Global activation using a single beat of tachycardia
- Noncontact system: nonsustained & hemodynamically unstable


393 393
489 428
492 422
HRA
AT Focus
HS
CT
DCS
PCS
LRA
504 410
564 403
506 396
LAO 40 Projection

Mapping of macroreentrant AT

- Myopathy/scar after surgery
- on 3-D mapping
- Single/figure-of-eight reentrant circuit

1. Normal tissue
2. Scar tissue

- low voltage
- slow conduction zone(SCZ)

- Pacing at/close to exit site of SCZ

- concealed entrainment with identical sequence
- short post-pacing interval

A Flutter

- Typical: isthmus-dependent
  - Clockwise & counterclockwise
- Anatomic approach: low RA, double potentials, with confirmatory entrainment
  - Simultaneous mapping: atrium(crista terminalis) & cavotricuspid isthmus

A Flutter

- Atypical: isthmus-independent

1. Low RA free wall
2. High RA: SVC-setum
3. Two or four PV orifices, mitral annulus isthmus, fossa ovalis

- Method

1. Simultaneous recording from multiple electrode catheters, entrainment
2. 3-D mapping