Supraventricular Tachycardia (SVT)

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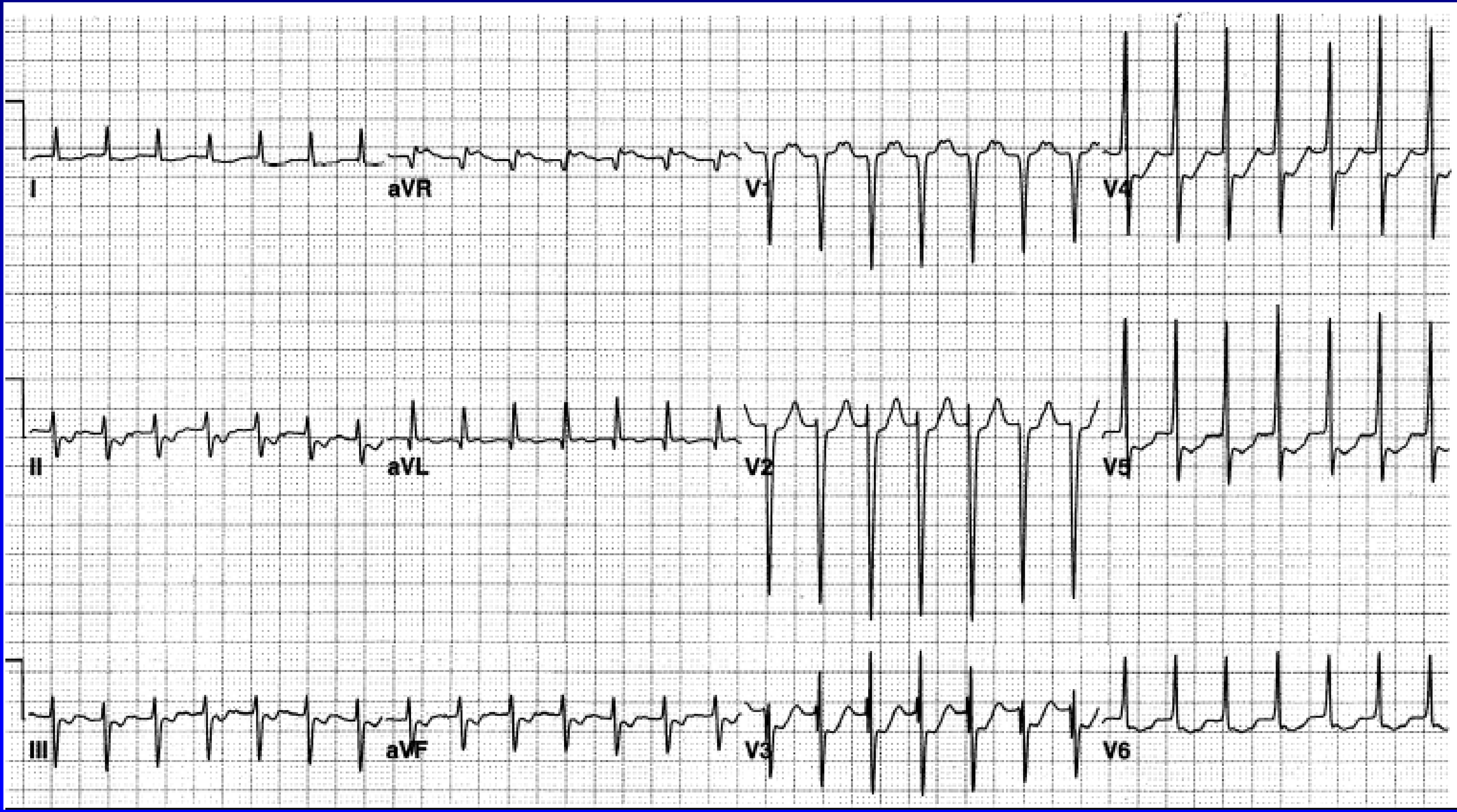
Supraventricular Tachycardia
Objectives

- Types and mechanisms
  - AV nodal reentrant tachycardia (AVNRT)
  - AV reciprocating tachycardia (AVRT)
- Treatment options
  - Acute
    - New investigational nasal spray (etripamil)
  - Chronic
    - Catheter ablation

Paroxysmal supraventricular tachycardia (PSVT)

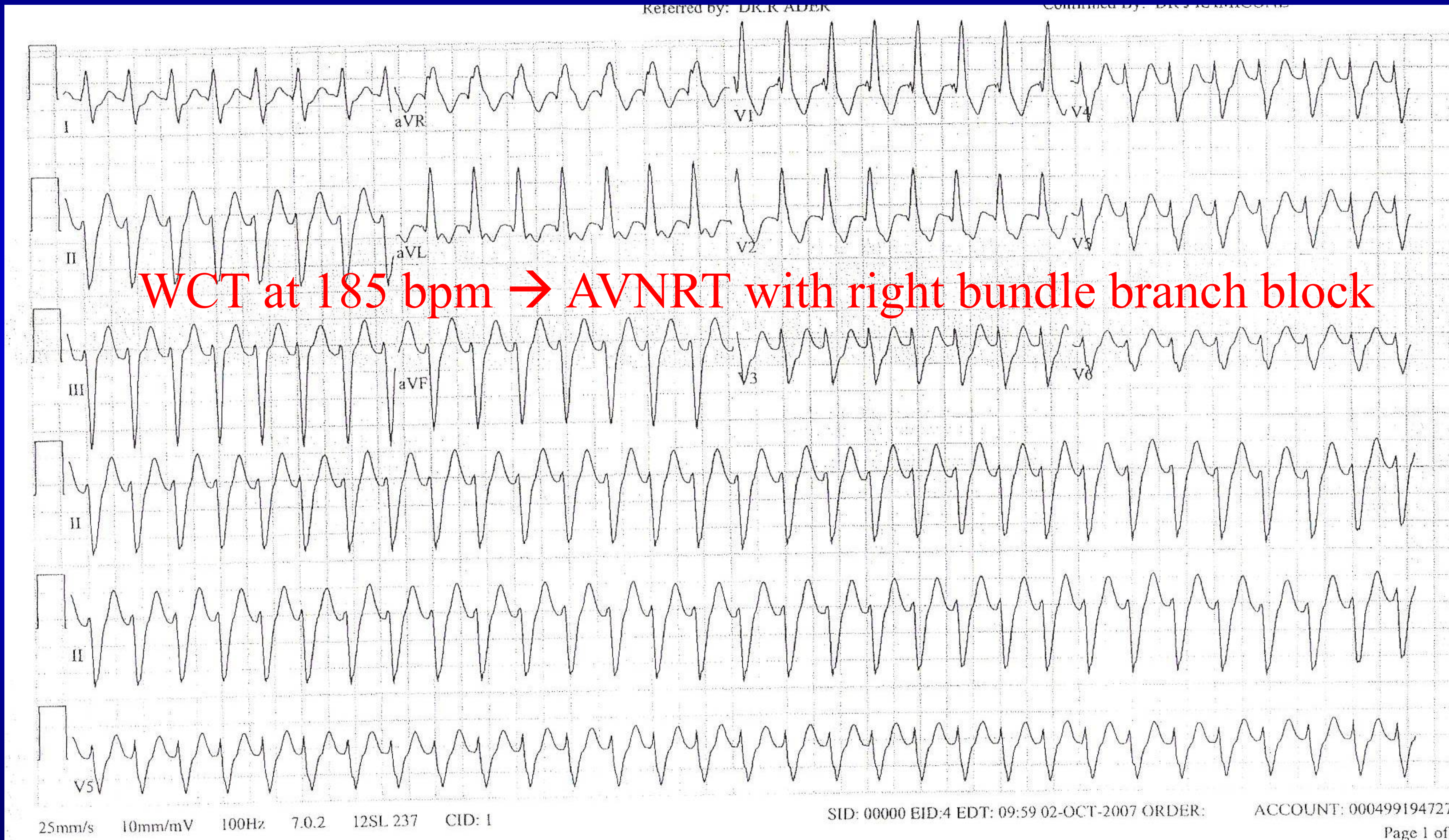


Supraventricular Tachycardia (SVT) Terminology

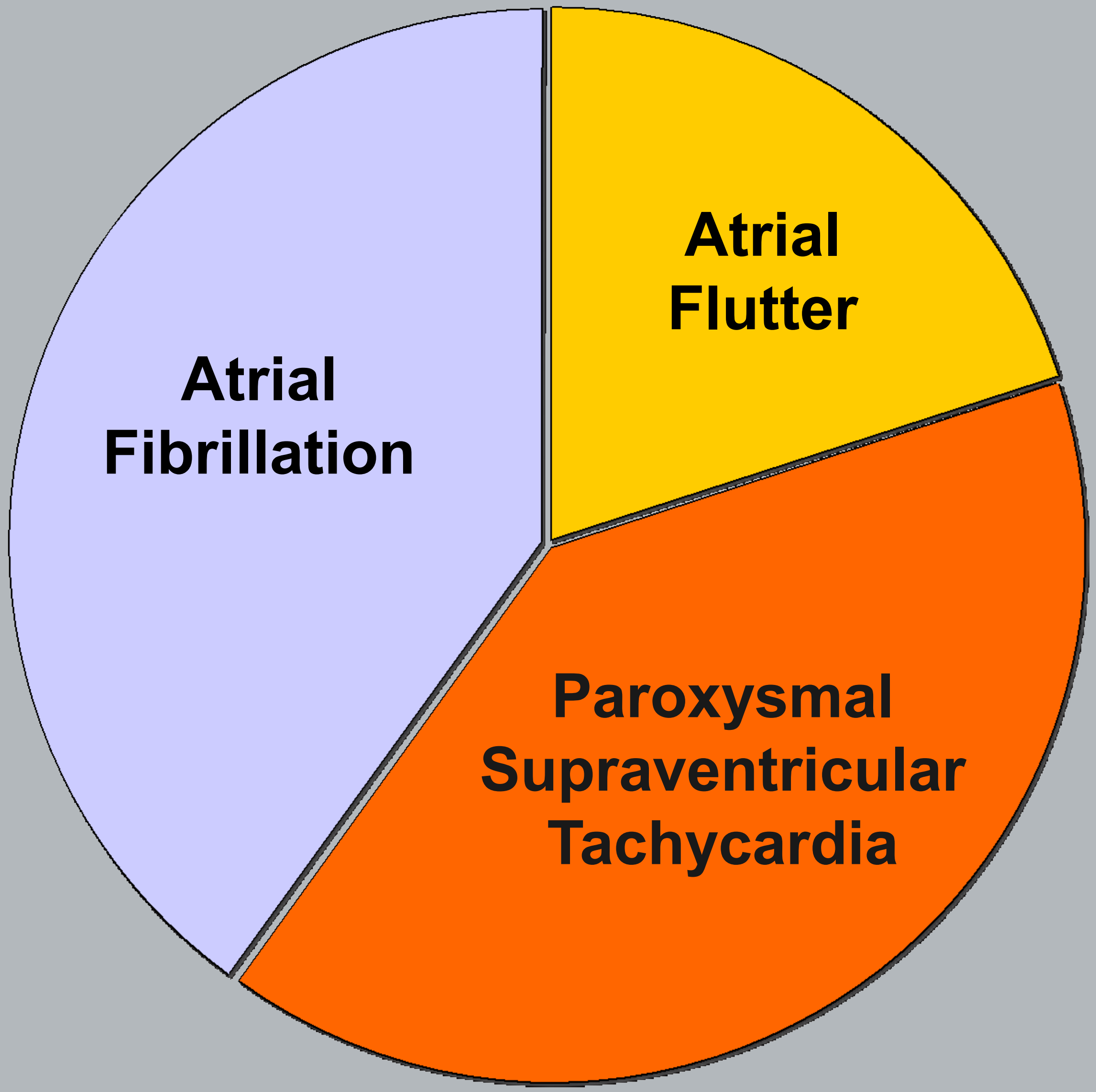
- *Supraventricular* - a rhythm process in which the ventricles are activated from the atria or AV node/His bundle region
- Usually *paroxysmal*, i.e, starts and stops abruptly; in which case, called **PSVT**
- QRS typically *narrow*; thus, also termed **narrow complex tachycardia**

Supraventricular Tachycardia

Not all SVTs have a narrow QRS complex



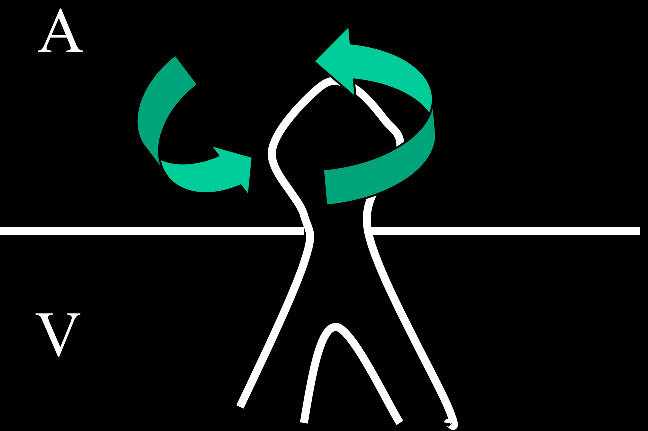
Supraventricular Tachyarrhythmias



Primary Mechanisms of PSVT

AVNRT

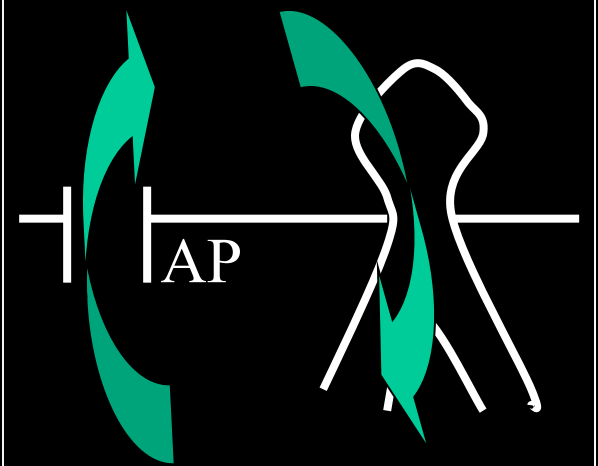
70%



Atrioventricular Nodal Reentrant Tachycardia

AVRT

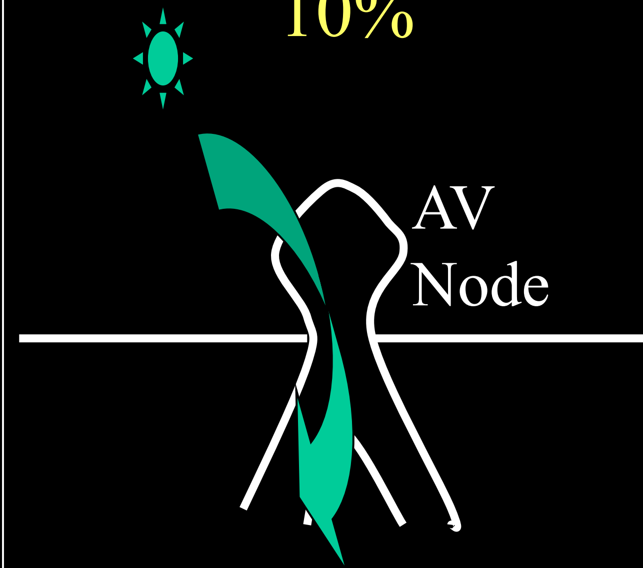
20%



Atrioventricular Reciprocating Tachycardia

AT

10%



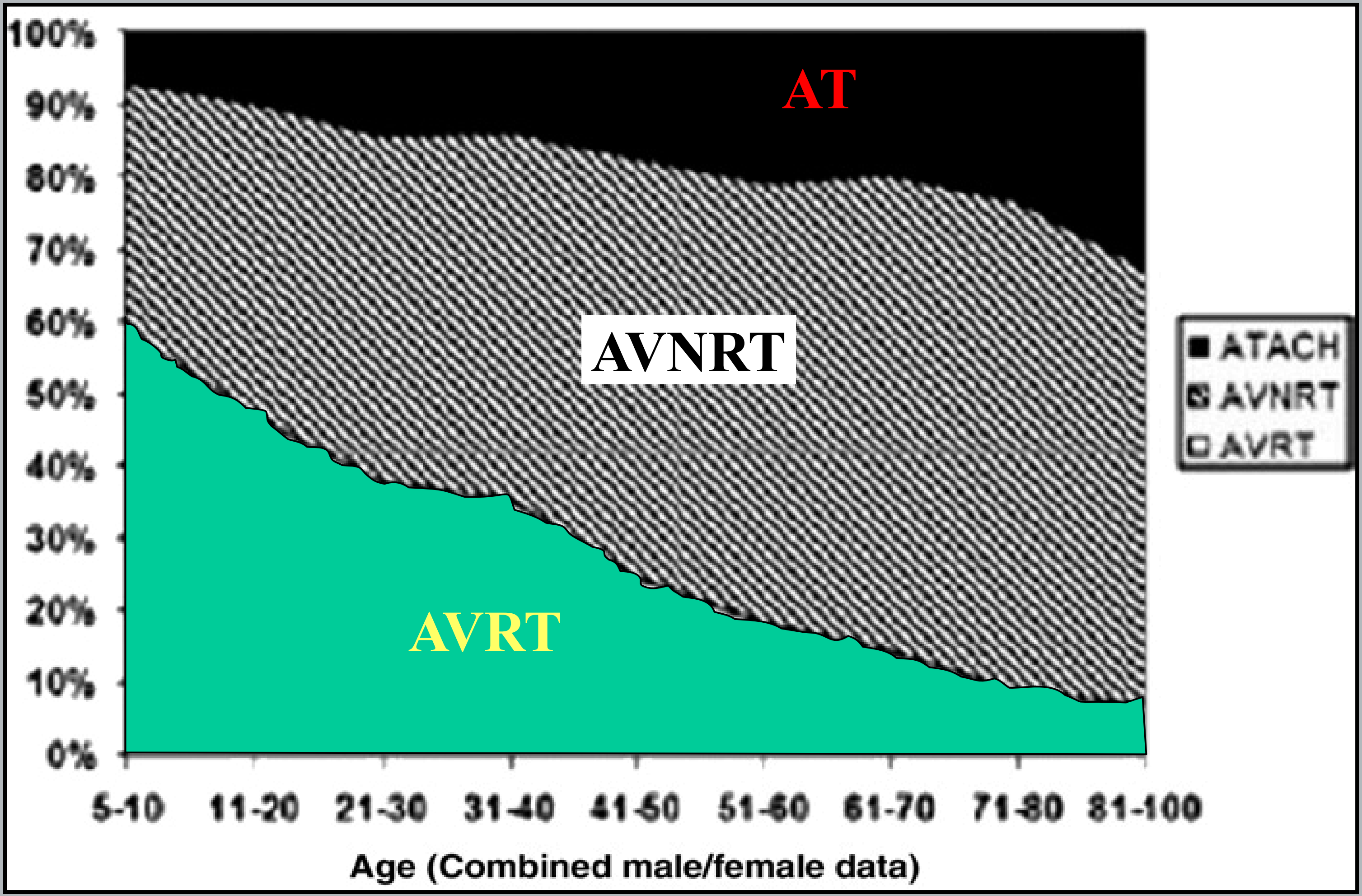
Atrial Tachycardia

Paroxysmal supraventricular tachycardia (PSVT)

- In the U.S., there are:
  - 600,000 persons with PSVT.
  - 90,000 new cases per year
  - 50,000 emergency department visits per year

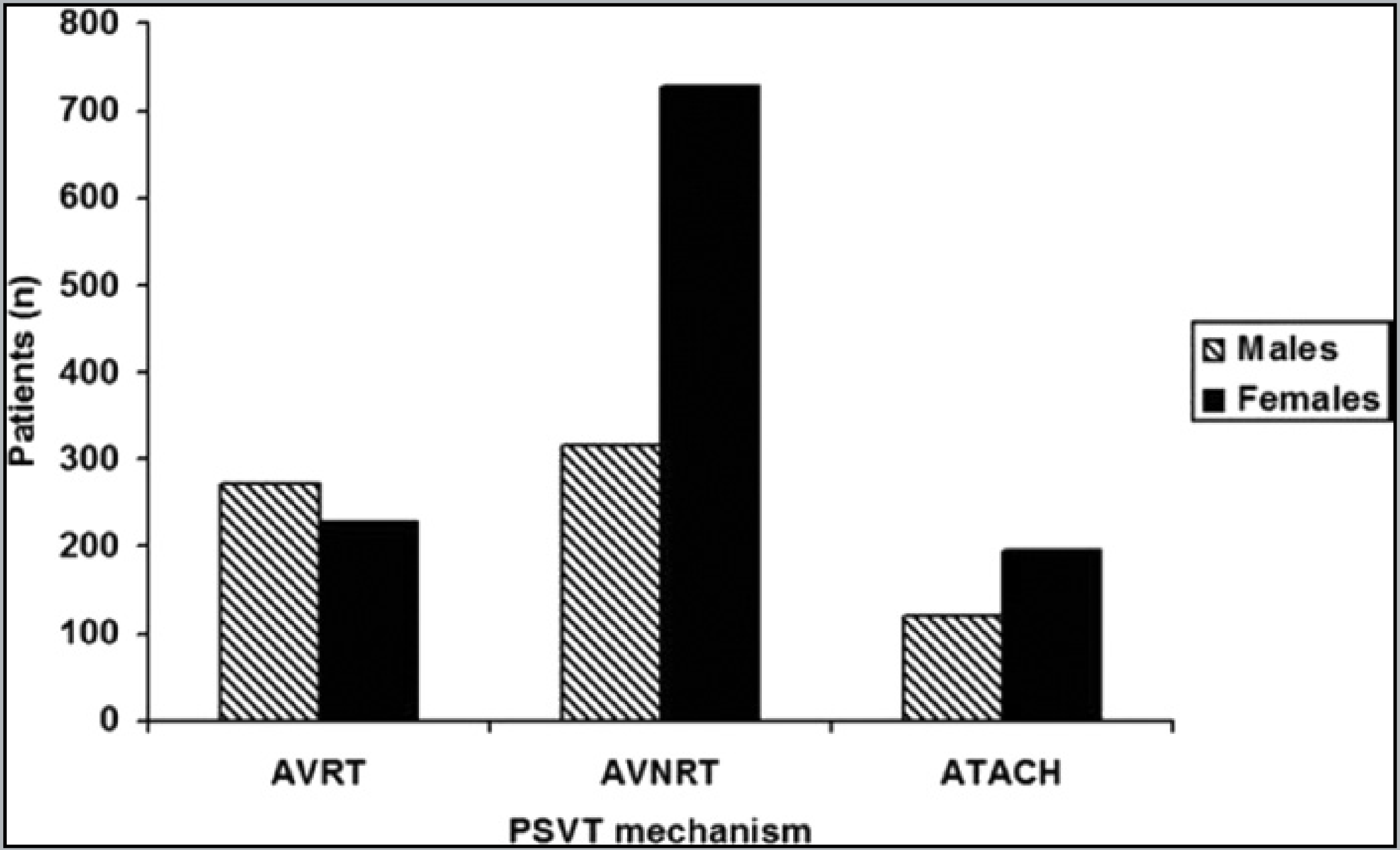
- Orejarena LA, et al. Paroxysmal supraventricular tachycardia in the general population. J Am Coll Cardiol 1998;31:150–7.
- Murman DH, et al. U.S. emergency department visits for supraventricular tachycardia, 1993-2003. Acad Emerg Med 2007;14: 578–81.

Influence of Age on SVT Mechanism

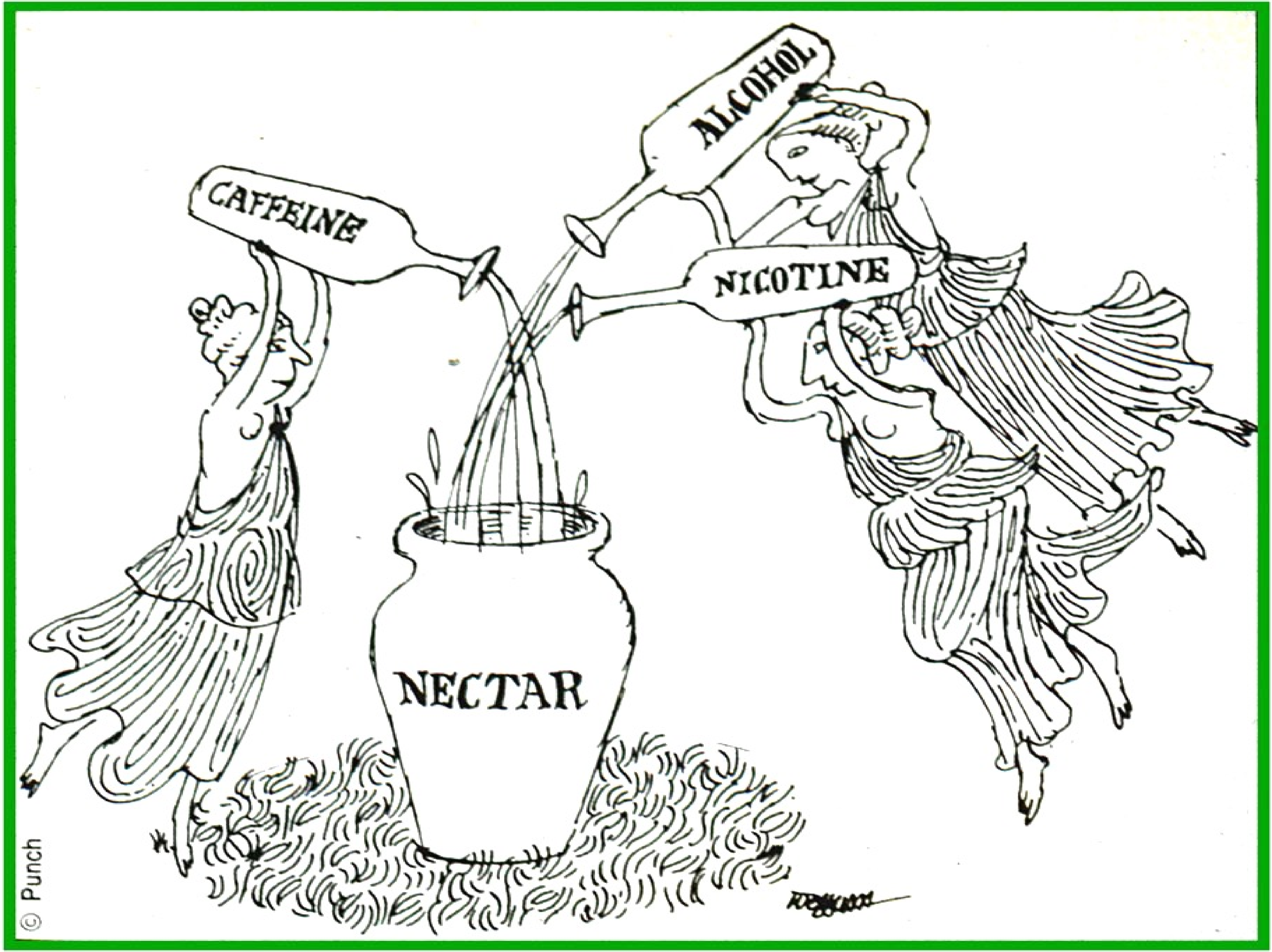


Porter MJ, et al. Heart Rhythm 2004;1:393

Influence of Gender on SVT Mechanism



Porter MJ, et al. Heart Rhythm 2004;1:393



© Punch

Prospective Placebo Controlled Randomized Study of Caffeine in Patients with SVT Undergoing Electrophysiologic Testing

- Moderate caffeine intake associated with:
  - significant increases in systolic and diastolic BPs
  - no effect on heart rate, cardiac conduction or refractoriness
  - no effect on induction of SVT or more rapid rates of induced tachycardias.

- Moderate caffeine intake should not be:
  - considered to cause cardiac arrhythmias.
  - restricted in patients with a history of arrhythmias.

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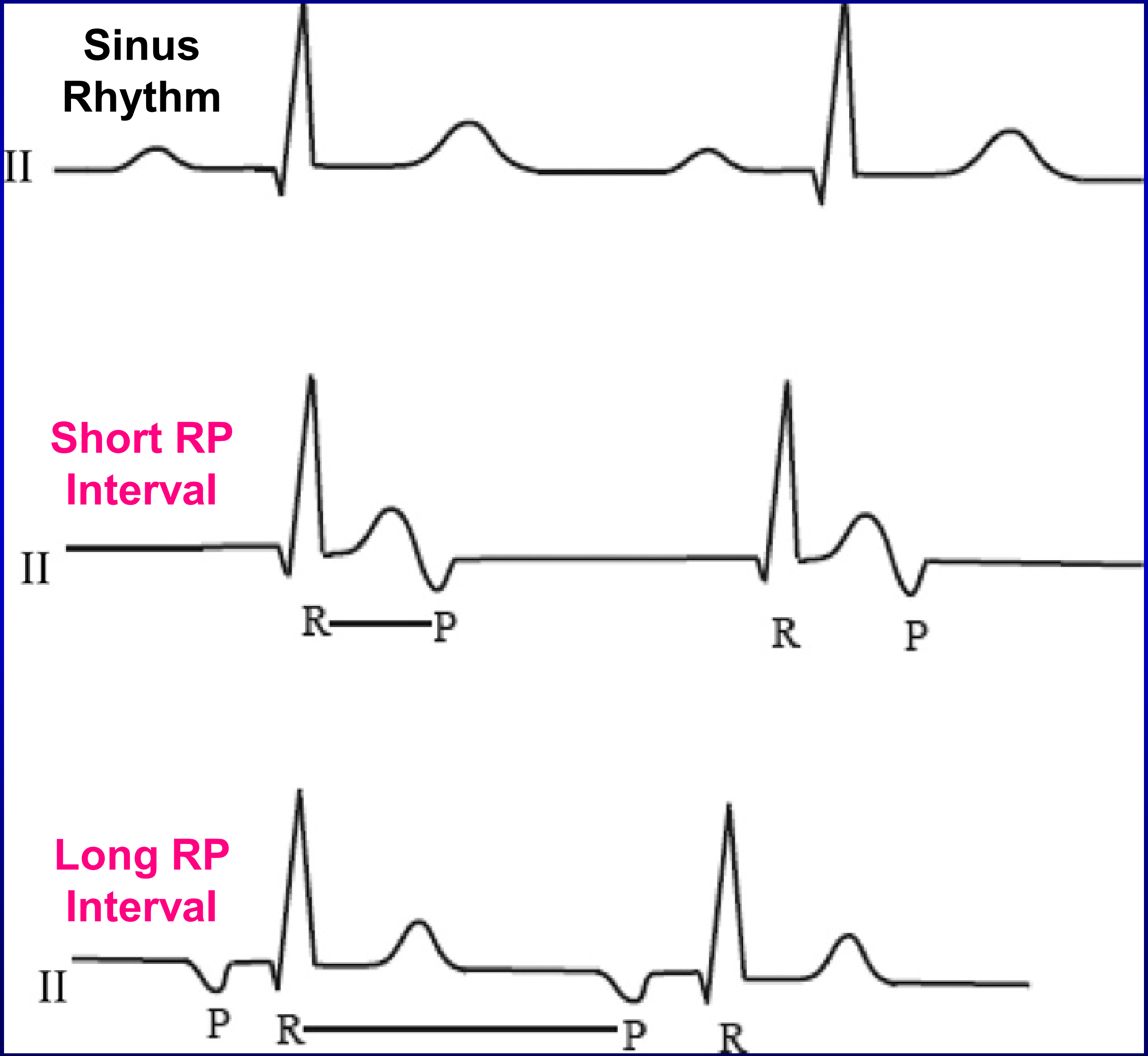
Supraventricular Tachycardia
Diagnosis

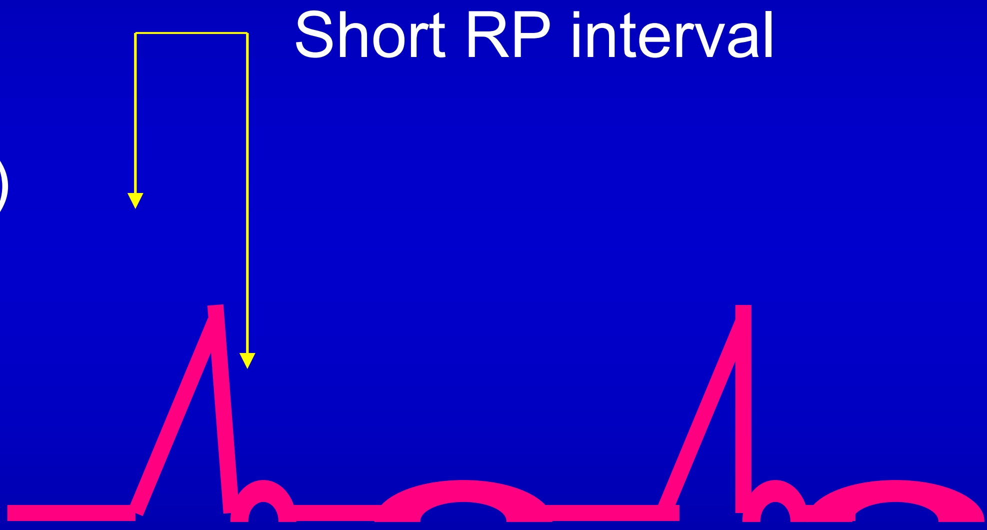
- ECG is cornerstone
- Tachycardia rate
- Wide vs. narrow QRS
- Relationship of P wave and QRS complex
- Morphology of P wave
- Zones of transition for clues to mechanism:
  - onset
  - termination
  - slowing, AV nodal block
  - bundle branch block

Differential Dx of Regular SVT



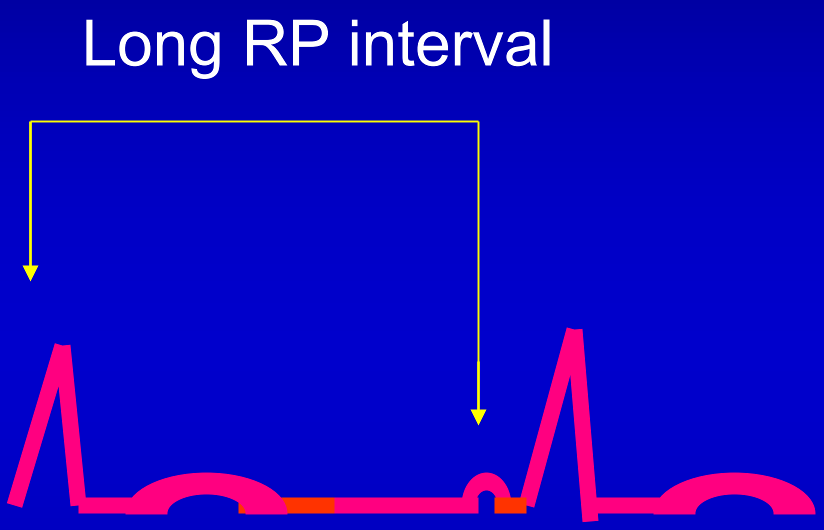
Differential Dx of Regular SVT

- Short RP tachycardia
  - AV nodal reentrant tachycardia (AVNRT)
  - AV reciprocating (AVRT) [ORT (Orthodromic reciprocating tachycardia)]
  - Atrial tachycardia with slow AV nodal conduction



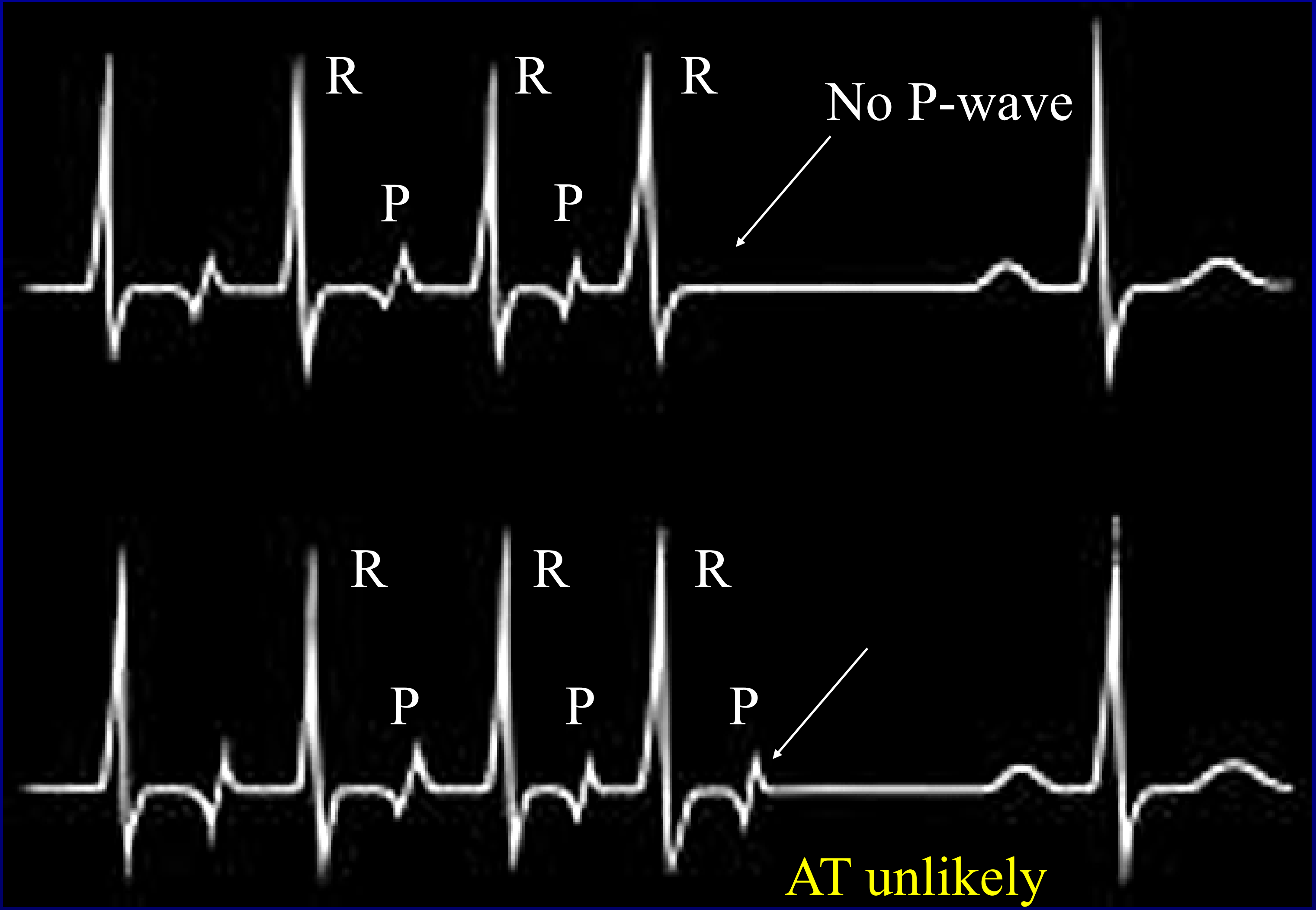
Differential Dx of Regular SVT

- Long RP tachycardia
  - Atrial tachycardia
  - Sinus tachycardia
  - Sinus node reentry
  - Atypical AV nodal reentrant tachycardia
  - Permanent form of junctional reciprocating tachycardia



Supraventricular Tachycardia

Mode of Tachycardia Termination

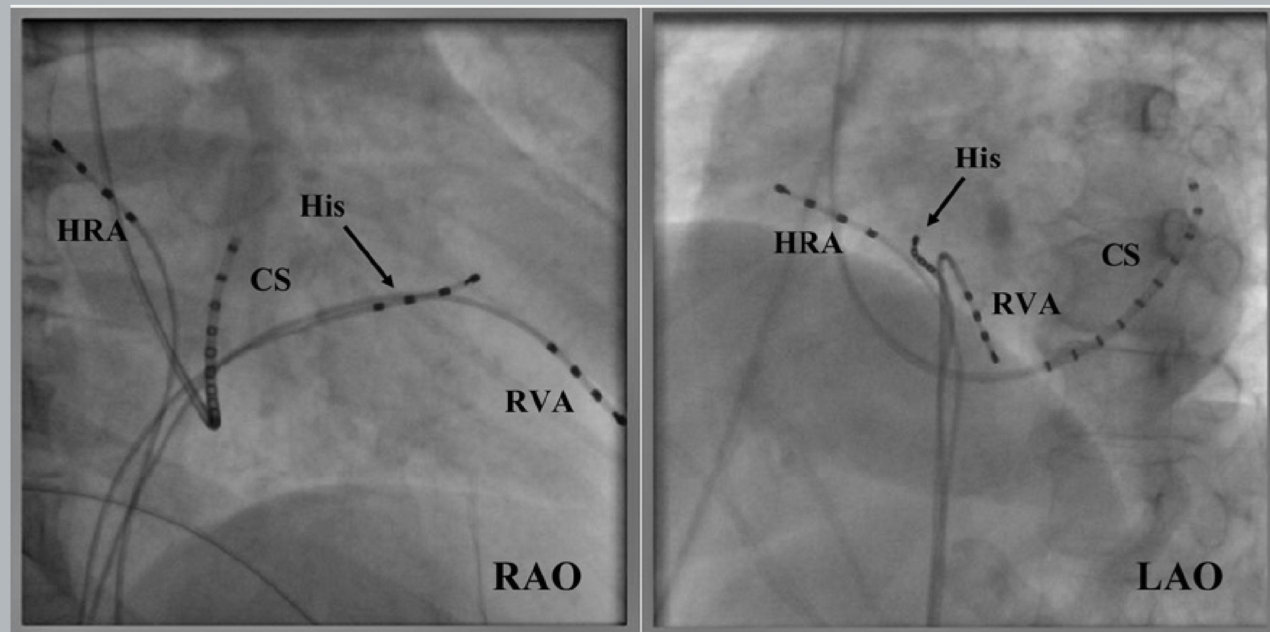


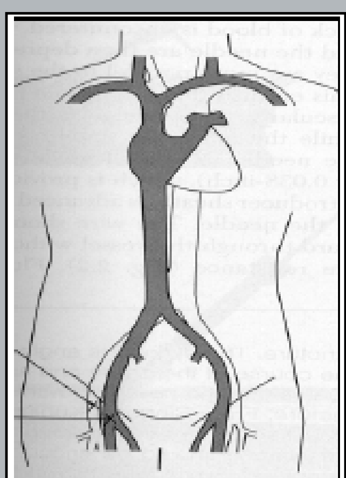
Intracardiac Electrophysiology

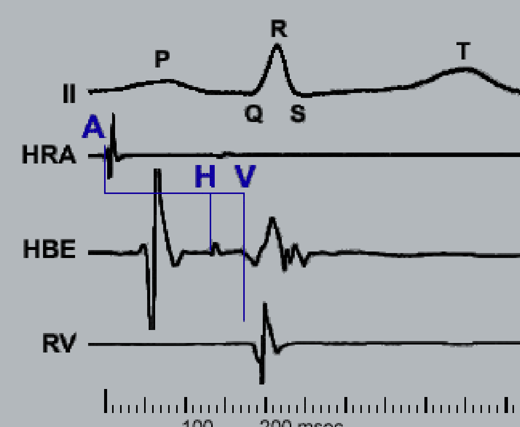
Electrode catheters:

- High right atrium (HRA)
- His bundle (His)
- Right ventricle (RV)
- Coronary sinus (CS)

Ablation catheter



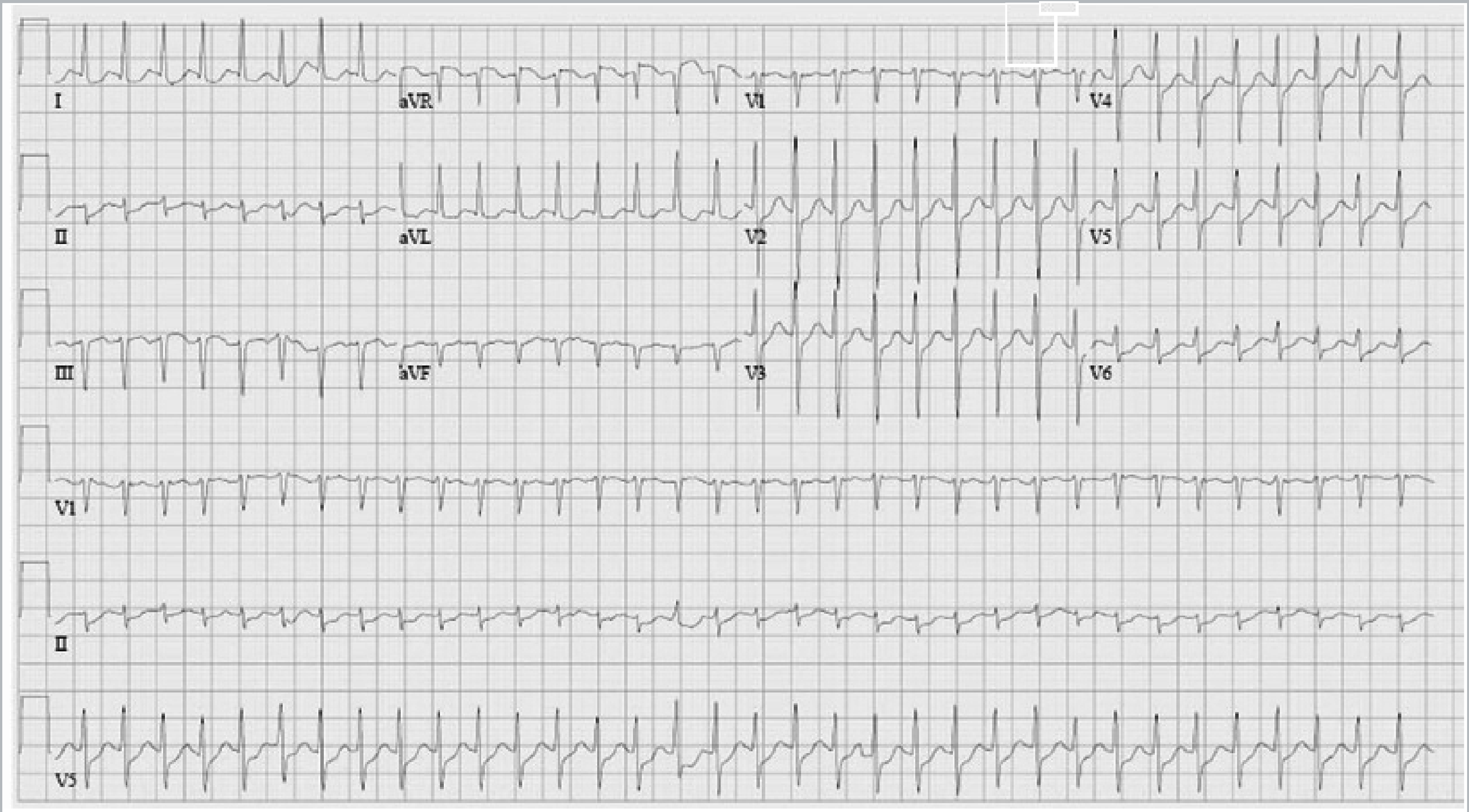




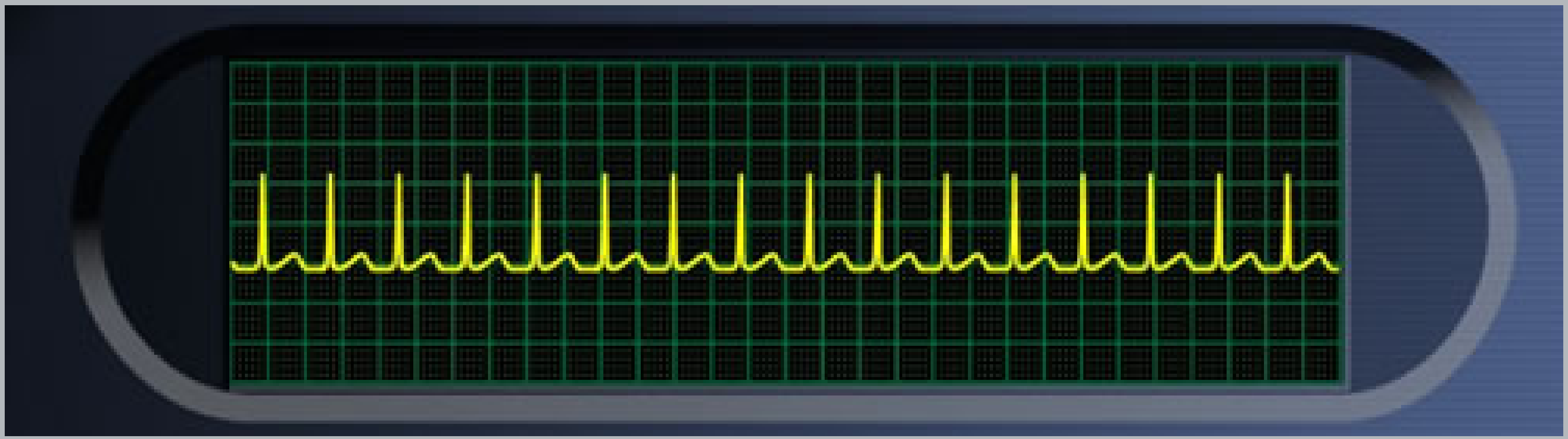
History of Electrophysiology

1929 Cardiac catheterization (Forssman)
1945 Intracardiac electrogram
1968 Surgical ablation of accessory pathway (Cobb)
1969 Catheter recording of His bundle signal (Scherlag)
1971 Programmed ventricular stimulation (Wellens)
1981 Catheter ablation in human (Scheinman)
1986 Radiofrequency current catheter ablation
1989 FDA approval IV adenosine for PSVT
1995 Electroanatomic mapping techniques

45 yo Female with Palpitations & "Panic Attacks"

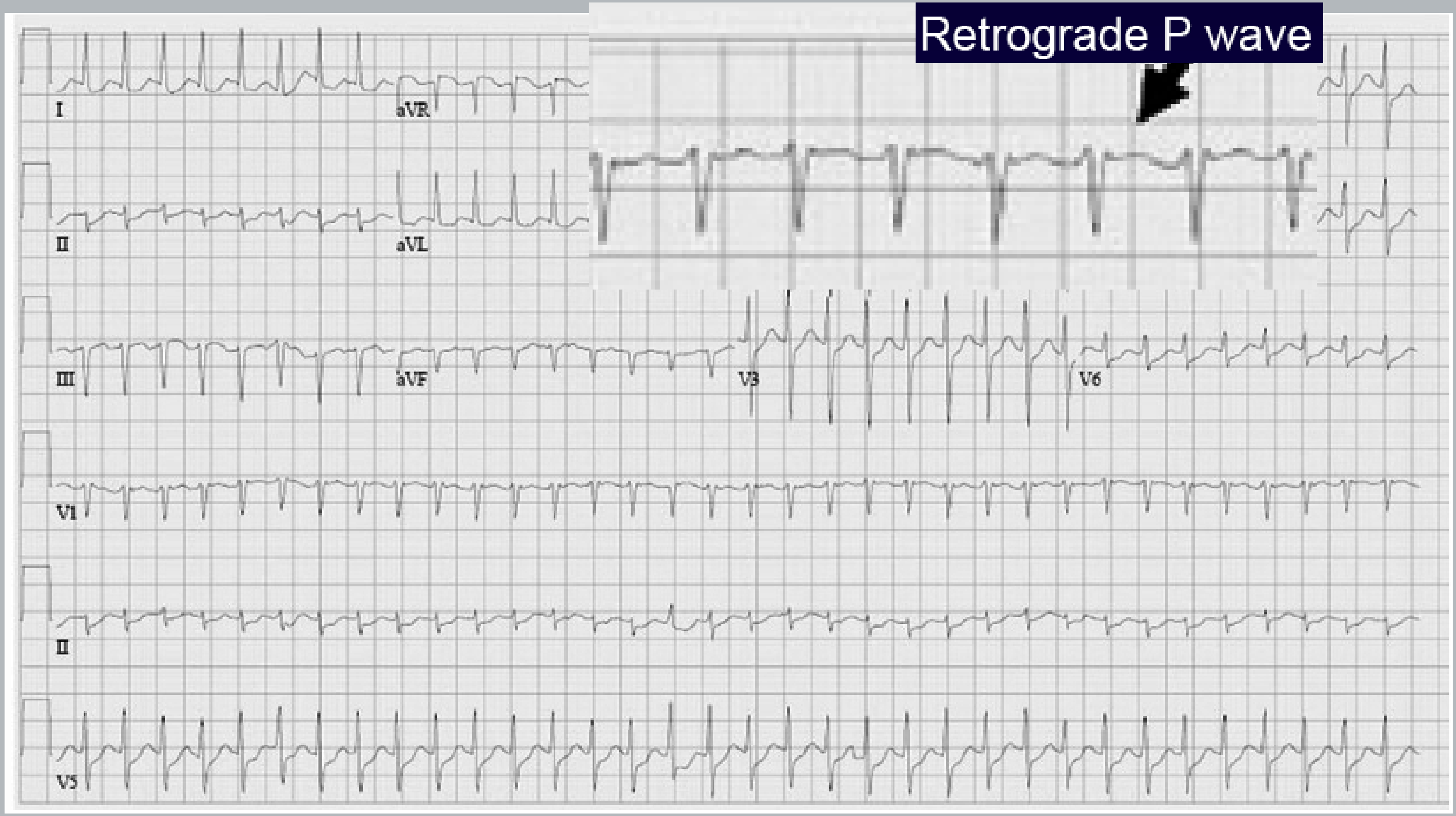


AV Nodal Reentrant Tachycardia



- **Origin:** AV nodal region
- **Mechanism:** Reentry
- **Tachycardia Rate:** 100 – 280 BPM (most around 170 bpm)
- **ECG:** QRS normal, P-wave not seen during tachycardia (within QRS).
- **Clinical Characteristics:** most common SVT in adults, females>males, can occur at any age (commonly in mid-40s), not associated with heart disease, catecholamine-sensitive

AV Nodal Reentry Tachycardia (AVNRT)



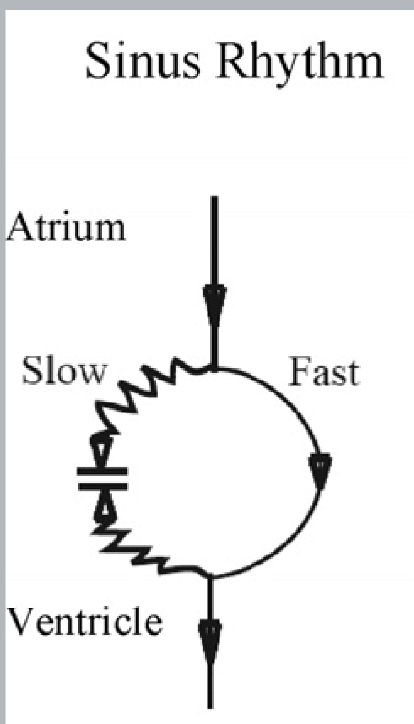
Note fixed, short RP interval mimicking r' deflection of QRS

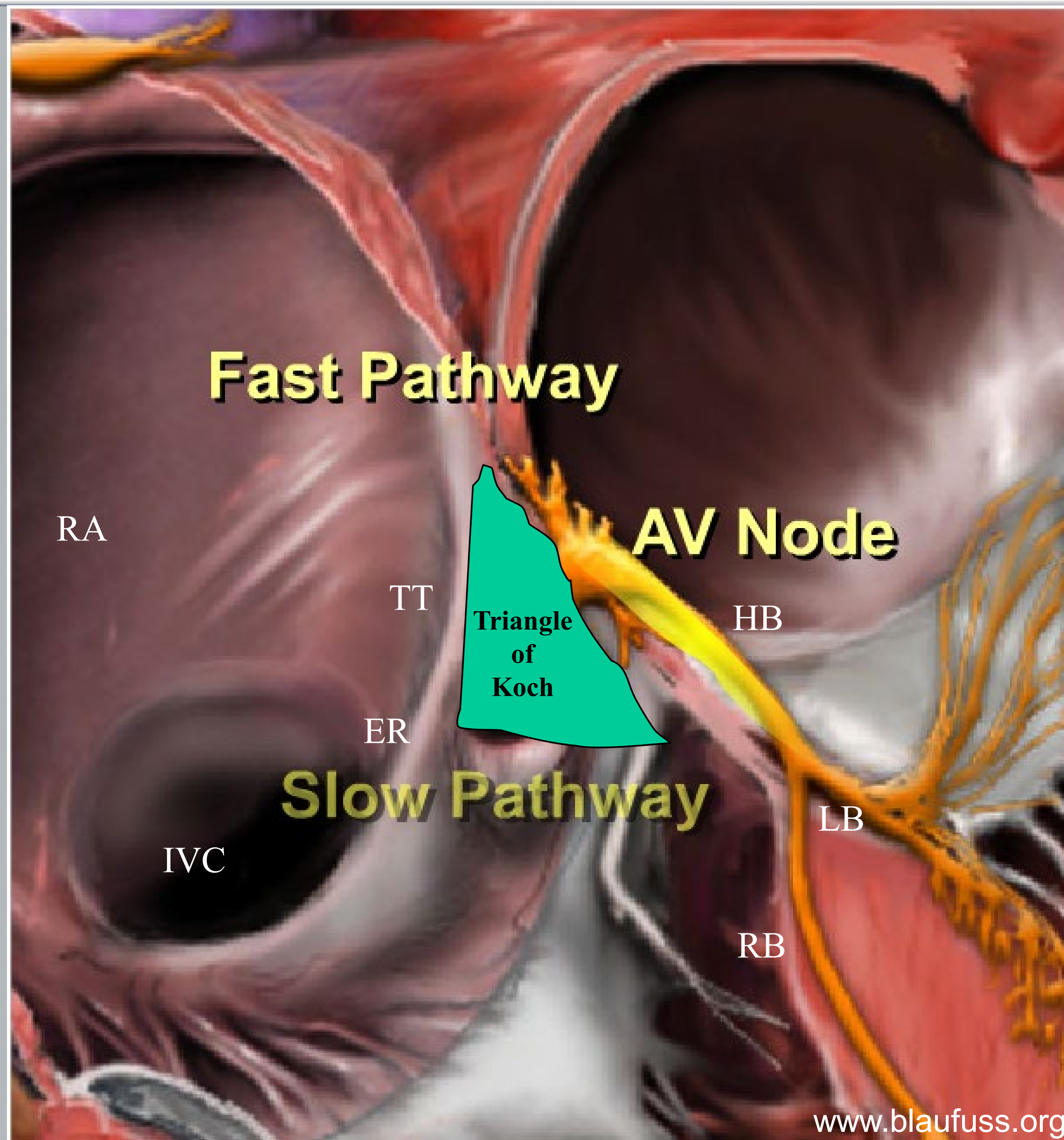
AVNRT: Dual AV Node Physiology

AVNRT Normal Sinus Rhythm

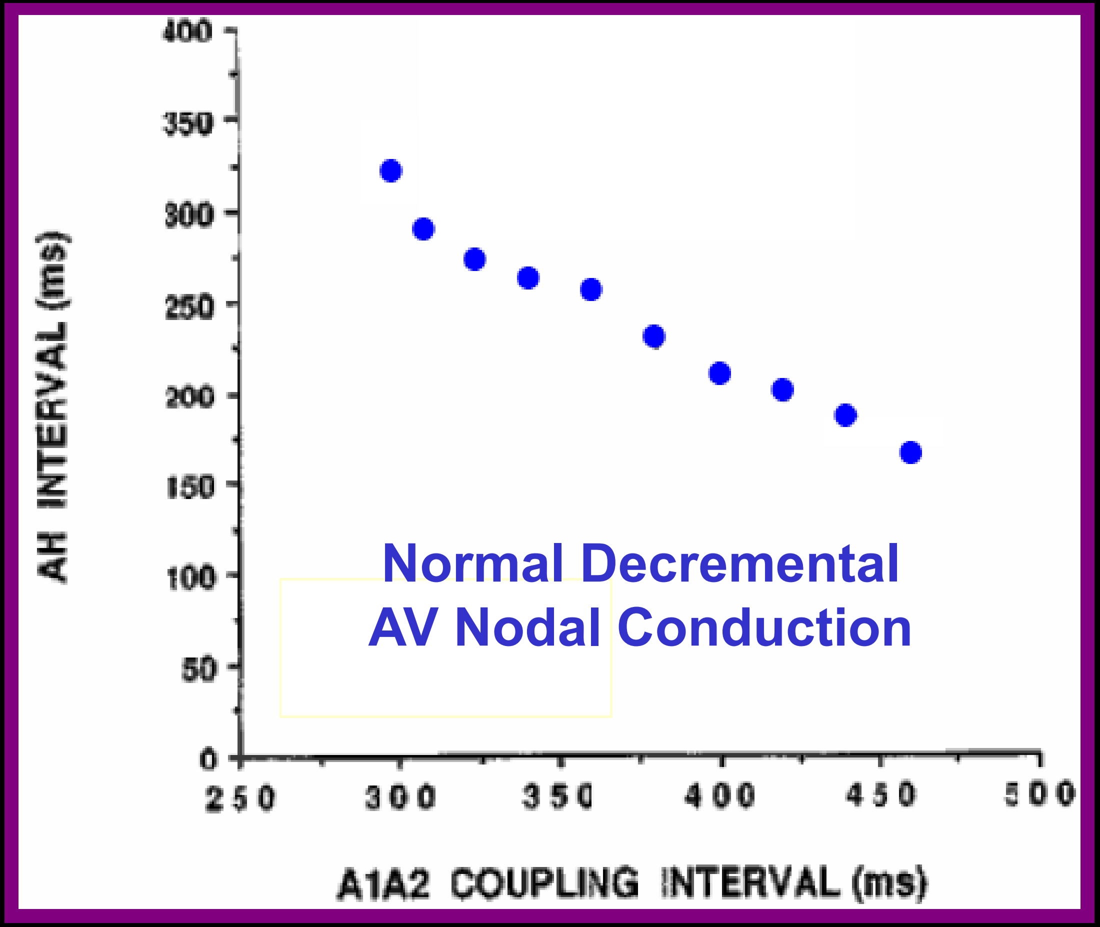
During sinus beats

- conduction via fast pathway
- conduction via slow pathway blocked

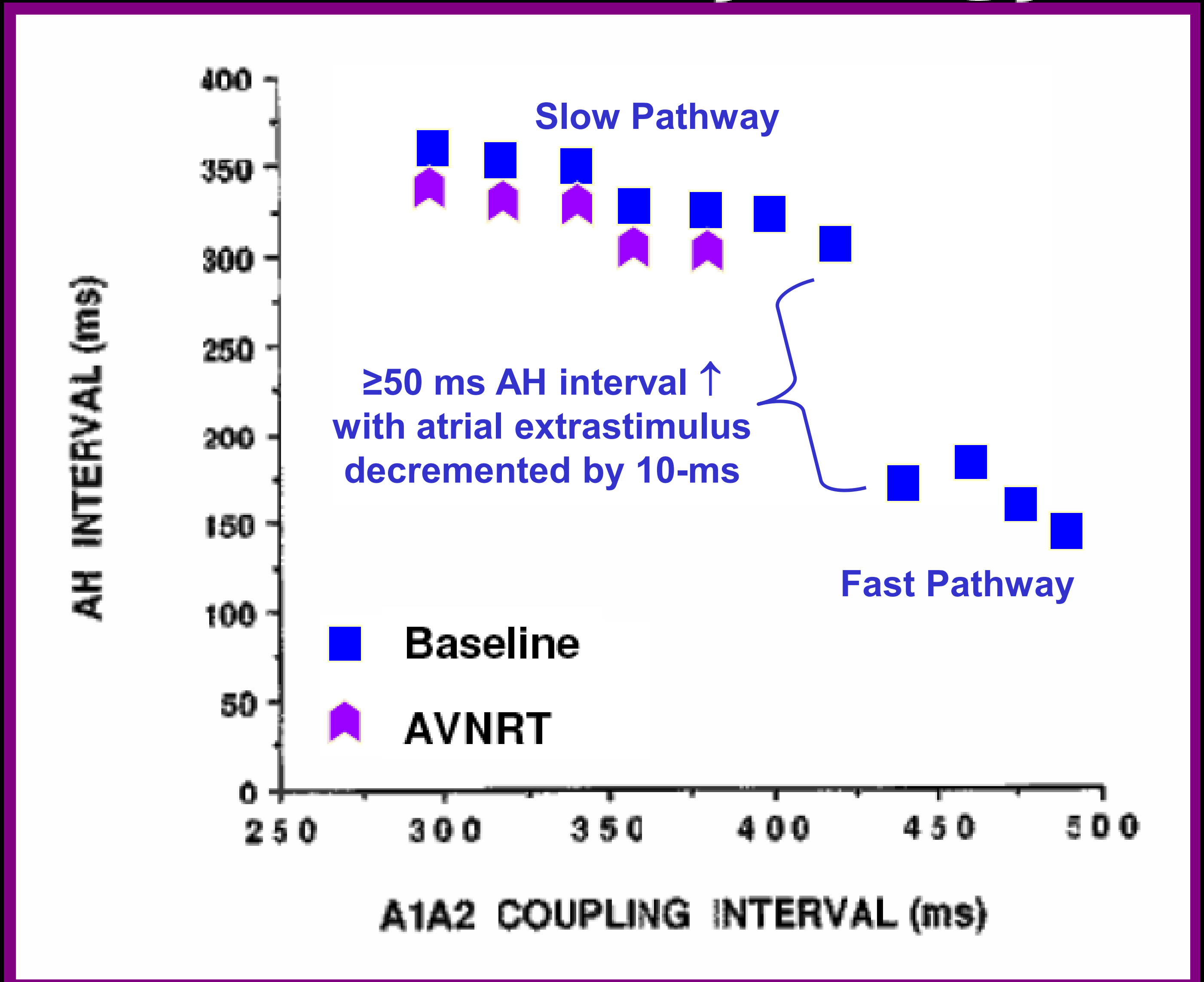




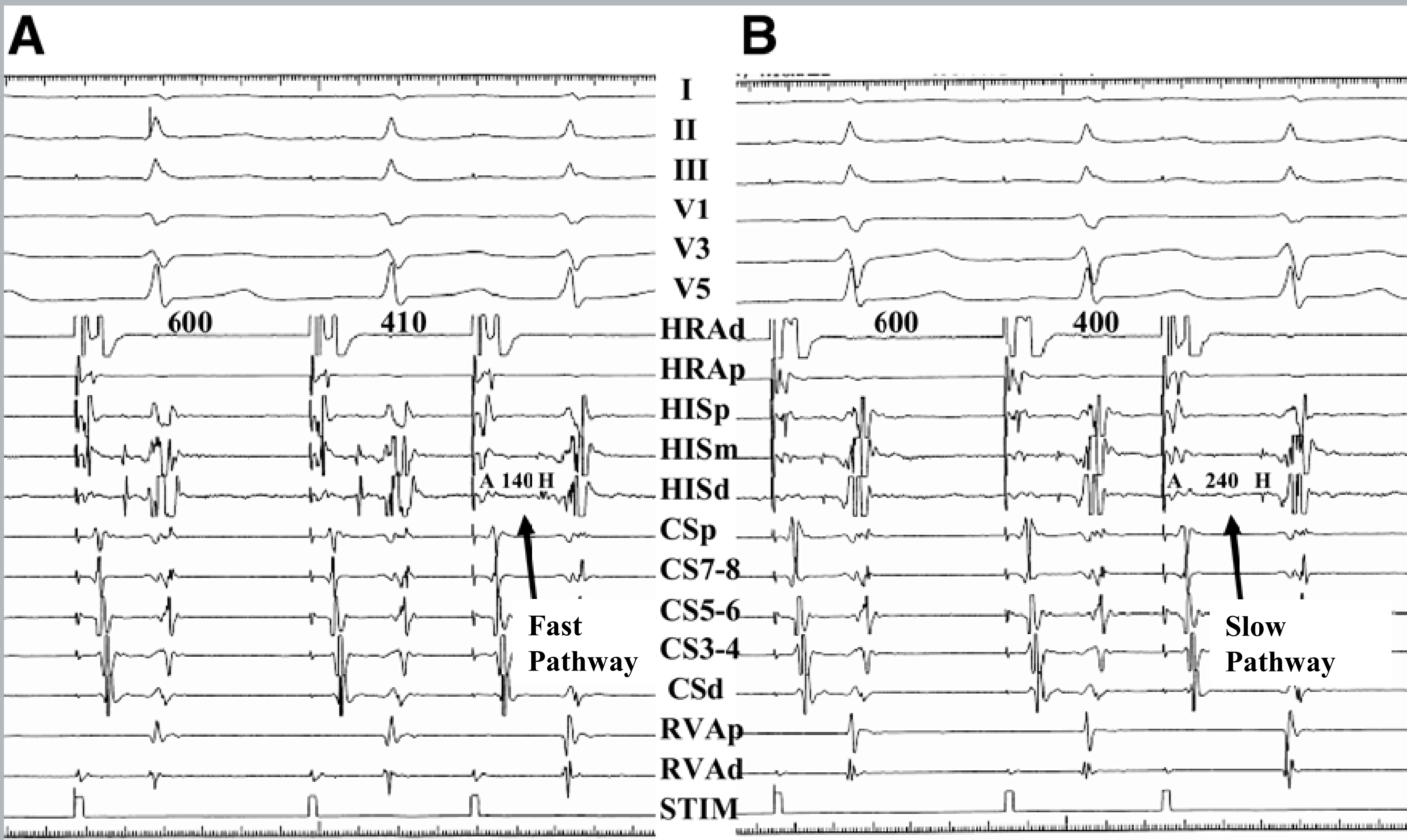
Normal AVN Conduction Curve



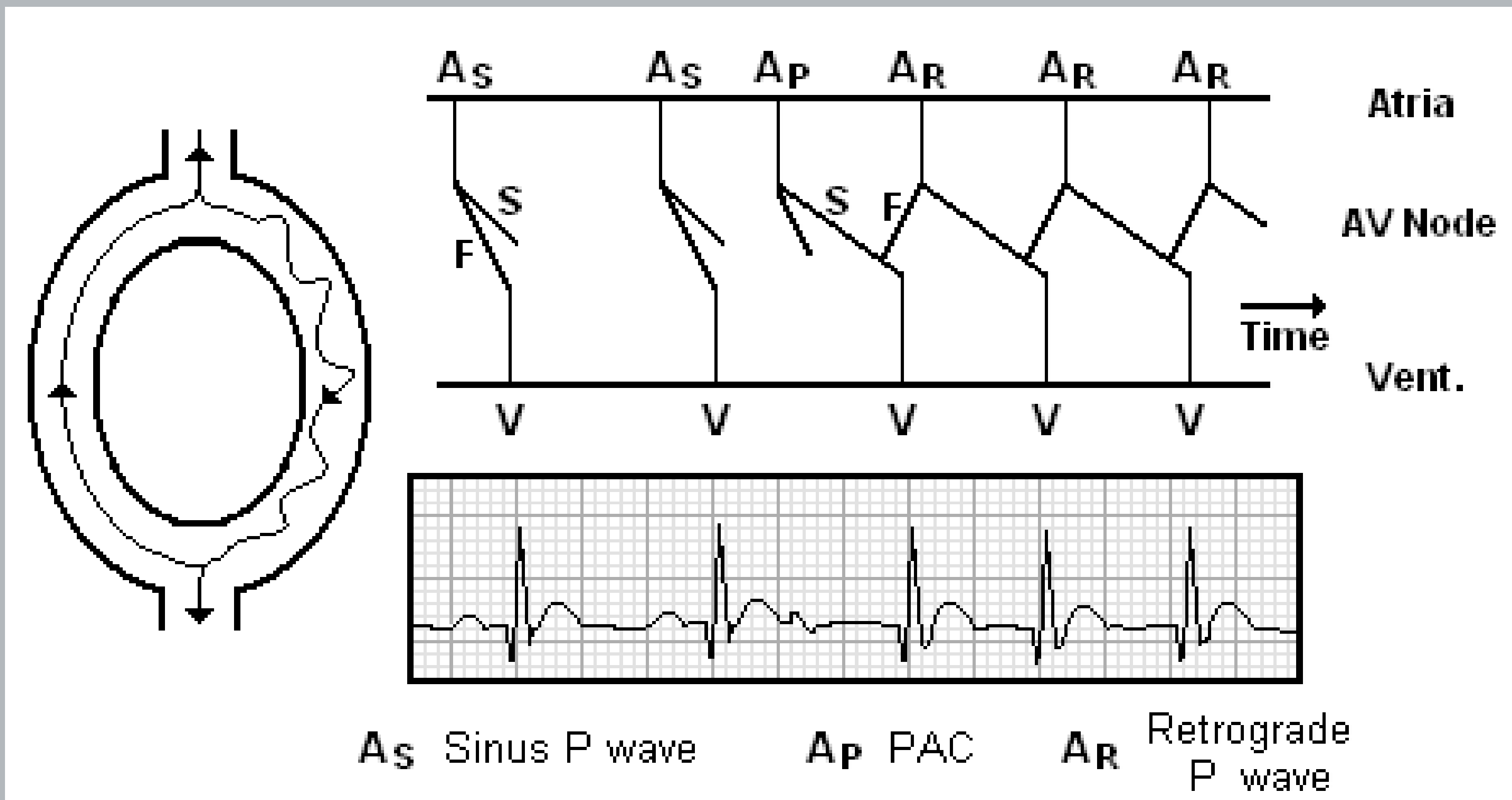
Dual AVN Physiology



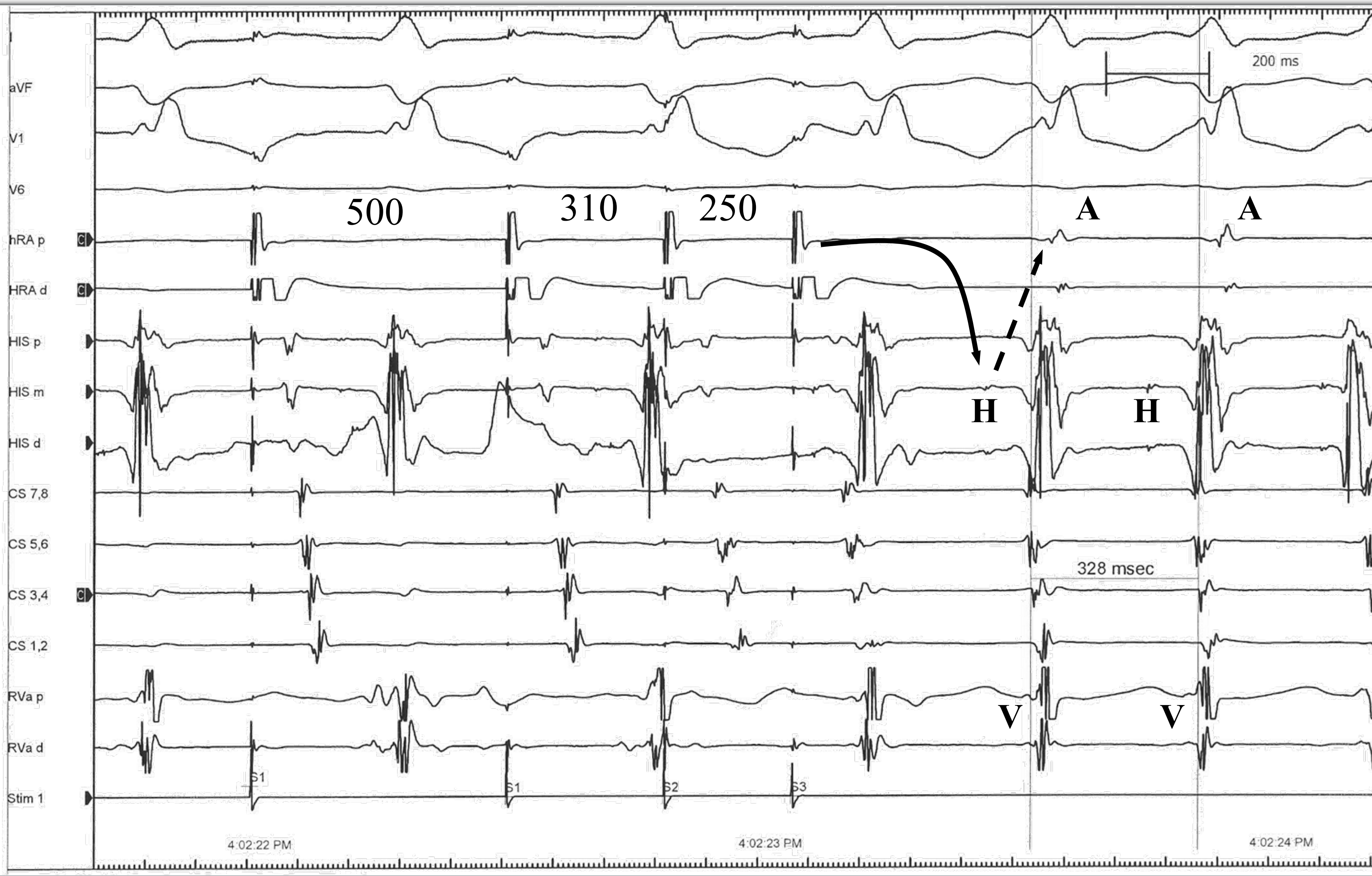
AVNRT: Dual AV Nodal Pathways



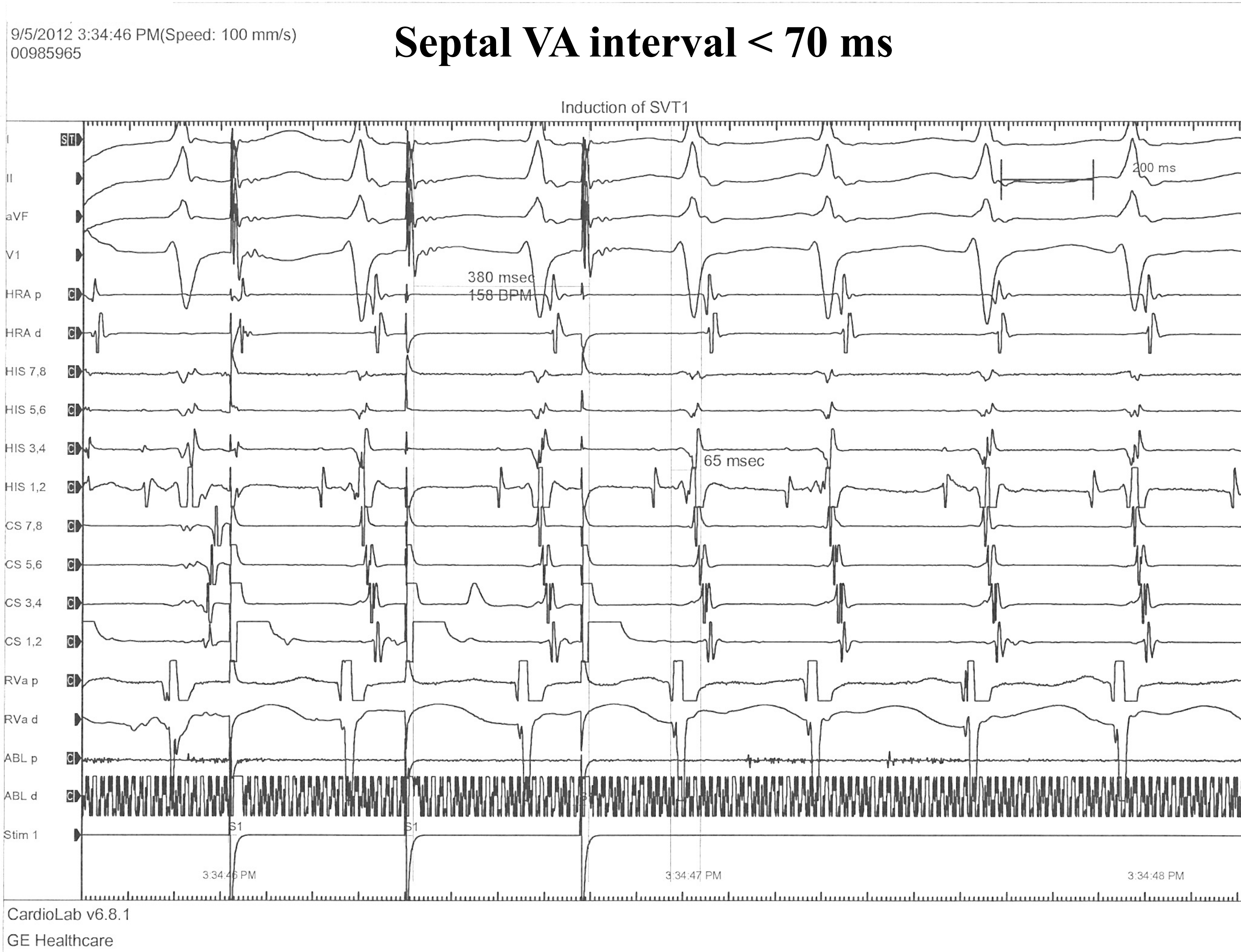
AVNRT: Initiation of Tachycardia



AVNRT: Initiation of SVT

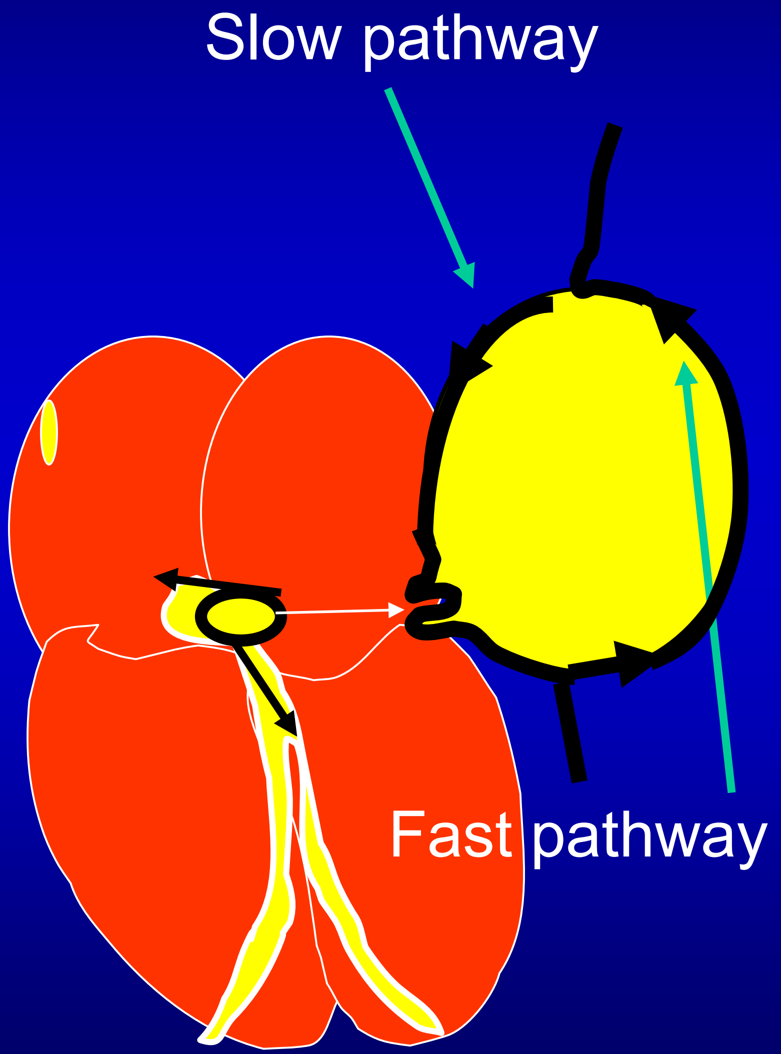


Septal VA interval < 70 ms



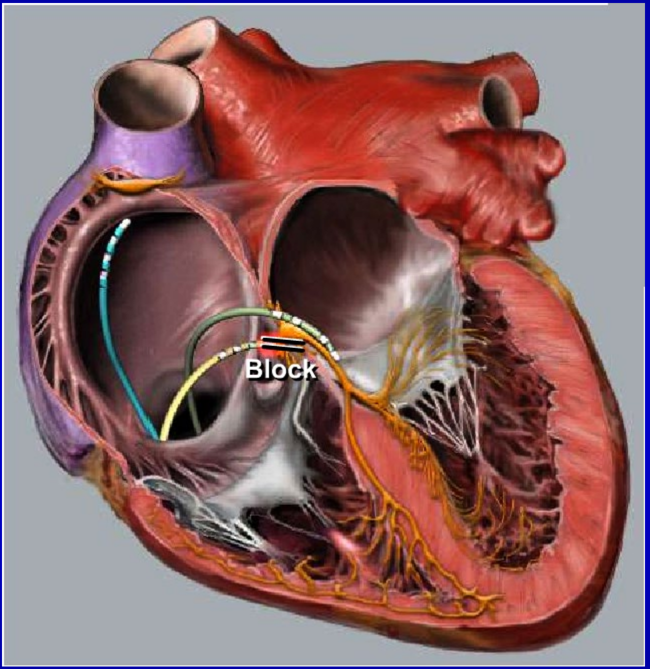
AV Nodal Reentrant Tachycardia

- Sometimes terminated by vagal maneuvers
- Highly responsive to AV nodal blocking agents:
  - Adenosine IV
  - Beta blockers IV
  - Ca^{2+} channel blockers
    - Diltiazem, verapamil IV
    - Etripamil Nasal Spray (Investigational).
- Recurrences common on medical therapy

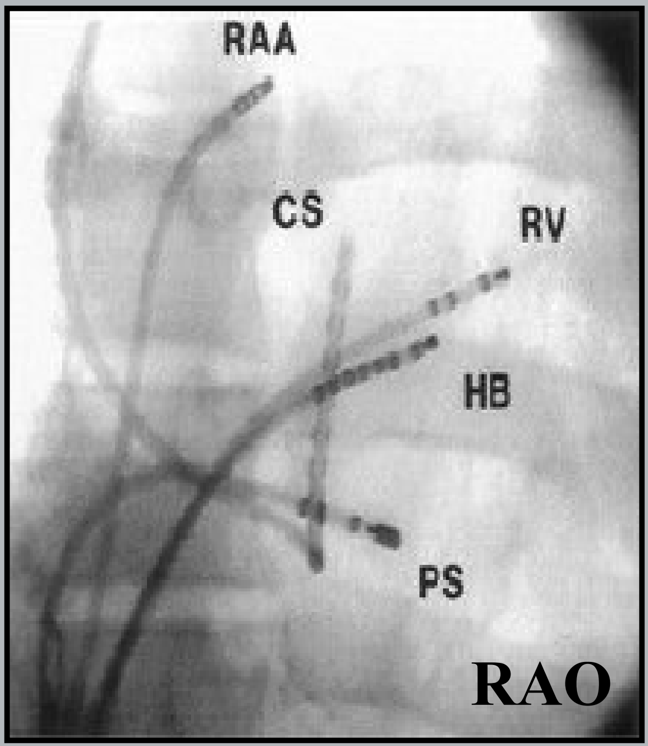


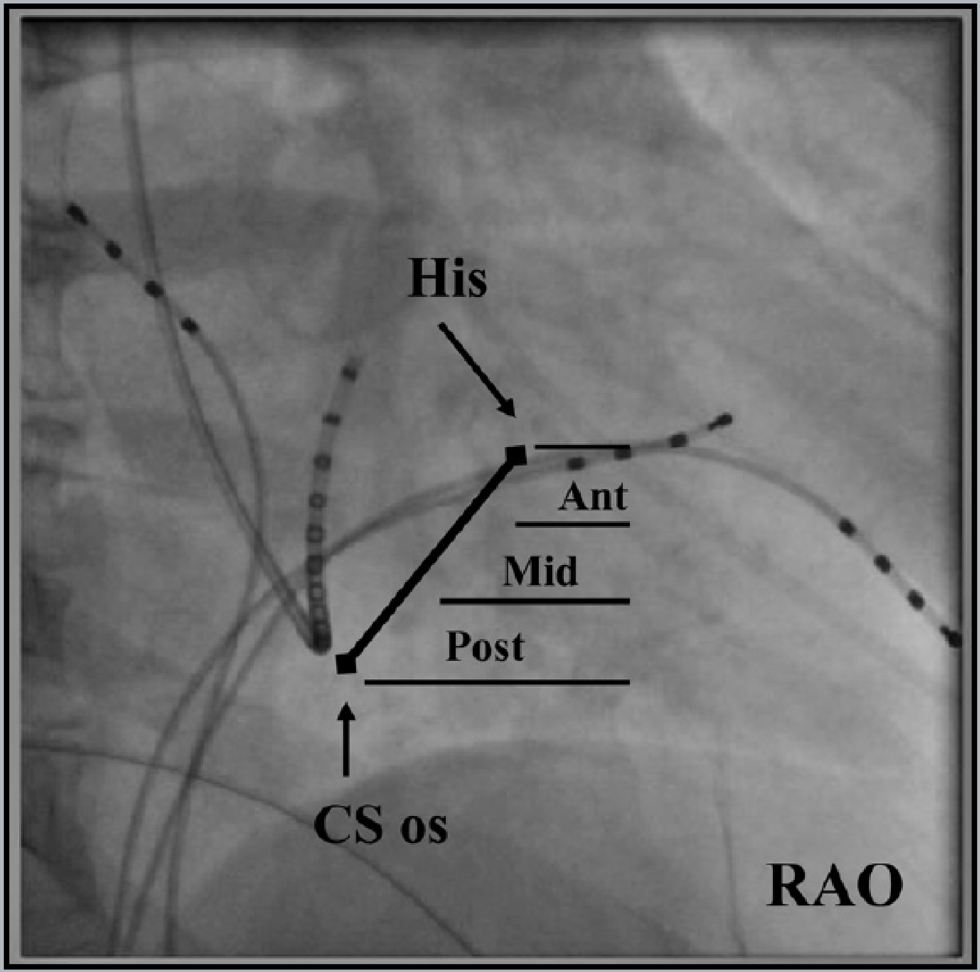
AVNRT
Catheter Ablation Techniques

- **Slow Pathway Ablation**
  - posterior approach (close to CS os)
  - preferred technique
  - does not affect normal AV conduction
  - risk of AV block ~ 0.5-1%
  - 95-99% successful

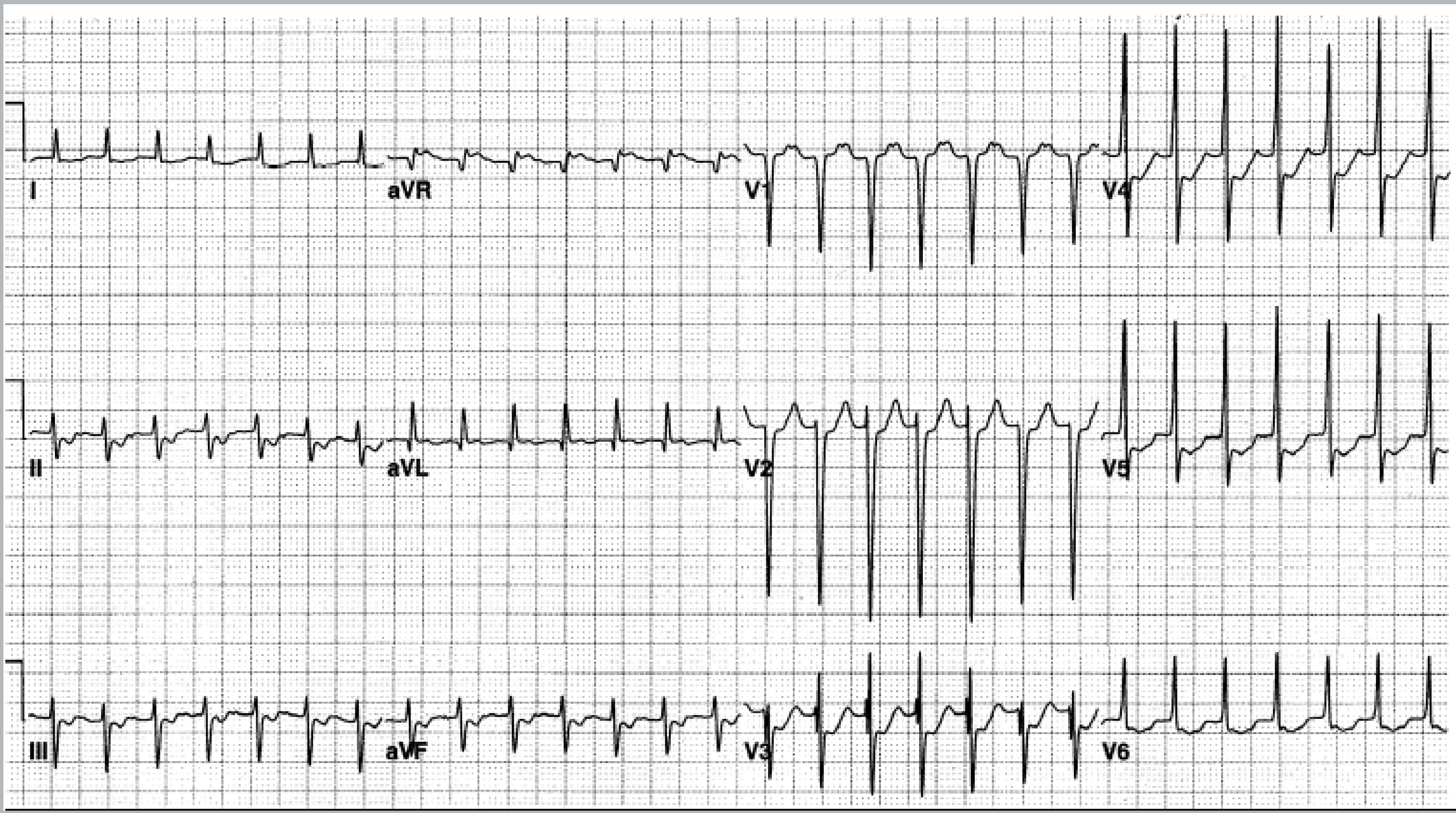


AVNRT: Slow Pathway Ablation



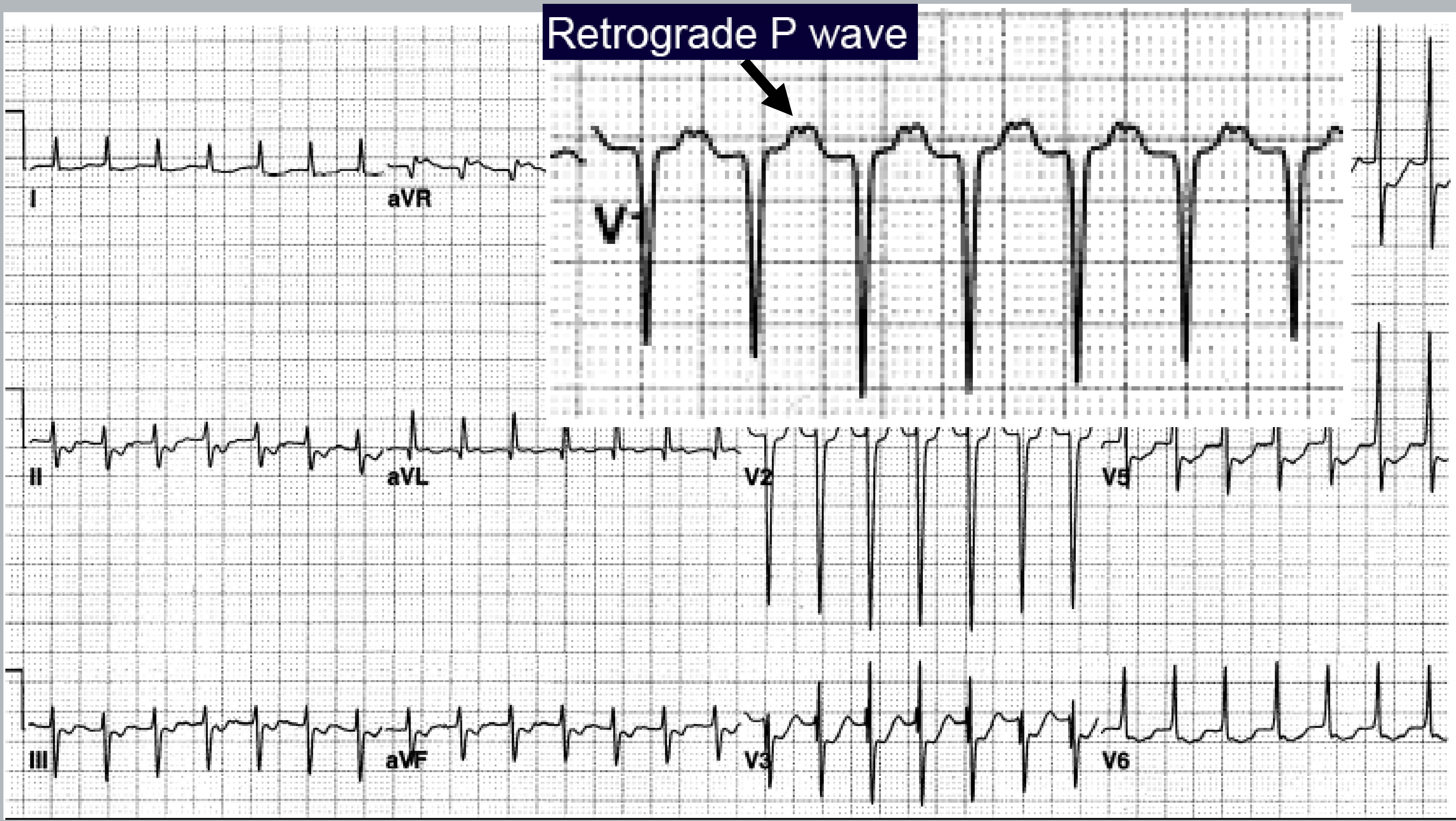


35 yo Male with Palpitations in the ER

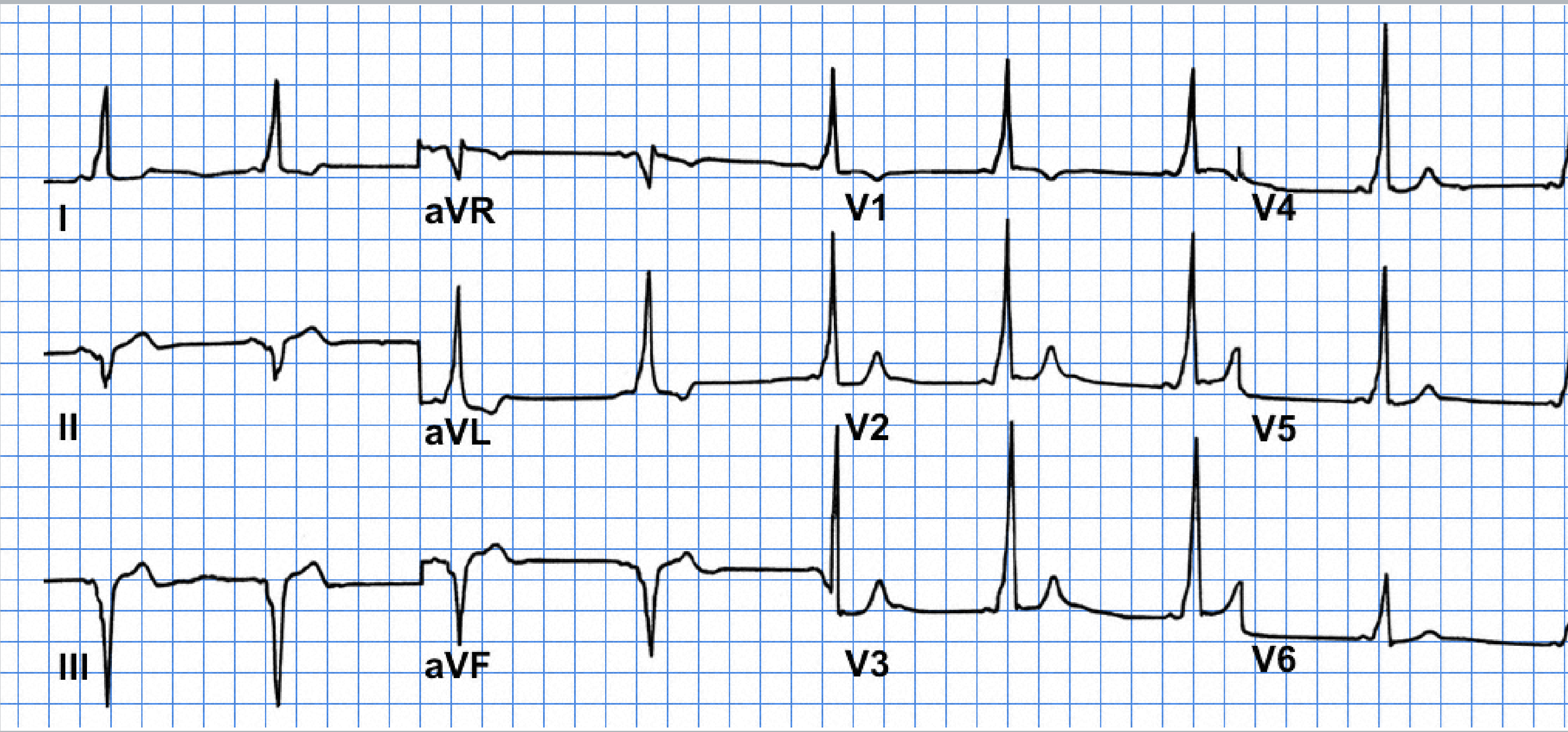


AV Reciprocating Tachycardia

“Orthodromic” AVRT (ORT)



AVRT: WPW syndrome: Preexcitation 12-Lead ECG



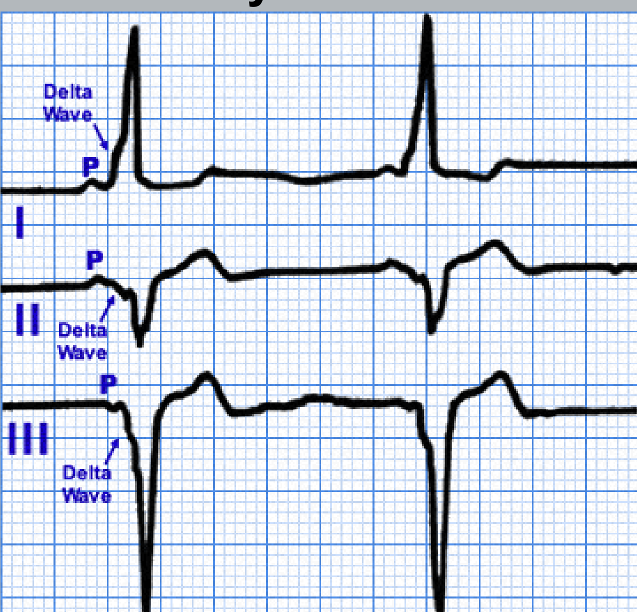
Incidence: 1-2/500 have an accessory pathway
~50% symptomatic with WPW syndrome

Wolff-Parkinson-White Pattern: Ventricular Preexcitation

ECG requirements for diagnosis of WPW Pattern

- P-R interval < 120 ms
- Normal P wave vector (to exclude junctional rhythm)
- Presence of a delta wave
- QRS duration > 100 ms

WPW ECG pattern + SVT = WPW syndrome



Wolff-Parkinson-White (WPW) Syndrome

The American Heart Journal

Vol. V | August, 1930 | No. 6

Original Communications

BUNDLE-BRANCH BLOCK WITH SHORT P-R INTERVAL IN HEALTHY YOUNG PEOPLE PRONE TO PAROXYSMAL TACHYCARDIA

Louis Wolff, M.D., Boston, Mass., John Parkinson, M.D., London, Eng., and Paul D. White, M.D., Boston, Mass.

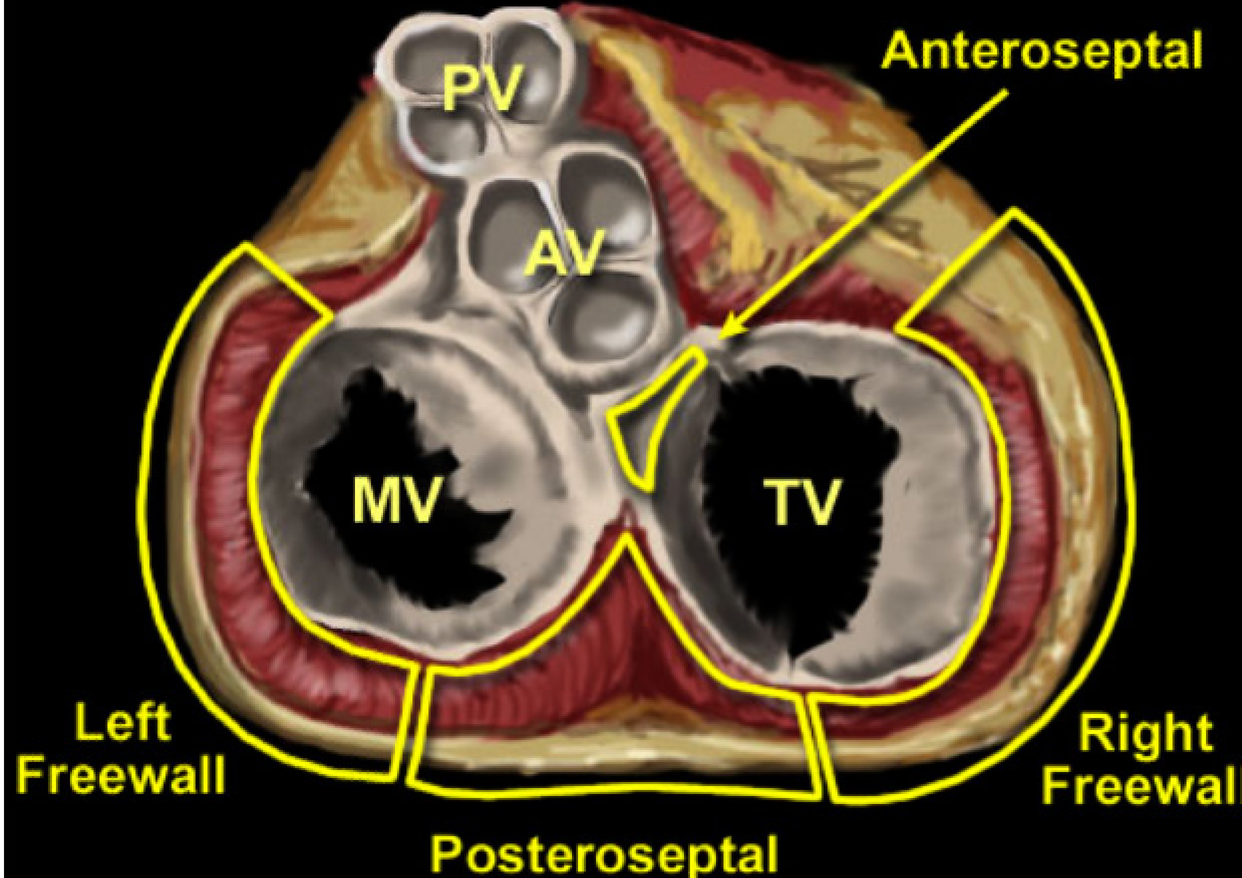
AV Reentry Tachycardia (AVRT): Accessory pathways

Atrioventricular bypass tracts, or accessory pathways, can be found anywhere along the muscular portion of the posterior and lateral aspects of the mitral and tricuspid annuli. They can be classified by their anatomic location as either

- **left-sided (50%)**
- **posteroseptal (25%)**
- **right-sided (15%)**
- **mid, anteroseptal (10%)**

Multiple APs: 2-10% of pts.

Locations of Accessory Pathways

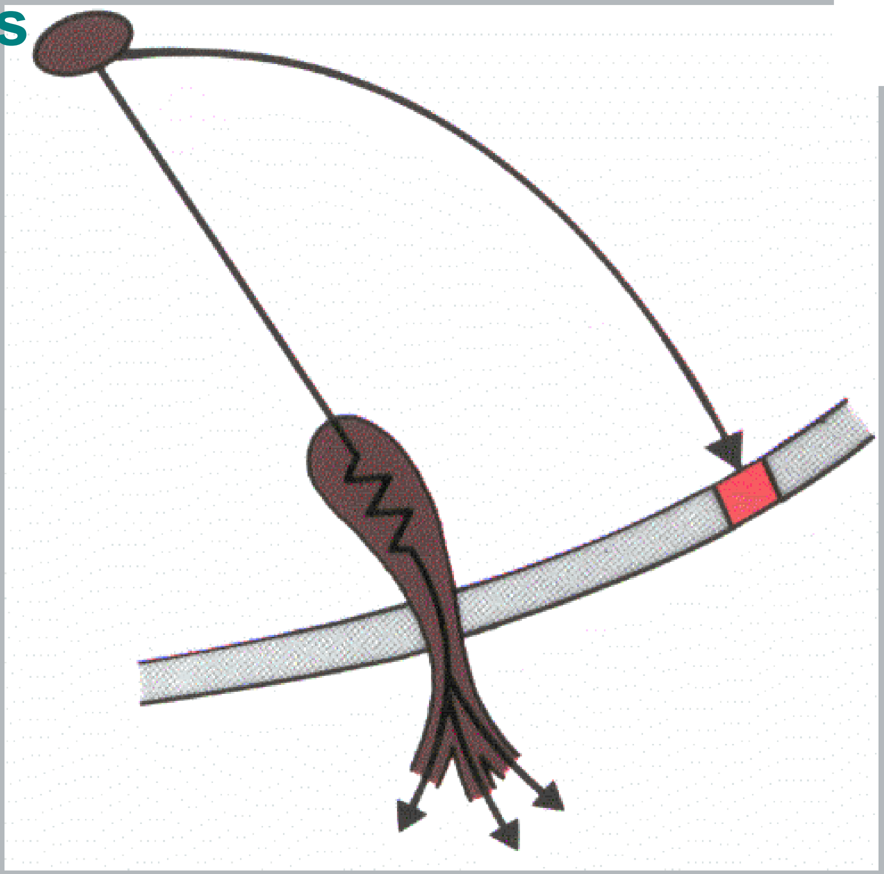


AP: histologically strands of NL myocardium

www.blaufuss.org

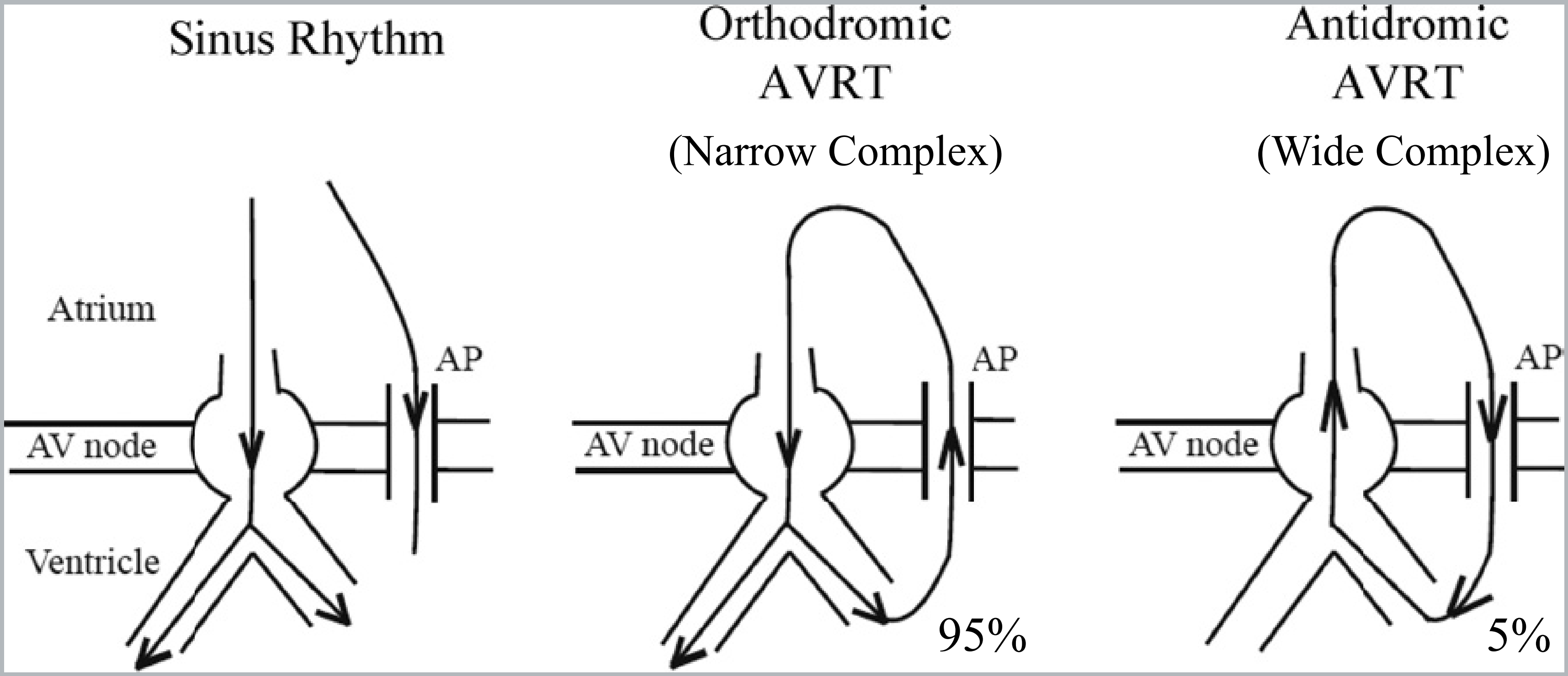
Concealed Accessory Pathway

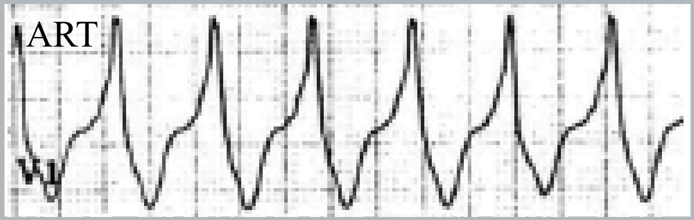
Sinus beat



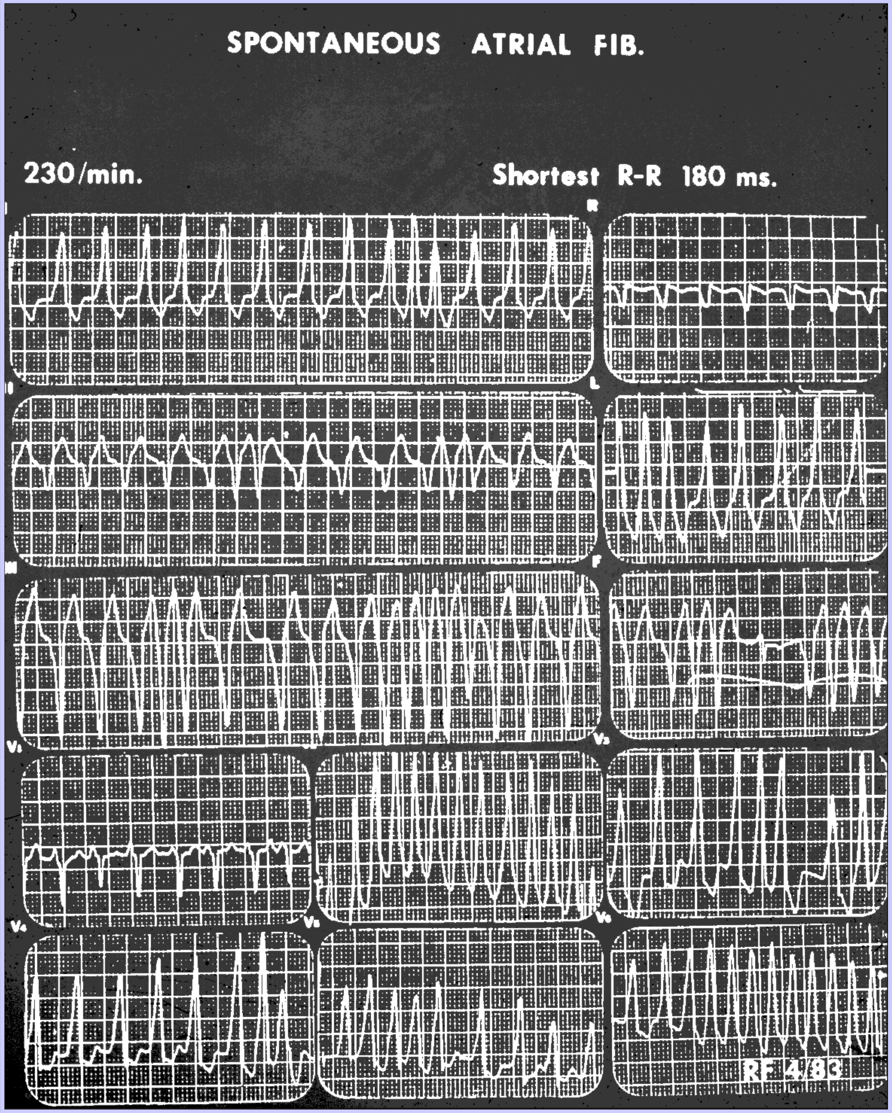
No Delta wave during NSR (but AP capable of *retrograde* conduction)

AVRT: Reentrant Circuits

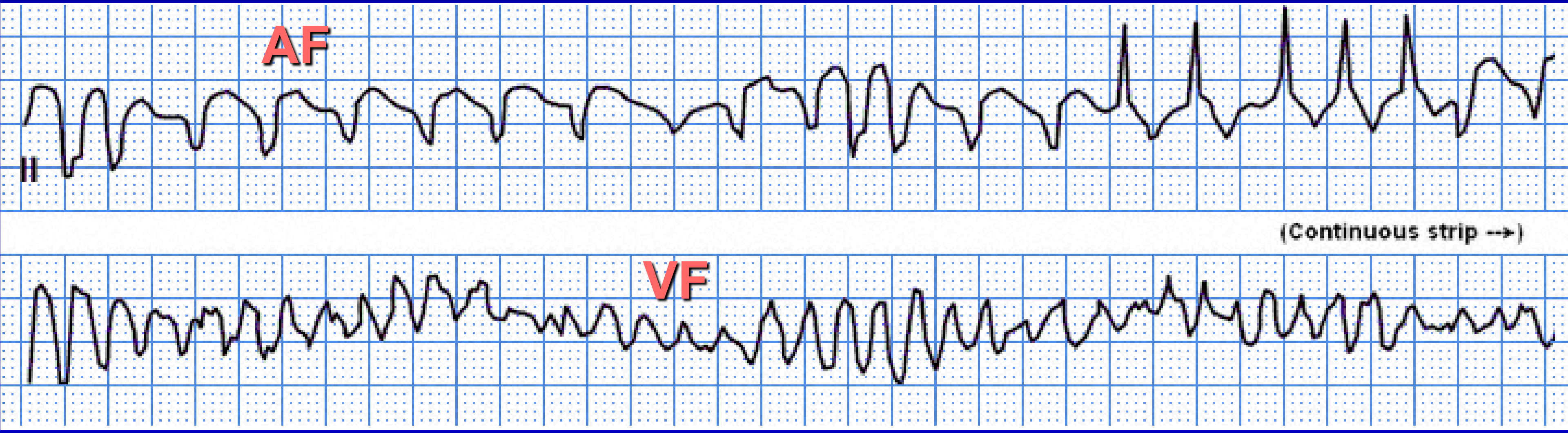




Preexcited Atrial Fibrillation
WPW Syndrome



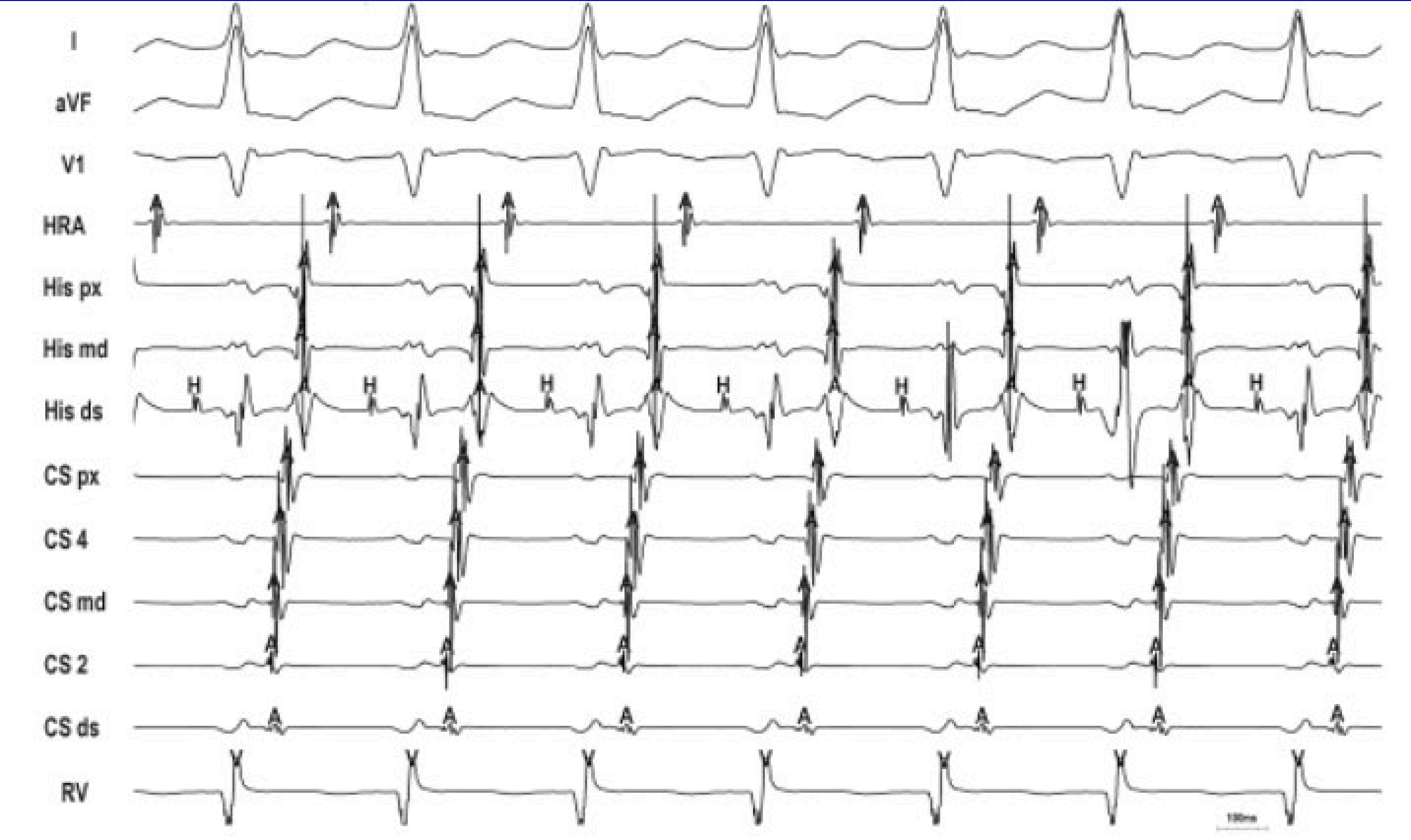
WPW: Atrial fibrillation with rapid ventricular response



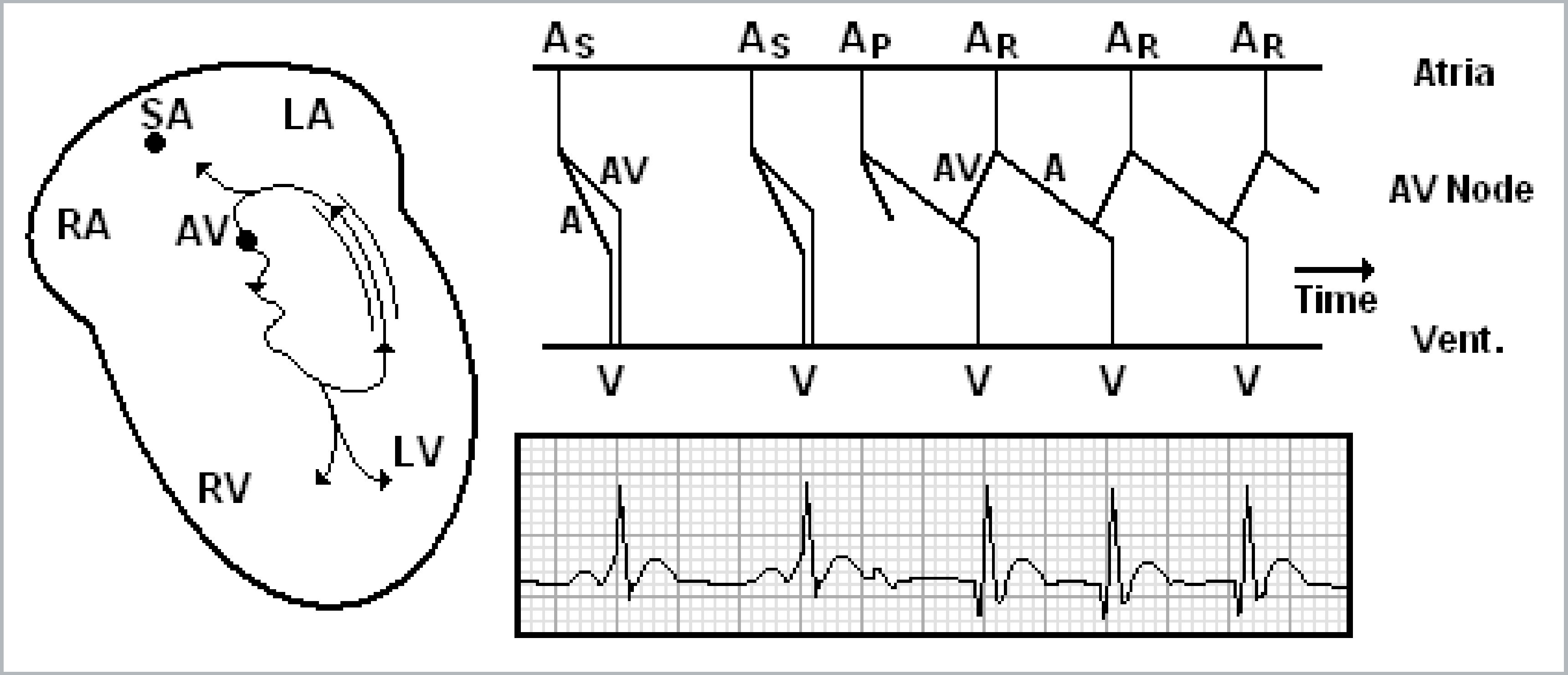
Risk of Sudden Cardiac Death in WPW:

- Symptomatic WPW: lifetime risk 3-4%
- Asymptomatic WPW: risk <1:10,000 (Class IIa indication catheter ablation)

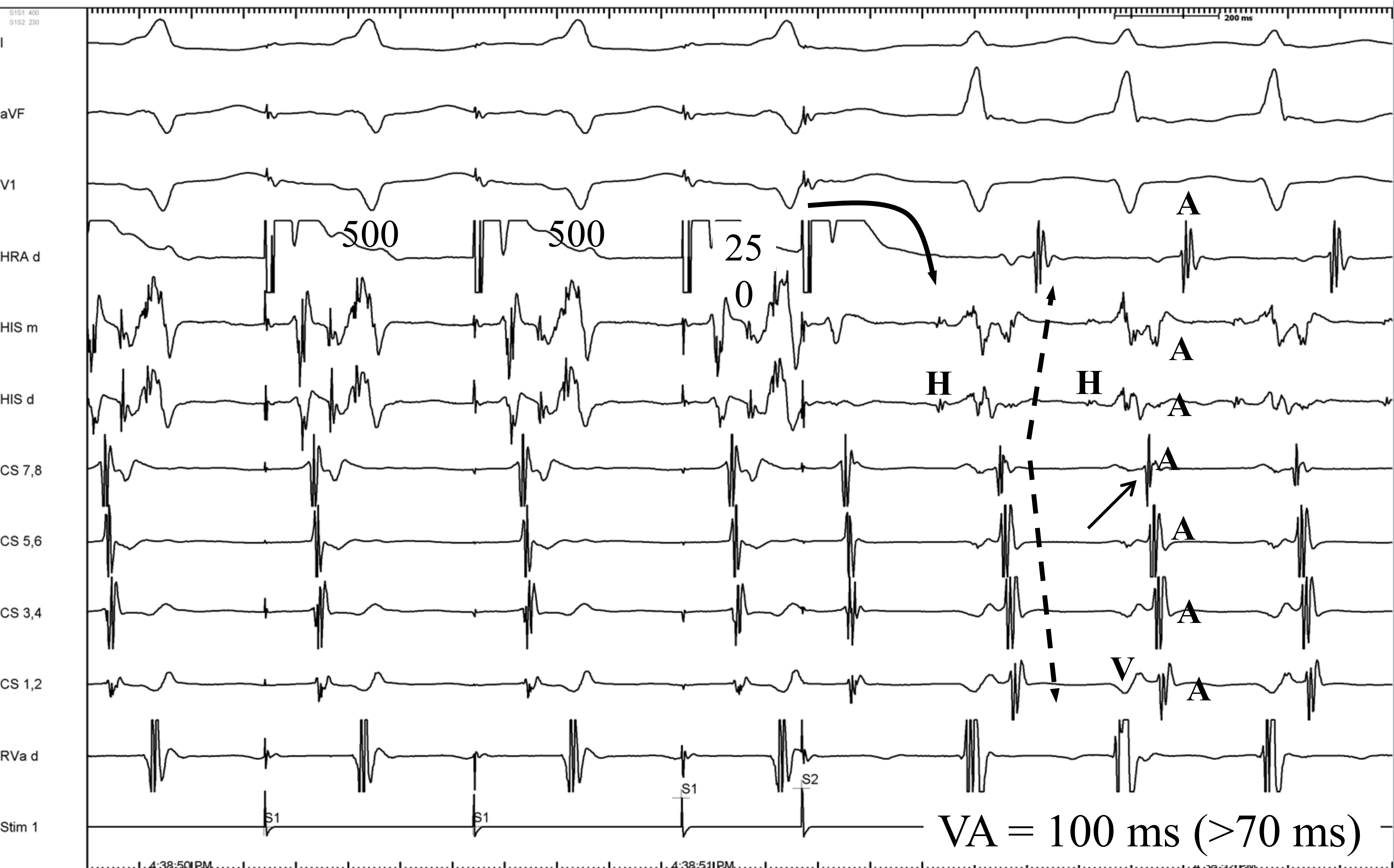
Diagnosis of Orthodromic AVRT in the EP Lab



Orthodromic AVRT: Mechanism

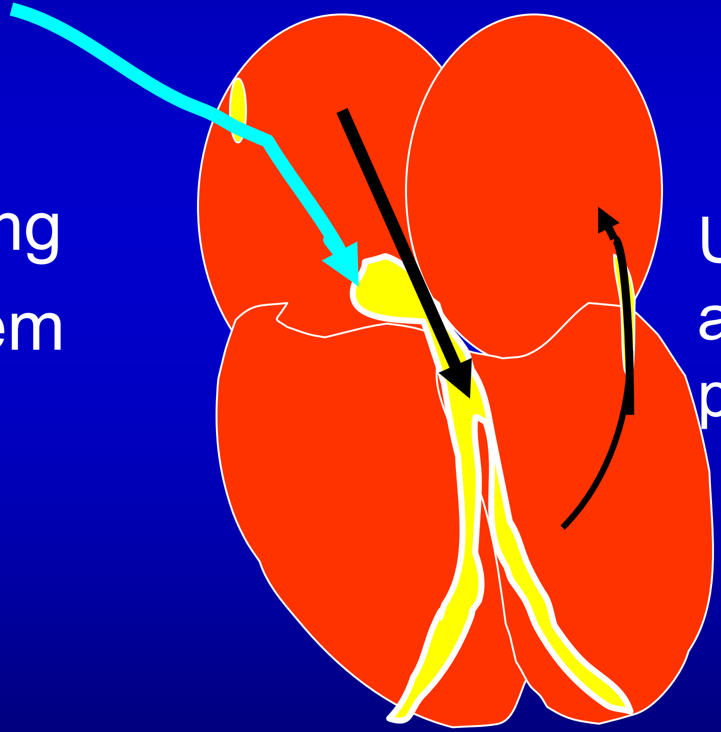


Orthodromic AVRT: Initiation of SVT



Treatment of AP-Mediated Tachycardias

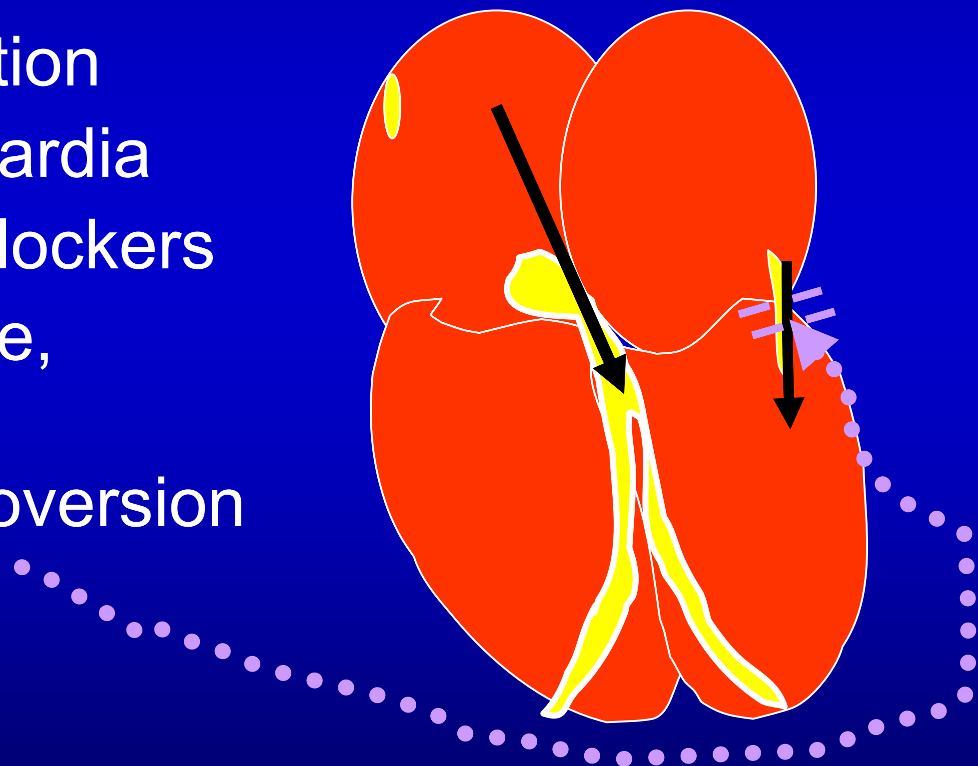
- **Acute Termination of ORT:**
  - – AV nodal blockade:
    - Vagal maneuvers
    - IV adenosine 6, 12 mg
    - IV verapamil; diltiazem
    - IV beta-blocker
    - NS etripamil (investigational)



*Avoid digoxin

Treatment of AP-Mediated Tachycardias

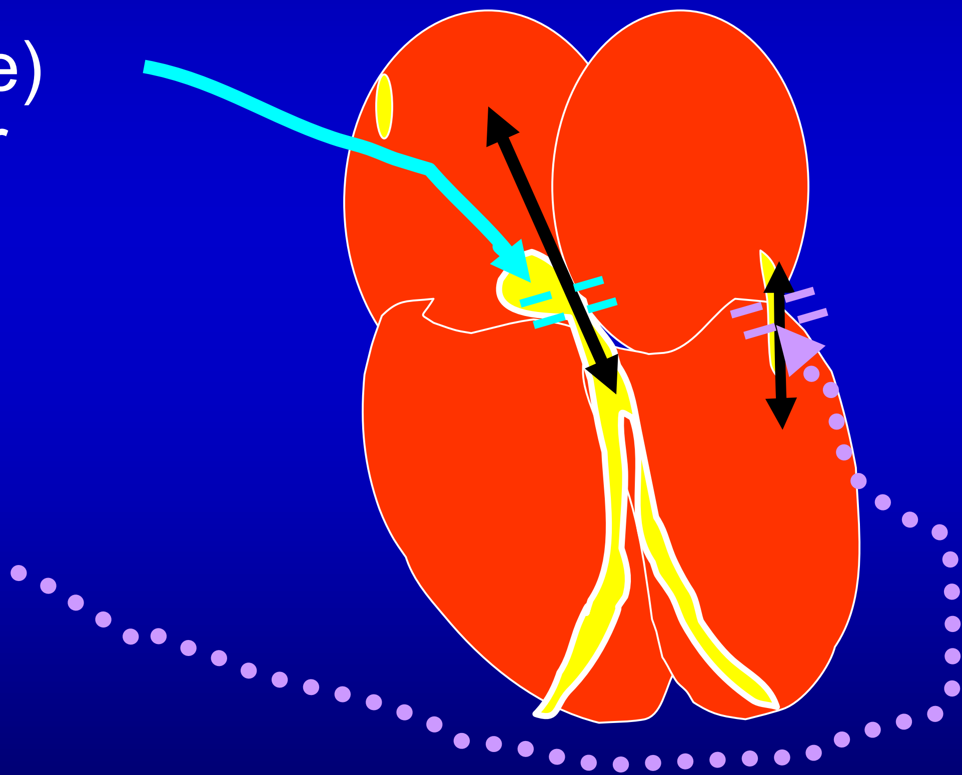
- **Wide complex tachycardia (WPW syndrome):**
  - AF with Preexcitation
  - Antidromic tachycardia
    - NO AV nodal blockers
    - IV procainamide, ibutilide
    - Electrical cardioversion



*Avoid digoxin

Treatment of AP-Mediated Tachycardias

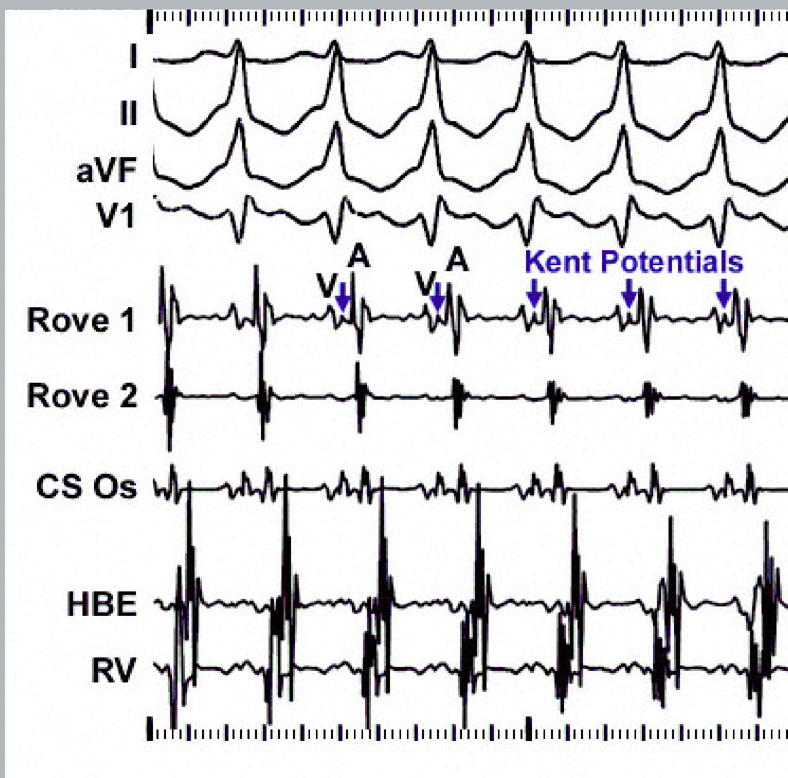
- **Chronic therapy:**
  - Class IC (flecainide) + AV nodal blocker

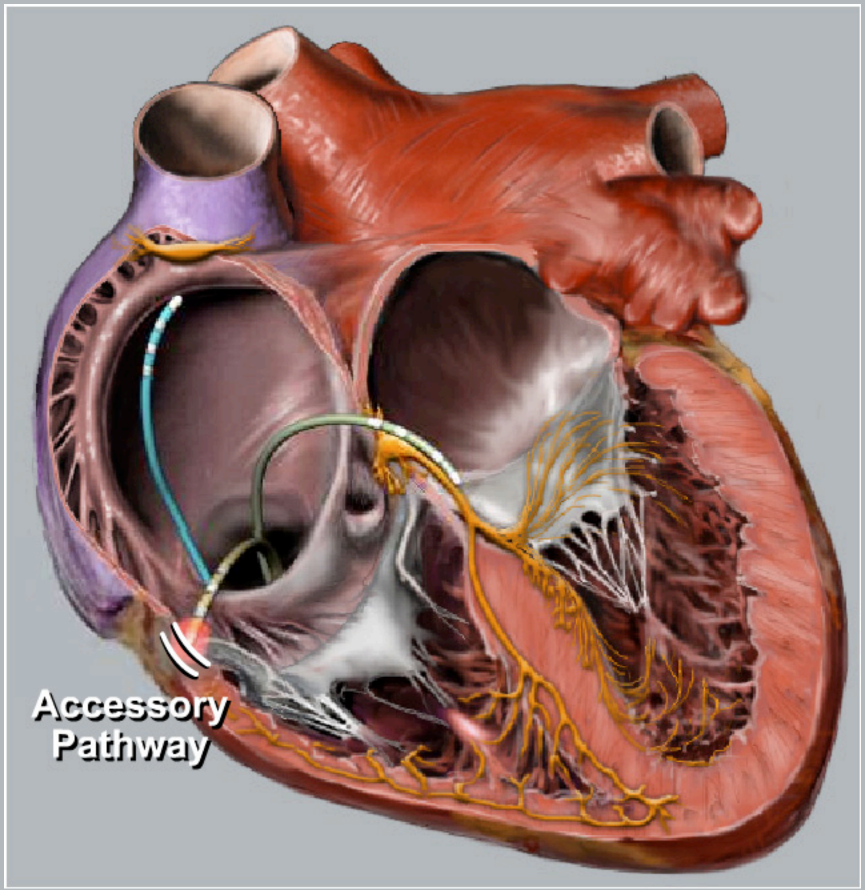


- ORT
- ART
- AF

*Avoid digoxin

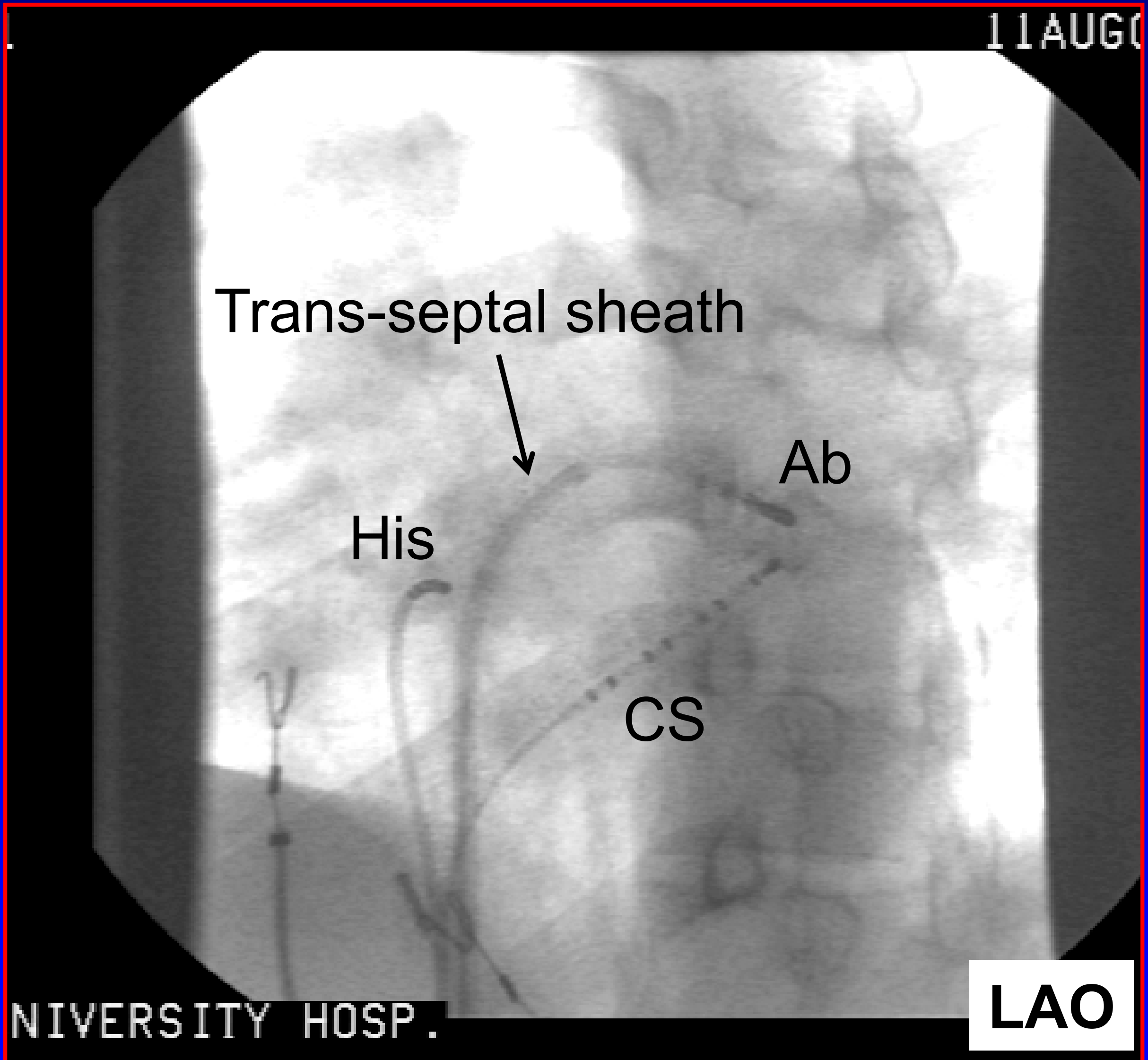
AVRT: Catheter ablation of accessory pathway





WPW Catheter Ablation

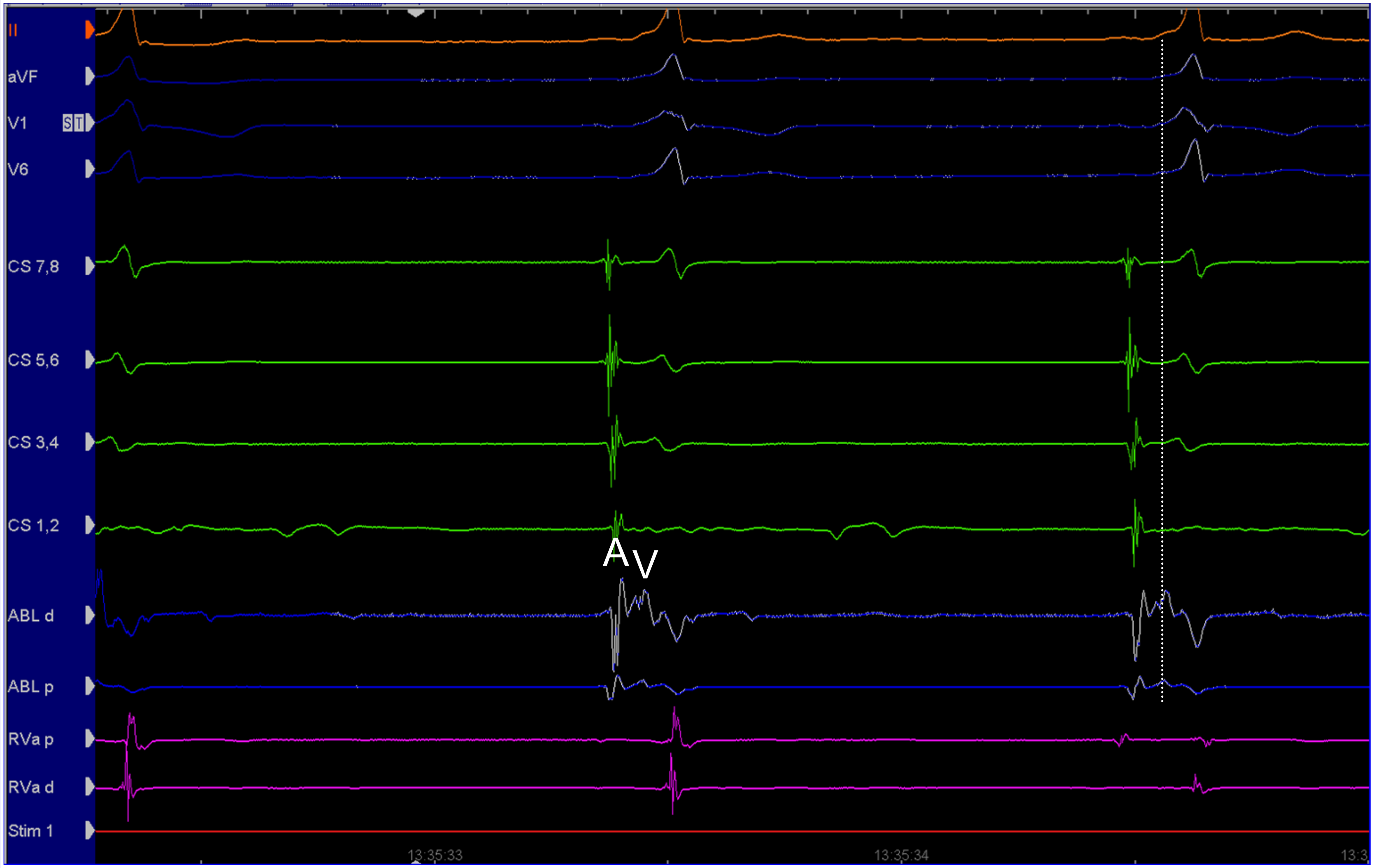
Left Lateral Accessory Pathway



I.R. 08/11/06

WPW Catheter Ablation

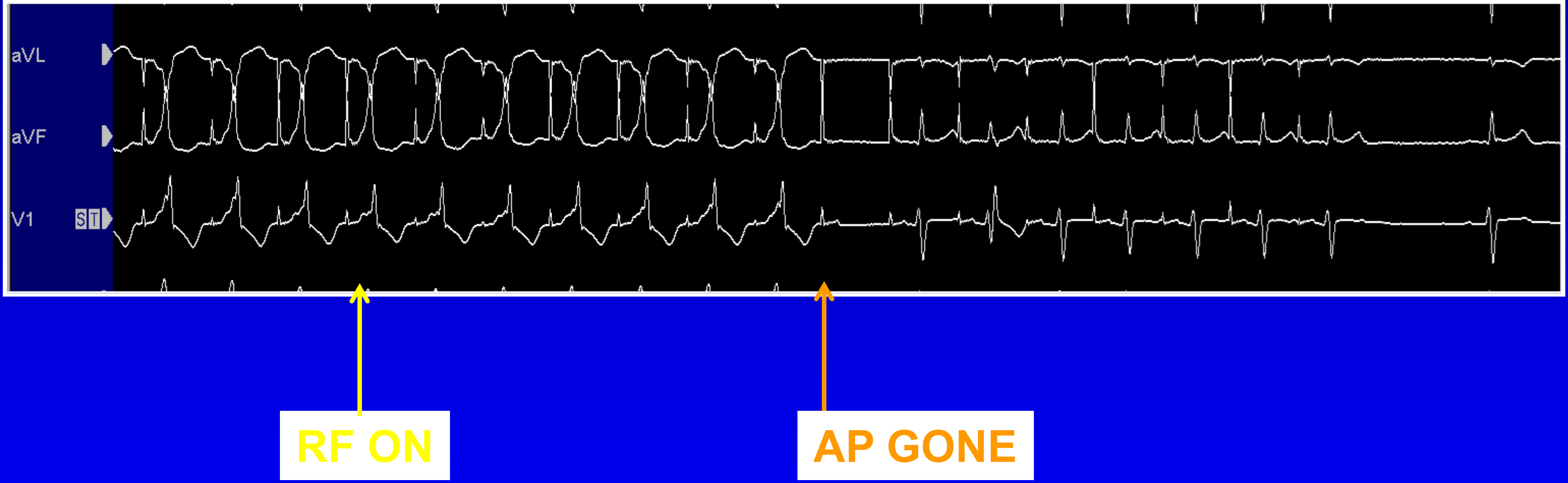
Left Lateral Accessory Pathway



I.R. 08/11/06

WPW Catheter Ablation

Left Lateral Accessory Pathway



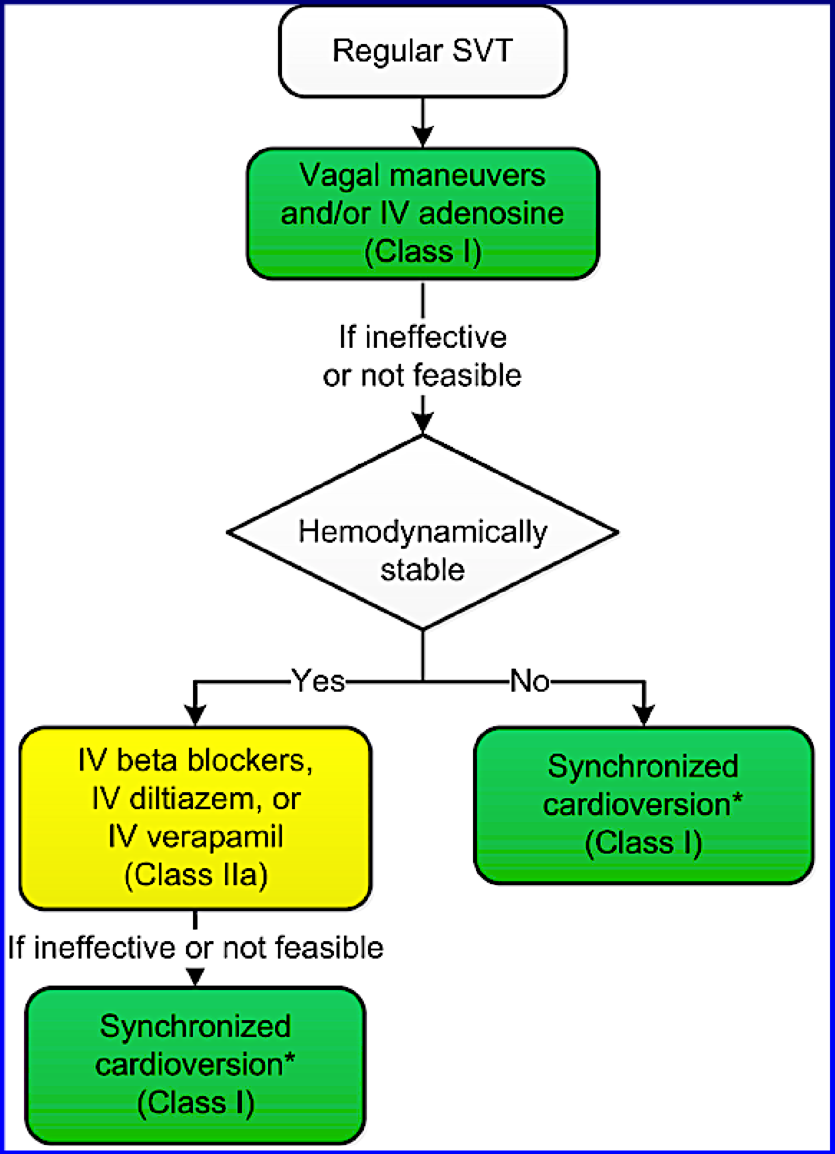
I.R. 08/11/06

Catheter Ablation of Accessory Pathways

AP Location	Success Rate (%)	Recurrence Rate (%)
Left free wall	>95	2-5
Right free wall	85-90	10-15
Posteroseptal	93-98	3-6
Anteroseptal, midseptal	95-98	3-6

Complication rate: 1-4% (AV block ~1-3%, esp with septal APs)

Acute Treatment of PSVT



2015 ACC/AHA/HRS Guideline for the Management of Adult Patients with SVT
Heart Rhythm 2016 13, e136-e221DOI: (10.1016/j.hrthm.2015.09.019)

Etripamil

- Novel, L-type calcium channel antagonist with rapid metabolism
- Rapid onset of action
- Short-acting
- Administered as a nasal spray
- Being developed as a self-administered therapy to terminate PSVT outside of the emergency room or hospital.

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Etripamil Nasal Spray for Rapid Conversion of Supraventricular Tachycardia to Sinus Rhythm

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Stambler BS, et al. JACC 2018;72:489-97

node-1
Etripamil Clinical Research in PSVT

MULTI-CENTER, PLACEBO-CONTROLLED, DOUBLE-BLINDED, DOSE-RANGING PHASE II ELECTROPHYSIOLOGICAL STUDY OF INTRANASAL ADMINISTRATION OF ETRIPAMIL FOR THE CONVERSION OF ***INDUCED*** PSVT (NODE-1)

Clinicaltrial.gov ID: NCT02296190

ELIGIBILITY CRITERIA

- Subjects who met all of the following inclusion criteria were eligible to participate:
  - Male or female, aged ≥18 years;
  - History of PSVT;
  - Scheduled to undergo EP study and possible catheter ablation;
  - Provided written informed consent.

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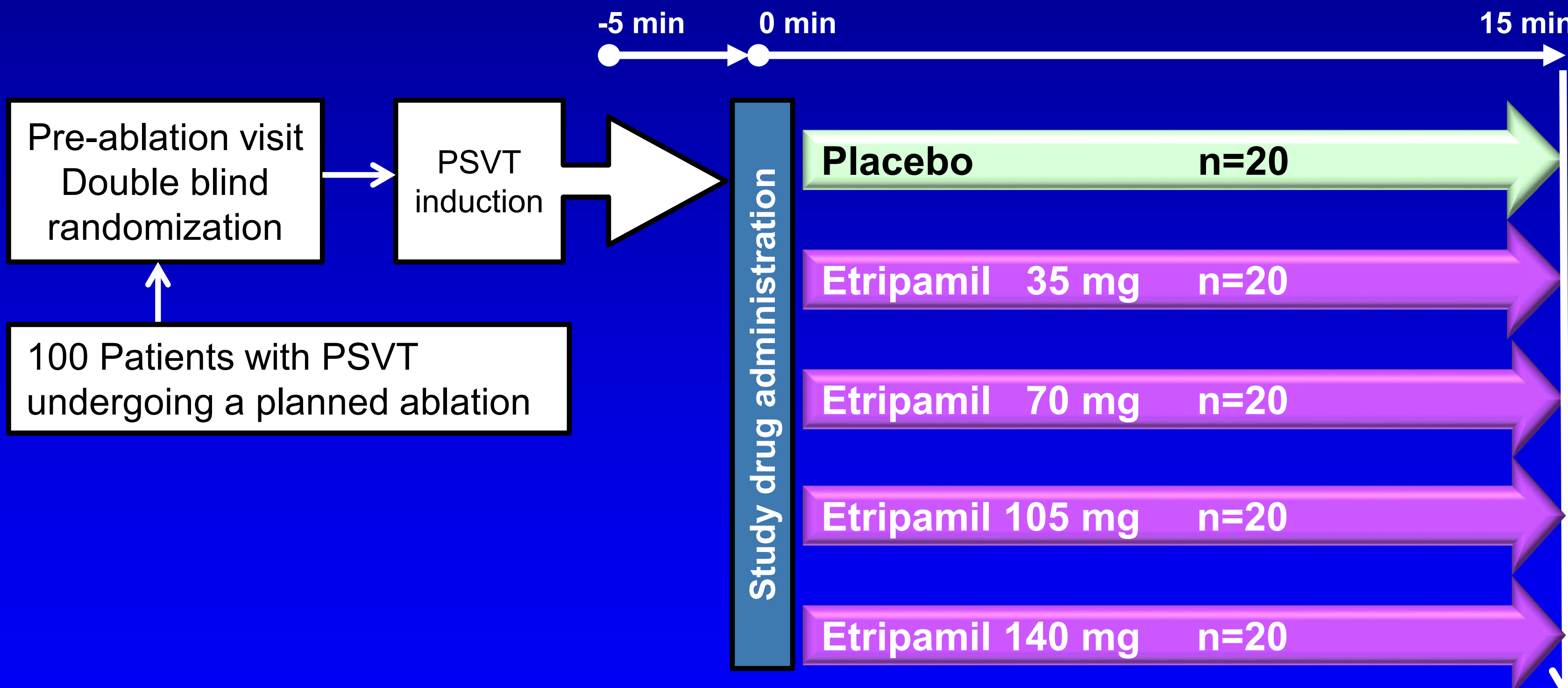
STUDY DESIGN

Objectives: Demonstrate **superiority of intranasal etripamil over placebo** in terminating SVT induced in the EP Lab and perform a **dose ranging trend analysis**



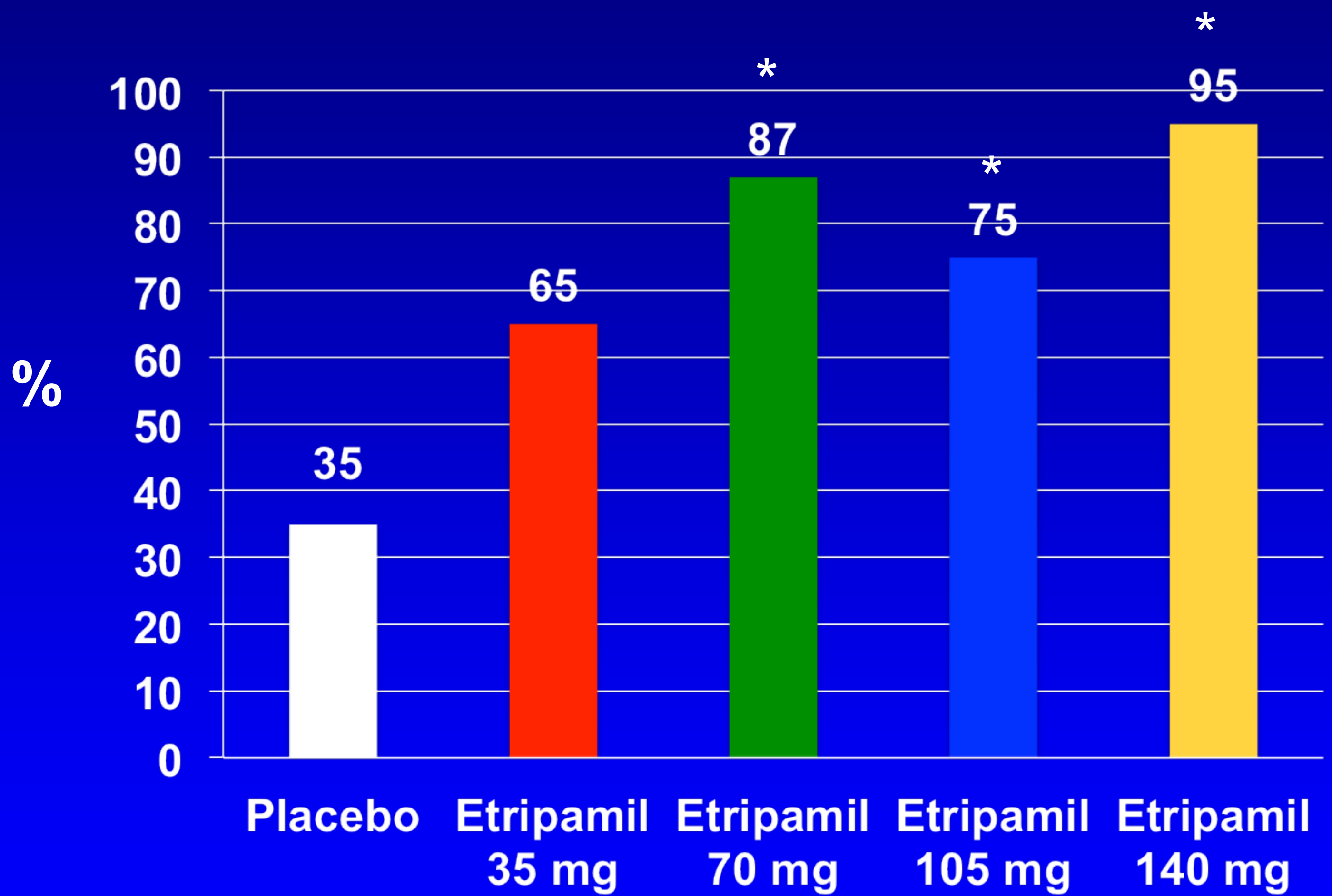
Primary endpoint: conversion within 15 min

>80% power to show a 50% absolute difference

(30% placebo & 80% etripamil conversion rates)

Primary Efficacy Endpoint

Conversion rate of PSVT#



#*within 15 min of study drug administration* *p<0.05 vs placebo

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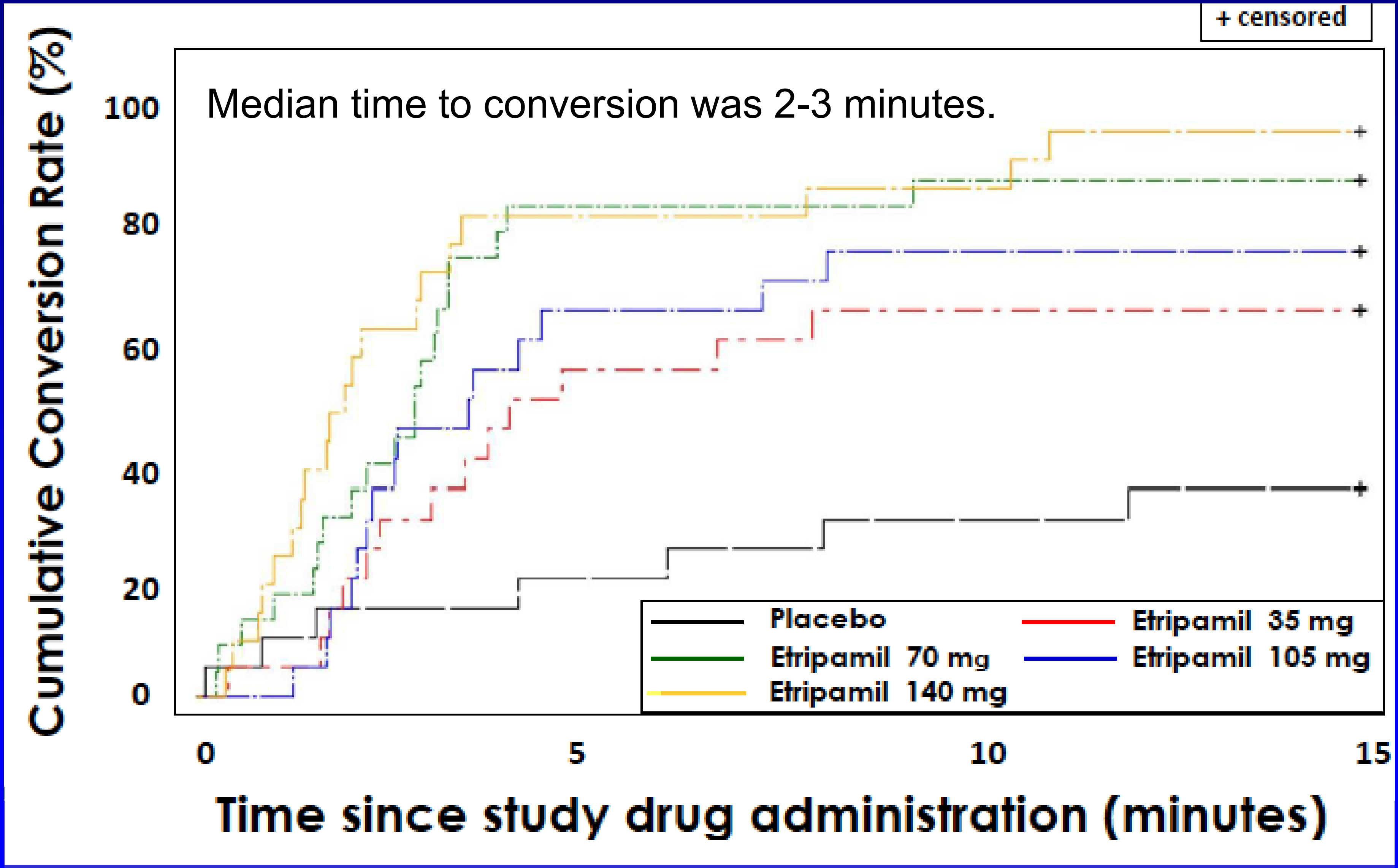
Primary Endpoint

Study drug	Placebo	Etripamil			
Dose	**0 mg**	**35 mg**	**70 mg**	**105 mg**	**140 mg**
Subjects converted at T15	**7/20 35%**	**13/20 65%**	**20/23 87%**	**15/20 75%**	**20/21 95%**
Treatment comparisons (vs. placebo)					
Odds ratio		3.45	12.38	5.57	37.14
95% CI of odds ratio		(0.79, 15.46)	(2.28, 82.26)	(1.19, 27.63)	(3.84, 1654.17)
Fisher's exact test p-value (vs placebo)		**0.1128**	**0.0006**	**0.0248**	**<.0001**
Cochran-Armitage test p-value (trend test)					<.0001

Kaplan-Meier Plots of Time to PSVT Conversion



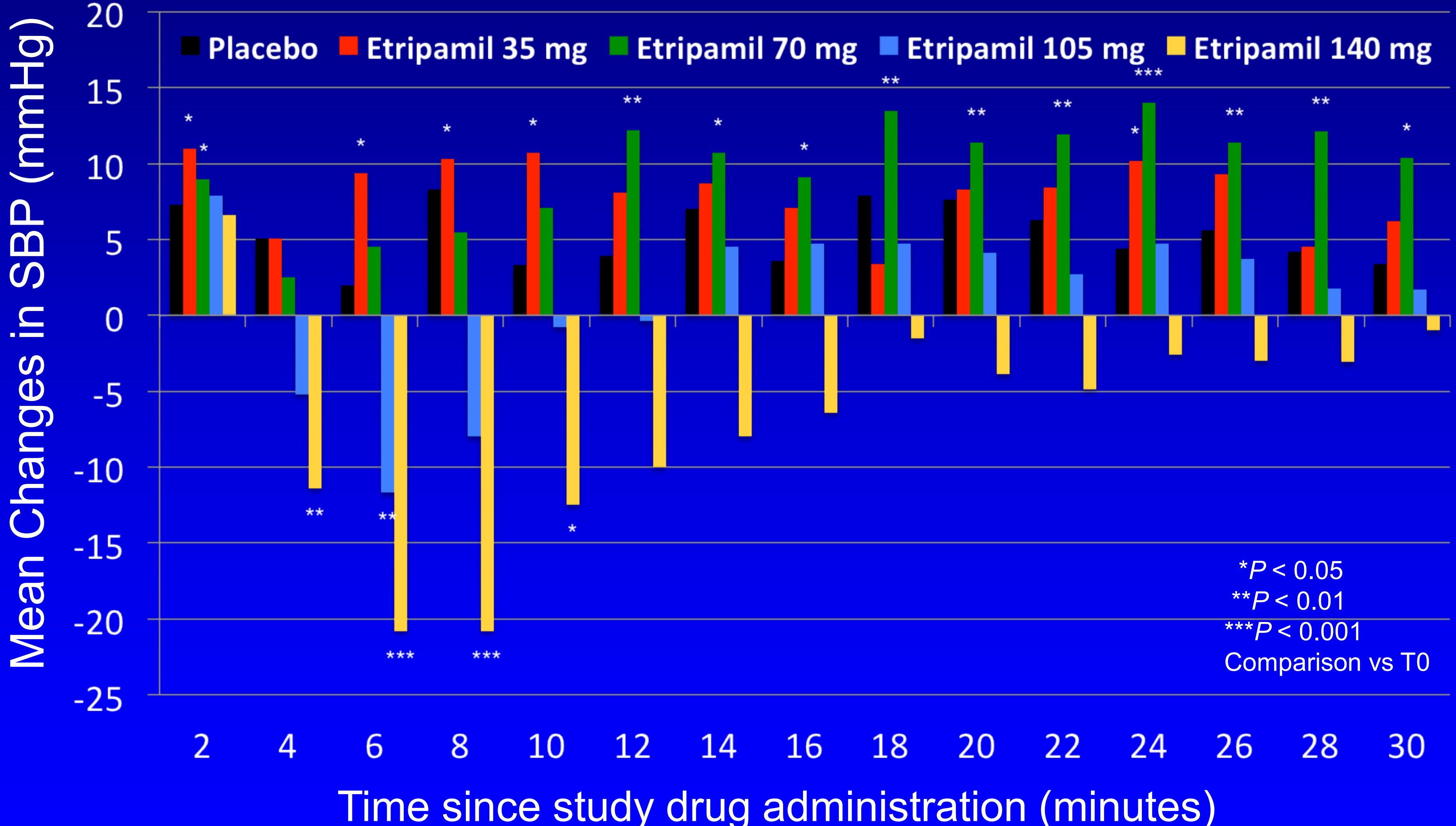
Adverse Events

System organ class	Placebo (N = 20)	Etripamil 35 mg (N = 20)	Etripamil 70 mg (N = 23)	Etripamil 105 mg (N = 20)	Etripamil 140 mg (N = 21)
NASAL DISCOMFORT	1 (5.0)	12 (60.0)	11 (47.8)	7 (35.0)	8 (38.1)
NASAL CONGESTION	0 (0.0)	5 (25.0)	6 (26.1)	9 (45.0)	8 (38.1)
THROAT IRRITATION	2 (10.0)	9 (45.0)	8 (34.8)	7 (35.0)	4 (19.0)
COUGH	0 (0.0)	0 (0.0)	4 (17.4)	3(15.0)*	2 (9.5)

Serious Adverse Event

* Severe cough occurred in one subject treated with etripamil 105 mg

Systolic Blood Pressure (SBP)



T0 = subject in SVT

node-1
Etripamil Clinical Research in PSVT

- The NODE-1 study supports development of intranasal etripamil in a “real world” setting of patient self-administration to terminate PSVT.
- If successful, etripamil could provide a fast-acting nasal spray that can safely terminate acute PSVT without the need for an urgent care visit and could change the treatment paradigm for acute management of PSVT.

NODE-301

Etripamil Clinical Research in PSVT

NOW RECRUITING

Multi-Center, Randomized, Double-Blind, Placebo-Controlled, Efficacy, and Safety Study of Etripamil Nasal Spray for the Termination of *Spontaneous* Episodes of Paroxysmal Supraventricular Tachycardia

The NODE-301 Trial

Clinicaltrial.gov ID: NCT03464019 Protocol: MSP-2017-1138

NODE-301
Etripamil Clinical Research in PSVT

RECRUITING

ELIGIBILITY CRITERIA

- Subjects who meet all of the following inclusion criteria are eligible to participate:
  - Male or female, aged ≥18 years;
  - ECG documented PSVT;
    - History suggestive of sustained episodes (lasting ~20 min or longer)
  - Signed written informed consent.