Diagnosis and Management of Common Supraventricular Tachycardias (SVT)

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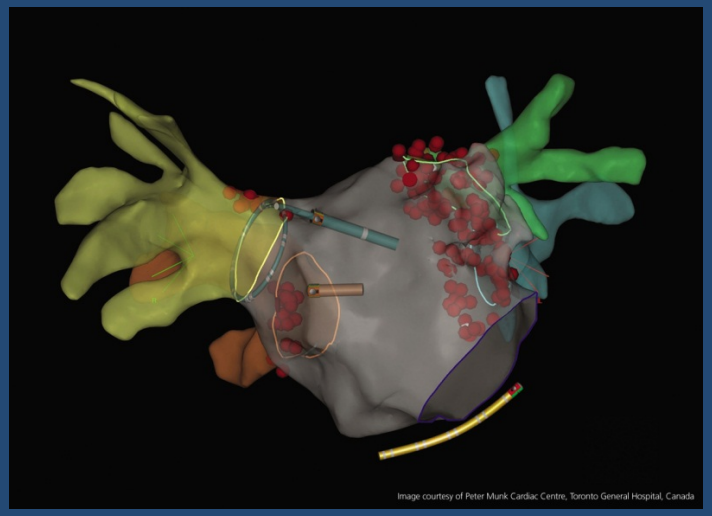

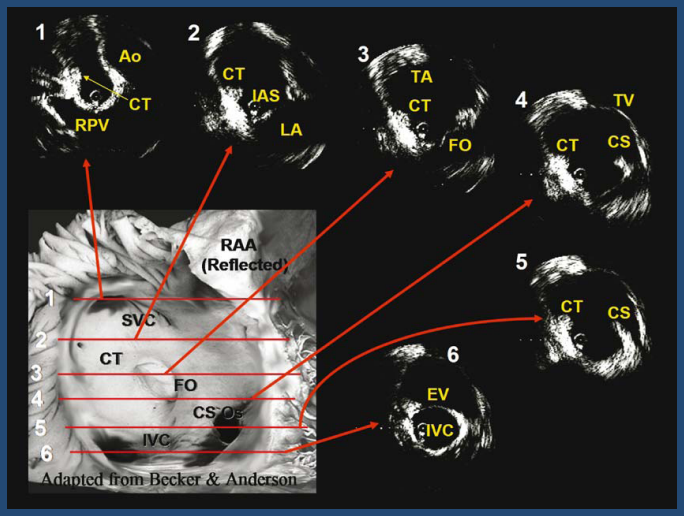

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Disclosures

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  - Samir Saba, MD, FHRS, EP Division Director, UPMC.
  - David Schwartzman, MD, FHRS, Butler Health System.
- ATTENDEES!

Objectives

- Be able to recognize the presentation, mechanism, and management of common supraventricular tachycardias.

It’s not about the nail… LISTEN!

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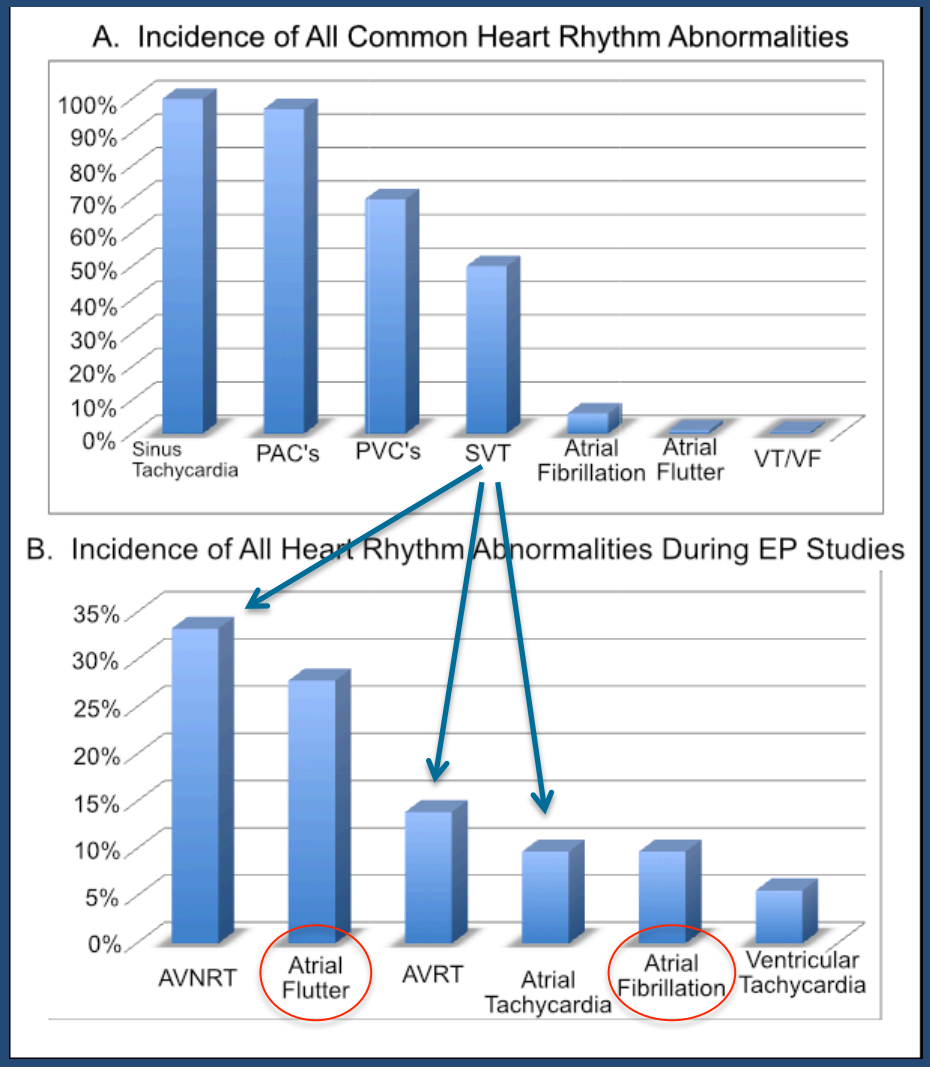
Incidence of Common SVT



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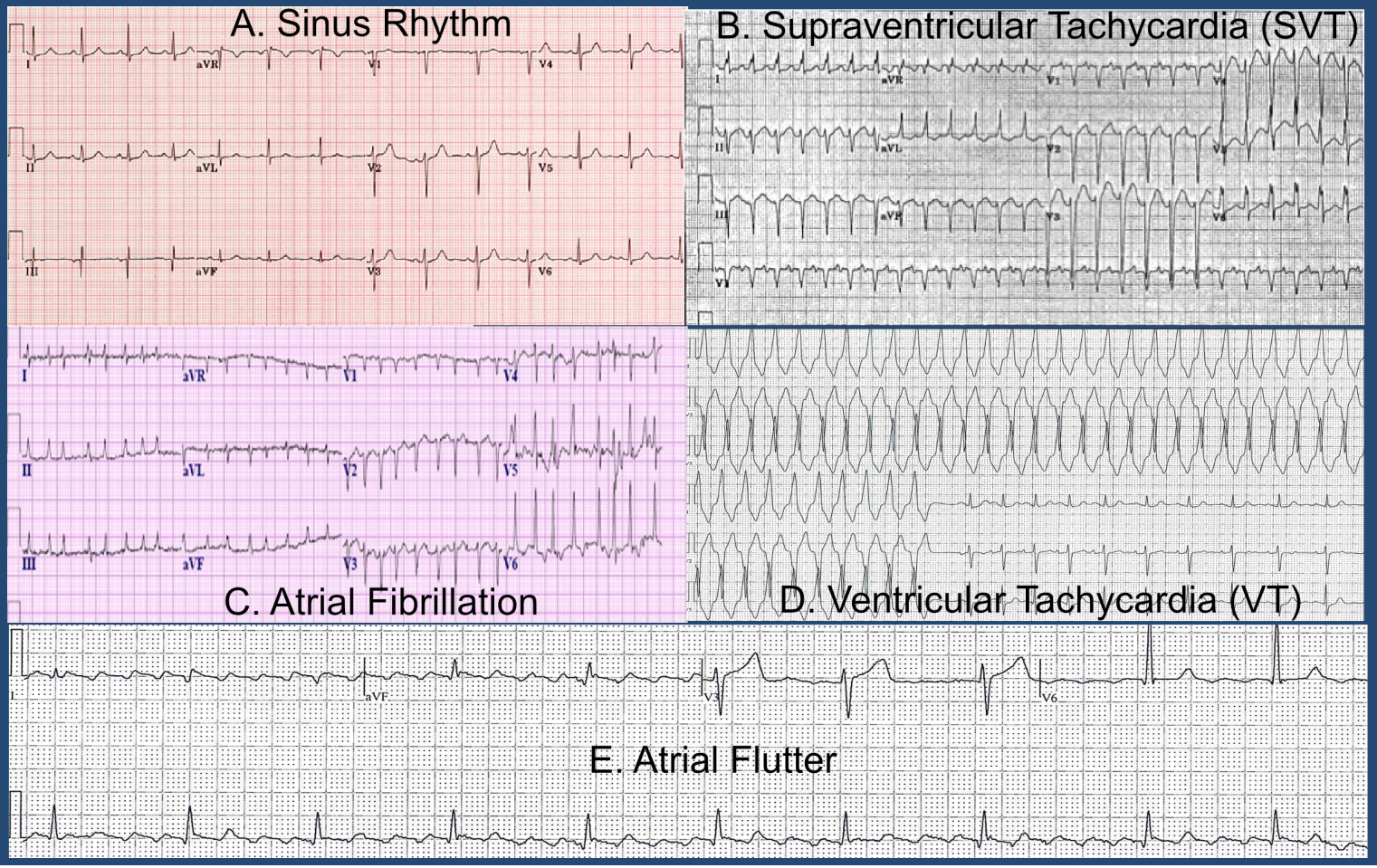
What do SVT's look like?



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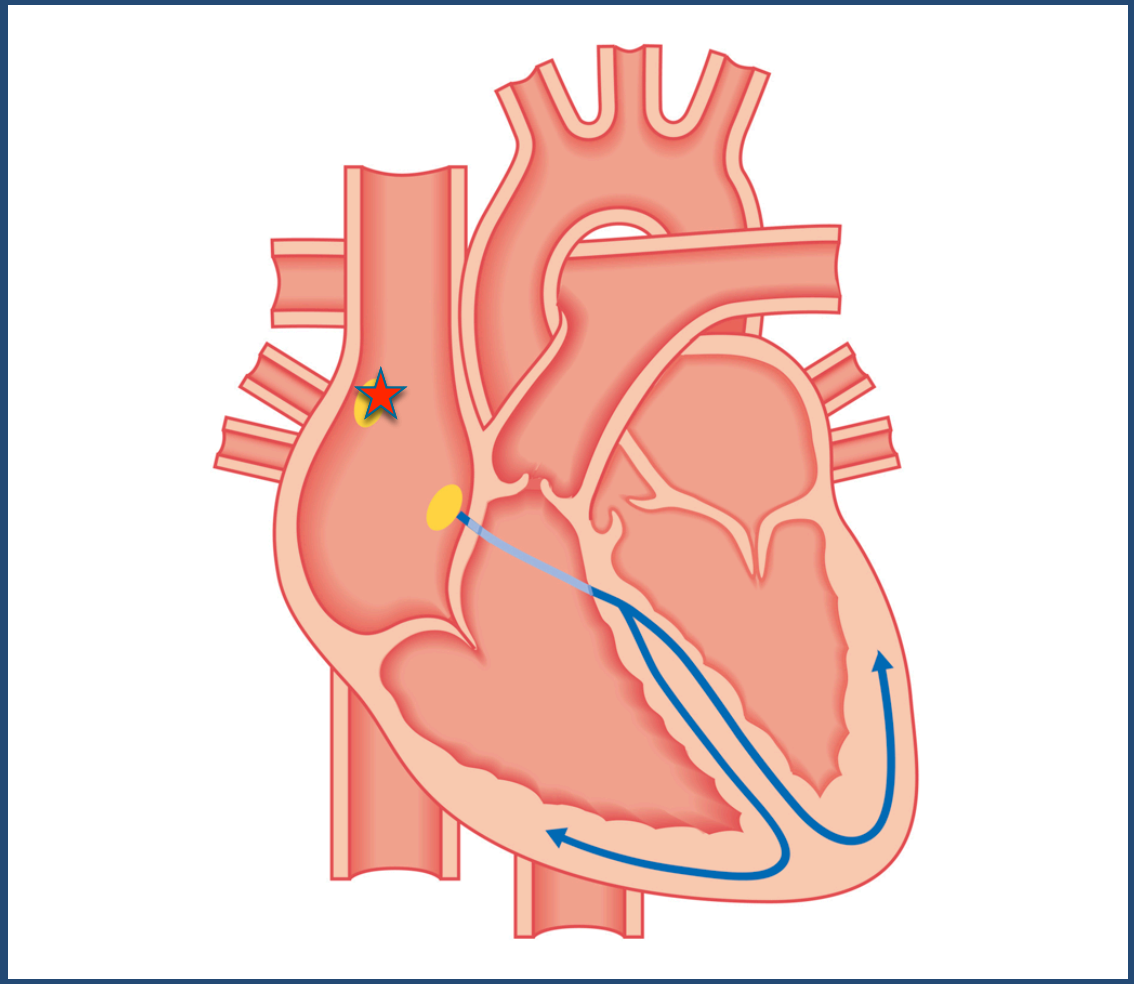
What are the symptoms of SVT's?

- Palpitations are the sensation of an irregular, fast, uncomfortable, or strong heartbeat.
  - Over 600,000 patients present to Emergency Departments each year in the United States (Probst et al. 2014) because of palpitations.
  - One in four of these patients will be admitted to the hospital for further care and roughly a third of patients will be diagnosed with a heart condition.

Cardiac Conduction System

SA Node

AV Node



Left Bundle Branch

Right Bundle

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Case #1: 52yo female with long history of palpitations but no documented arrhythmias.

- 52 yo female with no significant PMH has 30 year history of abrupt onset/offset of heart racing that can last several minutes to hours.
- May occur several times per week then no symptoms for several months.
- Sometimes terminates with vagal maneuvers.
- Multiple office evaluations including echo, stress, and holters were unremarkable.

You're thinking… thorough workup and not a single episode of arrhythmia. Perhaps supratentorial issue?

80% of patients can be diagnosed from their history.*

* Hampton JR, Harrison, MJF, Mitchell JRA, Prichard JF, Seymour C, “Relative contributions of history-taking, physical examination, and laboratory investigation to diagnosis and management of medical outpatients,” British Medical Journal, V. 2 (1975), pp. 486-89.

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Case #1: Look harder for hints to the mechanism

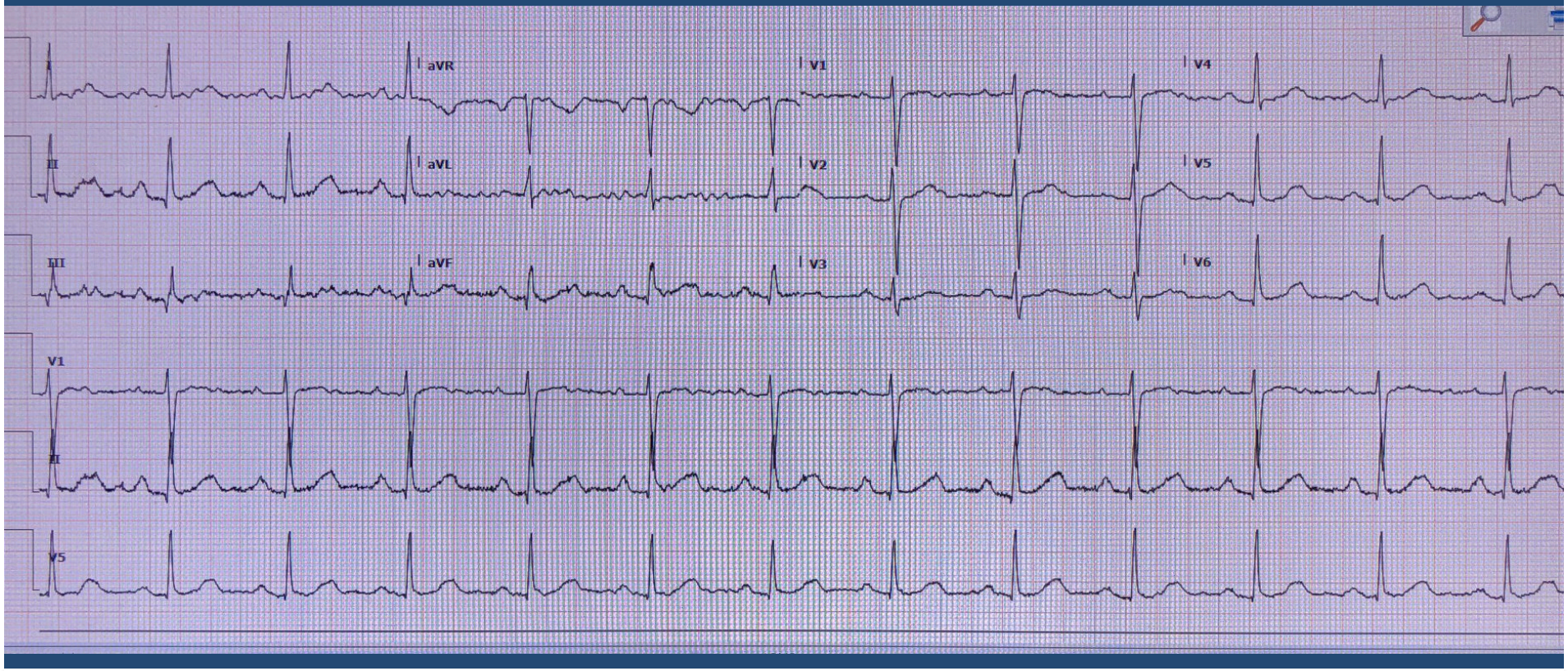
- *Sudden onset and offset*: Suspicious for SVT (AT, AVNRT, AVRT, Atrial Fibrillation/Flutter)
- *Regular*: Argues against Atrial Fibrillation/ Flutter but does not rule out.
- *Response to vagal maneuvers*: Suggests AV node is part of arrhythmia reentrant circuit. Vagal maneuvers should not terminate AT/ Afib/Aflutter.

AV Node Reentrant Tachycardia (AVNRT)

- Most common SVT that we induce during EP studies.
- 15-30% of population has “dual AV-node physiology.”
  - Most day-to-day conduction is from “fast” AV node pathway.
  - Patients with “dual AV node physiology” may occasional use the “slow” AV node pathway.

ECG Findings with AVNRT

- Generally normal resting ECG



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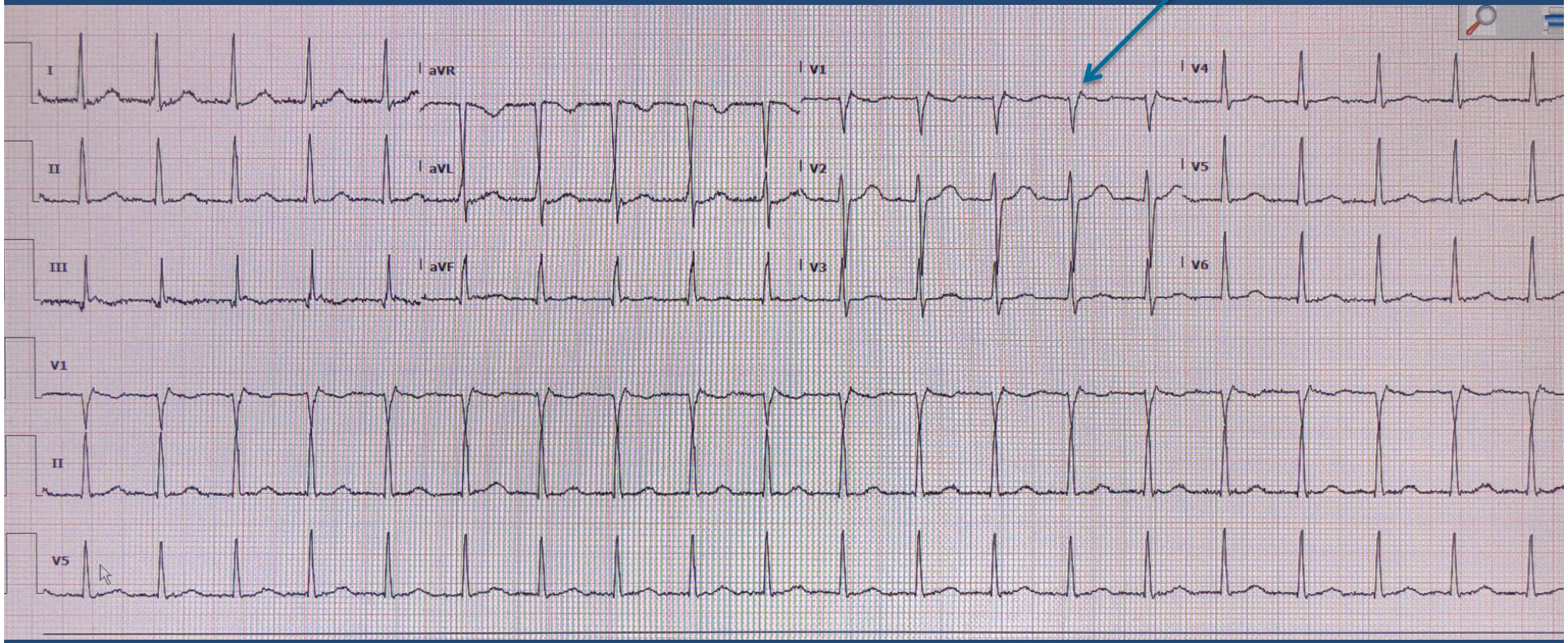
ECG Findings with AVNRT

- ECG in SVT usually narrow QRS with pseudo-r' in V1.



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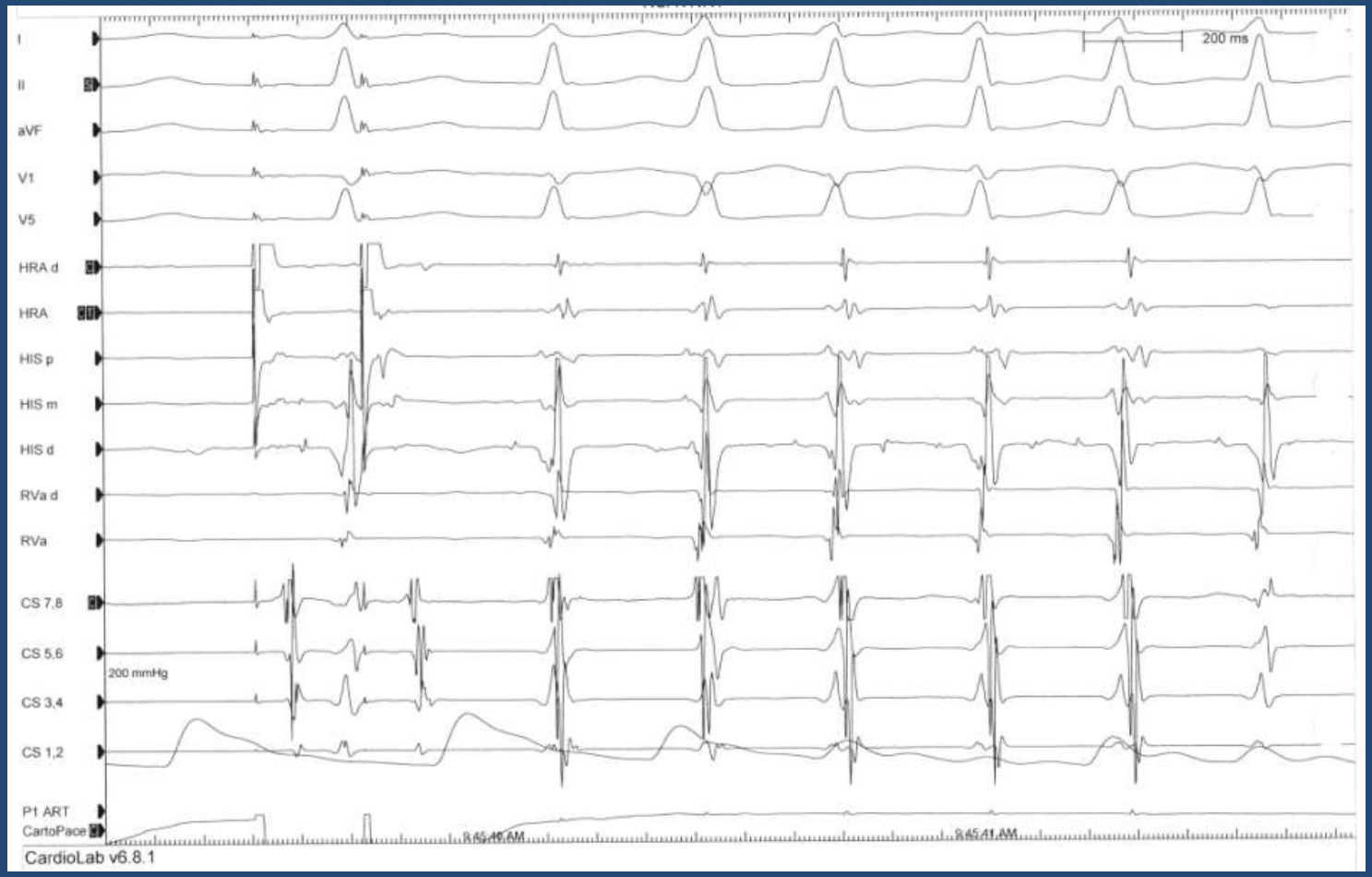
Why does typical AVNRT have P wave buried at end of QRS?



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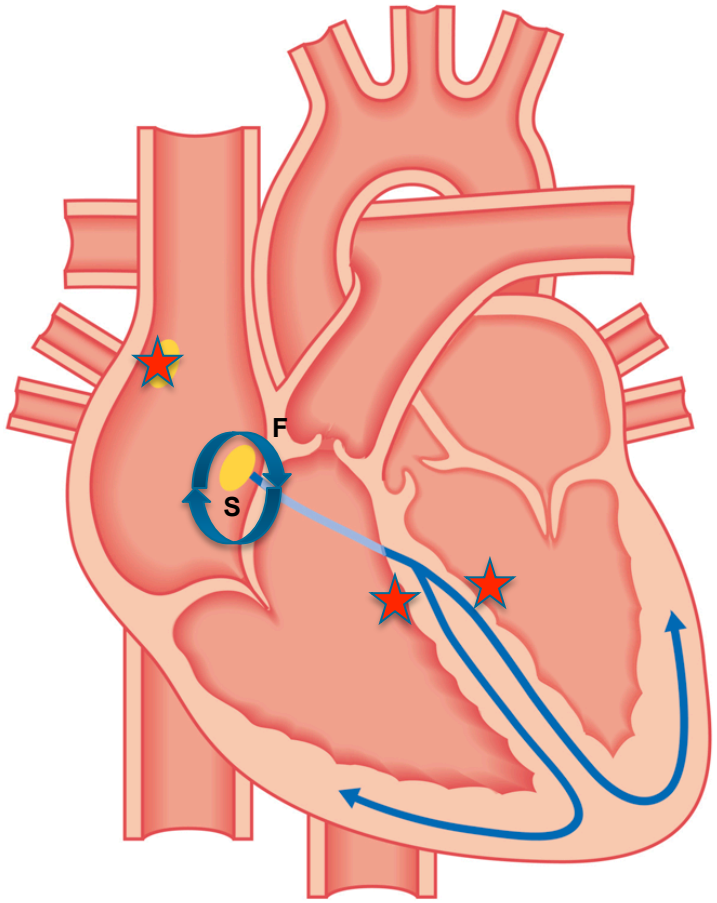
Mechanism of AVNRT

- Typical AVNRT: down slow AVN pathway and retrograde fast AVN pathway.
- Atypical AVNRT(shown): down fast AVN pathway and retrograde slow AVN pathway.



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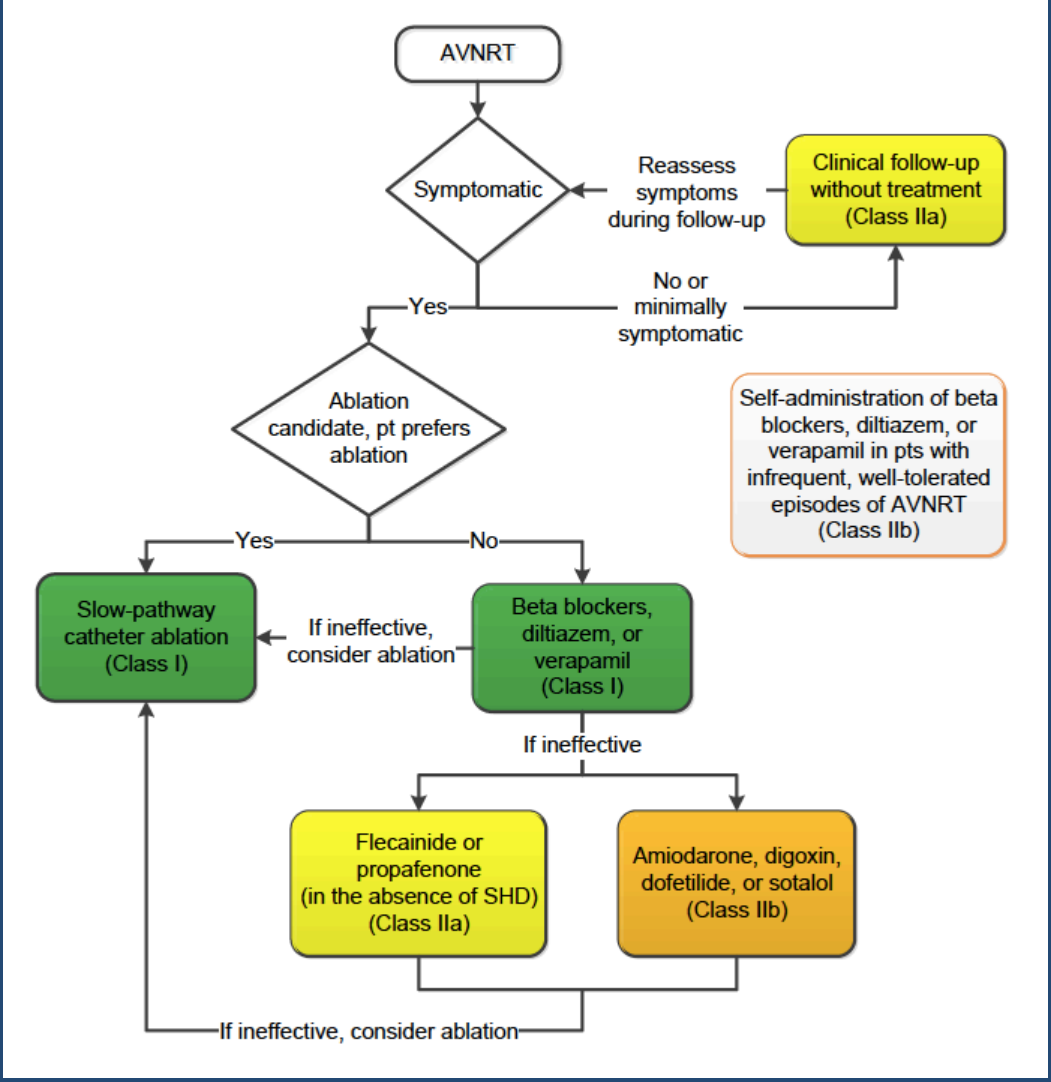
Management of AVNRT



Page RL, et al. 2015 ACC/AHA/HRS Guideline for Management of Adults with Supraventricular Tachycardia. JACC 2016;13: e27-115

Case 2: 22yo male with palpitations

- Developed over last 1-2 years.
- Short bursts of a regular tachycardia (some faster than others) that seems to start abruptly then slowly resolve.
- Multiple ER visits document only sinus rhythm or sinus tachycardia.
- Beta blockers and calcium channel blockers help but do not eradicate symptoms.
- GXT stress, echo, and labs all normal.

You are thinking…

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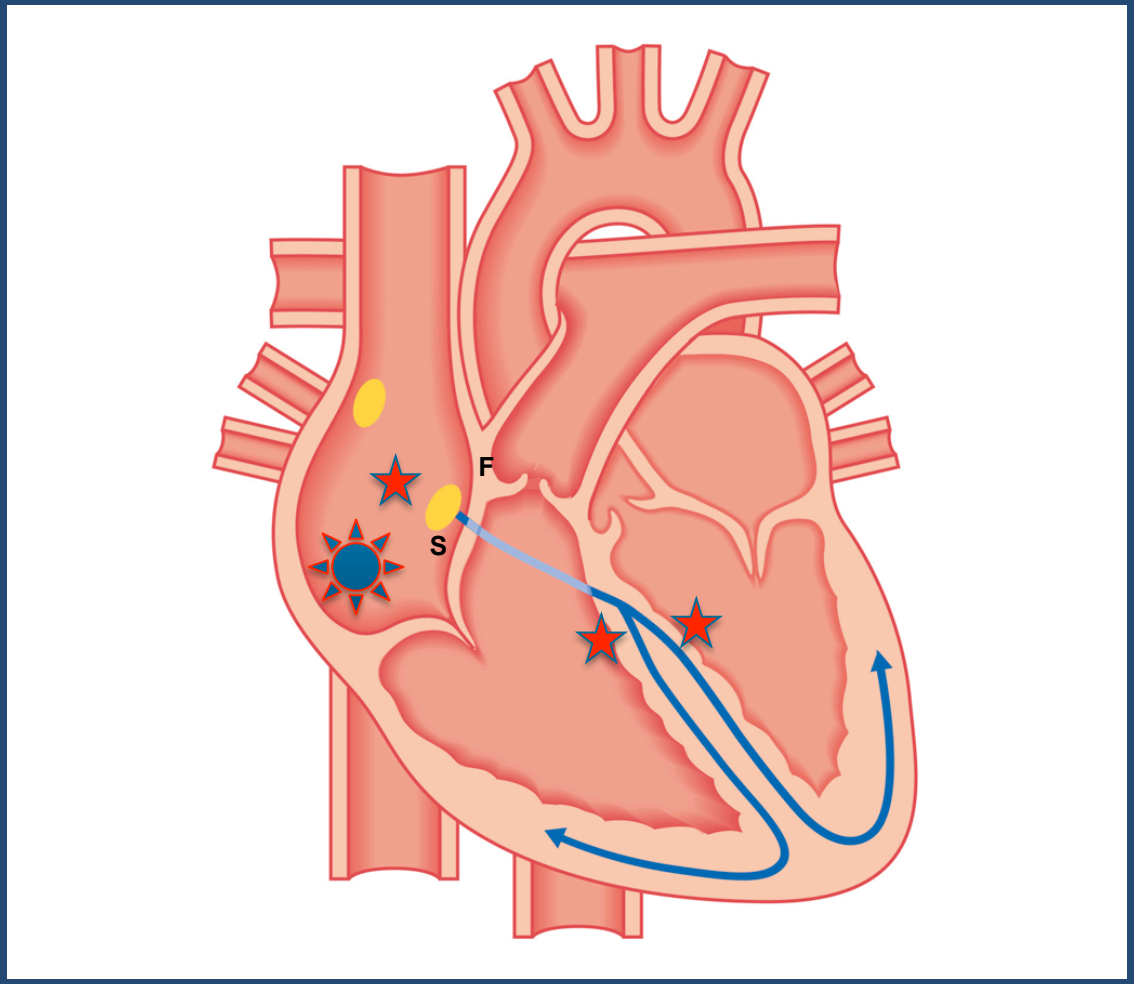
Case 2 Hints at mechanism

- *Abrupt onset* favors an SVT.
- AV nodal agents help.
- *Gradual offset*: sometimes SVT starts, patient gets anxious then sinus tachycardia ensues and overtakes/terminates SVT.
  - Overdrive suppression of atrial tachycardia.
- *Varying rates of tachycardia* suggests perhaps different foci of atrial tachycardia?
  - Tachycardia cycle length "wobble"

Mechanism of Atrial Tachycardia

- Focus often in the lateral right atrium overdrive suppresses the sinus rhythm and dictates heart rate.
- Adenosine generally does not terminate but may cause AV block so you can identify atrial tachycardia morphology.



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ECG of Atrial Tachycardia

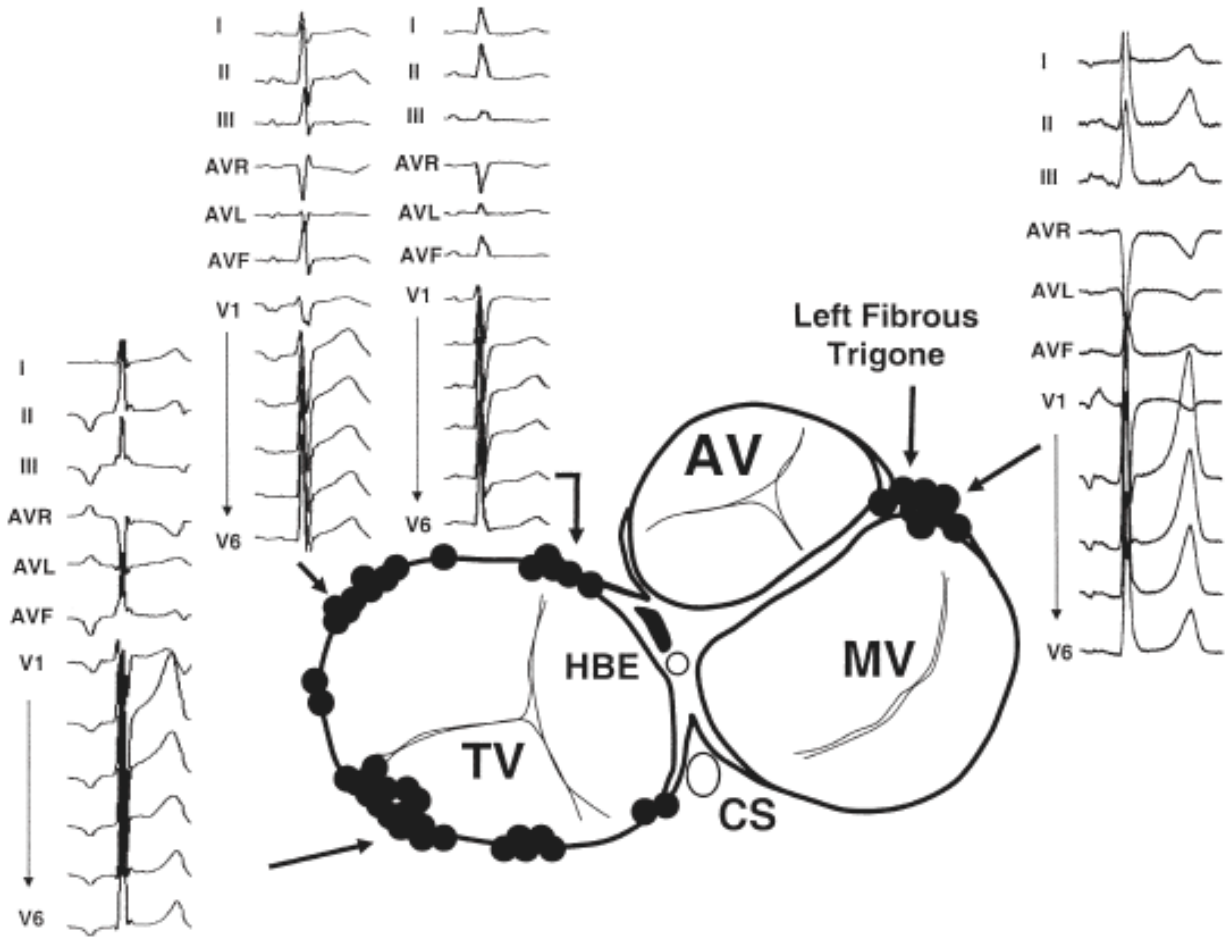


Figure 2. Anatomic distribution of tachycardia foci and tachycardia P waves at the atrioventricular valvular annuli. AV = atrioventricular; HBE = His bundle electrogram; MV = mitral valve; other abbreviations as in Figure 1.

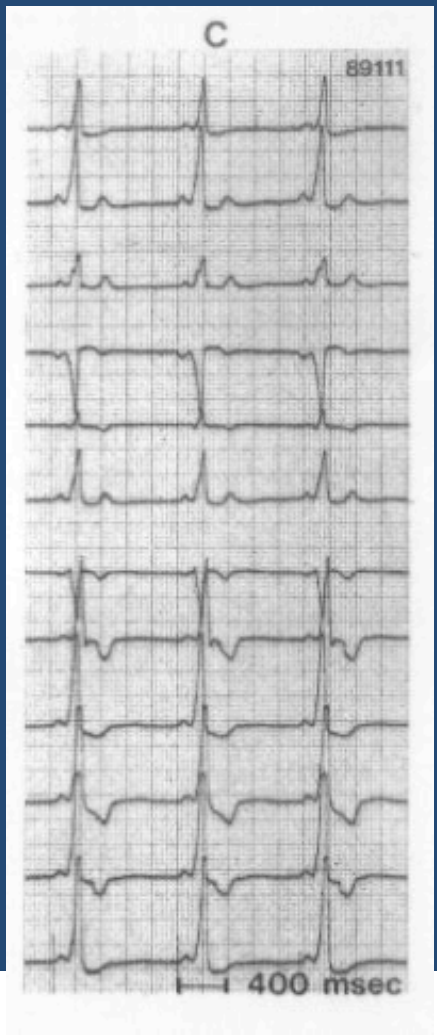
- Taken from Kistler et al, "P wave morphology in focal atrial tachycardia," JACC, V. 48, No. 5 (2006)

Treatment of Atrial Tachycardia

- Try various types of AV nodal agents.
- EP study an option but:
  - Anesthesia may suppress AT.
  - AT often has multiples sources and ablation success ~80-85%.
- Nonfatal though annoying.

Case 3: 23yo Mennonite with palpitations, syncope, and abnormal ECG

- Symptoms since childhood.
- Breath holding often terminates palpitations.
- History of occasional syncope.
- One ER visit had atrial fibrillation reported by EMS.



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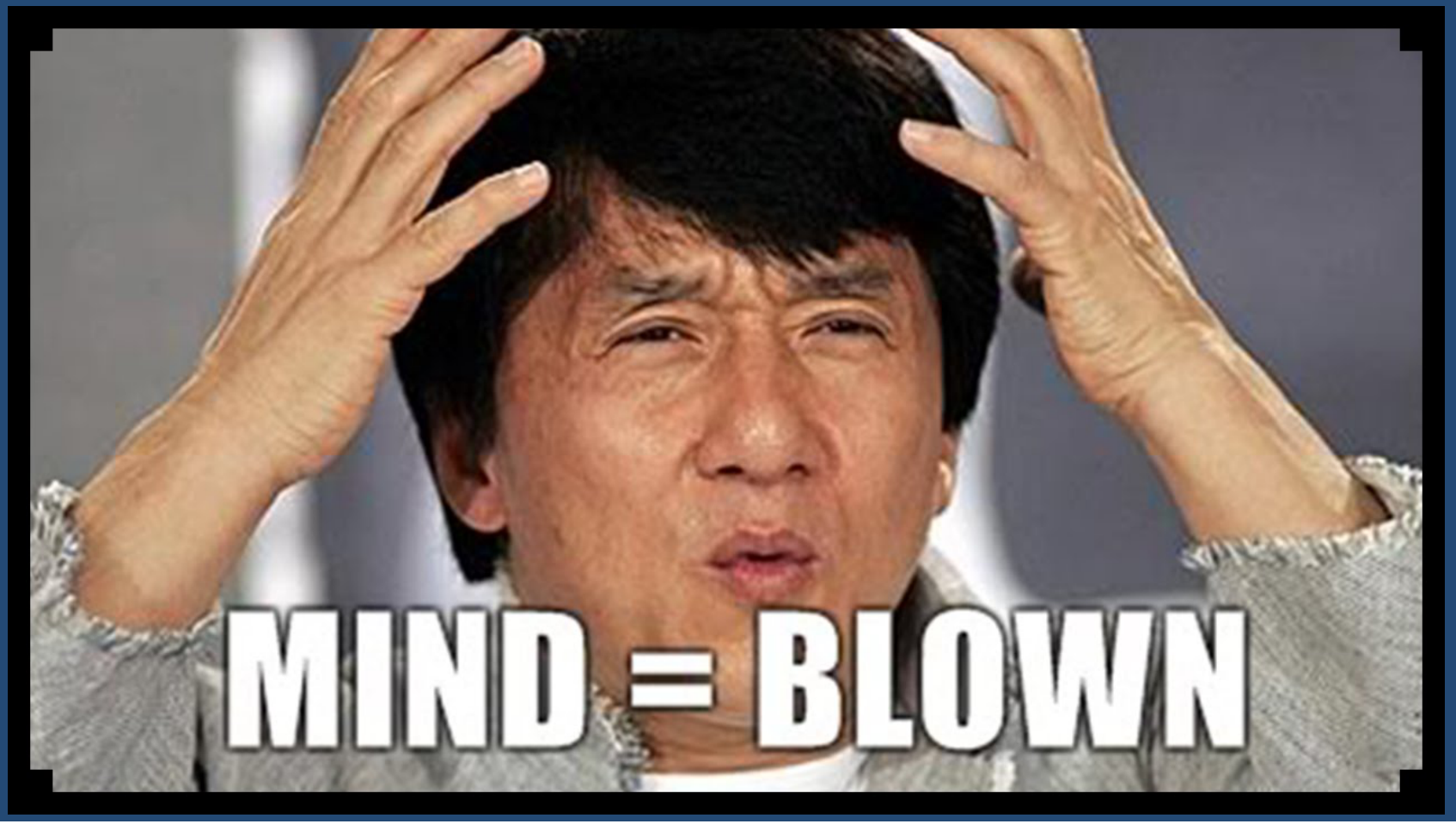
You are thinking…



Case 3: Hints at mechanism

- *Symptoms since childhood*: WPW onset often in teens or twenties.
- *Breath holding often terminates palpitations*: AV node is part of circuit with AV reentrant tachycardia.
- *Syncope*: Syncope in patients due to Wolff-Parkinson-White (WPW) syndrome may be related either to a rapid rate of supraventricular tachycardia or to rapid ventricular response over the accessory pathway during atrial fibrillation (AF). ~20% of patients with WPW syndrome have history of syncope.
- *Atrial fibrillation*: The incidence of spontaneous degeneration of induced AVRT into AF has been reported to be in the range of 16% to 26%.

- Paul T et al, "Relation of syncope in young patients with Wolff-Parkinson-White syndrome to rapid ventricular response during atrial fibrillation," Am J Cardiol. 1990 Feb 1;65(5):318-21.
- Centurion OA et al, "Atrial Fibrillation in the Wolff-Parkinson-White Syndrome," J Atr Fibrillation. 2011 May-Jun; 4(1): 287.

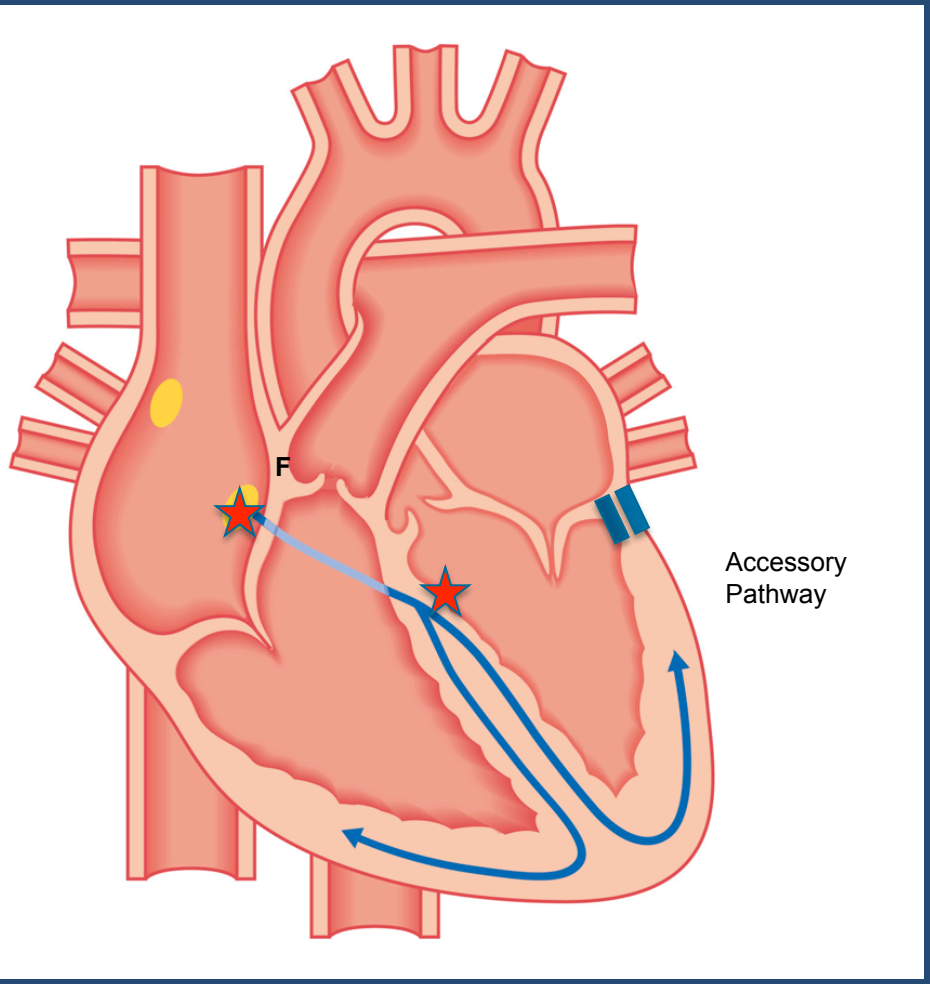
What is an accessory pathway?

- The heart's cardiomyocytes develop fibrous tissue between the atria and ventricle during the gestational stages of the seventh and twelfth week. The normal process of closure between the atria and ventricle does not occur and these accessory fibers allow conduction to occur between the two, outside of the normal pathway of the AVN.
- In normal conduction through the AVN there is a delay; however, there is no such delay in the conduction system of a patient with a conducting AP, in which the conduction through the AP can be anterograde, retrograde, or both.

Wilk D and Williams JL, "Genetic Forms of Wolff-Parkinson-White," EP Lab Digest, Volume 12 - Issue 10 - October 2012

Mechanism of Atrioventricular Reentrant Tachycardia (AVRT)

- Orthodromic AVRT (shown): down AV node and retrograde AP.
- Antidromic AVRT: down AP and retrograde AV node. This will be a wide complex (preexcited) tachycardia.



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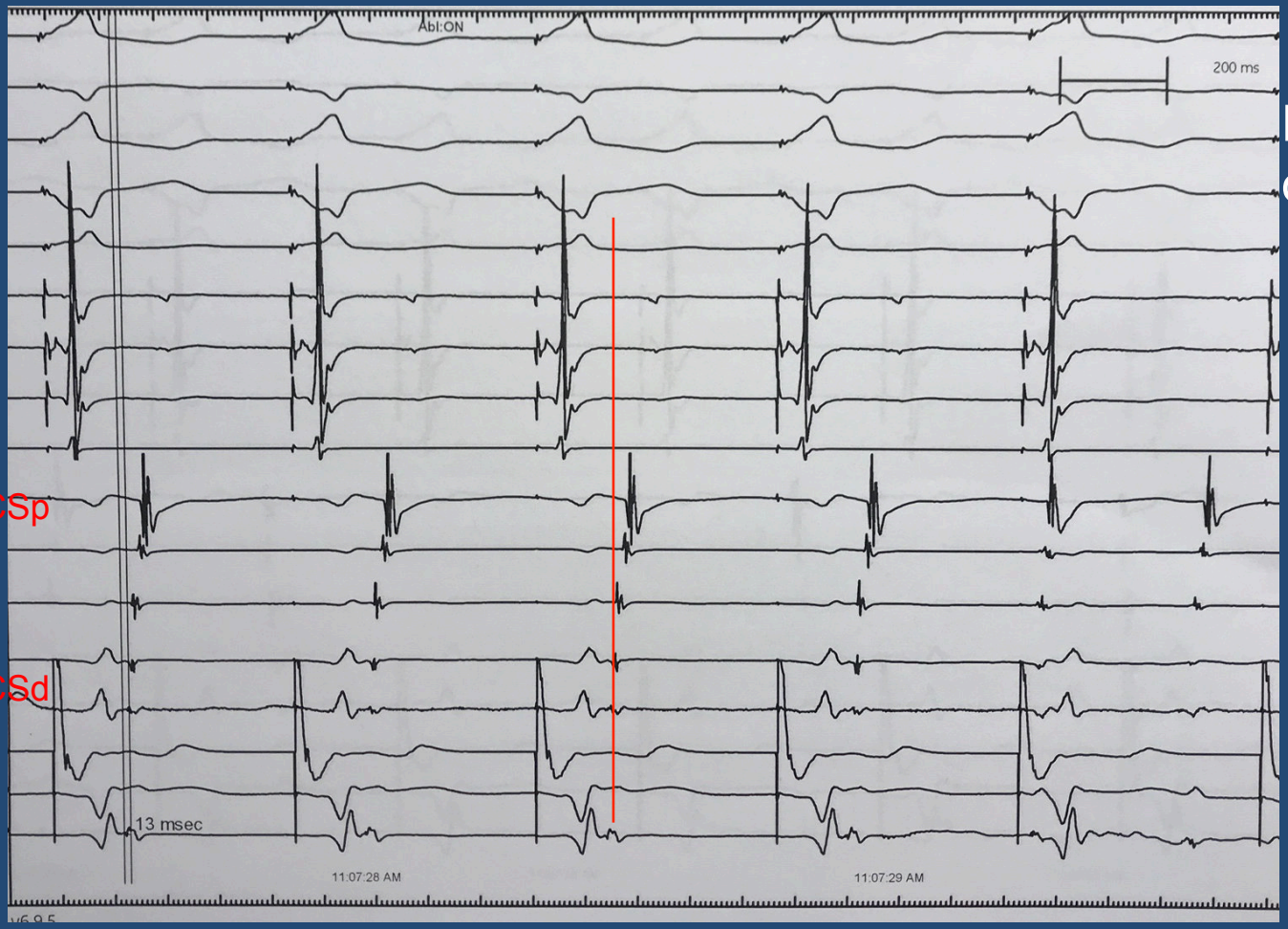
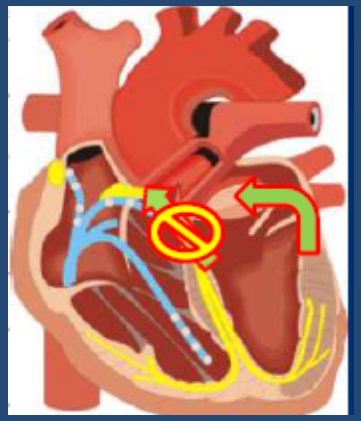
Ventricular Pacing: Eccentric Retrograde Conduction via Accesory Pathway



Earliest activation in distal coronary sinus.



- Pacing the ventricle and earliest atrial activation distal coronary sinus.

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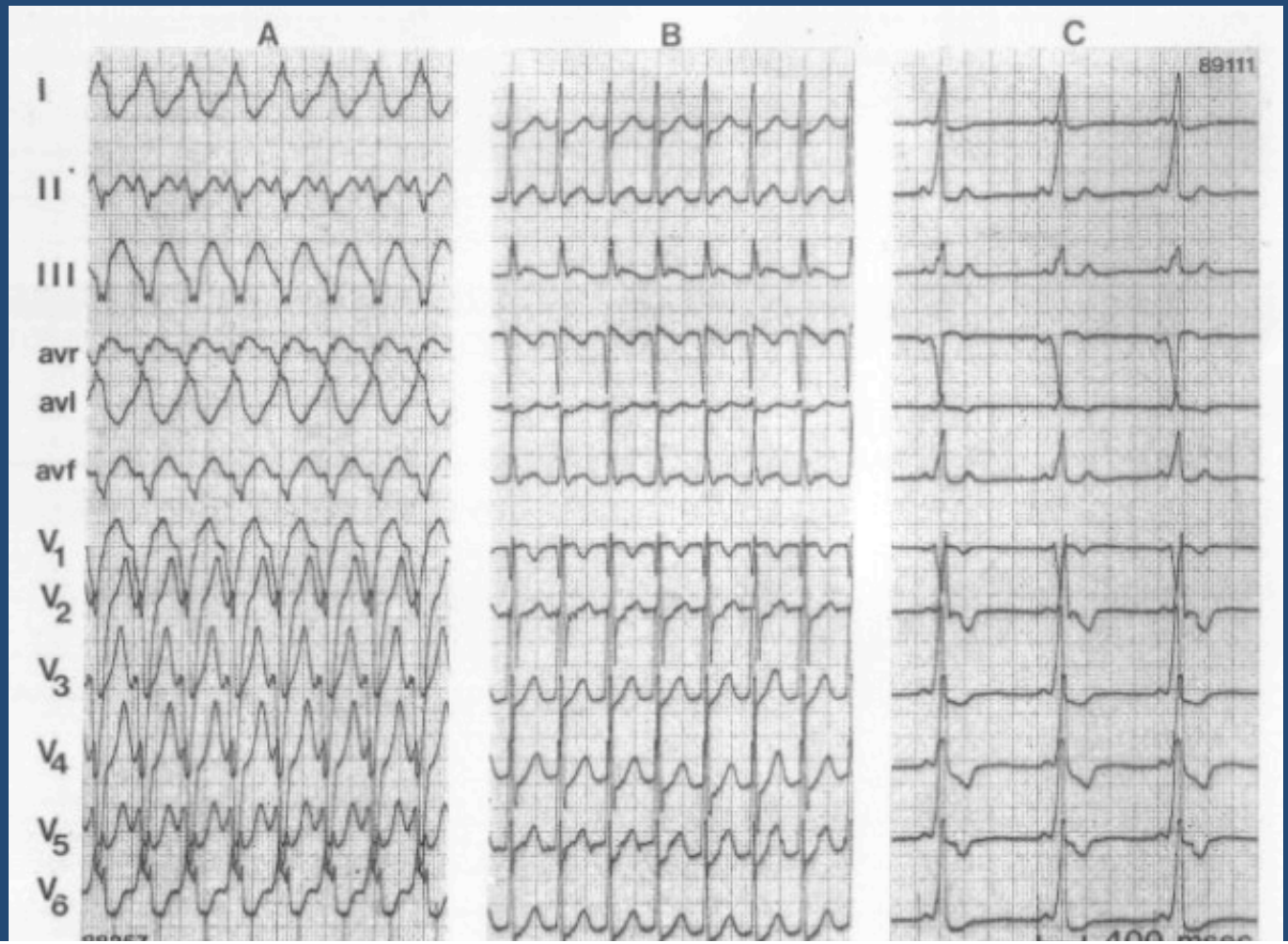
AVRT: Orthodromic versus Antidromic



A: Antidromic (down AP and up AVN) tachycardia, B: Orthodromic AVRT (down AV node and up L lat AP), C: SR preexcited.

AP Localization:

1. – or ± in I: Left lateral
2. QS in II: MCV left posteroseptal
3. – or ± in V1: Septal
4. Absent 1-3: R free wall (delta prior to completion of P wave)

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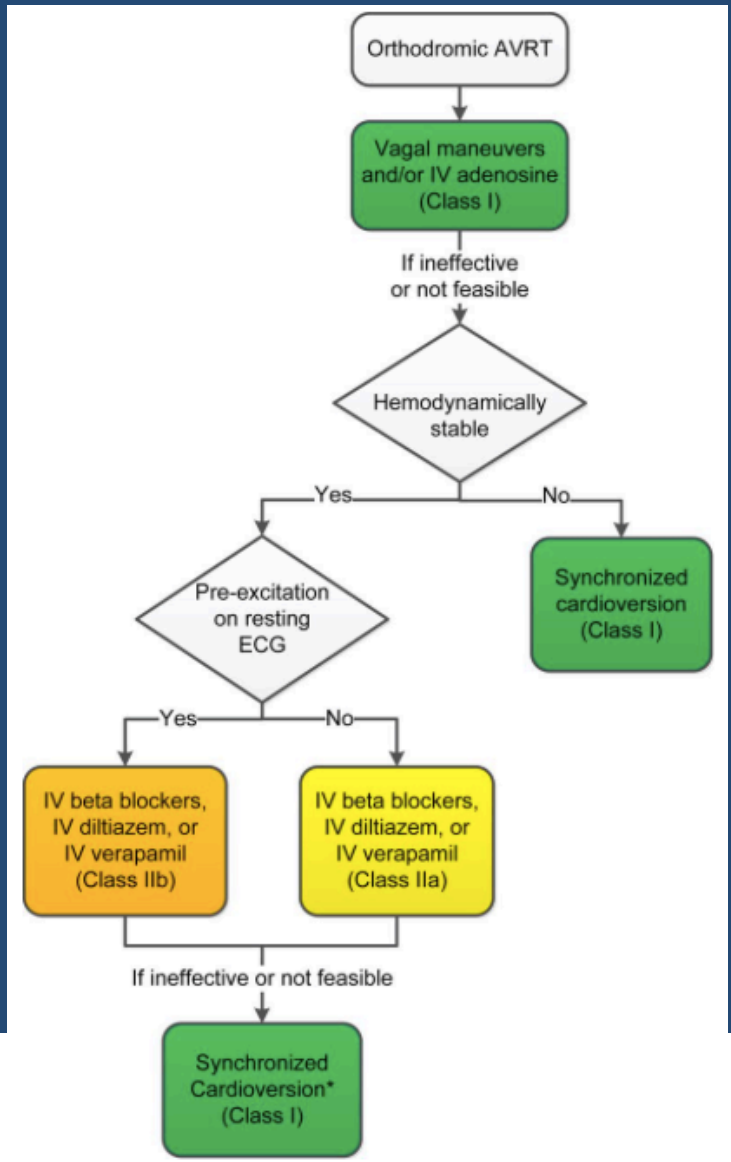
Acute Treatment of Orthodromic AVRT



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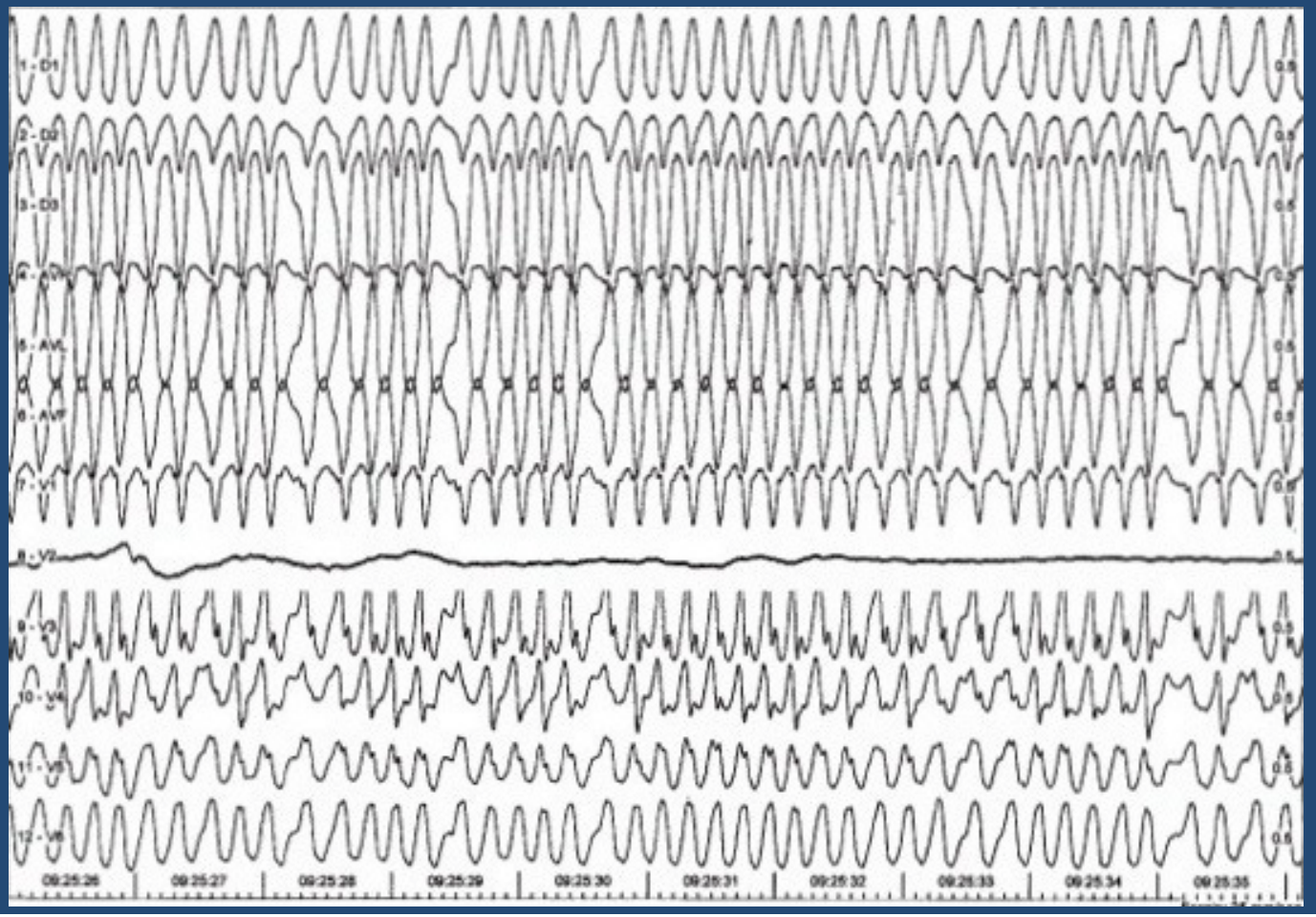
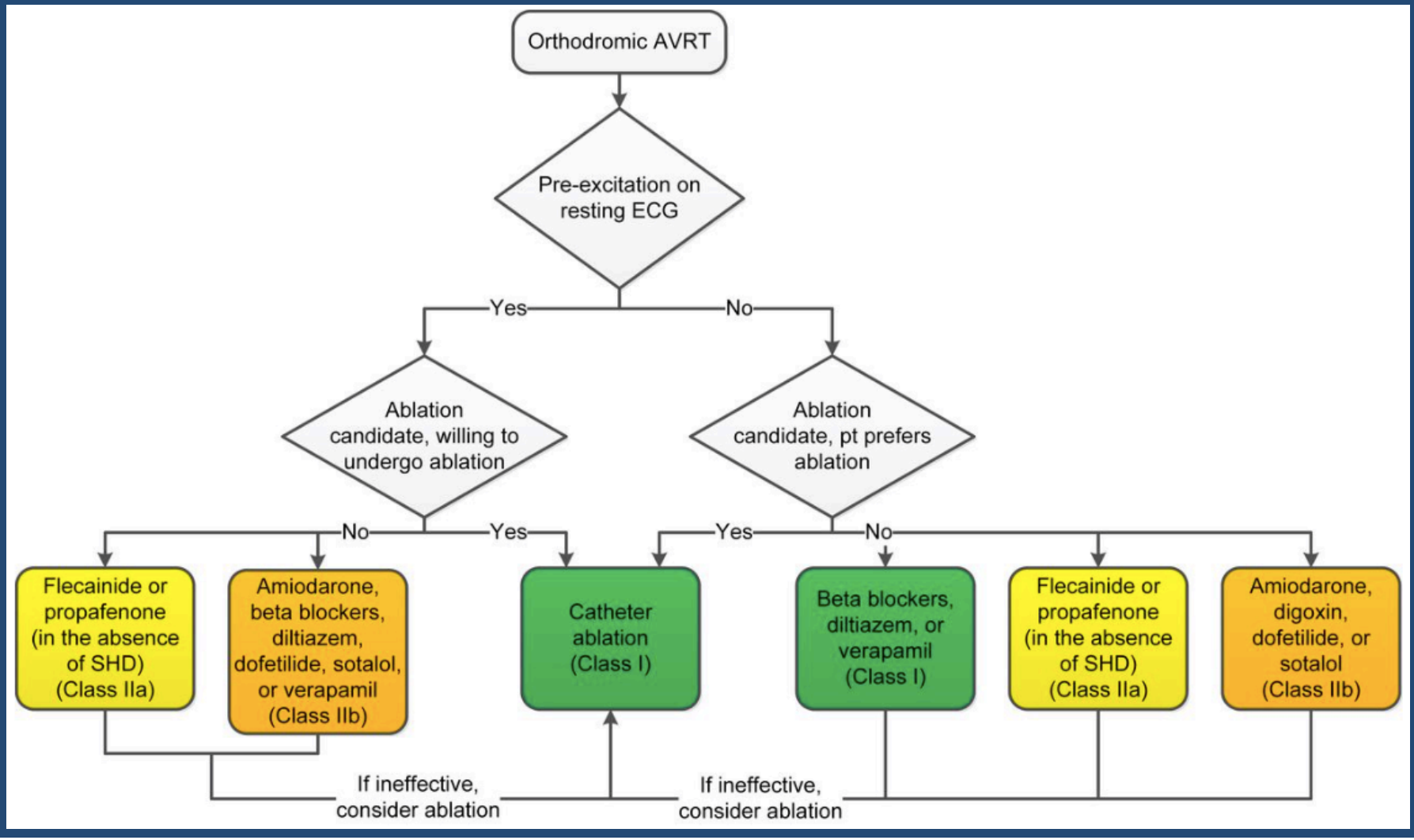
Preexcited Atrial Fibrillation



Treatment of Orthodromic AVRT



Page RL, et al. 2015 ACC/AHA/HRS Guideline for Management of Adults with Supraventricular Tachycardia. JACC 2016;13: e27-115

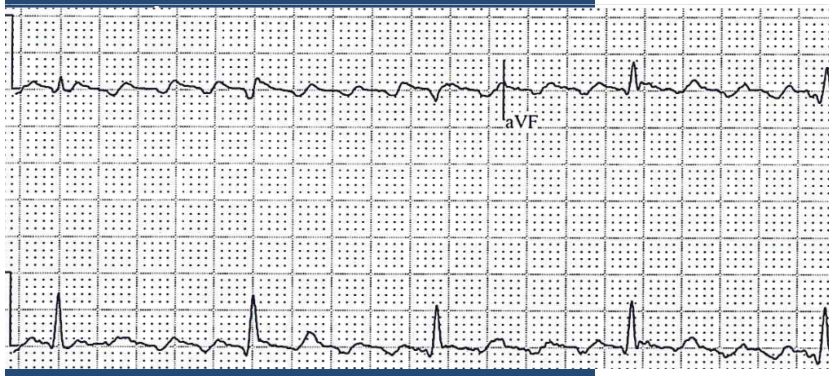
73yo male with SOB, palpitations, and dizziness.

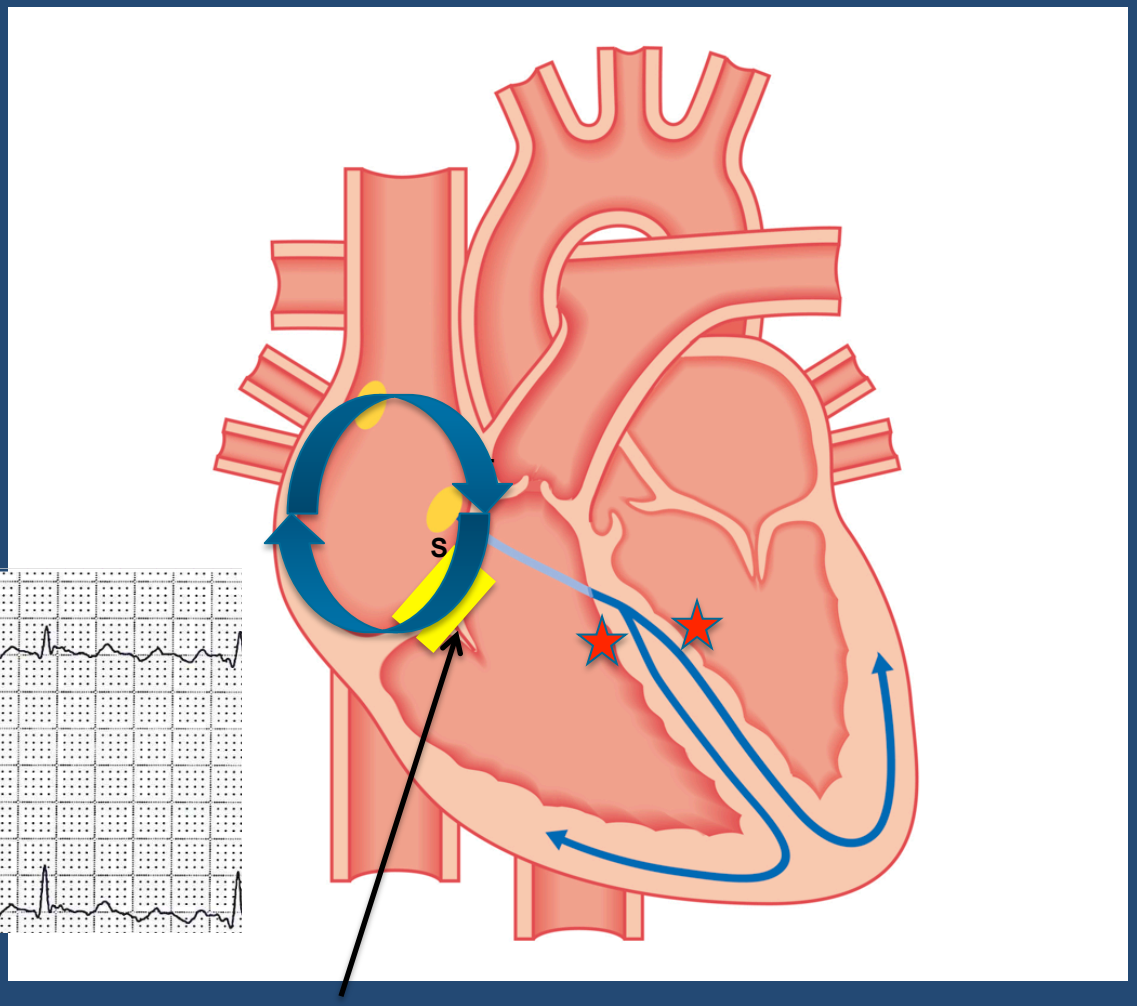
- ECG in office shows atrial flutter.
- Started on Eliquis due to CHADSVASC score.
- Heart rates controlled with metoprolol 25mg po BID. Holter shows average ventricular response is 80bpm.
- Echo with normal EF and no valve disease.

You are thinking, “Dude, I just diagnosed atrial flutter!”

Mechanism of Atrial Flutter

- Typical CTI atrial flutter: atrial activity rotates counterclockwise around right atrium.
- Atypical CTI atrial flutter (shown in animation): atrial activity rotates clockwise around





Cavotricuspid Isthmus: area between IVC and tricuspid valve that serves as "circuit" for atrial flutter.

Treatments for Atrial Flutter/ Fibrillation

- Anticoagulate both fibrillation and flutter!
- Rate control and anticoagulation
- Rhythm control and anticoagulation

Case #3: Typical atrial flutter

- Reasonable to anticoagulate with Eliquis for 4-6weeks to ensure no left atrial thrombus then arrange cardioversion.
- Consider EP study and ablation for recurrent atrial flutter within 3-9months of cardioversion.
  - There is a role for EPS at first presentation of atrial flutter.
  - 60-70% of patients with aflutter have had afib within preceding year.

Antiarrhythmics for SVT's

Vaughan-Williams Class	Medications	How it is used	Side Effects
1 (Sodium Channel Blockers)	Flecainide, Procainamide, Disopyramide, Quinidine	Atrial fibrillation, accessory pathways, ventricular arrhythmias	Could cause arrhythmias, dry mouth, decrease heart contractility, ECG abnormalities.
2 (Beta Blockers)	Metoprolol, carvedilol, propranolol, atenolol, bisoprolol	Heart attacks, coronary artery bockages, heart failure	Can make you feel lethargic or dizzy. May lower blood pressure and heart rate. Do not stop abruptly.
3 (Potassium Channel Blockers)	Amiodarone, sotalol, ibutilide, dofetilide, dronedarone	Atrial and ventricular arrhythmias	Could cause arrhythmias, fatigue, ECG abnormalities
4 (Calcium Channel Blockers)	Verapamil, diltiazem	Atrial arrhythmias	Constipation, lower extremity swelling.

Questions?

References

- Williams JL, What are Palpitations and Abnormal Heart Rhythms (Arrhythmias)? A Cardiologist's Guide for Patients and Care Providers (CreateSpace Publishing 2015)
- Hampton JR, Harrison, MJF, Mitchell JRA, Prichard JF, Seymour C, "Relative contributions of history-taking, physical examination, and laboratory investigation to diagnosis and management of medical outpatients," British Medical Journal, V. 2 (1975), pp. 486-89.
- Calkins et al. HeartRhythm 2007 HRS/EHRA/ECAS Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation; 4: 1-46
- Cappato R, Calkins H, Chen S-A, Davies W, Iesaka Y, Kalman J, Kim Y-H, Klein G, Natale A, Packer D, Skanes A, Ambrogi F, Biganzoli E, Updated Worldwide Survey on the Methods, Efficacy, and Safety of Catheter Ablation for Human Atrial Fibrillation," Circ Arrhyth Electrophysiol, (February 2010), pp. 32-38.
- Cappato R, Calkins H, Chen S-A, Davies W, Iesaka Y, Kalman J, Kim Y-H, Klein G, Natale A, Packer D, Skanes A, "Prevalence and Causes of Fatal Outcome in Catheter Ablation of Atrial Fibrillation," JACC, V. 53, No. 19 (2009), pp. 1798-1803.
- Kistler et al, "P wave morphology in focal atrial tachycardia," JACC, V. 48, No. 5 (2006).
- Wilk D and Williams JL, "Genetic Forms of Wolff-Parkinson-White," EP Lab Digest, Volume 12 - Issue 10 - October 2012

Afib Ablation Candidates

- Symptomatic Paroxysmal or Persistent Atrial Fibrillation
- Failure of Class IC or Class III agent
- Intolerance to Medical Therapy, Refusal of Medical Therapy
- Other Considerations:
  - Young patients with paroxysmal atrial fibrillation, in whom decades-long drug therapy is undesirable
  - Congestive Heart Failure due to tachycardia-induced cardiomyopathy, in whom drug choices are limited by the presence of CHF
- Limitations in Efficacy
  - Longstanding Persistent Atrial Fibrillation (>1 year)
  - Enlarged LA (>55 mm)
  - Age > 70 years
- Left atrial or Left atrial appendage thrombus is an absolute contraindication to atrial fibrillation ablation.

Calkins et al. HeartRhythm 2007 *HRS/EHRA/ECAS Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation*; 4: 1-46

Worldwide Experience with AF Ablation

1

Type of Complication	No. of Patients	Rate, %
Death	25	0.15
Tamponade	213	1.31
Pneumothorax	15	0.09
Hemothorax	4	0.02
Sepsis, abscesses, or endocarditis	2	0.01
Permanent diaphragmatic paralysis	28	0.17
Total femoral pseudoaneurysm	152	0.93
Total artero-venous fistulae	88	0.54
Valve damage/requiring surgery	11/7	0.07
Atrium-esophageal fistulae	6	0.04
Stroke	37	0.23
Transient ischemic attack	115	0.71
PV stenoses requiring intervention	48	0.29
Total	741	4.54

2

Table 3 Fatality Rates According to Type of Complication

Complication	Death/Overall Events (n)	Rate (%)
Tamponade	7/331	2.3
Atrioesophageal fistula	5/7	71.4
Massive pneumonia	2/2	100.0
Peripheral embolism		
Stroke	3/59	5.1
Myocardial infarction	1/3	33.3
Torsades de pointes	1/1	100.0
Septicemia (3 weeks after procedure)	1/3	33.3
Sudden respiratory arrest	1/1	100.0
Acute pulmonary vein occlusion of both lateral veins	1/6	16.7
Internal bleeding (includes hemothorax, subclavian hematoma, and extrapericardial pulmonary vein perforation)	3/21	14.3
Anaphylaxis	1/6	16.7
Acute respiratory distress syndrome	1/1	100.0
Esophageal perforation from intraoperative TEE probe	1/1	100.0
Intracranial bleeding under oral anticoagulation therapy in prior stroke	1/4	25.0

- This is report from only *85 centers in the world*.
- **4.5% rate of major complications.**
- Carto-guided left atrial circumferential ablation (48%) and lasso-guided ostial electric disconnection (27%).
- Overall drug-free (with AAD) 18 month success rates were 75% (83%) and 63% (72%) for paroxysmal and persistent atrial fibrillation.

1. Cappato R, Calkins H, Chen S-A, Davies W, Iesaka Y, Kalman J, Kim Y-H, Klein G, Natale A, Packer D, Skanes A, Ambrogi F, Biganzoli E, Updated Worldwide Survey on the Methods, Efficacy, and Safety of Catheter Ablation for Human Atrial Fibrillation," Circ Arrhyth Electrophysiol, (February 2010), pp. 32-38.
2. Cappato R, Calkins H, Chen S-A, Davies W, Iesaka Y, Kalman J, Kim Y-H, Klein G, Natale A, Packer D, Skanes A, "Prevalence and Causes of Fatal Outcome in Catheter Ablation of Atrial Fibrillation," JACC, V. 53, No. 19 (2009), pp. 1798-1803.

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Example of Listening to Patient for Diagnosis

- 80 yo male with PMH permanent Afib (Eliquis 2.5mg po BID), HTN, lipids, DM2, CKD3 and prior admit for afib/RVR and failed DCCV 6months ago. Extremely SOB, Afib/RVR, and O2 sats in the 80's.
- EP consulted for AVN RFA and DDD.
- Patient SOB with talking, clear lungs, EF nml, hypoxic with pO2=56.
- This is not afib… PE and DVT.