# *Tachyarrhythmia*

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# Tachyarrhythmia

Definition:

• Abnormal heart rhythm with rate >100 bpm

## Differential Diagnosis

**Regular**

- Physiological sinus tachycardia
- Inappropriate sinus tachycardia
- Sinus nodal re-entrant tachycardia
- Focal AT
- Atrial flutter with fixed AV conduction
- AVNRT
- JET (or other non-re-entrant variants)
- Orthodromic AVRT
- Idiopathic VT (especially high septal VT)

**Irregular**

- AF
- Focal AT or atrial flutter with varying AV block
- Multifocal AT

**Regular**

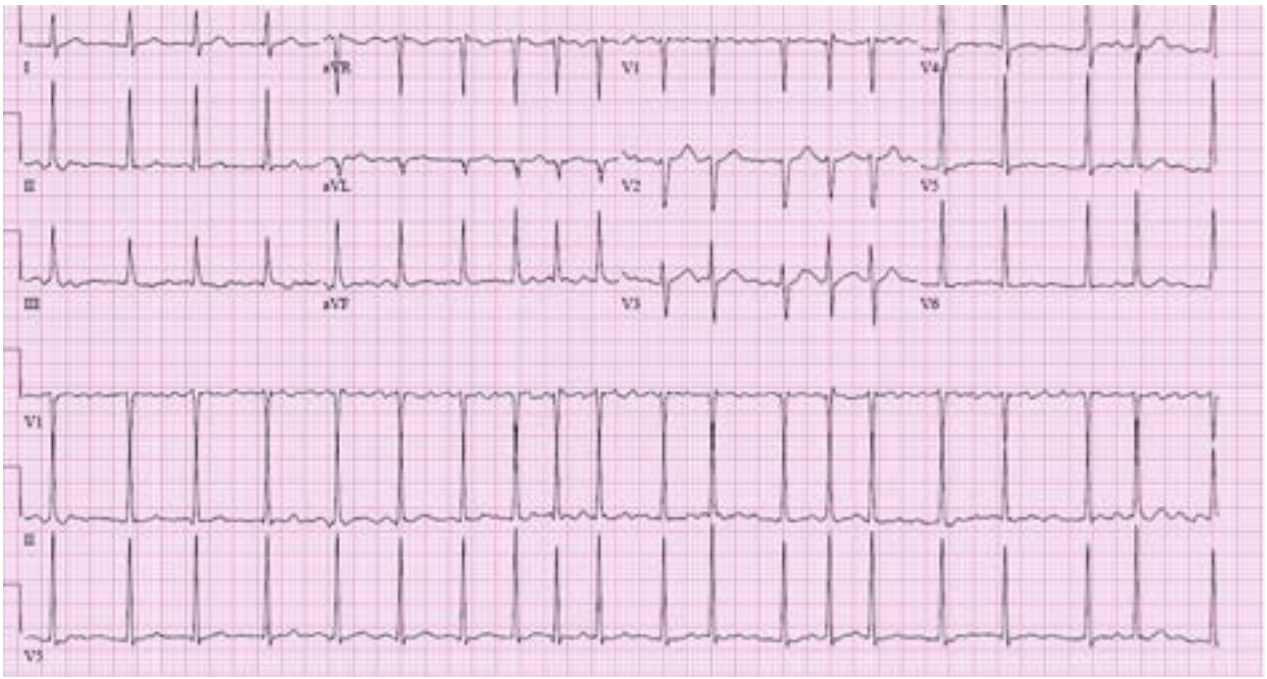
- VT/flutter 80%
- Ventricular paced rhythm / PMT
- Antidromic AVRT 5%
- SVTs with aberration/BBB (pre-existing or rate-dependent during tachycardia) 15%
- Atrial or junctional tachycardia with pre-excitation/bystander AP
- SVT with QRS widening due to electrolyte disturbance or antiarrhythmic drugs → class Ia/Ic/III

**Irregular**

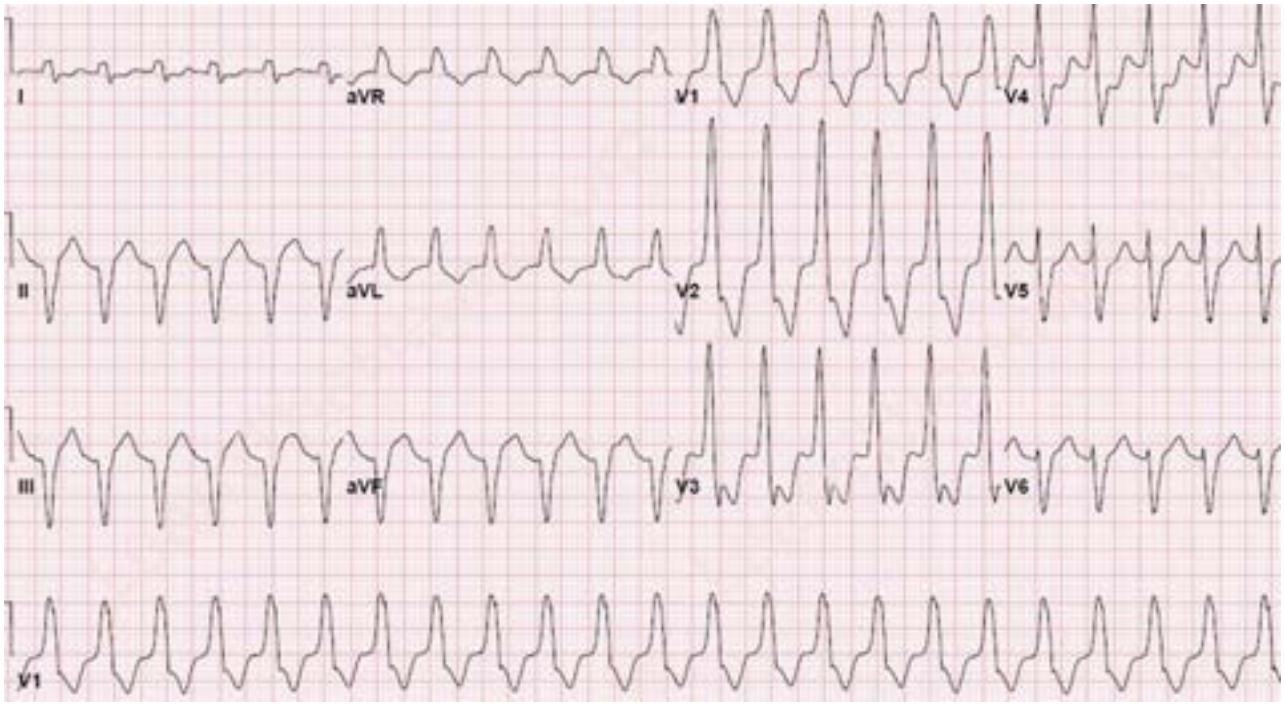
- AF or atrial flutter or focal AT with varying block conducted with aberration
- Antidromic AV re-entrant tachycardia due to a nodo-ventricular/fascicular AP with variable VA conduction
- Pre-excited AF
- Polymorphic VT
- Torsade de pointes
- Ventricular fibrillation

Occasionally, AF with very fast ventricular response may apparently resemble a regular narrow QRS tachycardia.

# QRS < 120 ms □ NCT



# QRS > 120 □ WCT


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1


Narrow QRS tachycardia
(QRS ≥ 120 ms)
A>V
V>A
A=V

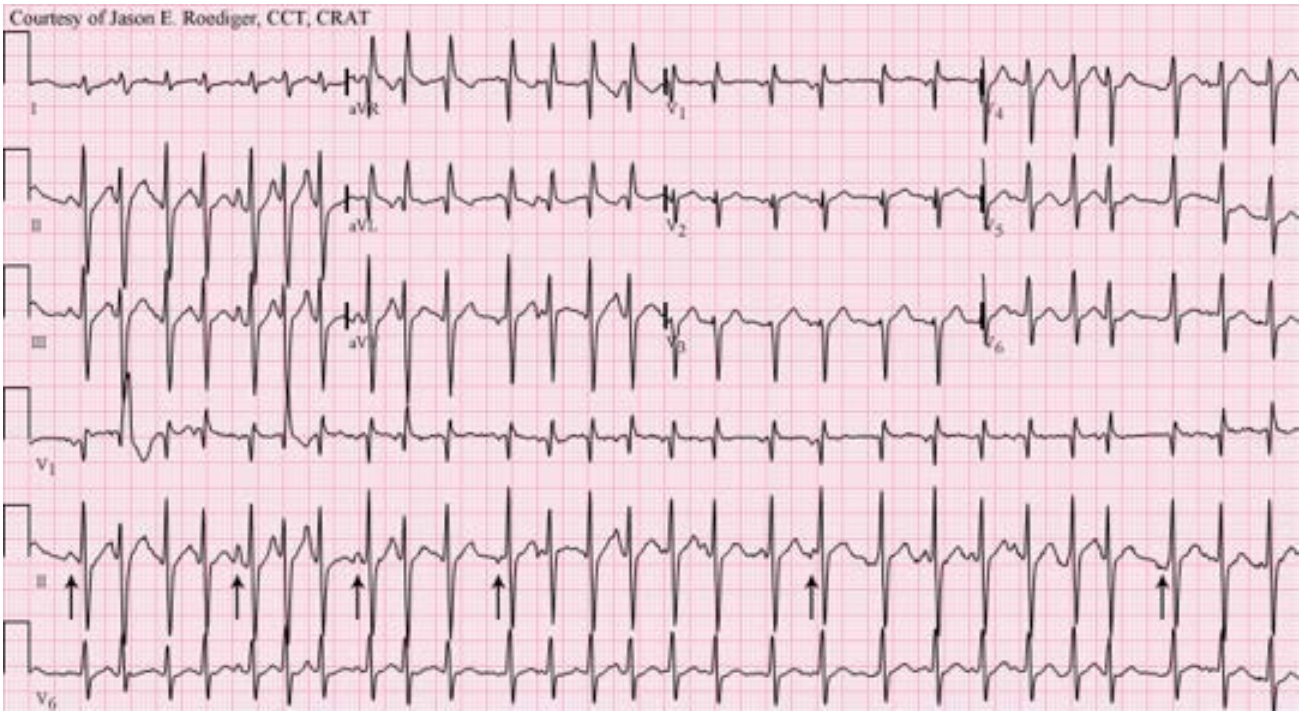
## *Step 1*

**Regular / Irregular ?!**

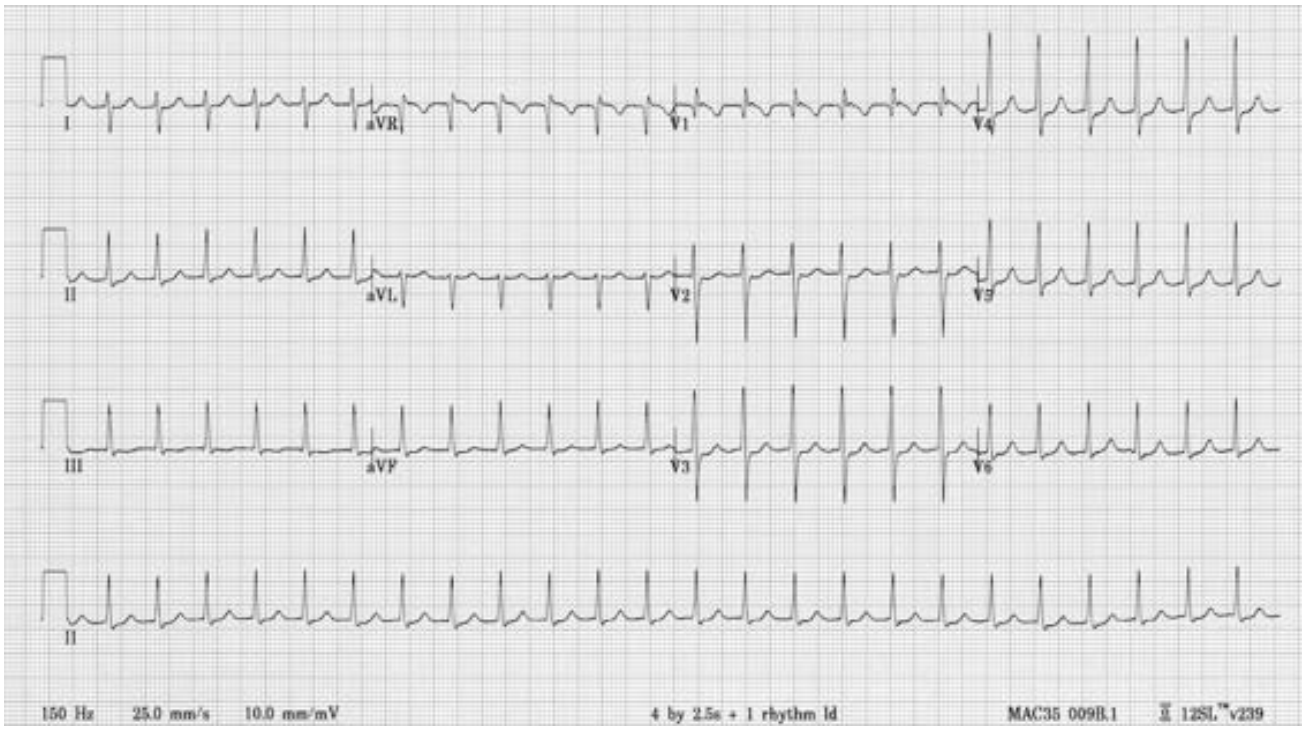
Next Step

AFib
MAT
AFL / AT with variable conduction

# Irregular



# Regular

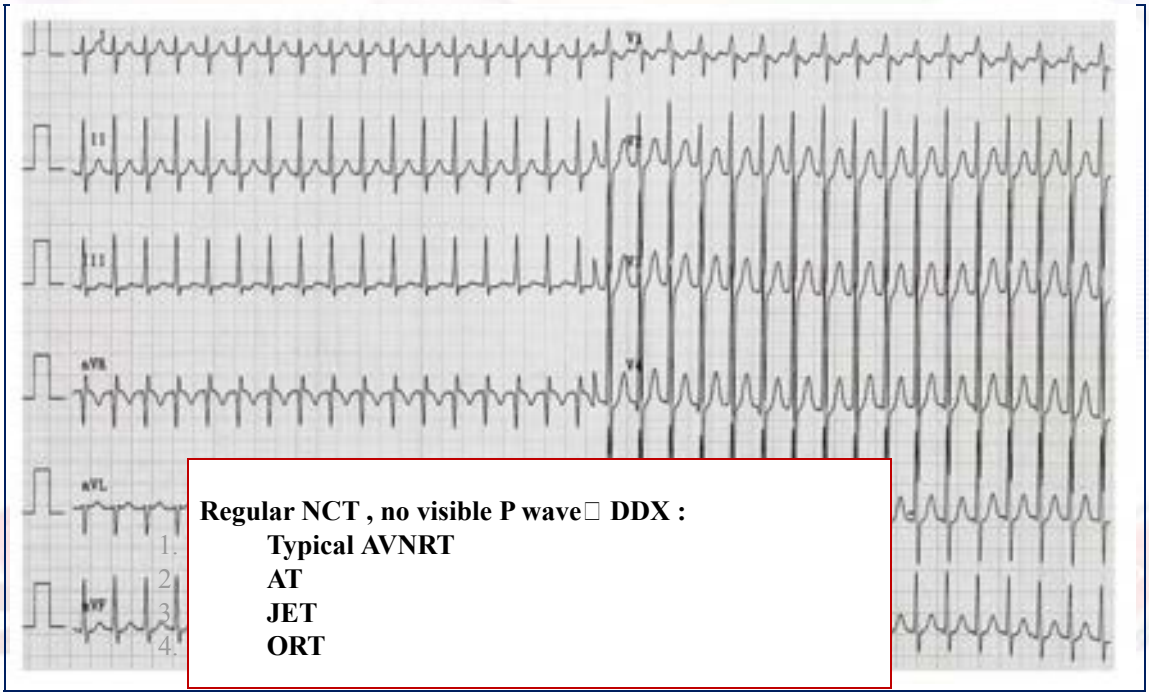



## *Step 2*

**Visible P wave ?**

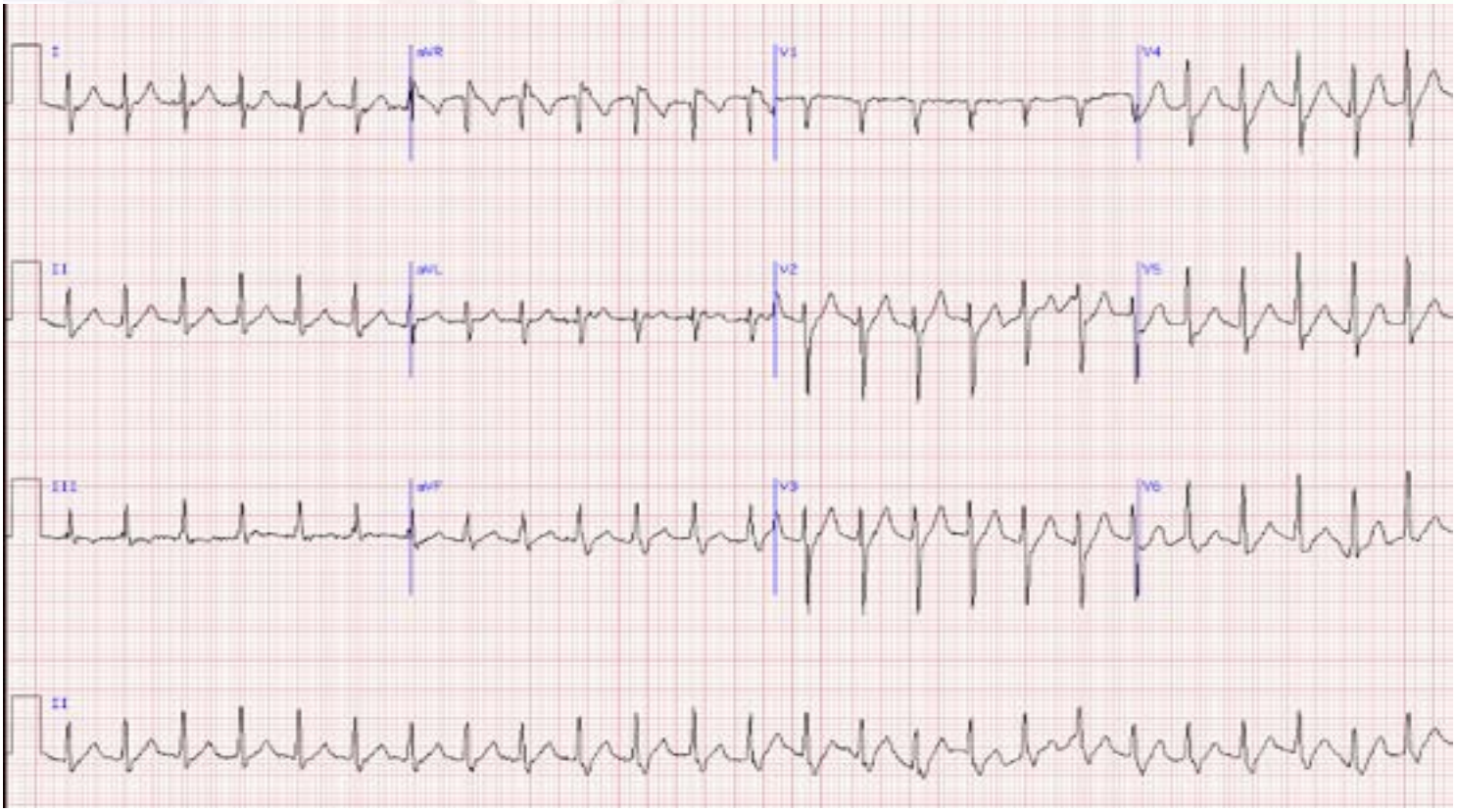
yes ⇐ next step

NO → T. AVNRT / AT / JET / ORT (rare)



**Regular NCT , no visible P wave DDX :**

1. **Typical AVNRT**
2. **AT**
3. **JET**
4. **ORT**



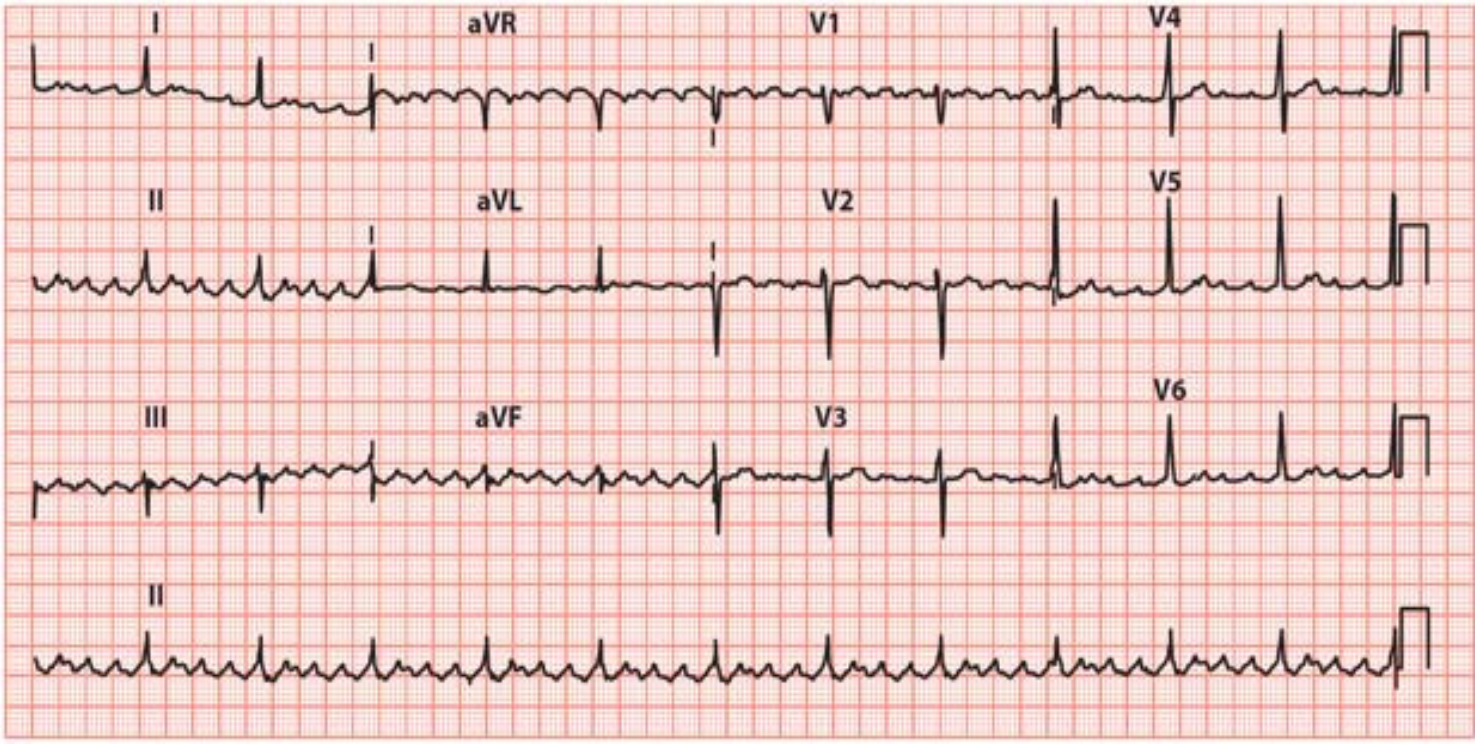
## *Step 3*

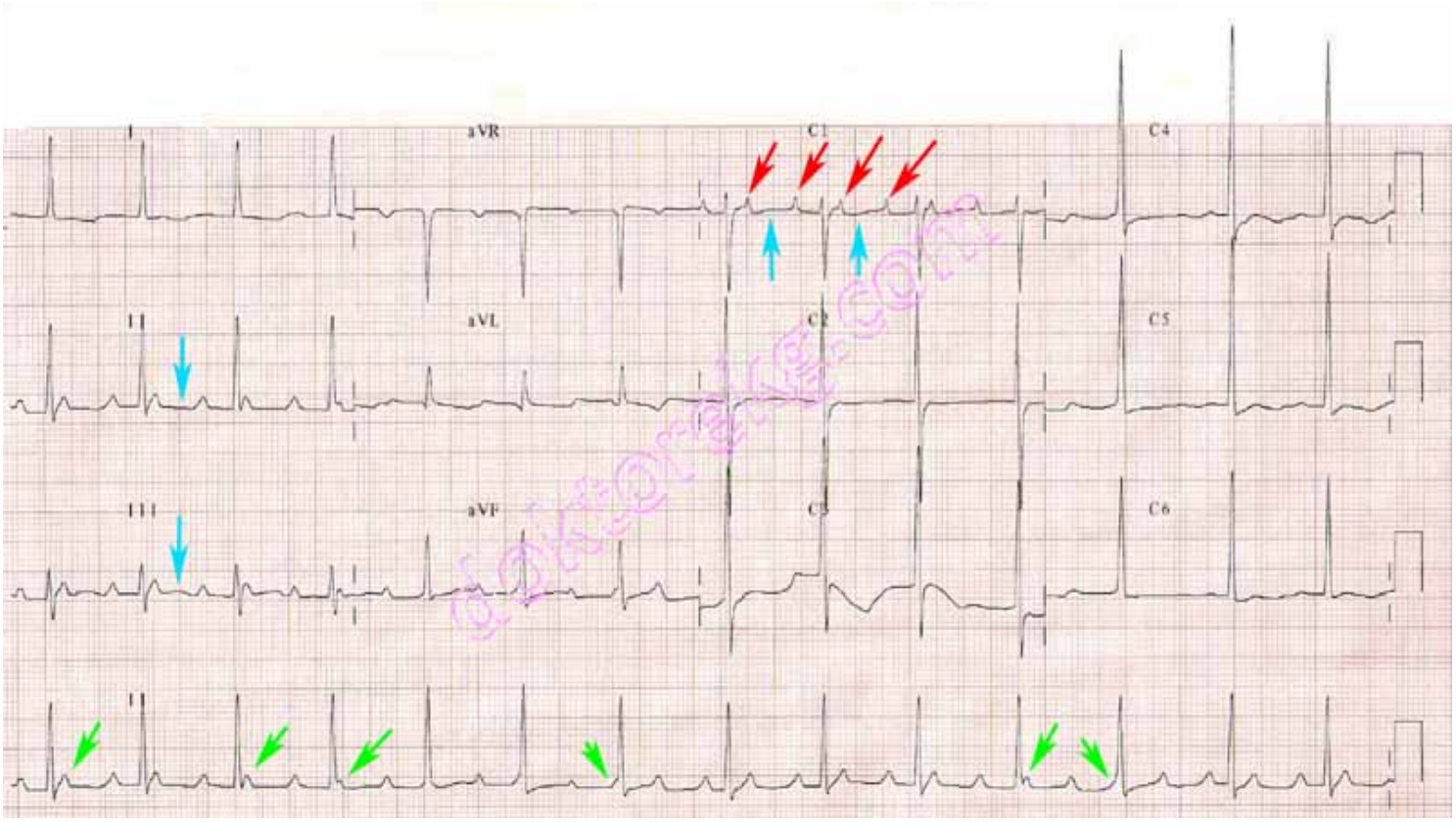
A > V

AFL

AT

AVNRT (2:1)






## *Step 3*

A = V → RP / PR relation

very short RP (RP ≤ 90 msec)

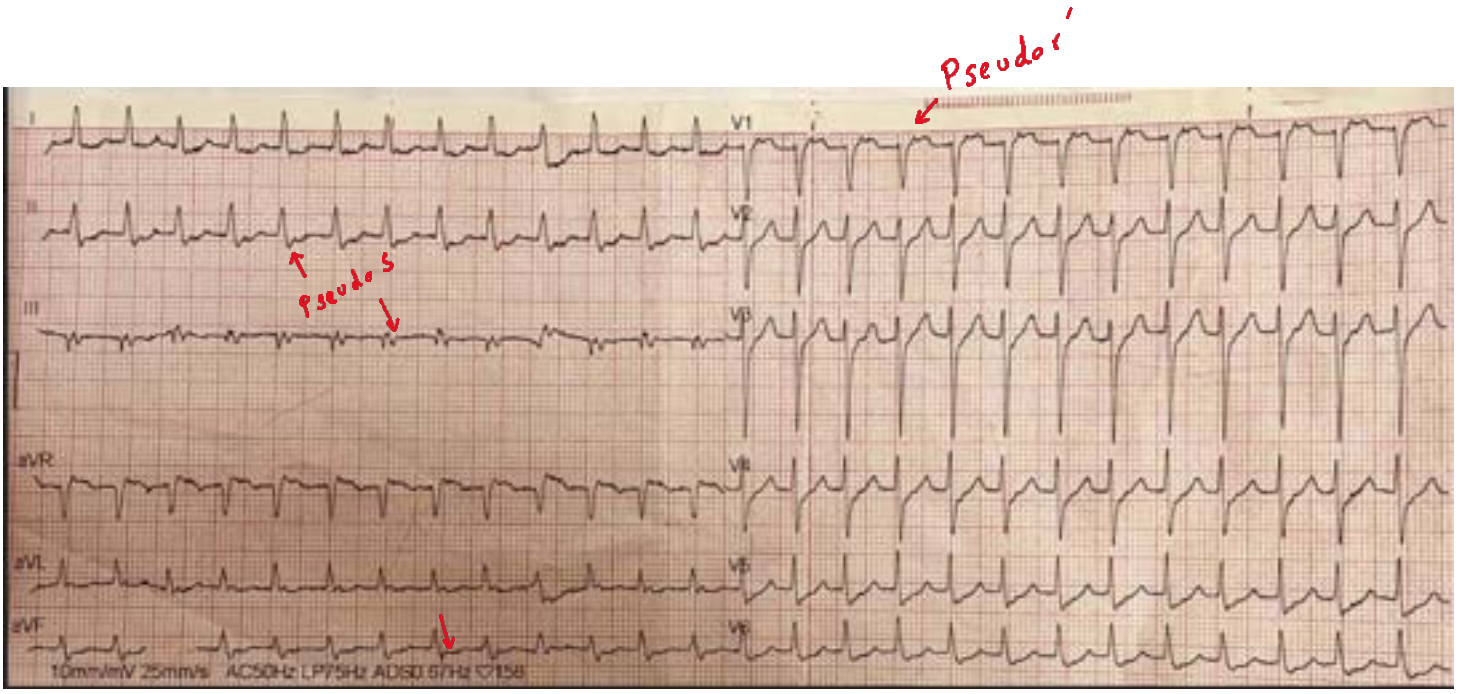
- T. AVNRT
- AT
- JET
- ORT

Short RP (90 msec)

- ORT
- AT
- Slow/Slow AVNRT

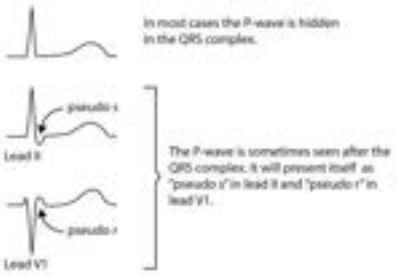
long RP

- AT
- Fast/Slow AVNRT
- PJRT
- ST




## Typical AVNRT most possible if:

- Pseudo r'in lead V1 and **avR**
- Pseudo S wave in the inferior leads
- A difference in **RP intervals** in **leads V1 a**
- QRS notch in lead **aVL**

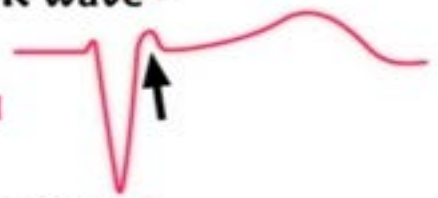


## P wave morphology

### Typical AVNRT

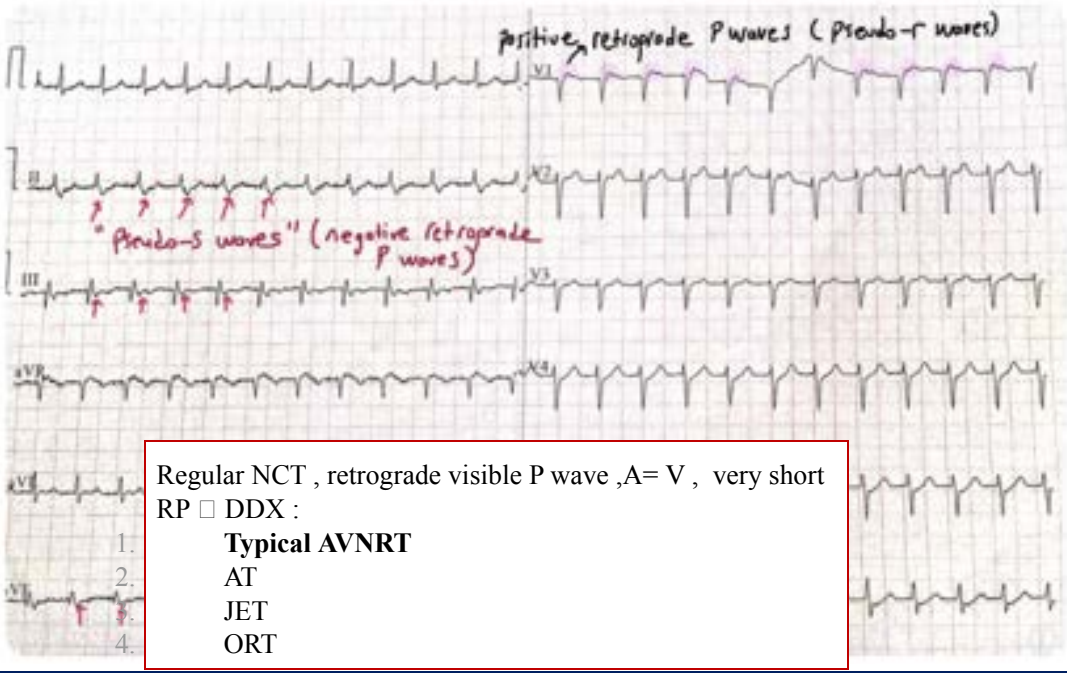
- P wave - buried within QRS complex

- Pseudo - R wave[Q]



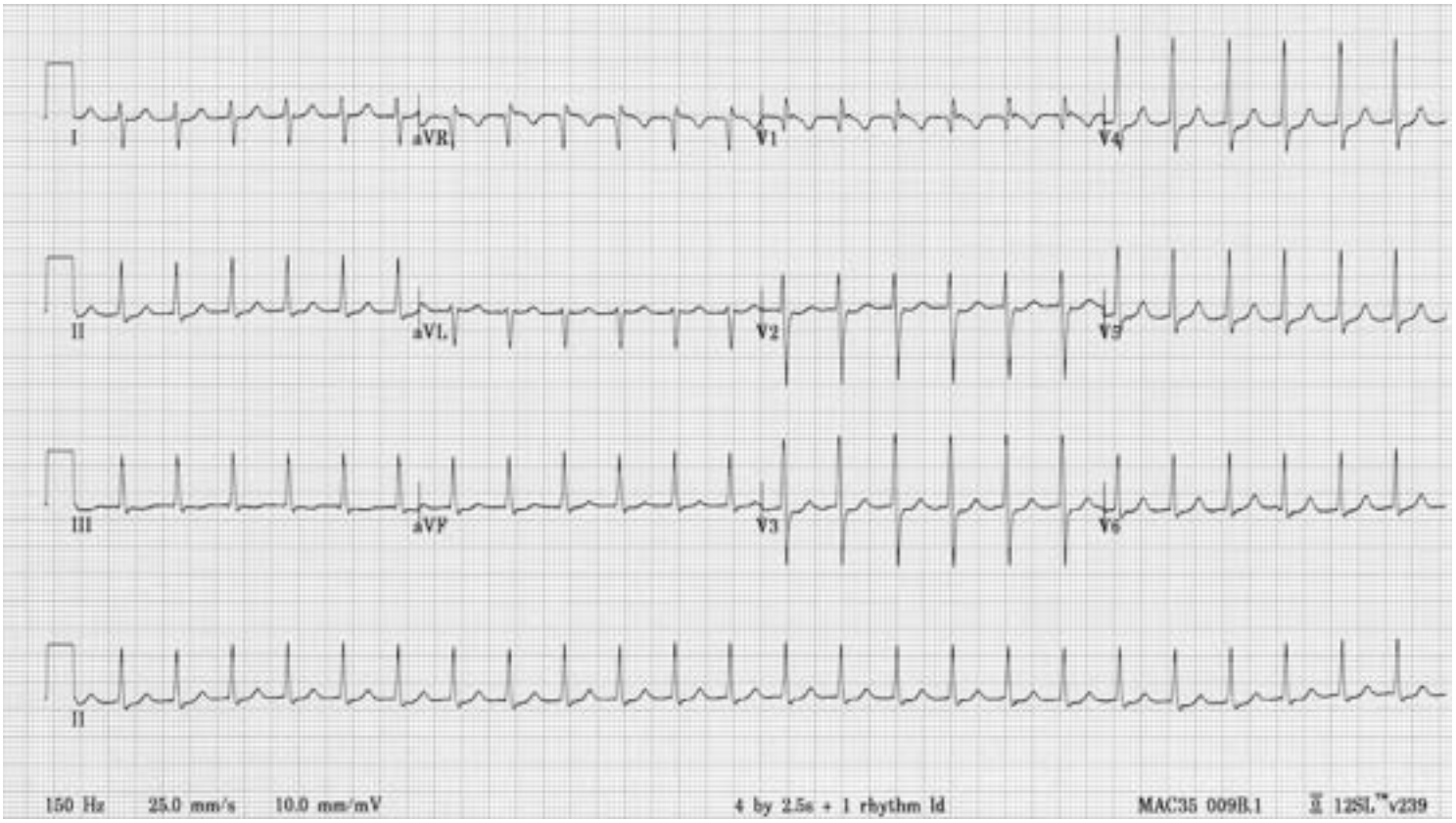

- Pseudo - S wave[Q]


# Management




Regular NCT , retrograde visible P wave ,A= V , very short RP □ DDX :

1. **Typical AVNRT**
2. AT
3. JET
4. ORT




# AVNRT

## ECG findings

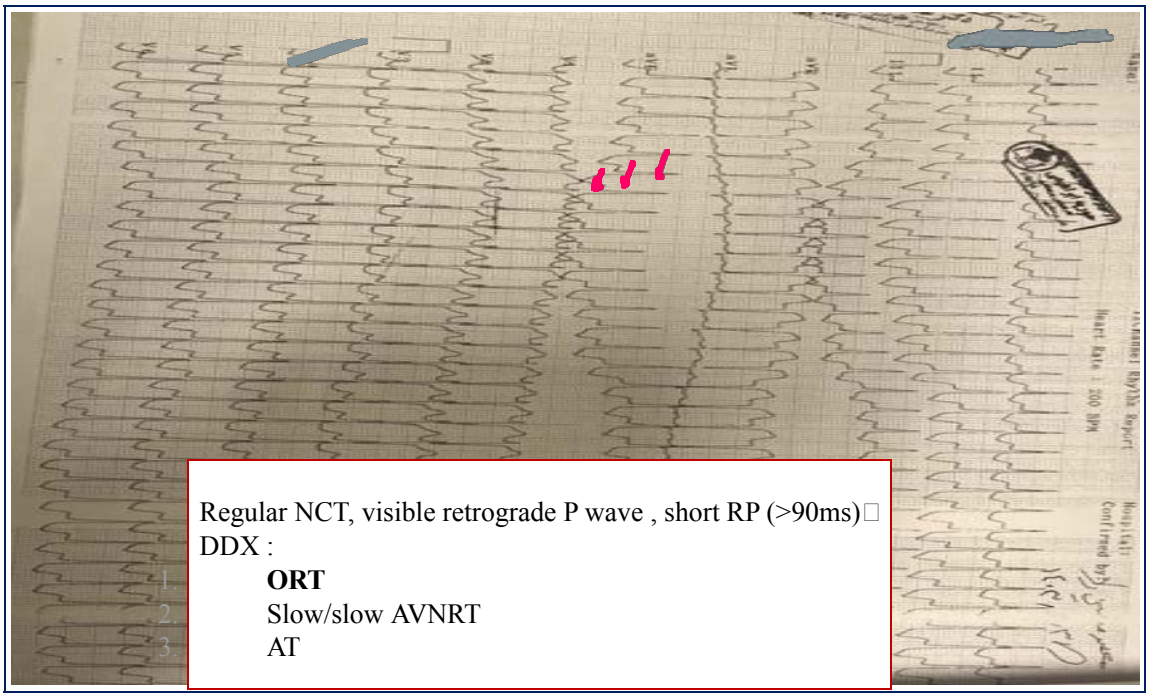
- ST segment depression
  - Significant ST depression (20% - 50%)
  - M/C seen in AVRT
- T wave inversion (40%)
  - After acute termination of AVNRT & other paroxysmal SVTs

**Due to Repolarization abnormality NOT ischemia**

**When:**
**Just after termination or up to 6h**

**Last: Hours or days**

# Management



Regular NCT, visible retrograde P wave , short RP (>90ms)
DDX :

1. **ORT**
2. Slow/slow AVNRT
3. AT

# *Step 3*

$$V > A$$

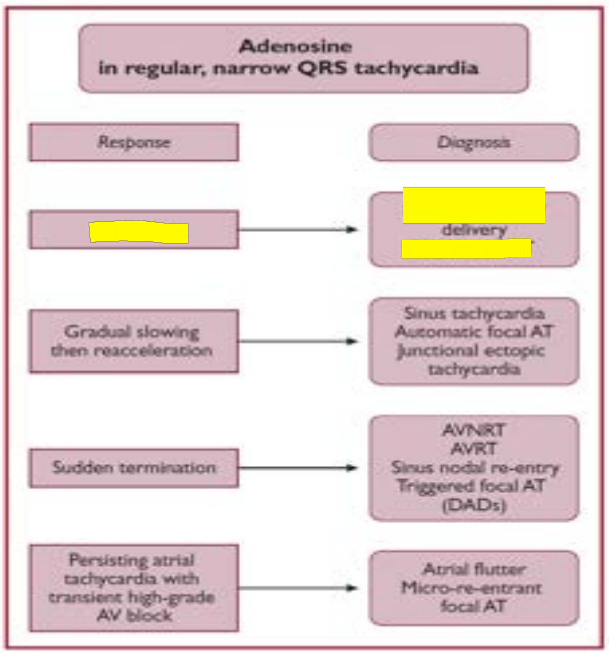
high septal VT

JET

AVNRT ( upper common block)

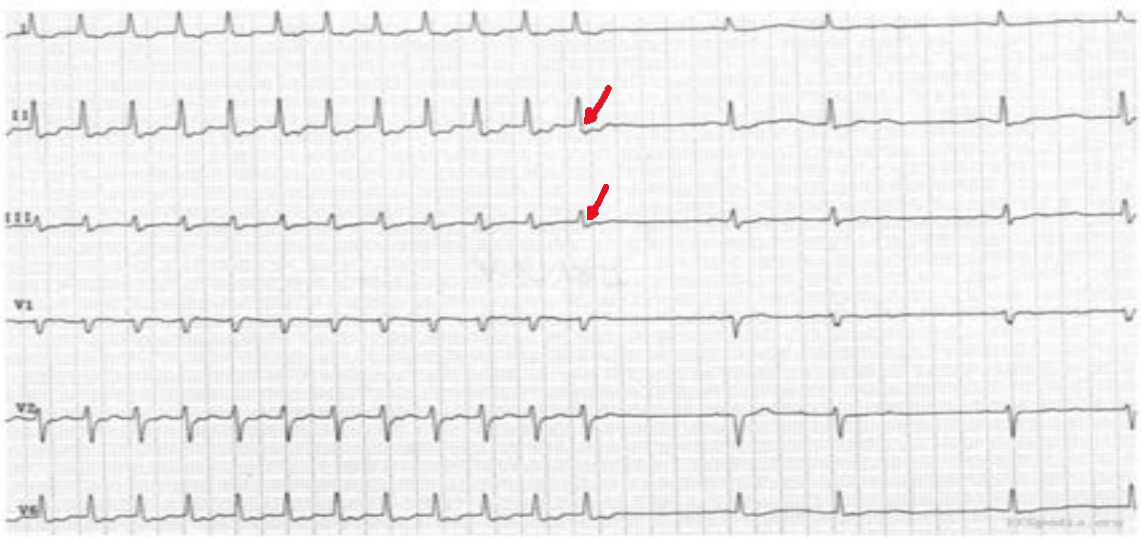
NFT / NVT

**Possible Responses of NCT to Vagal Maneuvers and Adenosine**

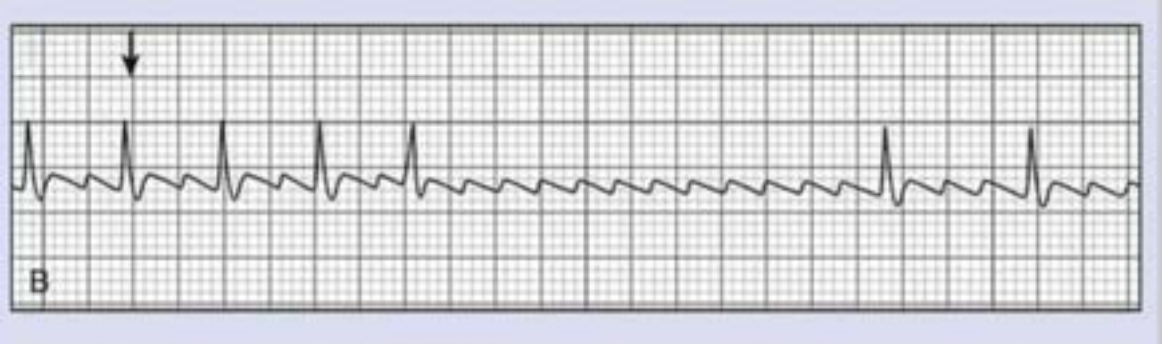


# Adenosine Response: Termination


## Adenosine Response: Termination with Retrograde P wave



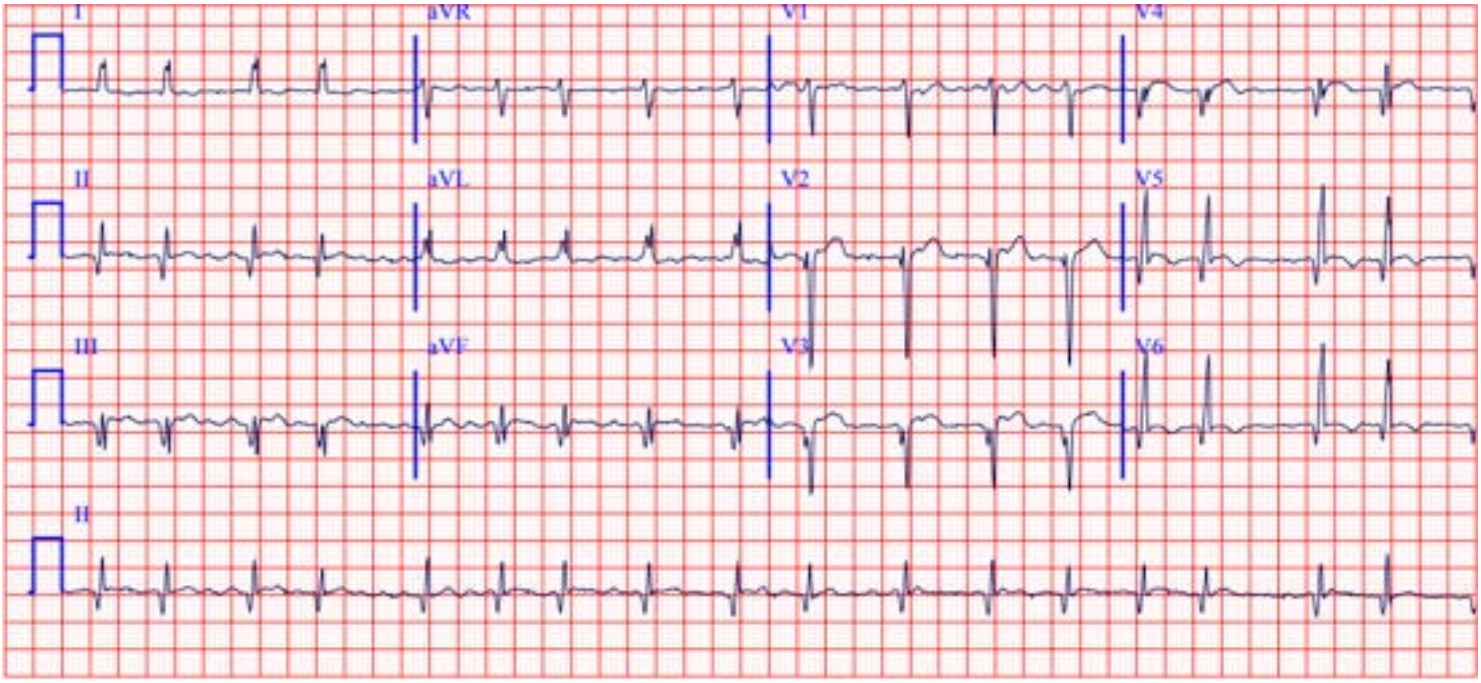
## Adenosine Response: Unmasking Flutter waves

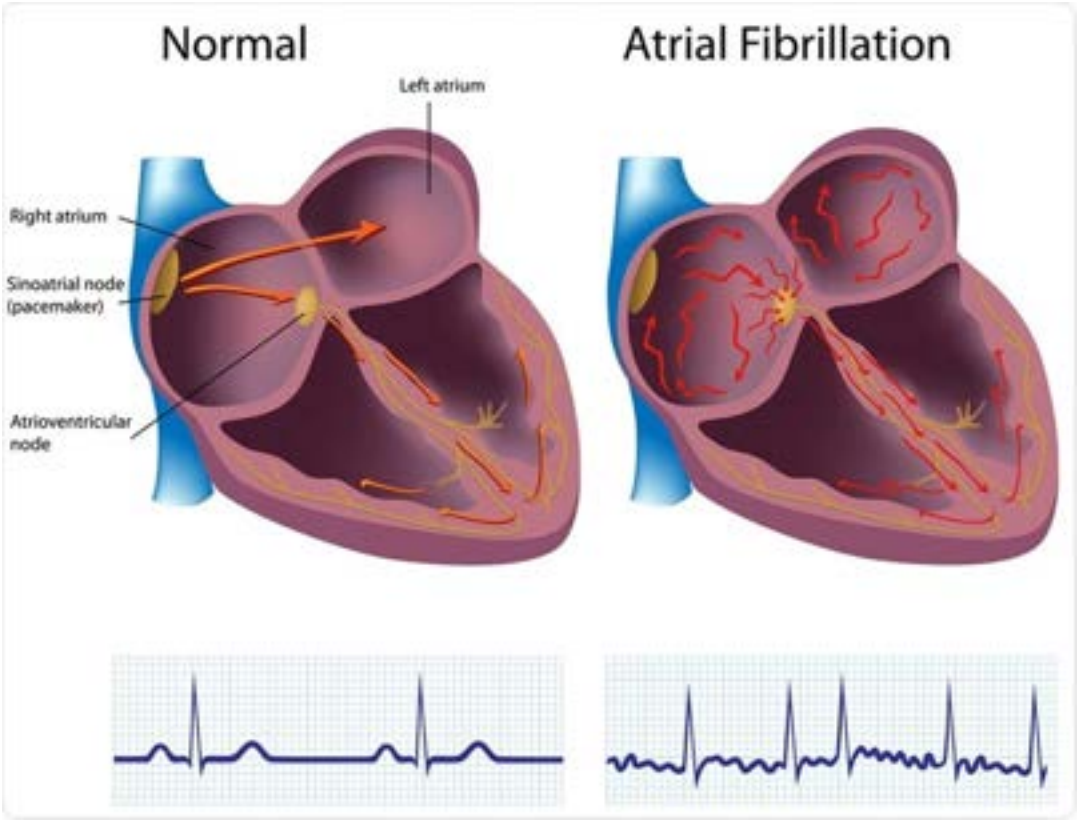



**Note:**
**- Rebound increase in AV conduction to 1:1**
**- May precipitate AF**

## Spontaneous Termination with QRS

# Adenosine Response: Unmasking Preexcitation

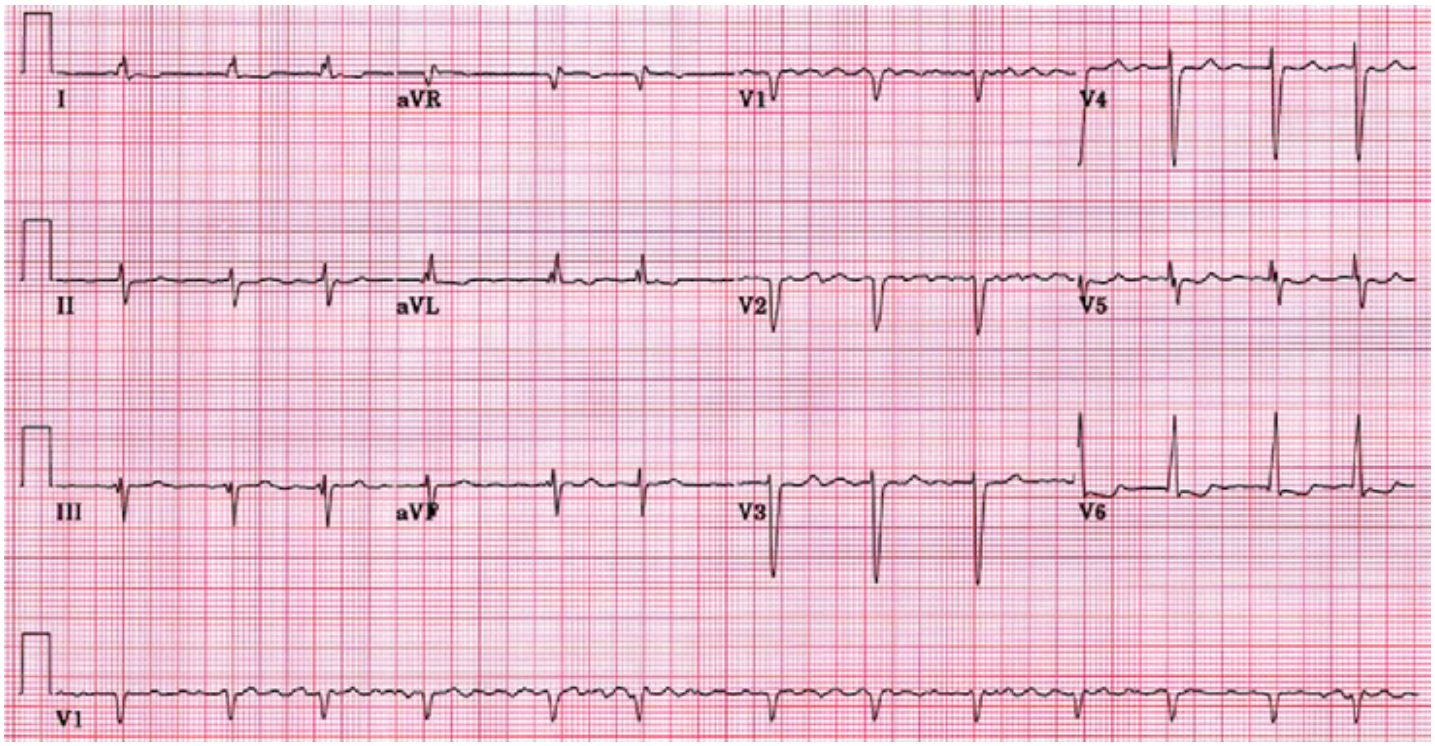



# AF

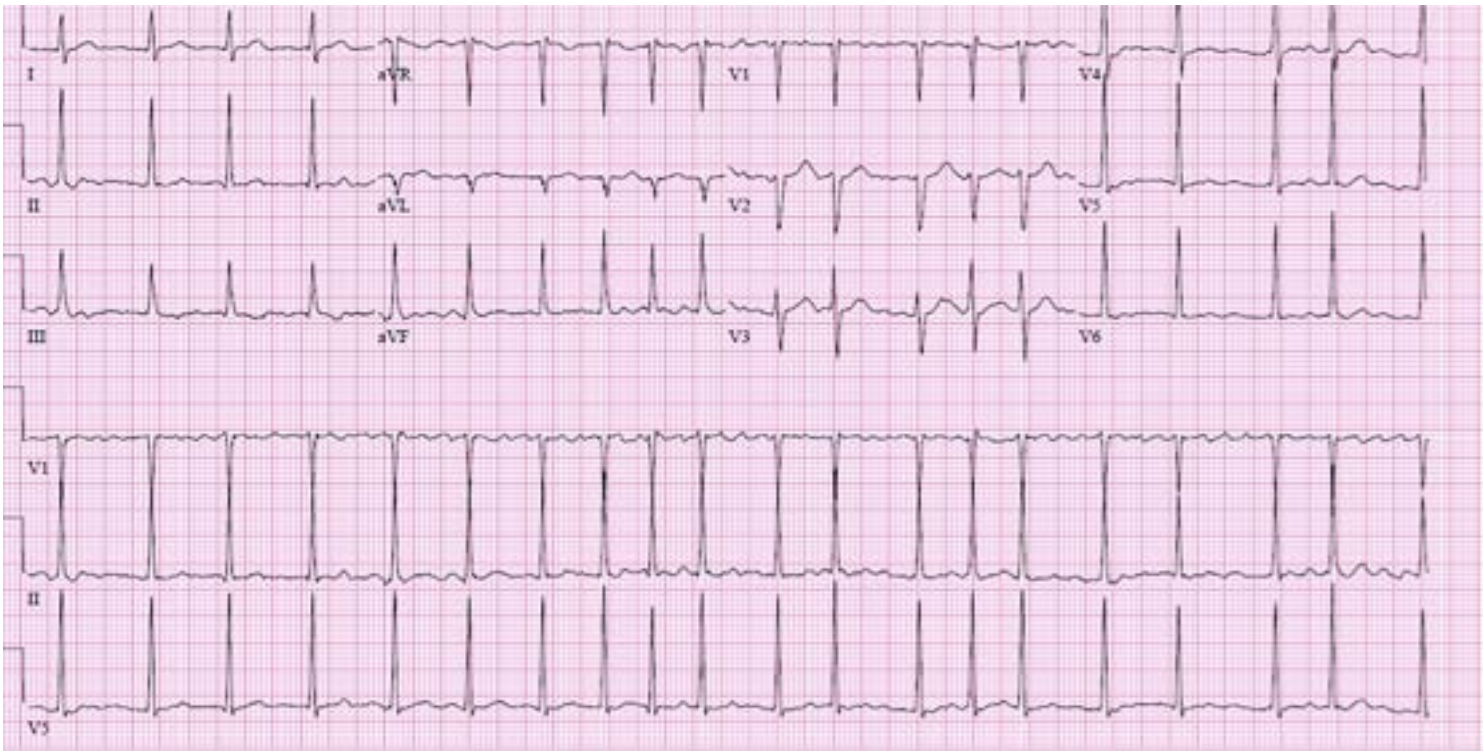
• Characterized:

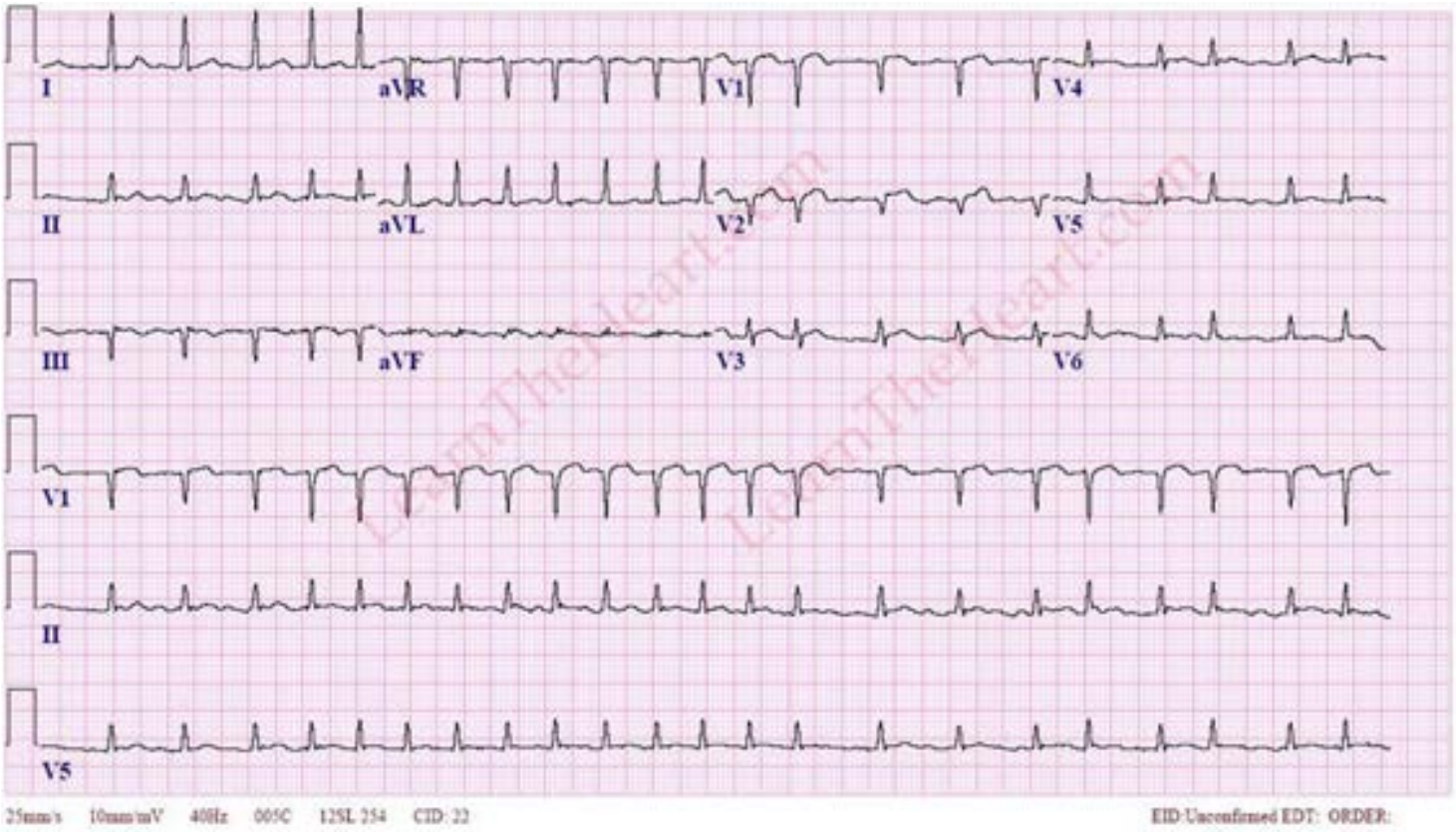
1. Irregular irregular rhythm
2. Fibrillation waves ( F ) can be fine or coarse or not visible
3. Atrial rate > 350 bpm

# Coarse AF




# AF RVR

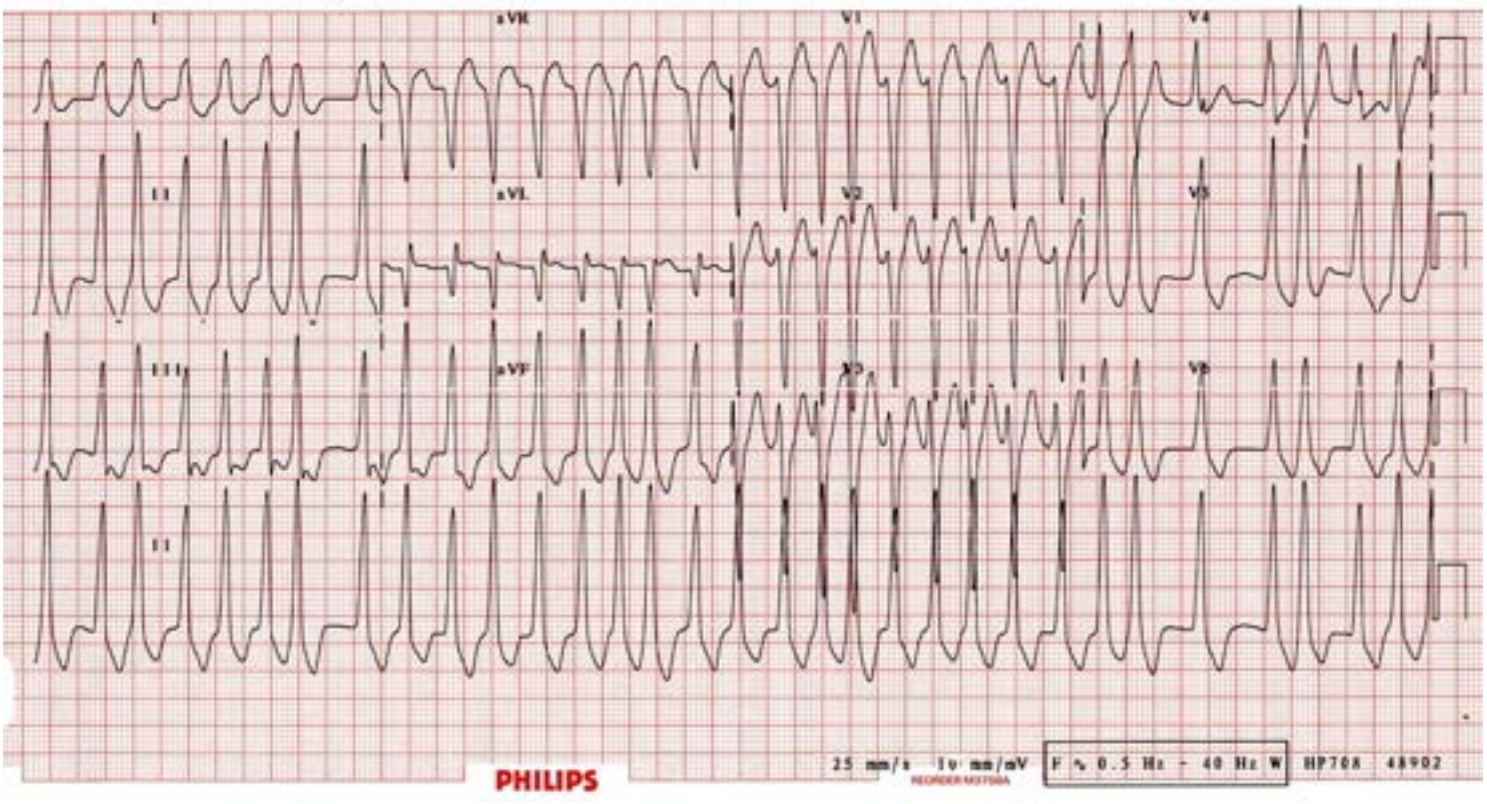



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV 40Hz 005C 12SL 254 CID: 22
EID-Unconfirmed EDT: ORDER:

FBI !

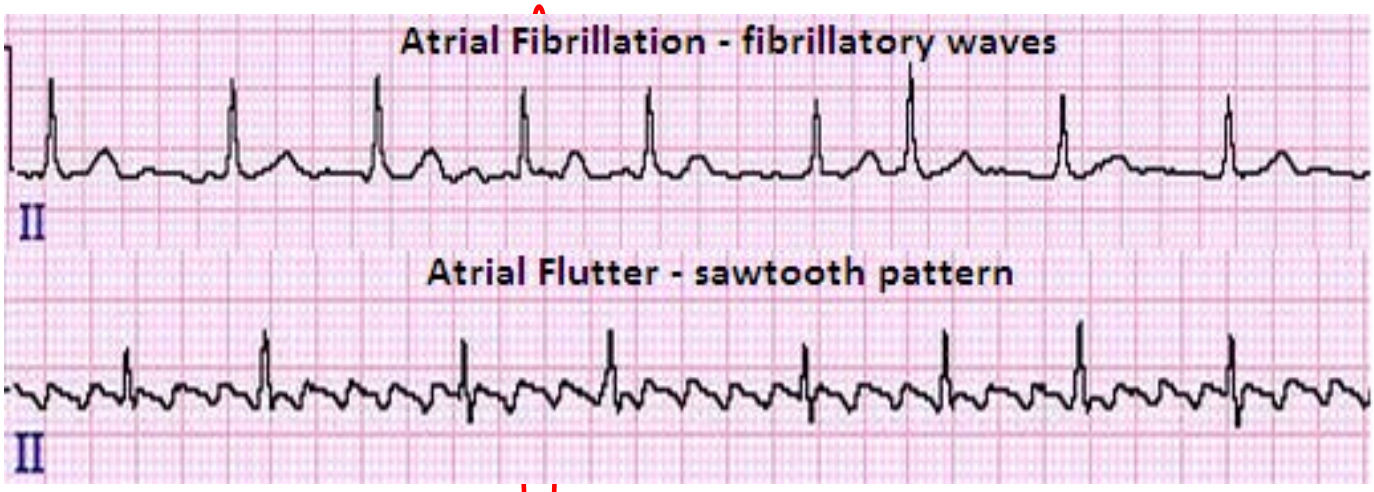
# AF WPW

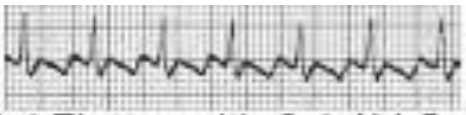

aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
Rhythm Strip: II
25 mm/sec 1 cm/mV


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
PHILIPS
25 mm/s 10 mm/mV
F ∿ 0.5 Hz - 40 Hz W
HP70A 48902

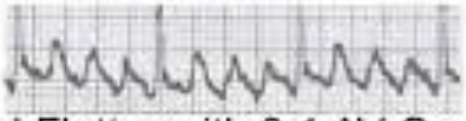
# Sawtooth


II
V1
V5

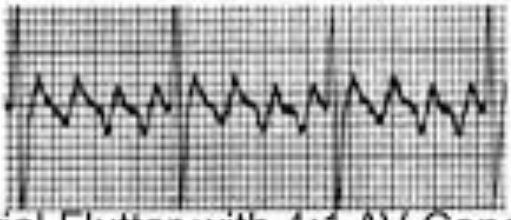

Atrial Fibrillation - fibrillatory waves
II
Atrial Flutter - sawtooth pattern
II



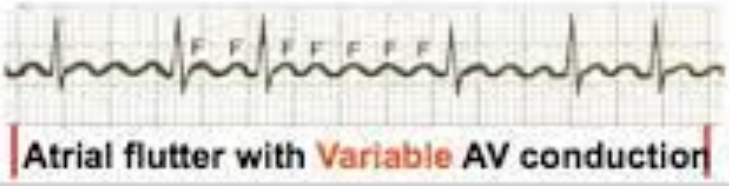
Atrial Flutter with 2:1 AV Conduction



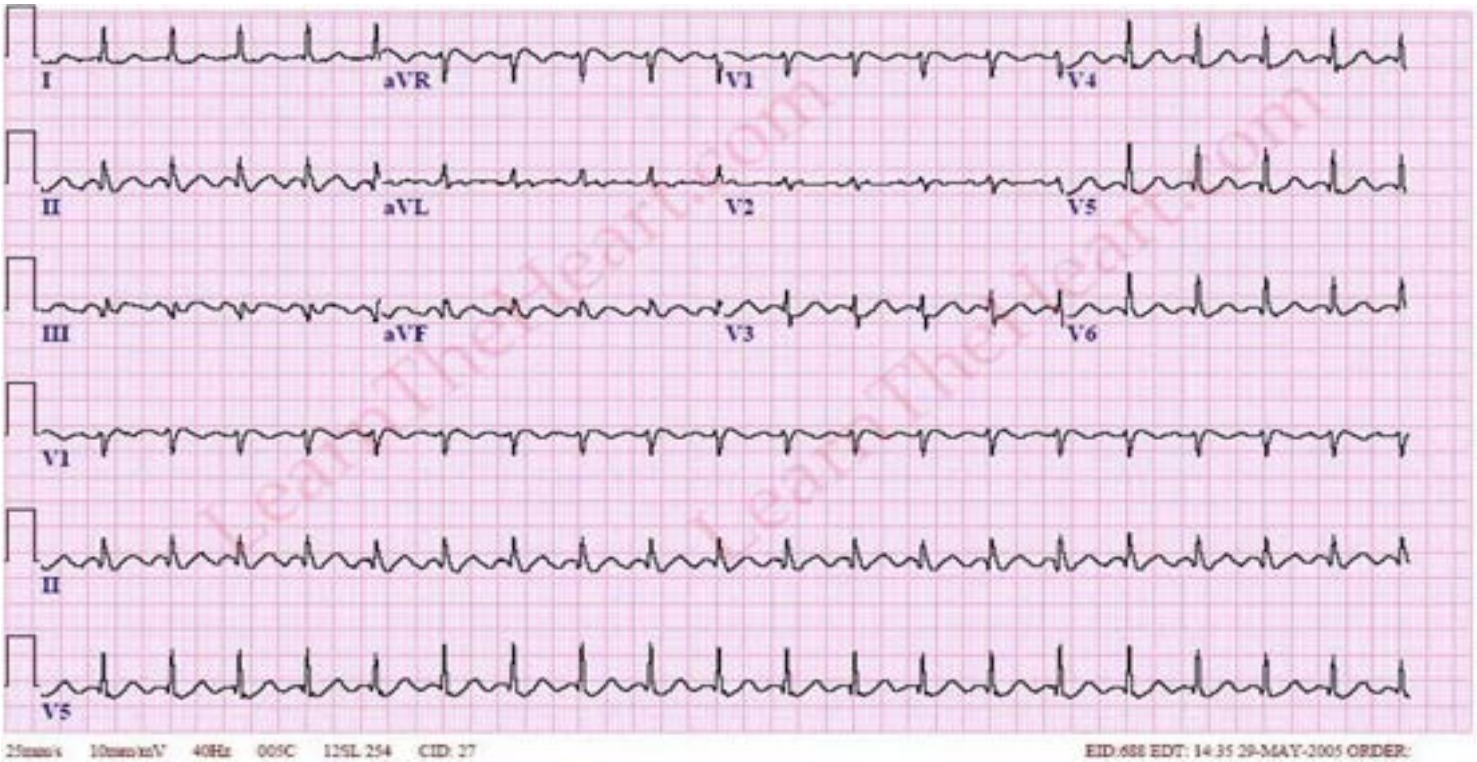
Atrial Flutter with 3:1 AV Conduction



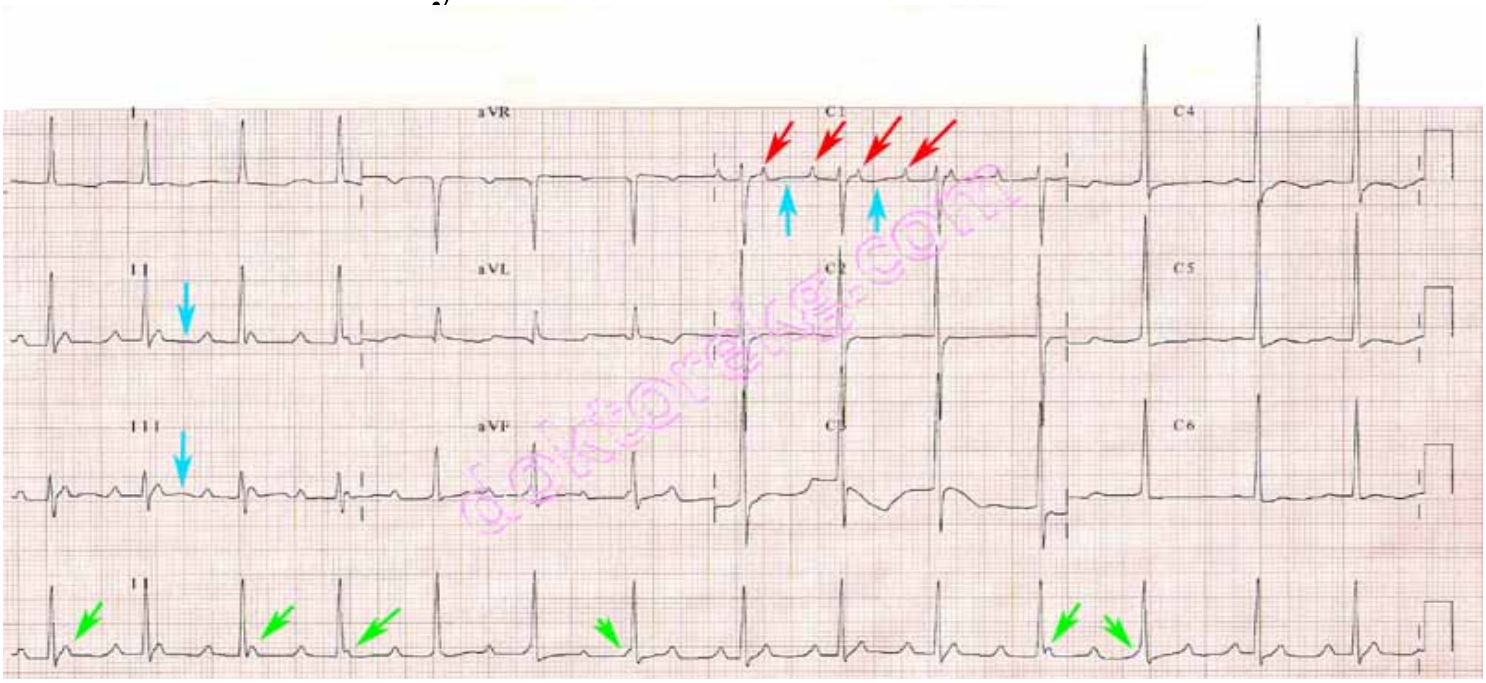
Atrial Flutter with 4:1 AV Conduction

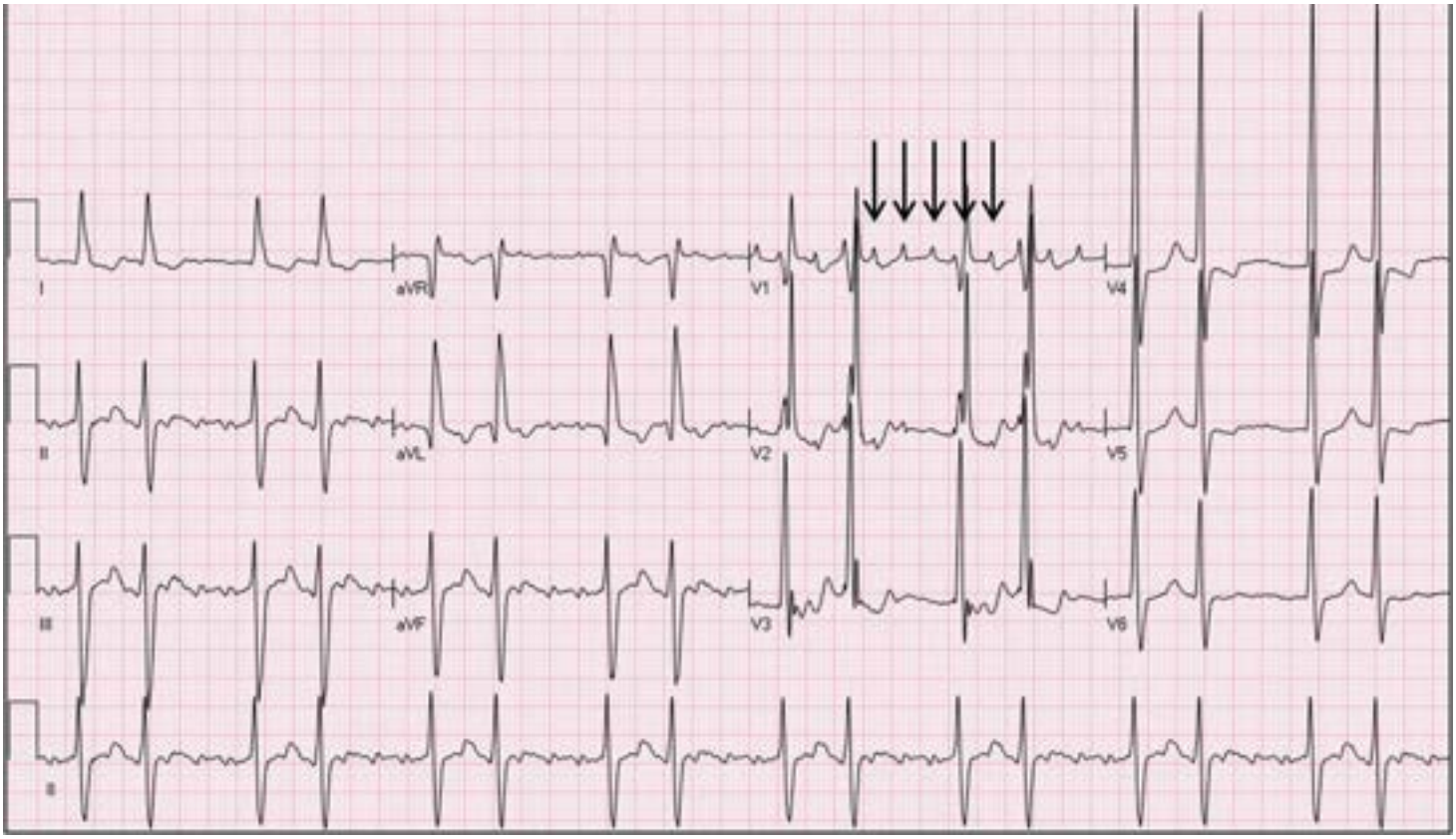



# 2:1 AFL

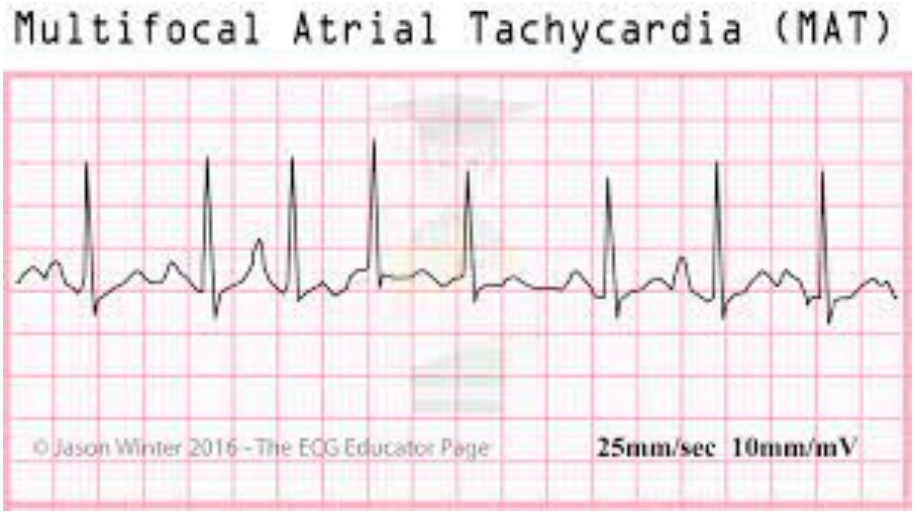


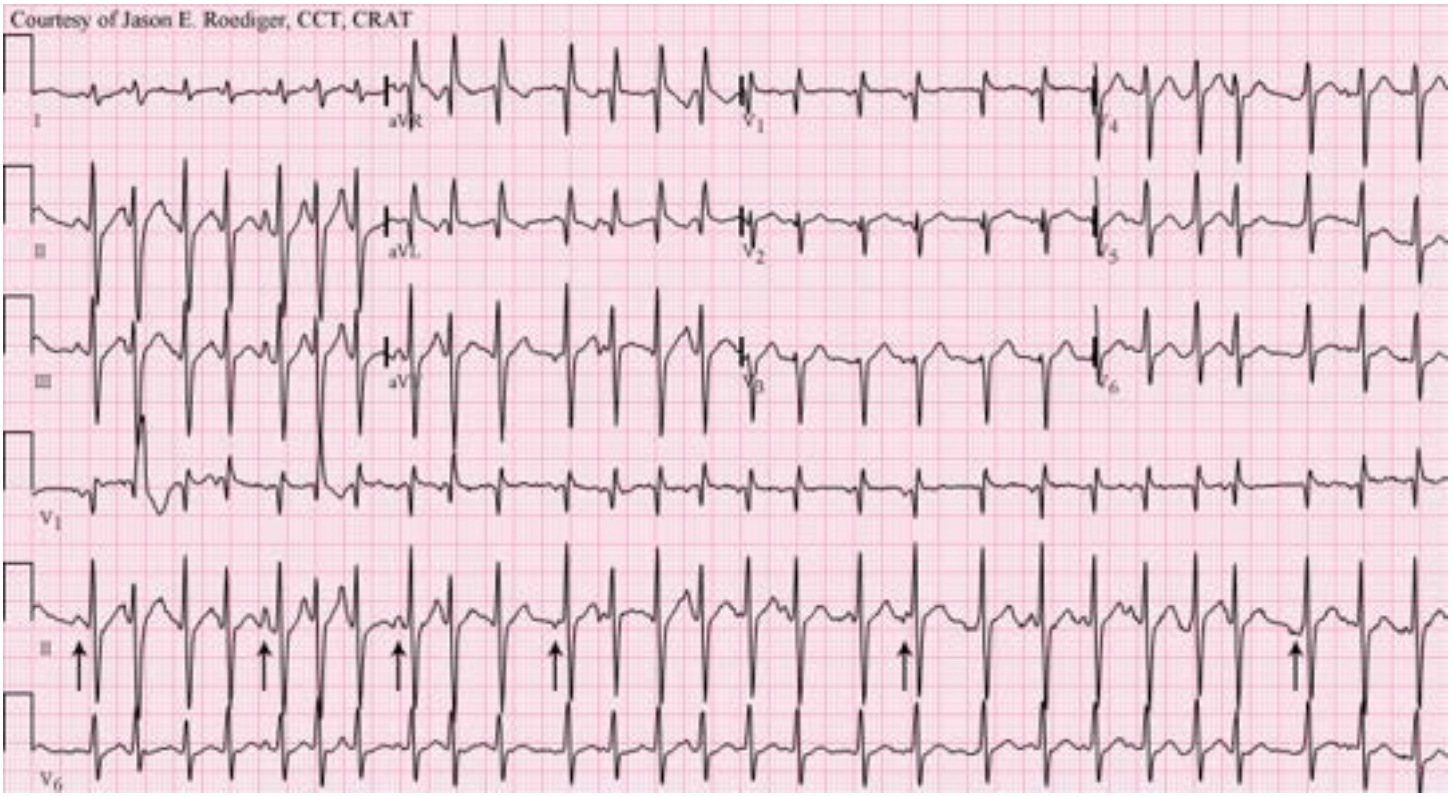
# Atrial tachycardia



# Multifocal AT (MAT)



# Ventricular Tachycardia

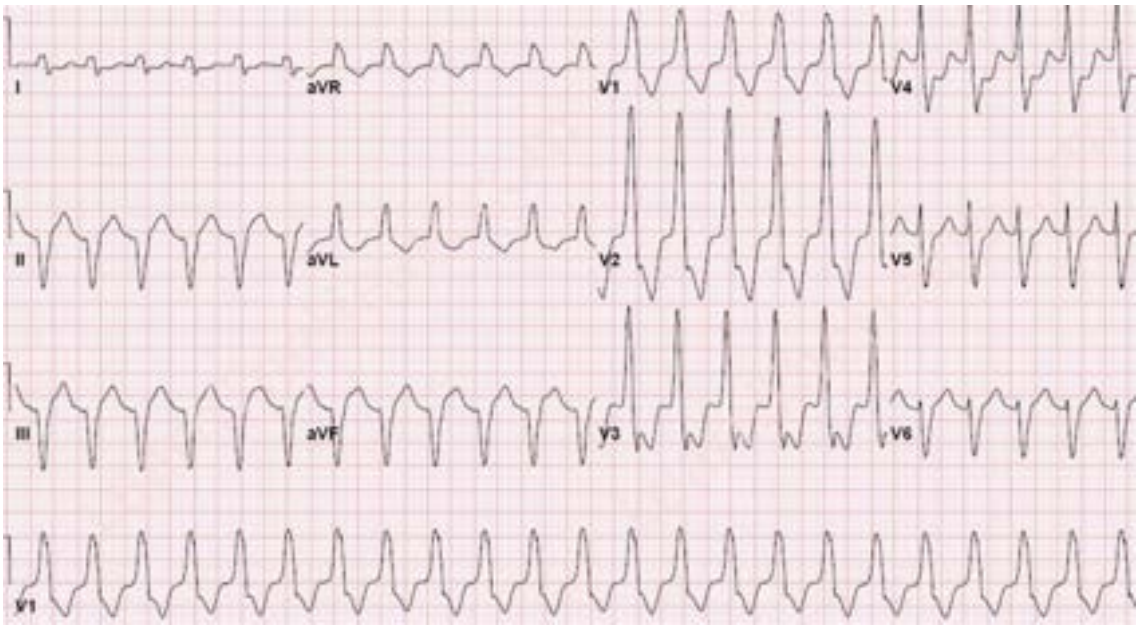
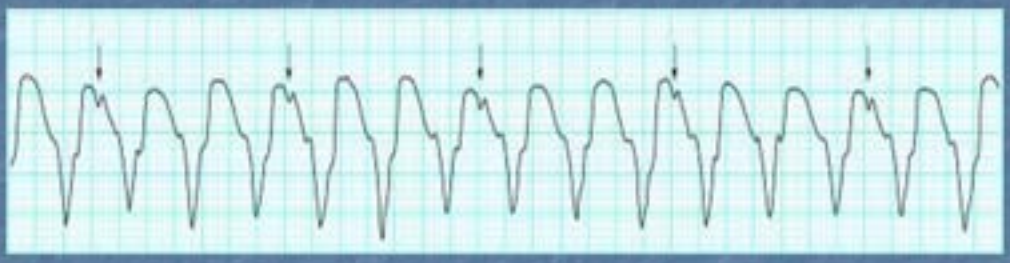



**Table 9** **Summary of key electrocardiographic criteria that suggest ventricular tachycardia rather than supraventricular tachycardia in wide complex tachycardia**

| | |
|---|---|
| **AV dissociation** | Ventricular rate > atrial rate |
| **Fusion/capture beats** | Different QRS morphology from that of tachycardia |
| **Chest lead negative concordance** | All precordial chest leads negative |
| **RS in precordial leads** | - Absence of RS in precordial leads<br>- RS >100 ms in any lead[a] |
| **QRS complex in aVR** | • Initial R wave<br>• Initial R or Q wave >40 ms<br>• Presence of a notch of a predominantly negative complex |
| **QRS axis −90 to ±180°** | Both in the presence of RBBB and LBBB morphology |
| **R wave peak time in lead II** | R wave peak time ≥50 ms |
| **RBBB morphology** | ***Lead V1:*** Monophasic R, Rsr', biphasic qR complex, broad R (>40 ms), and a double-peaked R wave with the left peak taller than the right (the so-called 'rabbit ear' sign)<br>***Lead V6:*** R:S ratio <1 (rS, QS patterns) |
| **LBBB morphology** | ***Lead V1:*** Broad R wave, slurred or notched-down stroke of the S wave, and delayed nadir of S wave<br>***Lead V6:*** Q or QS wave |

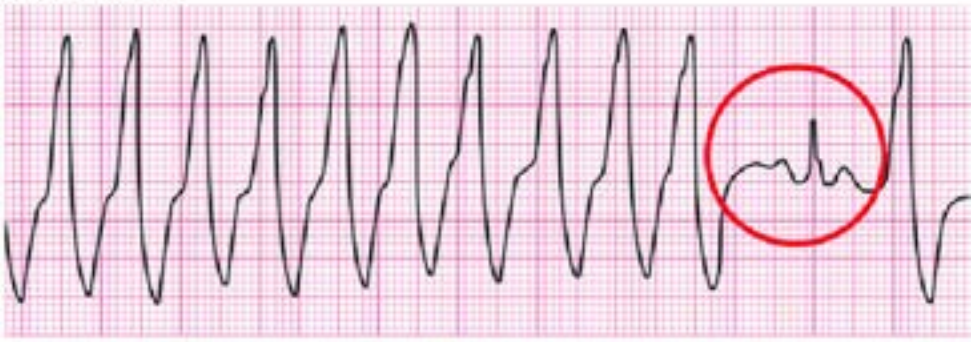
AV = atrioventricular; LBBB = left bundle branch block; RBBB = right bundle branch block.
[a]RS: beginning of R to deepest part of S.

# AV dissociation



- Atrioventricular dissociation in monomorphic ventricular tachycardia (note P waves, arrowed)

Capture beat:



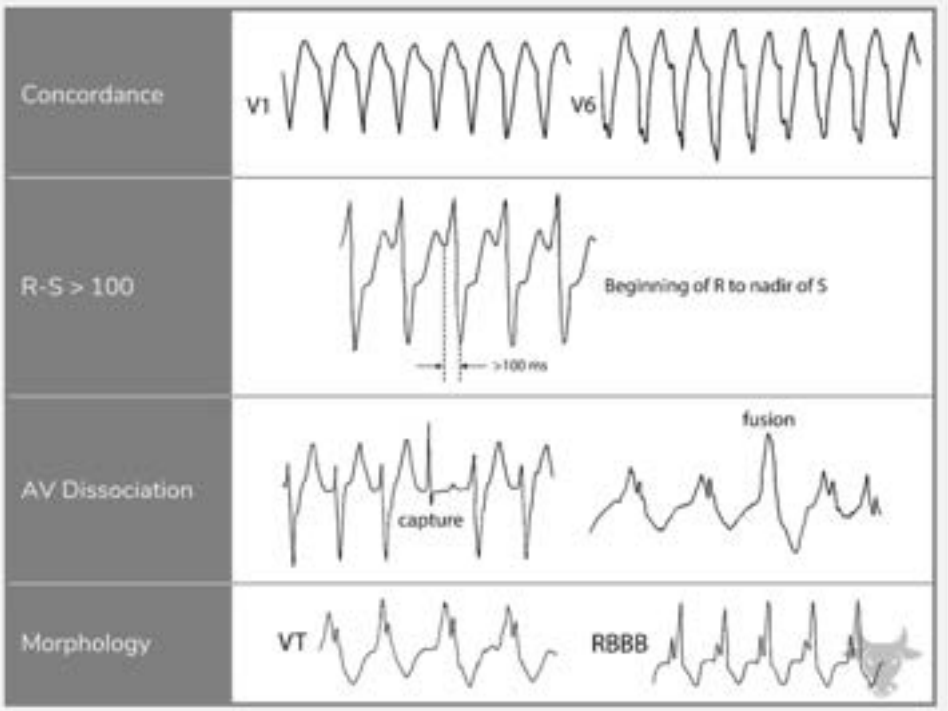
Fusion beat:

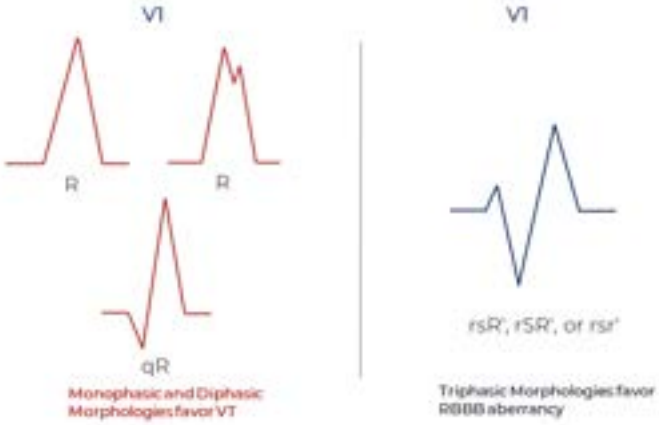


QS in V1 to V6 is negative concordance and almost always VT

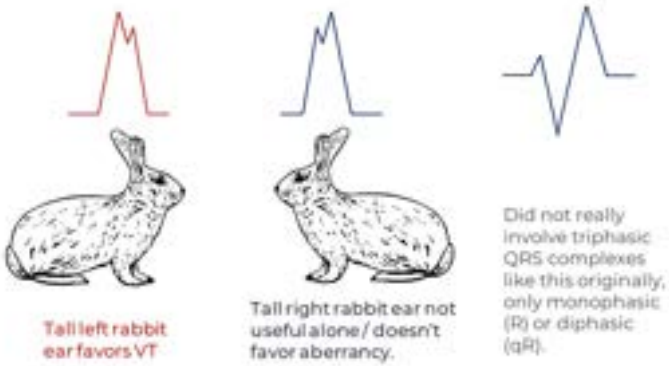
R in V1 to V6 is positive concordance and is usually VT but can be pre-excited tachycardia

Concordance as originally defined by Marriott and Wellens. Not mostly negative or mostly positive but all positive (monophasic R, regardless if it has one or two peaks) or all positive (QS complexes, usually with a notch on the downstroke).

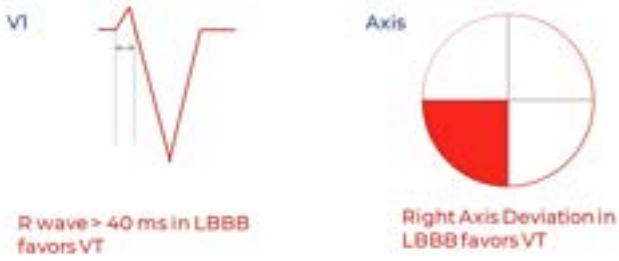


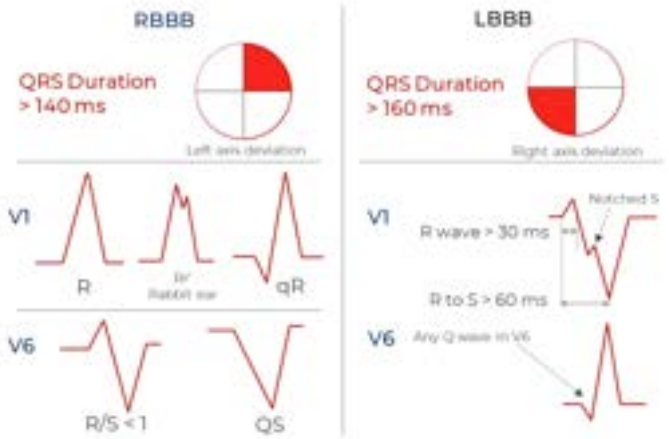

From the work of Sandler and Marriott, we have the foundations of the morphology criteria for RBBB-like wide QRS complexes. Their work only included lead V1 morphologies. While Marriott had observations regarding lead V6 published in a letter to the editor in 1968, it was Wellens' work that eventually solidified the lead V6 criteria a decade later.




The Rabbit Ear criteria as initially reported by Gozensky and Marriott. In monophasic (R) or diphasic (qR) complexes, the R usually has two peaks. The left rabbit ear is usually taller in ventricular ectopy. There is a misconception that if the right rabbit ear is taller, it's more likely RBBB aberrancy but ectopy and aberrancy are equally probable. The rabbit ear description initially did not apply to triphasic (rsR') complexes but some authors have applied it to such thus causing some confusion.




In Swanick and Marriott's work, we see the beginnings of the LBBB morphology criteria favoring ventricular tachycardia. The finding of a wide *r* wave in an LBBB-like QRS complex in V1 points towards VT and will be incorporated into the LBBB morphology criteria moving forward.



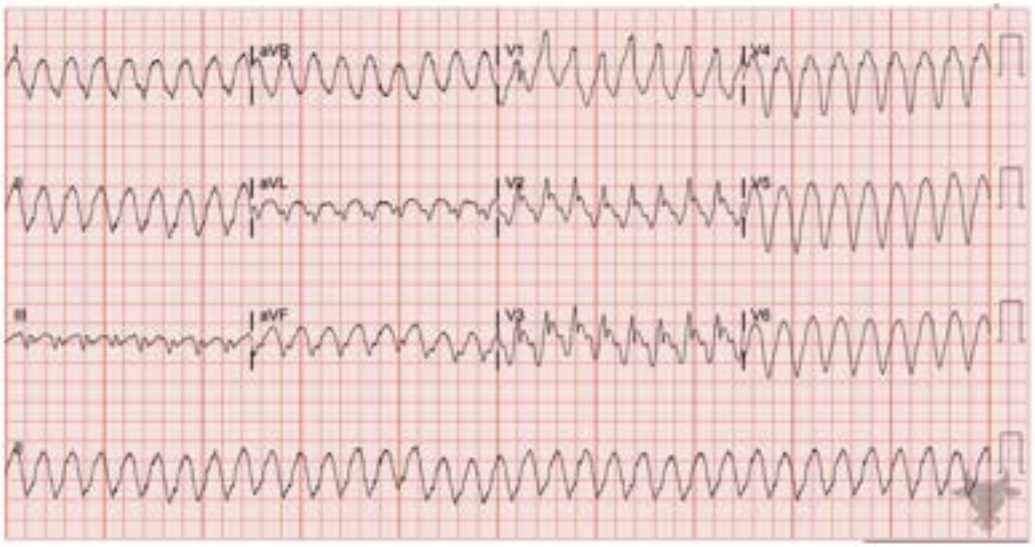

Criteria favoring the diagnosis of ventricular tachycardia in RBBB and LBBB morphology wide QRS tachycardias.

## Ventricular Tachycardia

Features that favor ventricular tachycardia include R-S time greater than 100 ms.

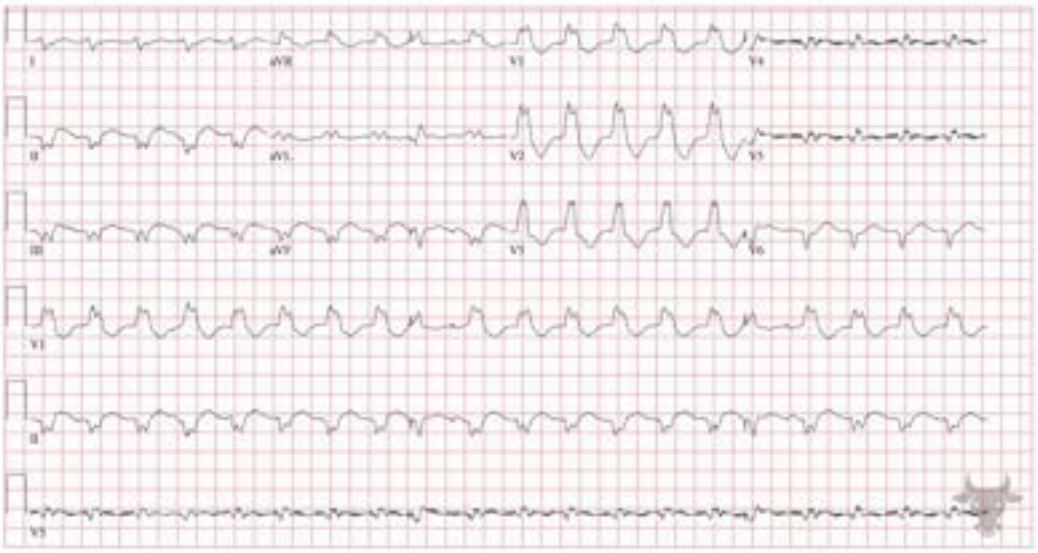

## Ventricular Tachycardia

The presence of a narrow capture beat about 1/3 of the way through the rhythm strip confirms atrioventricular dissociation - a criterion that indicates ventricular tachycardia. (The vertical green bars can be ignored).




## Ventricular Tachycardia

The "northwest" axis strongly favors ventricular tachycardia.



## Ventricular Tachycardia

Although the rate is slower than typical ventricular tachycardia, features favoring ventricular tachycardia include RSr' (left "bunny ear" taller than the right one in V1) and northwest axis. This rhythm was confirmed to be ventricular tachycardia by electrophysiology and the patient was electrically cardioverted.

## Ventricular Tachycardia

The right bundle branch block pattern with the first R larger than the r' in V1 is very specific for ventricular tachycardia.


**Ventricular Tachycardia**

Josephson's sign, notching near the nadir of the S wave, can be seen in V1 and V2, and suggests ventricular tachycardia. This patient was ultimately diagnosed with ventricular tachycardia.