

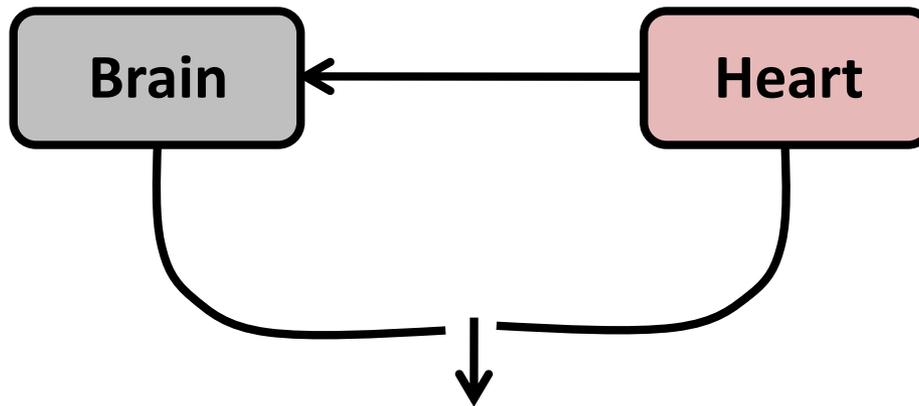
Tachyarrhythmia

DR. D.P Khaitan

M.D (Medicine) F.C.G.P(IND) F.I.A.M.S (Medicine) FICP FICCMD

Tachyarrhythmia – AHA-ACLS 2023

- ❑ Tachyarrhythmia is defined as a rhythm disorder with a heart rate greater than 100 bpm.
- ❑ An unstable tachyarrhythmia exists when cardiac output is reduced to the point of causing serious signs and symptoms.



- ❑ Serious signs and symptoms commonly seen with unstable tachycardia are: chest pain, signs of shock, SOA (short of air), altered mental status, weakness, fatigue, and syncope.

This talk on tachyarrhythmia is dedicated to Willem Einthoven (1860-1927) : Father of ECG



Basis of P-QRS-T morphology in tachyarrhythmia

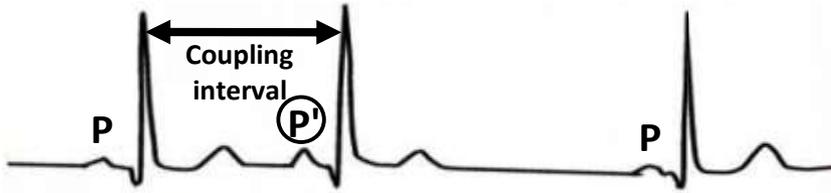
As a speaker , I consider this as essential to express in the beginning that

The driving signal for tachyarrhythmia may be initiated at cellular level acting through automaticity, re-entry \pm triggered activity during the cardiac vulnerable period. The resulting irregularities have patterns too, may be called the **'Theory of deterministic choice'**

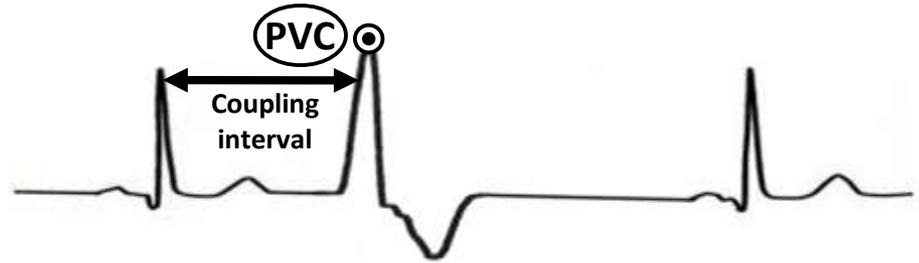
The point of interest is that any cellular change does not cause cardiac arrhythmia unless it is set at the critical point of vulnerable period.

Theory of deterministic choice

THE DRIVING SIGNAL :

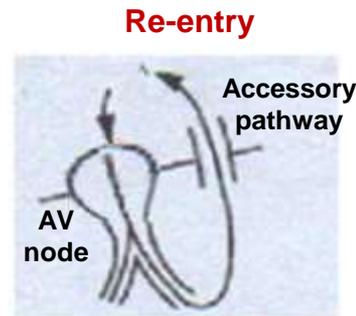
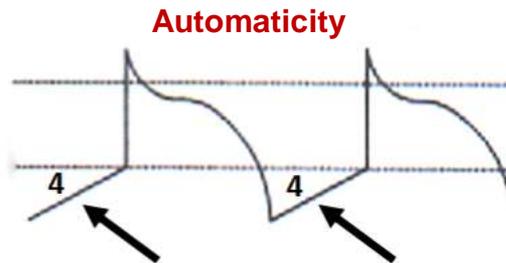
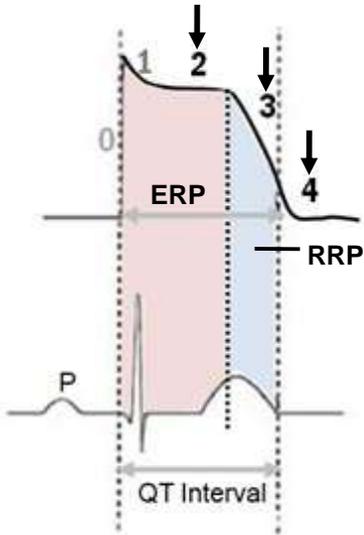


Supraventricular Premature Complex



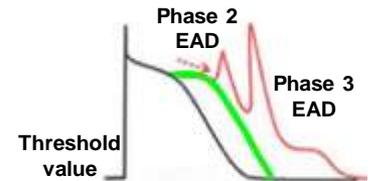
Premature Ventricular Complex (PVC)

Critical vulnerable period , as indicated by arrow

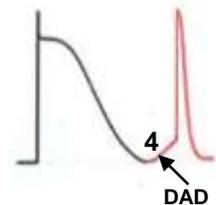


e.g. Orthodromic AVRT

Triggered activity
EADs (Bradycardia-dependent)

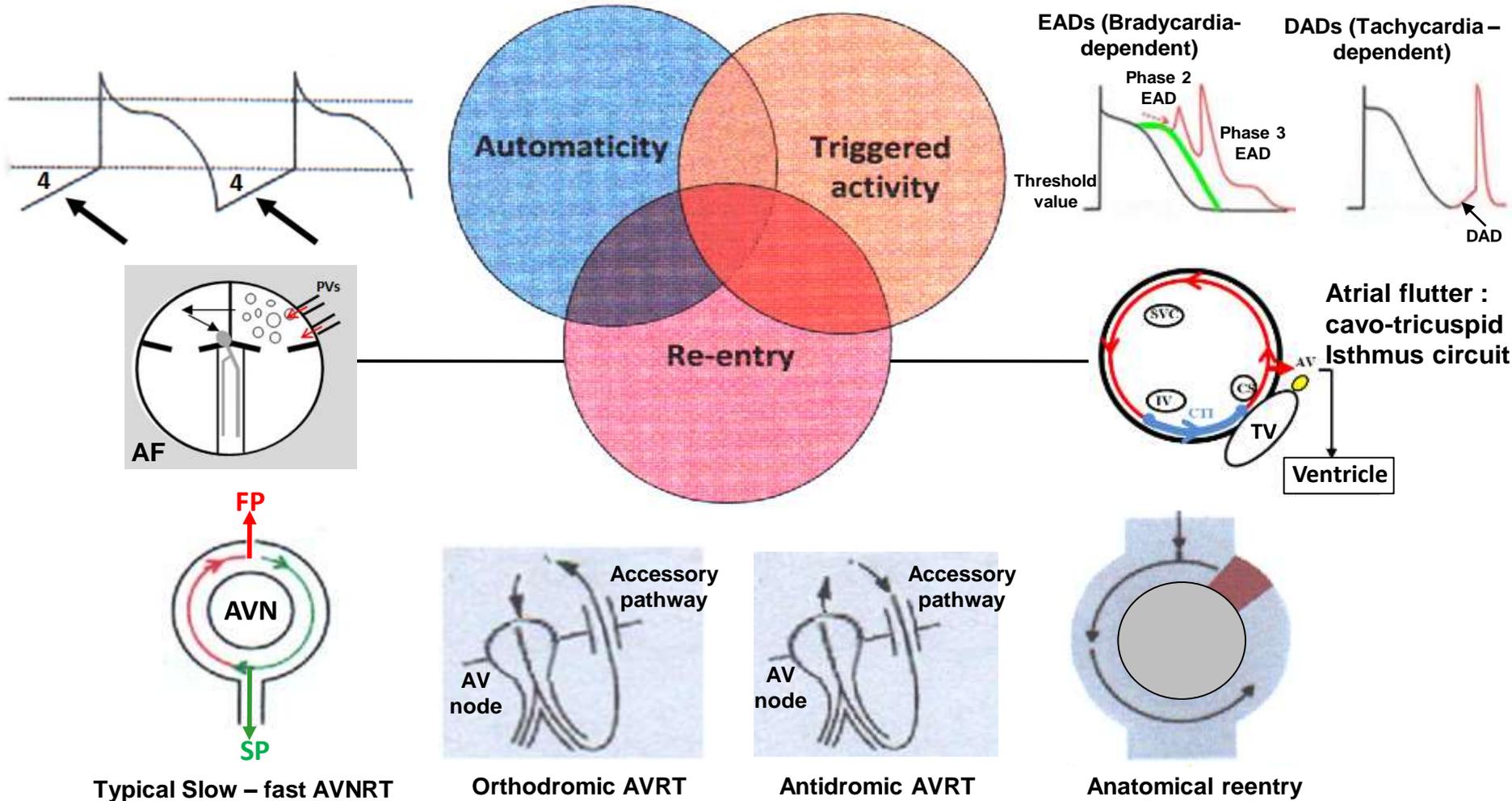


DADs (Tachycardia-dependent)



The morphology of tachyarrhythmias , as per pathway adopted by the impulse.

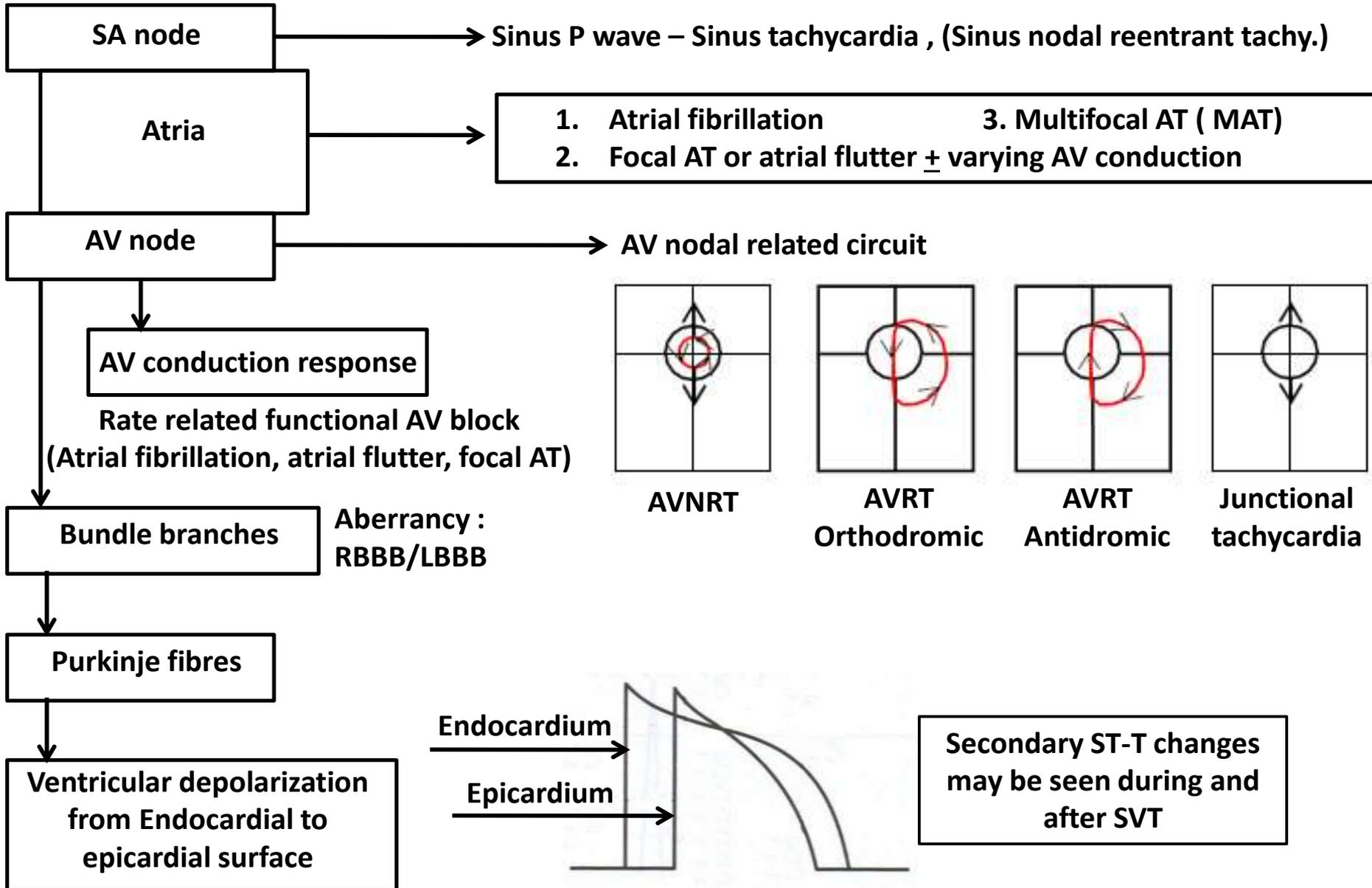
The basic electrophysiology in tachyarrhythmia



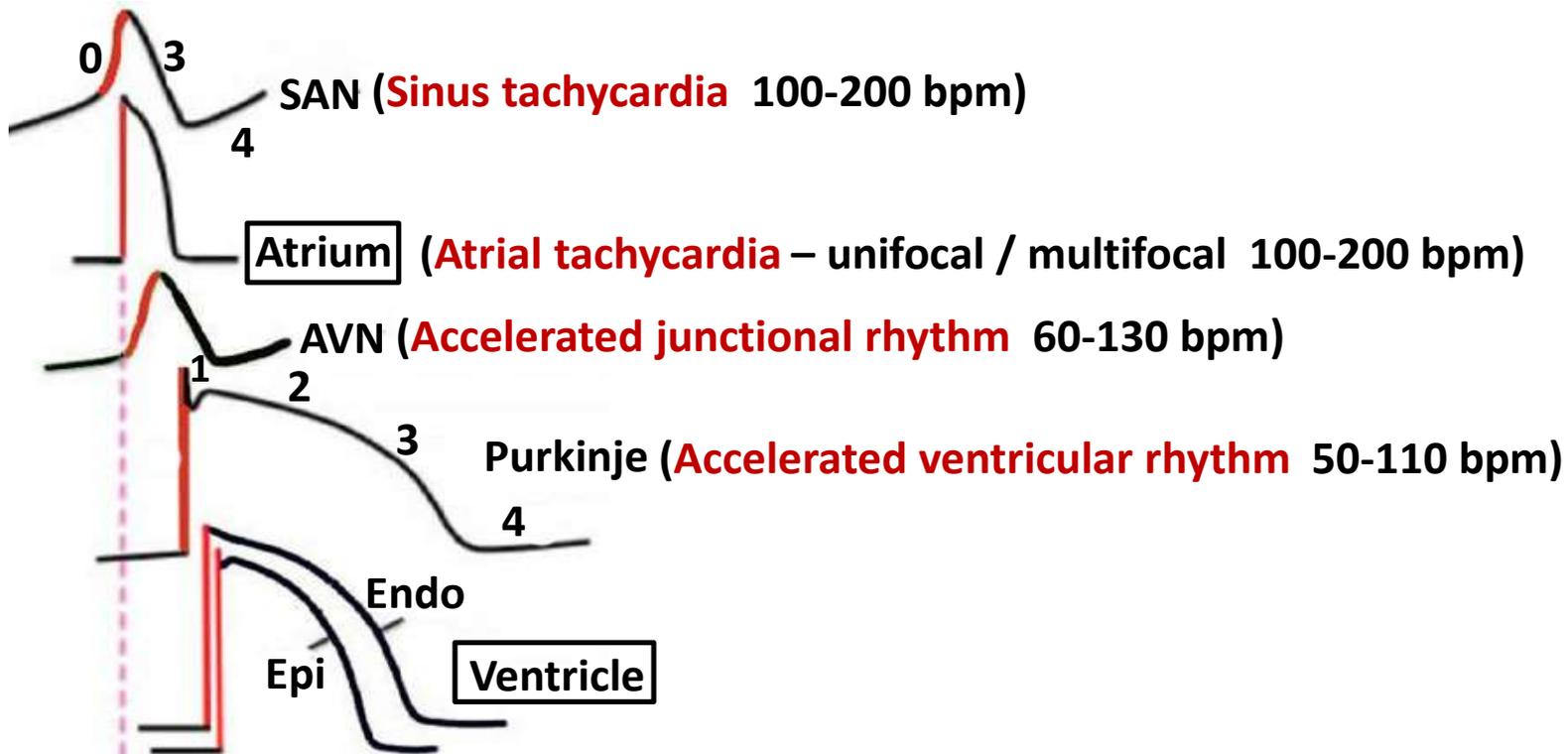
Basic Principle :

- **Negative P in leads (II aVF III) when the flow of current is away (Junctional , AVNRT , orthodromic AVRT)**

A simplified approach to SVT



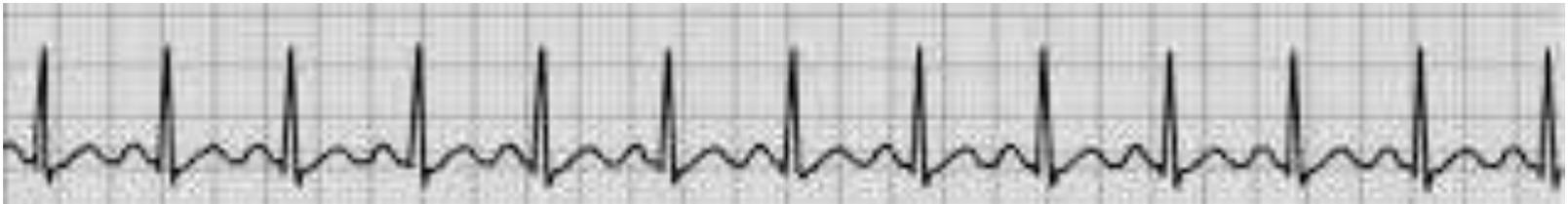
Automaticity related SVT



Atrial myocardial cells can develop the enhanced automaticity of depolarization when a repetitive impulse initiation sets in: known as 'Depolarized induced automaticity'.

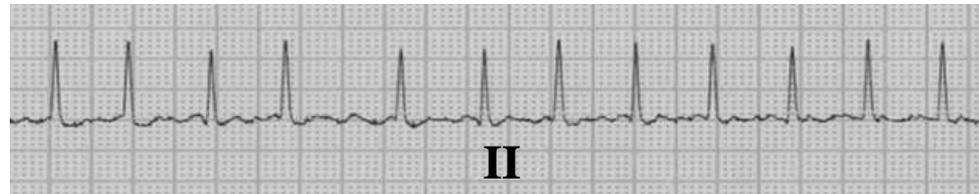
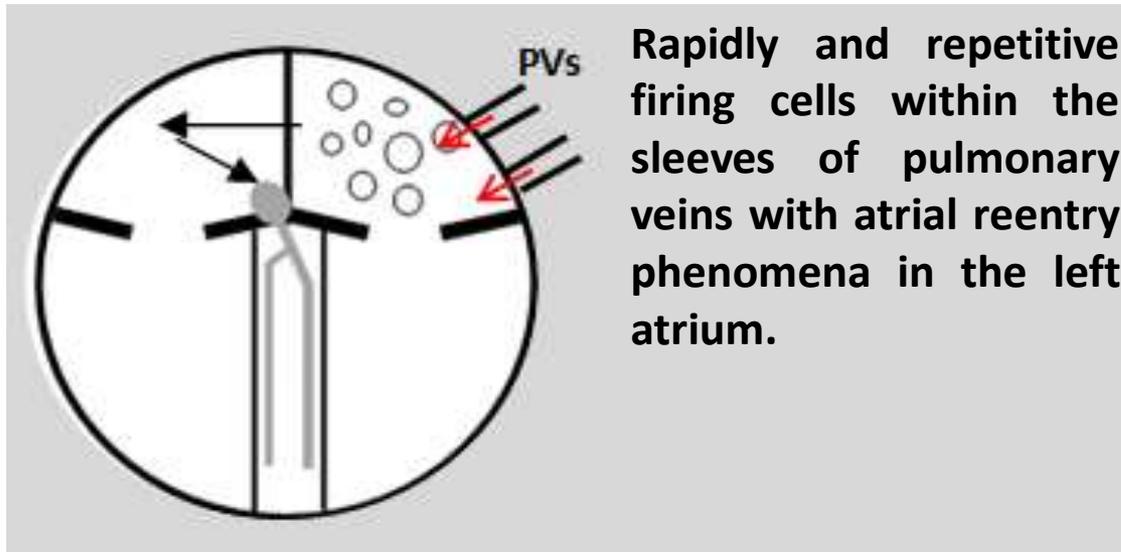
Sinus tachycardia

- ❑ **Physiological sinus tachycardia** : Associated with an appropriate response to effort, stress , pregnancy or illness or some causes as well. A gradual increase and decrease in the rate favours physiological sinus tachycardia.
- ❑ **Inappropriate sinus tachycardia** : Persistent tachycardia at rest or with minimal activity in young, mainly females.
- ❑ **Postural orthostatic tachycardia syndrome** : A clinical entity characterized by an increase in heart rate of ≥ 30 b.p.m when standing for >30 s (or ≥ 40 b.p.m in individuals aged 12-19 years) in an absence of orthostatic hypotension (>20 mmHg drop in systolic blood pressure).



PQRST complex is similar in either of the entity with the heart rate more than 100 per minute

Atrial fibrillation

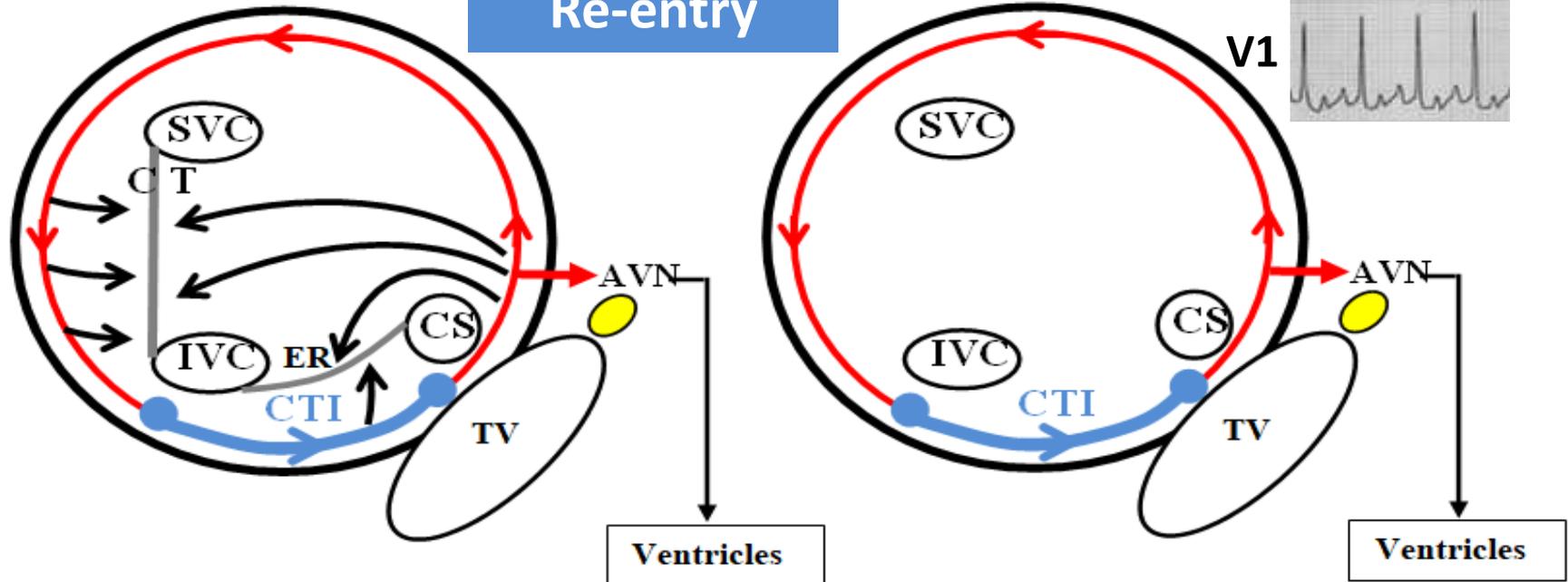


Triggering factors:

Arising from the pulmonary veins / outside the pulmonary veins: posterior left atrial, coronary sinus, venae cavae, septum, left atrial appendage , etc.

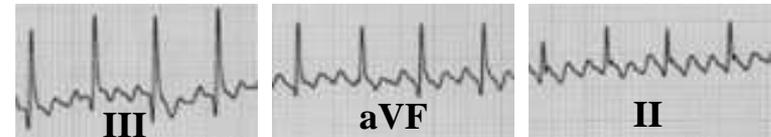
Cavo-tricuspid isthmus dependent circuit : Atrial flutter

Re-entry



Anisotropic mechanism :

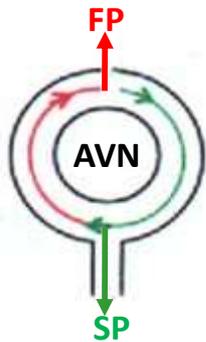
Functional blockade across crista terminalis ,
eustachian ridge and Cavo-tricuspid isthmus



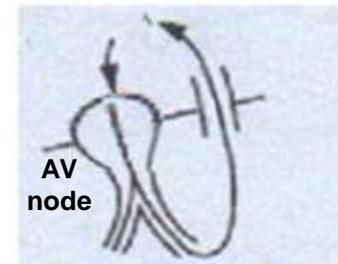
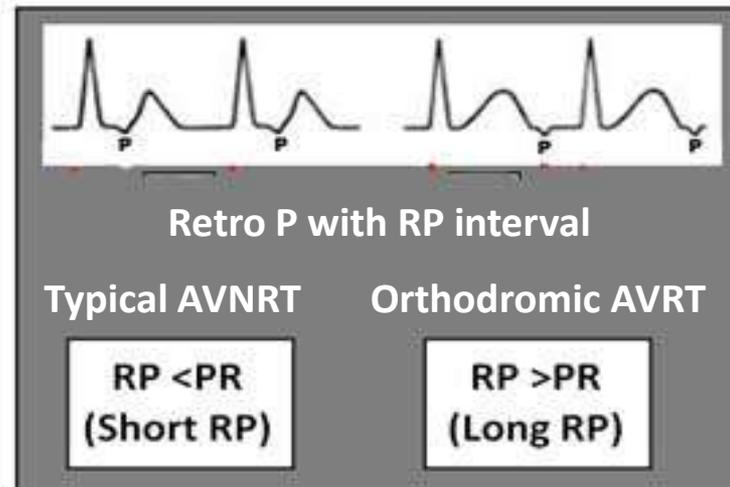
- Counterclockwise** : flutter waves
preminantly -Ve in inferior leads II , III and
aVF and +Ve in V1 (the most common variety)
- Clockwise** : Vice versa

Both counterclockwise and clockwise atrial flutter may occur in the same patient

AVNRT and Orthodromic AVRT



Typical Slow – fast AVNRT
Slow RP tachycardia



Orthodromic AVRT
Long RP tachycardia
(with slow conduction through accessory pathway)

- **Short RP may also be expressed as less than 50% of RR interval**
- **Long RP may be also be expressed as more than 50% of RR interval**

Illustration by ECGs

BIX rule : Dr. Harold Bix

Bix Rule
QRS --P'-- QRS
(P')

- Seek the P' midway in between two QRS
- The next P' would be lurking within the next QRS

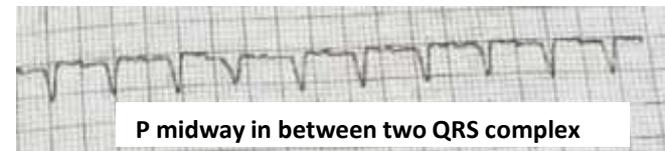
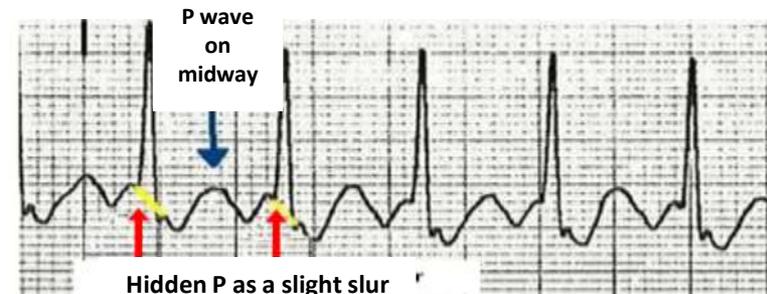
□ Hide-and-seek play

Since flutter waves tend to be somewhat wide and rarely fall perfectly inside a narrow QRS complex, one can still find imprints of buried wave as a slight notch or slur at the base of accompanying QRS complex confirming the atrial activity hidden therein.

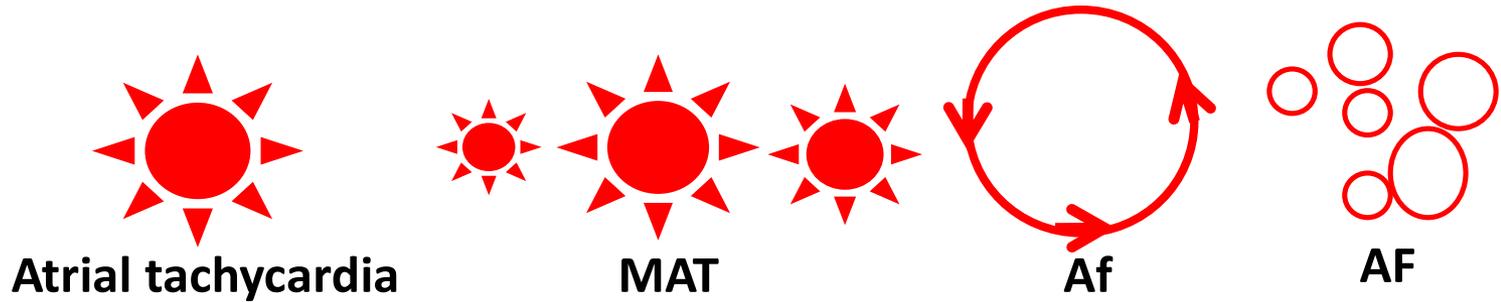
Atrial tachycardia with long RP interval as 2:1 AV conduction : AT wave not so wide falls perfectly inside QRS

With 2:1 conduction one atrial beat is allowed to pass through AV Node in a sequential way P-QRS-T, but the next atrial beat is just coincidentally coming at a time of QRS so it is hidden within.

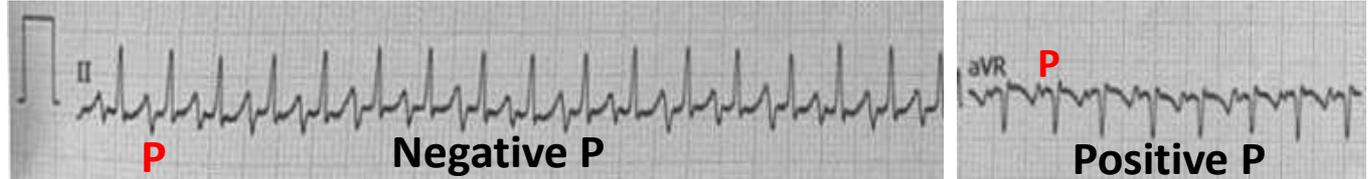
Suspect any supraventricular tachycardia around 150/min to be atrial flutter / atrial tachycardia with 2:1 AV conduction, unless and until disproved



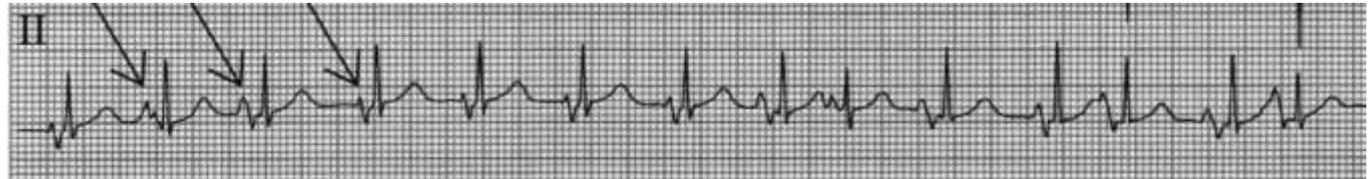
Non-sinus Atrial activity



**ATRIAL
TACHYCARDIA**



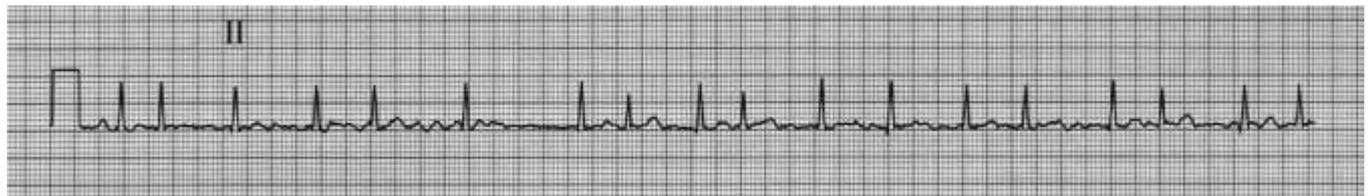
MAT



**ATRIAL
FLUTTER**

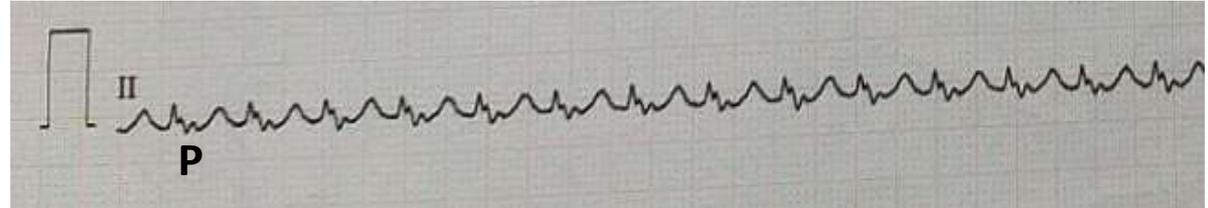
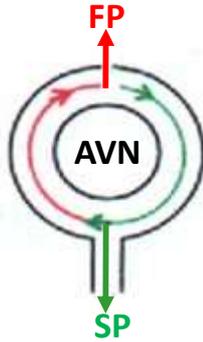


**ATRIAL
FIBRILLATION**

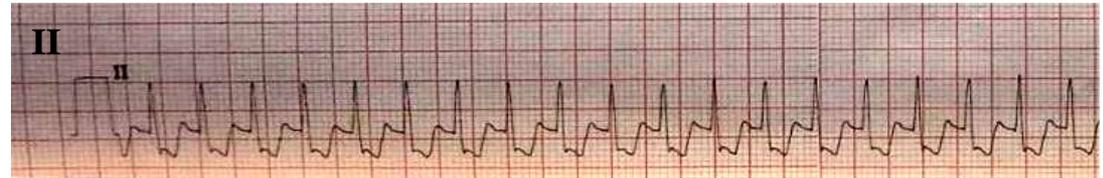
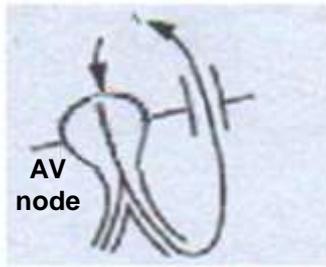


AVNRT and AVRT orthodromic

**AVNRT
(Slow - Fast)**



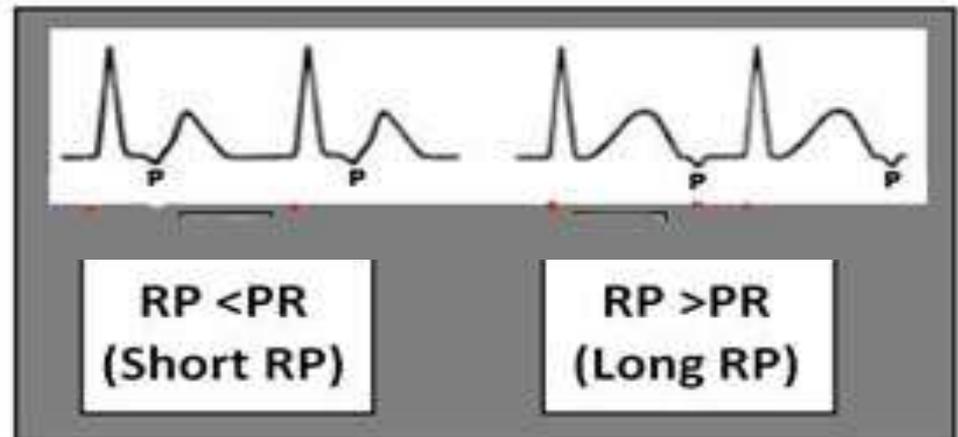
**AVRT
Orthodromic**



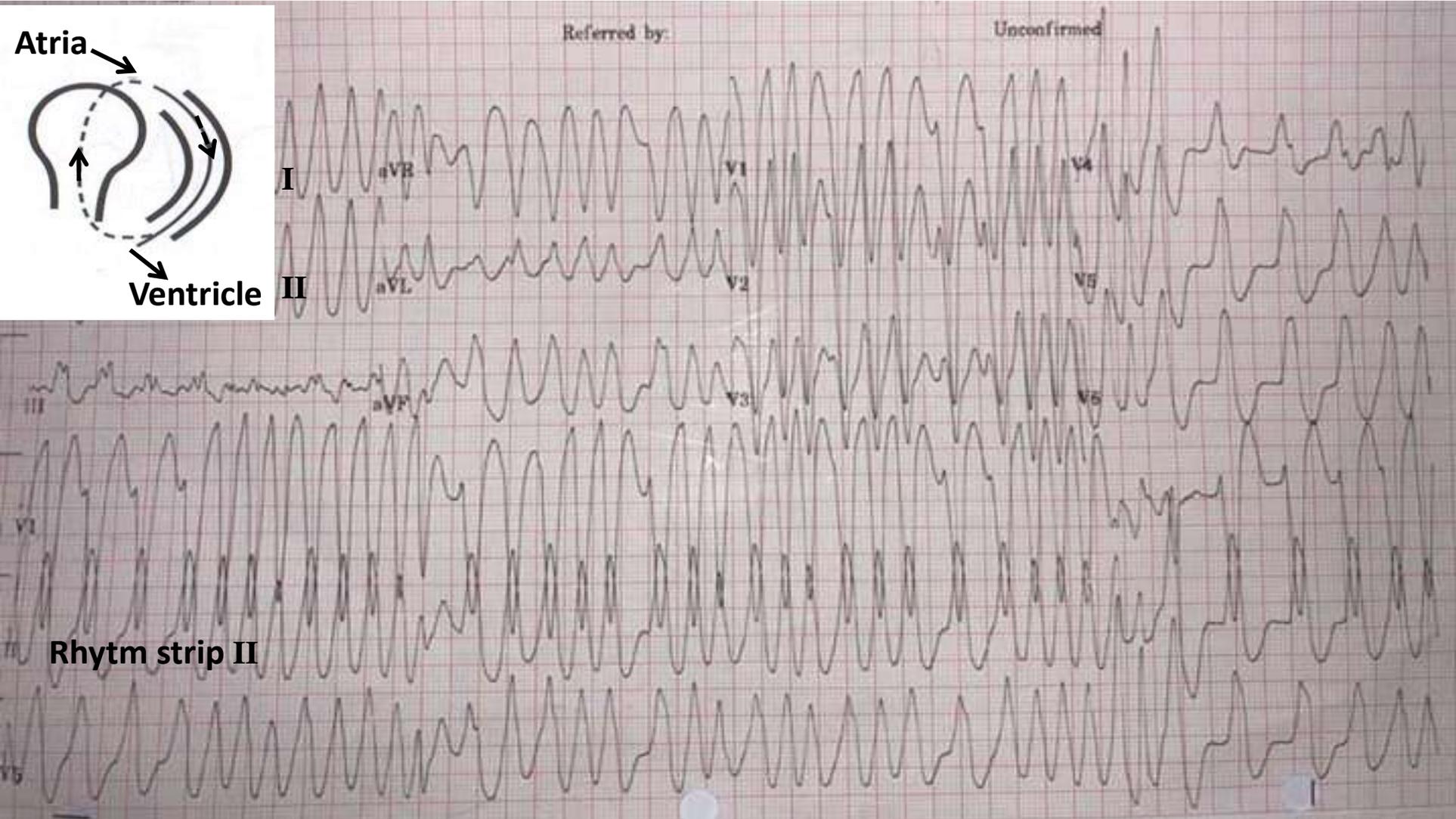
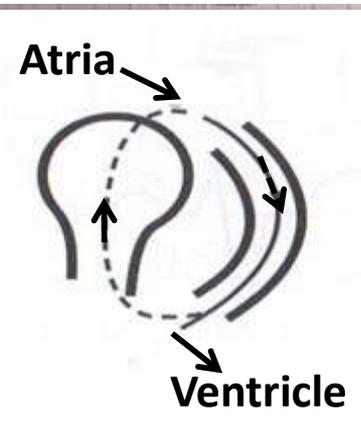
Orthodromic AVRT
Long RP tachycardia
(with slow conduction through
accessory pathway)

AVNRT : Short RP Tachycardia

**AVRT (Orthodromic) Long RP
Tachycardia**



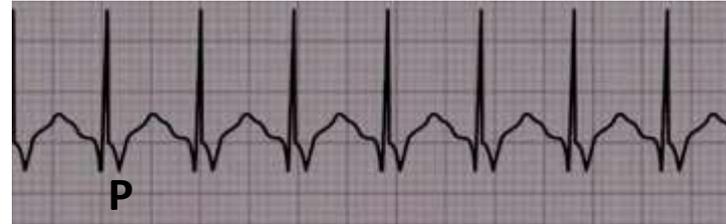
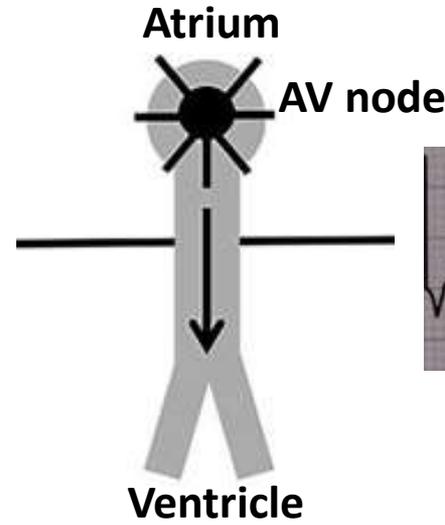
PREEXCITATION – ATRIAL FIBRILLATION



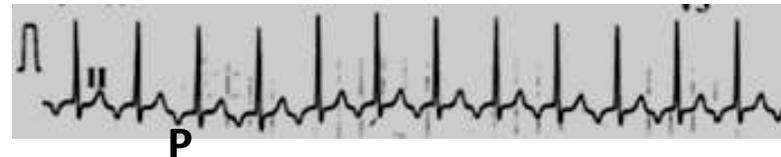
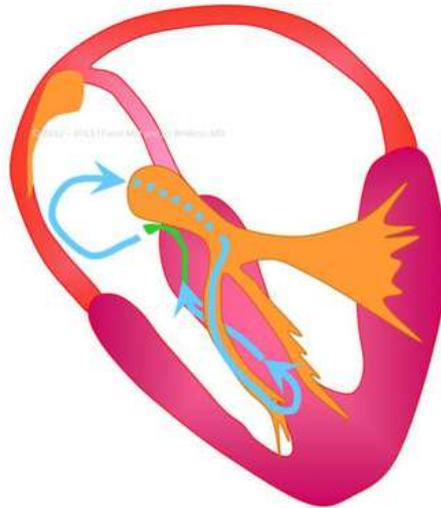
- Irregular ventricular response (atrial fibrillation) : 180-230 bpm (on average 120-300 bpm)
- Anomalous ventricular activation leading to completely bizarre QRS

JUNCTIONAL TACHYCARDIA

JUNCTIONAL ECTOPIC TACHYCARDIA



**PJRT
(Very uncommon)**



A long RP tachycardia with deeply inverted retrograde P waves in inferior leads – II , III and aVF

PJRT is an AVRT using as retrograde limb a septal accessory AV pathway with long conduction times and decremental conducting properties

Diagnostic approach to SVT

Irregular narrow complex VT

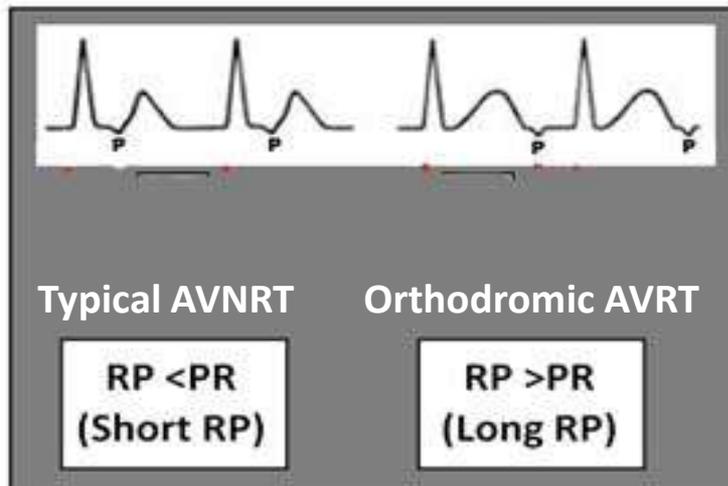
- Atrial fibrillation
- Focal AT or Atrial flutter with variable AV conduction
- Multifocal AT (MAT)

P waves not seen

- Atrial fibrillation
- AVNRT (retro P buried inside or as pseudo s in inferior leads + pseudo r' in V1/aVR)
- Accelerated junctional rhythm (when P buried inside)

P waves well seen

- Normal morphology (sinus tachycardia)
- Junctional tachycardia either pre or retro P in respect to QRS complex



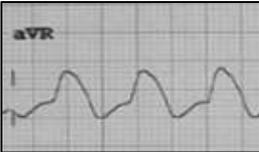
Pre-excitation atrial fibrillation - a special variant

Ventricular tachyarrhythmia

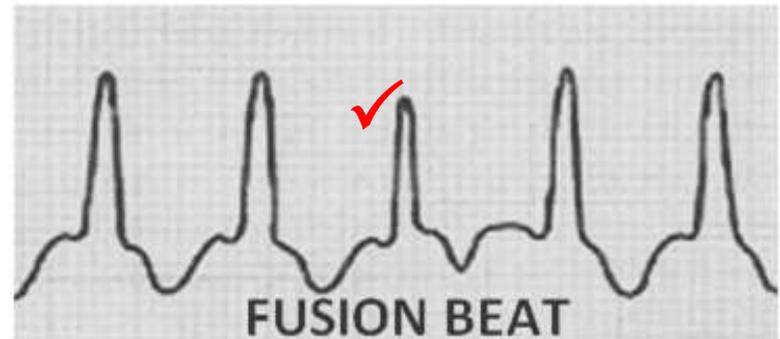
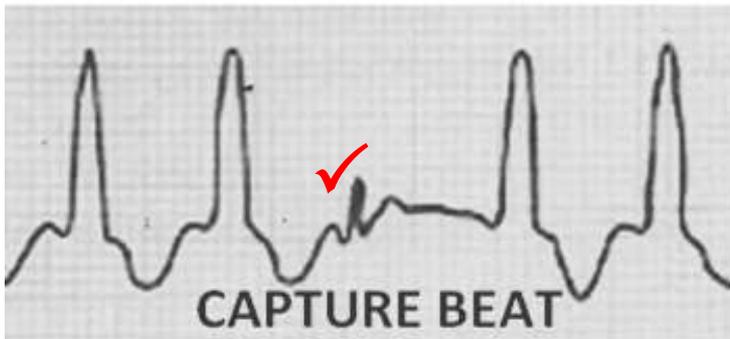
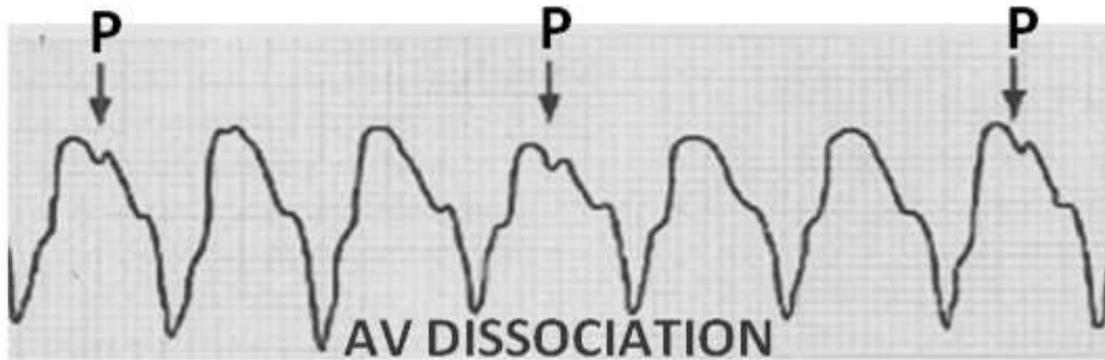
Classification of Ventricular arrhythmia

ECG Findings	Classification
3 or more PVCs in a row, <30 sec in duration	Non sustained VT (NSVT)
VT lasting >30 sec and/or causing hemodynamic instability	Sustained VT
VT with stable QRS morphology from a single focus within the ventricles.	Monomorphic VT
VT with variable QRS morphology originating from different sides of the ventricles	Polymorphic VT
Polymorphic VT occurring in people with prolonged QTc interval with 'twisting around an axis'.	Torsades de pointes
Ventricular rhythm as a continuous sine wave with no identifiable P waves, QRS complexes or T wave, Rate usually > 200 beats / min, rapidly progression to ventricular fibrillation.	Ventricular flutter
Completely disorganised ventricular electrical activity with chaotic irregular deflections of varying amplitude, rate 150-500 / min, ultimately degenerating into asystole.	Ventricular fibrillation

Ventricular tachycardia

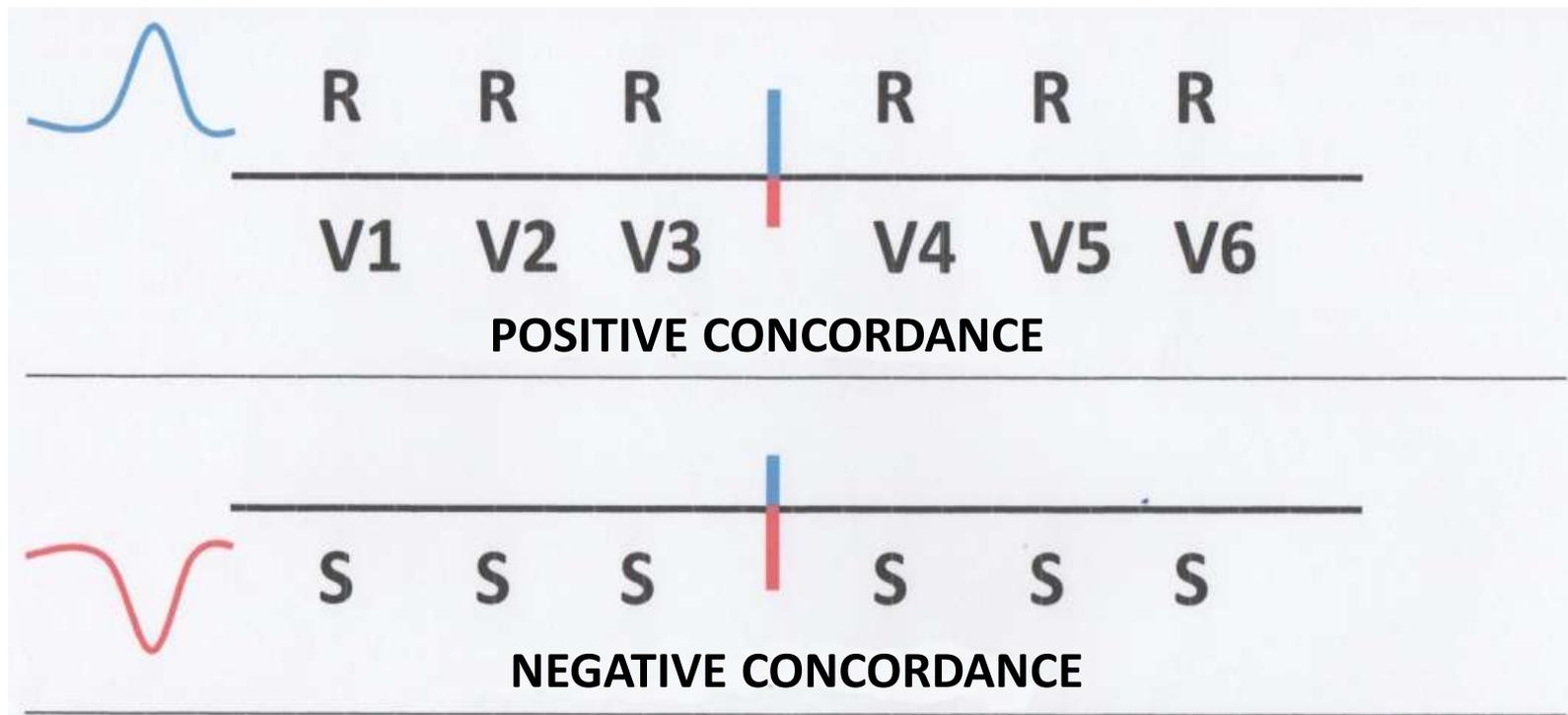
AV dissociation	Ventricular rate more than atrial rate ; VA dissociation ± Capture beat, ± Fusion beat (with different QRS morphology)
Positive or Negative concordance	Either totally positive or totally negative QRS complex over the precordial leads.
RS in precordial leads	Absence of RS in precordial leads. Brugada's sign - The distance from the onset of the QRS complex to the nadir of the S-wave is >100 ms.
Look at aVR lead  Vereckei criteria	Tall R (North-west axis – 90 to 180°). Initial r or q wave > 0.04 sec. Notching over the initial downstroke of the predominant negative QRS complex. $V(i)/V(t) < \text{or} = 1$ (Vertical excursion in mV)
Josephson's sign	Notching near the nadir of the S-wave.
RBBB Pattern	Lead V1 (monophasic R , Left rabbit ear , biphasic qR / Rs) ; Lead V6 rS/(QS) - more or less mirror image. QRS duration > 140 ms
LBBB Pattern	Lead V1 /V2 initial r (>40 ms) followed by slurred deep S wave (>60 ms) ; V6 qR /(QS) QRS duration > 160 ms

AV dissociation

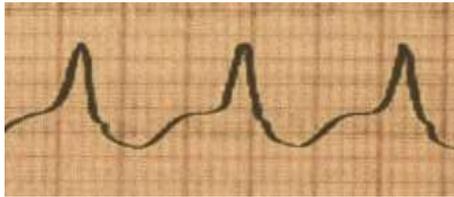


Positive or negative concordance

Positive or negative concordance (either totally positive or totally negative waves) of the QRS complex over the precordial leads strongly suggests VT.



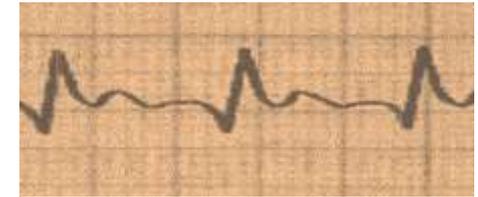
RBBB pattern in V1 (VT)



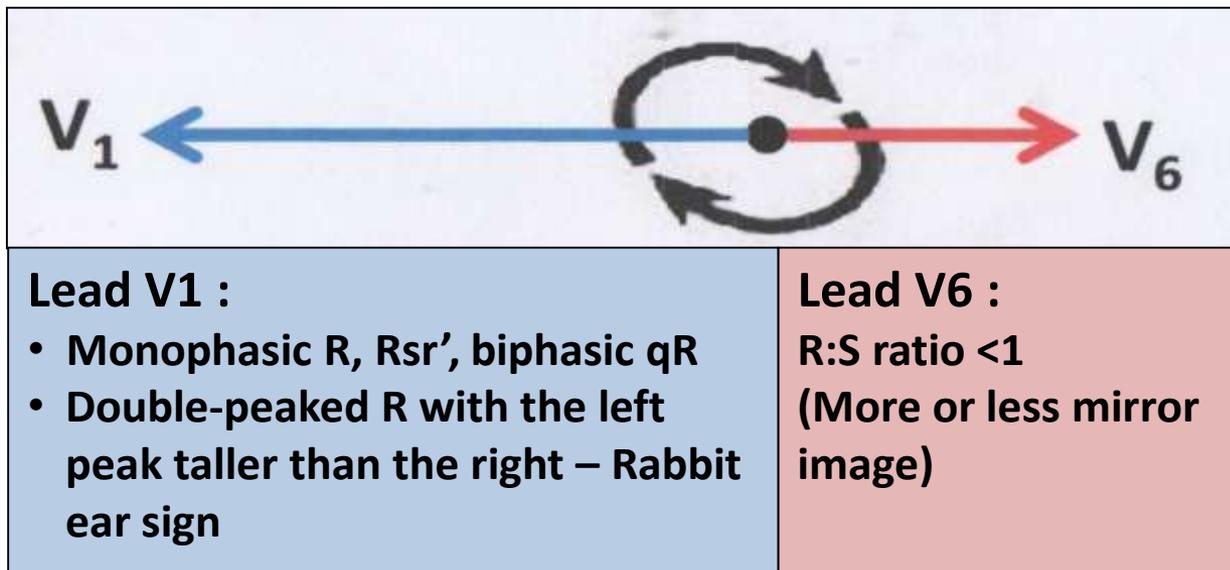
'Monophasic R'



'Left rabbit ear'



Biphasic qR



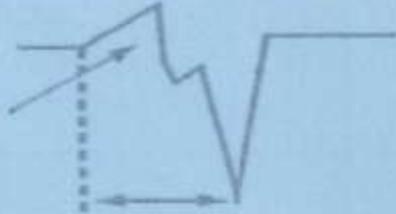
A QRS duration > 140ms with RBBB pattern suggest VT

LBBB pattern in V1 (VT)/V6

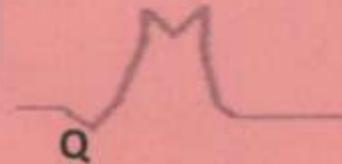


V1 or 2

≥ 0.04



V6



Lead V1/V2 :

Initial broad R wave (≥ 40 ms) slurred or notched-down stroke of the S wave, with delayed nadir of S wave (>60 ms)

Lead V6 :

Any Q or QS

A QRS duration > 160 ms with LBBB pattern suggest VT

Brugada algorithm for VT

Absence of RS complexes in all precordial leads

Yes

VT

R to S interval > 100 msec in 1 precordial lead

Yes

VT

More QRS complexes than P waves (AV dissociation)

Yes

VT

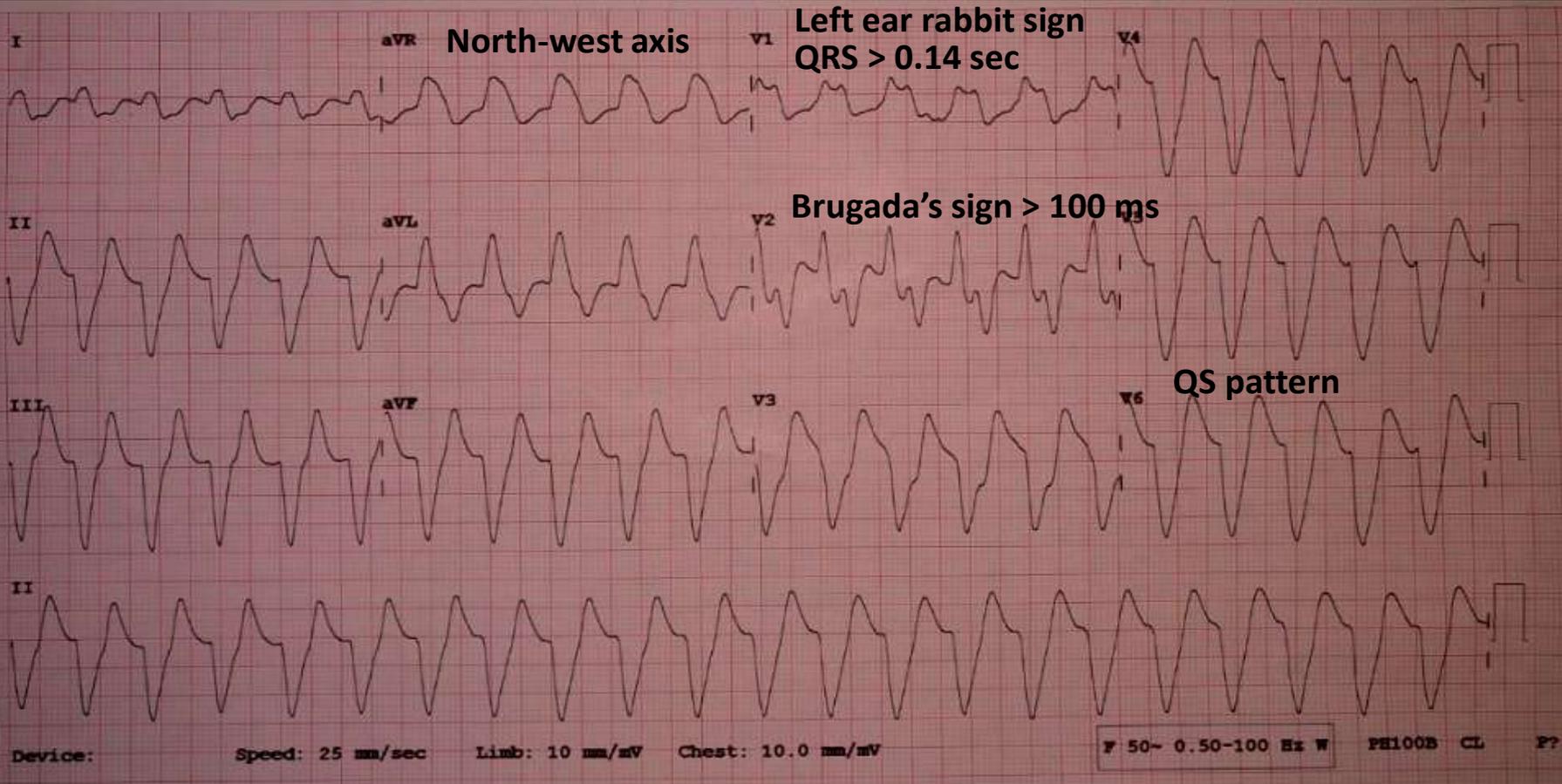
Morphologic criteria for VT present in V1-V6

Yes

VT

SVT with aberrant conduction

Illustration of VT by ECG



If in doubt , consider the followings

- Age >35 (positive predictive value of 85%)
- Structural heart disease like coronary artery disease, congestive heart failure, cardiomyopathy etc.
- Family history of the sudden cardiac death.

Other Varieties of Ventricular tachycardia

Fascicular tachycardia

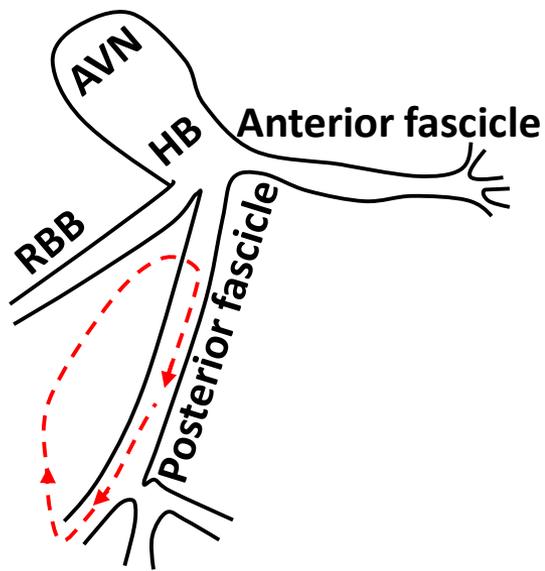
- Posterior fascicular VT (90-95%) : RBBB pattern + left axis deviation

Right Ventricular outflow tract VT

- RVOT-VT

Bidirectional VT

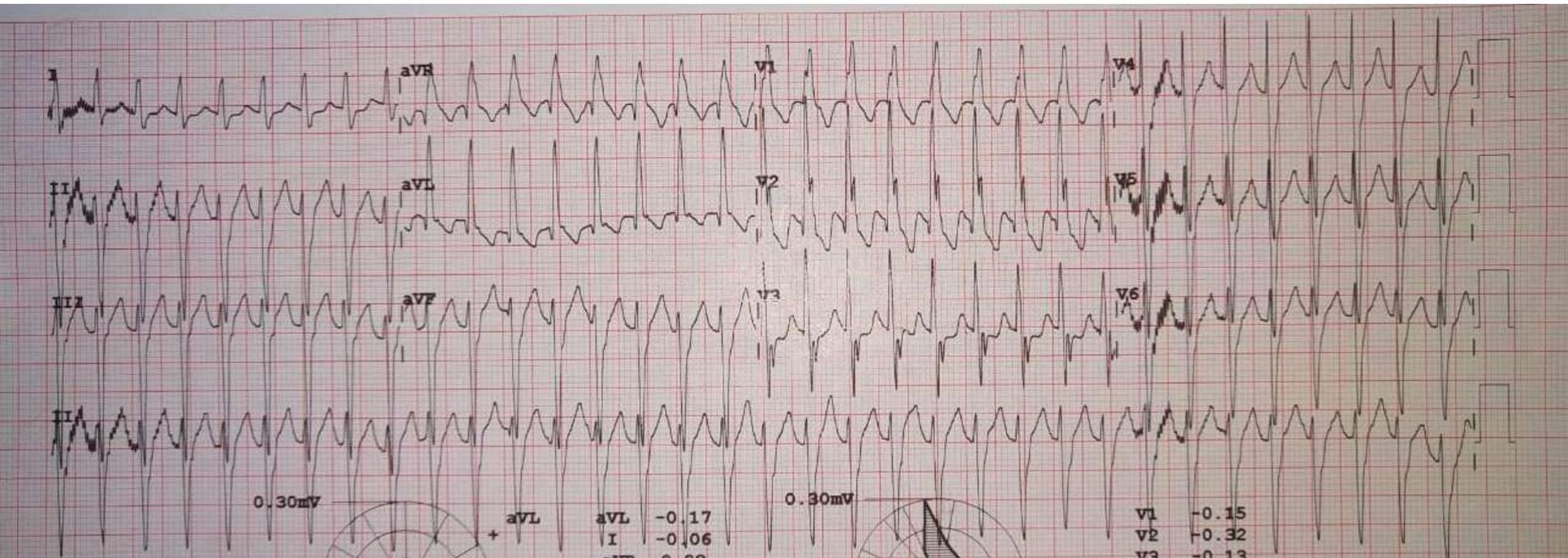
- Familial catecholaminergic polymorphic ventricular tachycardia (CPVT)



❑ Posterior fascicular VT (Narrow complex) :

RBBB pattern + Left axis deviation , arising close to the left posterior fascicle

It occurs in young healthy person mostly in males. The episodes may either arise at rest or may be triggered by exercise, stress and beta agonists. The mechanism is re-entrant tachycardia.

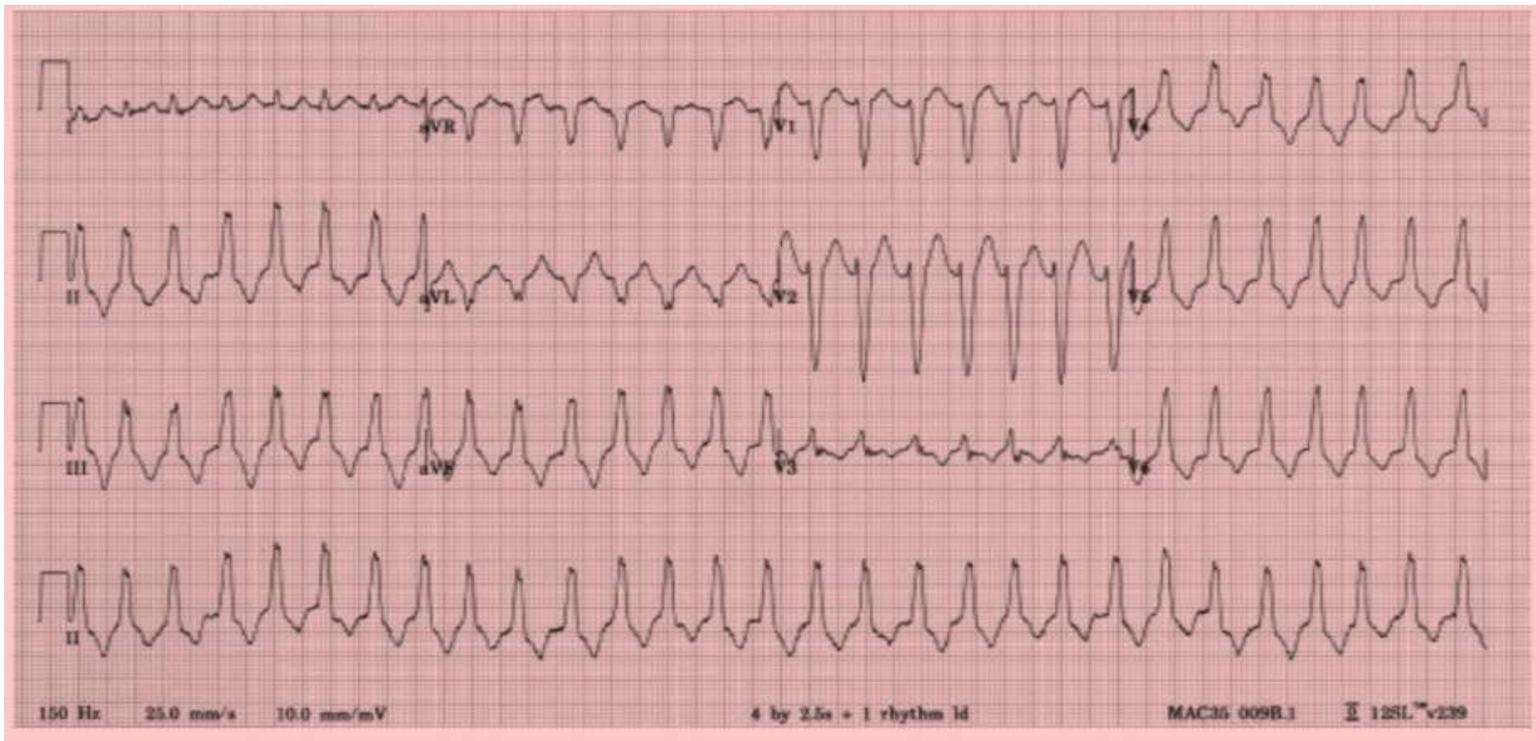


□ RVOT-VT

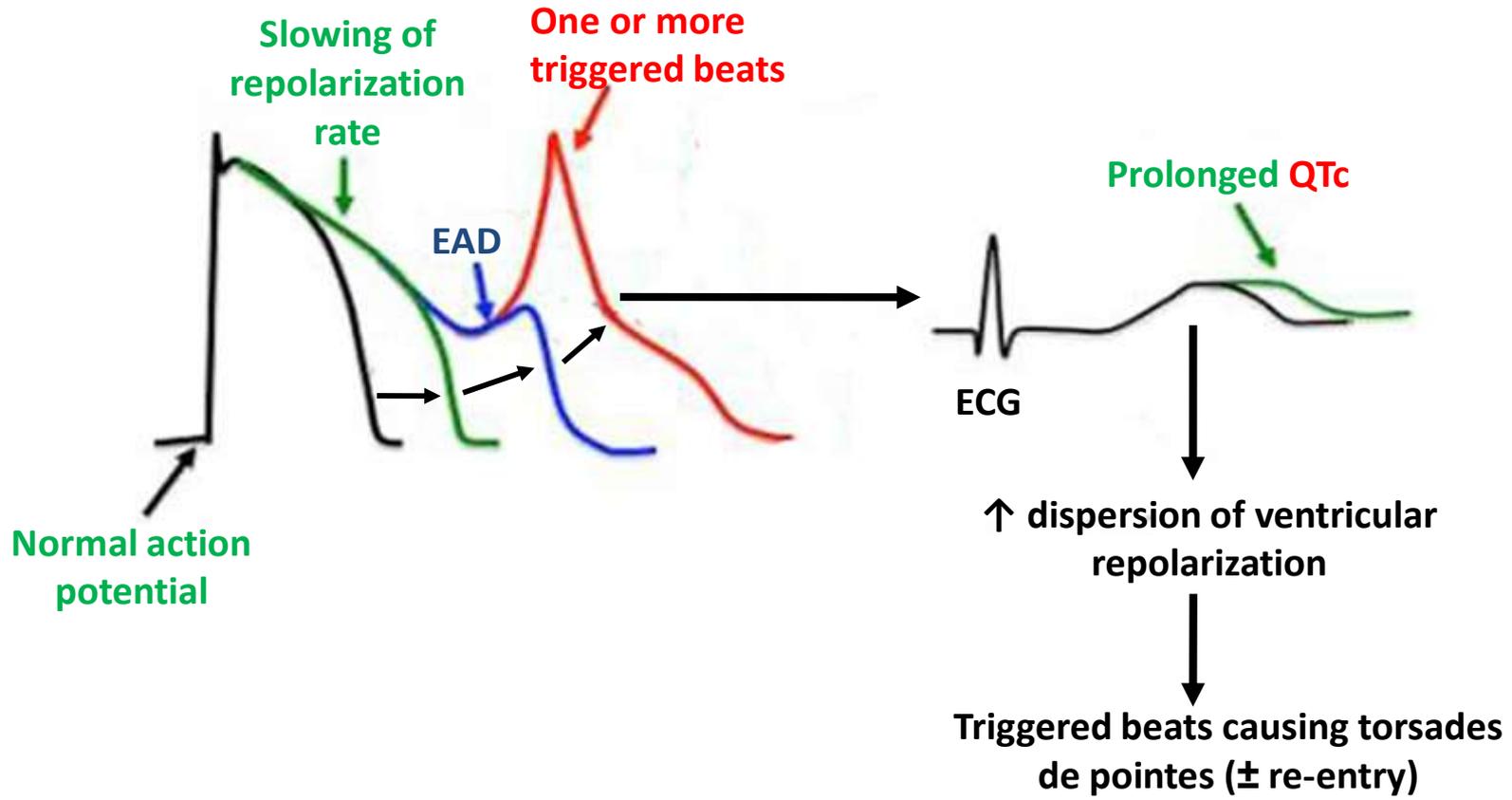
Arising from right ventricular outflow tract which is an infundibular extension of the ventricular cavity , connecting it to the pulmonary artery

ECG findings :

- Wide complex tachycardia = 176/min
- Axis QRS + 110° (or may be inferiorly directed)
- Left bundle branch morphology
- Earlier transition zone

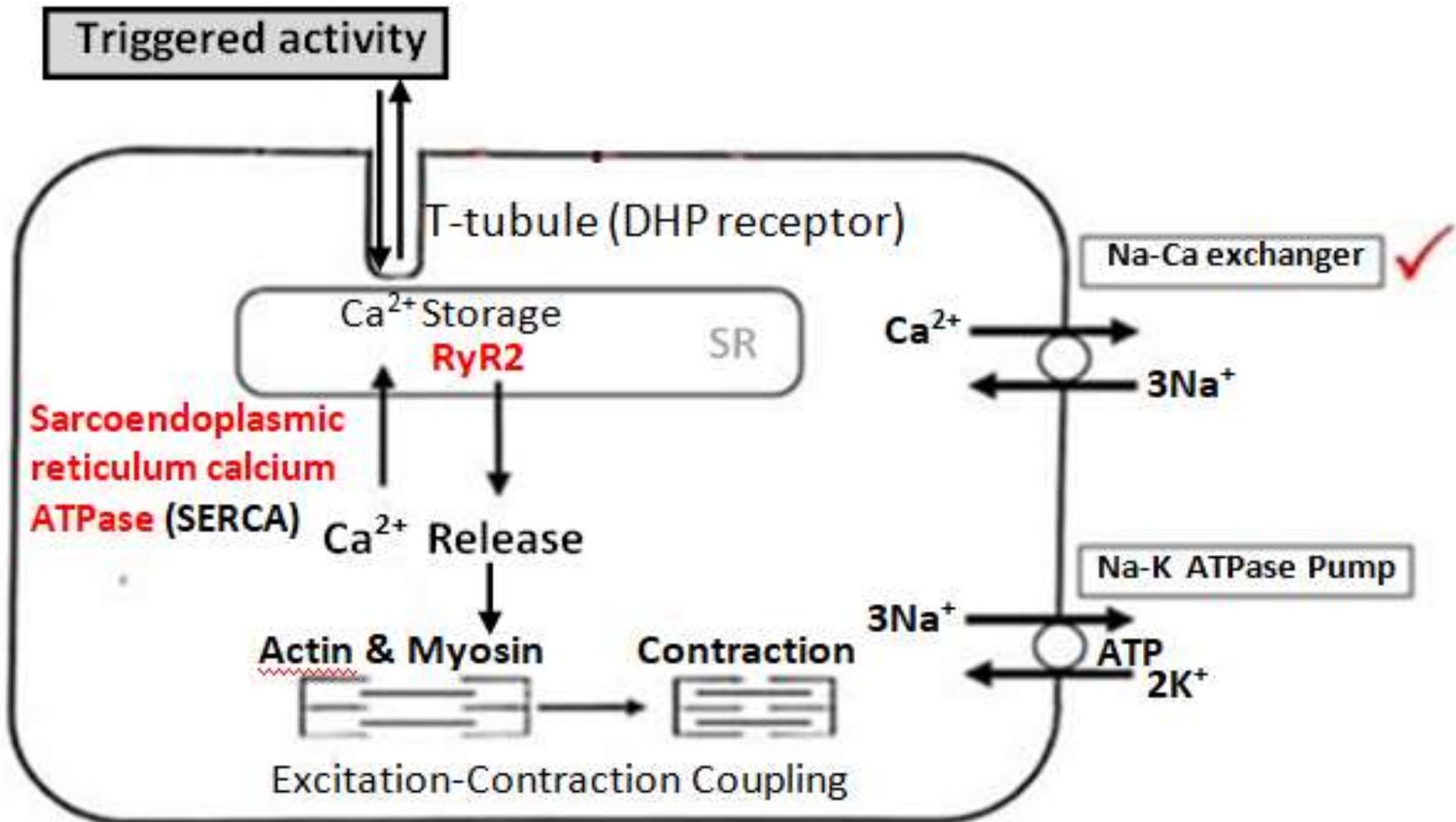
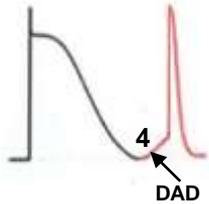


Early afterdepolarization induced triggered activity

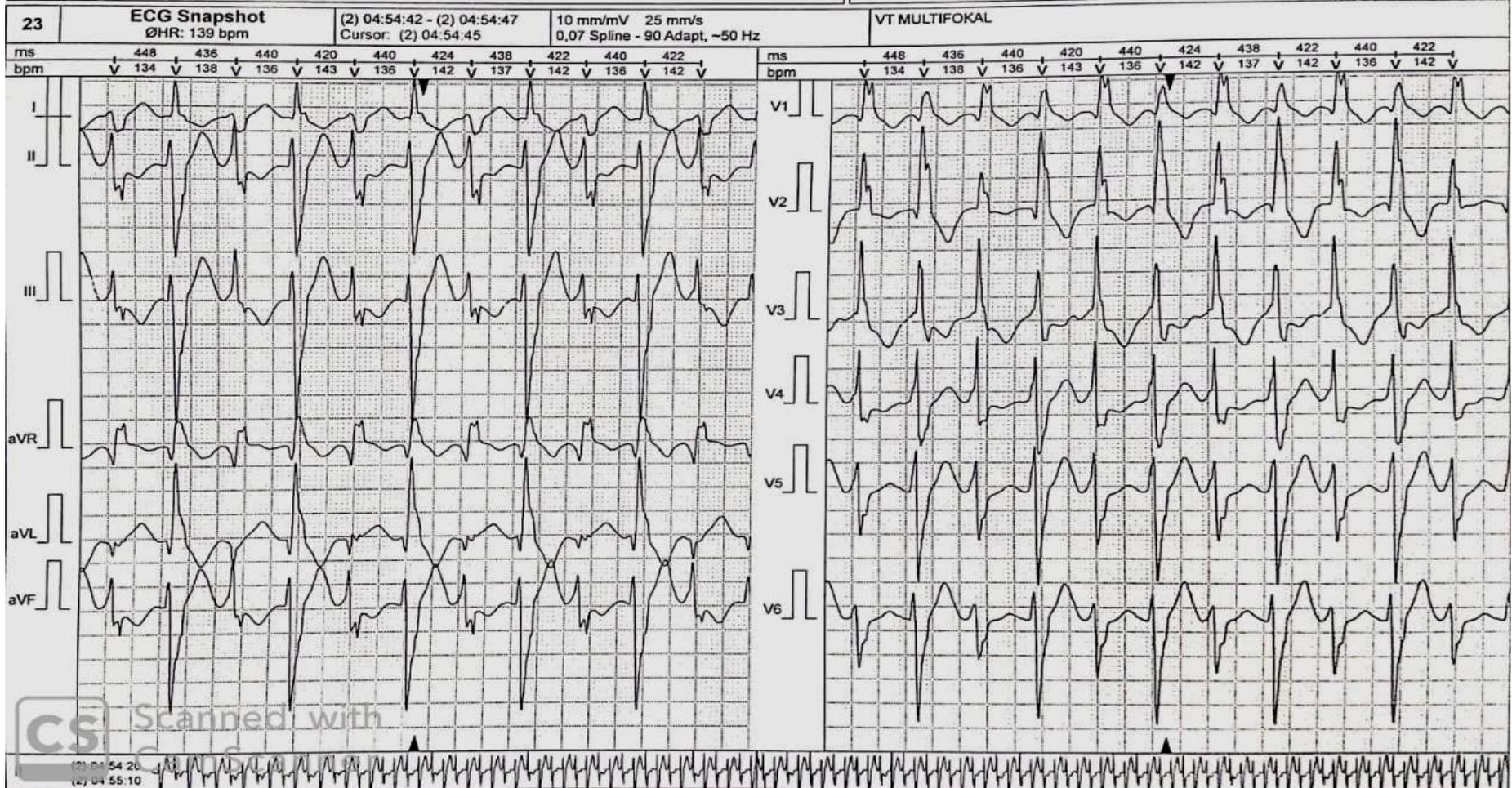


Triggered delayed afterdepolarization

DADs (Tachycardia – dependent)

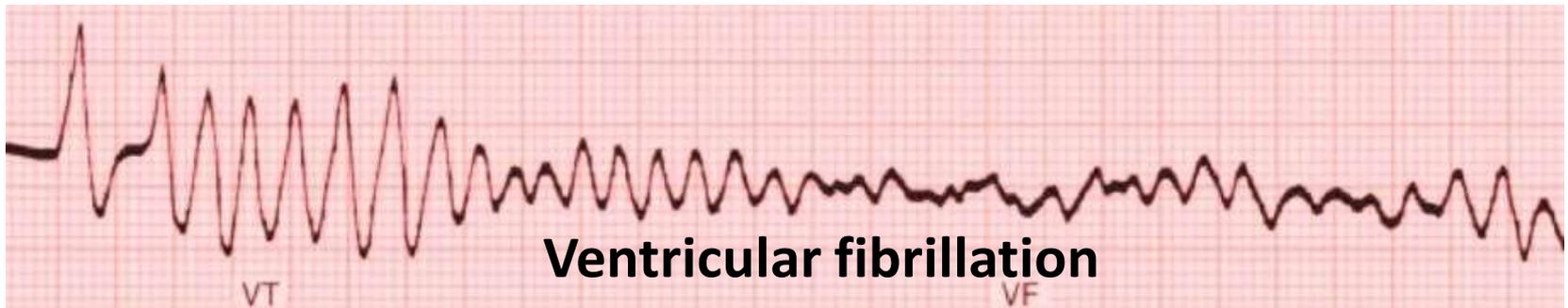
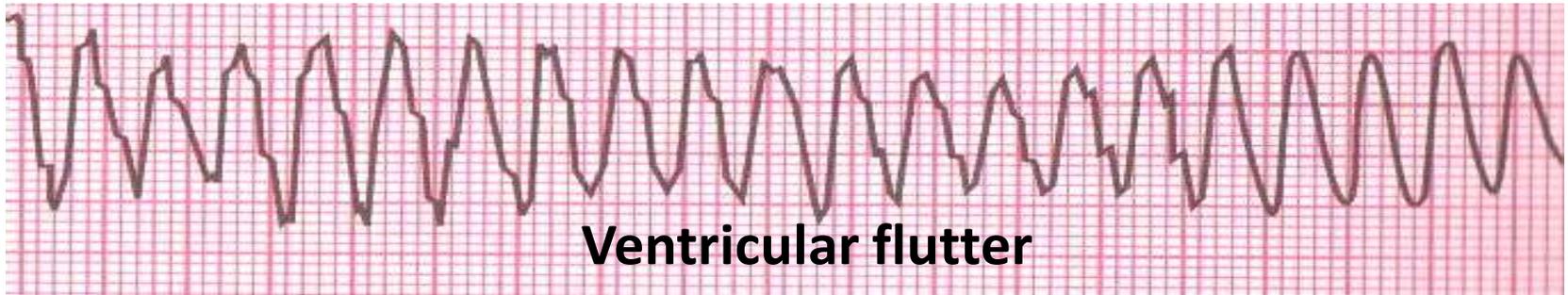
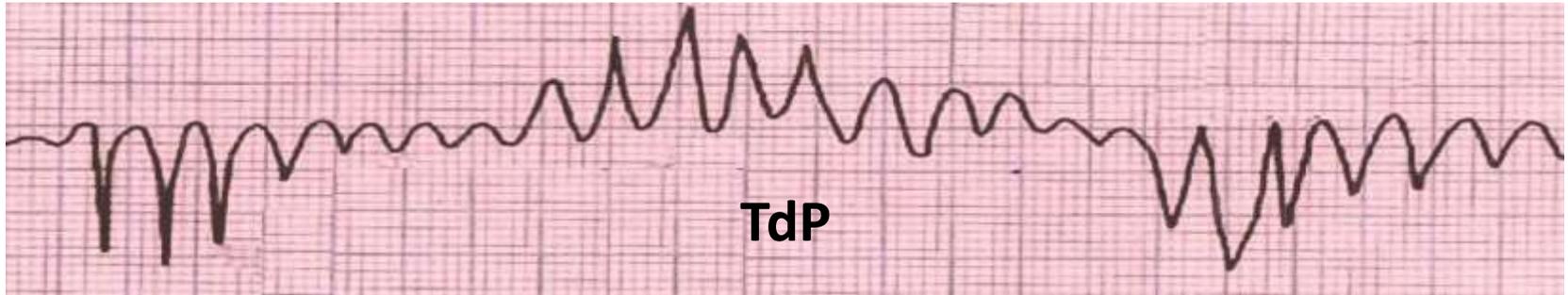


ECG showing CPVT



A female 24 years old with history of palpitation – CPVT - Bidirectional VT (Source : Global Heart Rhythm Form by Dr. Fera Hidayati – Famous Cardiologist of Indonesia dated 18th Feb..2020)

'Red Signal' – Ventricular arrhythmias



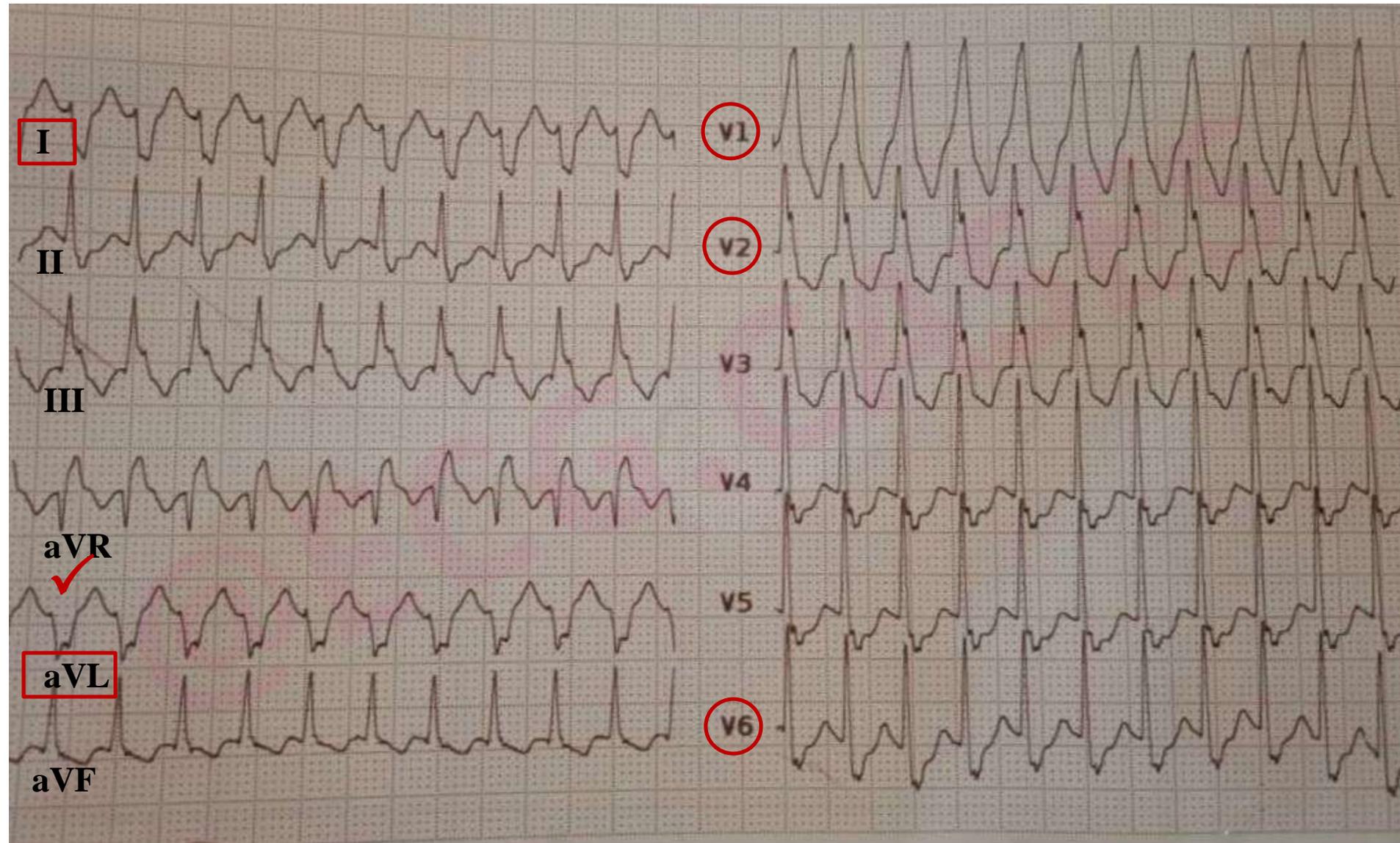
**ECG distinction of VT
from SVT with Aberrancy**

ECG Distinction of VT from SVT with Aberrancy

Favours SVT with aberrancy :

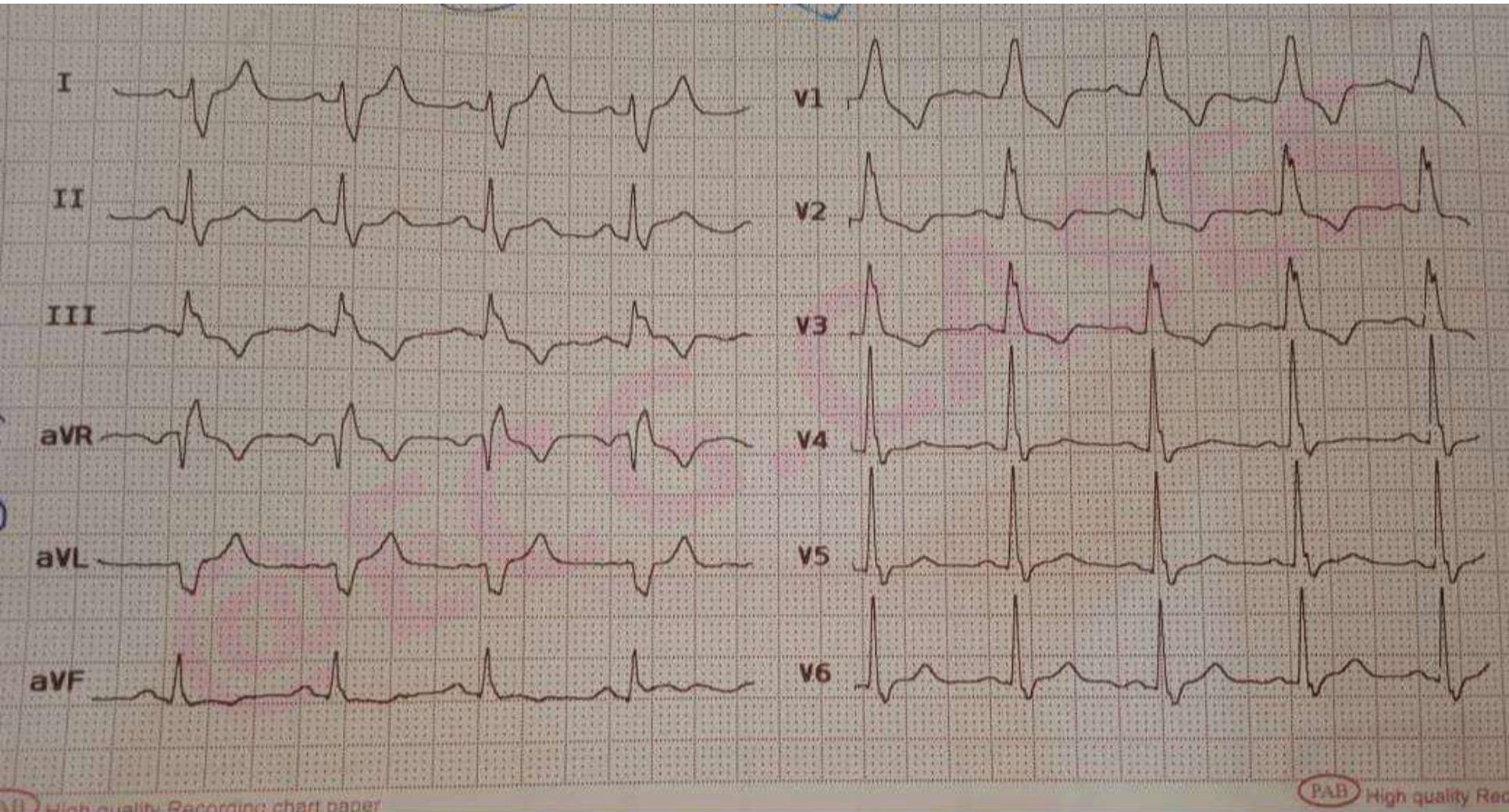
- The QRS complex is wide but its initial orientation is similar to the sinus conducted beats
- It has a pattern of one of the bundle branches blocks
- QRS duration with
 - RBBB pattern < 0.14 sec
 - LBBB pattern < 0.16 sec
- Absence of criteria in favour of VT

? VT or SVT with aberrancy



**Hints : See leads V1-V2 and V6 (Configuration of QRS)
Axis determination whether north-west axis or not**

The same patient after DC shock



SVT with pre-existing RBBB

HOME TAKE MESSAGE

- ❑ Tachyarrhythmia is defined as a rhythm with a heart rate greater than 100 bpm.
- ❑ The driving signal for tachyarrhythmia may be initiated at cellular level acting through automaticity , re-entry ± triggered activity during the cardiac vulnerable period. The resulting irregularities have patterns too, may be called the **'Theory of deterministic choice'**
The driving signal = Premature beats either from atrium or ventricle
- ❑ Automaticity related SVT
Sinus tachycardia / Atrial tachycardia (unifocal / multifocal)
- ❑ Atrial fibrillation
Atrial re-entry nearby pulmonary veins
- ❑ Cavo-triscupid isthmus dependent circuit : Atrial flutter (re-entry)
Counterclockwise/clockwise
- ❑ Bix rule
Suspect any supraventricular tachycardia around 150/min to be atrial flutter / atrial tachycardia with 2:1 AV conduction , unless and until disproved

Diagnostic approach to SVT

Irregular narrow complex VT

- Atrial fibrillation
- Focal AT or Atrial flutter with variable AV conduction
- Multifocal AT (MAT)

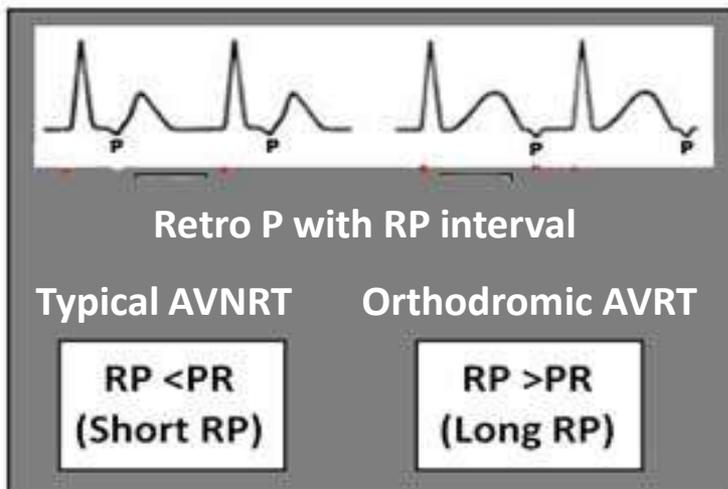
P waves not seen

- Atrial fibrillation
- AVNRT (buried inside)
- Accelerated junctional rhythm when buried inside

P waves well seen

- Normal morphology (sinus tachycardia)
- Retro P (see RP interval)
- Junctional tachycardia either pre or retro P in respect to QRS complex

- Pre-excitation atrial fibrillation - a special variant



Ventricular arrhythmias related tachycardia

- Typical VT**
Monomorphic / Polymorphic : Non-sustained or sustained
- Torsades de pointes**
Ventricular fibrillation

Other varieties of VT

- Fascicular tachycardia**
 - **Posterior fascicular VT (90-95%) : RBBB pattern + left axis deviation**
- Right Ventricular outflow tract VT**
 - **RVOT-VT**
- Bidirectional VT**
 - **Familial catecholaminergic polymorphic ventricular tachycardia (CPVT)**
- Keep in mind the diagnostic Brugada criteria for VT**
- Favours SVT with aberrancy**
 - **The QRS complex is wide but its initial orientation is similar to the sinus conducted beats**
 - **It has a pattern of one of the bundle branches blocks**
 - **QRS duration with (i) RBBB pattern < 0.14 sec (ii) LBBB pattern < 0.16 sec**
 - **Absence of criteria in favour of VT**

Thanks

