ECG Breakout Session

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Learning Objectives

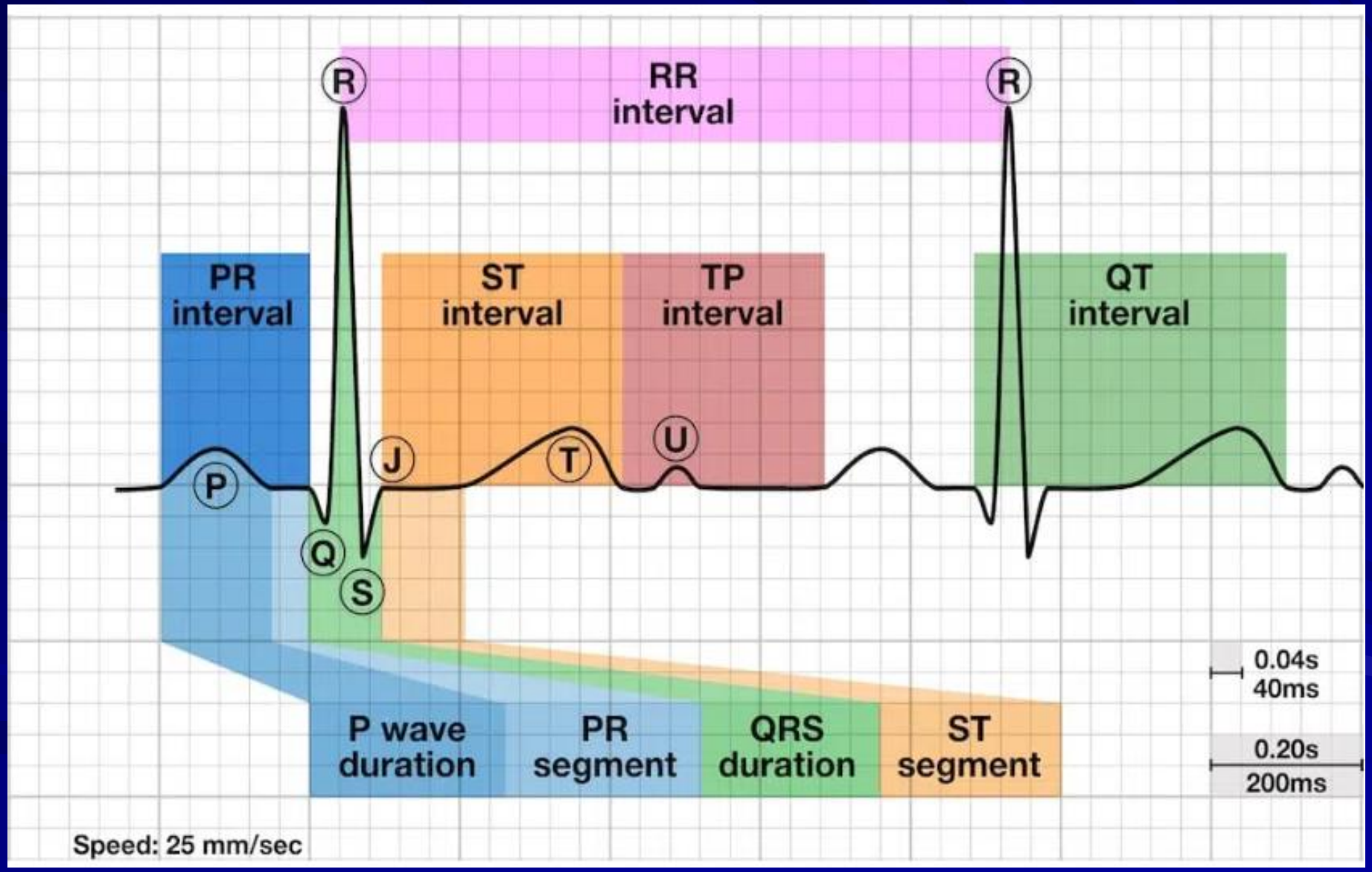
- Review 6 step approach to 12 lead interpretation
  - Name the rhythm
  - Name the abnormality
- Recognize common clinical ECG findings including ECG changes associated with myocardial ischemia & infarction
- Clinical ECG applications/findings in an acute setting
- Practice

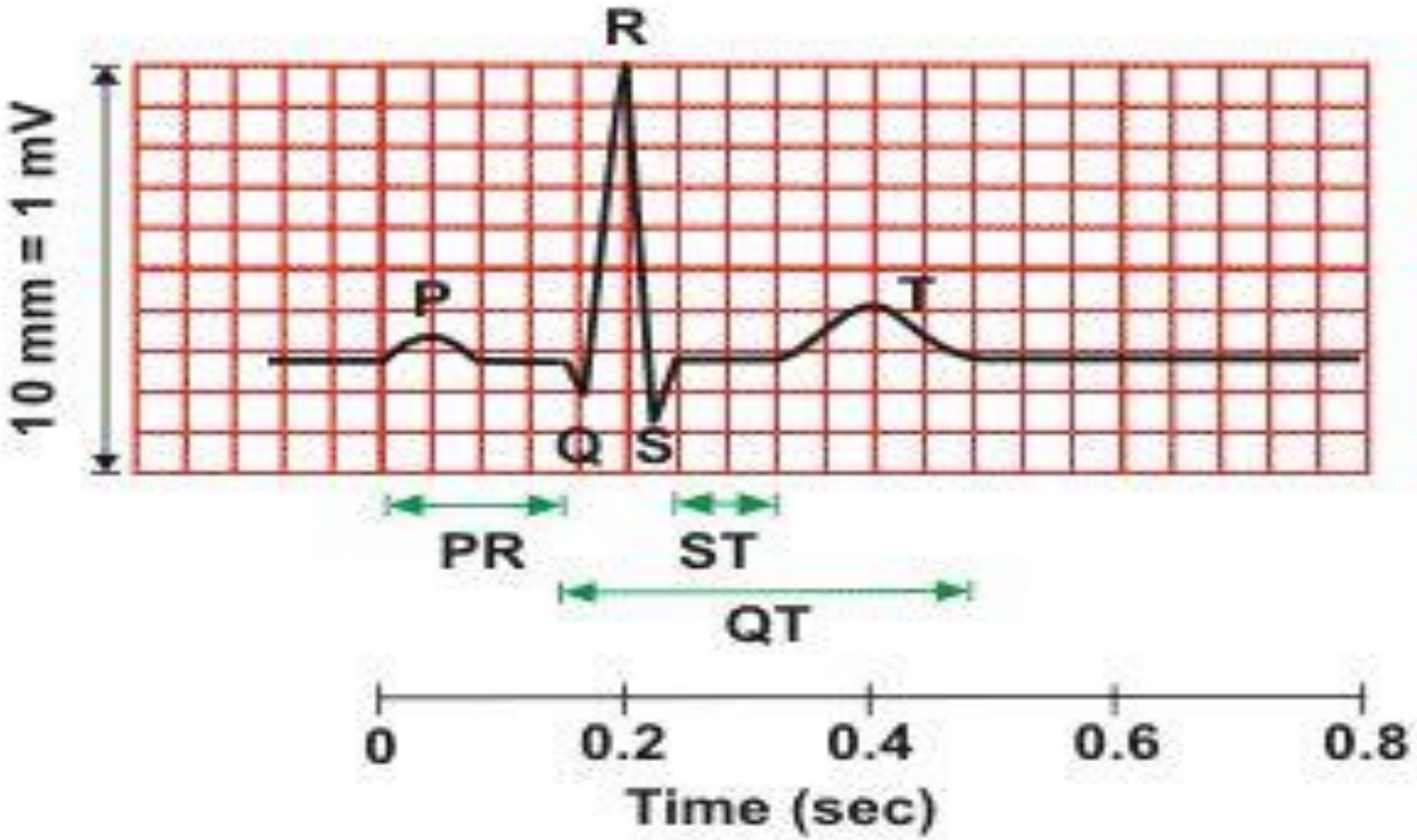
Key To 12 Lead Interpretation

6 step method

- Rate & Rhythm
- Axis determination
- Intervals (PR, QRS, QT)
- Morphology (BBB)
- Ischemia, Injury, Infarct
- Bonus step: Correlate to history and clinical presentation

•Intervals (PR, QRS, QT)





P wave (0.08 - 0.10 s)

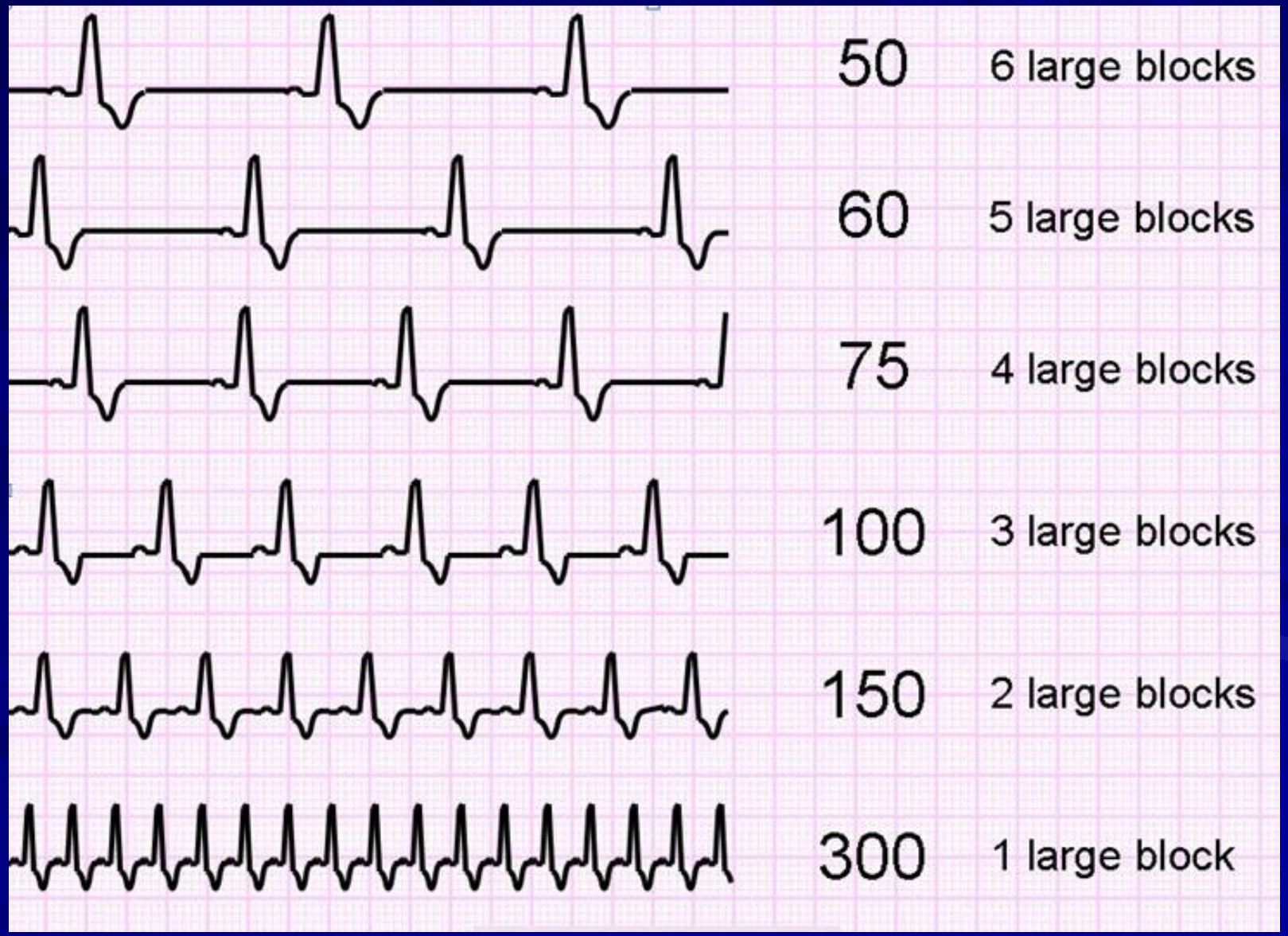
P-R interval (0.12 - 0.20 s)

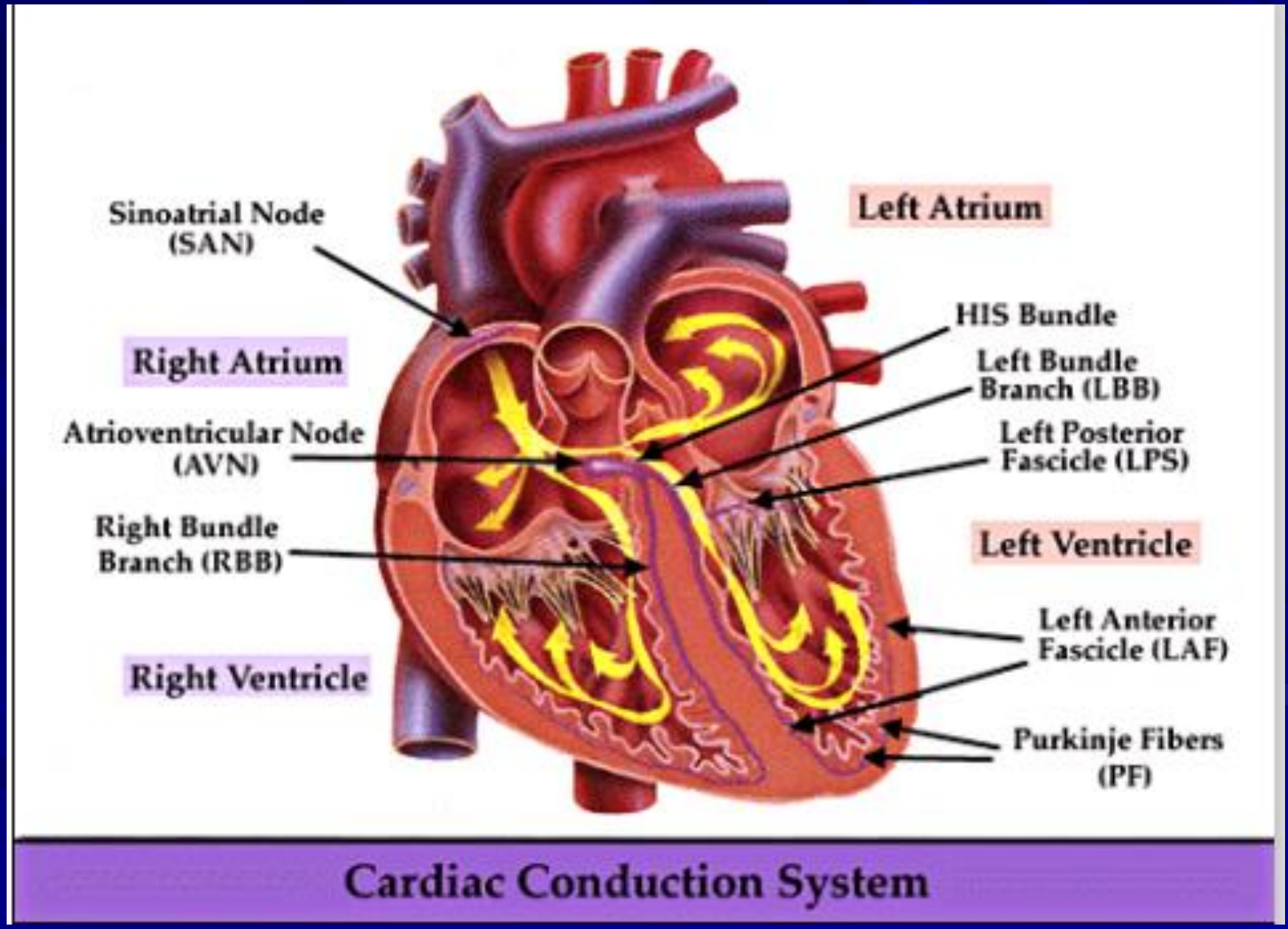
QRS (0.06 - 0.10 s)

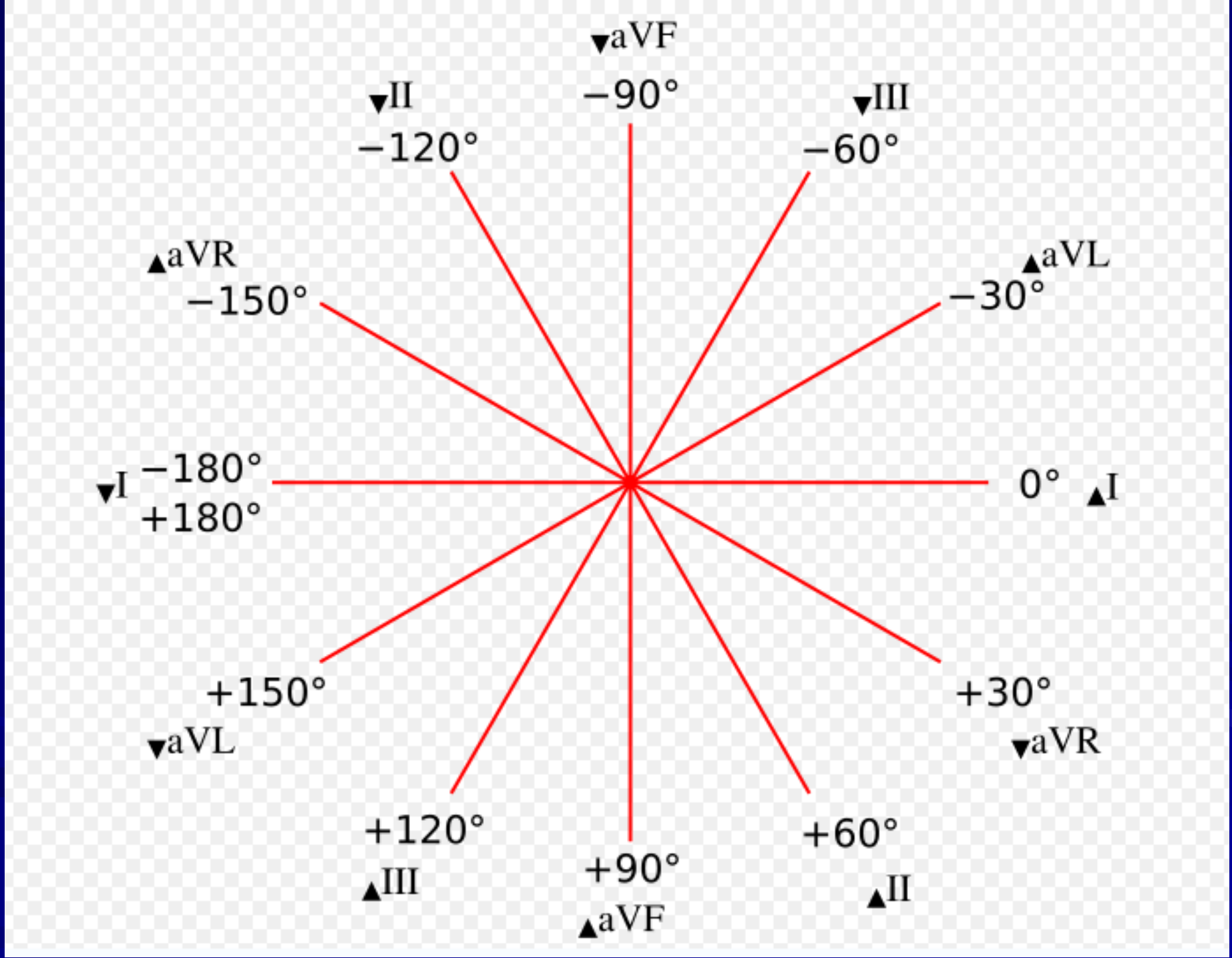
Q-T_C interval ($\leq$ 0.44 s)*

$$*QT_C = QT / \sqrt{RR}$$

Determining Heart Rate

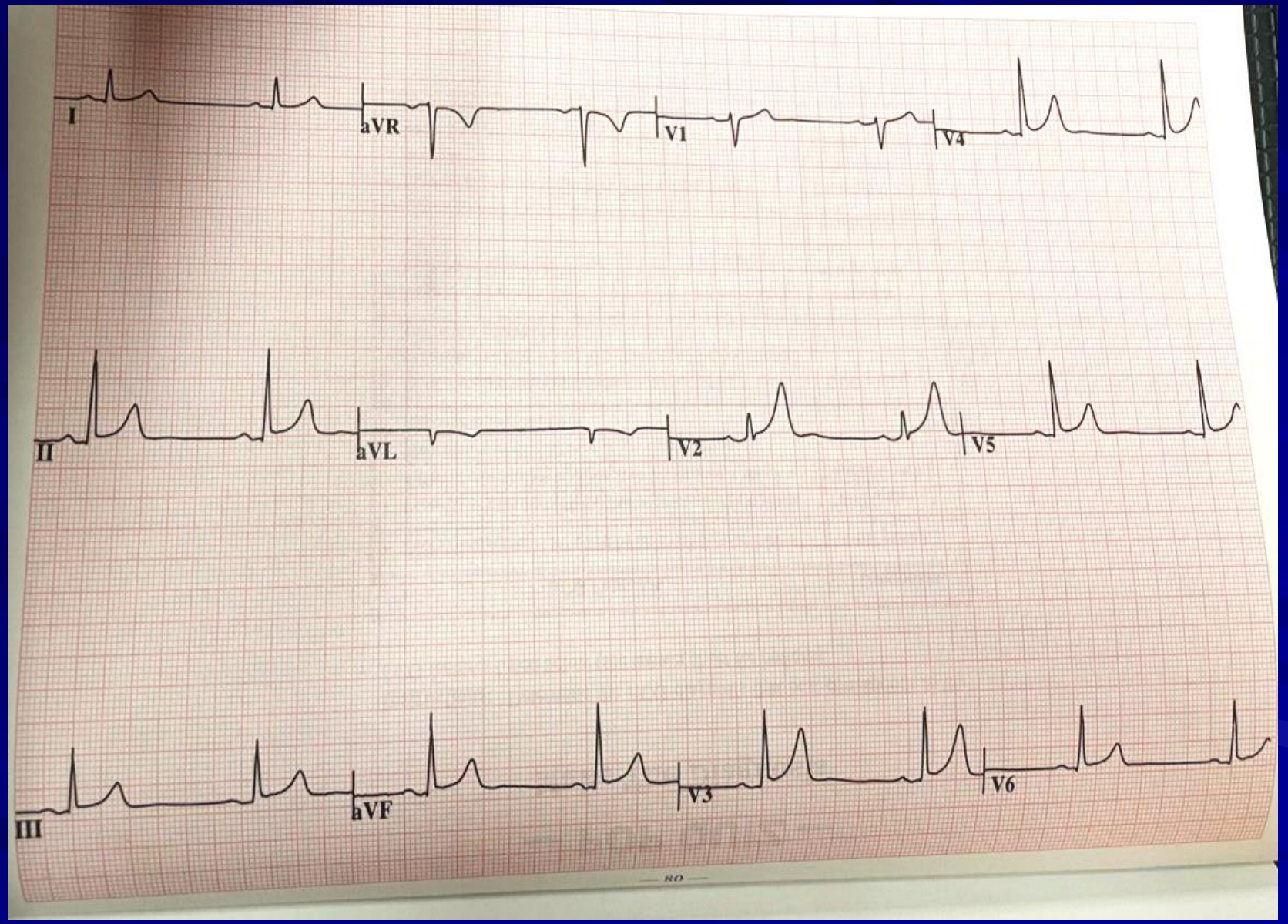



Sinoatrial Node
(SAN)
Left Atrium
HIS Bundle
Right Atrium
Left Bundle
Branch (LBB)
Atrioventricular Node
(AVN)
Left Posterior
Fascicle (LPS)
Right Bundle
Branch (RBB)
Left Ventricle
Left Anterior
Fascicle (LAF)
Right Ventricle
Purkinje Fibers
(PF)
Cardiac Conduction System


▼aVF
−90°
▼II
−120°
▼III
−60°
▲aVR
−150°
▲aVL
−30°
▼I
−180°
+180°
0°
▲I
+150°
▼aVL
+30°
▼aVR
+120°
▲III
+90°
▲aVF
+60°
▲II

Axis

Axis	Lead I	aVF	Lead II
Normal Axis (0º to 90º)	+	+	
Normal variant (0º to -30º)	+	-	+
Left axis deviation (-30º to -90º)	+	-	-
Right axis deviation (>100º)	-	+	
Right superior axis (-90º to +180º)	-	-	


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

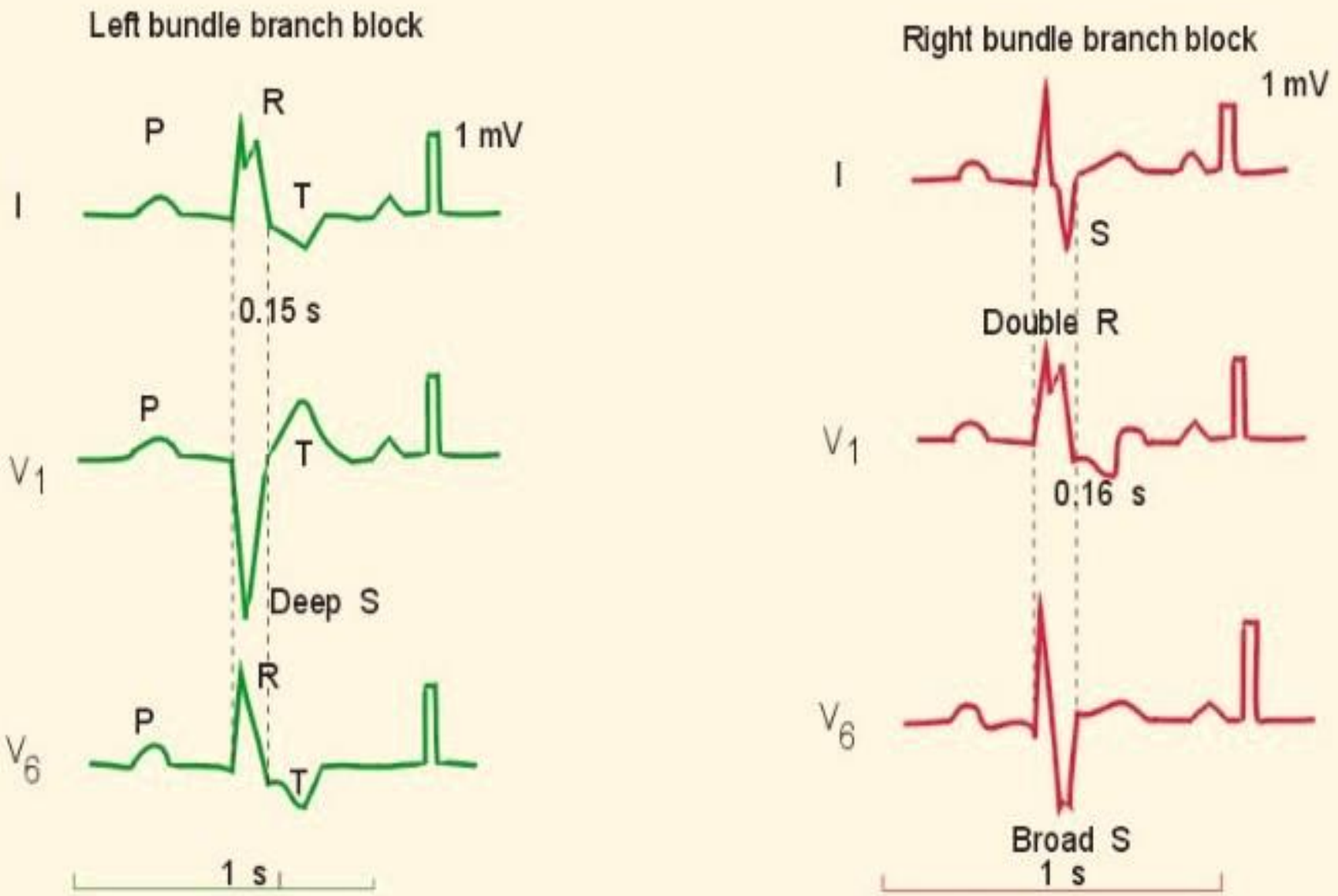
Bradycardia

- Sinus Bradycardia
- Junctional Rhythm
- Heart blocks
- Atrial fibrillation with SVR
- ** Where are the P waves?
- ** Is the Patient symptomatic?

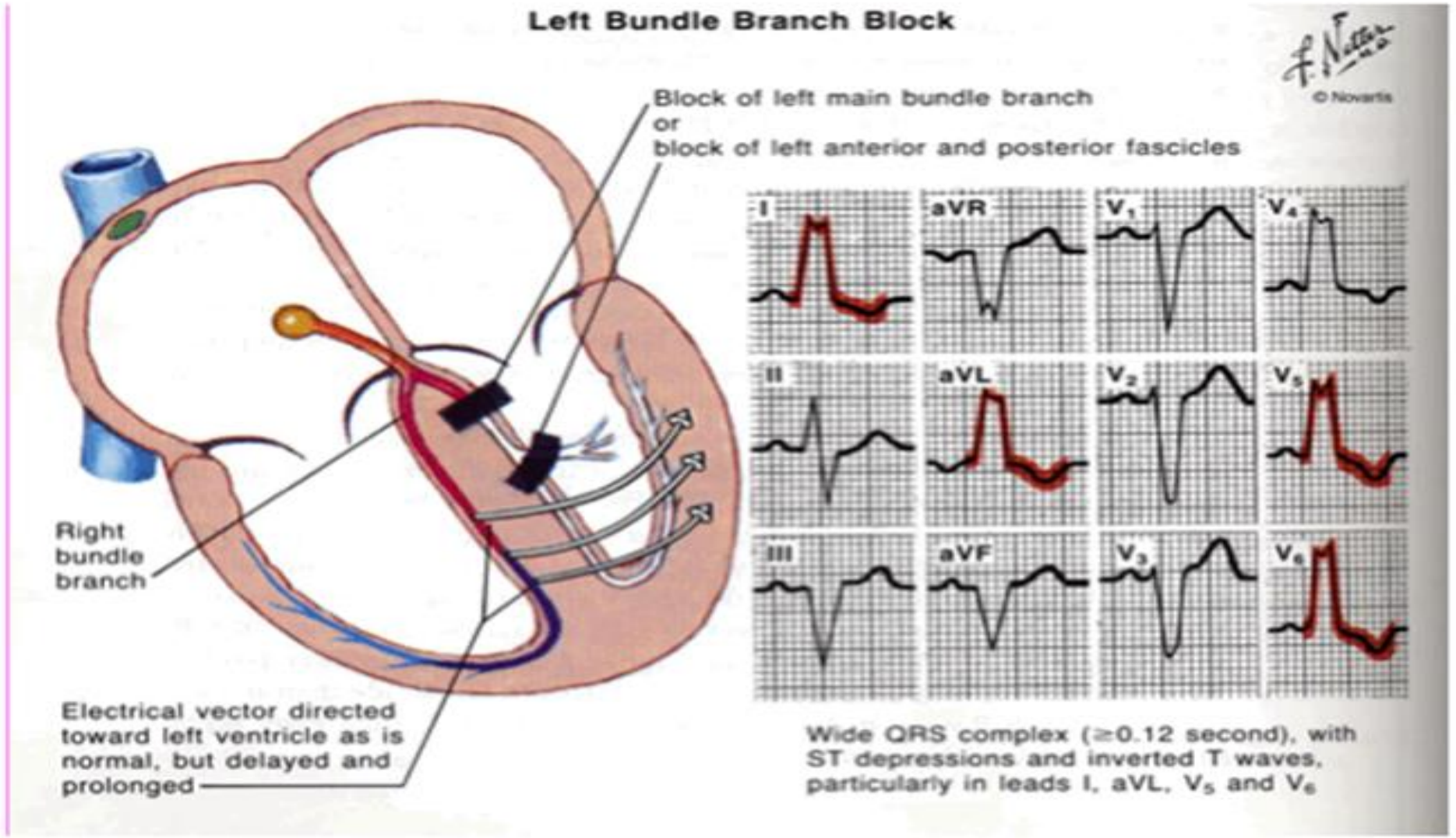
Junctional Rhythm

Narrow or Wide?

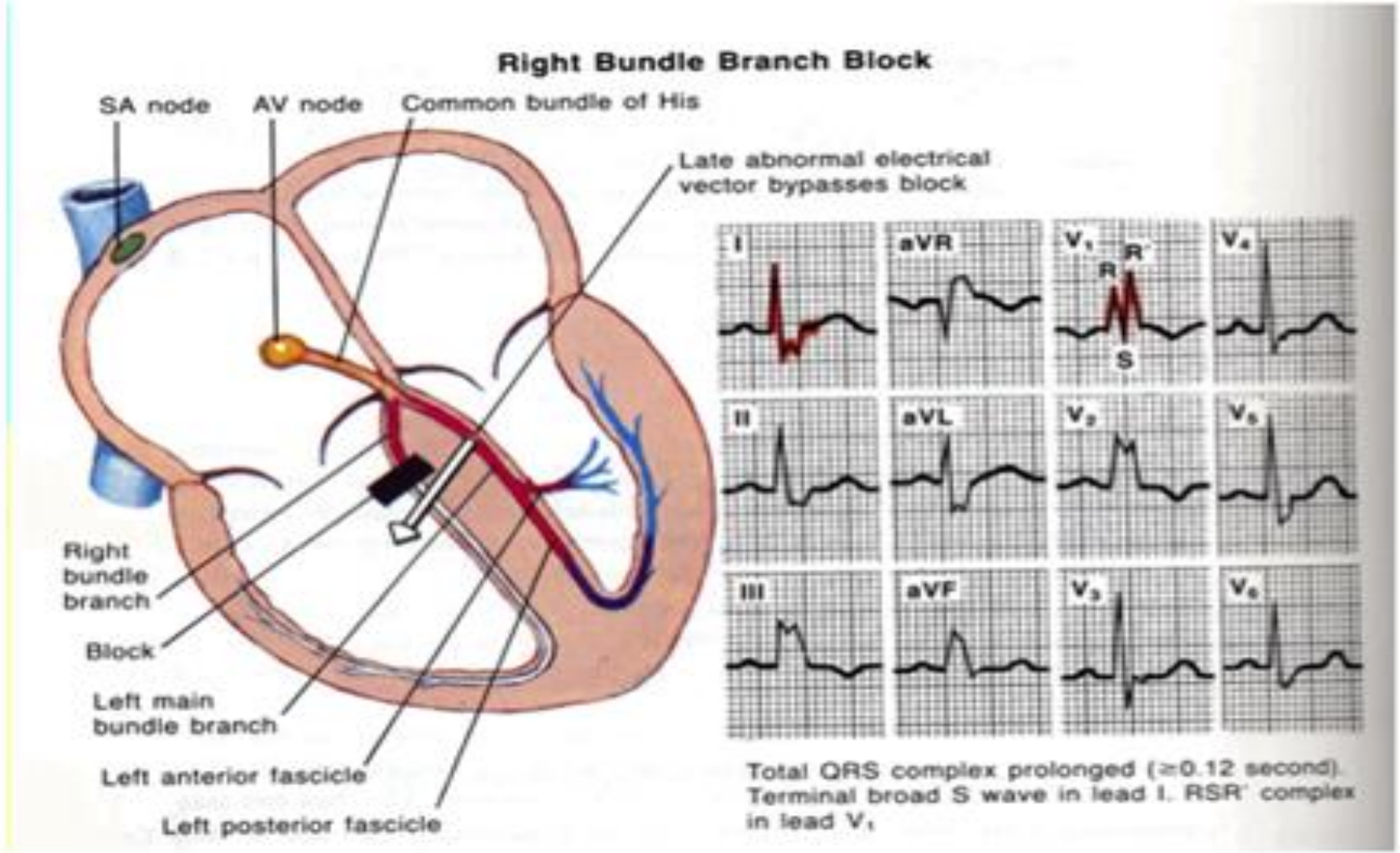
Bundle Branch Block



Left bundle branch block



Right bundle branch block



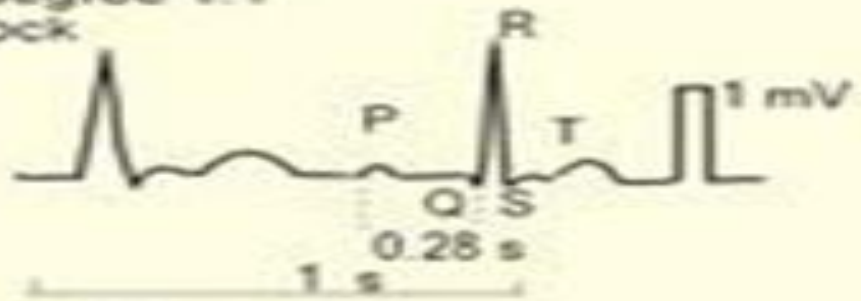
Blocks

- 1st Degree
- 2nd Degree
  - Type I (Mobitz I) Wenchebach
  - Type II (Mobitz II)
  - 2:1 AV block
- 3rd Degree (Complete Heart Block)

Heart Block Poem

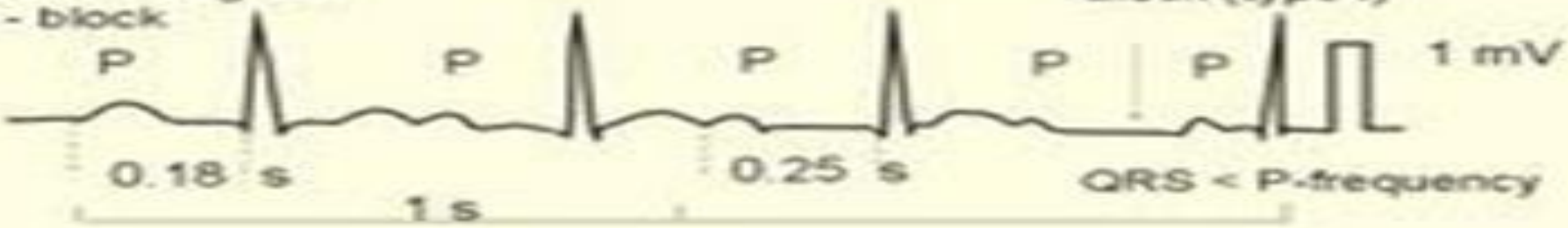
- If the “R” is far from “P,” then you have a FIRST DEGREE
- Longer, longer, longer, drop! Then you have a Wenkebach
- If some “P”s just don’t get through, then you have MOBITZ II
- If “P”s and “Q”s just don’t agree, then you have a THIRD DEGREE

First - degree 1:1
AV - block



Second - degree
AV - block

Wenchebach
block (type I)

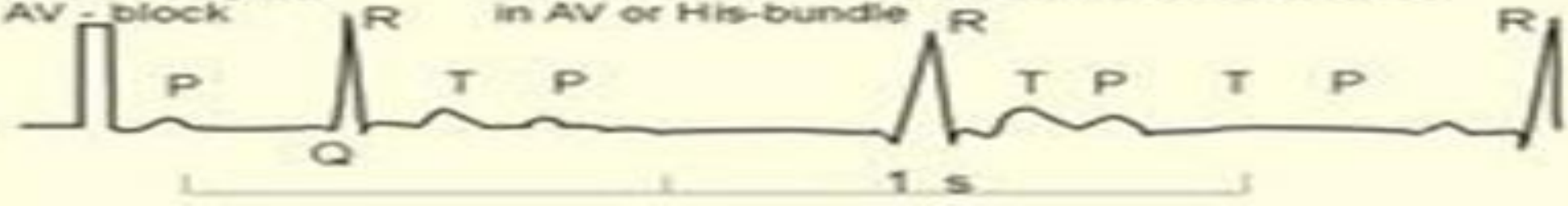


Second - degree
AV - block

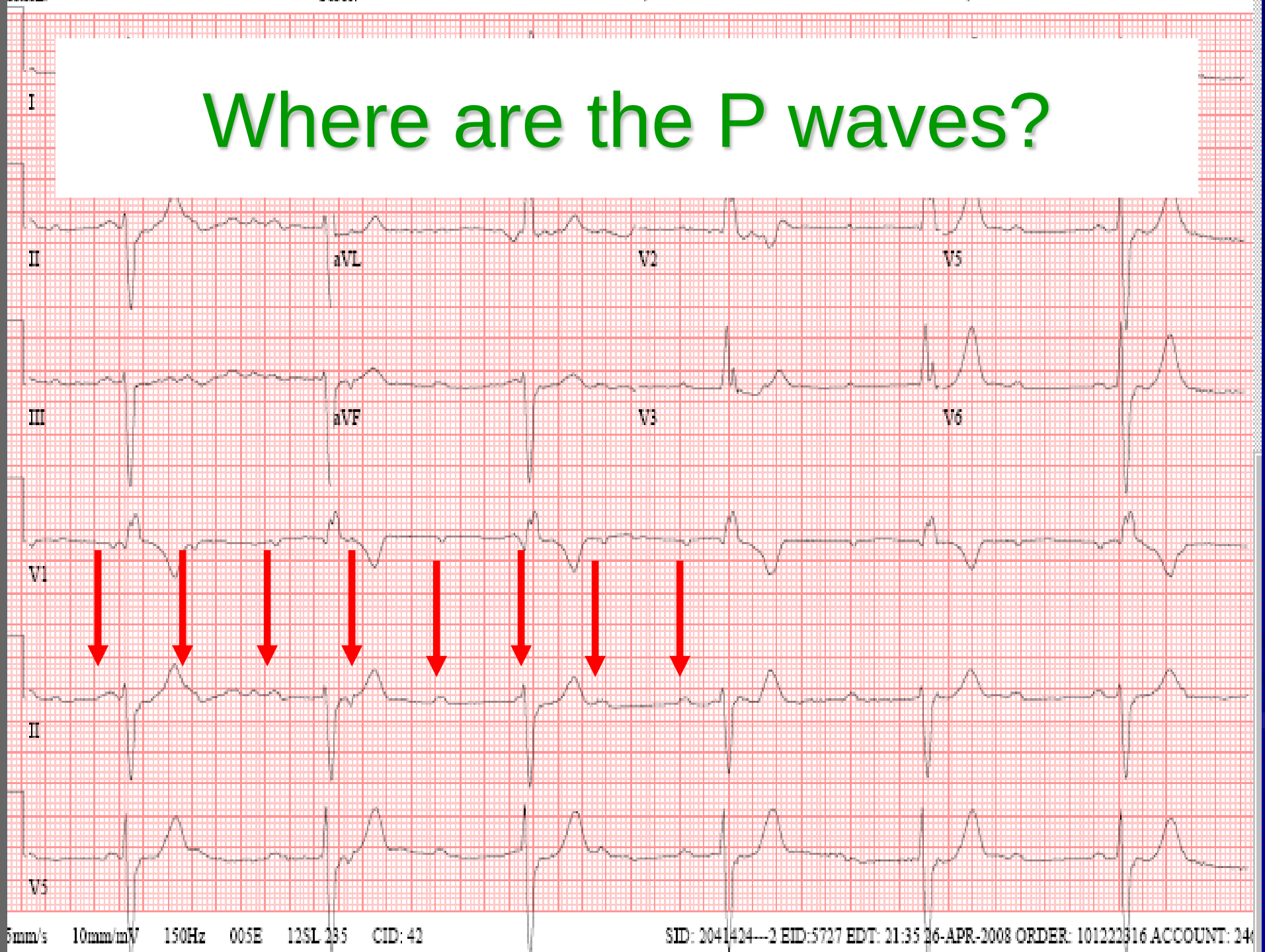
Mobitz II block (no warning)

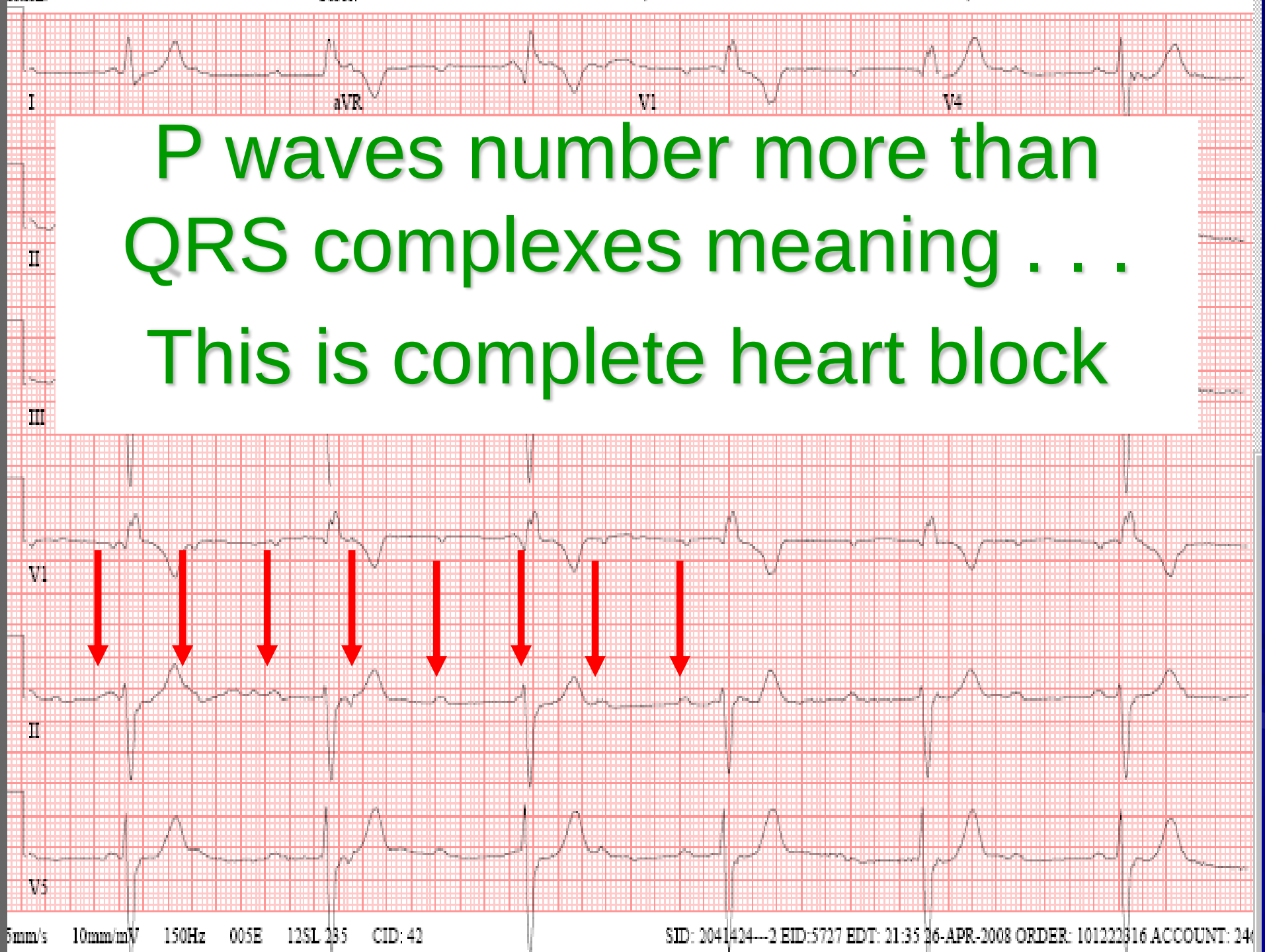
Third - degree
AV - block

Complete AV - block (Adam Stokes disease
in AV or His-bundle



Where are the P waves?





P waves number more than QRS complexes meaning . . .

This is complete heart block

2:1

Feature	Mobitz Type I	Mobitz Type II
QRS Duration	Narrow	Wide
Response to maneuvers that increase heart rate & AV conduction (ie Atropine, Exercise)	Block Improves	Block worsens
Response to maneuvers that reduce heart rate & AV conduction (ie carotid massage)	Block worsens	Block improves
Develops during acute MI	Inferior MI	Anterior MI
Other	Grouped beating	History of Syncope

O'Keefe, James H., et al., 2019

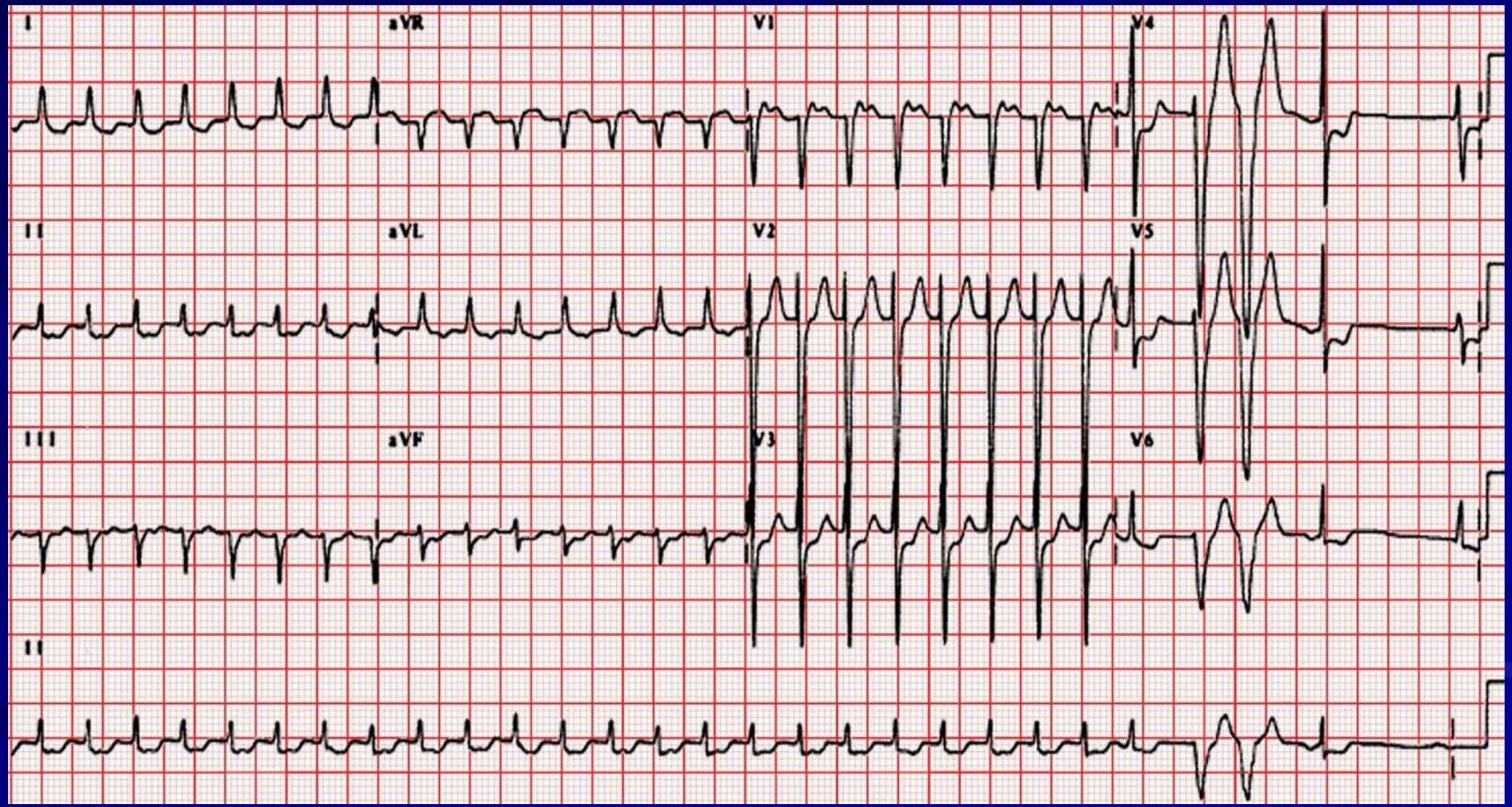
Tachyarrhythmia

Tachyarrhythmia	Rate	QRS	Rhythm	P waves
Sinus tachycardia	Fast	Narrow	Regular	Yes
Supraventricular tachycardia or SVT (AVNRT)	Fast	Narrow	Regular	No
Atrial Fibrillation	Fast	Narrow	Irregular	No
Atrial Flutter	Fast	Narrow	Regular	Sawtooth
Ventricular tachycardia	Fast	Wide	Regular	No
Ventricular fibrillation	Fast	Wide	Irregular	No

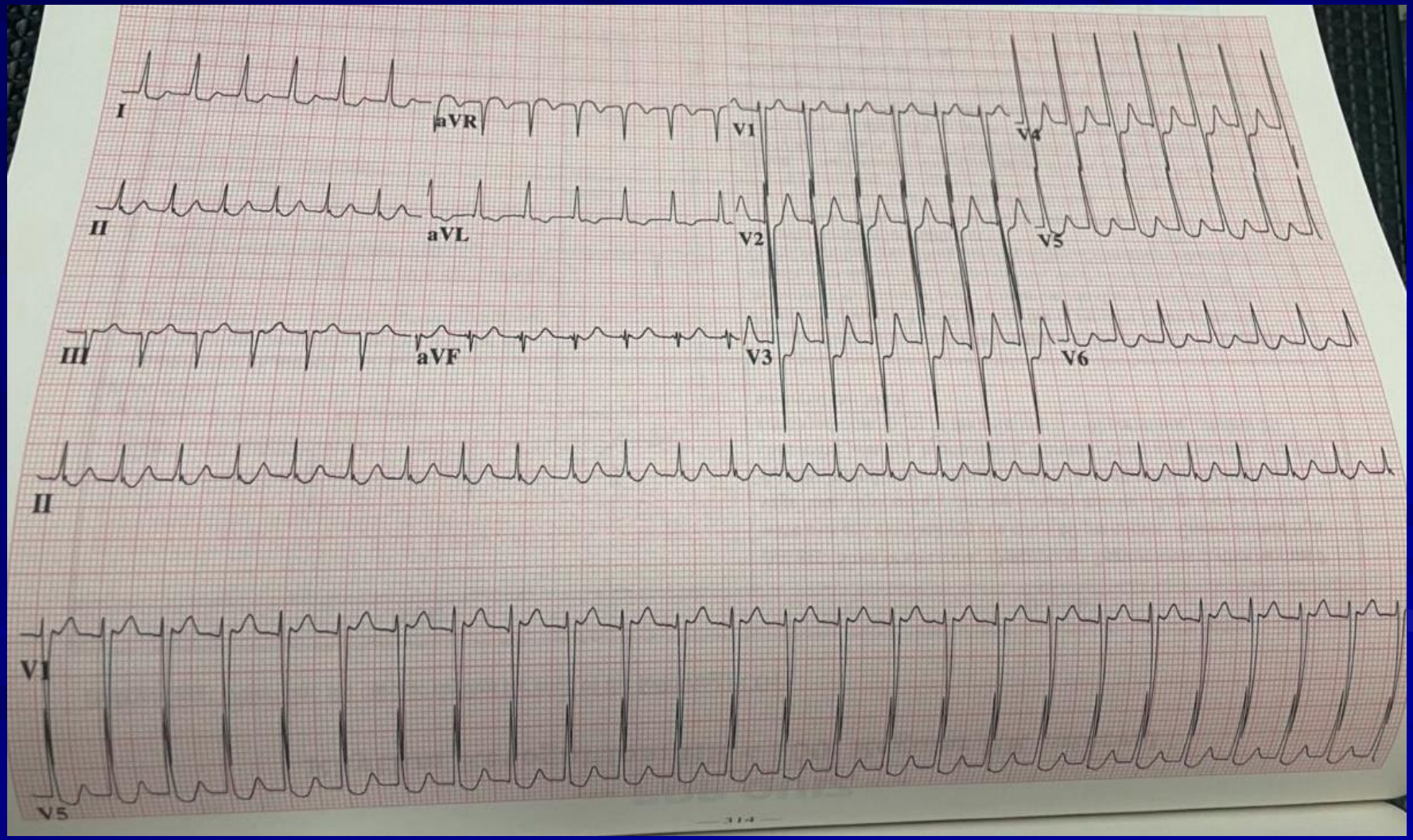
SVT

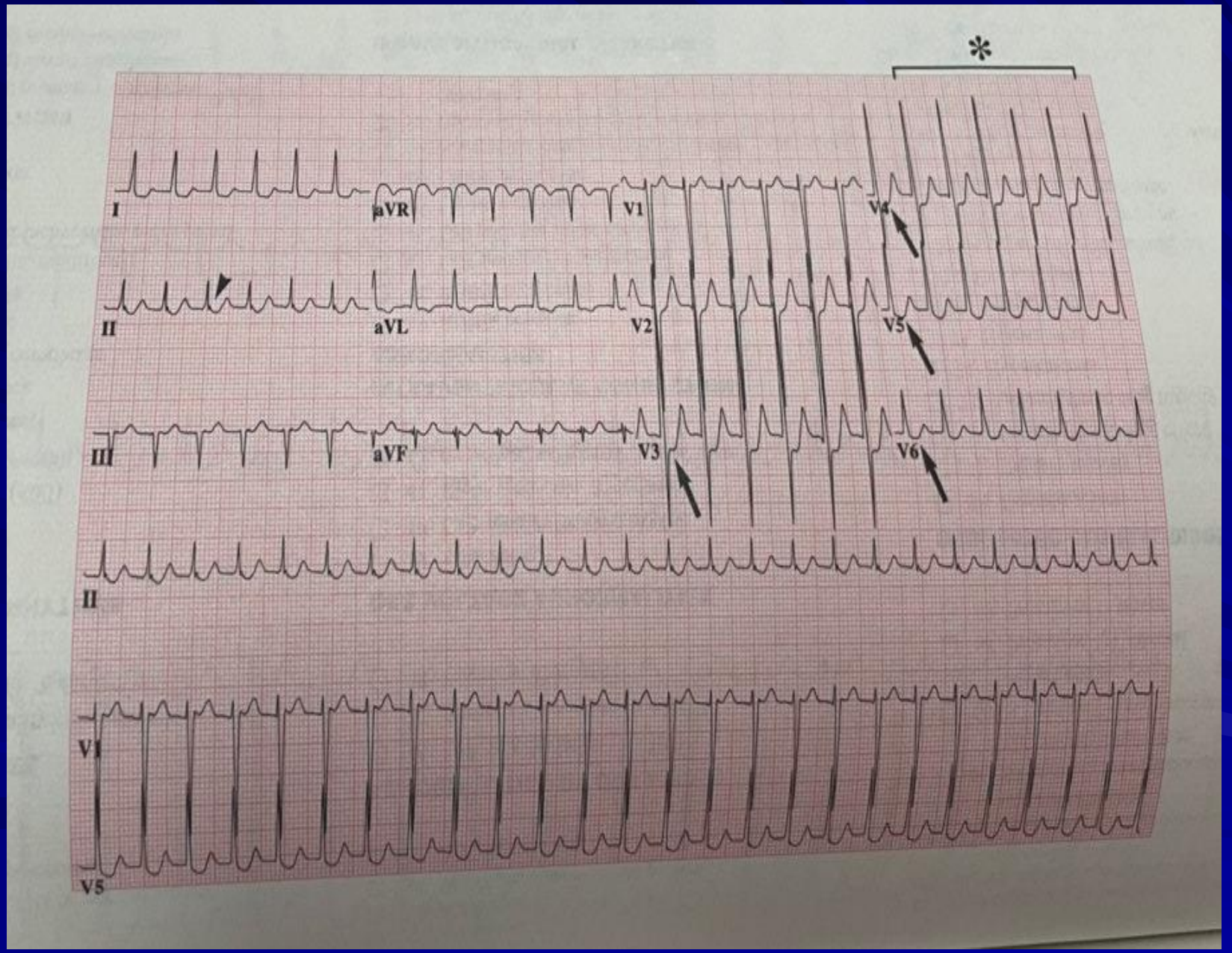
Abnormally fast rhythm that starts in the atria

- Atrial tachycardia
- AV node re-entrant tachycardia
- Atrial Fibrillation
- Atrial Flutter
- Paroxysmal SVT

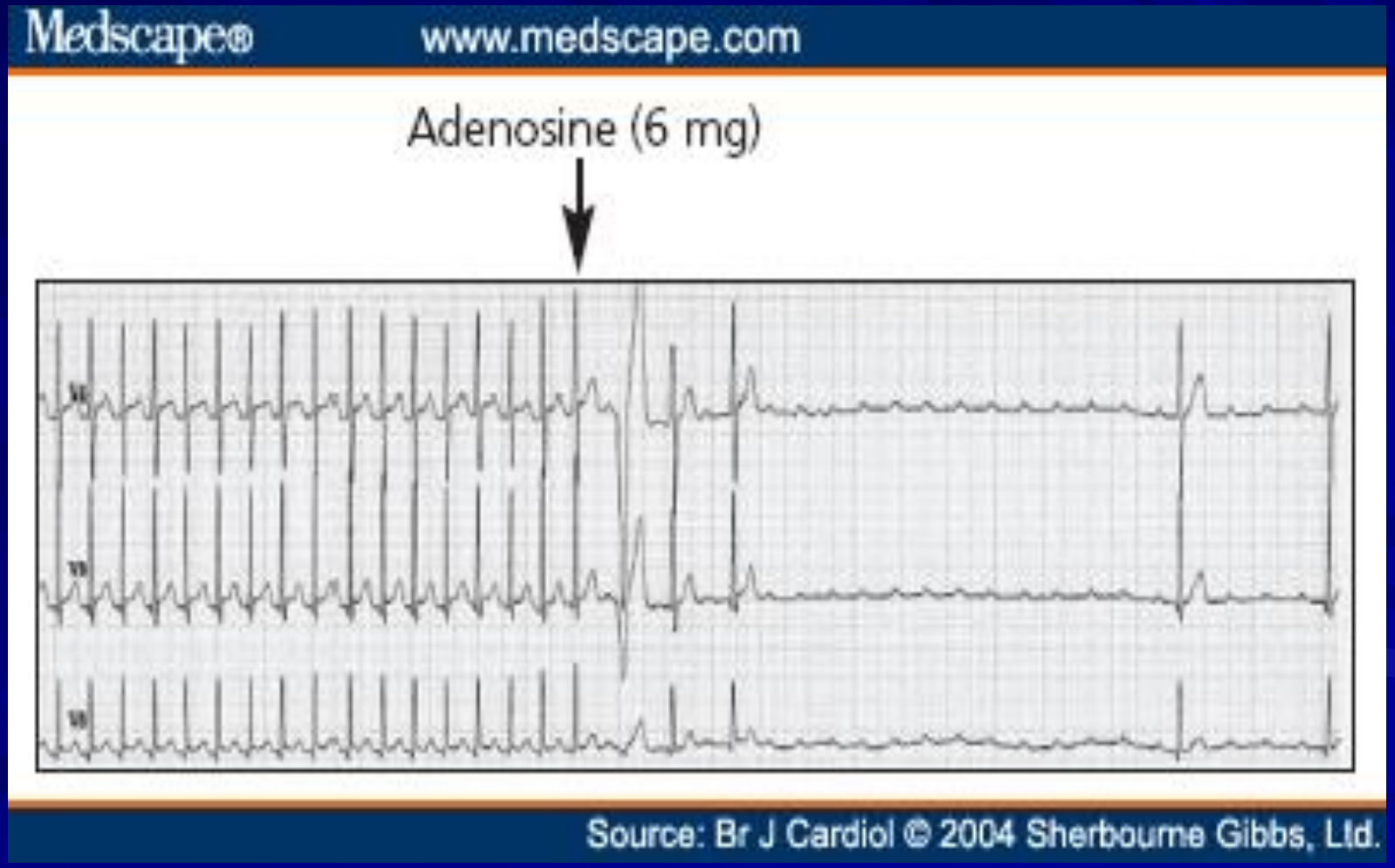

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

71 yr old M presenting with palpitations




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

SVT


Medscape®
www.medscape.com
Adenosine (6 mg)
Source: Br J Cardiol © 2004 Sherbourne Gibbs, Ltd.

Regular or Irregular?

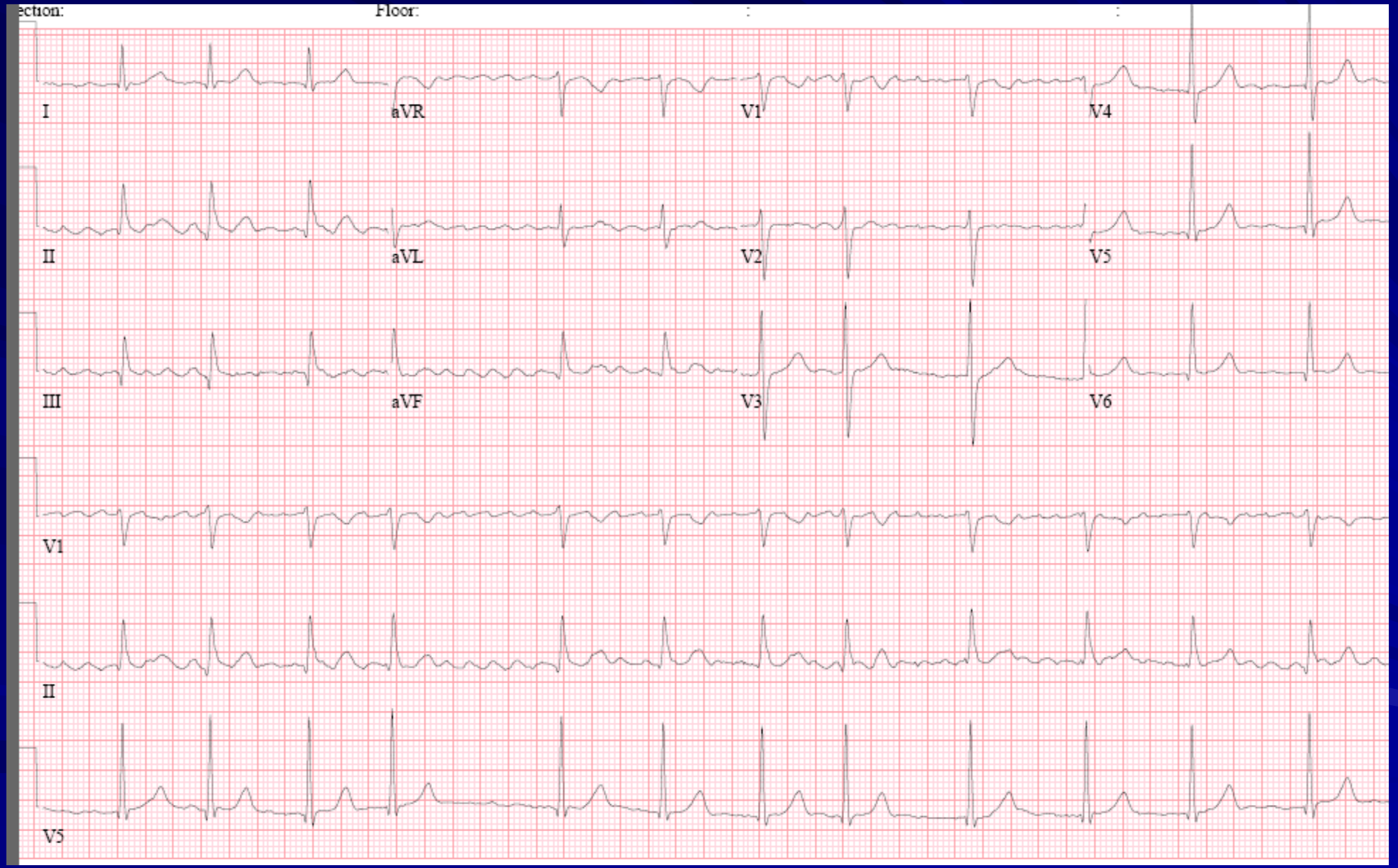
Afib vs. Aflutter

- Afib is regularly irregular meaning: Variation in R-R intervals that are not multiples of the P-P interval
- Atrial flutter has undulations (“F waves”) that are regular
- Coarse AF vs Atrial Flutter
- Typical Atrial Flutter vs Atypical Atrial Flutter

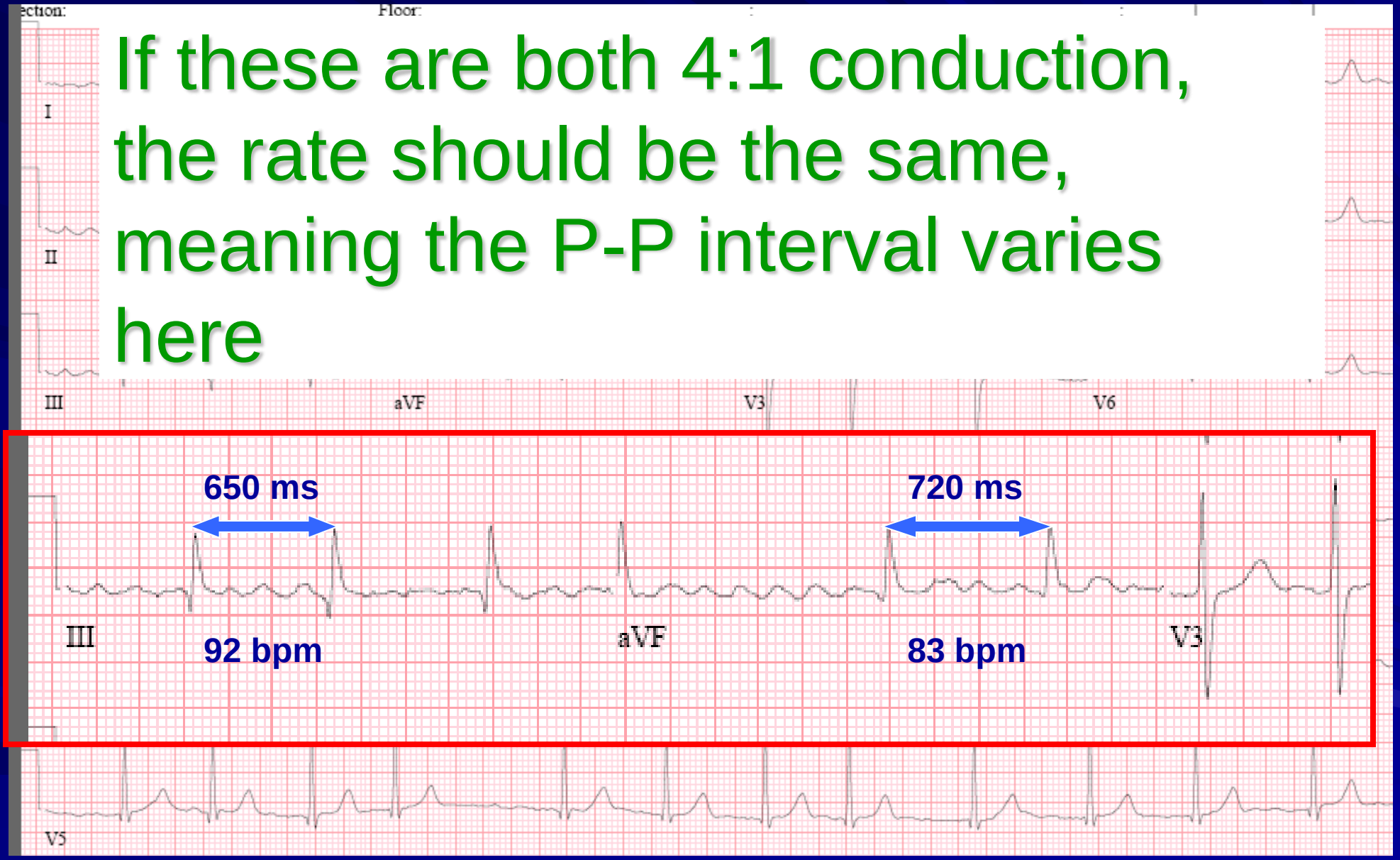
Clinic Case

- 70 year old man
- Fatigue and weakness
- Palpitations
- No chest pain, dyspnea, syncope
- PMHx: HTN
- SHx: Tobacco, quit 1970. Prior 2ppd x10 years. 1 martini Q3 days
- FHx: none

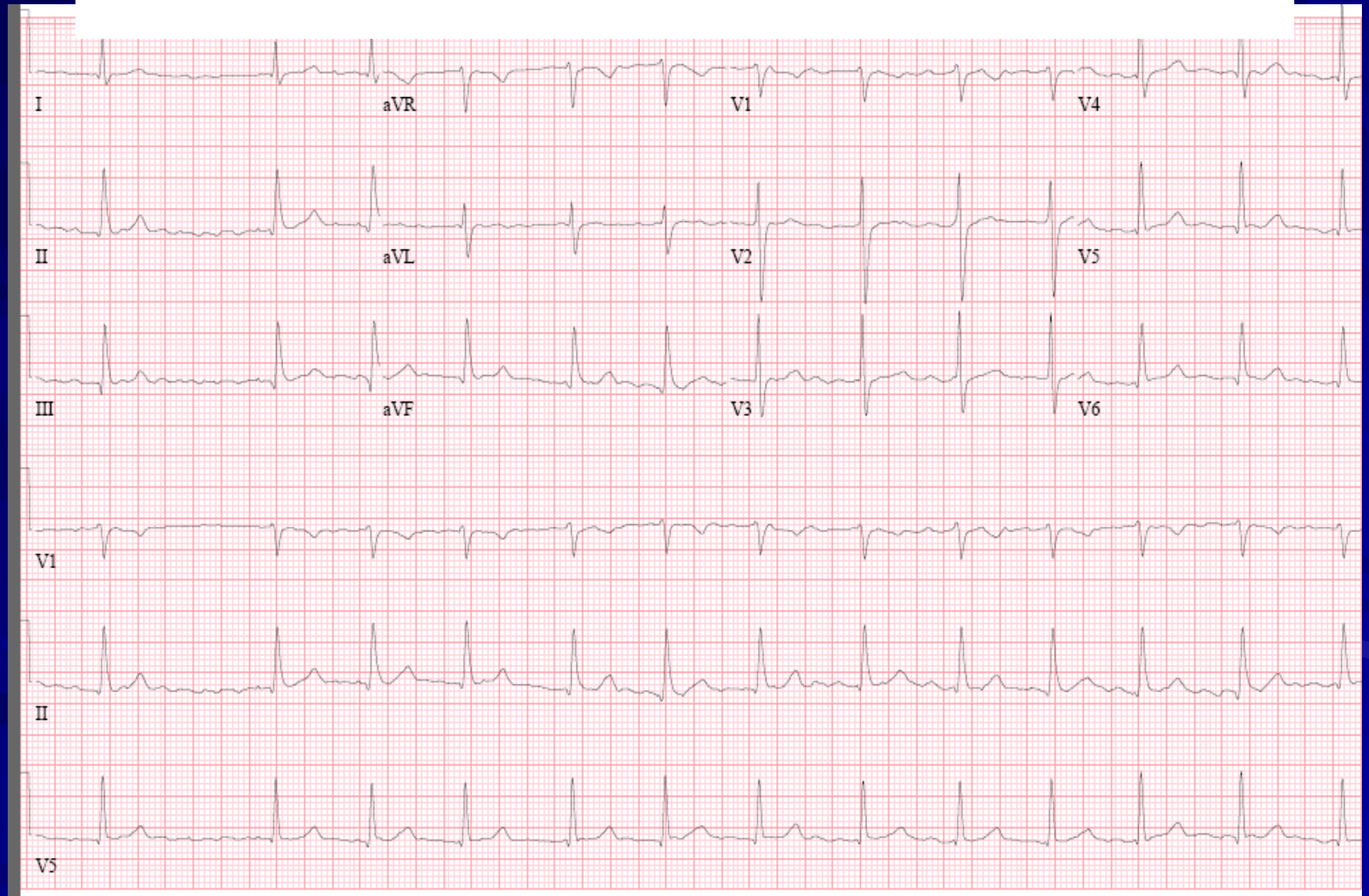
- Metoprolol 100 mg BID
- Warfarin per Coumadin Clinic
- Levothyroxine 112 mcg daily
- Zocor 40 mg daily
- Coenzyme Q10
- Prilosec 20 mg daily


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

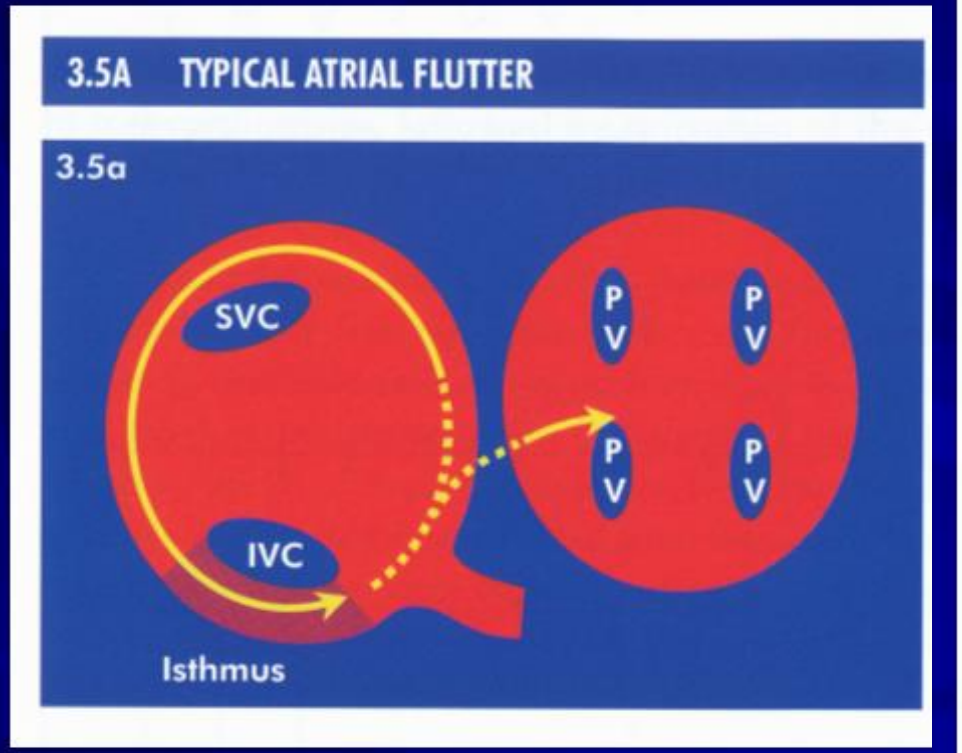
If these are both 4:1 conduction, the rate should be the same, meaning the P-P interval varies here

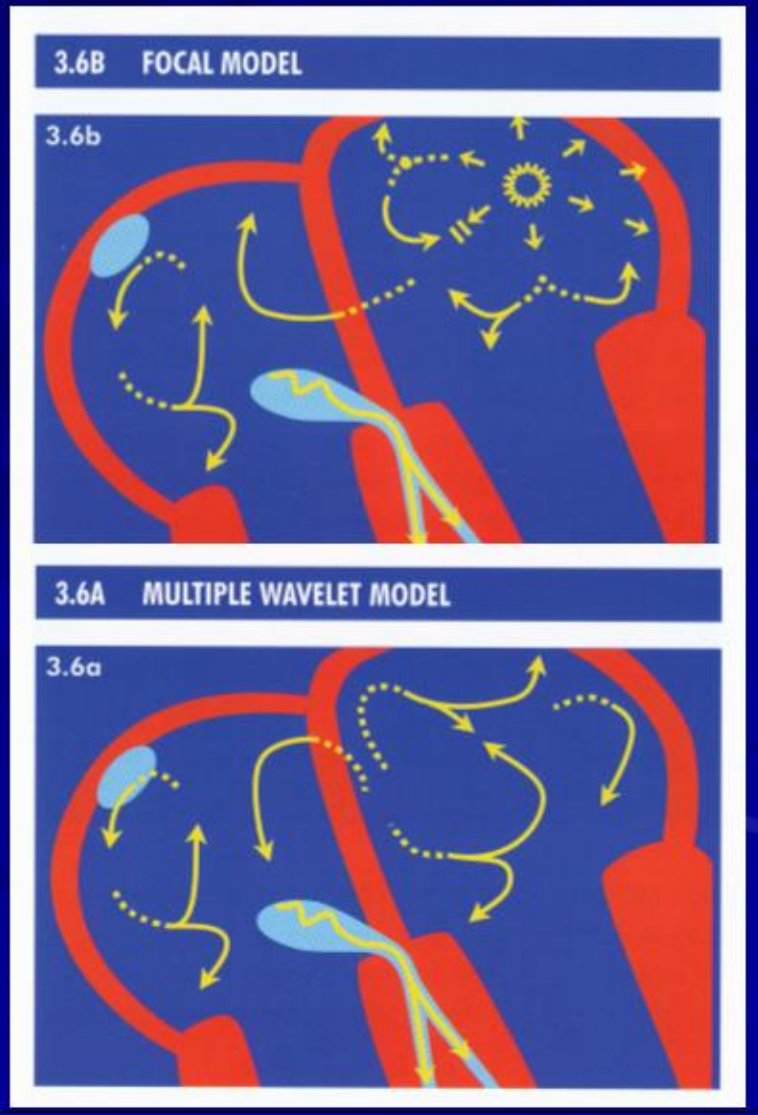


Another ECG



Models of Atrial Flutter and Fibrillation

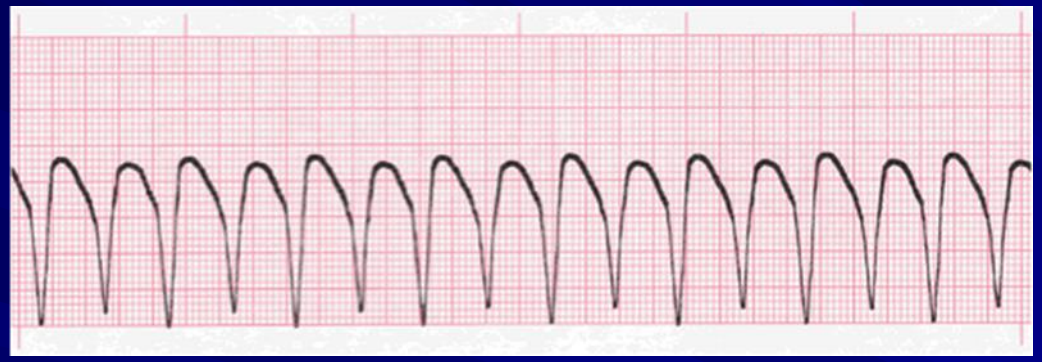


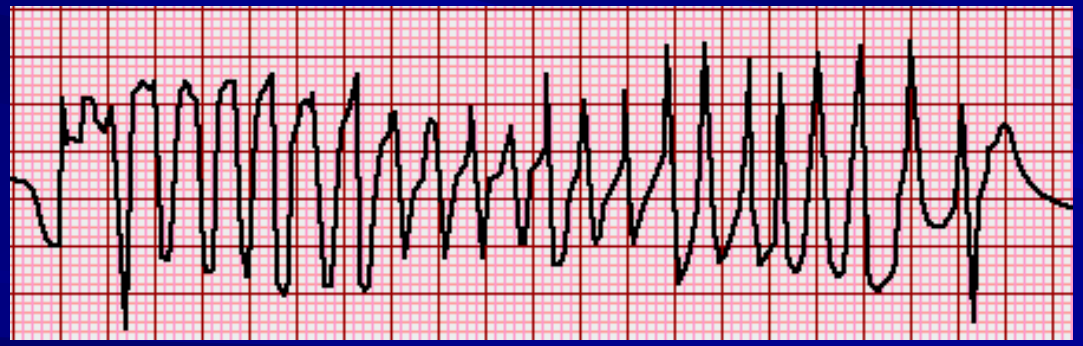


Ventricular Tachycardia

- Monomorphic VT
- Polymorphic VT
- NSVT

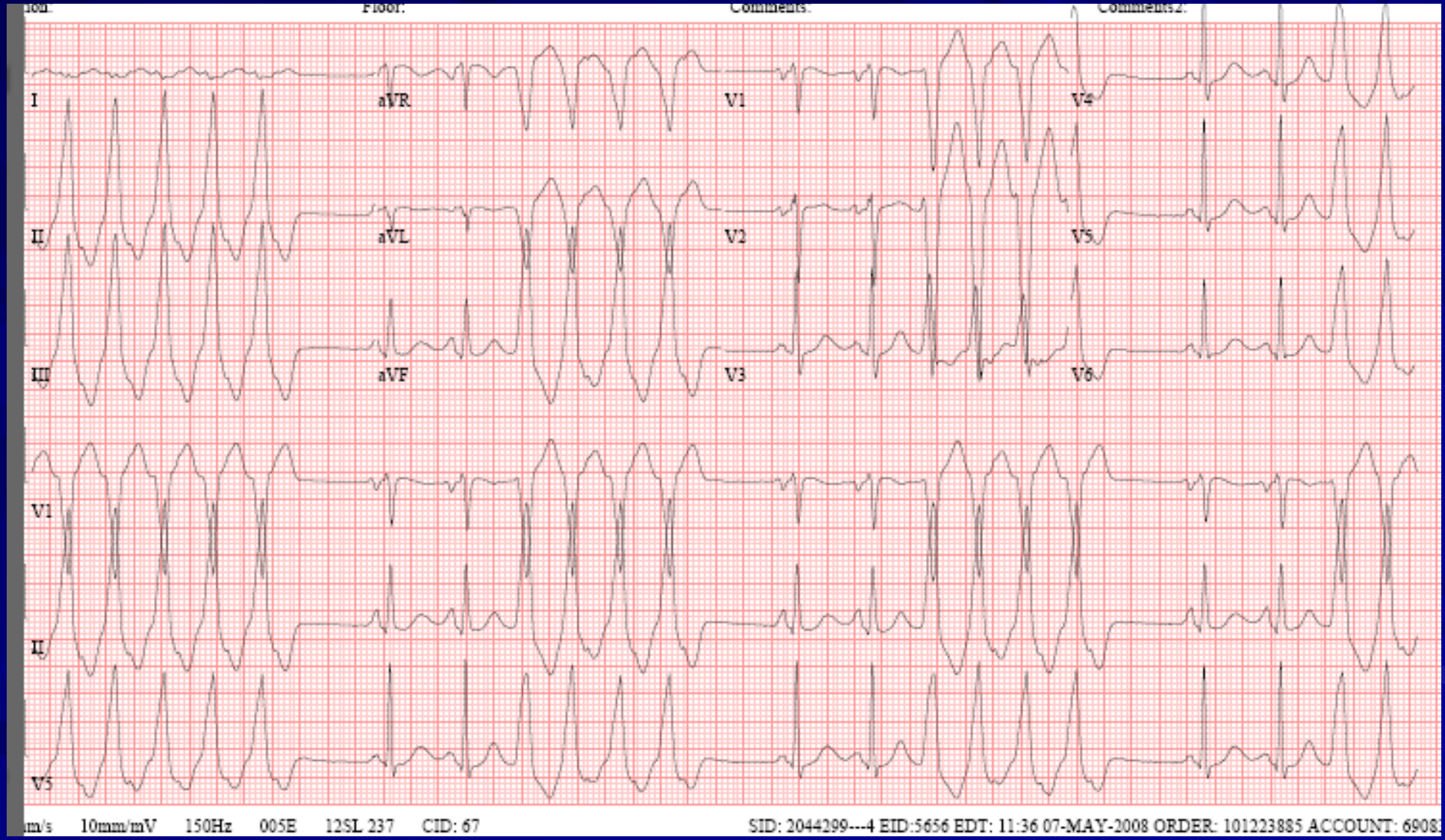
Ventricular Tachycardia (VT)

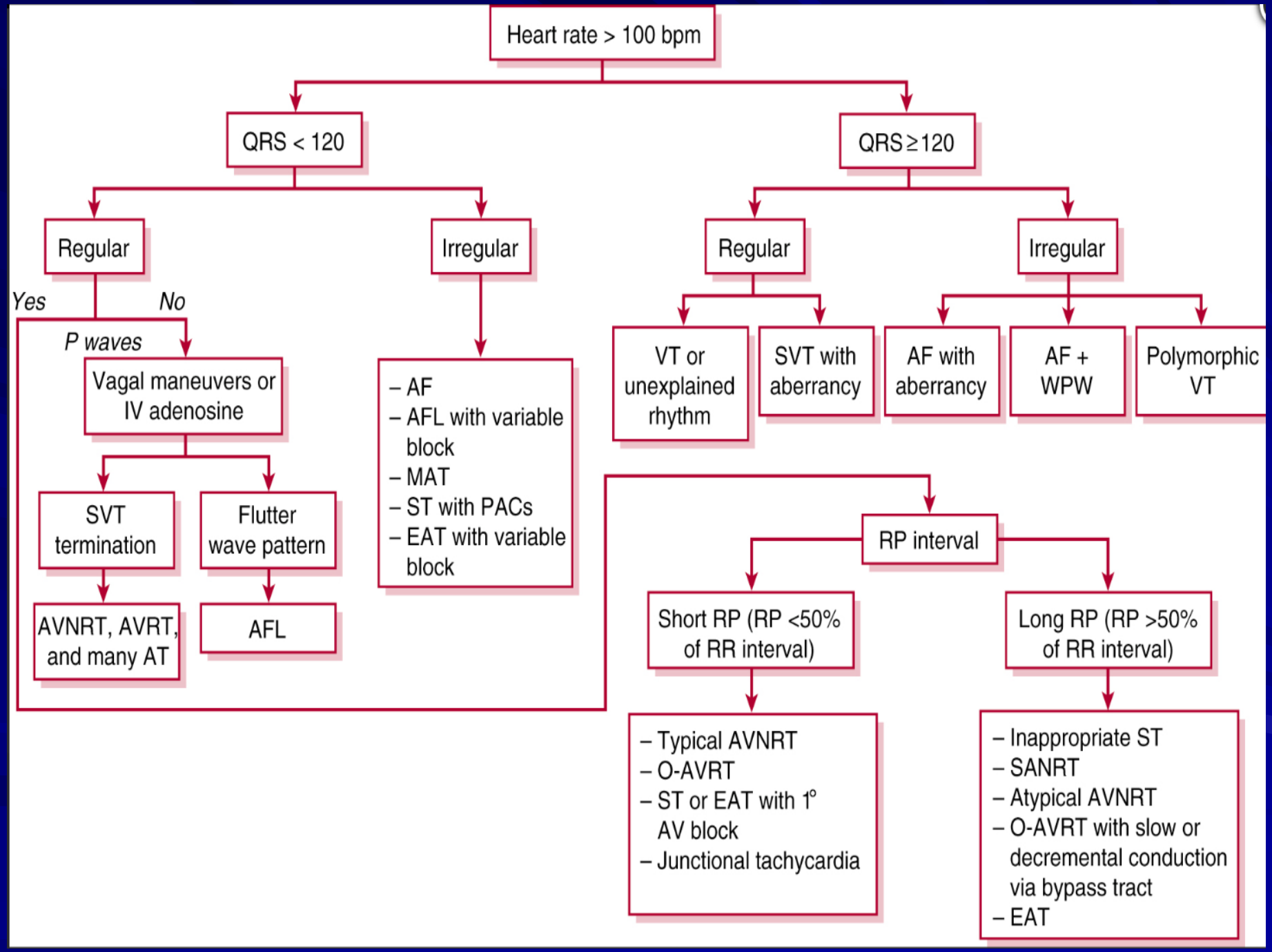


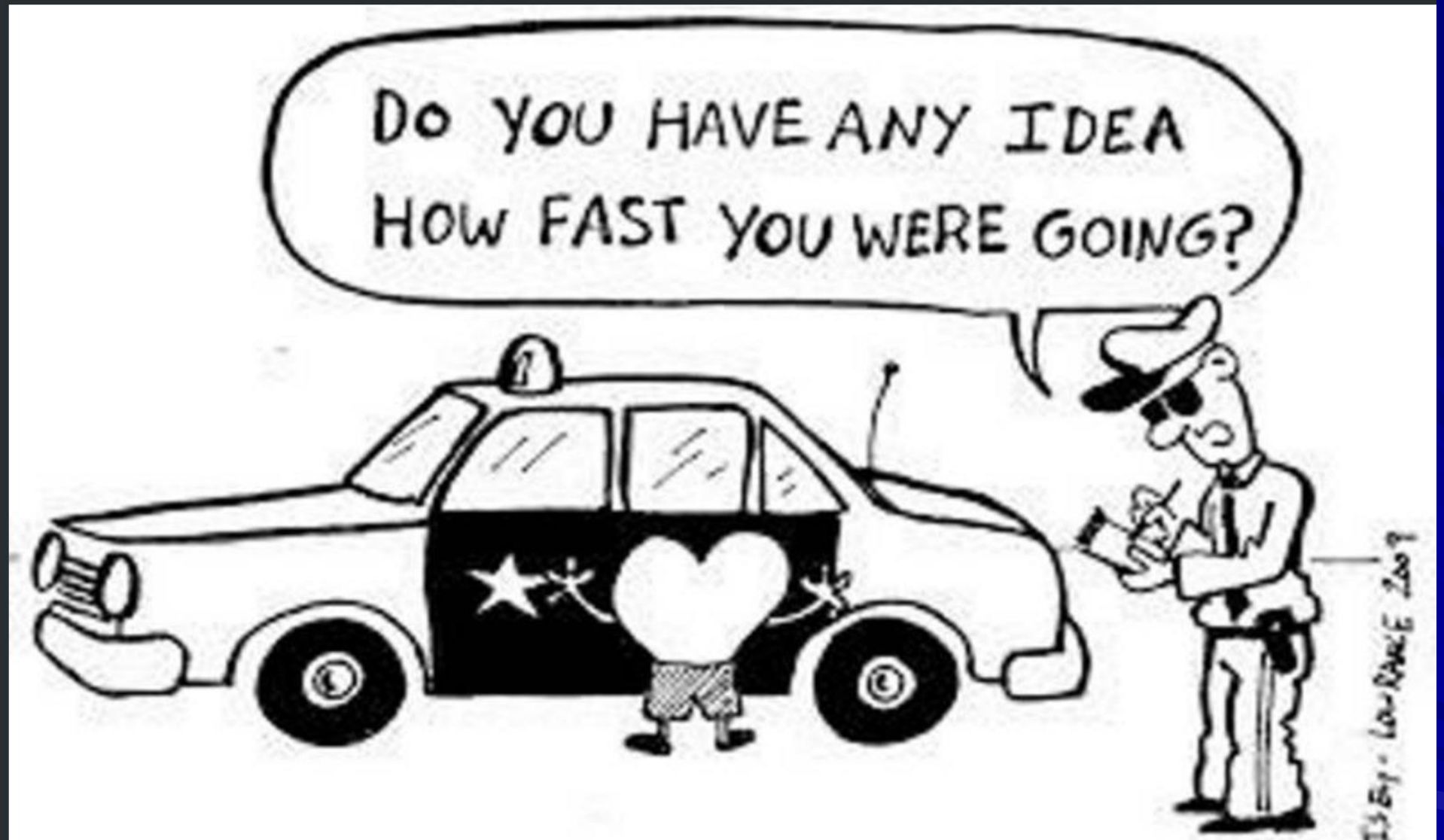


Criteria for VT

- Rapid succession of 3 or more ventricular premature complexes at ≥ 100 bpm
- RR interval is usually regular but may be irregular
- Abrupt onset and termination of arrhythmia is evident
- AV dissociation is common (P and QRS complexes at different rates)


Floor:
Comments:
Comments2:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
10mm/mV
150Hz
005E
12SL 237
CID: 67
SID: 2044299---4 EID:5656 EDT: 11:36 07-MAY-2008 ORDER: 101223885 ACCOUNT:

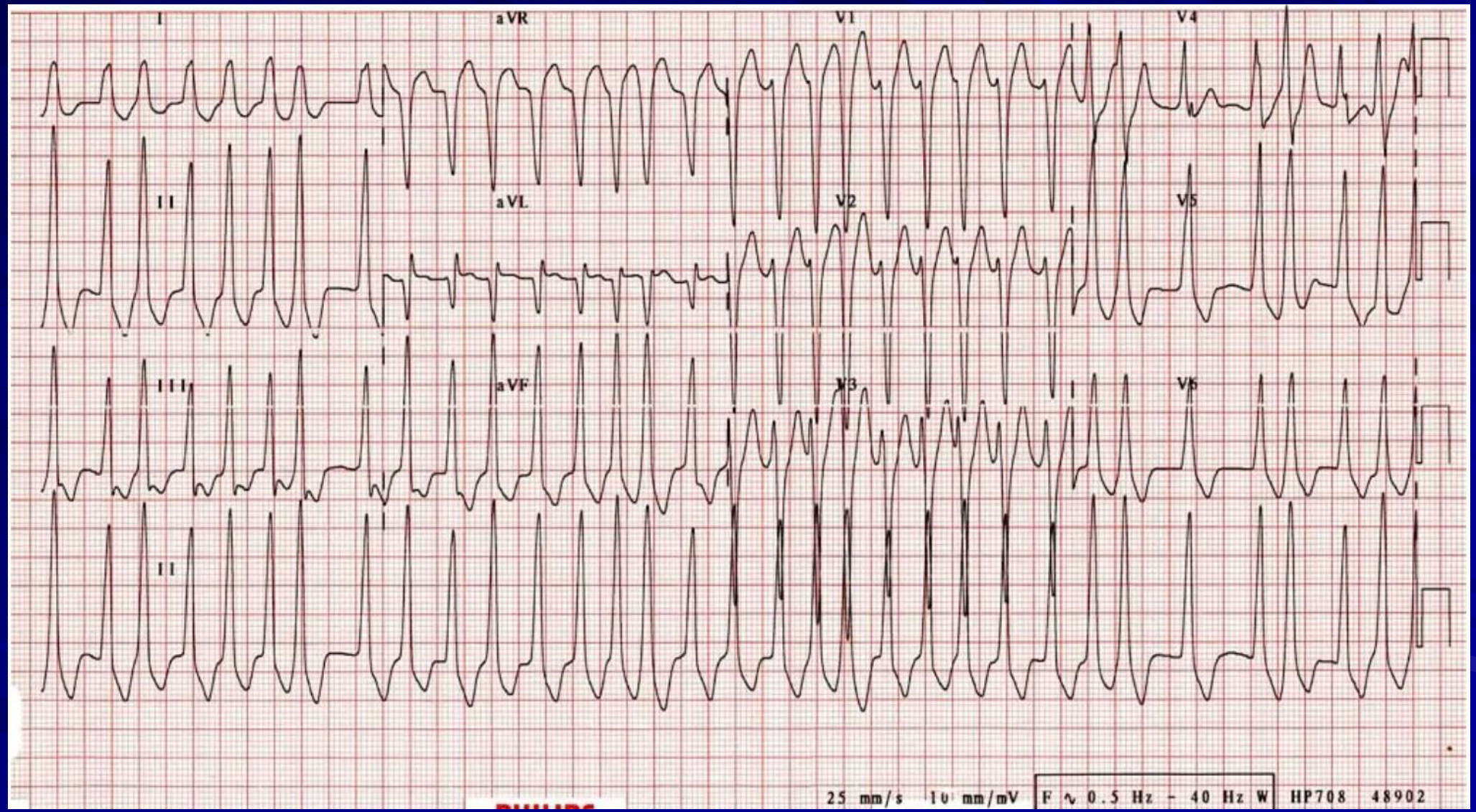

Heart rate > 100 bpm
QRS < 120
QRS ≥ 120
Regular
Irregular
Regular
Irregular
Yes
No
P waves
Vagal maneuvers or IV adenosine
SVT termination
Flutter wave pattern
AVNRT, AVRT, and many AT
AFL
– AF
– AFL with variable block
– MAT
– ST with PACs
– EAT with variable block
VT or unexplained rhythm
SVT with aberrancy
AF with aberrancy
AF + WPW
Polymorphic VT
RP interval
Short RP (RP <50% of RR interval)
Long RP (RP >50% of RR interval)
– Typical AVNRT
– O-AVRT
– ST or EAT with 1° AV block
– Junctional tachycardia
– Inappropriate ST
– SANRT
– Atypical AVNRT
– O-AVRT with slow or decremental conduction via bypass tract
– EAT

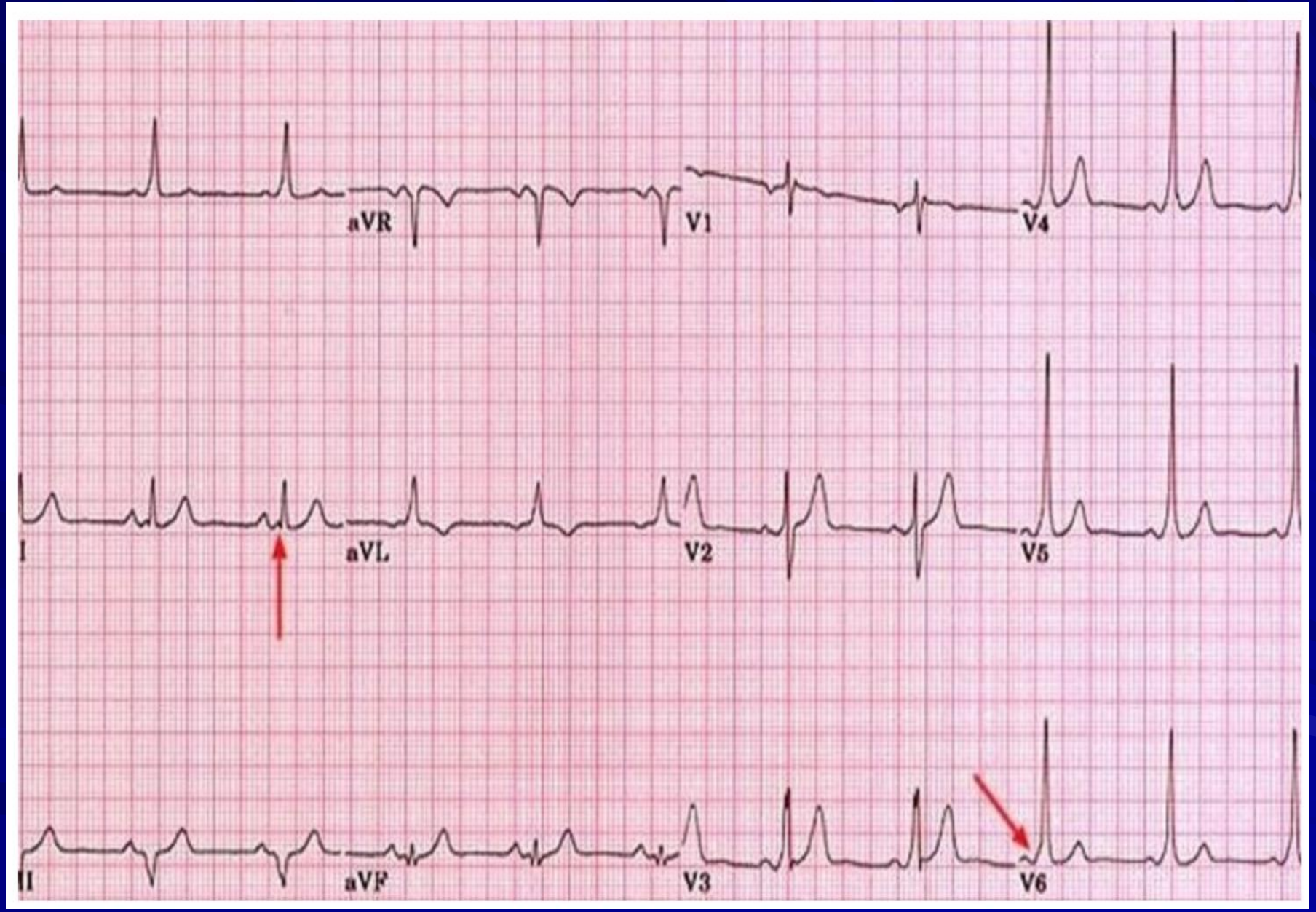


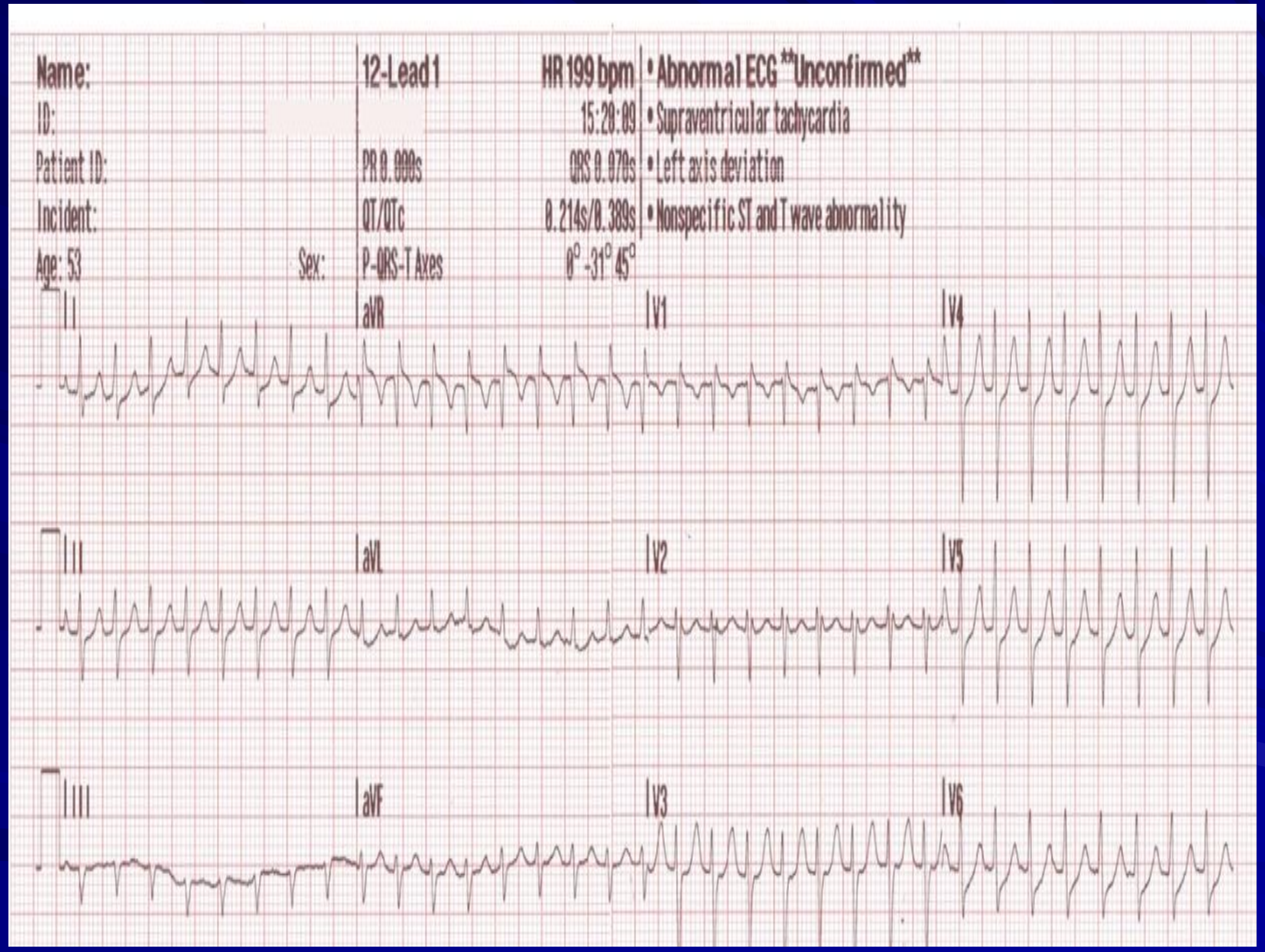
CARDIAC ARREST

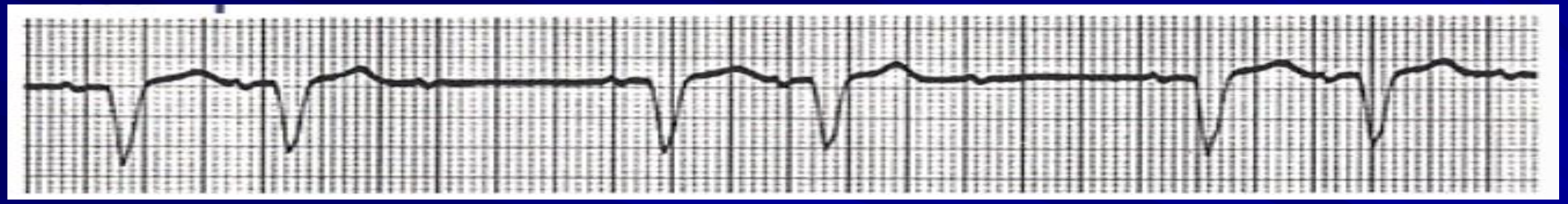

PENOBSCOT 17
WESTFALIA


I
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
25 mm/s 10 mm/mV
F ∿ 0.5 Hz - 40 Hz W
HP708 48902


aVR
V1
V4
I
aVL
V2
V5
II
aVF
V3
V6


Name:
ID:
Patient ID:
Incident:
Age: 53
Sex:
12-Lead 1
HR 199 bpm
15:20:09
PR 0.099s
QRS 0.079s
QT/QTc
0.214s/0.389s
P-QRS-T Axes
0° -31° 45°
• Abnormal ECG **Unconfirmed**
• Supraventricular tachycardia
• Left axis deviation
• Nonspecific ST and T wave abnormality
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6



ECG Findings in Pulmonary Embolism

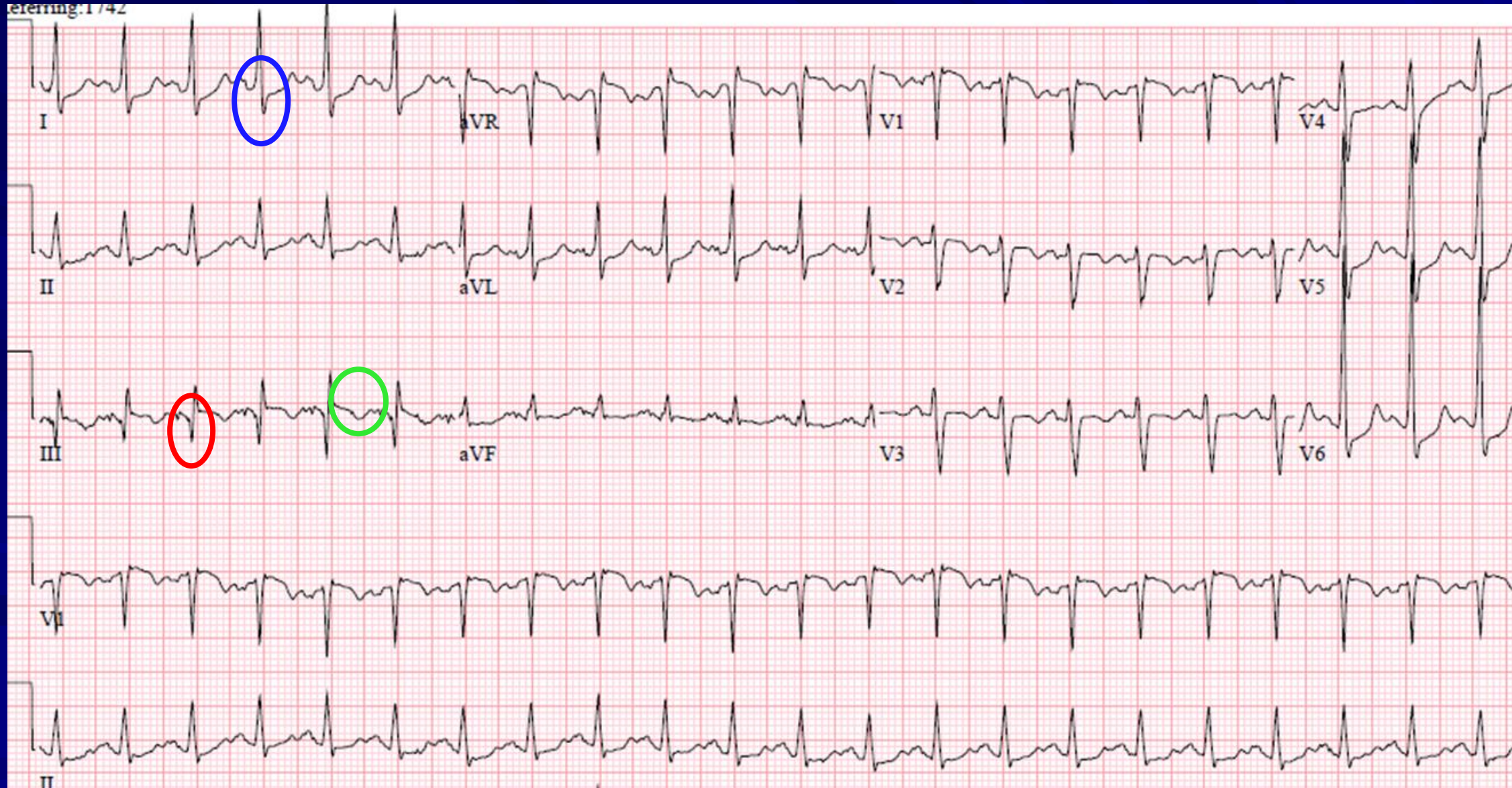
#1 most common finding is…

Tachycardia

S1Q3T3

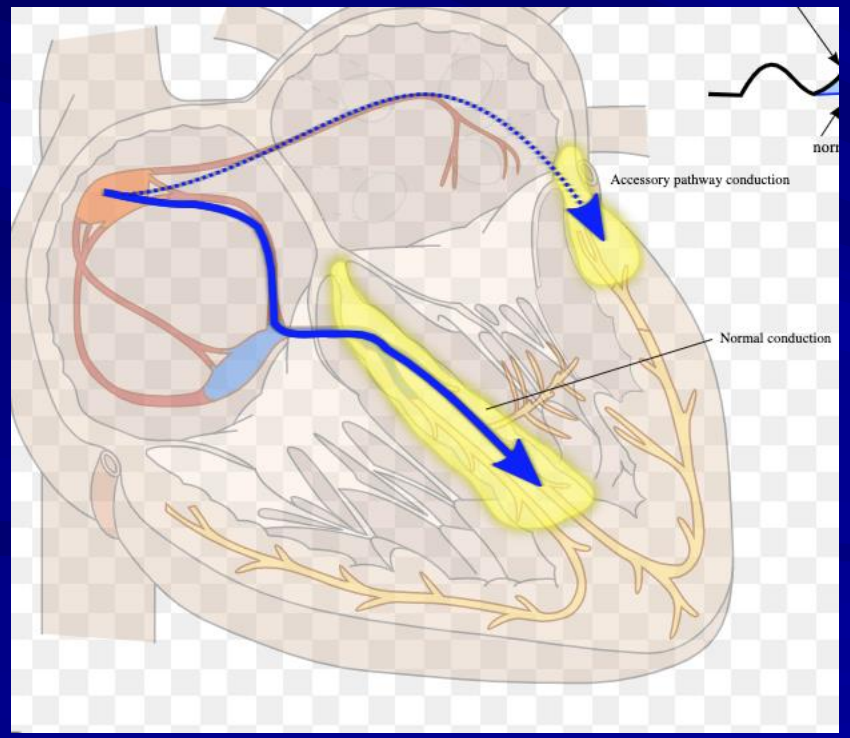
- S wave in Lead 1
- Q wave in Lead 3
- T wave inversion in Lead 3

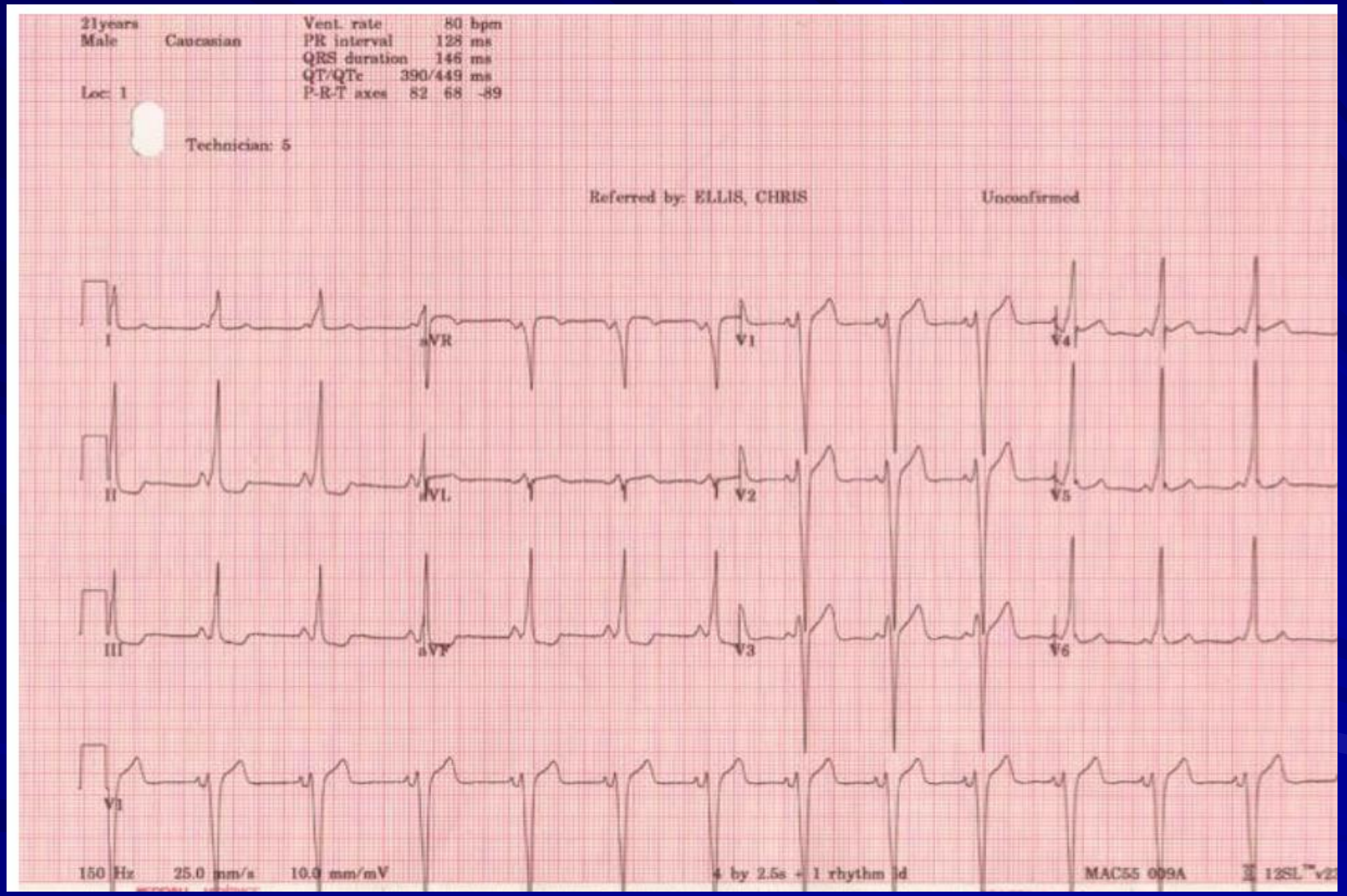
S1Q3T3

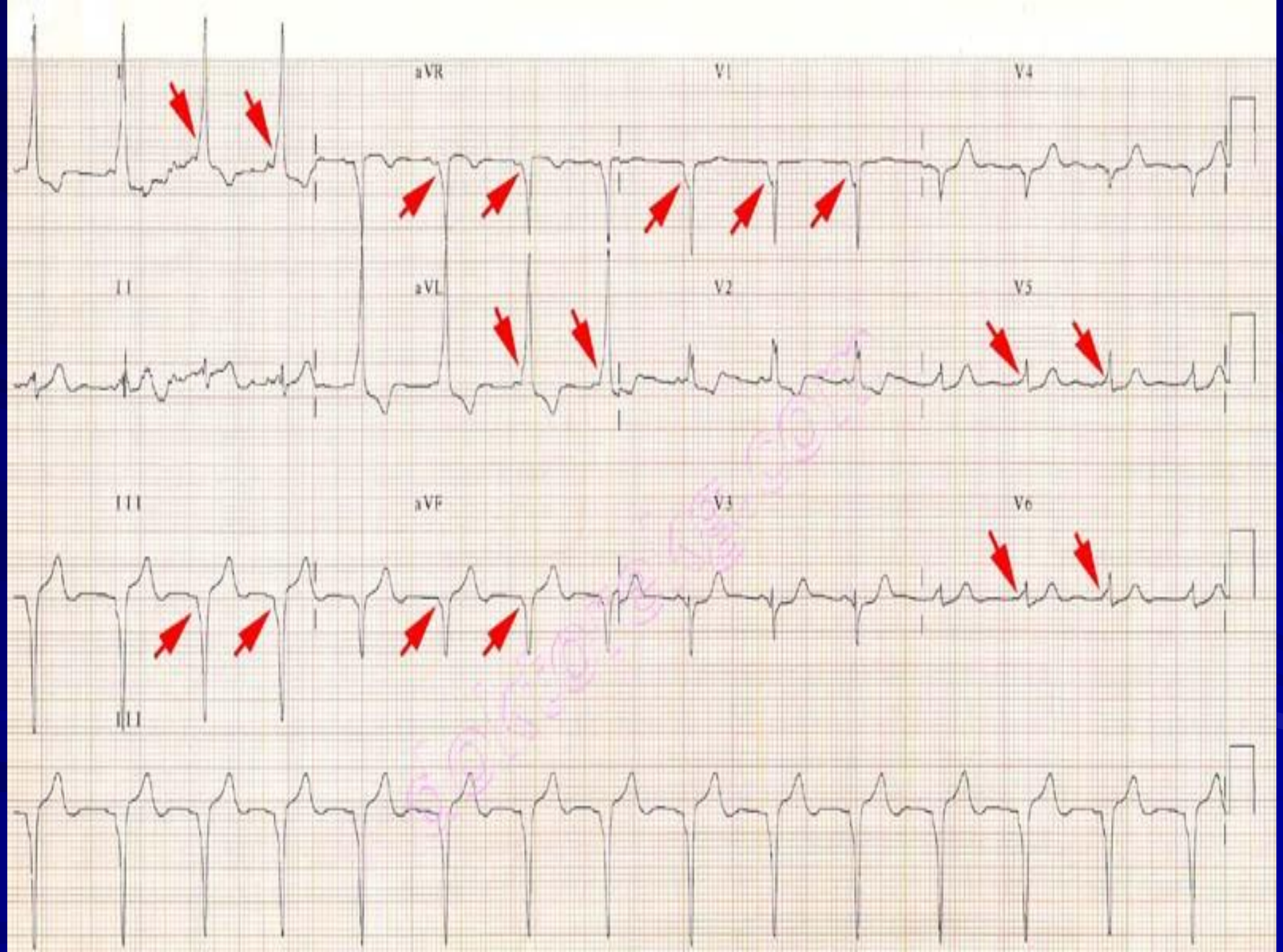


Wolff-Parkinson-White (WPW) Syndrome

- Pre-excitation
- The Delta wave is a slurred upstroke in the QRS complex with a short PR interval.

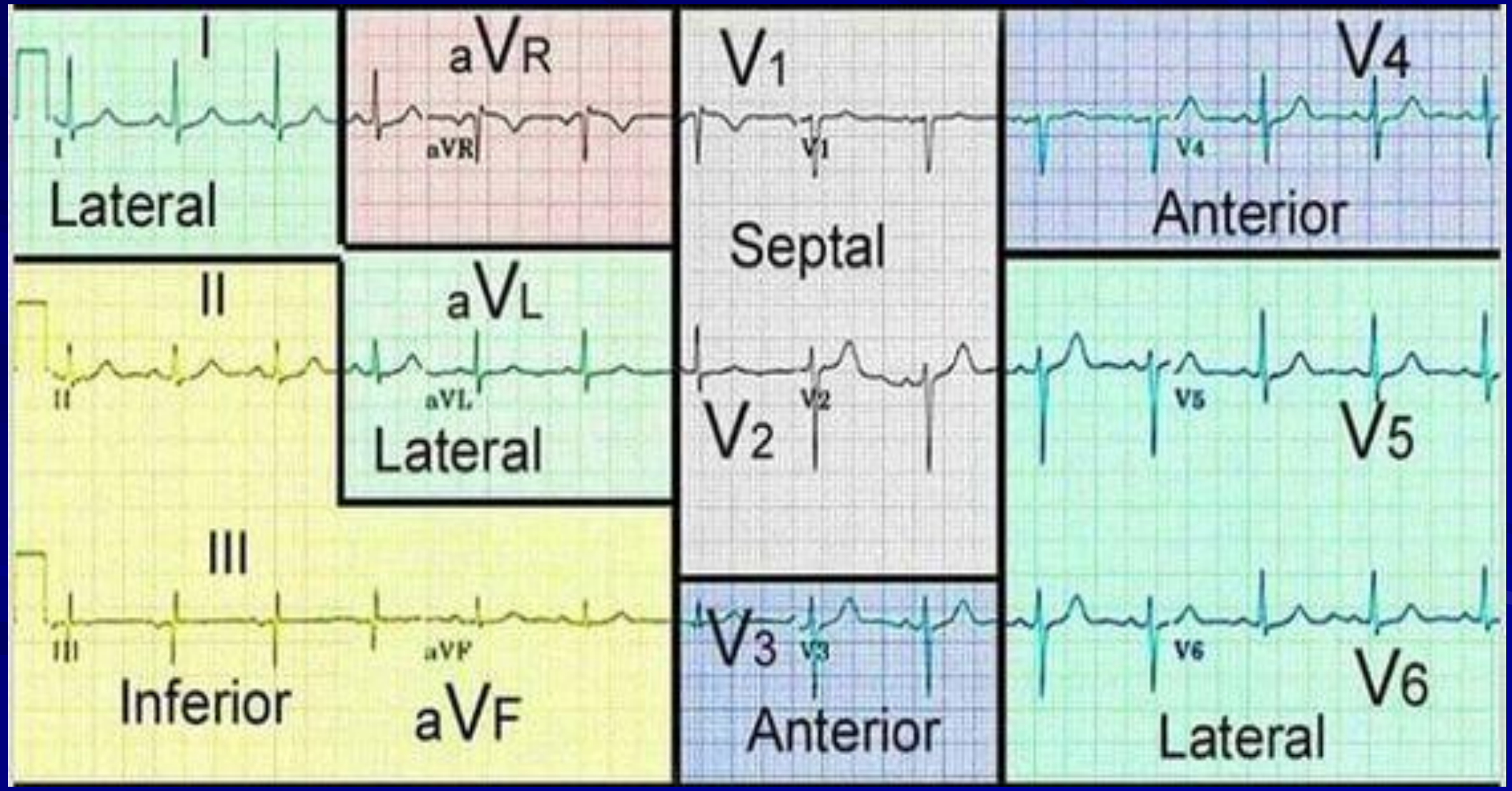



21years
Male
Caucasian
Vent. rate 80 bpm
PR interval 128 ms
QRS duration 146 ms
QT/QTc 390/449 ms
P-R-T axes 82 68 -89
Loc: 1
Technician: 5
Referred by: ELLIS, CHRIS
Unconfirmed
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
150 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 1 rhythm
MAC55 009A
12SL™v2

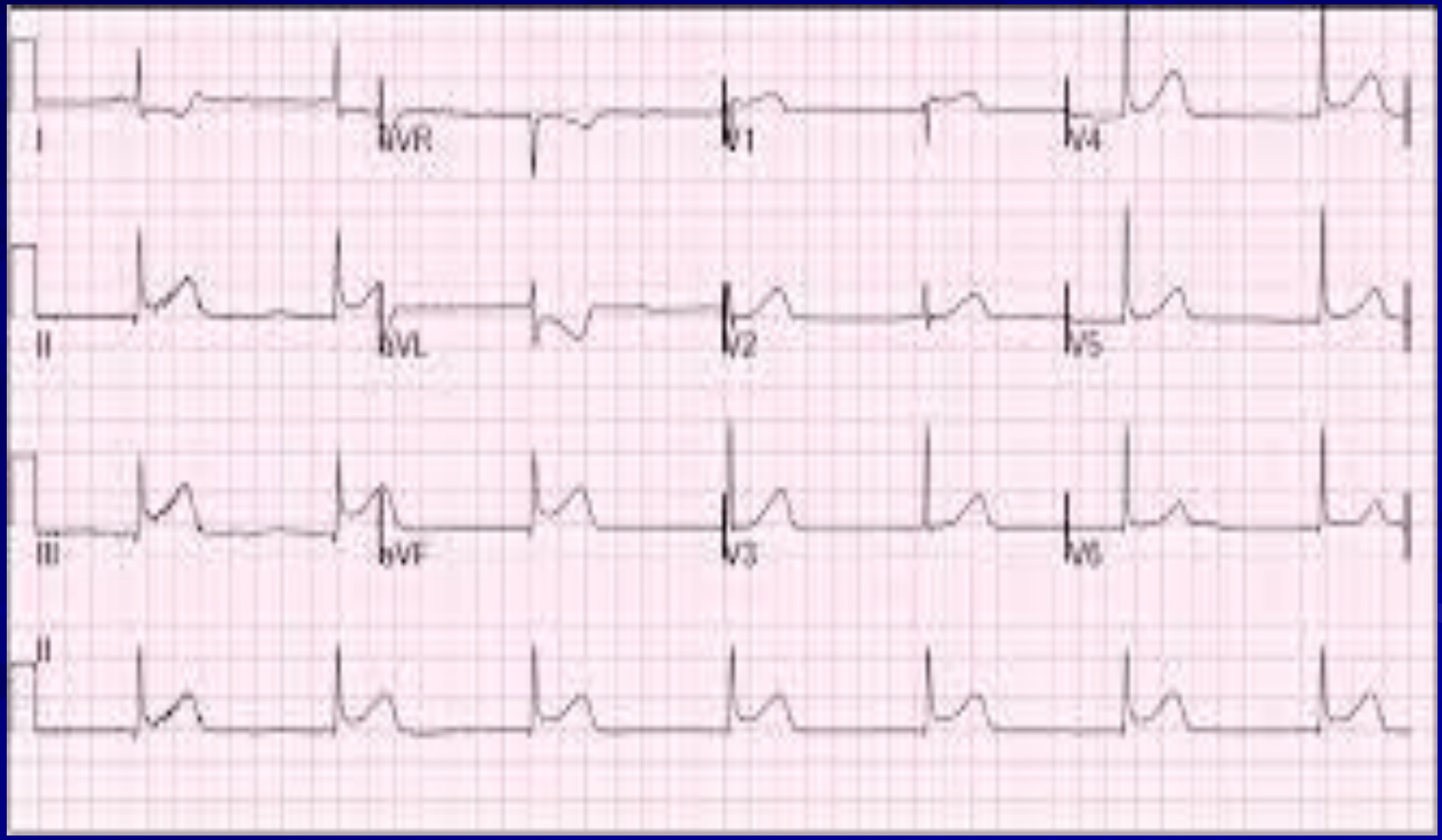

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II(II)

Ischemia, Injury, Infarct

STEMI Location by ECG



Where is the STEMI?



Location of Infarct (ST elevation MI)	Reciprocal changes* seen (ST depression)
Anterior (V1-V6)	Inferior leads (II, III, aVF)
Anteroseptal (V1-V2)	Inferior (II, III, aVF) or lateral leads (I, aVL, V5, V6
Lateral (I, aVL, V5-V6)	Inferior (II, III, aVF) *In some cases leads V1-V2***
Inferior (II, III, aVF)	Lead I and aVL *In some cases leads V1-V3***

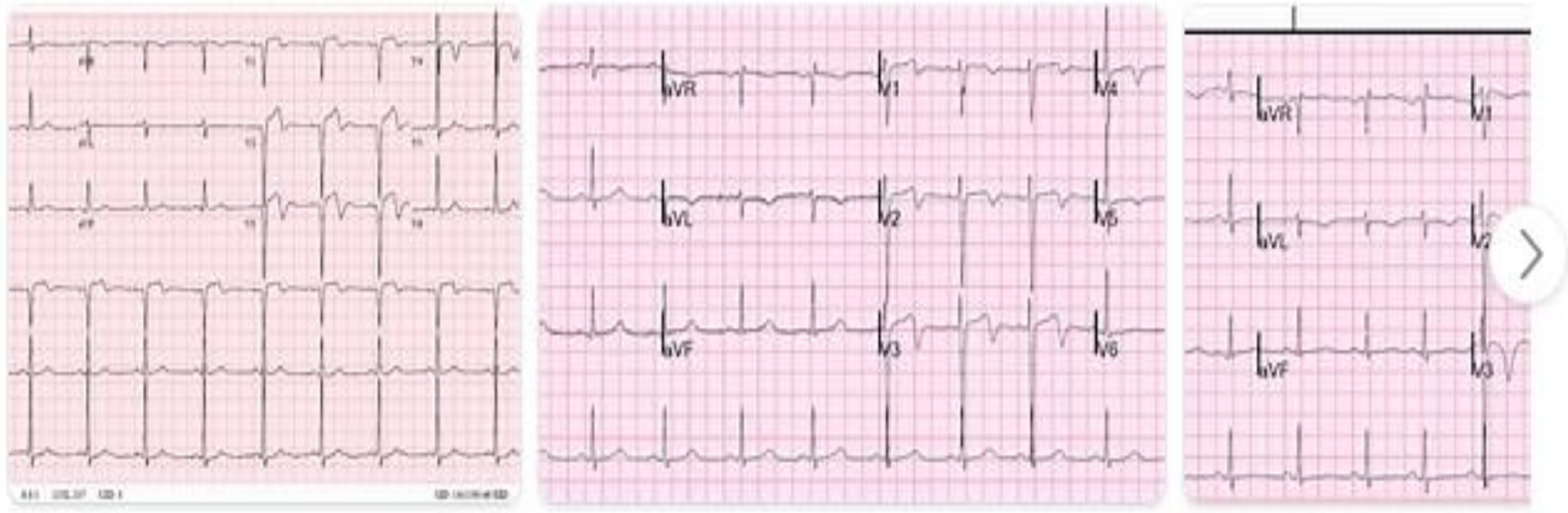
*Reciprocal changes are the same ST segment shifts as seen from a different angle or direction.

**May be reciprocal, but more likely represents posterior MI.

Posterior wall MI may be missed on typical ECG!

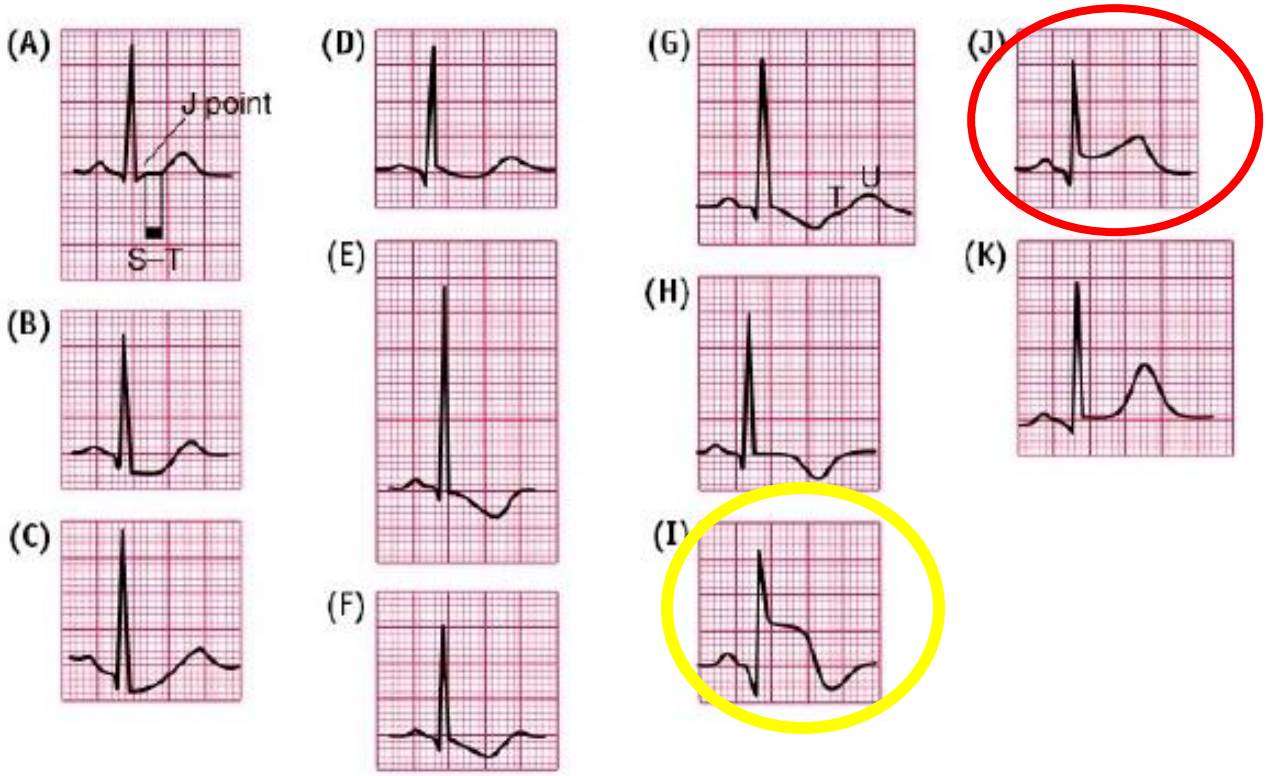
- **High degree of suspicion** if ST depression in V1-V3

Wellen’s Sign



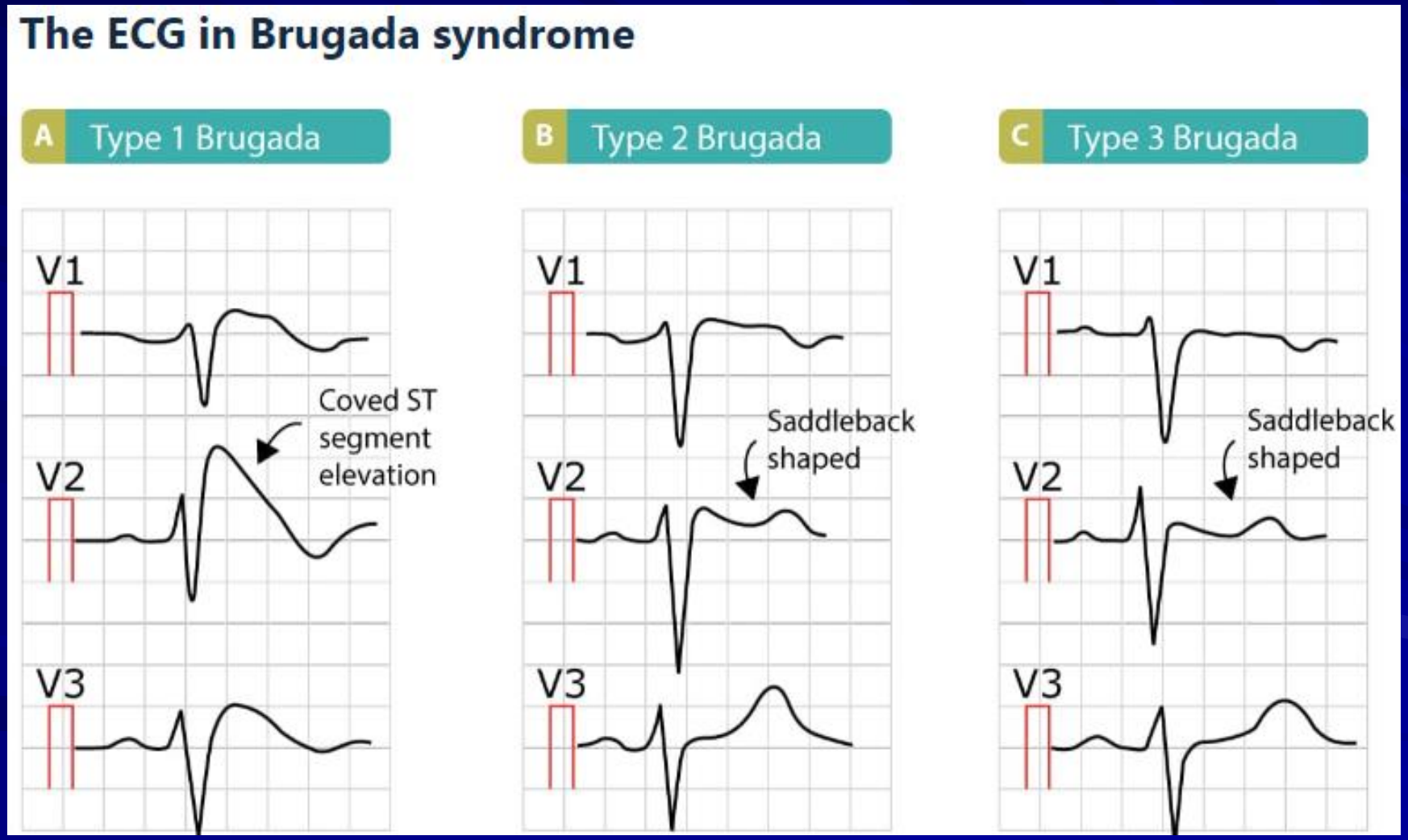
Wellens' ECG (sometimes referred to as Wellens syndrome or sign) is an ECG manifestation of **proximal left anterior descending stenosis** in patients with acute coronary syndrome. It is characterized by symmetrical, often deep (>2 mm), T wave inversions in the anterior precordial leads.

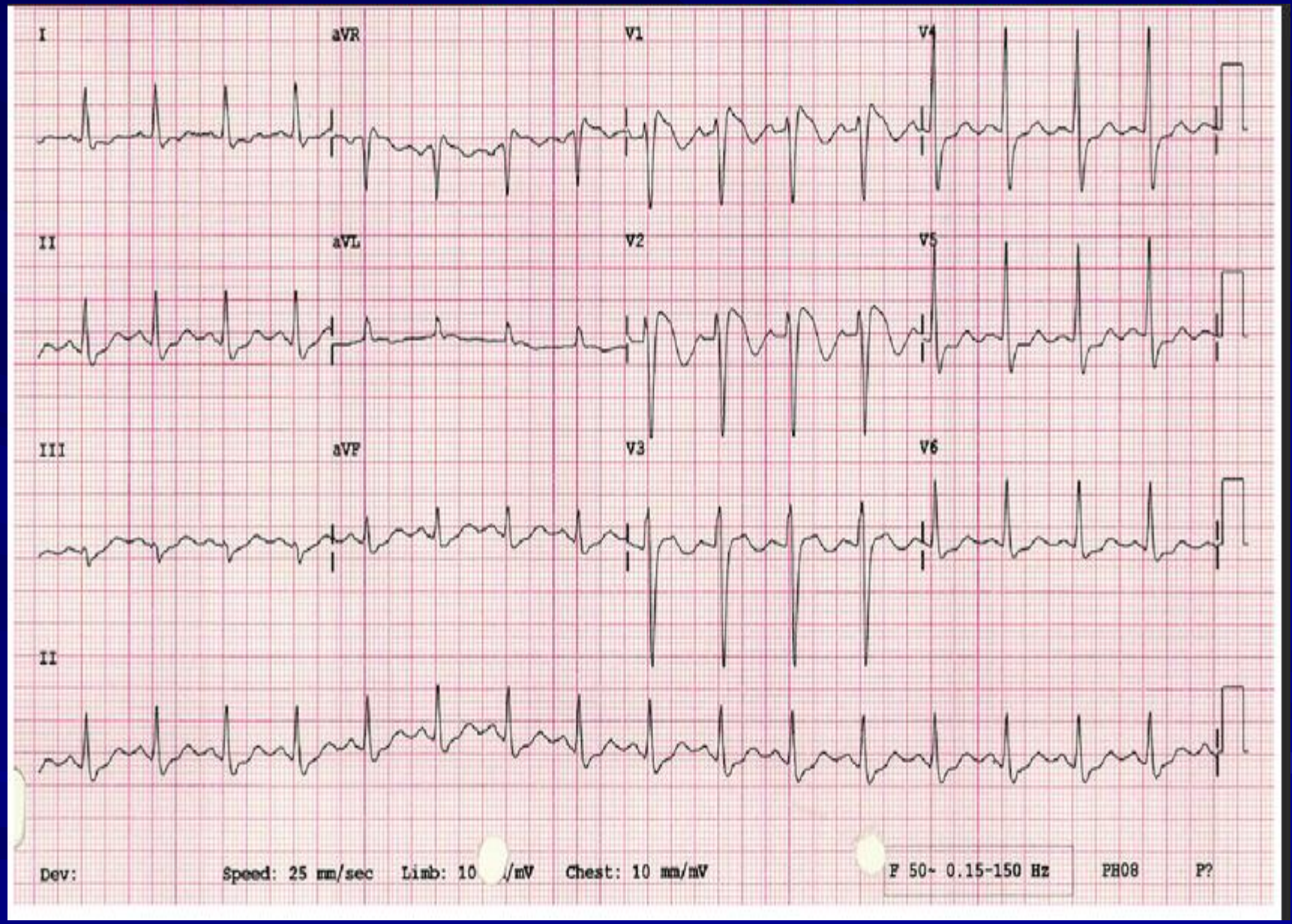
NORMAL AND ABNORMAL *ST* SEGMENTS AND *T* WAVES



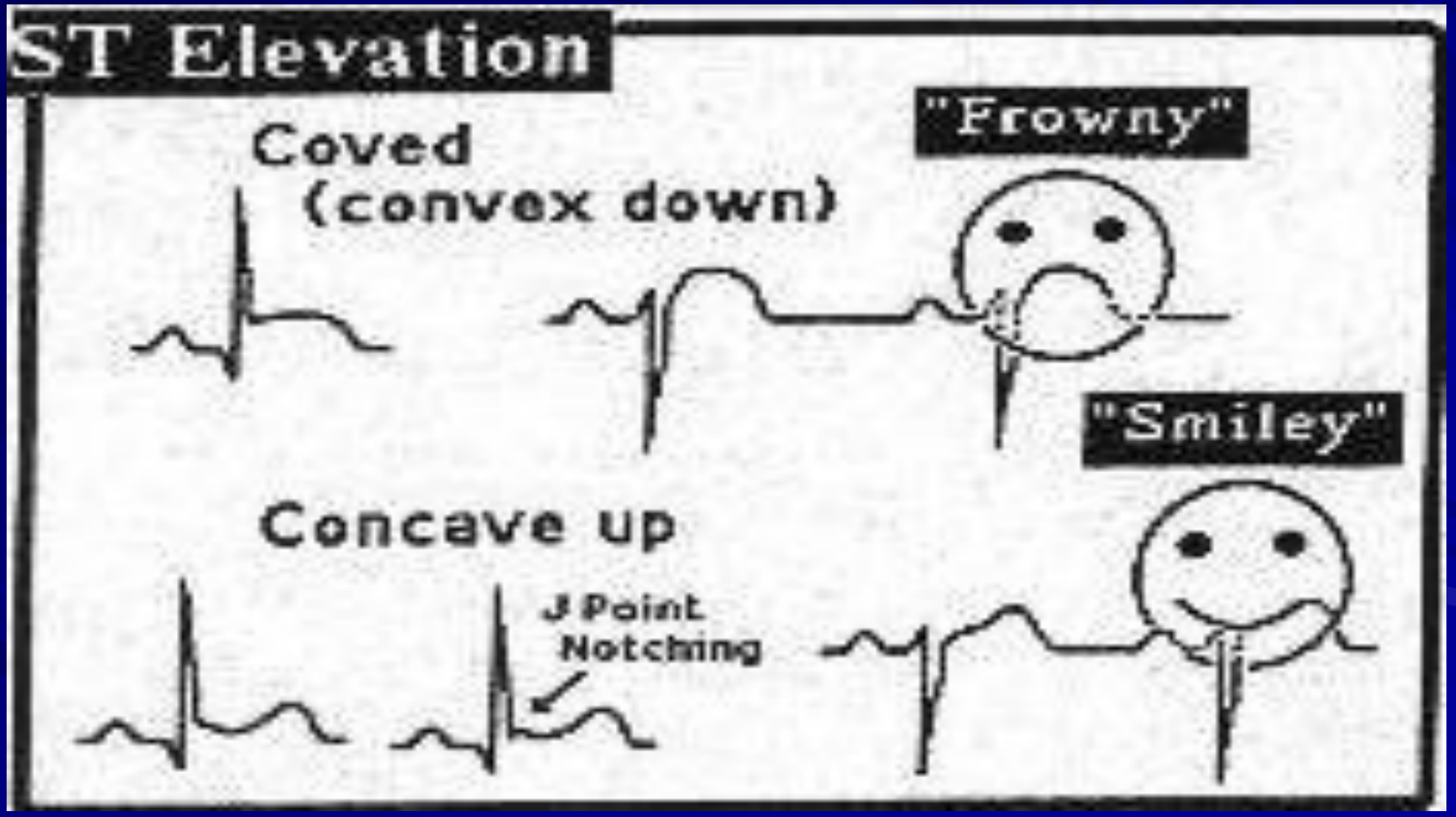
(A) Normal *ST* segment with J point. (B) Horizontal *ST* depression in myocardial ischaemia. (C) *ST* segment sloping upwards in sinus tachycardia. (D) *ST* sagging in digitalis therapy. (E) Asymmetrical *T* wave inversion associated with ventricular hypertrophy. (F) Similar pattern sometimes seen without voltage changes in hypertrophy – 'strain'. (G) *ST* sagging and prominent *U* waves of hypokalaemia. (H) Symmetrically inverted *T* wave of myocardial ischaemia or infarction. (I) *ST* elevation in acute myocardial infarction. (J) *ST* elevation in acute pericarditis. (K) Peaked *T* wave in hyperkalaemia.

Brugada 1,2,3

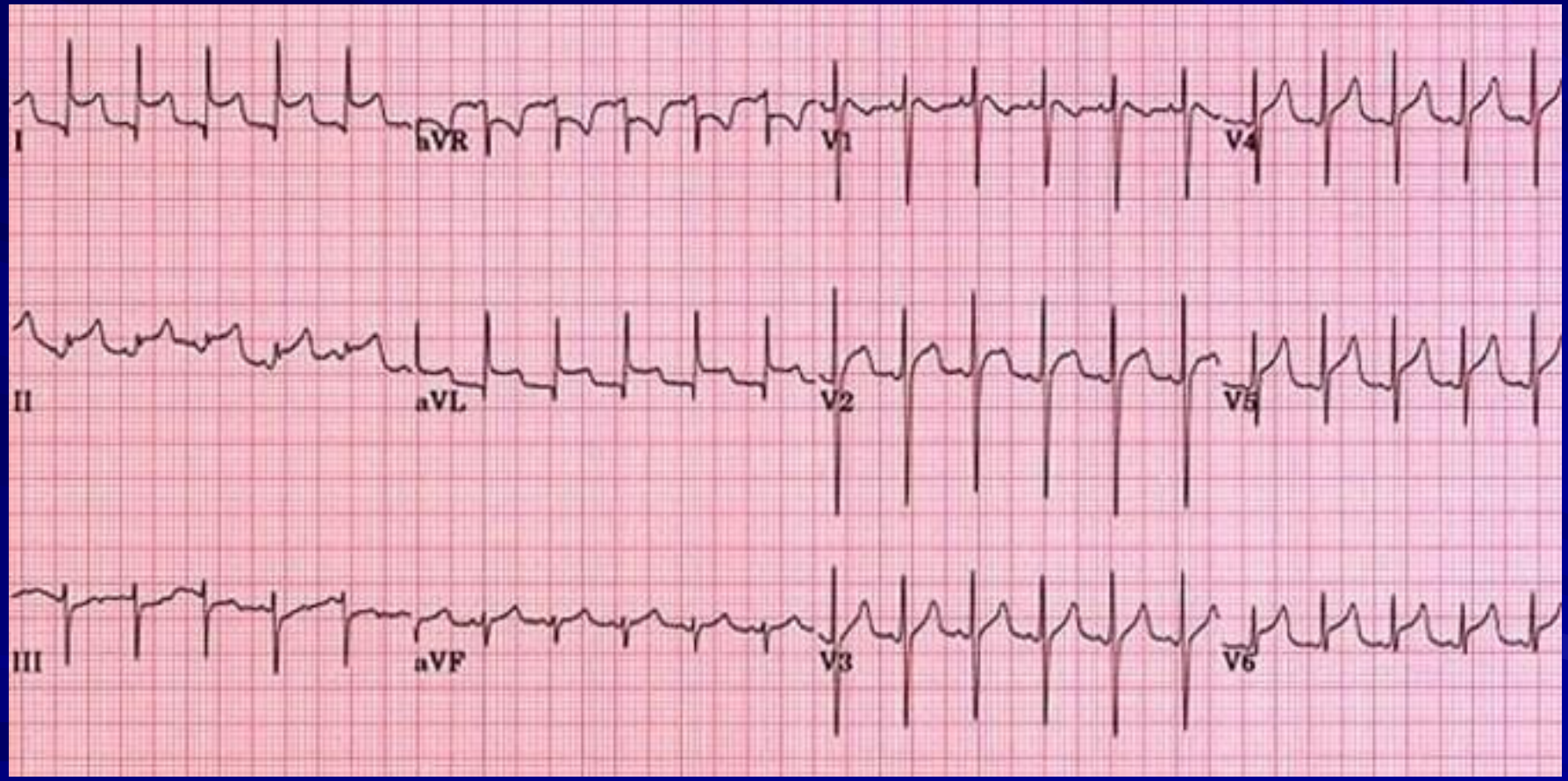

The ECG in Brugada syndrome
A Type 1 Brugada
B Type 2 Brugada
C Type 3 Brugada
V1
V2
V3
Coved ST segment elevation
Saddleback shaped
Saddleback shaped


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Dev:
Speed: 25 mm/sec
Limb: 10
/mV
Chest: 10 mm/mV
F 50~ 0.15-150 Hz
PH08
P?

Pericarditis



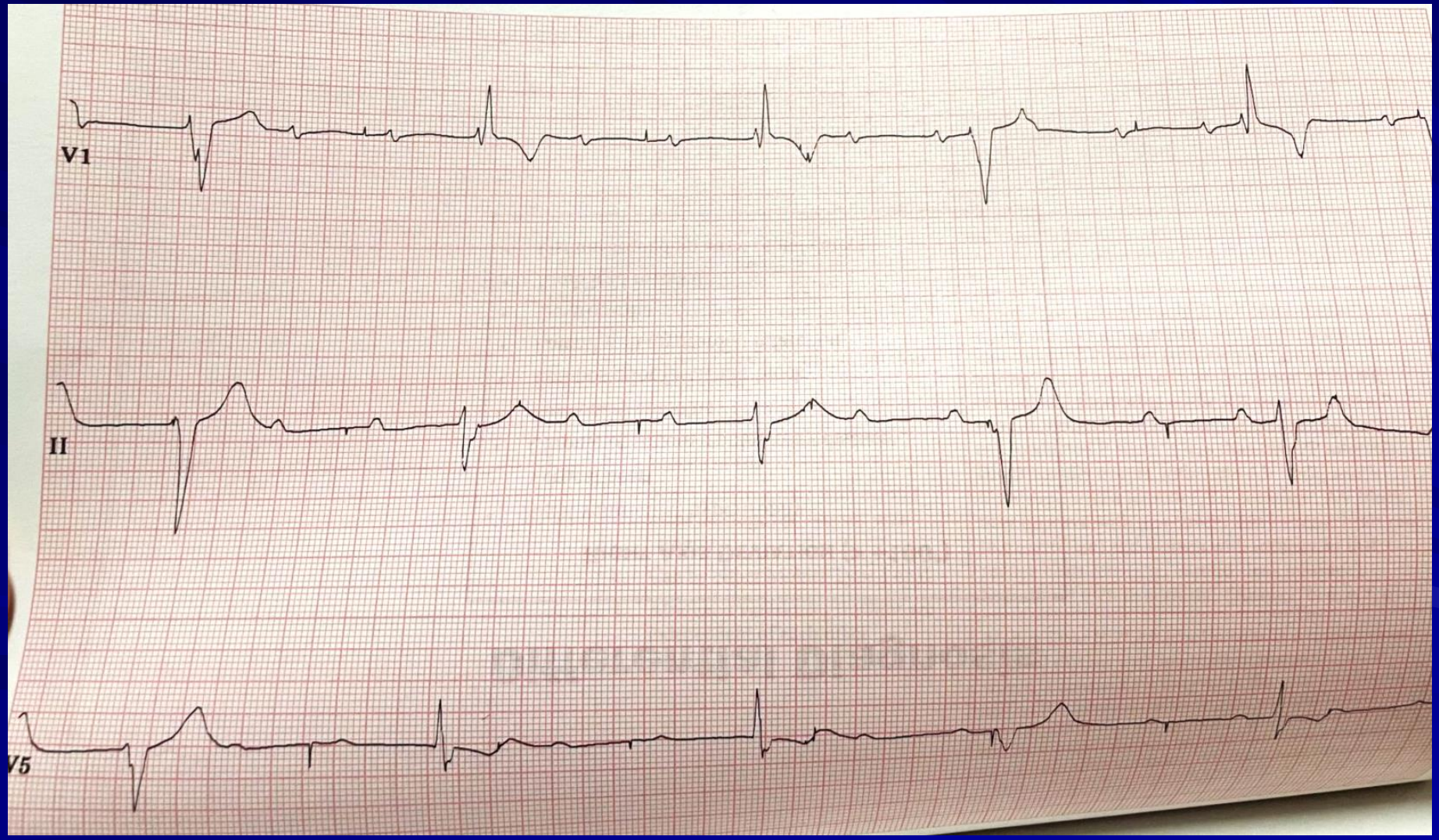
STEMI or Pericarditis?

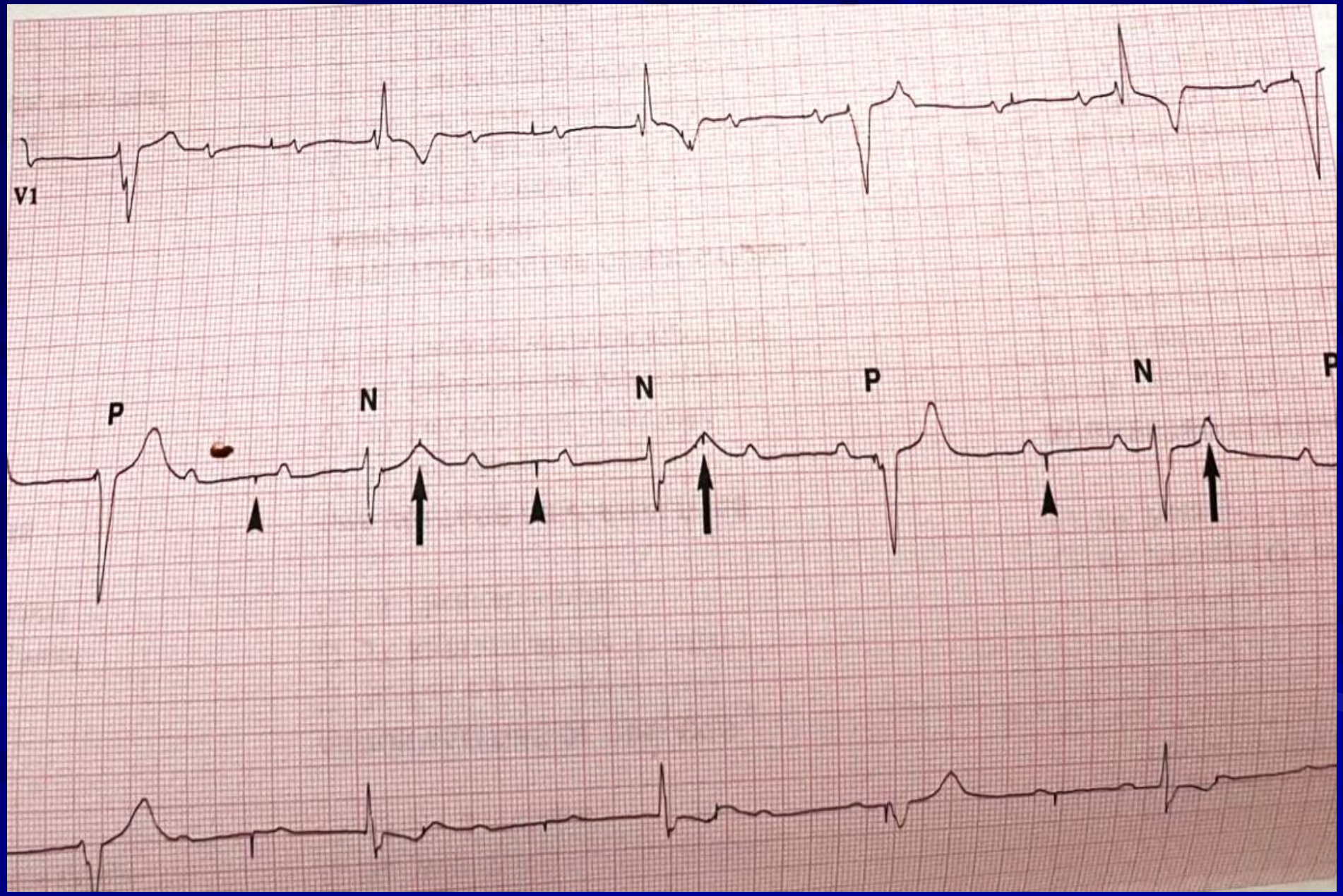


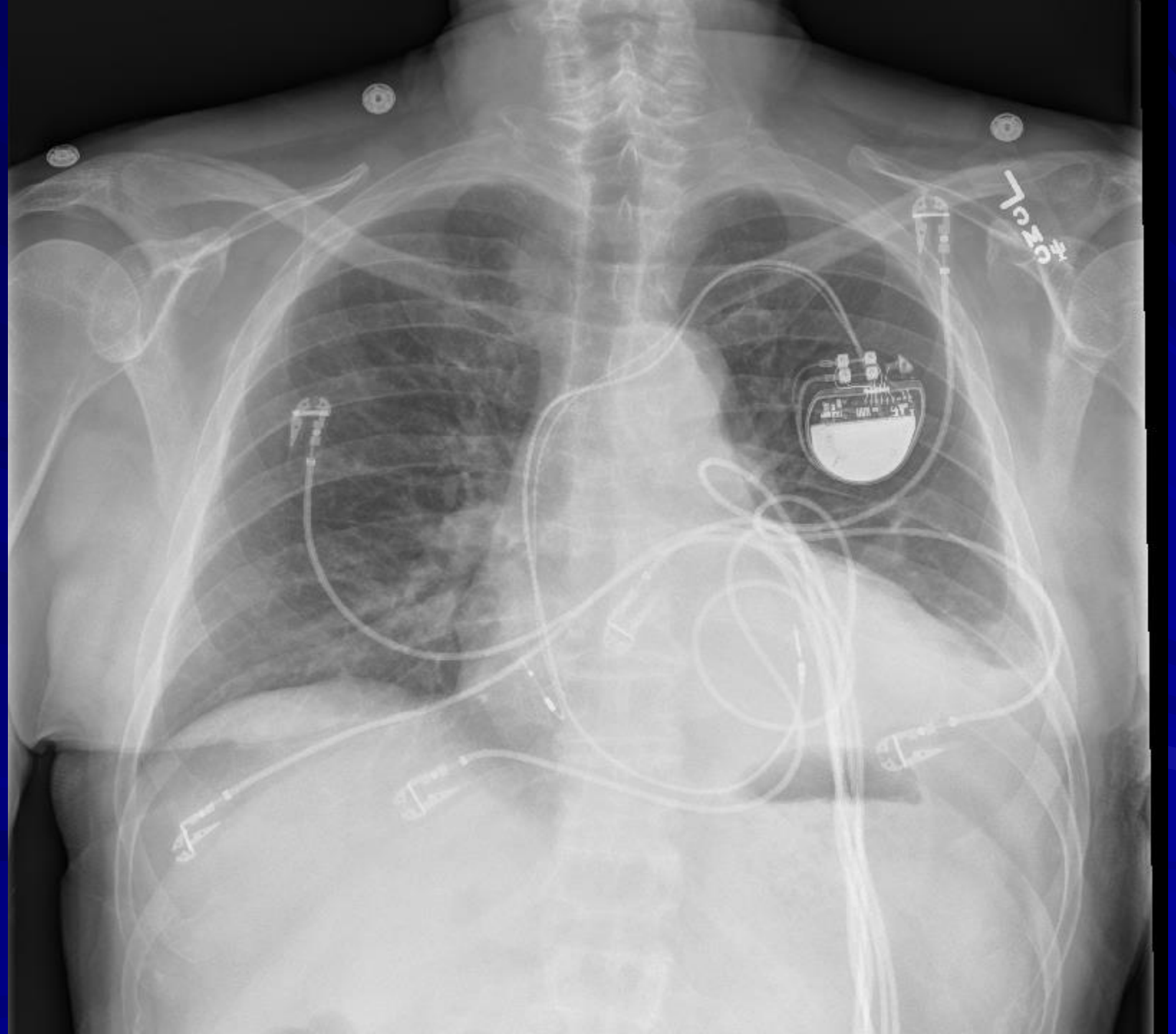
Correlate to history and clinical presentation

- Pacer spikes?
- Pt presenting symptoms & labs
- Aberrancy vs VT- Remember the basics

54 yr old F presenting with lightheadedness




V1
P
N
N
P
N
P



Take home pearls

- Its like a free-throw; the same every time
- Rate of 150, sometimes we clinically may not be sure, yet. How do we help ourselves better understand the rhythm? SLOW IT DOWN.
- Where are the P waves?
- Compare arrhythmia ECG with NSR ECG (if able)


When you feel like giving up, look at this picture and remember just how strong the human spirit really is.
THE BLUE STREET JOURNAL

References

- O'Keefe, James H., et al. *The Complete Guide to ECGS: A Comprehensive Study Guide to Improve ECG Interpretation Skills*. Jones & Bartlett Learning, 2019.
- Chan TC, Vilke GM, Pollack M, Brady WJ. Electrocardiographic manifestations: pulmonary embolism. Journal of Emergency Medicine. 2001 Oct;21(3):263–70.
- Ullman E, Brady WJ, Perron AD, Chan T, Mattu A. Electrocardiographic manifestations of pulmonary embolism. American Journal of Emergency Medicine. 2001 Oct;19(6):514–9.
- Life in the Fastlane. Retrieved on July, 12, 2017 from https://lifeinthefastlane.com/ecg-library/basics/delta-waves/

5 ECG Practice Questions

Austin, Texas Sept 2022

Question #1

What is the most common ECG finding for Pulmonary Embolus (PE)?

- A. S1Q3T3 Sign (S wave in lead I, Q wave & inverted T wave lead III)
- B. Tachycardia
- C. Lateral T wave inversion
- D. Bradycardia

Answer: B

- **Answer: B. Tachycardia is the most common ECG finding in PE. The S1Q3T3 is a sign of acute cor pulmonale (acute pressure and volume overload of the right ventricle because of pulmonary hypertension) and reflects right ventricular strain. However, this finding is present in 15% to 25% of patients ultimately diagnosed with PE. T wave inversion is occasionally present, but is typically anterior V1-V4.**

References

- Chan TC, Vilke GM, Pollack M, Brady WJ. Electrocardiographic manifestations: pulmonary embolism. Journal of Emergency Medicine. 2001 Oct;21(3):263–70.
- Ullman E, Brady WJ, Perron AD, Chan T, Mattu A. Electrocardiographic manifestations of pulmonary embolism. American Journal of Emergency Medicine. 2001 Oct;19(6):514–9.

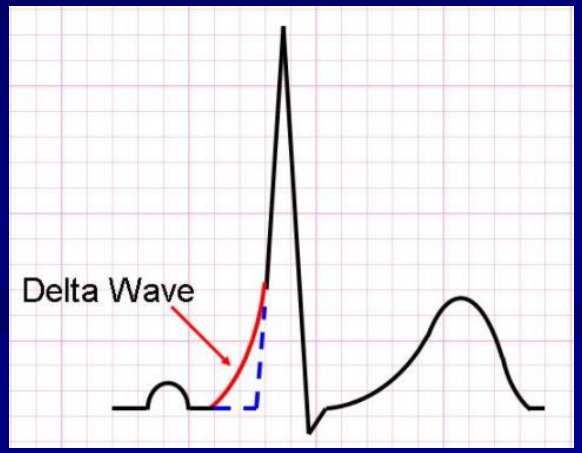
Question #2:

What prominent ECG finding below is characteristic of Wolff-Parkinson-White (WPW) Syndrome:

A. Prolonged QT Interval
B. Delta Wave
C. Long PR interval
D. Peaked T waves

Answer: B

- **Answer: B. The Delta wave is a slurred upstroke in the QRS complex often associated with a short PR interval. It is most commonly associated with pre-excitation syndrome such as WPW. The other common findings are Short PR Interval and a broad QRS.**



Question #3

What sense can you make of this ECG

- Ventricular demand pacing, oversensing
- Ventricular demand pacing, normal function
- Ventricular demand pacing, under sensing
- Ventricular demand pacing, lead fractured

Answer: B

- **Answer: B Ventricular demand pacing, normal function. Pacemaker stimulus followed by a QRS complex of different morphology than intrinsic QRS. A VVI pacemaker senses and paces only in the ventricle and is oblivious to native atrial activity. Appropriately sensed ventricular activity resets pacemaker timing clock. After an interval of time with no sensed ventricular activity, a ventricular paced beat is delivered and a new cycle begins. A spontaneous QRS arising before the end of the V-V interval is sensed and the ventricular output of the pacemaker is inhibited. A new timing cycle begins.**

- O'Keefe, James H., et al. *The Complete Guide to ECGS: A Comprehensive Study Guide to Improve ECG Interpretation Skills*. Jones & Bartlett Learning, 2019.

Question #4

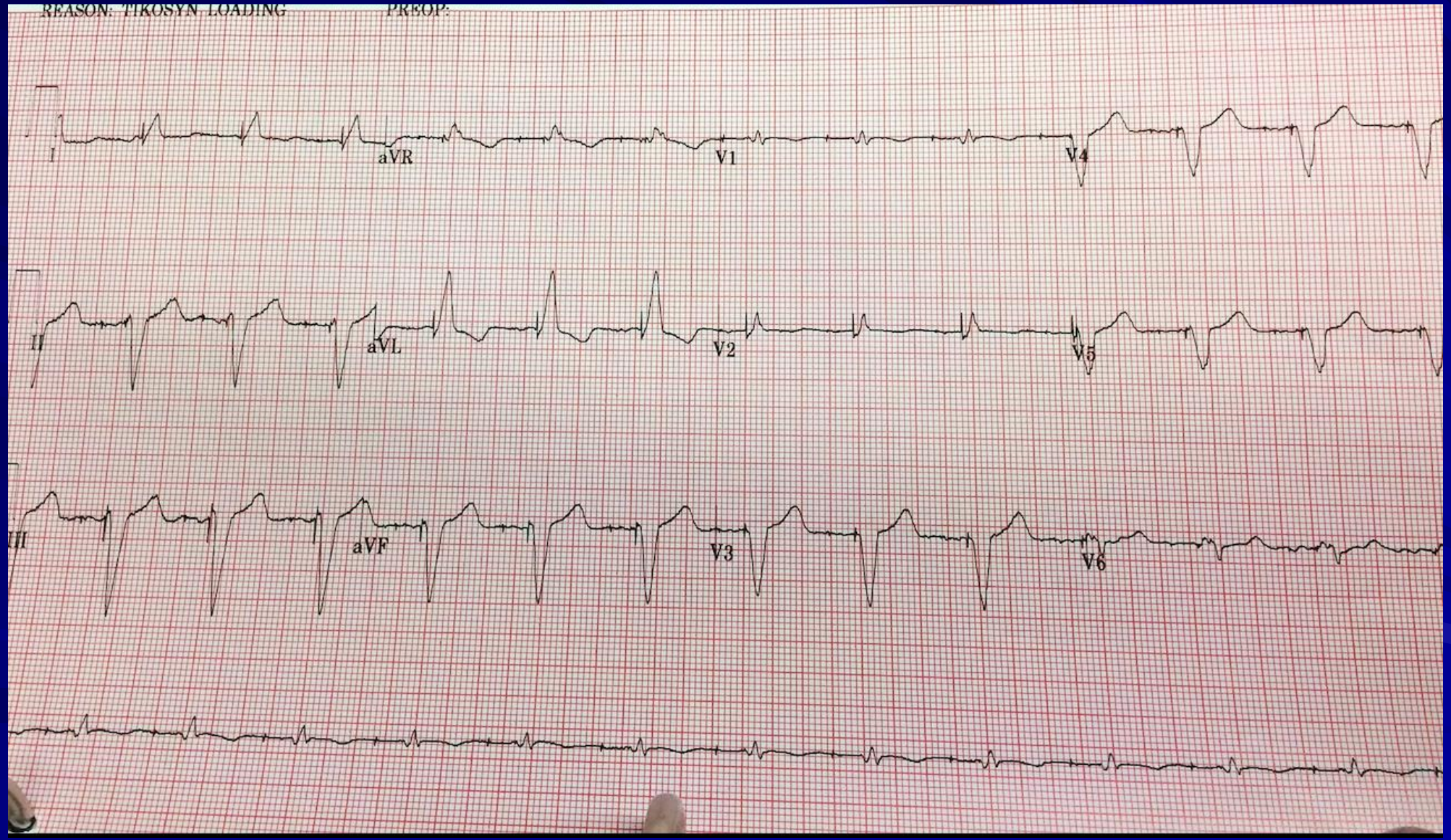
Pt is a 65 year old male with known coronary artery disease s/p PCI to LAD, ischemic cardiomyopathy s/p dual chamber ICD placement and paroxysmal atrial fibrillation. APP noticed an increase In atrial fibrillation burden from 1% to 30% with last ICD interrogation. Pt presents as a direct admit for Tikosyn loading. Why does the patient need to be monitored in the hospital for the first 5 doses of Tikosyn?

- QRS monitoring; risk of polymorphic ventricular tachycardia
- QRS monitoring; risk of monomorphic ventricular tachycardia
- QTc monitoring; risk of polymorphic ventricular tachycardia
- QTc monitoring; risk of monomorphic ventricular tachycardia

Answer: C

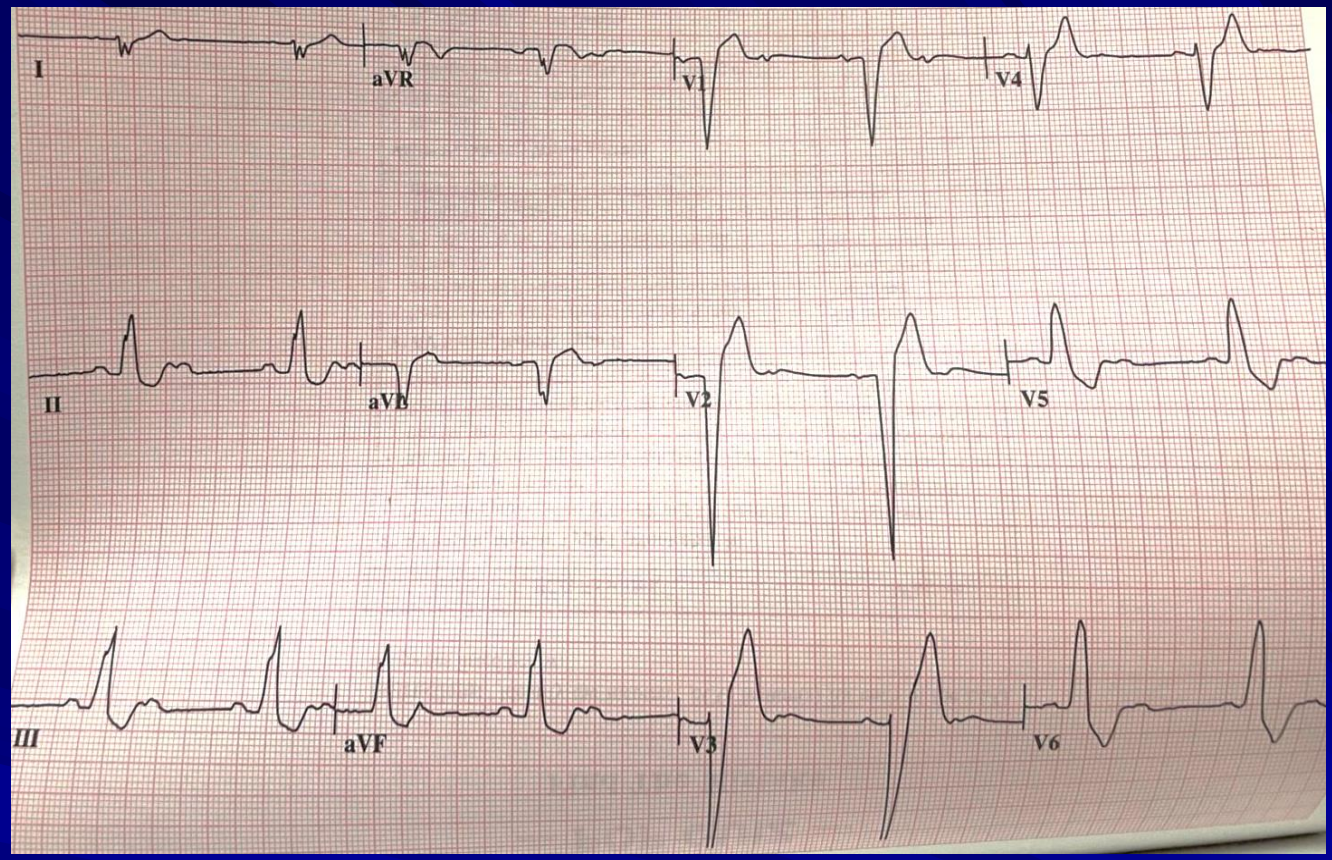
- **Answer: C**

QTc monitoring; risk of polymorphic ventricular tachycardia


REASON: TIKOSYN LOADING
PREOP:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

Question # 5

51 year-old F presenting with orthopnea and paroxysmal nocturnal dyspnea. What rhythm do you see here that may be the culprit of her symptoms?



- Mobitz Type I (Wenckeback)
- Mobitz Type II
- 2:1 AV block
- Sinus bradycardia with pre-atrial complex (PACs)

Answer: A

- **Answer: A. ECG shows sinus bradycardia with predominantly 2:1 AV block (arrowheads mark P waves), LBBB with secondary ST-T changes and right axis deviation. Close inspection reveals Mobitz Type I – the third P wave conducts at a normal PR interval, the fourth P wave at a prolonged PR interval, and the fifth P wave (hidden in the T wave) is blocked. The Q waves and ST elevation in leads V1-V3 are most likely due to LBBB, rather than acute anteroseptal MI (LBBB often results in a pseudoinfarct patter).**

Questions