Introduction to EKG's
The Basics

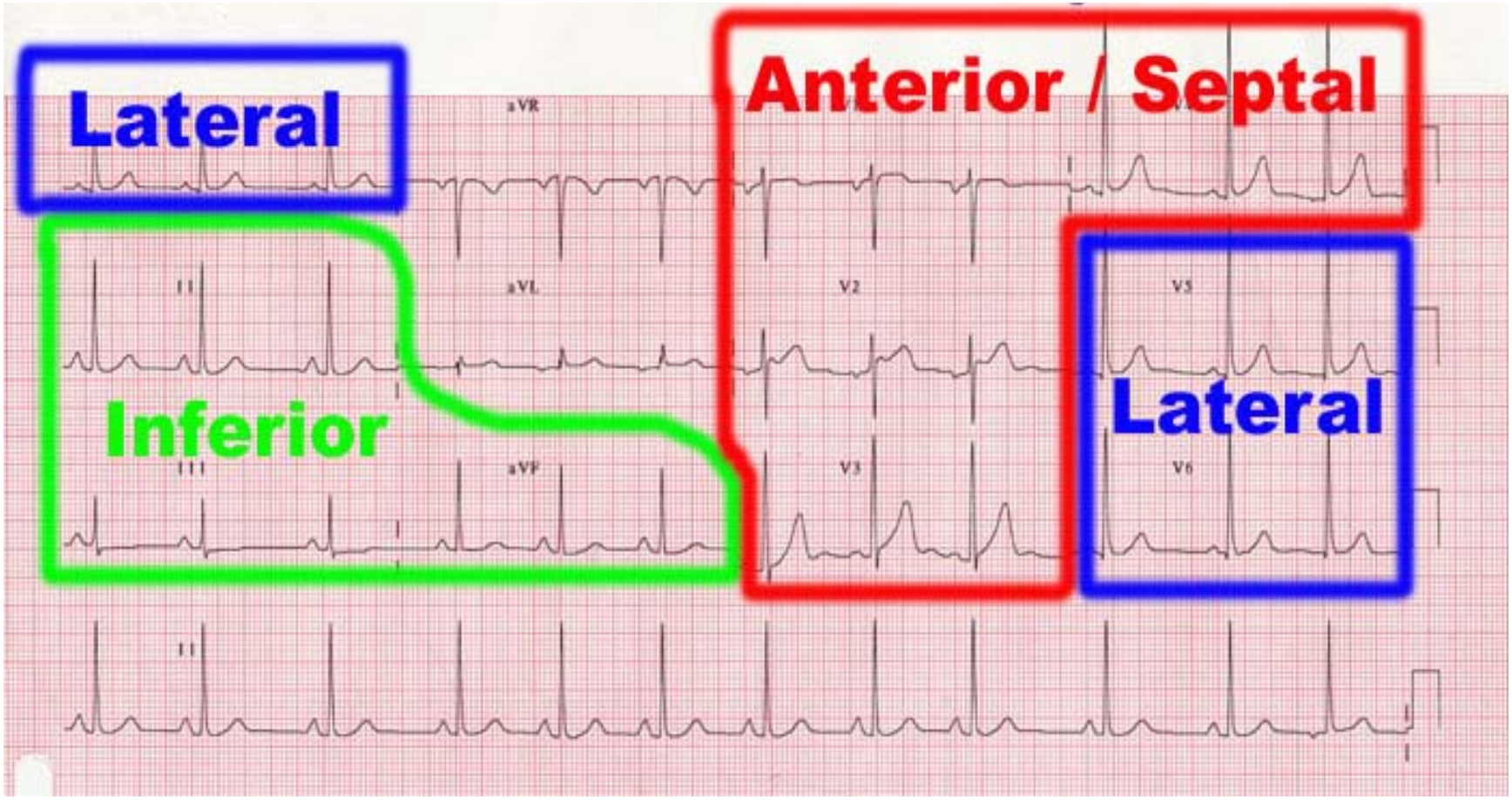
Sheri Tokarczyk, MS, PA-C

Introduction to EKG's

- August 8th: Basics
- August 15th : Review of Rate, Axis, Rhythm
- August 22nd : Conduction abnormalities; Chamber enlargement
- **August 29th: Ischemia, Injury, Infarct, Practice EKG's**

Myocardial Infarctions

- EKG designation
  -Inferior Wall MI: Leads II, III, AVF
  -Anterior Wall MI: Precordial/chest Leads
    Anteroseptal: V1, V2
    Anteroapical: V3, V4
    Anterlateral: V5, V6, Leads I and AVL
  -Posterior Wall MI
    V1: increased R to S ratio of >=1


Lateral
Anterior / Septal
Inferior
Lateral
aVR
I
II
aVL
V2
V5
III
aVF
V3
V6
II

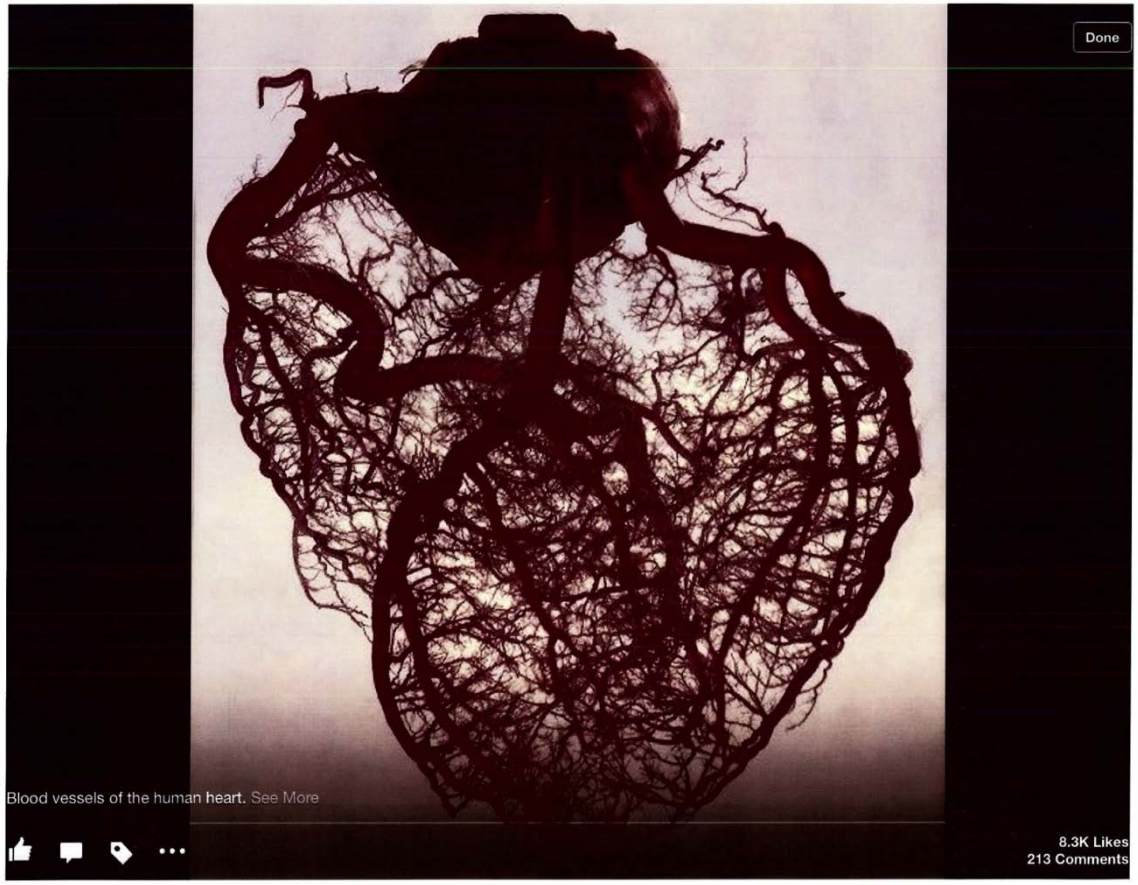
Coronary Arteries

- **LEFT MAIN (widow maker)**: Supplies entire anterior wall of the heart

  Bifurcates into the Left Anterior Descending (LAD) and the Circumflex artery.

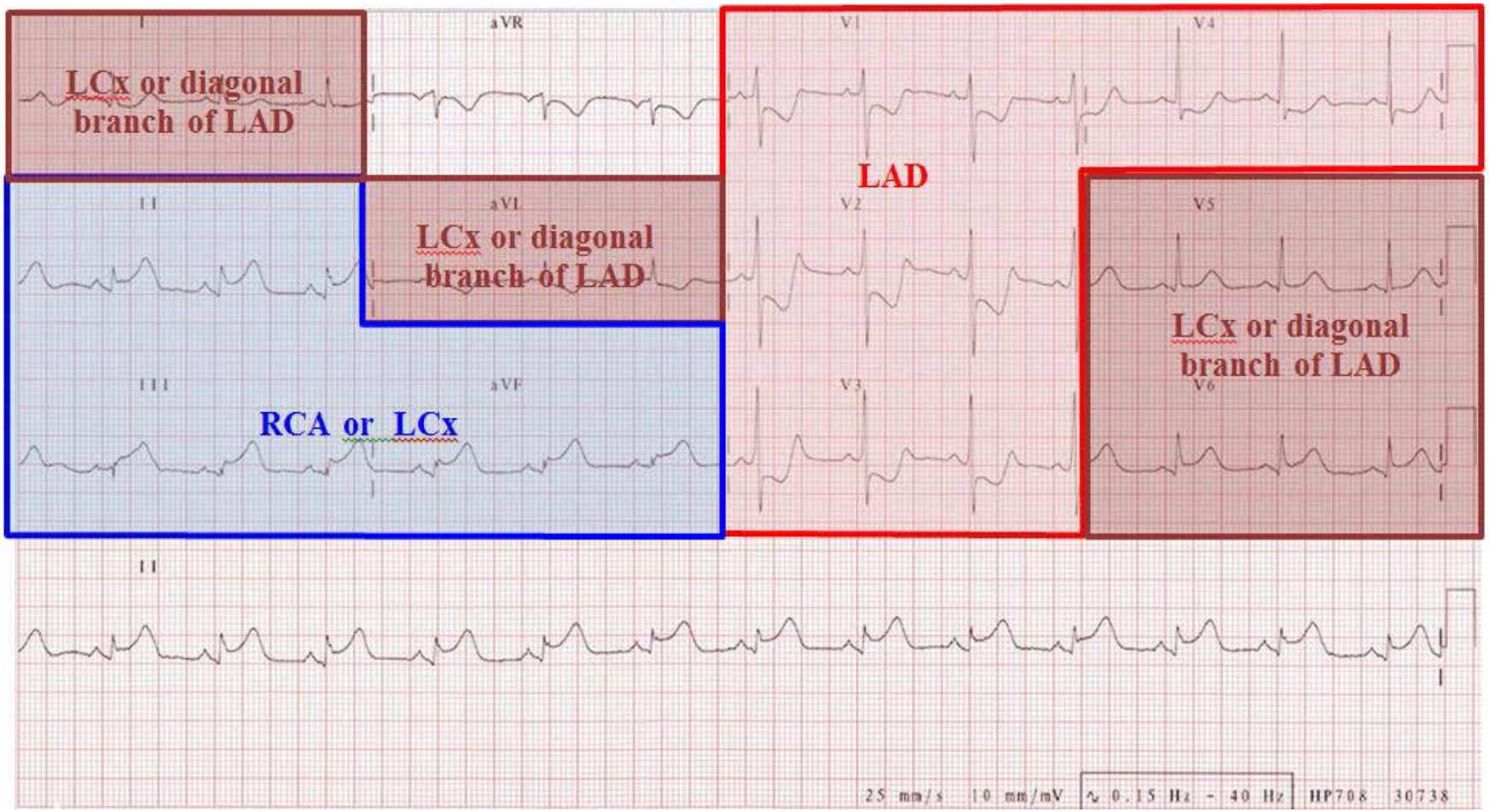
- Right Coronary Artery (RCA): Supplies the inferior wall of the heart

CORONARY ARTERIES



RCA dominant in most humans:

Dominance determined by vessel giving off branch to the AV node



Blood Supply to the Conduction

- Sinus node and SA region : 55% by RCA and 45% LCx
- AV node and proximal His: 90 RCA.
- Distal His, RBB and AF by septal branches of LAD
- Posterior fascicle by septal branches of RCA/LAD

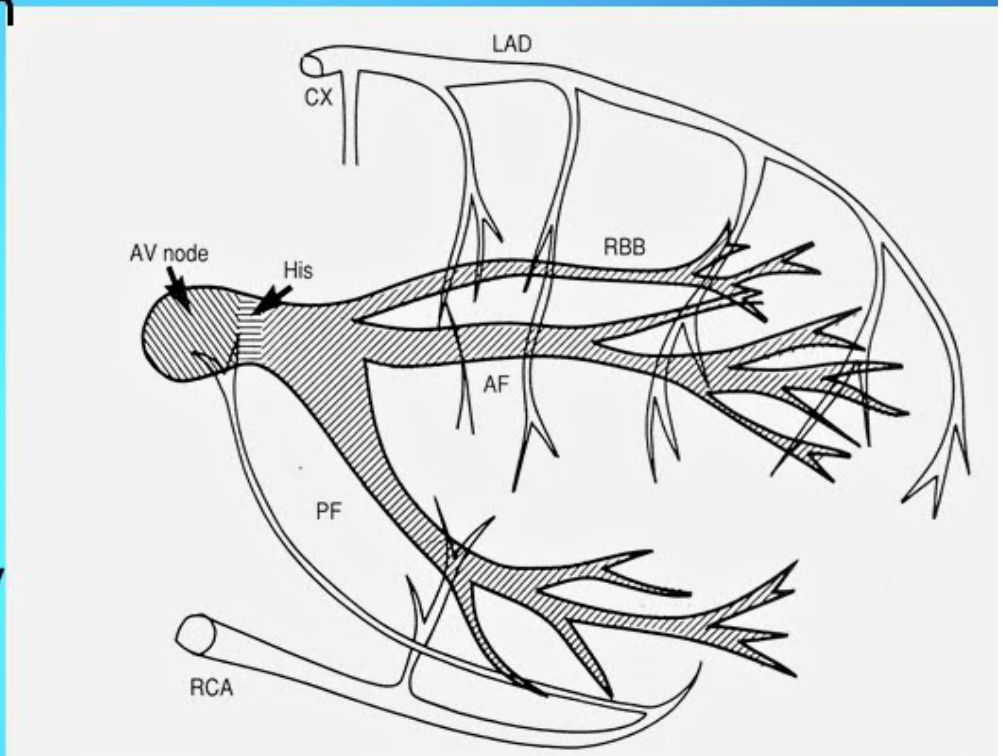
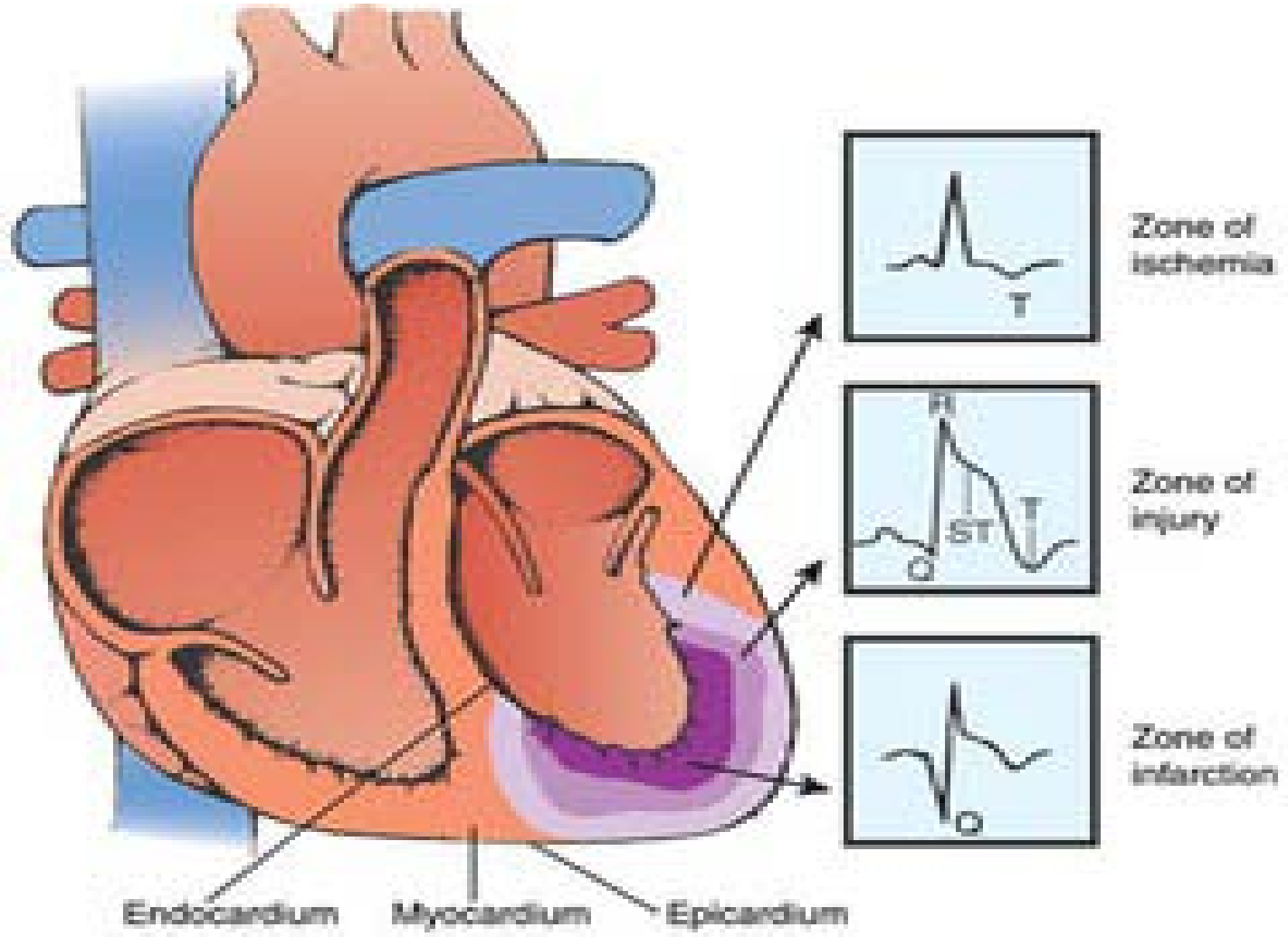


Figure 1-23 Scheme of the blood supply to the AV conduction system. *AF*, anterior fascicle; *PF*, posterior fascicle; *His*, His bundle; *RBB*, right bundle branch.

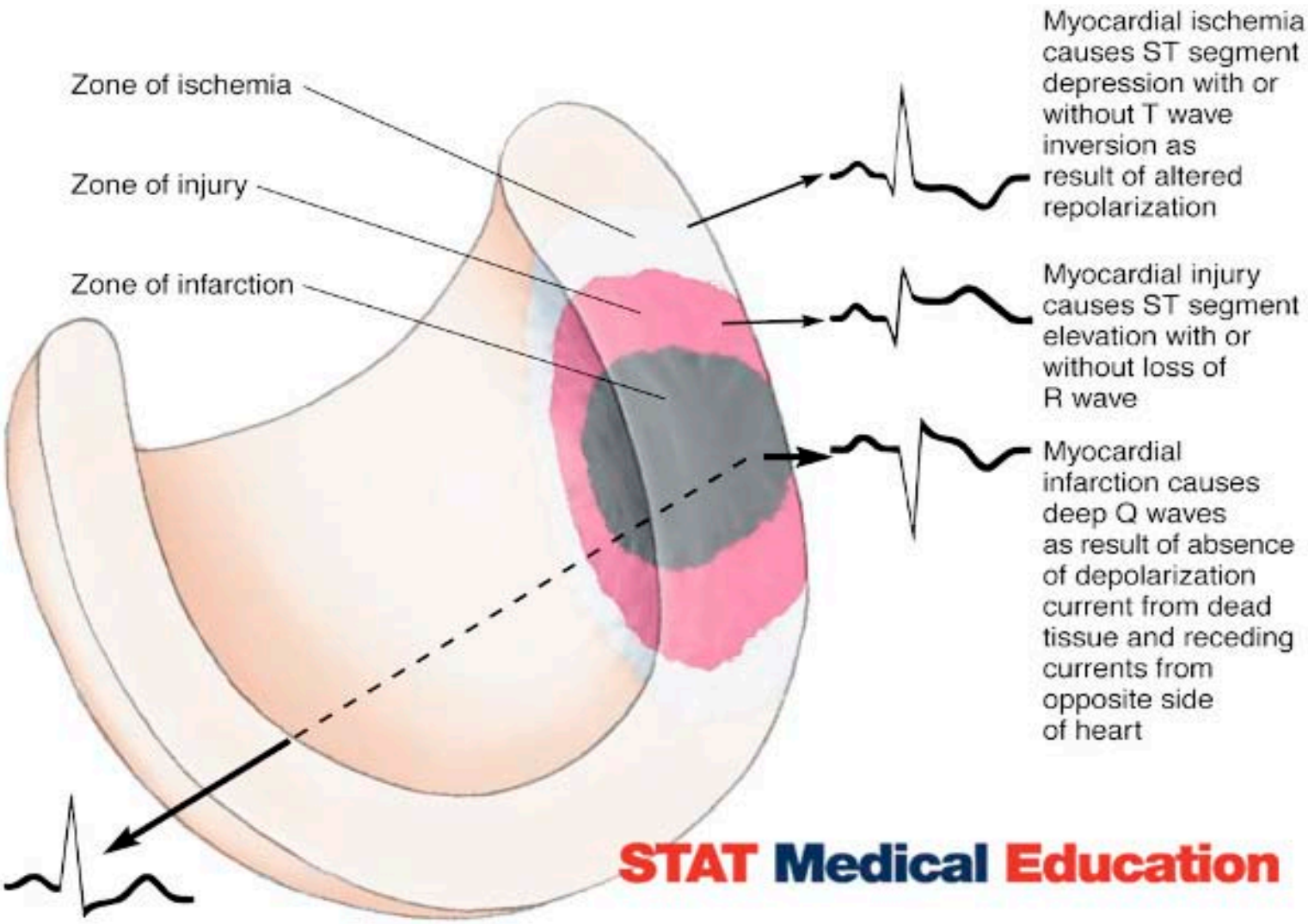
ISCHEMIA, INJURY, INFARCT

- **Ischemia:** Characterized by J-point depression of 1mm or more below the baseline with Upsloping, horizontal or downsloping ST segment depression of 2mm or more at .08 sec past J-point.
- **Injury:** Characterized by J-point elevation with ST segment elevation
- **Infarct:** ST segment elevation with evolving changes; Q-waves (transmural) or deep, inverted, symmetrical T-waves (Subendocardial)

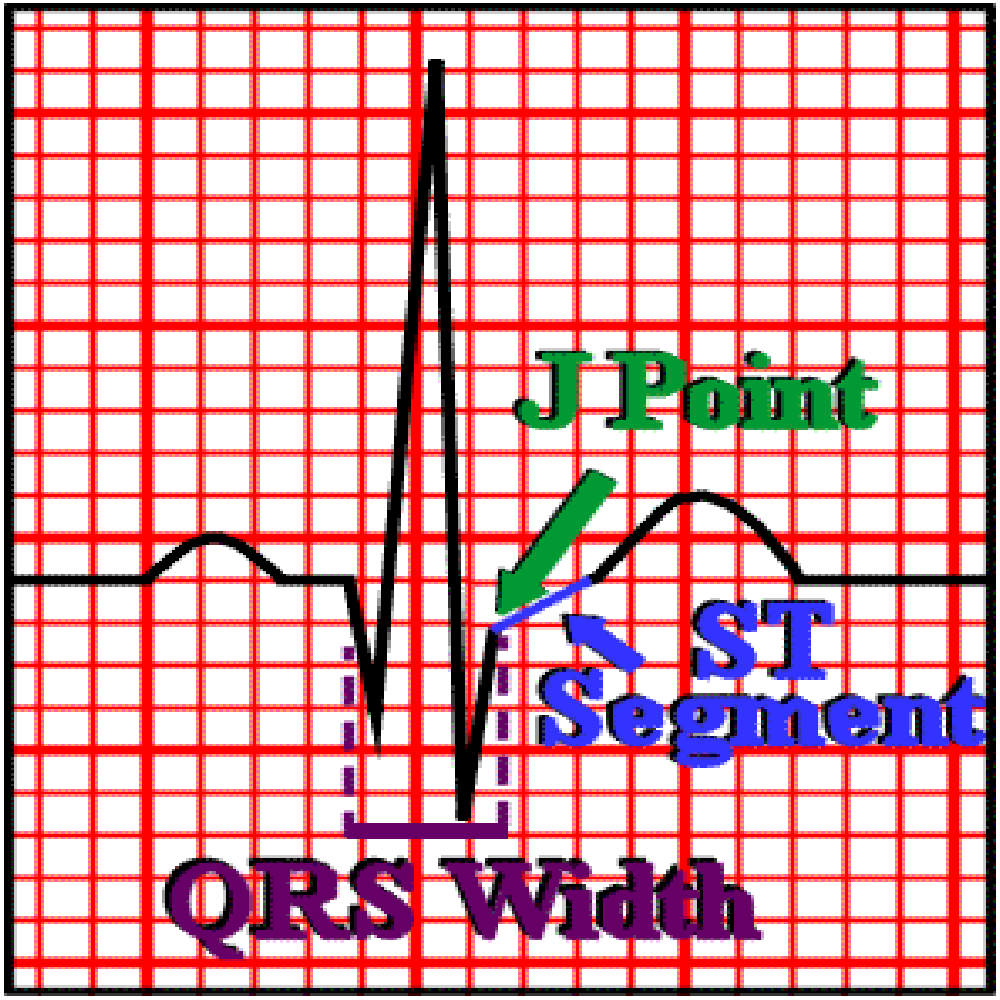
Ischemia, Injury, Infarct



ISCHEMIA


Zone of ischemia
Zone of injury
Zone of infarction
Myocardial ischemia causes ST segment depression with or without T wave inversion as result of altered repolarization
Myocardial injury causes ST segment elevation with or without loss of R wave
Myocardial infarction causes deep Q waves as result of absence of depolarization current from dead tissue and receding currents from opposite side of heart
STAT Medical Education

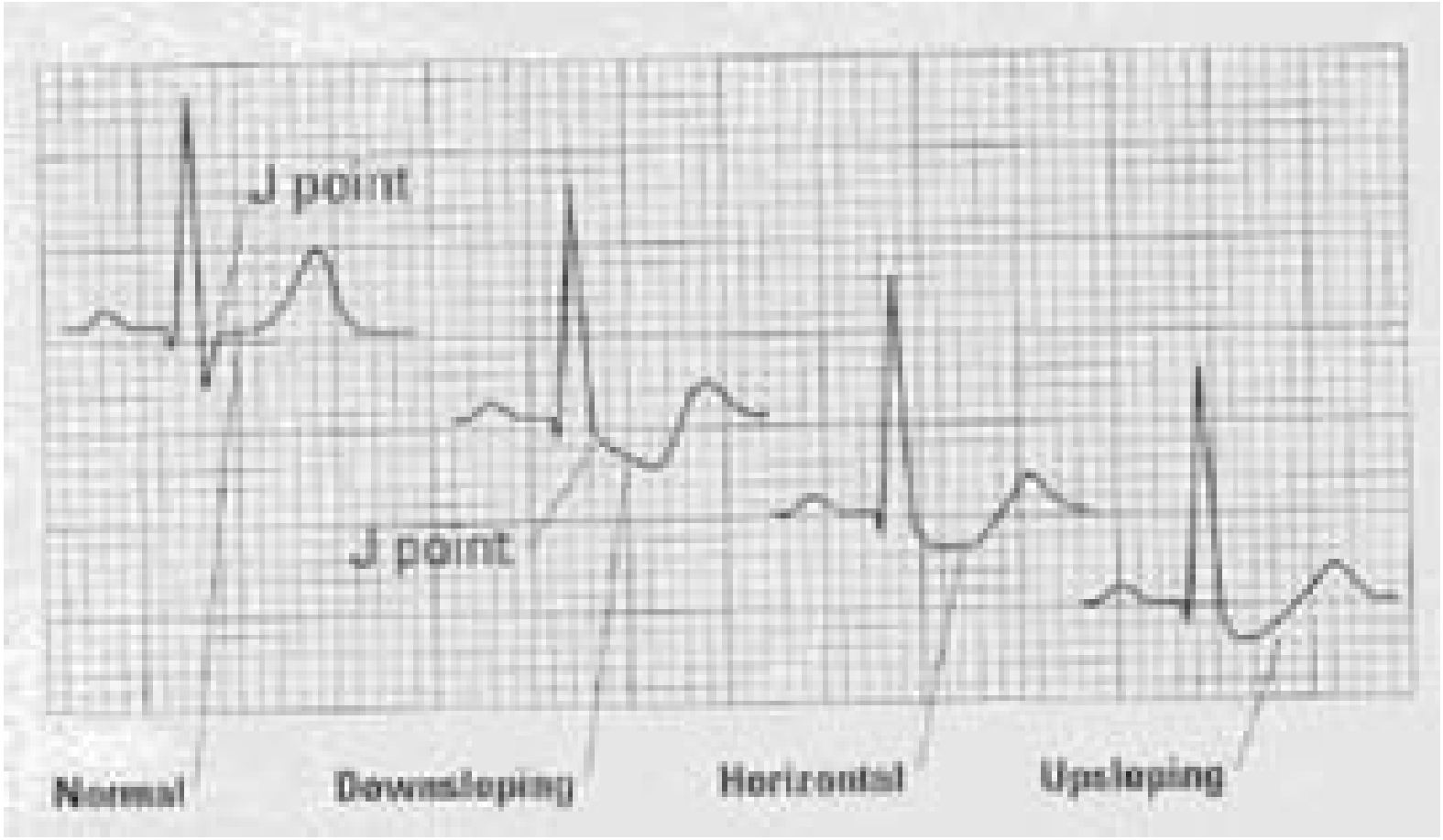
Review of QRS, J-point and ST segment



Determining significance of ST depression

- Find the J-point
- Measure .08 sec (two small boxes) to the right
- If the ST segment is depressed at least 1 mm (1 small box) it is considered significant possible ischemic changes.

ST Depression
Upsloping, horizontal, or downsloping



How do I know when to be concerned?

- Upsloping ST segment depression is of concern
- Horizontal ST segment depression is of more concern
- Downsloping ST segment depression is of greatest concern
- NOTE: clinical correlation is ALWAYS required

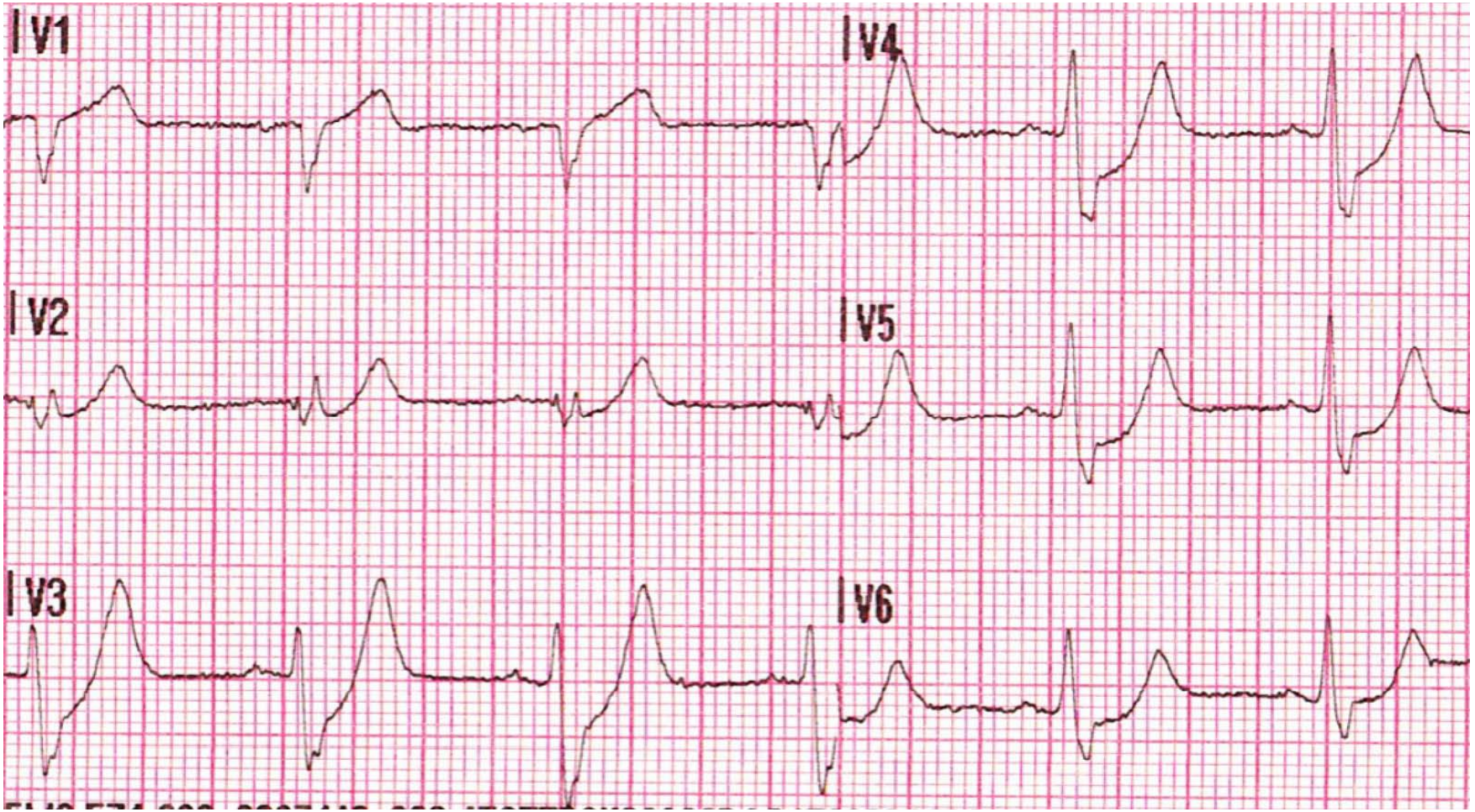
Additional factors

- ST depression is of greater concern when you see it with minimal amounts of exertion (lower heart rates) when compared to peak exertion
- ST depression is of greater concern when it takes longer to return to baseline after exercise
- ST depression is of greatest concern when changes continue to occur after exertion is terminated

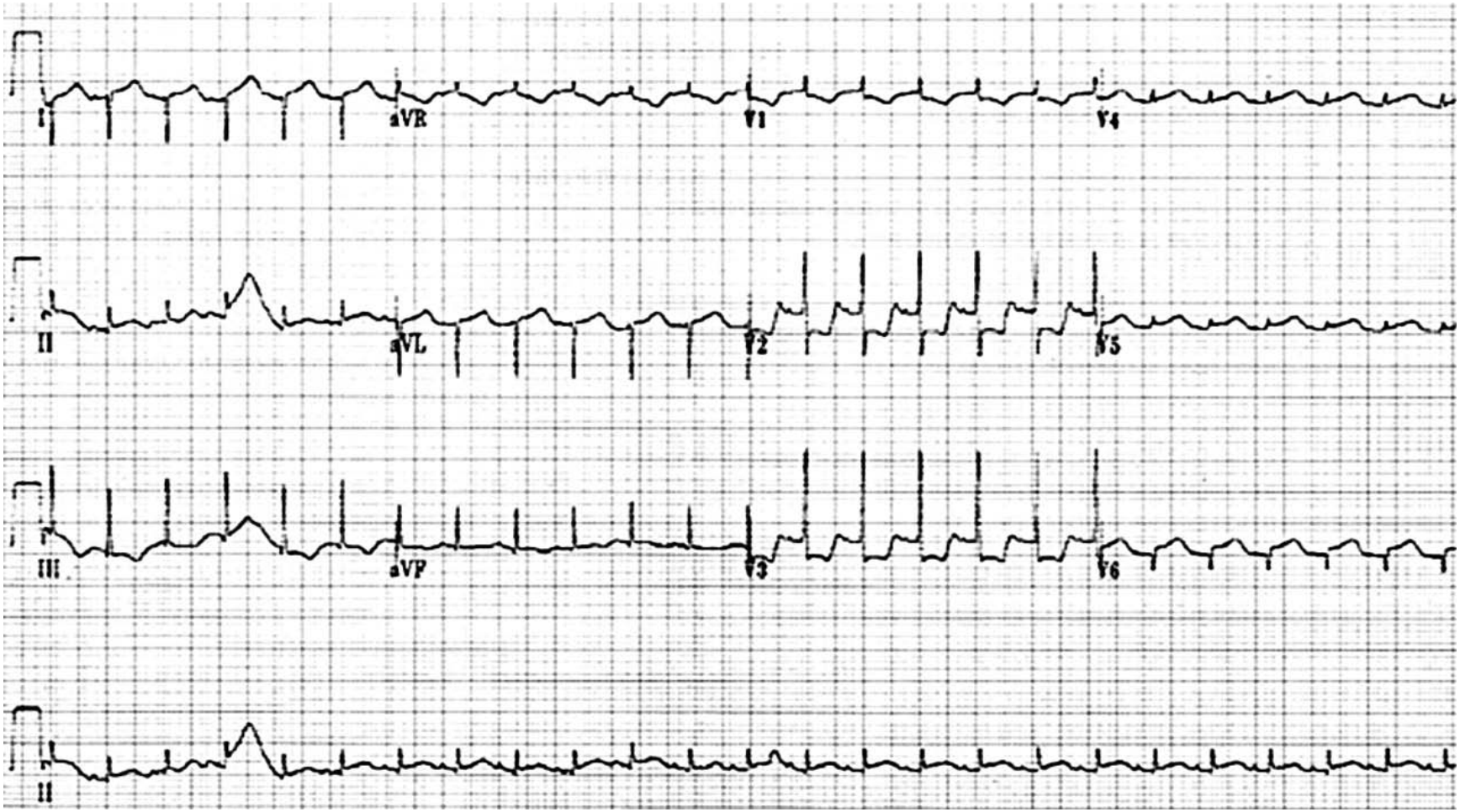
But clinical correlation is ALWAYS required

- Always monitor the patient
  - Vitals
  - Symptoms
  - Just the way the patient looks:
    - Pallor, sweating, ashen

Up sloping ST depression

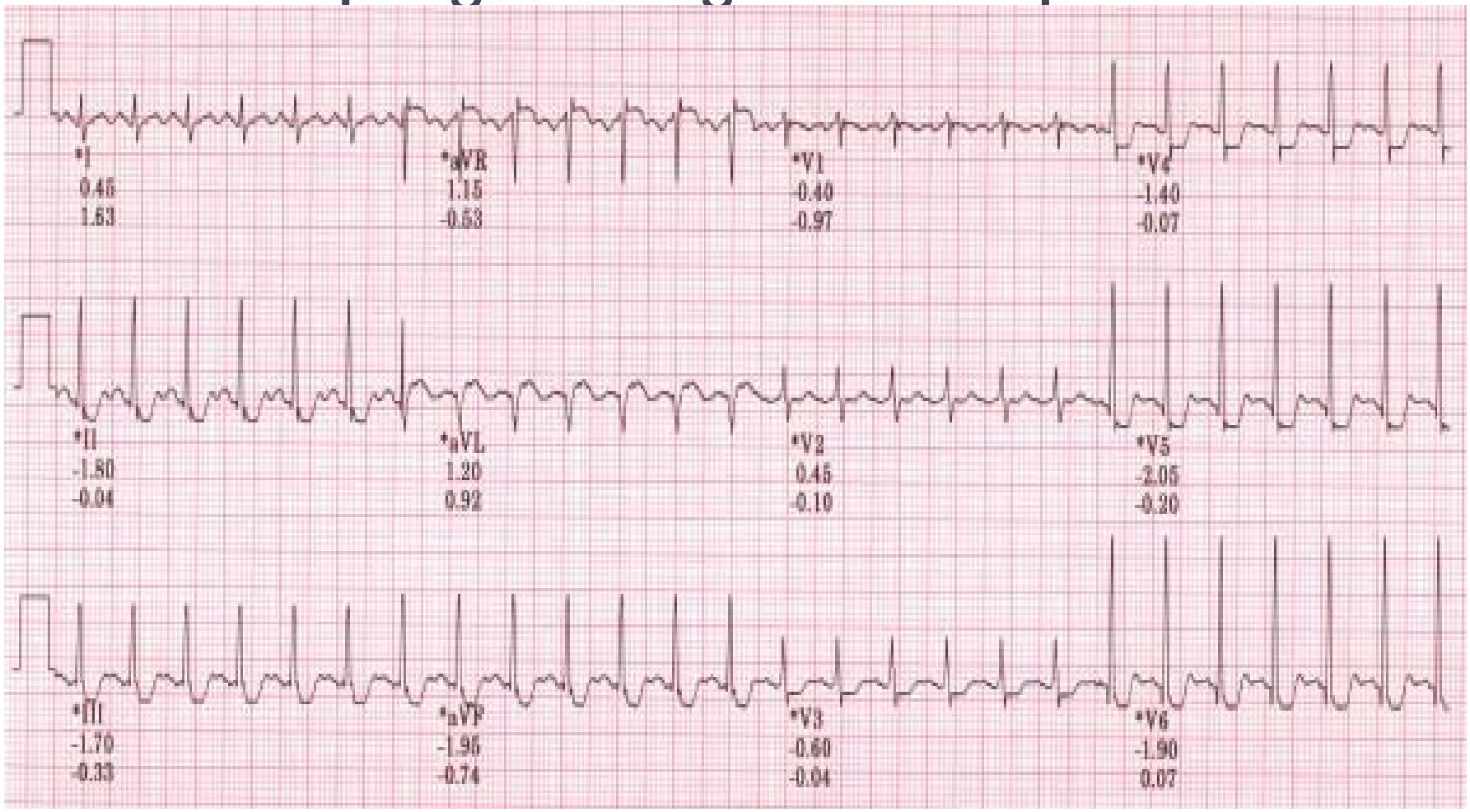


Horizontal ST Segment Depression

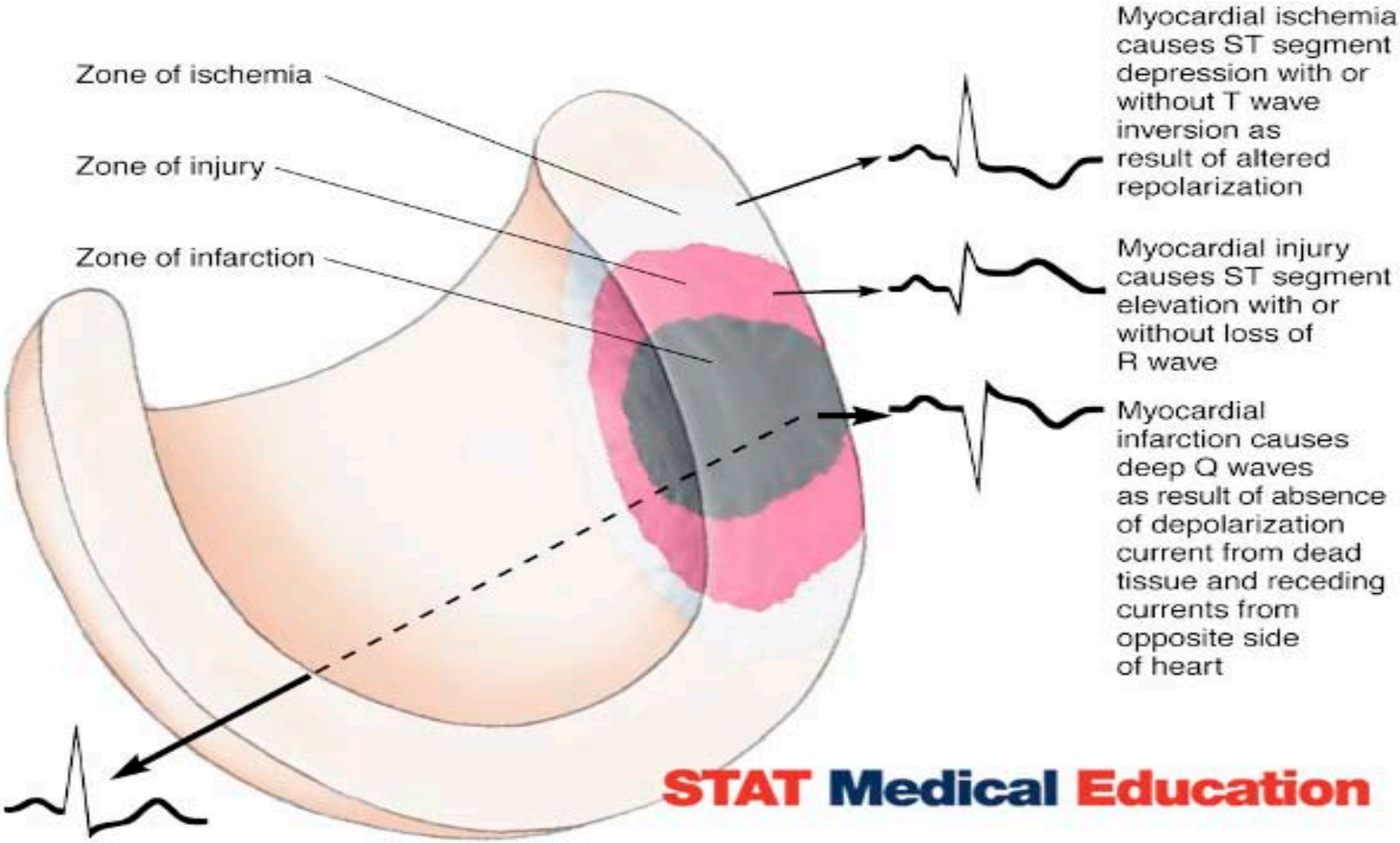


Note posterolateral MI

Downsloping ST Segment Depression



INJURY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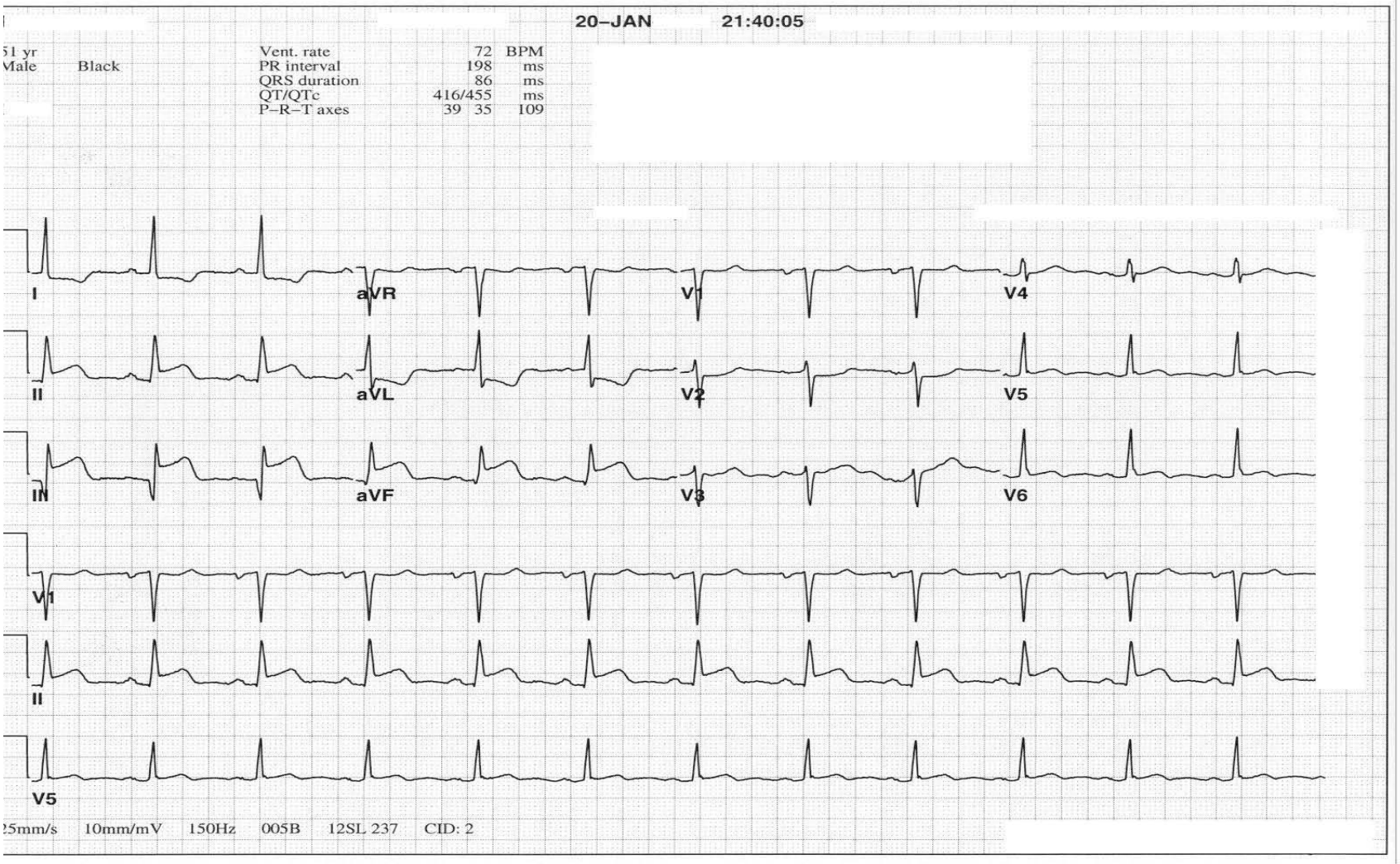
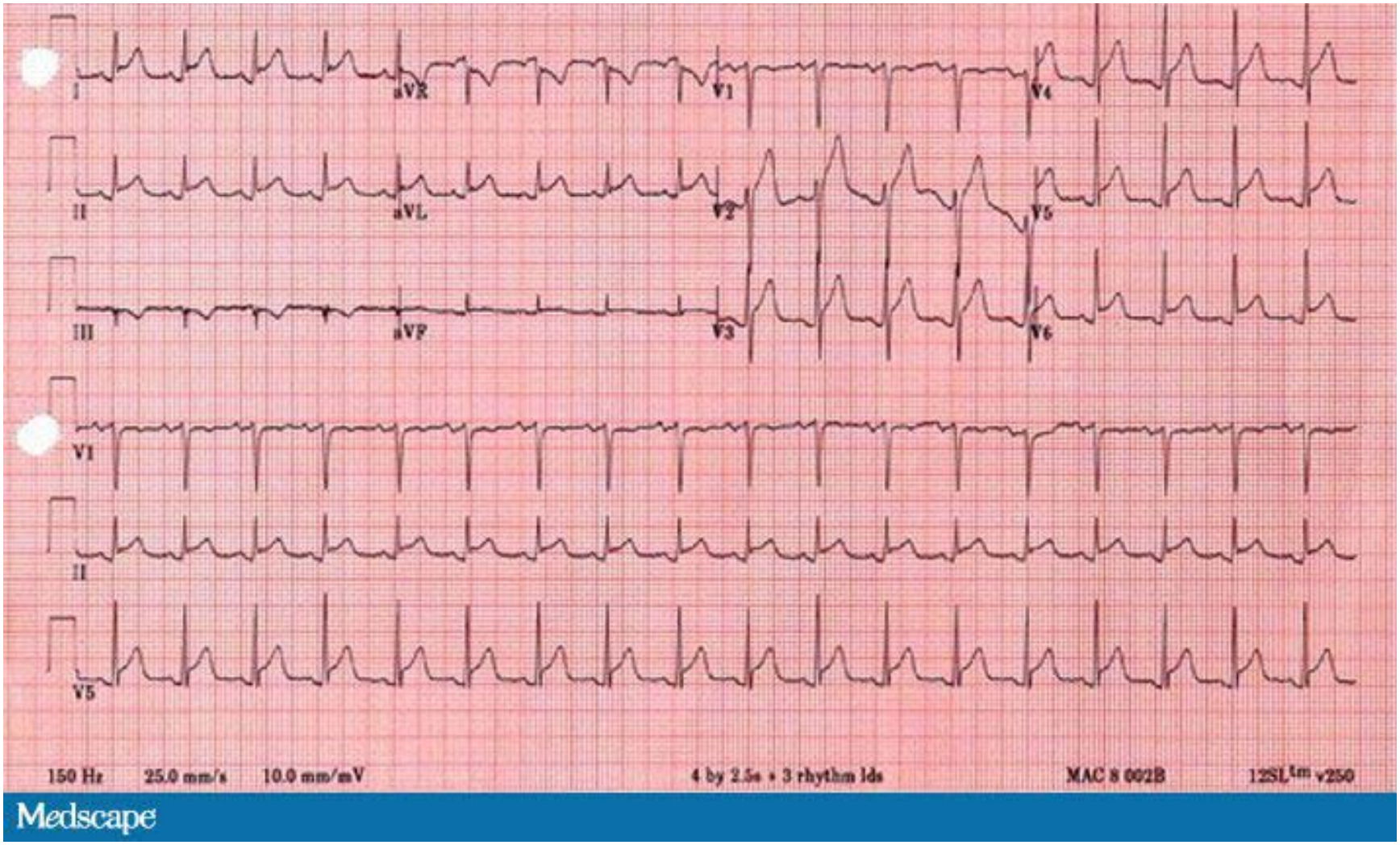
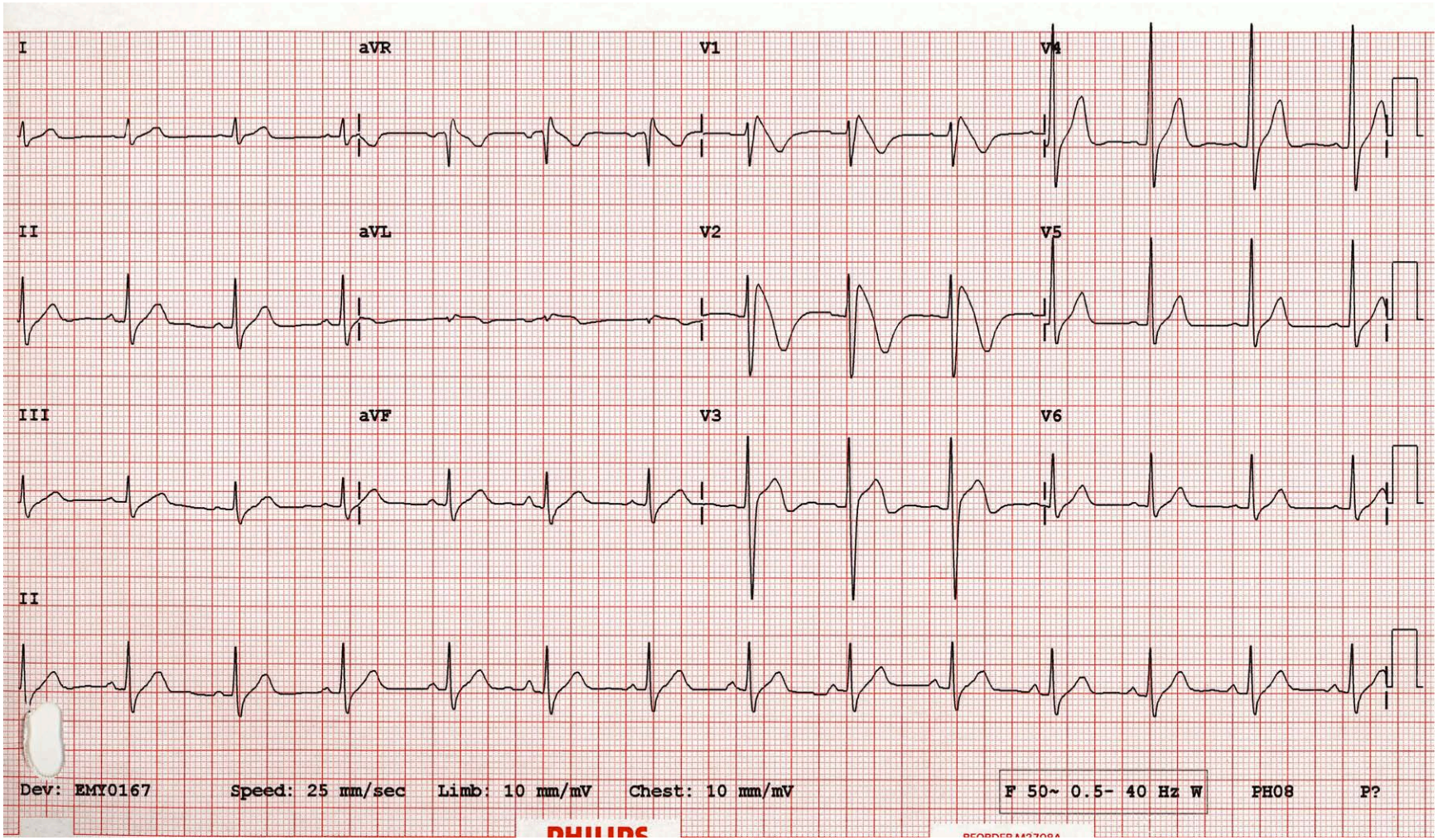
INJURY


20–JAN 21:40:05
51 yr
Male Black
Vent. rate 72 BPM
PR interval 198 ms
QRS duration 86 ms
QT/QTc 416/455 ms
P–R–T axes 39 35 109
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV 150Hz 005B 12SL 237 CID: 2

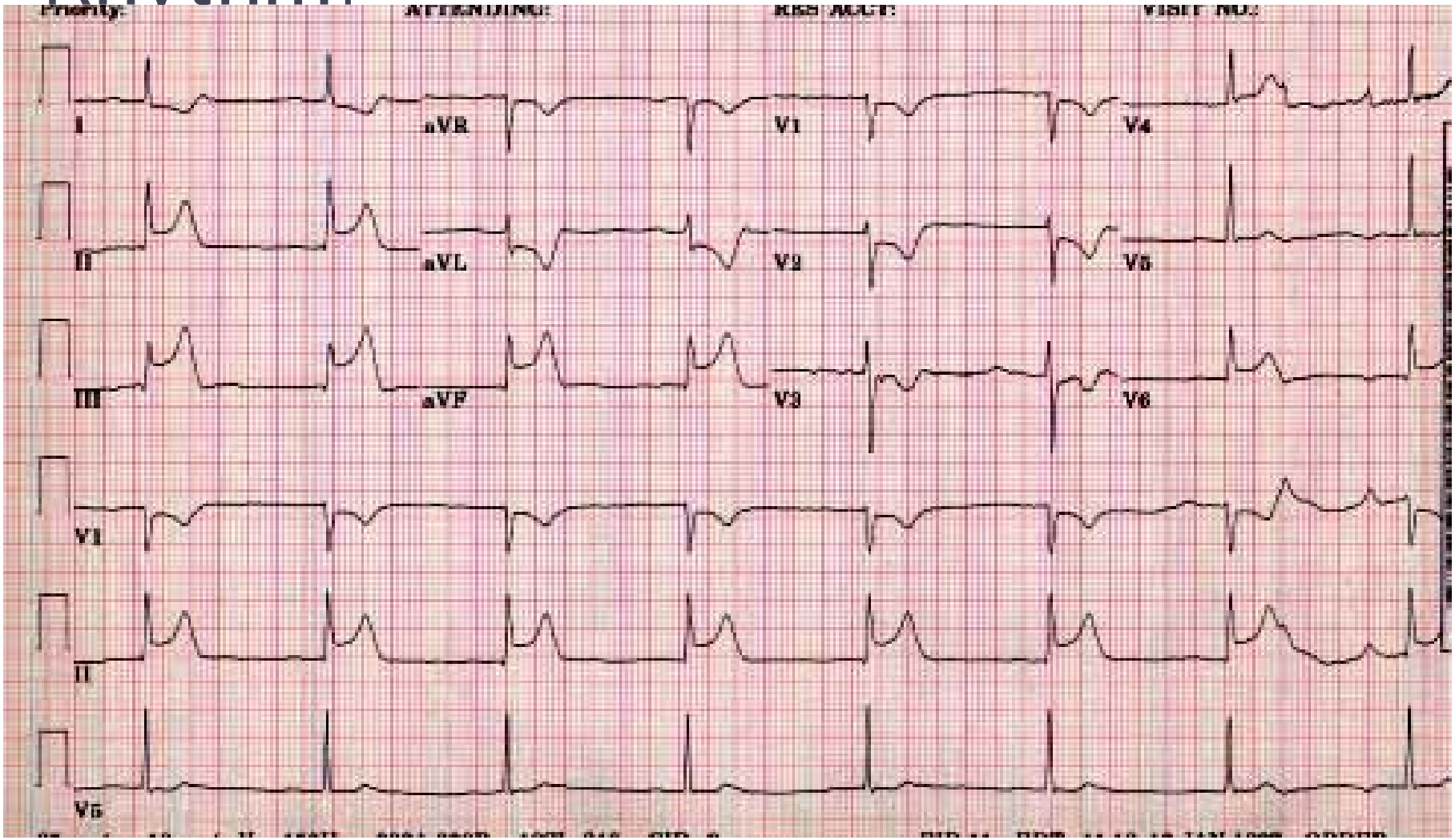
INJURY due to acute pericarditis



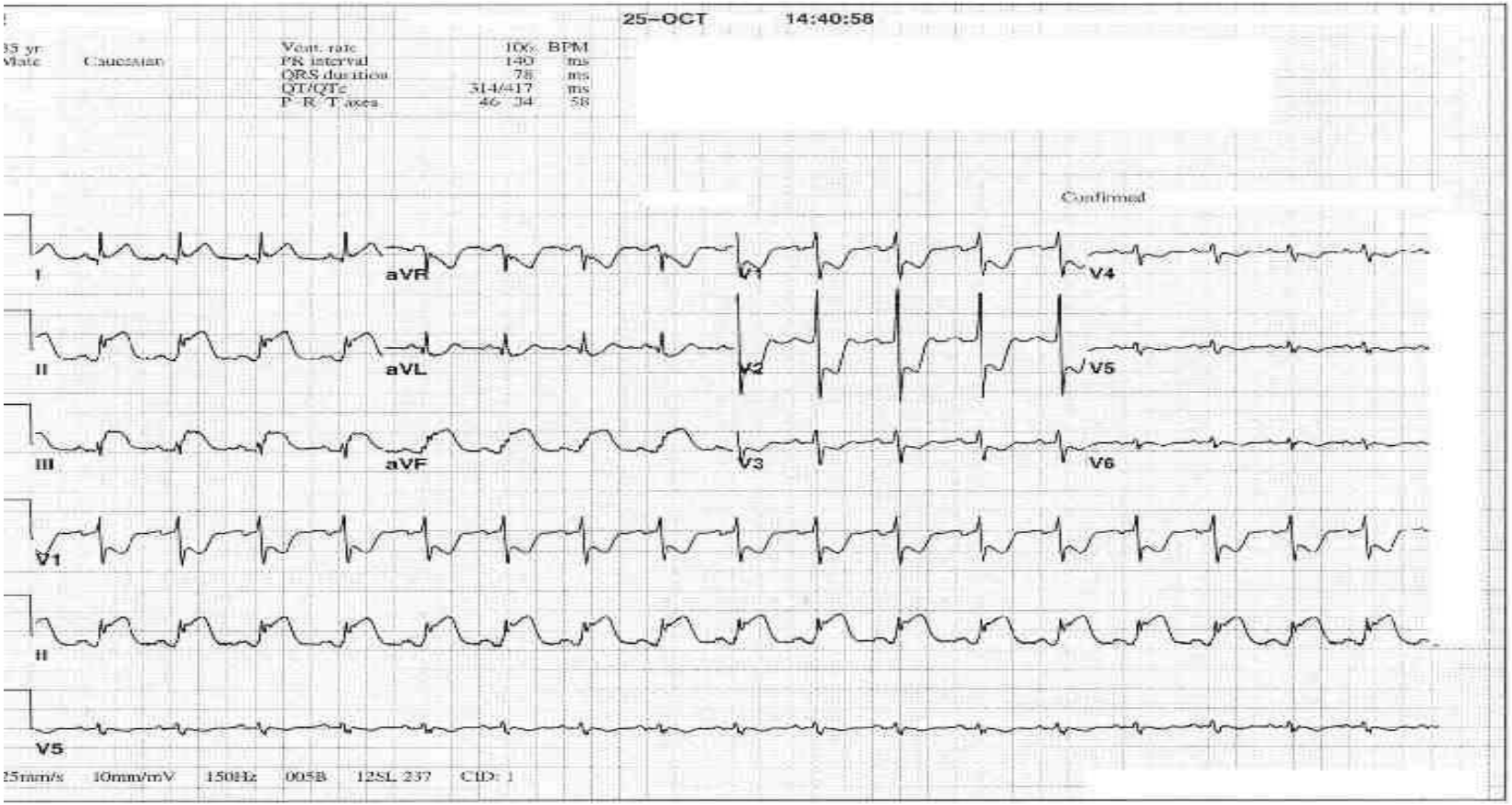
INJURY


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Dev: EMY0167
Speed: 25 mm/sec
Limb: 10 mm/mV
Chest: 10 mm/mV
F 50~ 0.5- 40 Hz W
PH08
P?
PHILIPS

Acute Inferolateral Injury with Reciprocal Changes: Early inf-lat MI. Rhythm?



Injury pattern with reciprocal changes



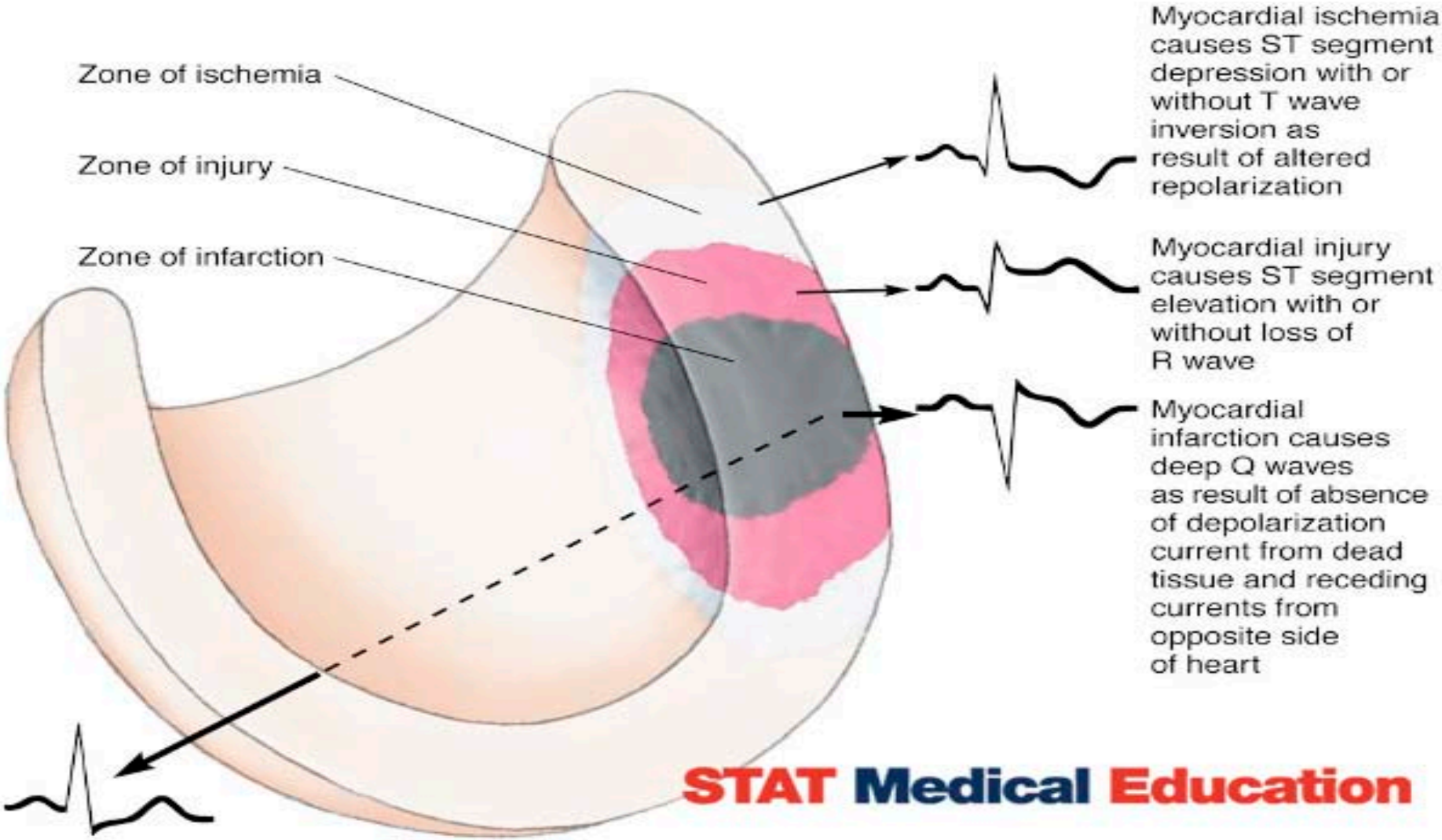
What are reciprocal changes?

- when ST segment elevation is present in leads that face the acute injury, ST segment depression will often be present in leads that face the "ischemic boundary".

SITE	FACING	RECIPROCAL
SEPTAL	V1, V2	NONE
ANTERIOR	V3, V4	NONE
ANTEROSEPTAL	V1, V2, V3, V4	NONE
LATERAL	I, aVL, V5, V6	II, III, aVF
ANTEROLATERAL	I, aVL, V3, V4, V5, V6	II, III, aVF
INFERIOR	II, III, aVF	I, aVL
POSTERIOR	NONE	V1, V2, V3, V4

ems12lead.blogspot.com

INFARCT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MYOCARDIAL INFARCTIONS

- **Transmural (full thickness)**

  Significant Q waves on EKG (greater than 25% of the height of the R wave)

- **Subendocardial (partial thickness)**

  Symmetrically inverted T waves on EKG

Subendocardial vs Transmural MI

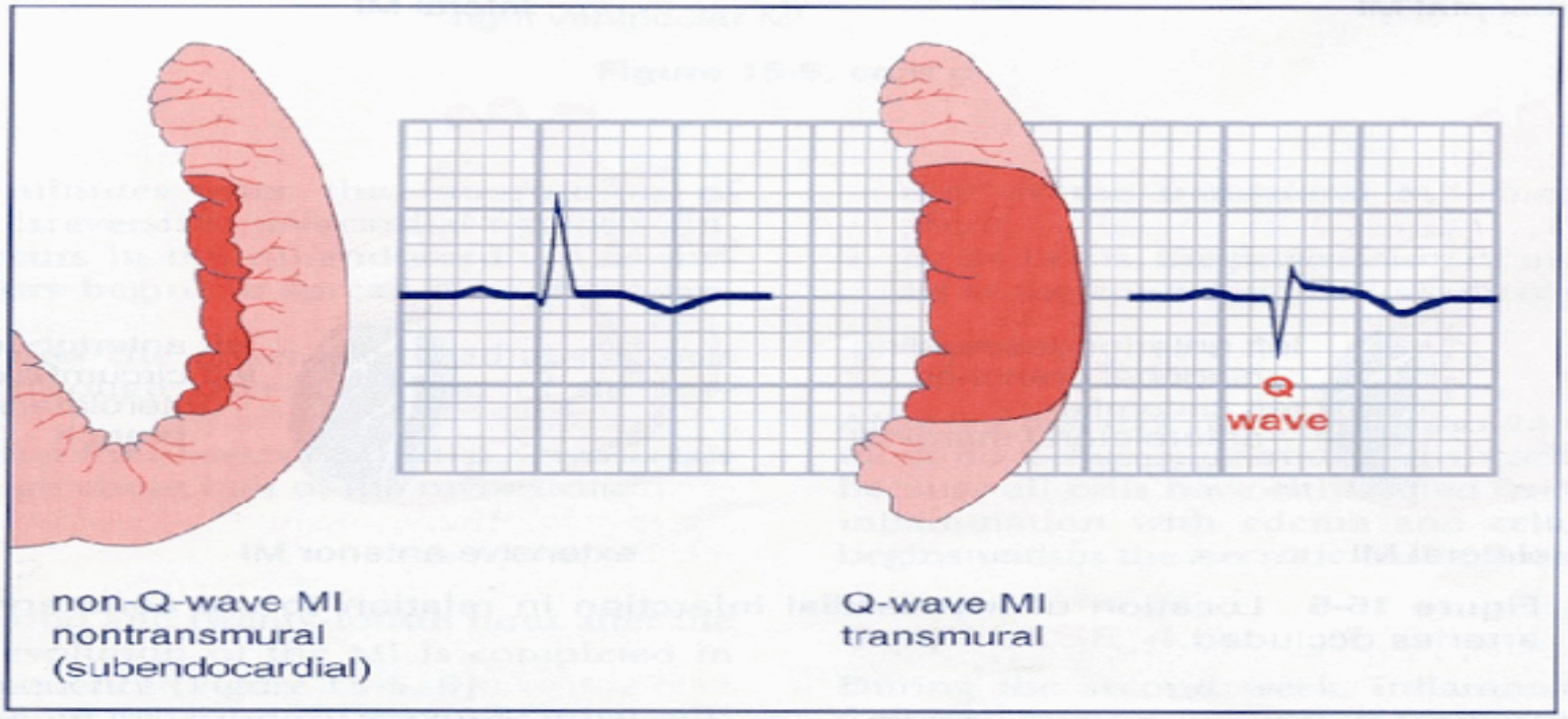
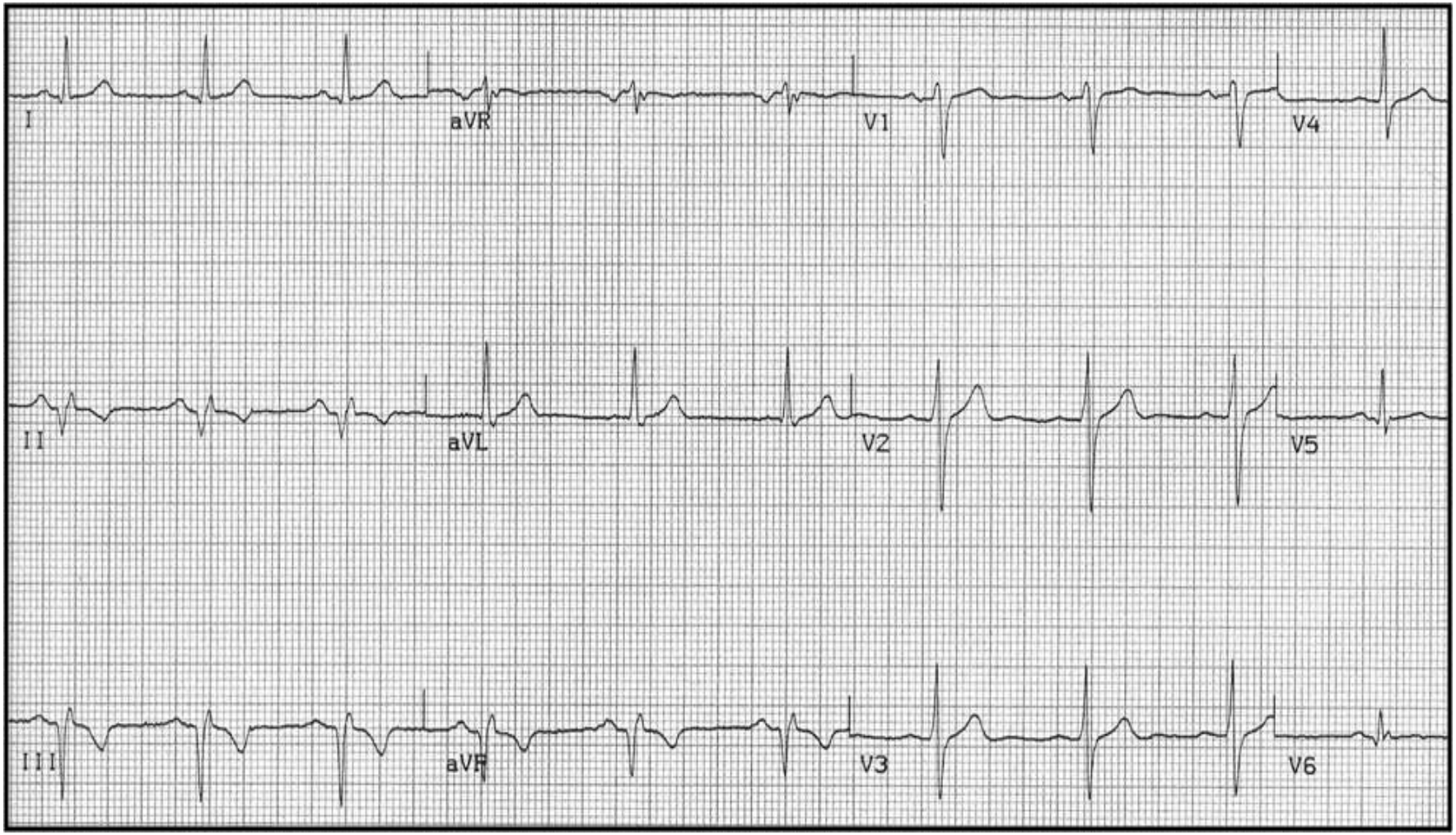
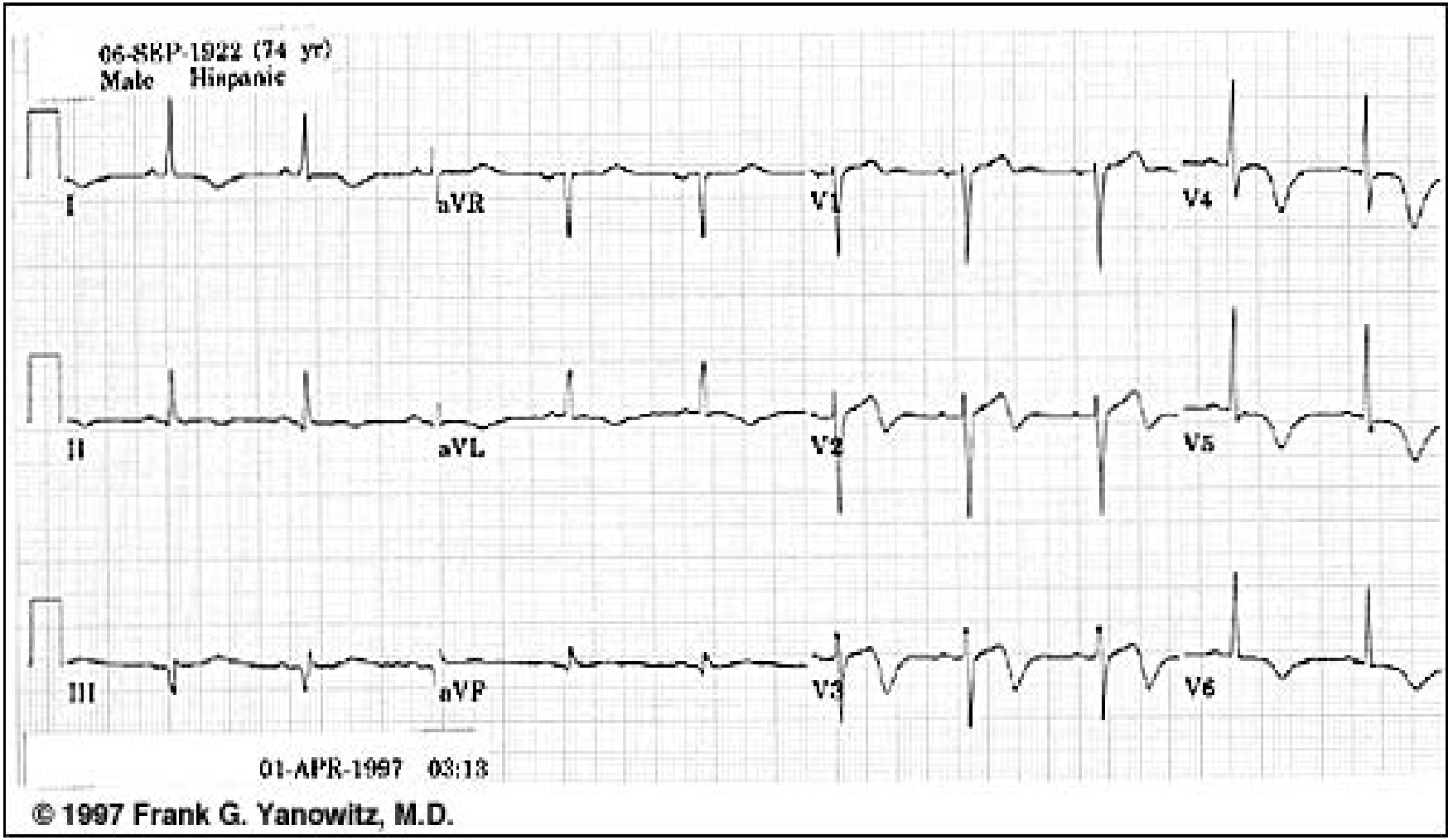


Figure 15-4 A subendocardial (non-Q-wave) versus a transmural (Q-wave) myocardial infarction.

Transmural Inferior Wall MI



Subendocardial (non-Q wave) Anterior Wall MI



Myocardial Infarctions

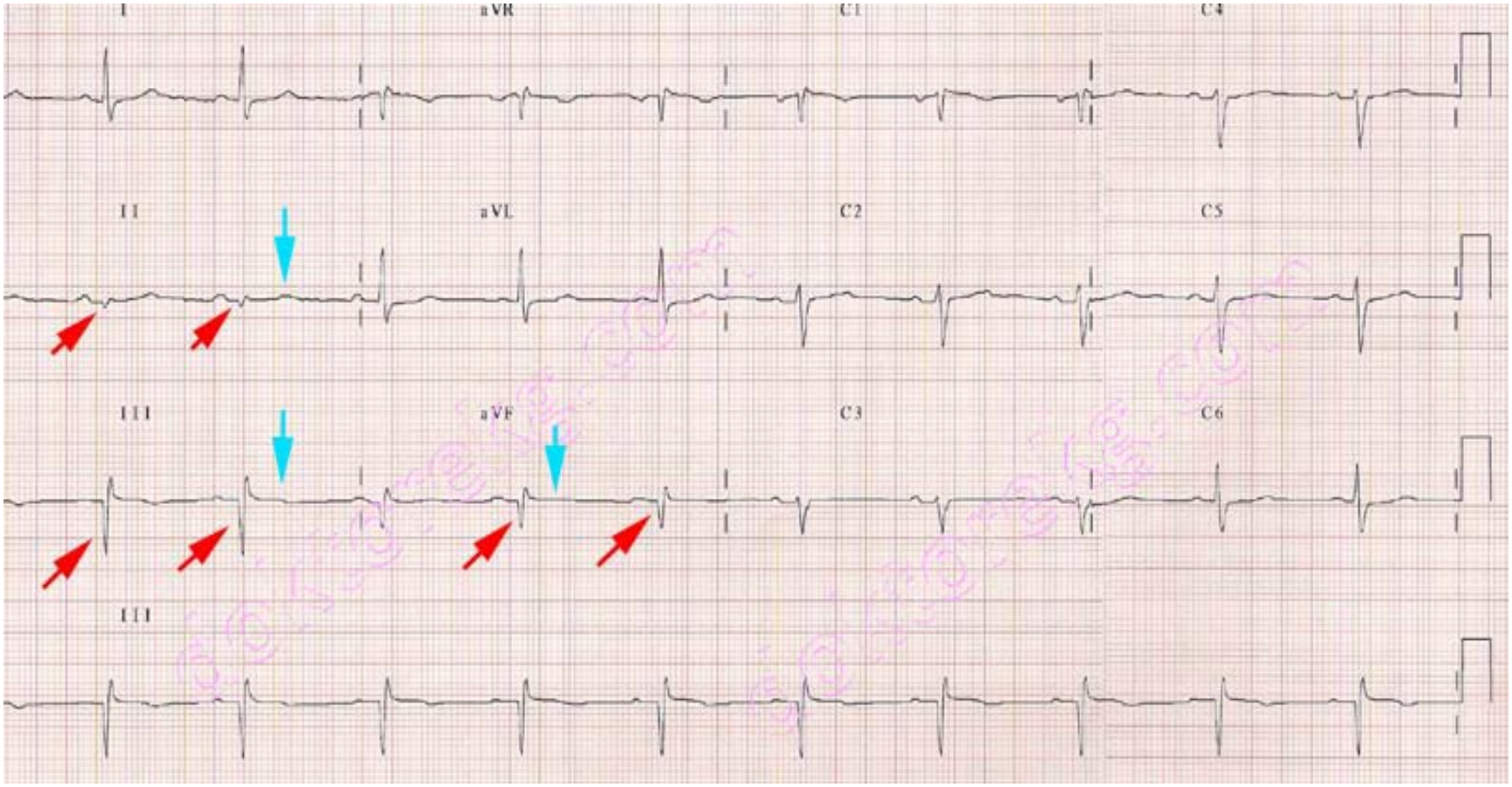
- Locations
  - Inferior Wall
  - Anterior Wall
  - Lateral Wall
  - Posterior Wall

INFERIOR WALL MI's

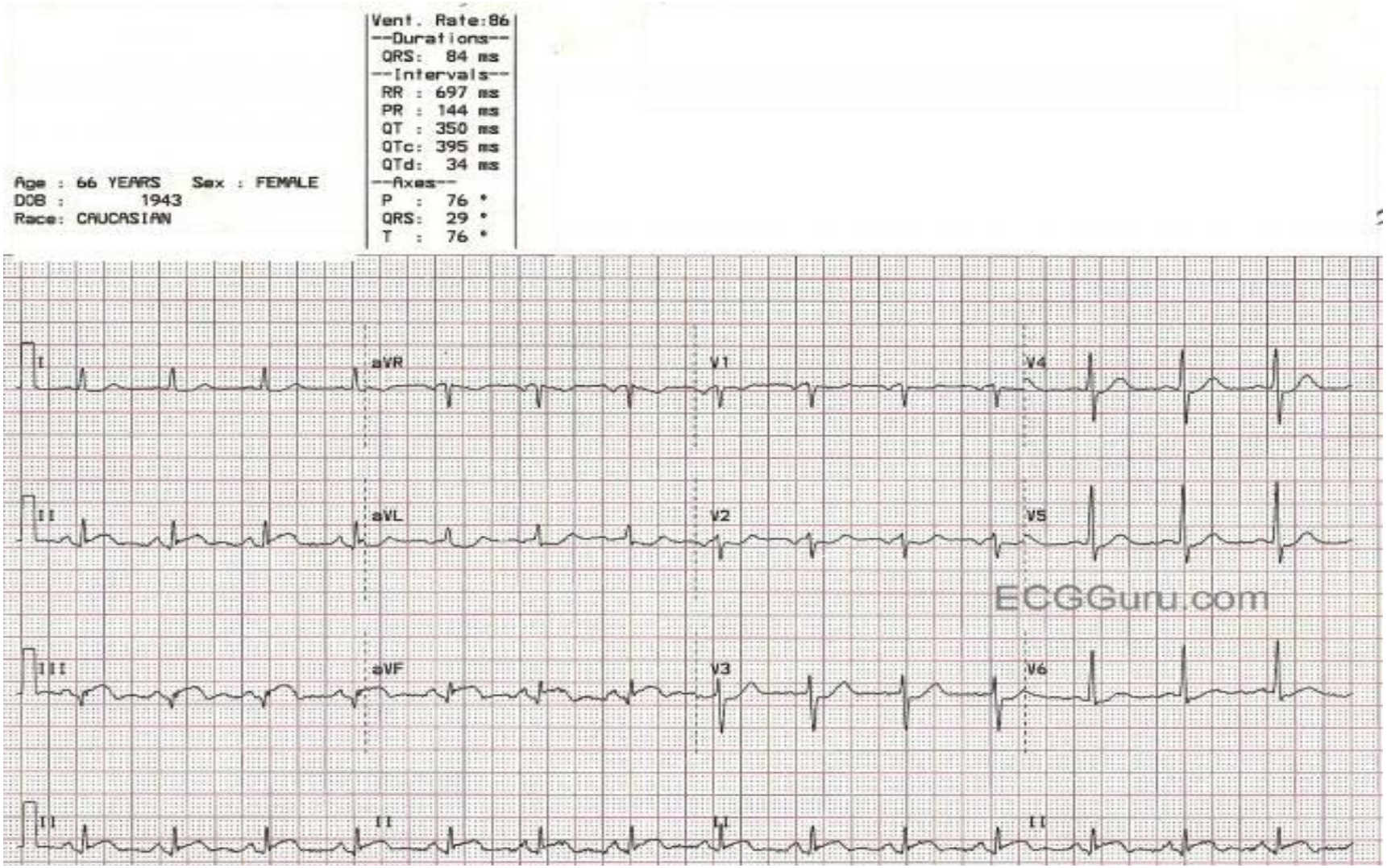
- Usually due to blockage of the Right Coronary Artery (RCA)

- EKG: primary changes seen in Leads II, III and AVF with reciprocal changes in V5 and V6

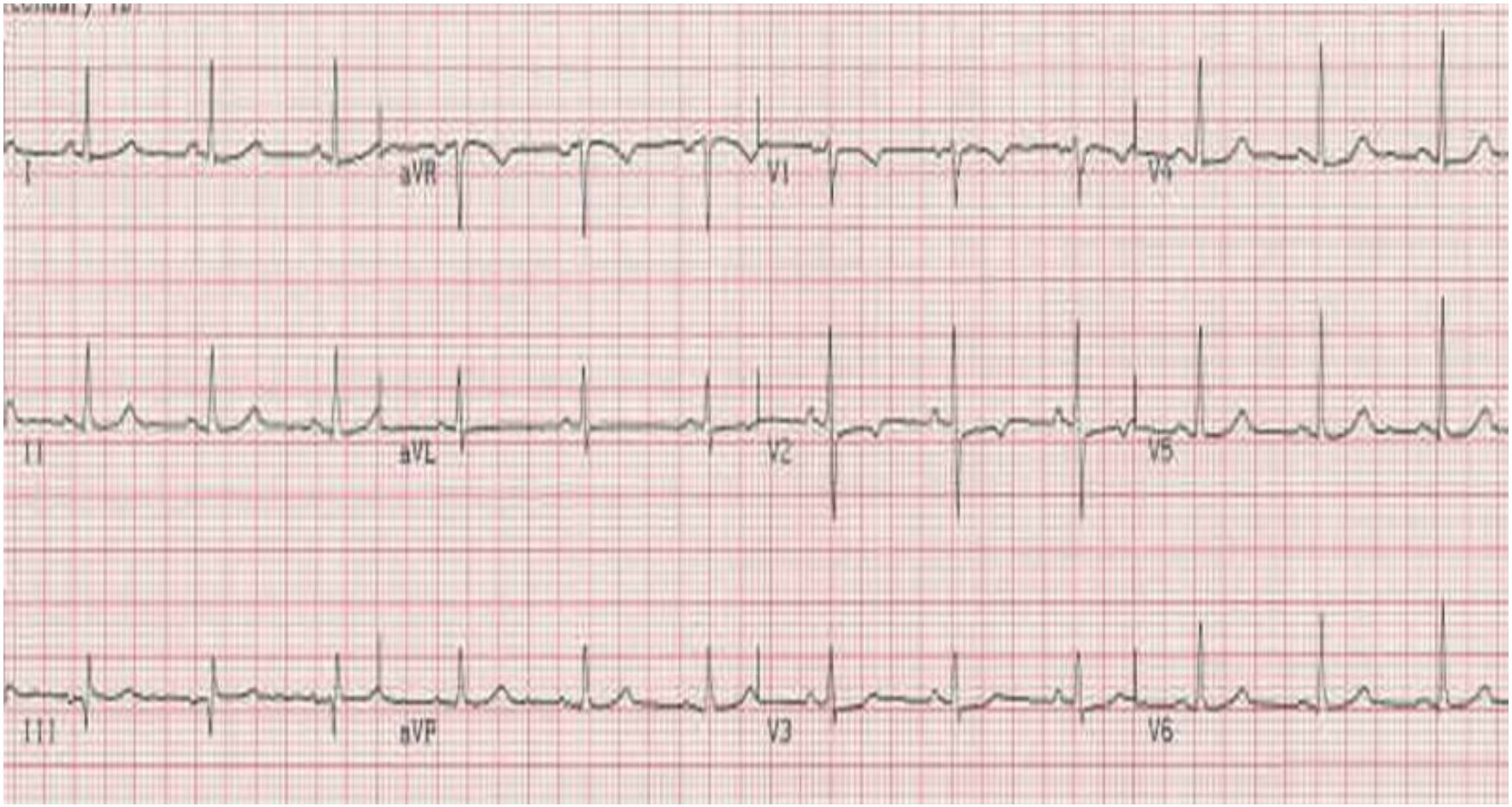
Old Inferior Wall MI



Acute Inferior Wall MI



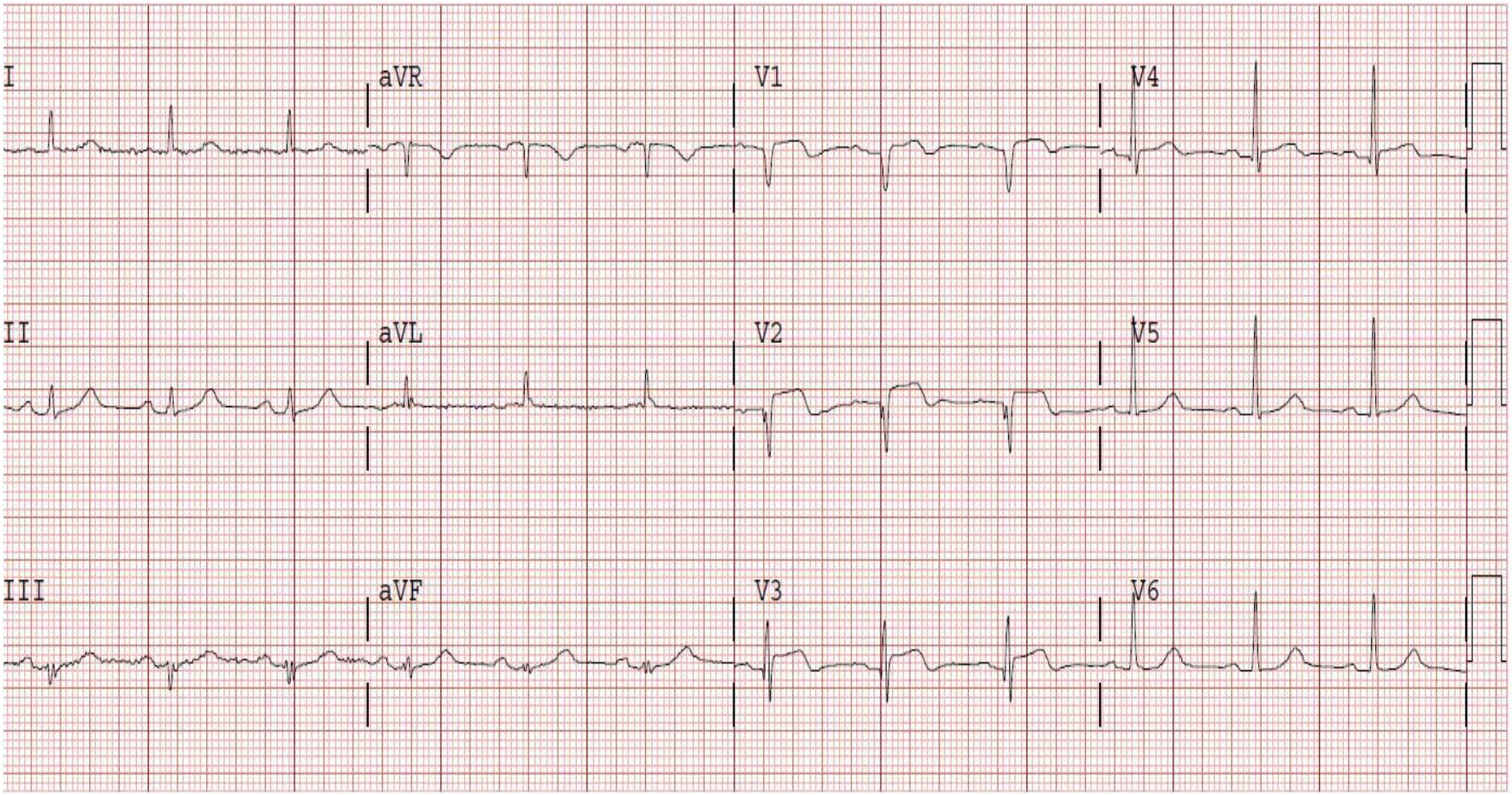
Normal Sinus Rhythm: NOT an old inferior Wall MI



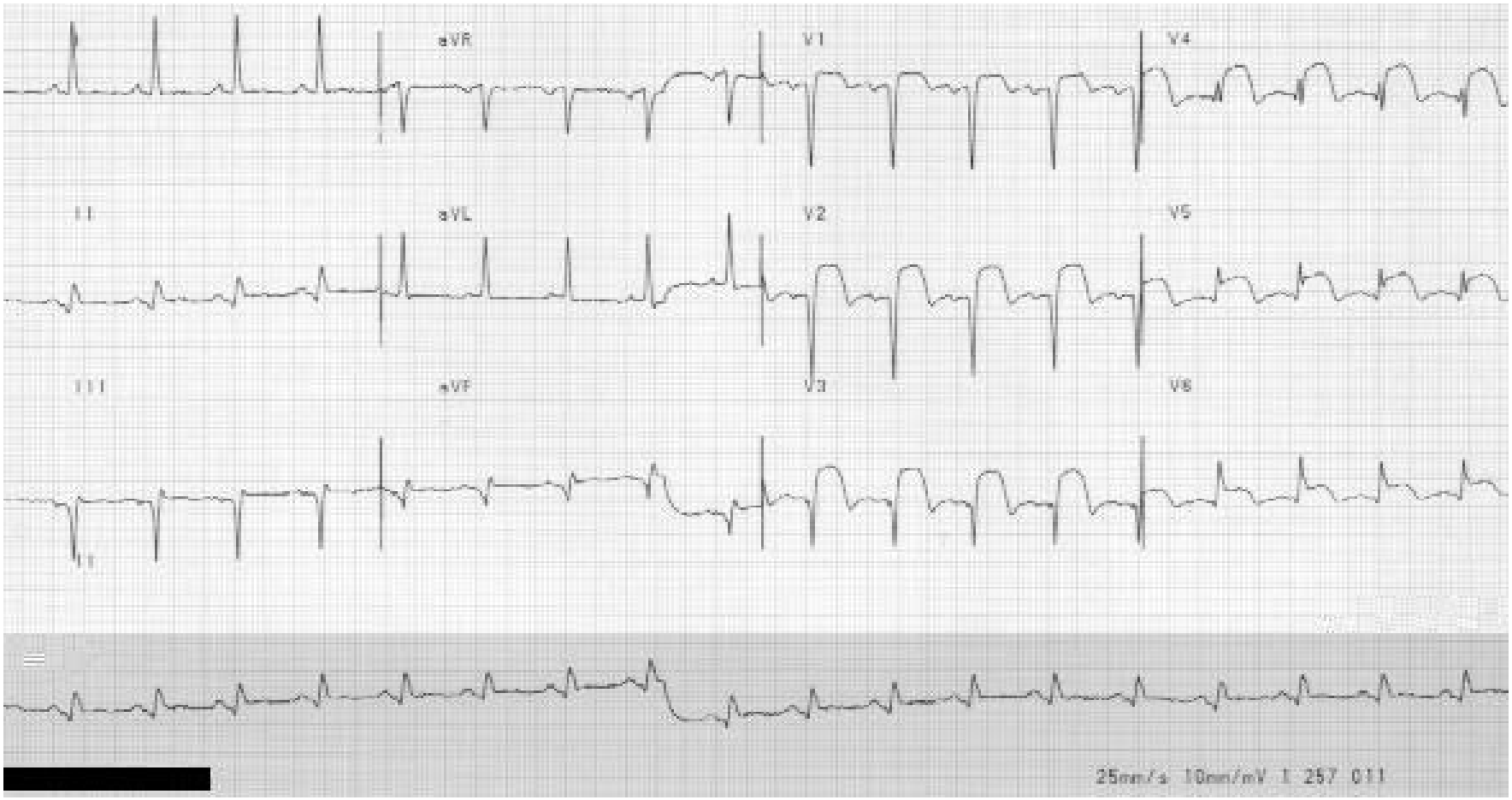
Anterior Wall MI's

- Can be due to blockage of Left Main Coronary Artery,

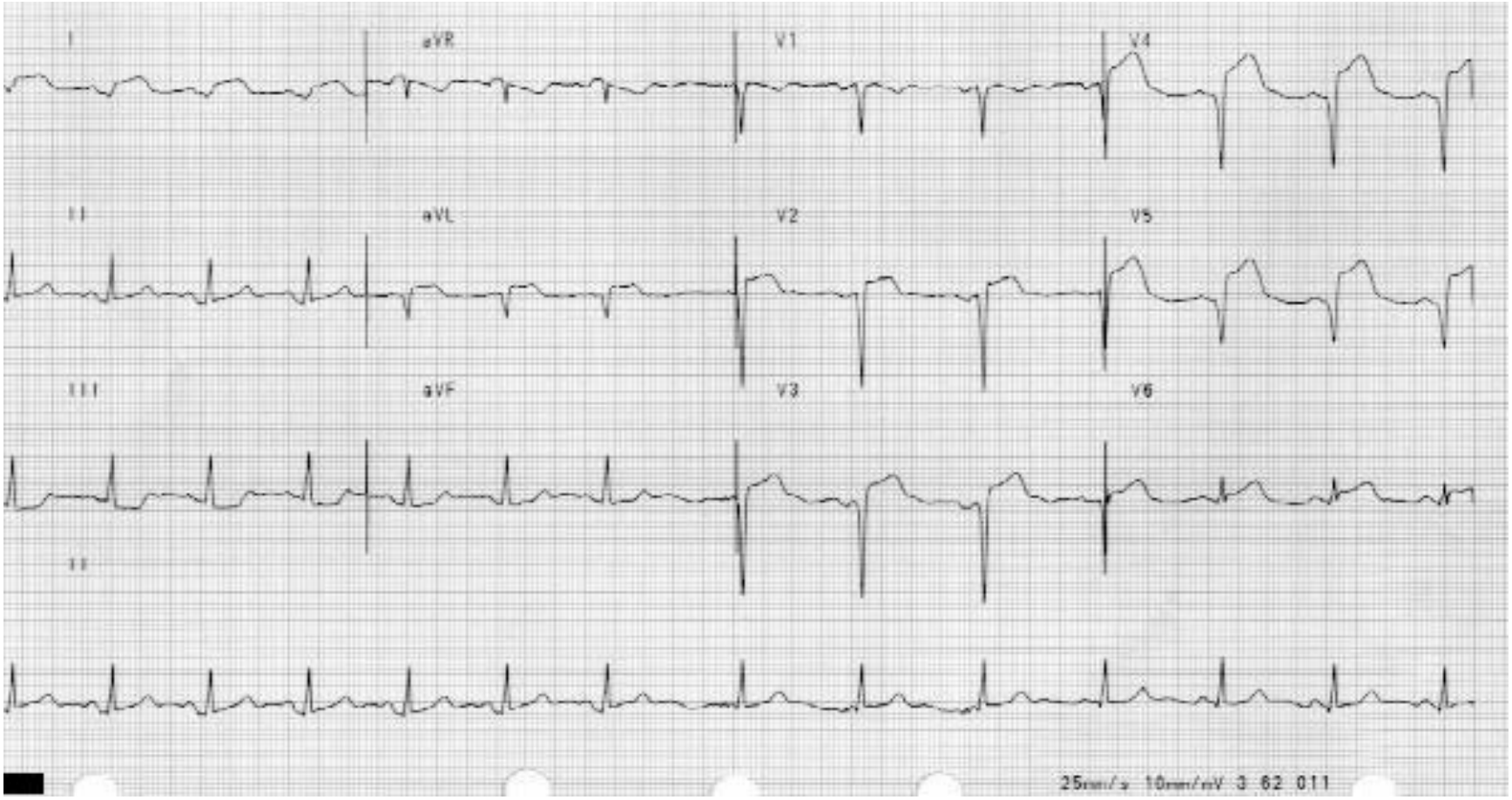
Anterior Wall MI



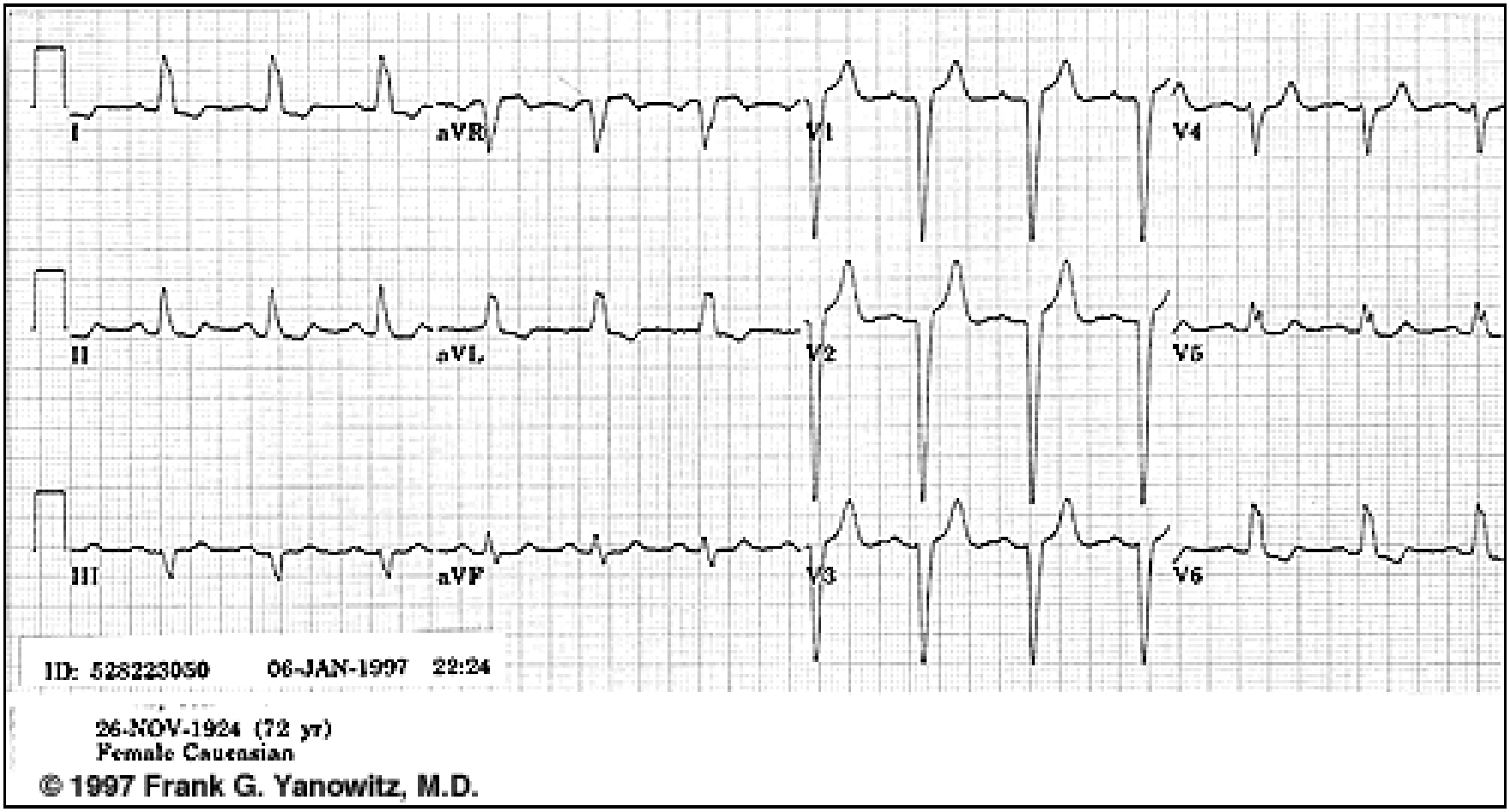
Acute Anterolateral wall MI (old Inferior wall MI)



Acute extensive anterior MI



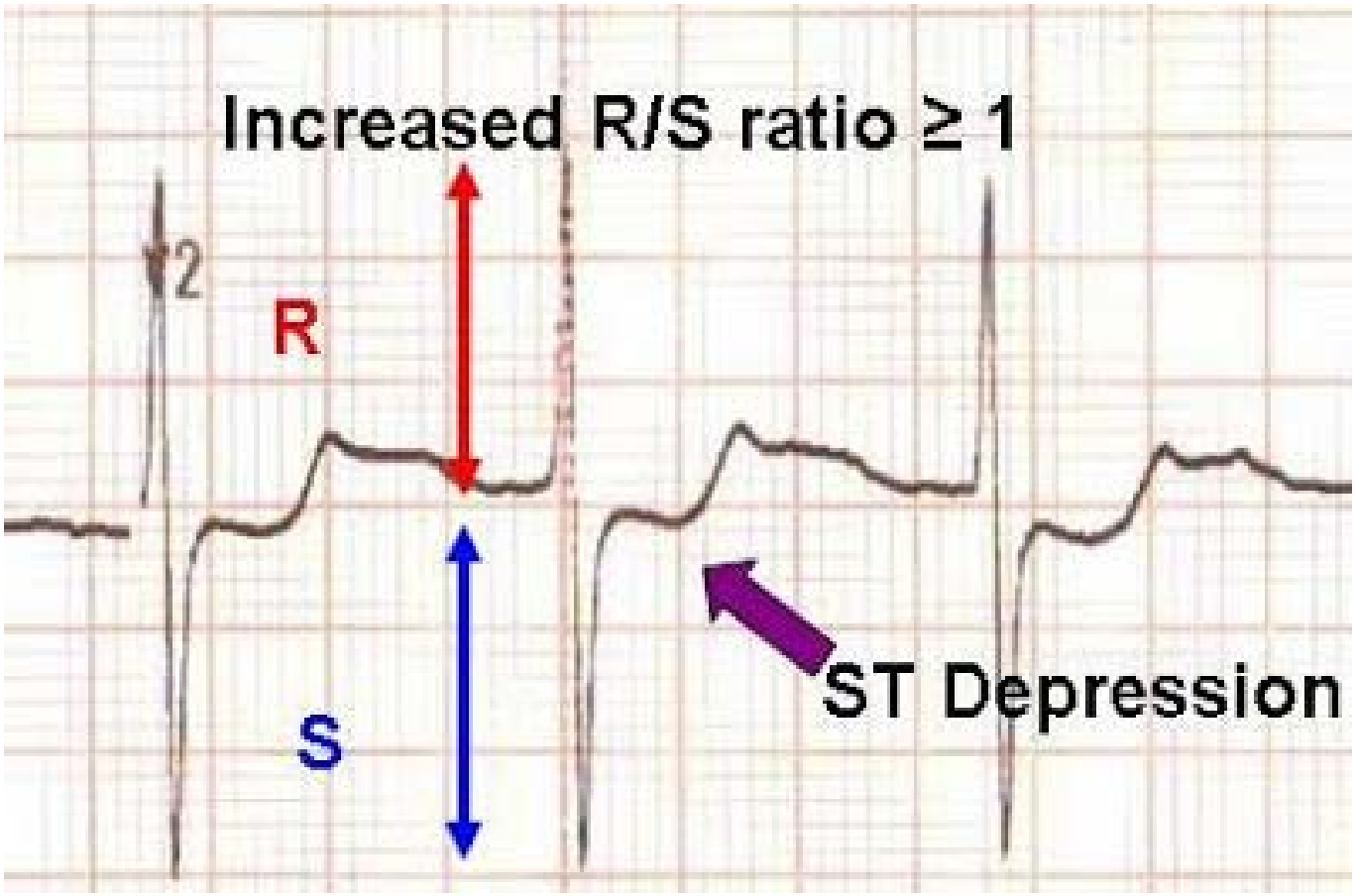
Pseudoinfarct due to LBBB



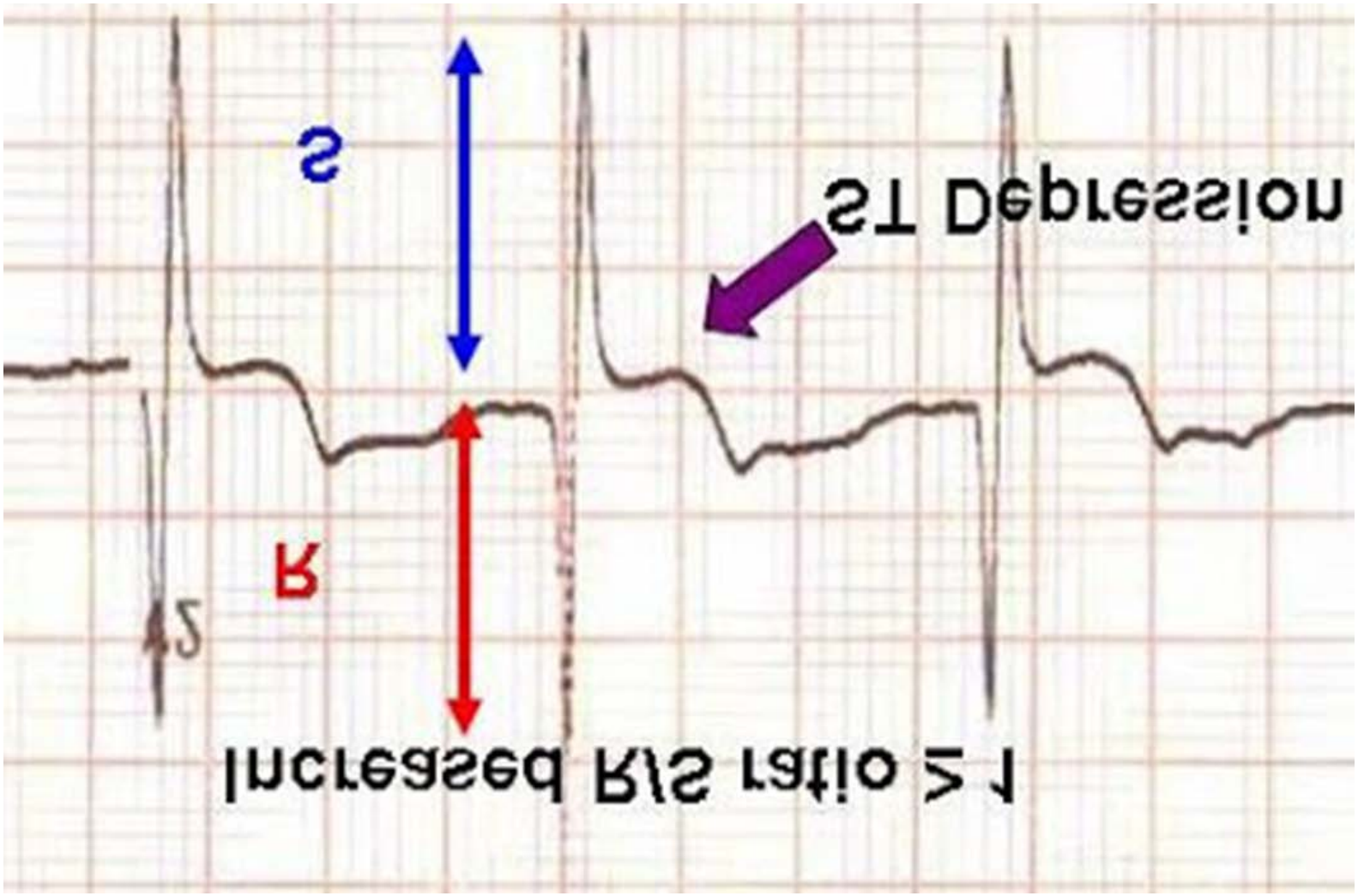
What about the posterior wall infarction?

- There are no ECG leads overlaying the posterior wall
- Use reciprocal changes in right chest leads. Do additional right chest leads if suspected
- Difficult to diagnose
- Posterior MI not uncommonly associated with inferior or lateral wall MIs

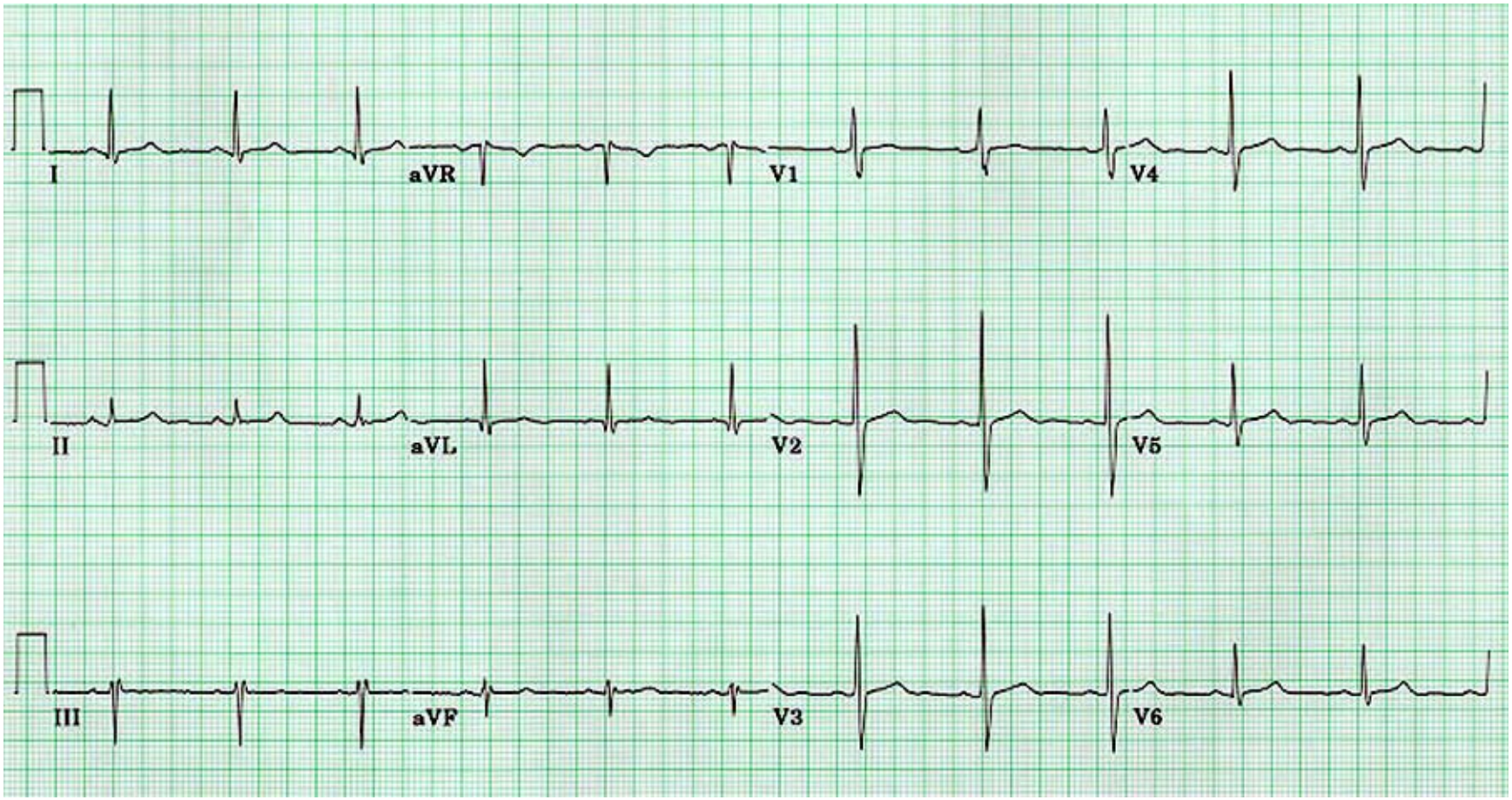
Posterior Wall MI



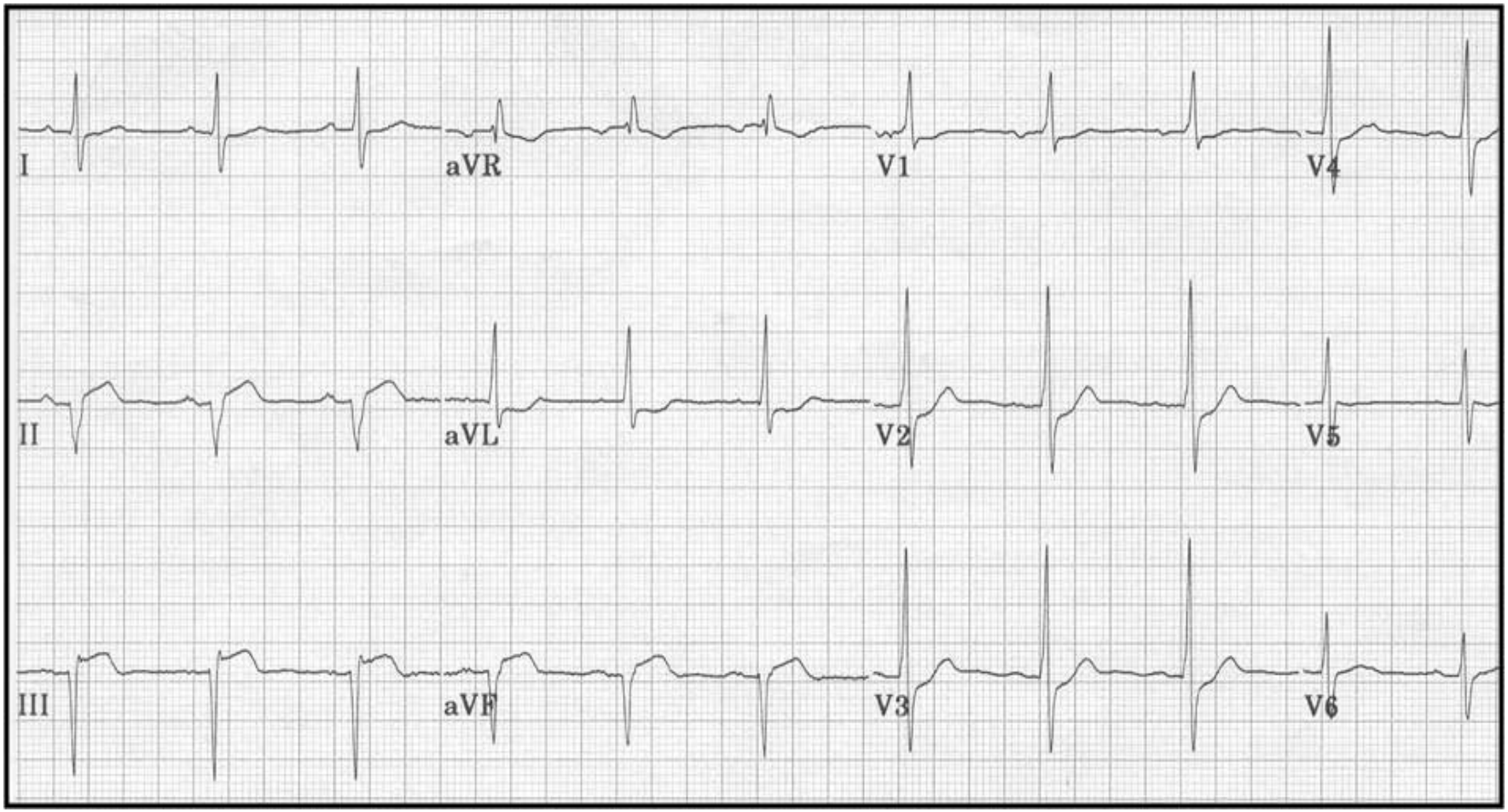
Trick: Look at V1 upside down



Posterior Wall MI



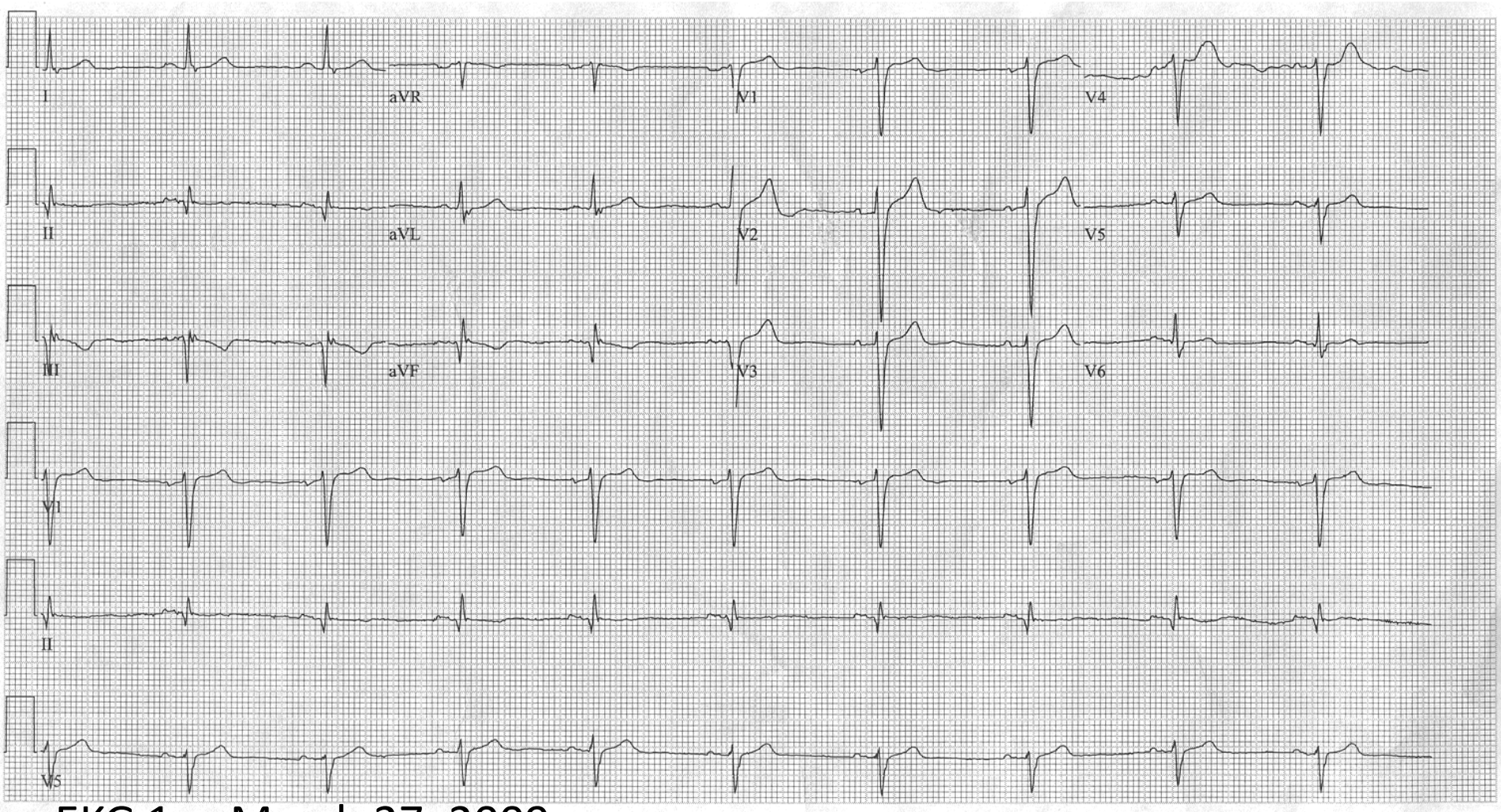
Note T's upright in right chest leads. In RVH expect inverted T's here.


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

Break Time ☺

Real Patient Case

A 66 Y/O diabetic with known CAD has a pre-op EKG for a laparoscopic cholecystectomy

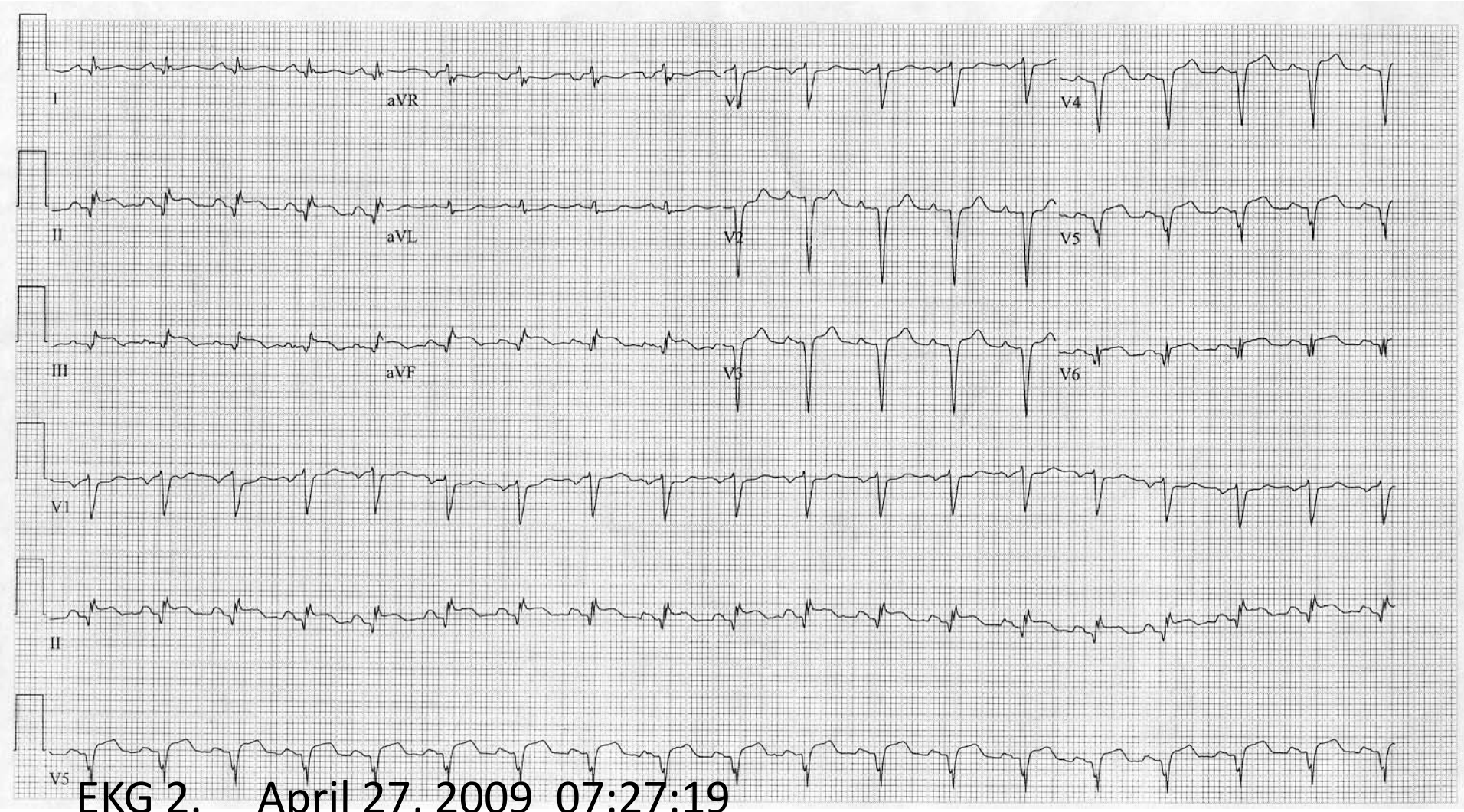


EKG 1. March 27, 2009

DH is a 66 Y/O diabetic with known CAD who was “cleared” for a laparoscopic cholecystectomy after an examination and EKG #1. His Plavix & ASA were stopped pre-op. Surgery was uncomplicated.

In the recovery room anesthesia saw him for some PVC’s on the monitor. He was then allowed to return to his room. That evening he complained of pain in his left biceps. The nurse gave him Tylenol, which had been ordered for pain, and he did not require another dose.

EKG ordered post op day 1 by surgical PA-C. Patient had C/O left biceps pain & had tachycardia.



EKG 2. April 27, 2009 07:27:19

Day 1 post op:

On morning rounds a surgical PA noted tachycardia and the previous biceps pain. She obtained EKG 2 and called her supervisor who immediately had a cardiologist review the EKG by fax. He told her the changes showed an extensive acute MI, the kind often associated with complications such as papillary muscle rupture, a ruptured septum or heart, heart failure and/or shock. He urged immediate interventional consultation for treatment and an emergency cardiac catheterization.

Day 1 post op:

A formal emergency cardiology consult followed, revealing stable hemodynamics but a new systolic murmur. Meanwhile the supervising PA checked the previous hospital notes. She noted that the patient's Plavix & ASA had been stopped pre-op. Reviewed rhythm strips from the recovery room revealed the noted PVCs but also some ST elevation.

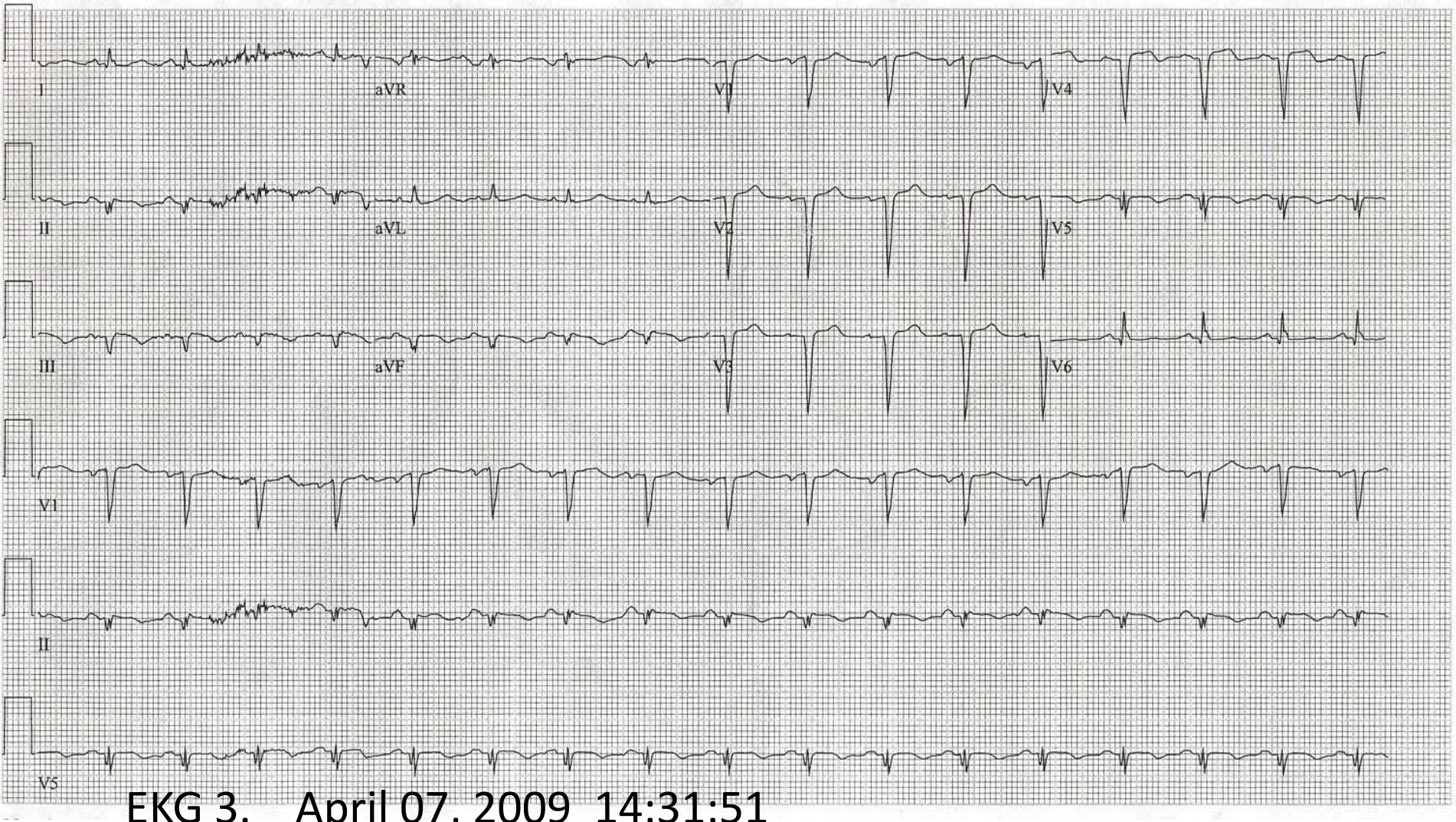
Cardiac markers and an emergency cardiac catheterization were ordered.

Day 1 post op:

The cardiac catheterization revealed total occlusions of both the LAD and RCA and a VSD consistent with a ruptured septum. Cardiac markers had come back positive. Post cath EKG #3 was obtained.

He underwent emergency CABG and repair of the VSD. His post op EF was 35%. Several weeks later his VSD repair failed and repeat surgery was needed. He tolerated this well.

Follow-up EKG post op day 1



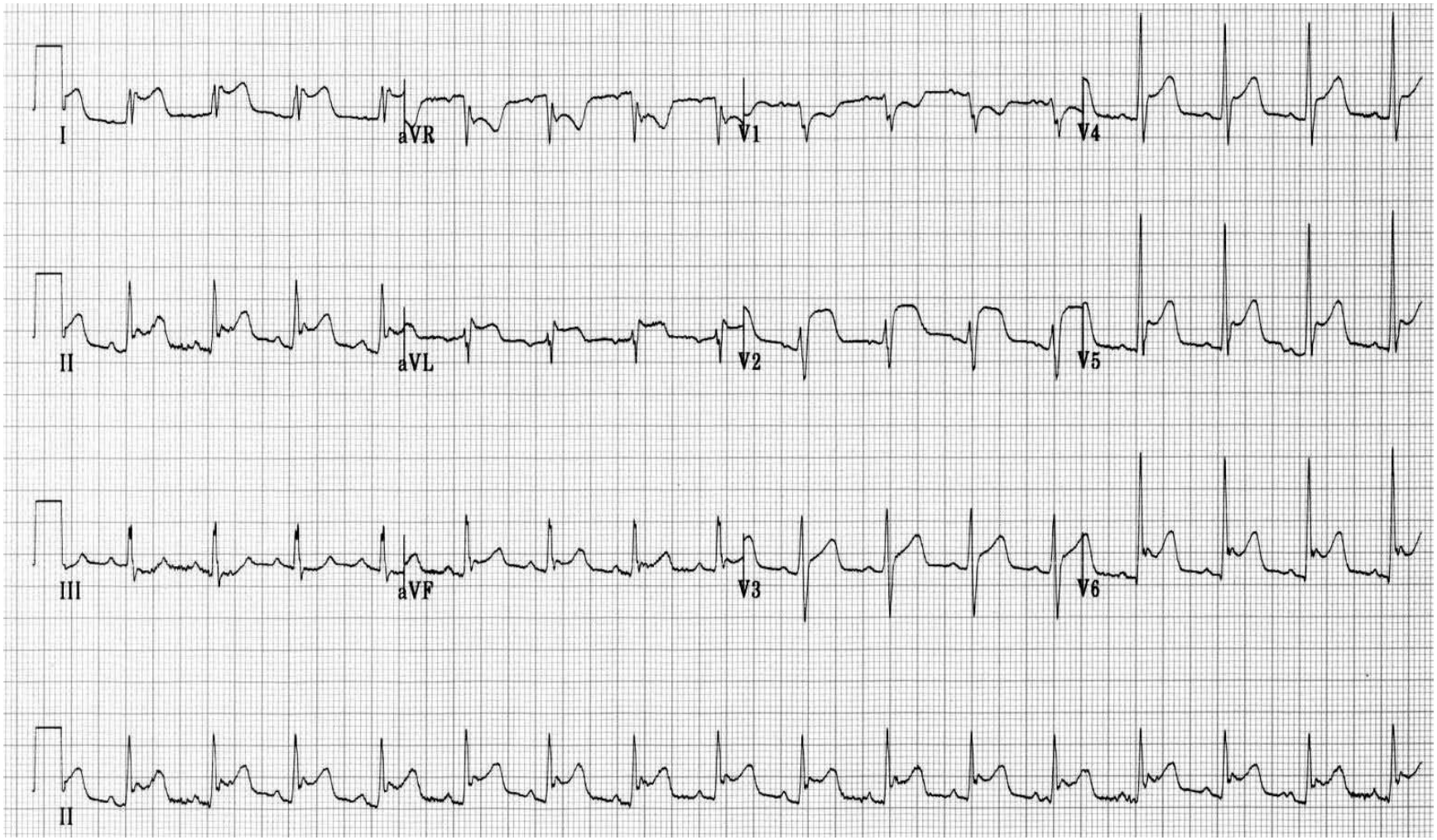
EKG 3. April 07, 2009 14:31:51

THOUGHTS????

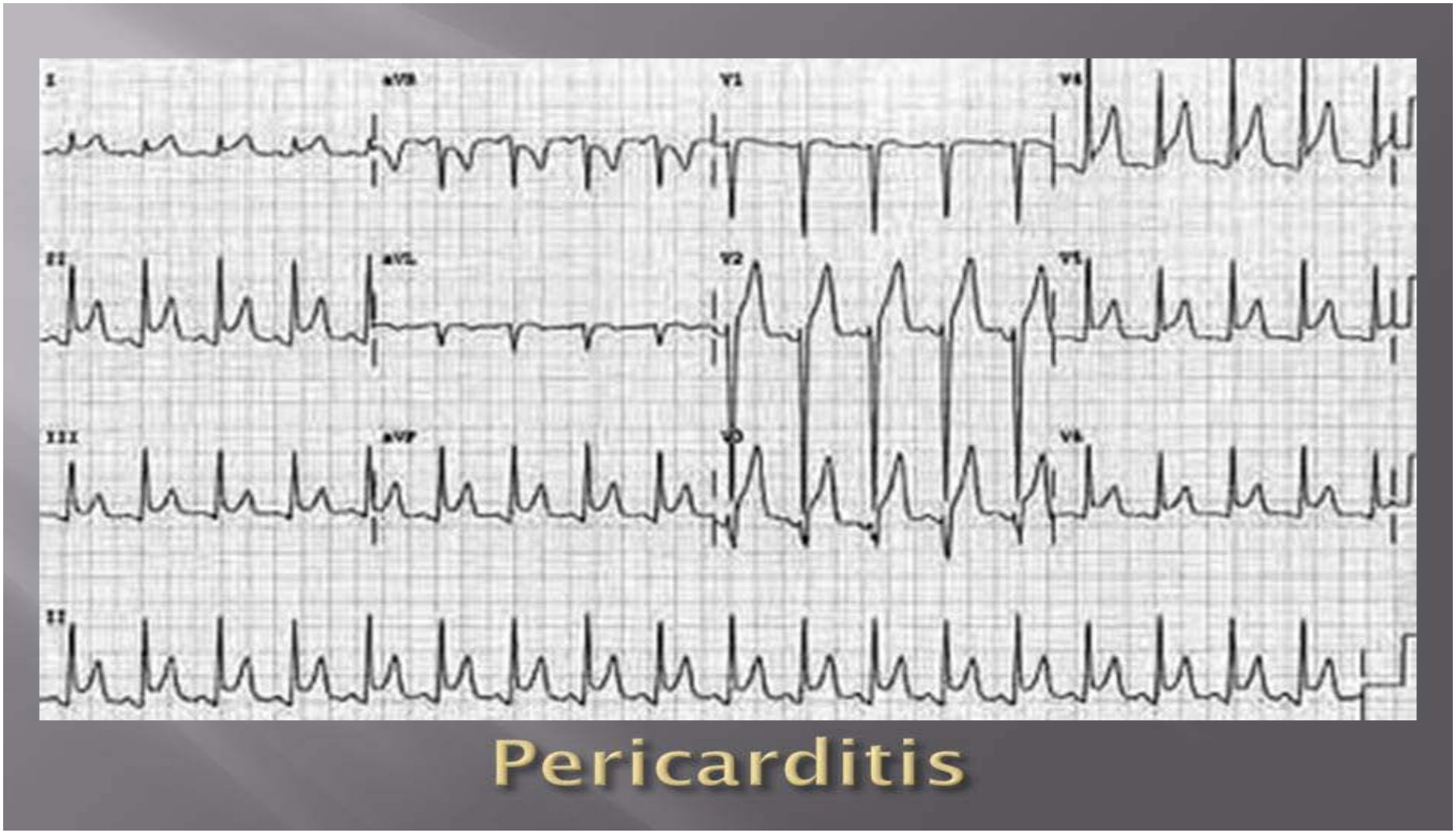
Acute Pericarditis

- EKG can easily be confused with an evolving MI
- The ST segment and T wave changes in pericarditis tend to be diffuse (although not always) and involve far more leads than the localized effect of infarction
- No reciprocal changes
- Q wave formation does not occur
- Elevated ST returns to baseline before the T wave inverts

Acute Pericardits



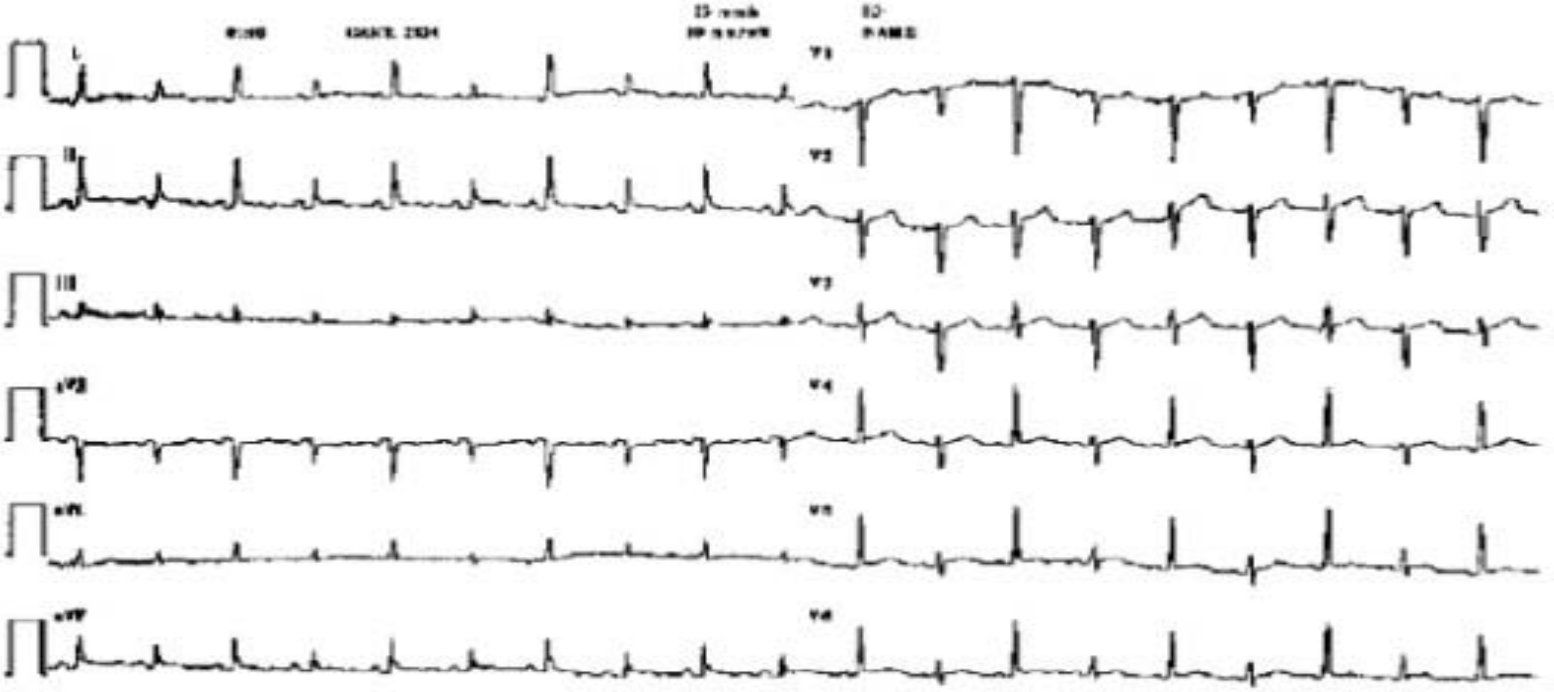
Acute Pericarditis



Cardiac Tamponade

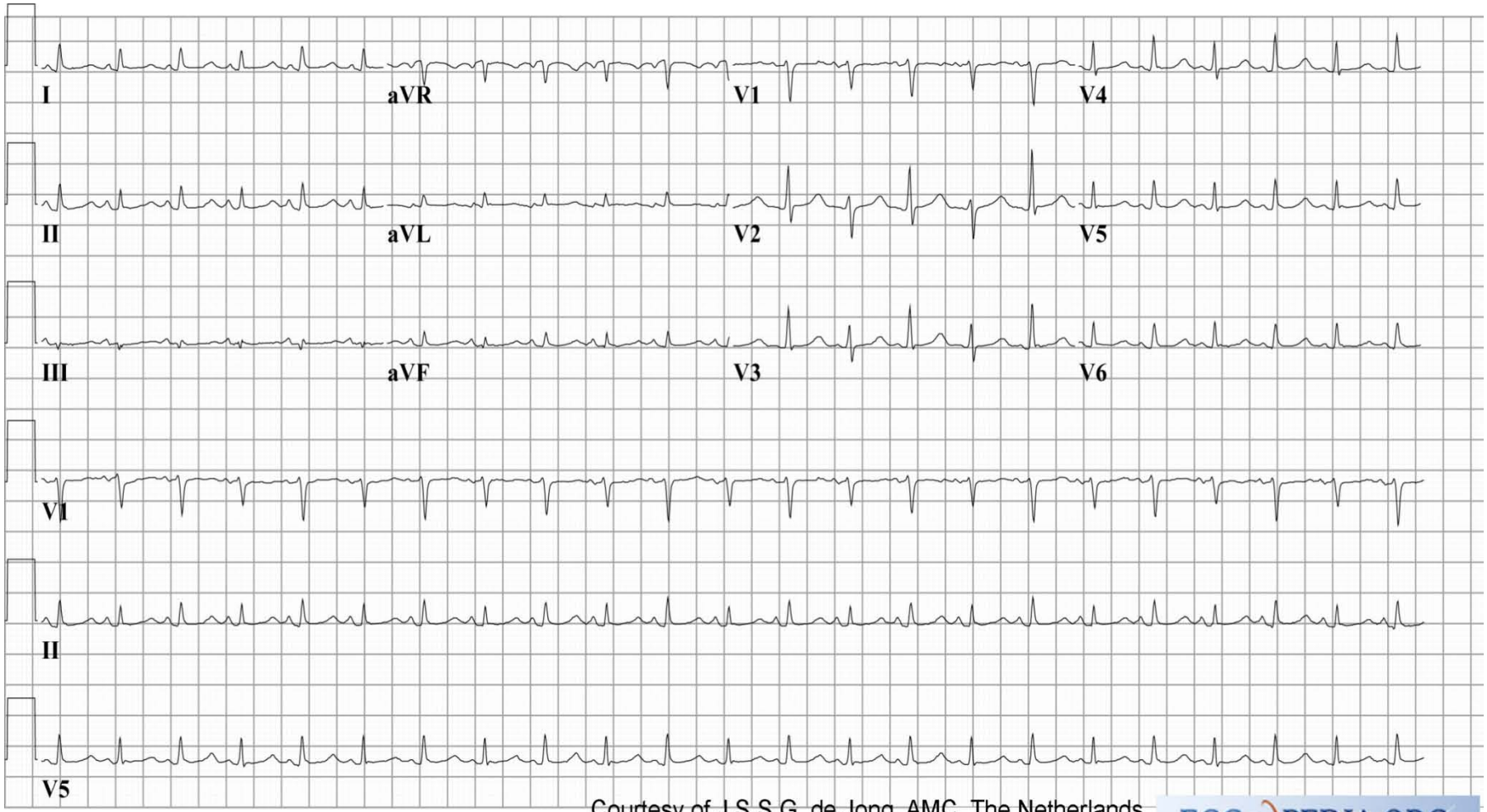
- Low Voltage of the QRS complexes due to pressure from fluid surrounding the heart
- **Electrical Alternans**: Beat to beat shift in QRS axis
- Electrical Alternans with sinus tachycardia is virtually diagnostic of cardiac tamponade

Electrical Alternans
showing alternating QRS complex axis



Cardiac Tamponade

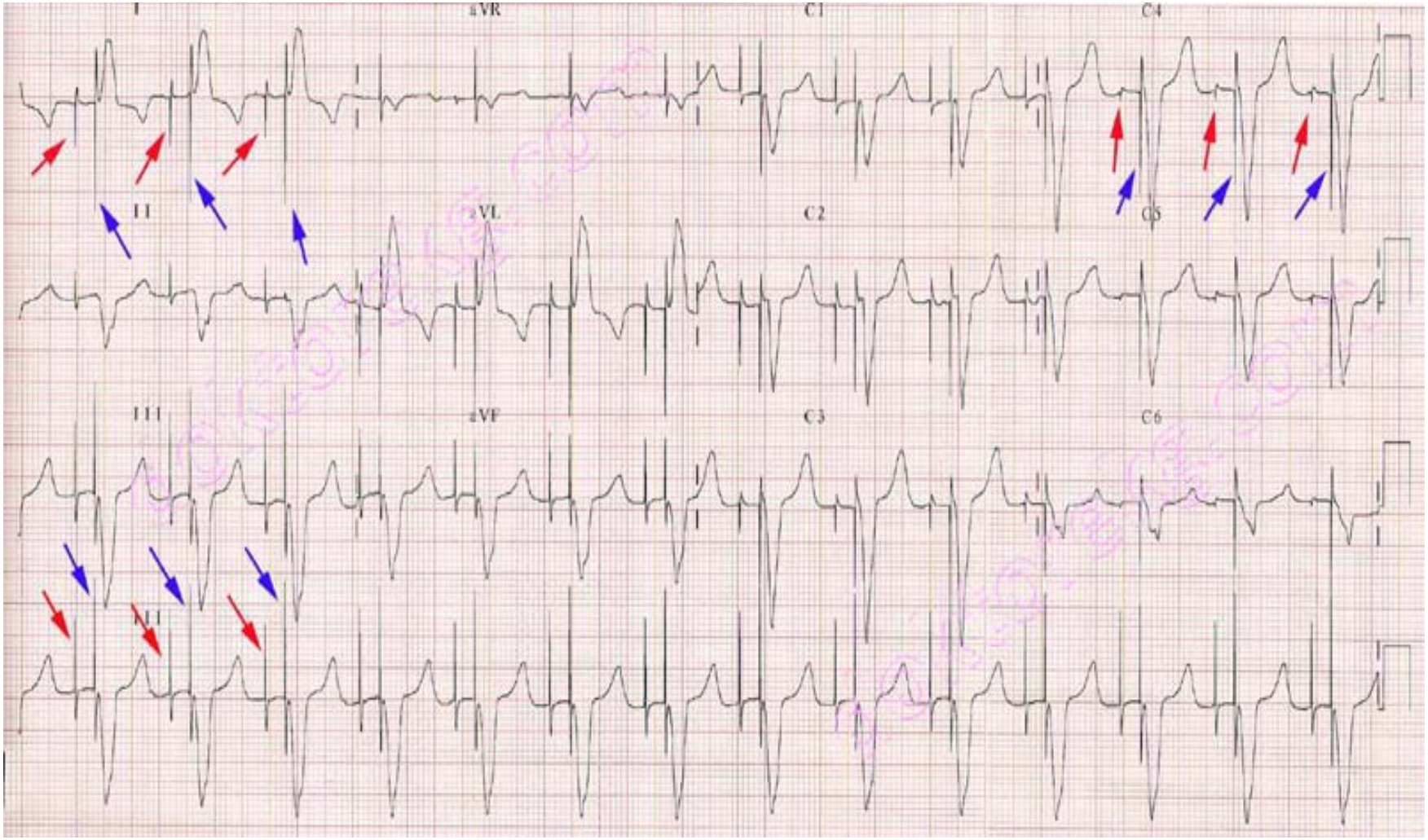
Cardiac Tamponade



Courtesy of J.S.S.G. de Jong, AMC, The Netherlands

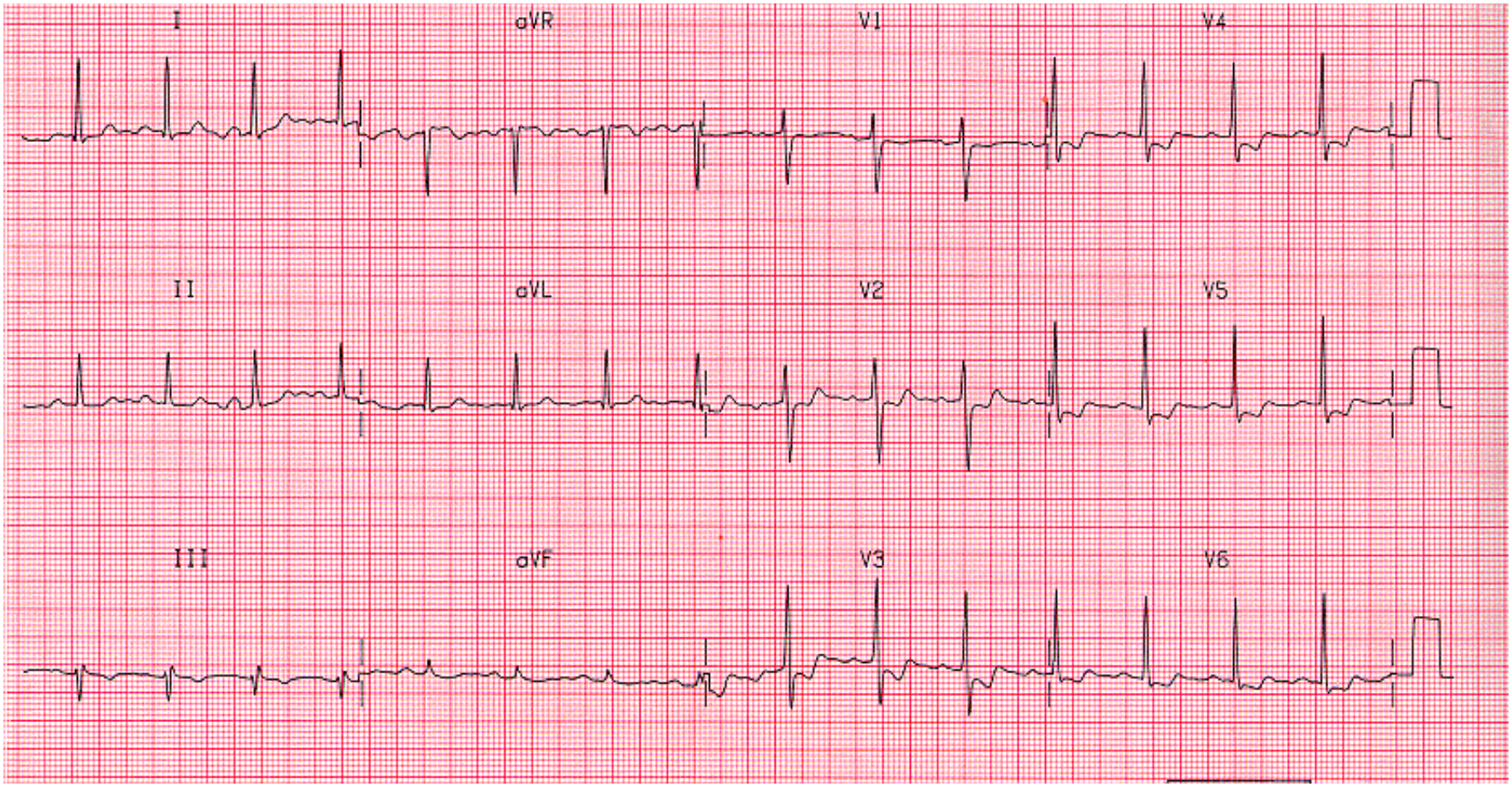
ECG PEDIA.ORG

Pacemaker

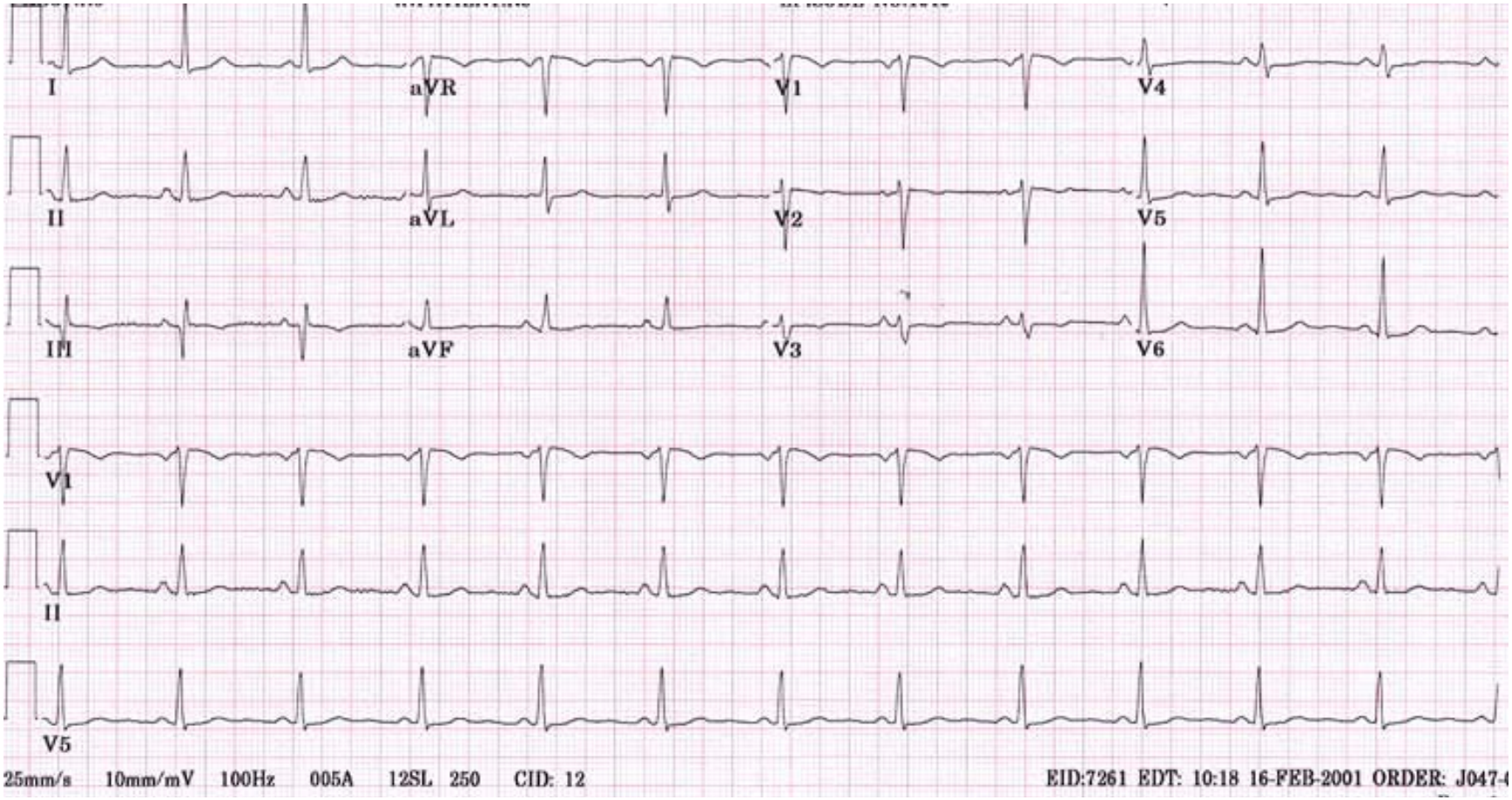


LET’s PRACTICE

Anterolateral Wall ischemia

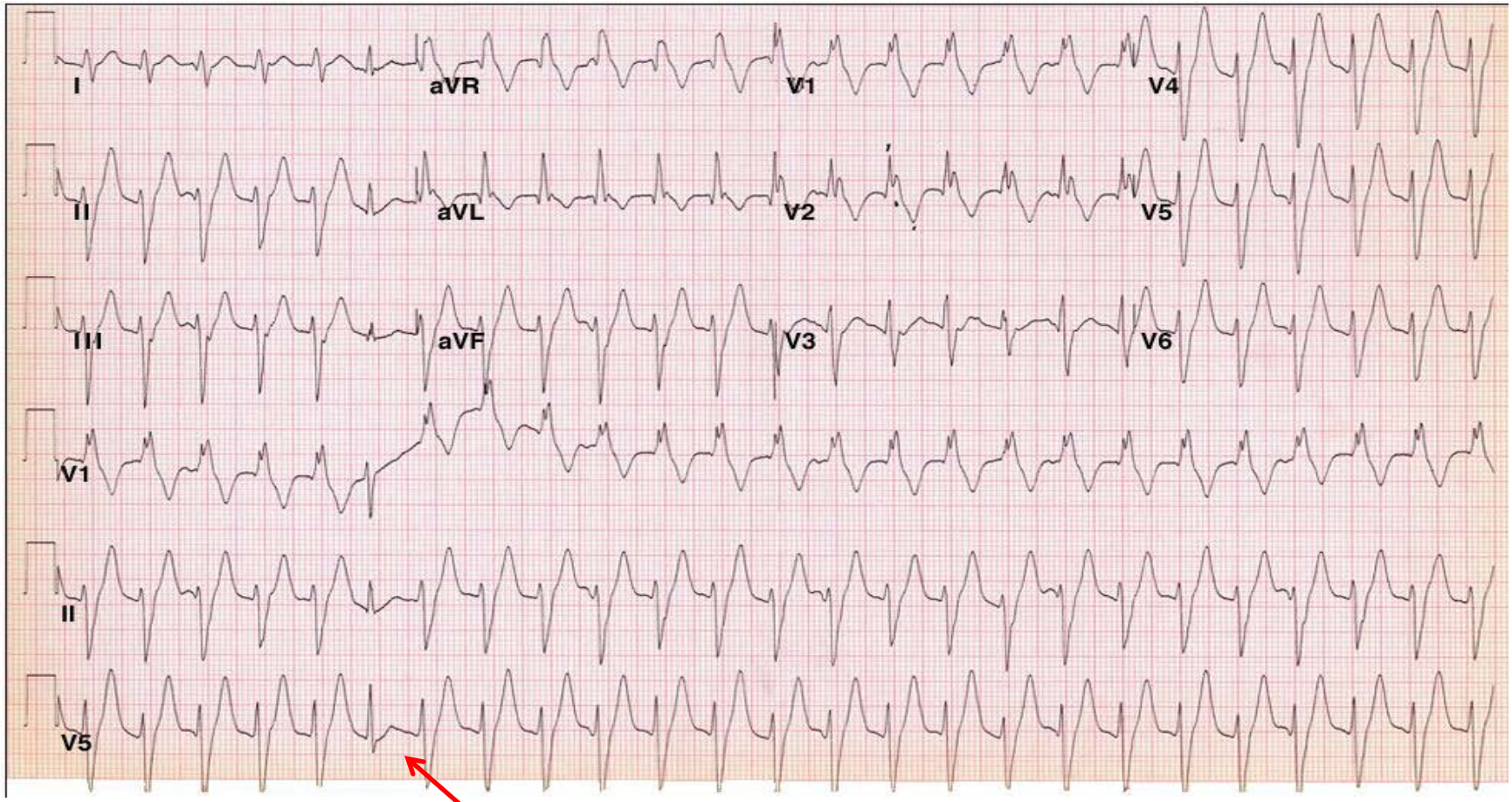


Normal Sinus Rhythm



Ventricular Tachycardia

Could suspect hyperkalemia with the tall T waves but the capture beat (6th beat) doesn't show a tall T wave.

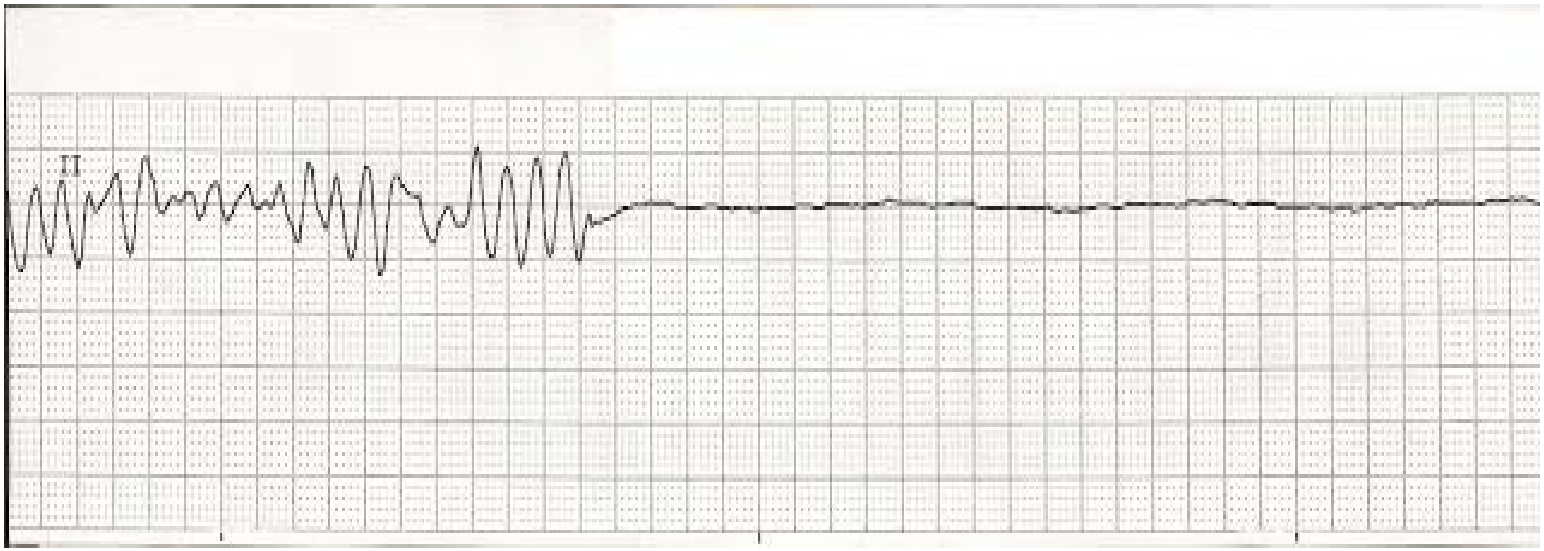


Sinus Bradycardia with notched wide P wave consistent with intra-atrial conduction defect.

Left Bundle Branch Block

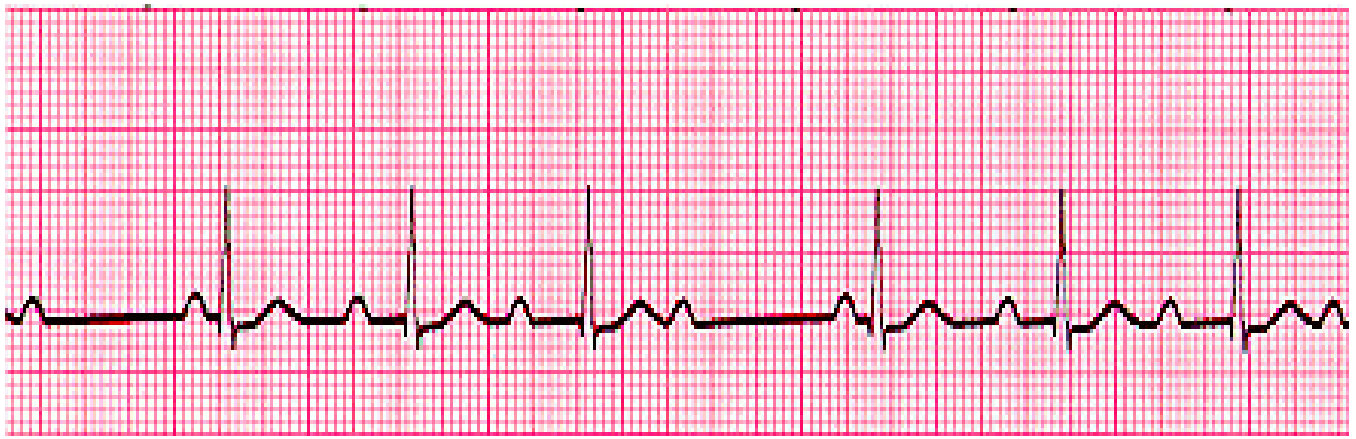
Ventricular Fibrillation to Asystole

- But look at patient to be sure this isn't artifact

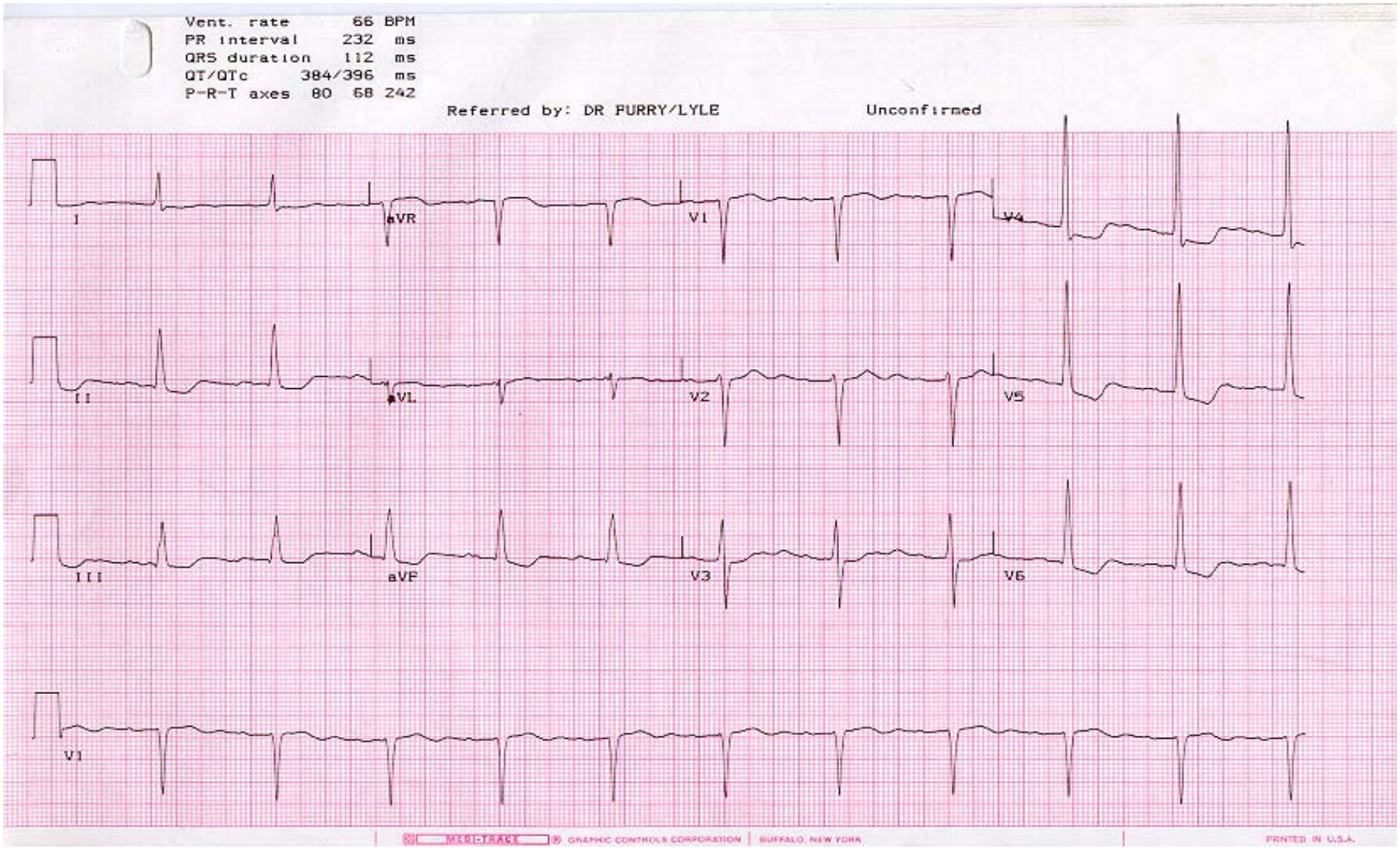


Second Degree AV Block Type I: Shows the 5 features of Wenckebach

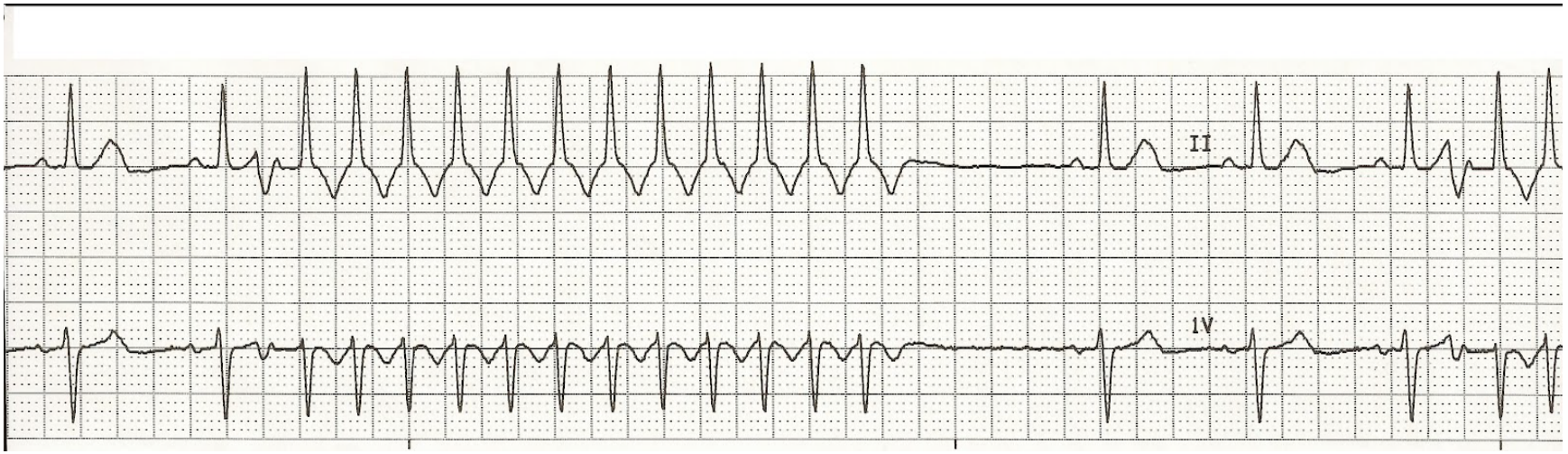
- Group beating (1) with progressive PR lengthening (2) and RR shortening (3).
- Pause less than 2 cycles (4).
- RR after pause longer than RR before pause (5).



Left Ventricular Hypertrophy

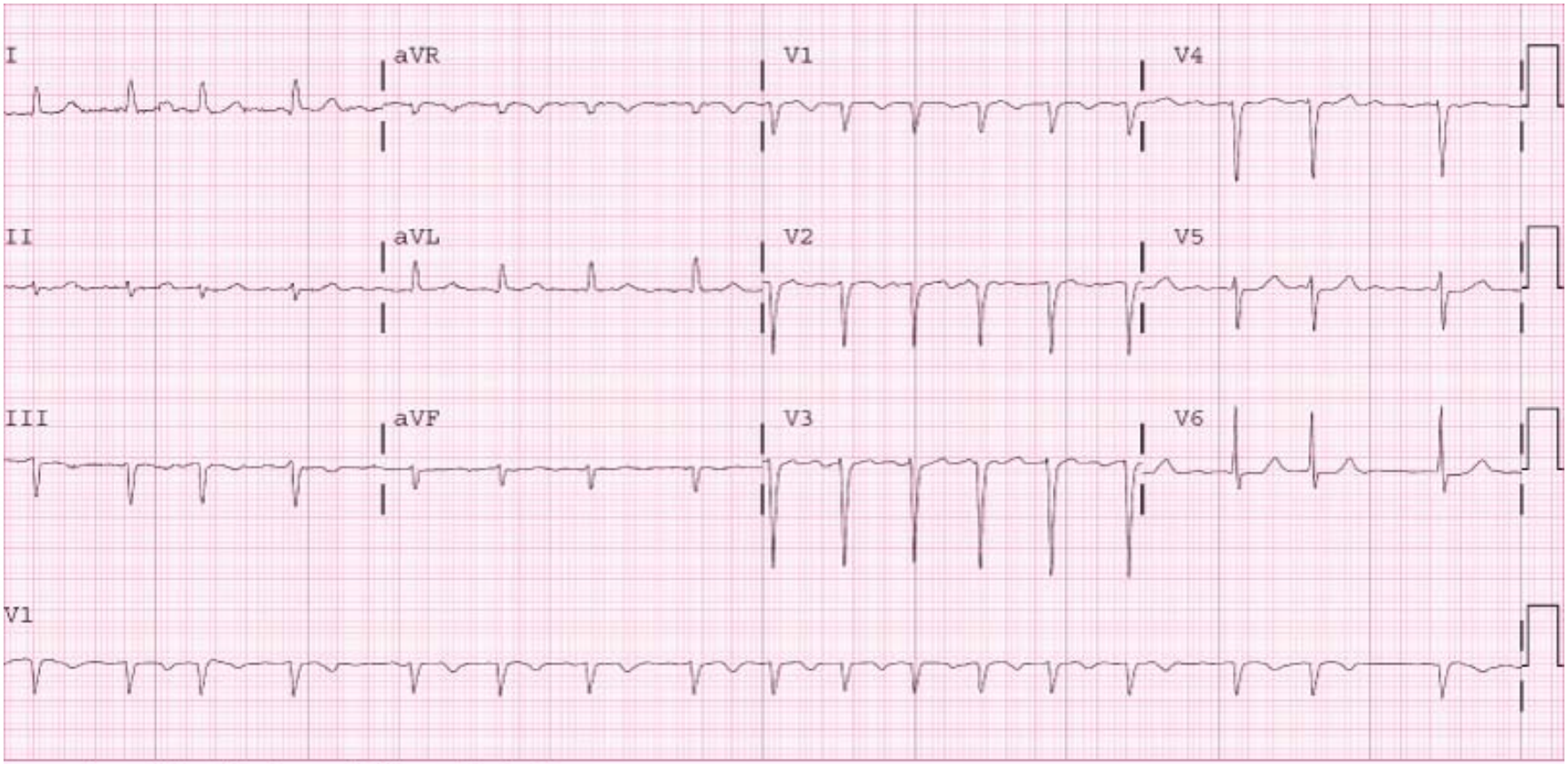


PSVT with aberrant conduction



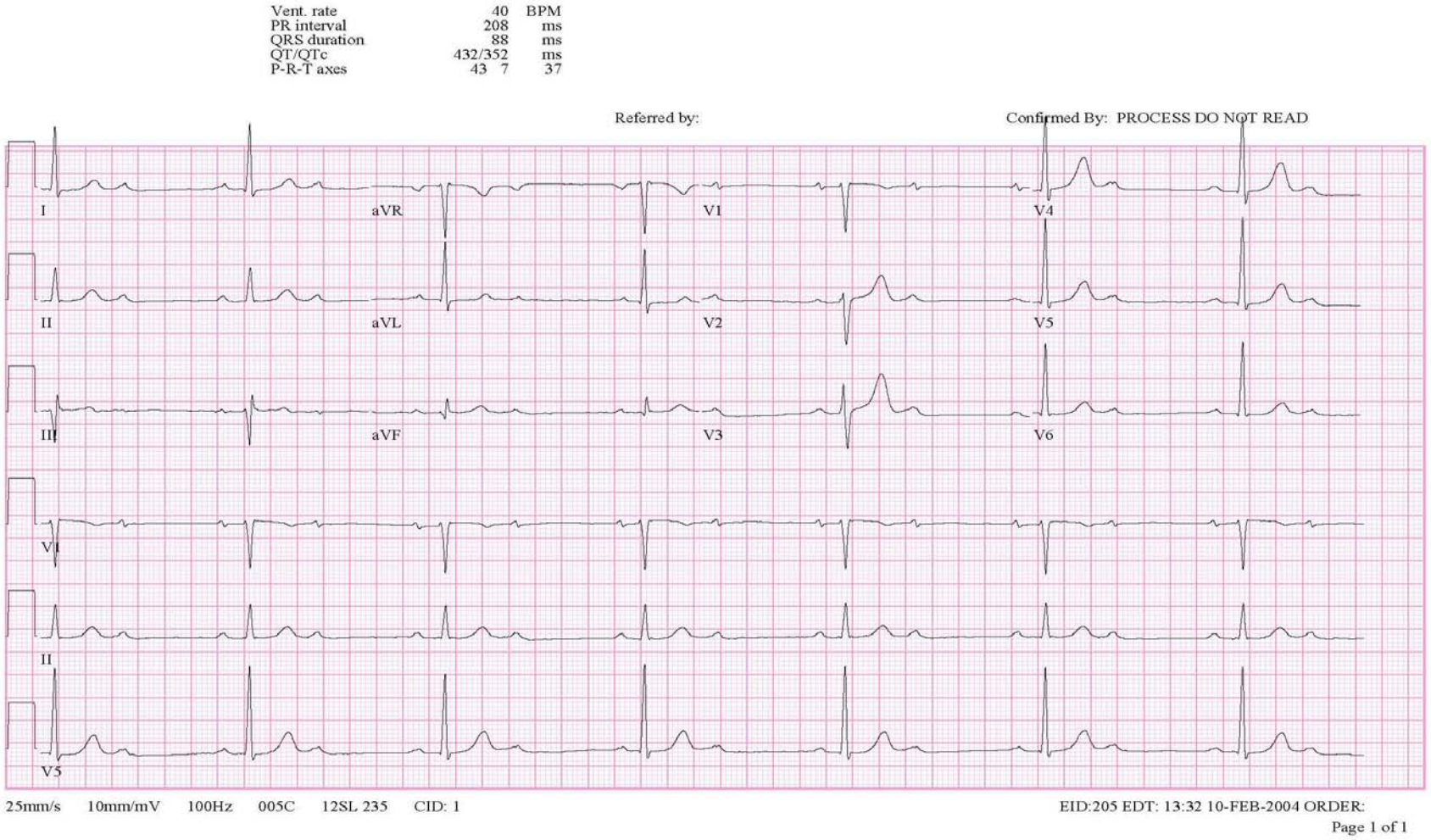
Note the tachycardia begins with a PAC and has slightly different QRS morphology and inverted T waves. Also note the short pause after termination of the tachycardia.

Atrial Fibrillation

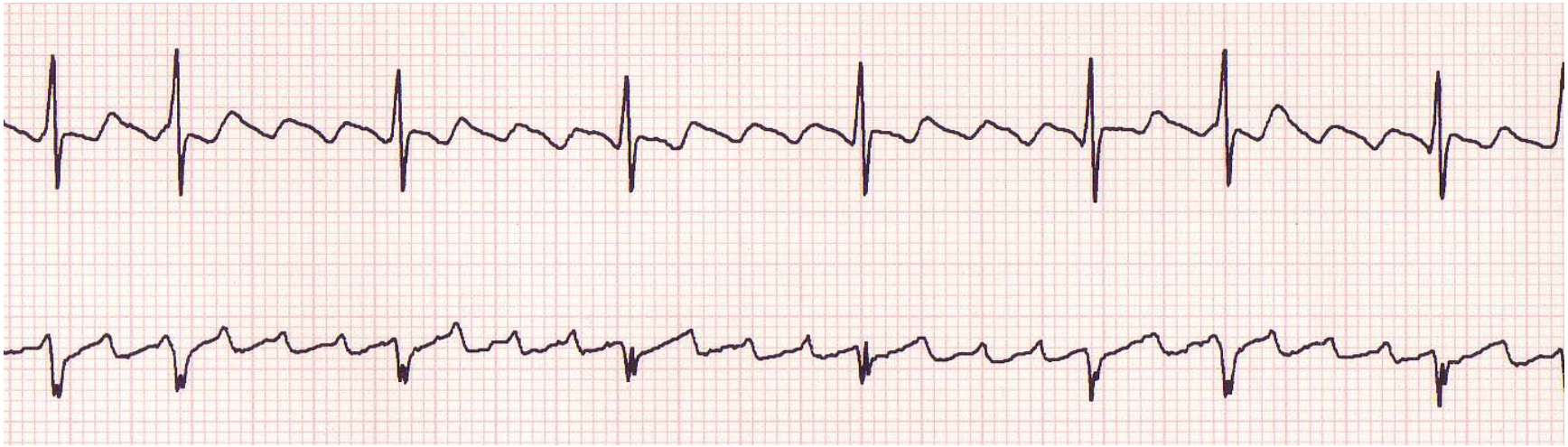


Source: Knoop KJ, Stack LB, Storrow AB, Thurman RJ: *The Atlas of Emergency Medicine, 3rd Edition:* http://www.accessmedicine.com

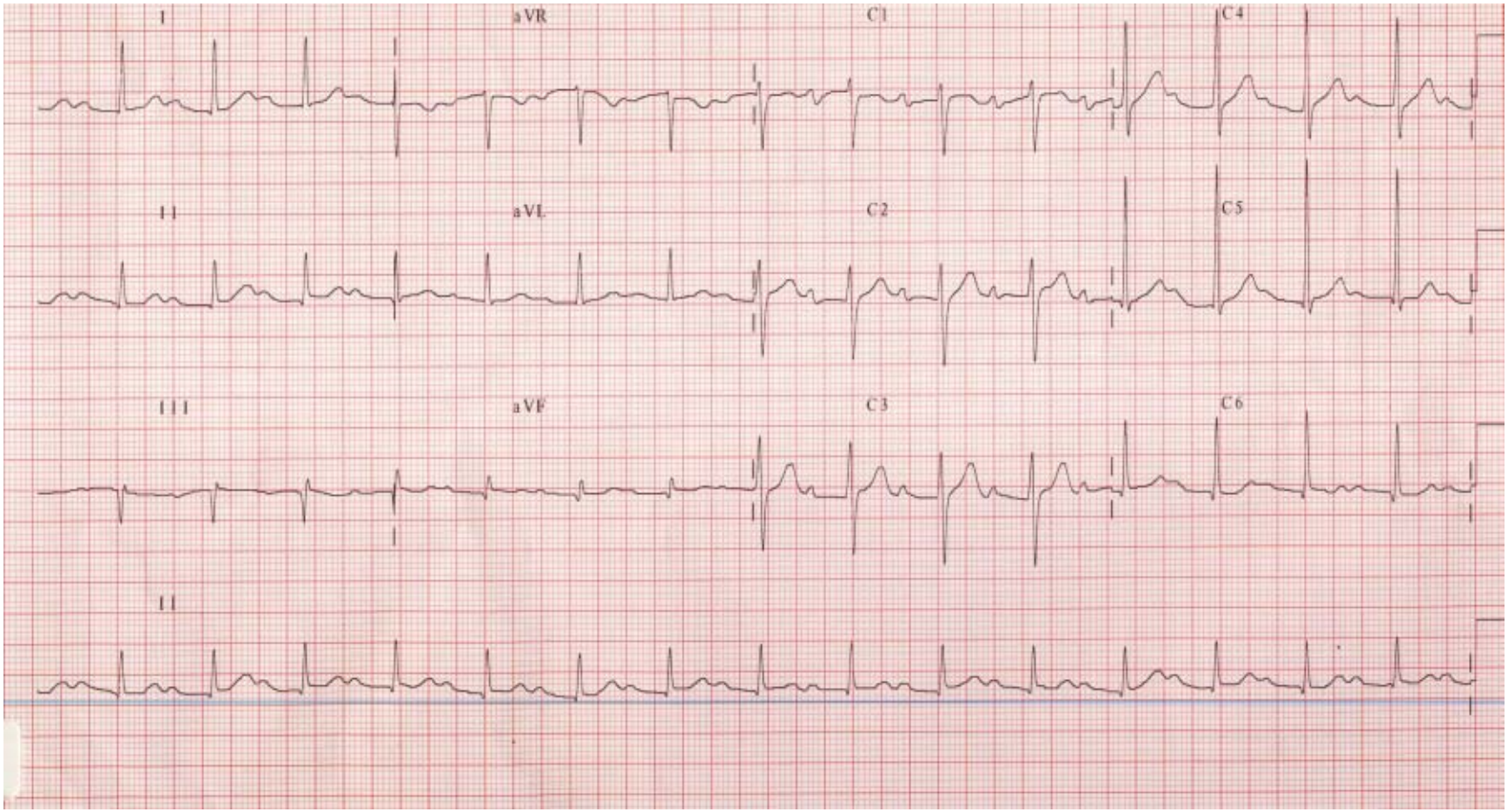
Second Degree AV block Type II



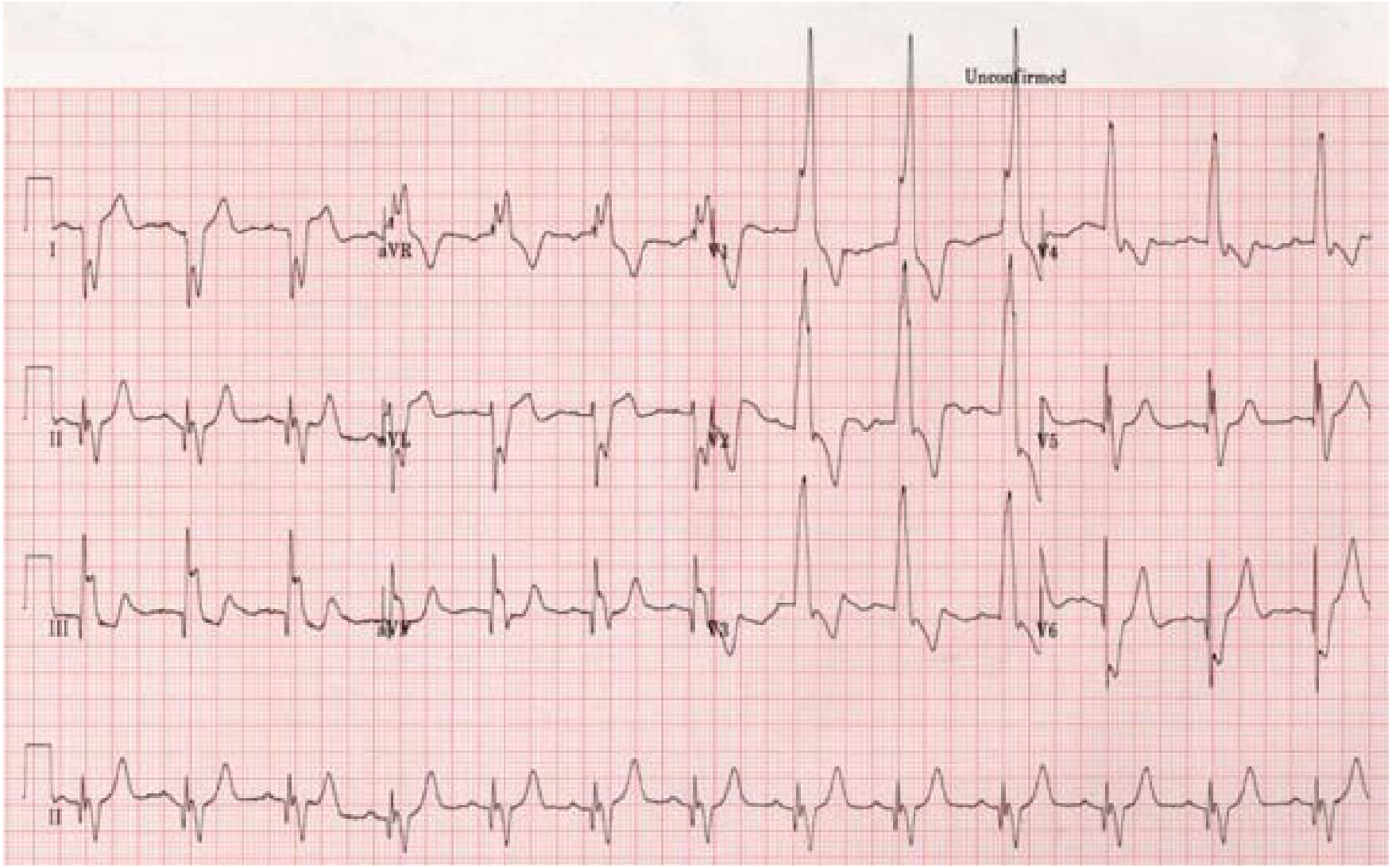
Atrial Flutter (variable conduction)



NSR with First Degree AV Block

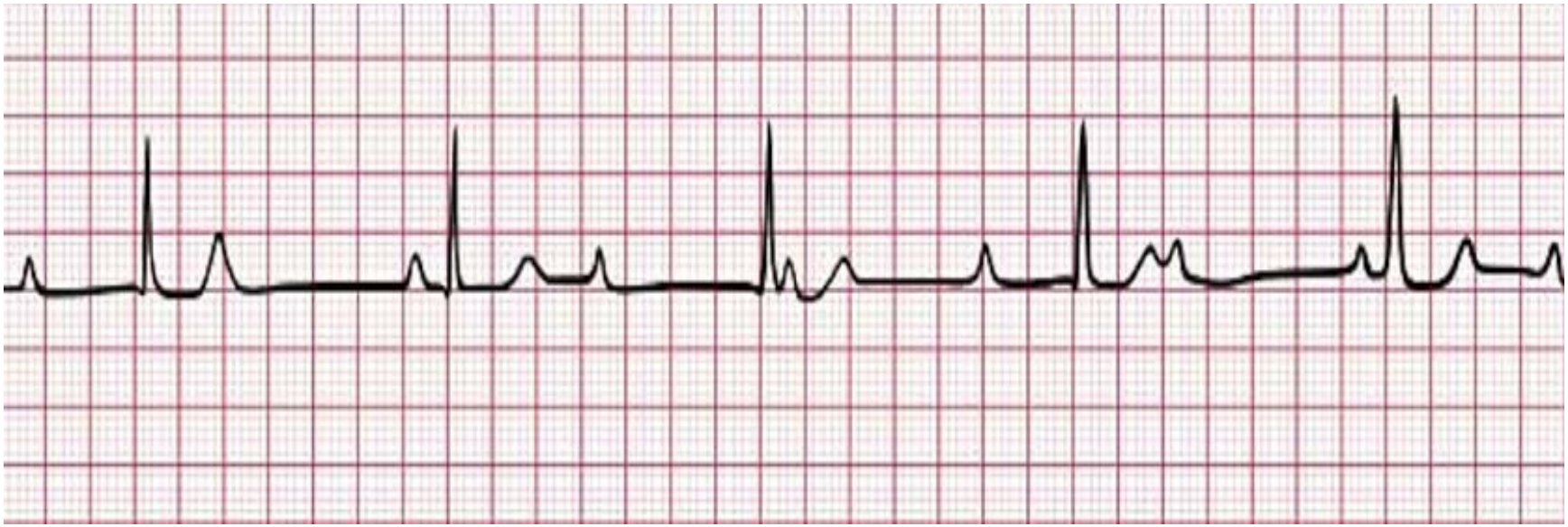


Right Bundle Branch Block



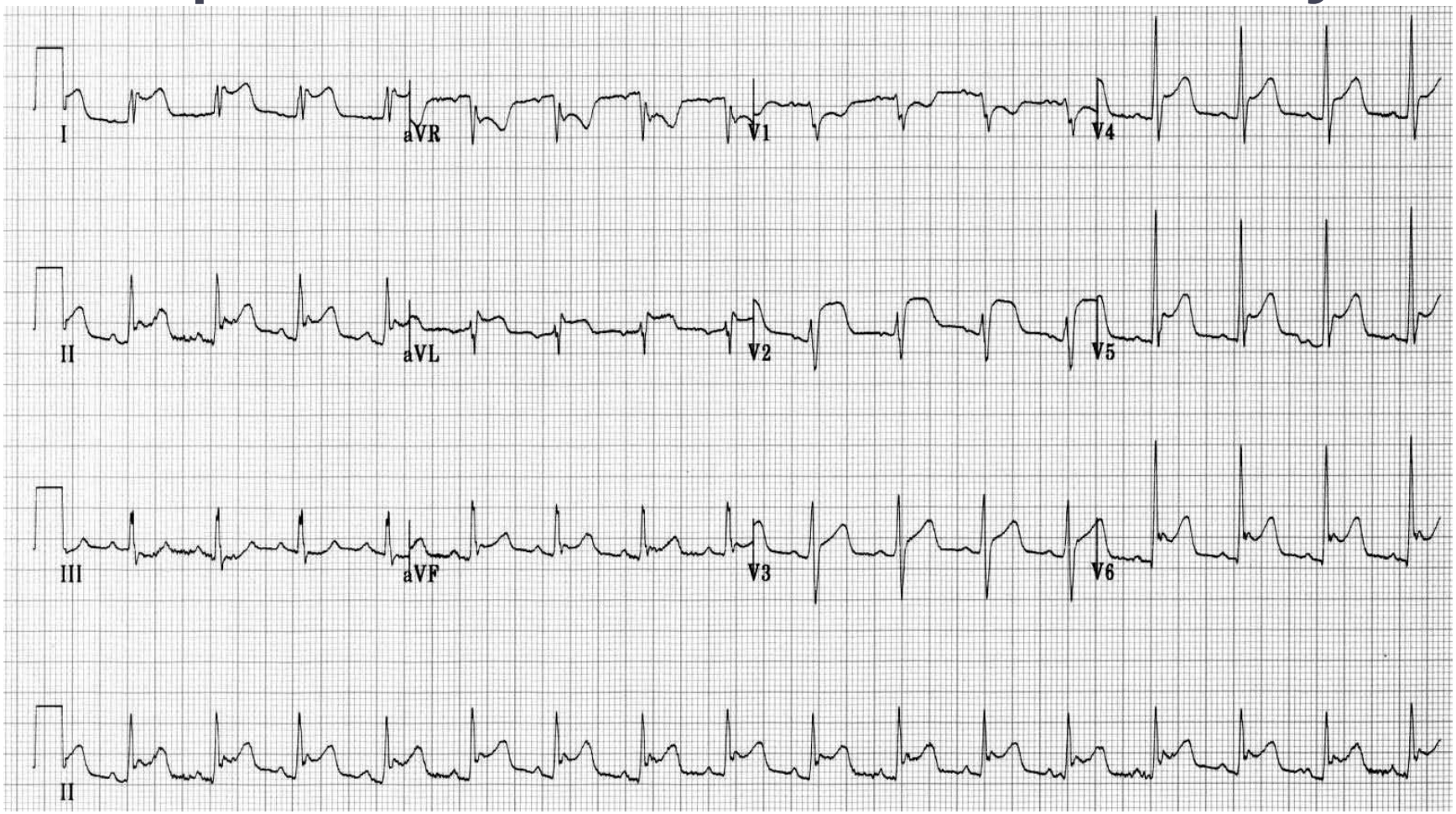
Third Degree AV Block

- Note the AV dissociation due to heart block



The atrial mechanism is sinus while the ventricles are controlled by a junctional escape rhythm.

Acute Pericarditis: Don't forget to look for signs of tamponade on EKG and clinically



Cardiac Tamponade