

2020 American Heart Association Virtual Cardiac Symposium

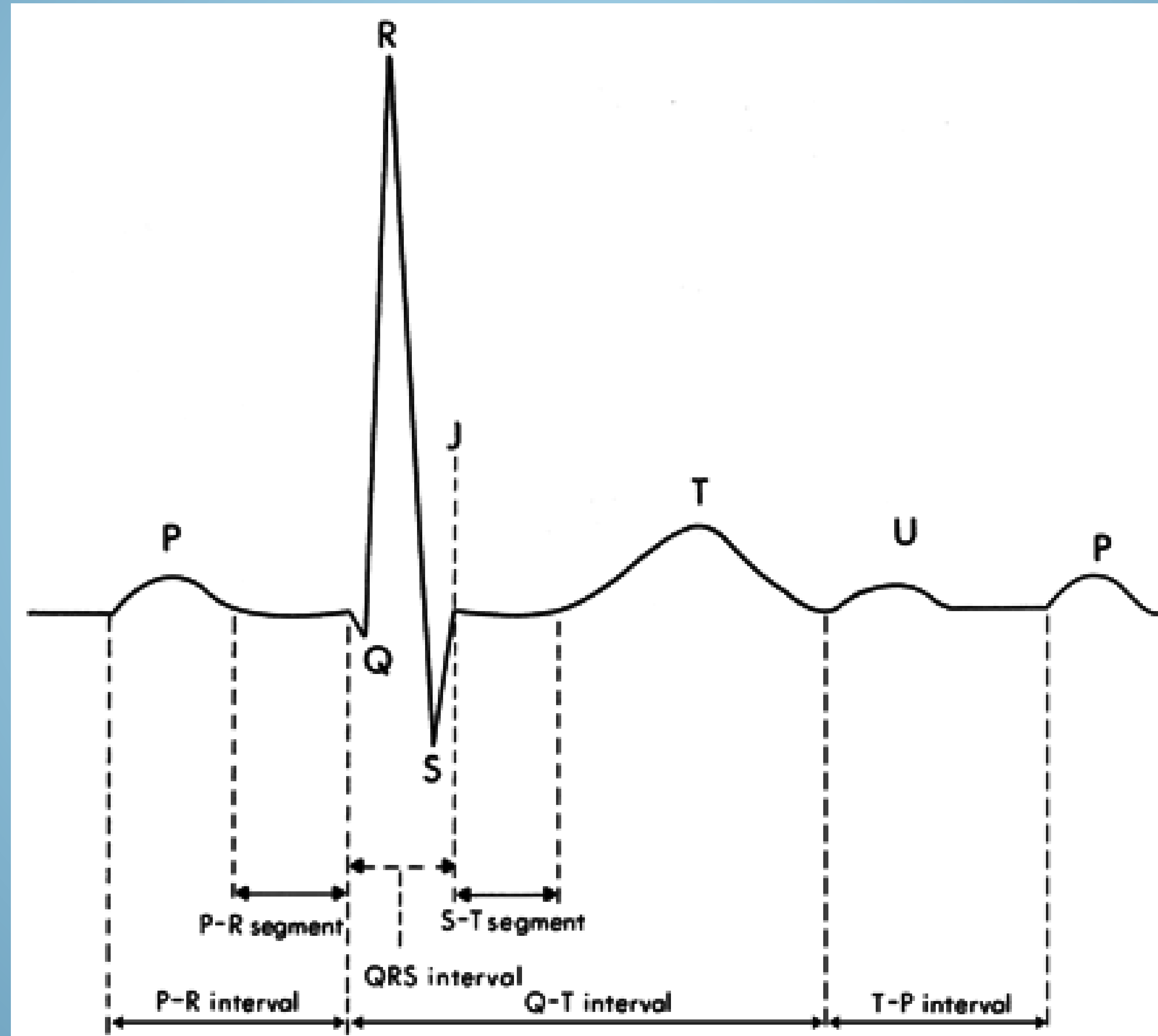
ECG Review 2020

Eric Hockstad, MD

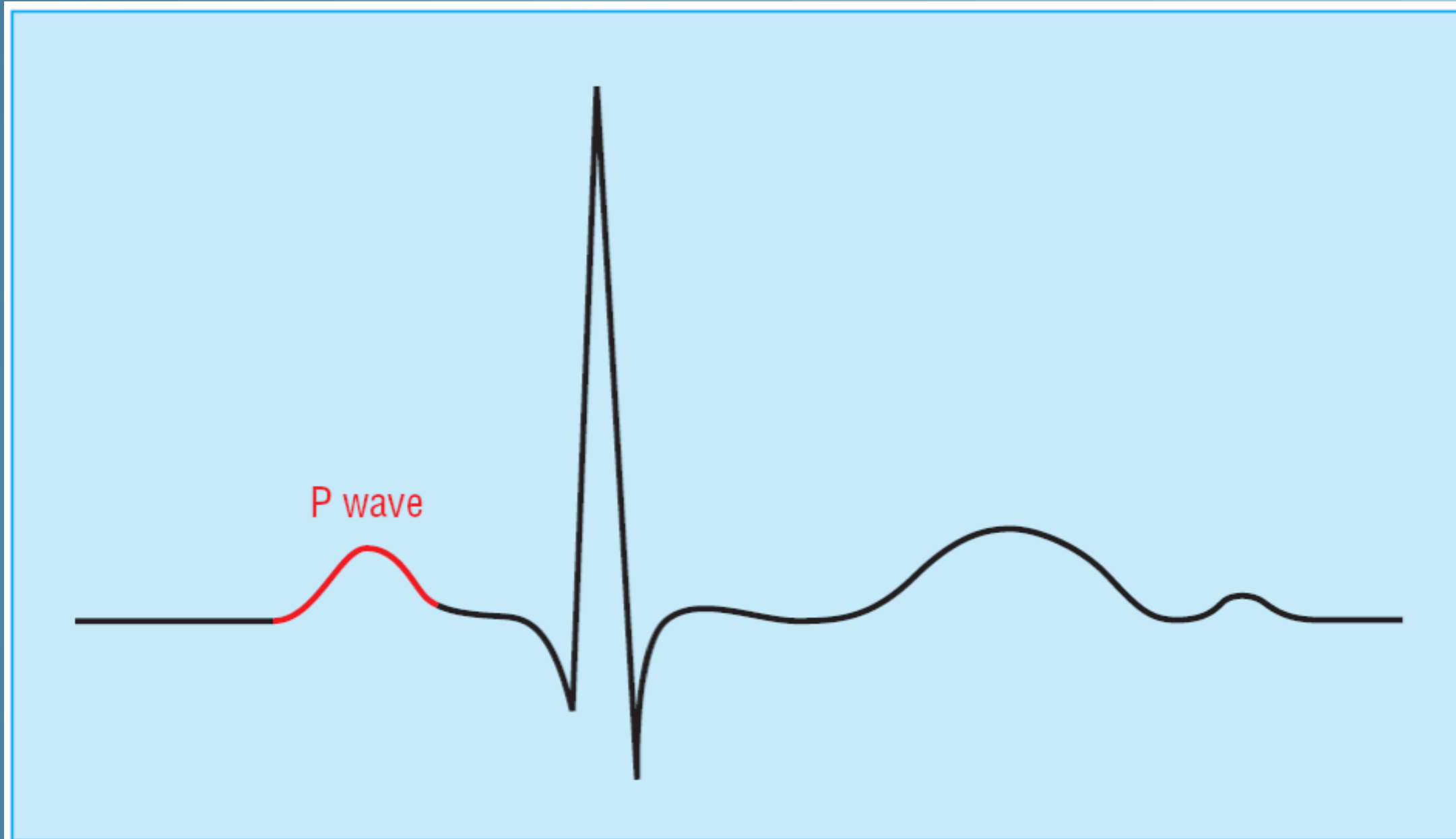
Medical Director of Cardiac Cath Labs

University of Kansas Medical System

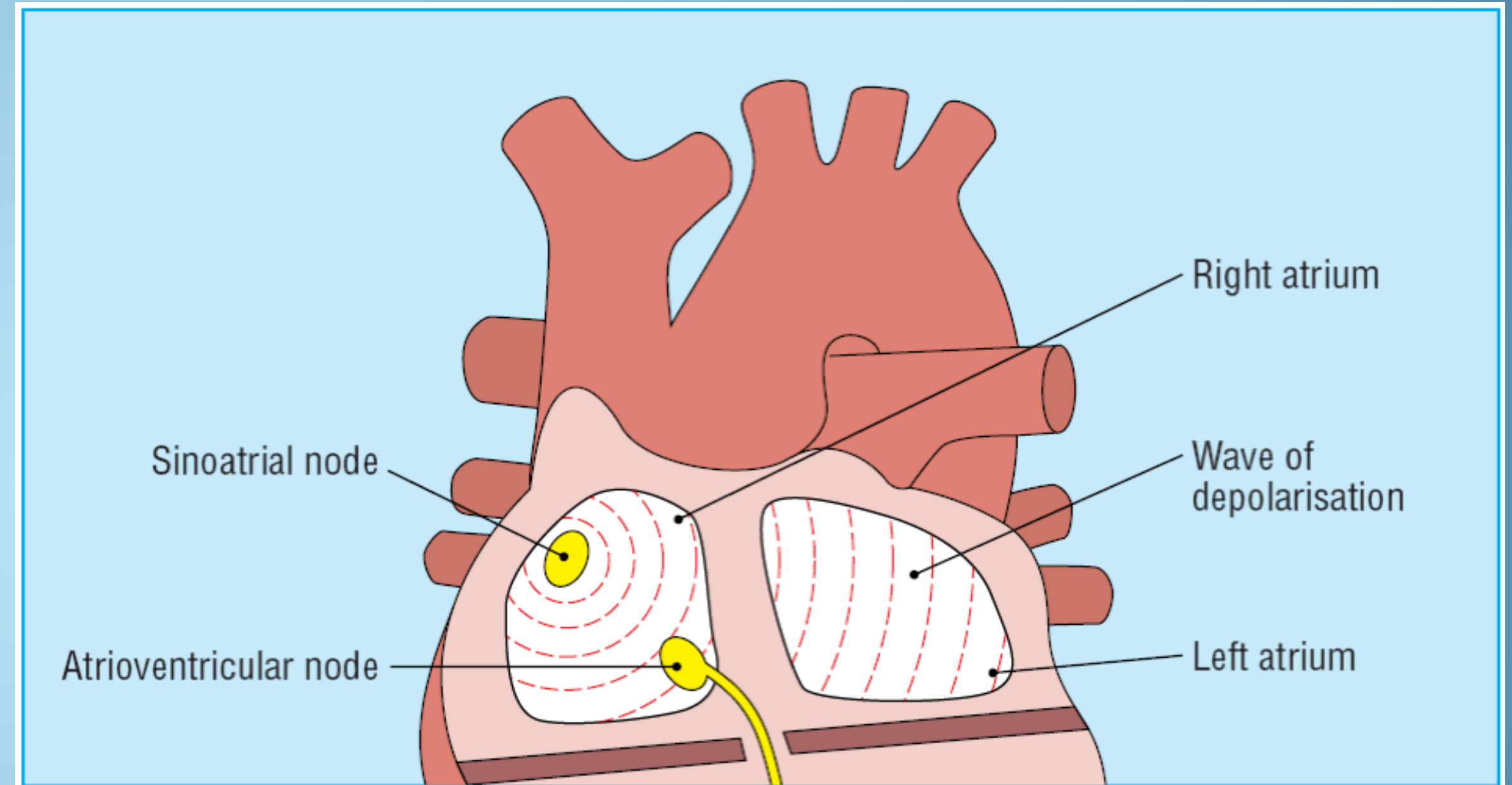
ECG Basics



ECG Basics

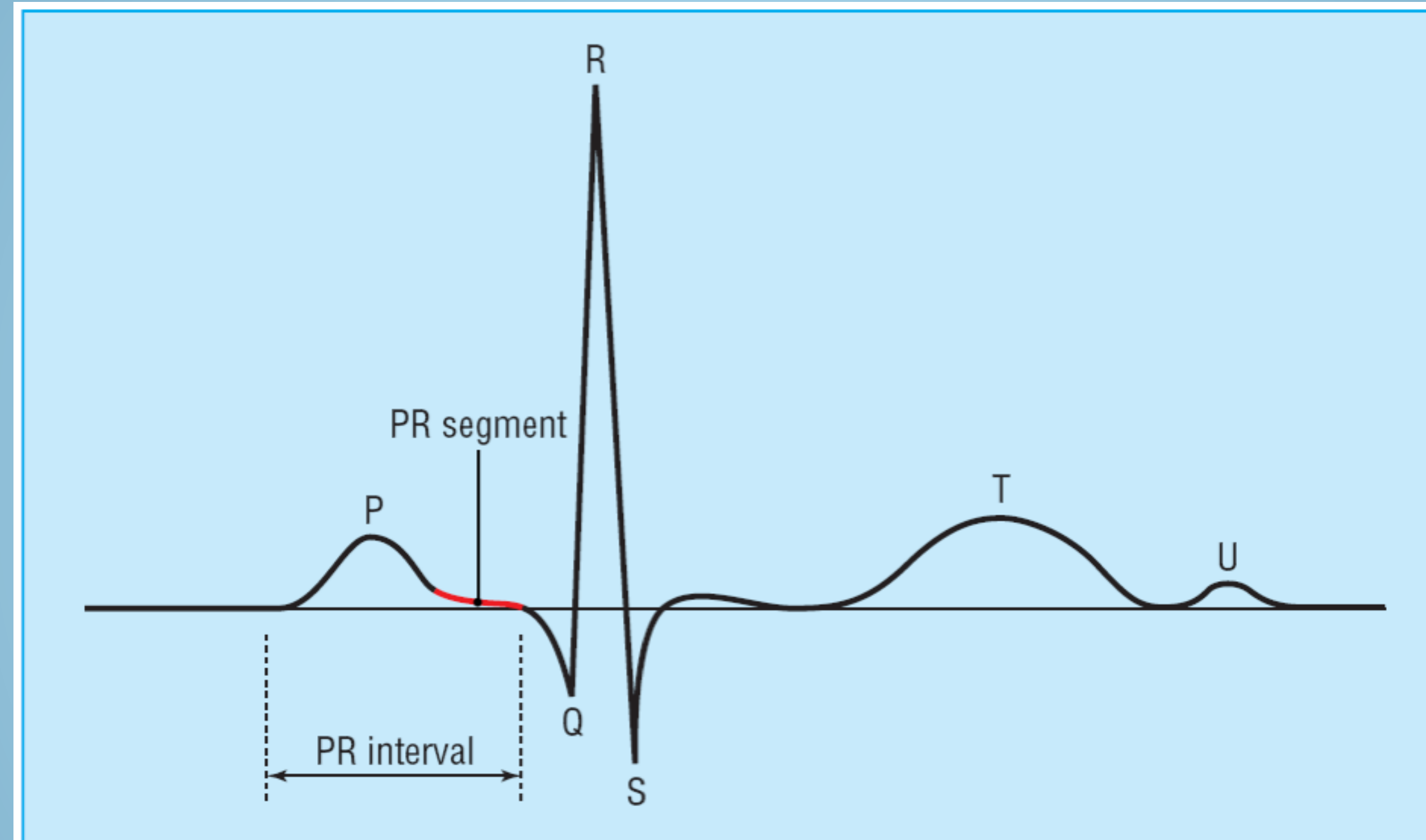


Complex showing P wave highlighted



Atrial depolarisation gives rise to the P wave

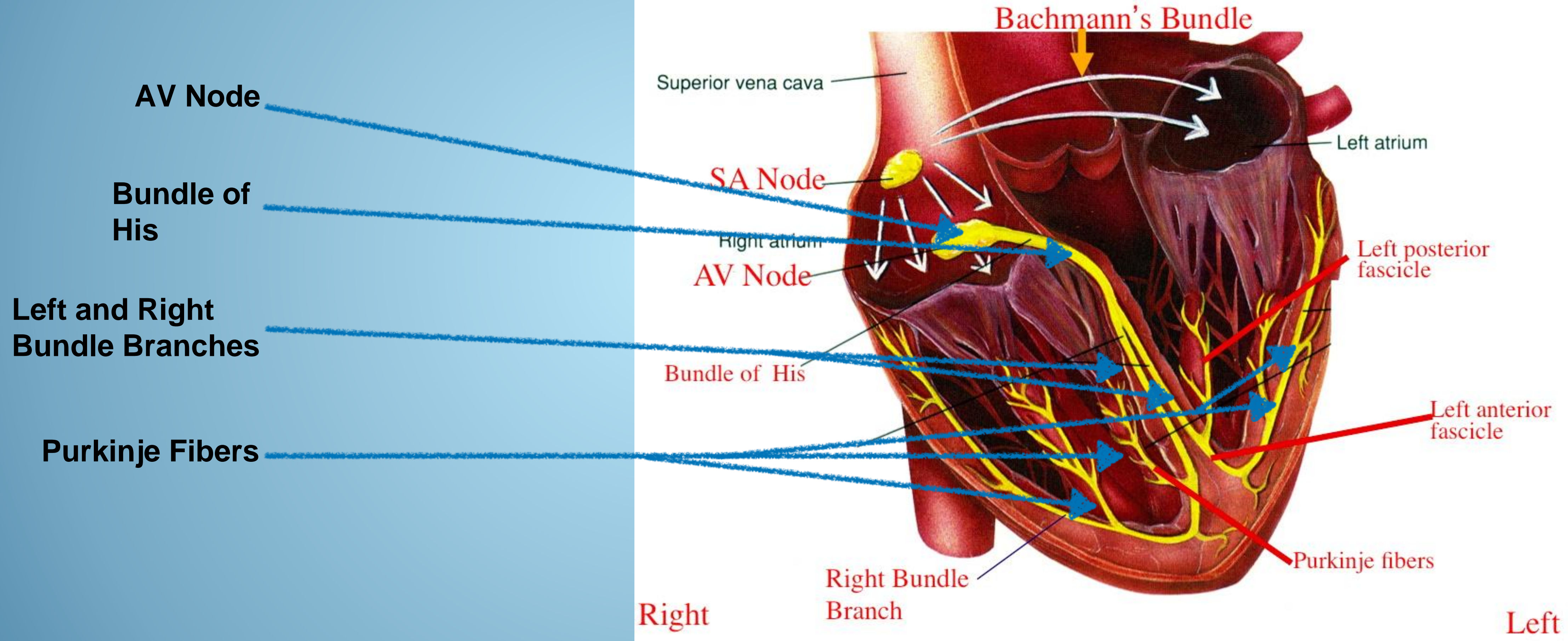
PR Interval / Segment



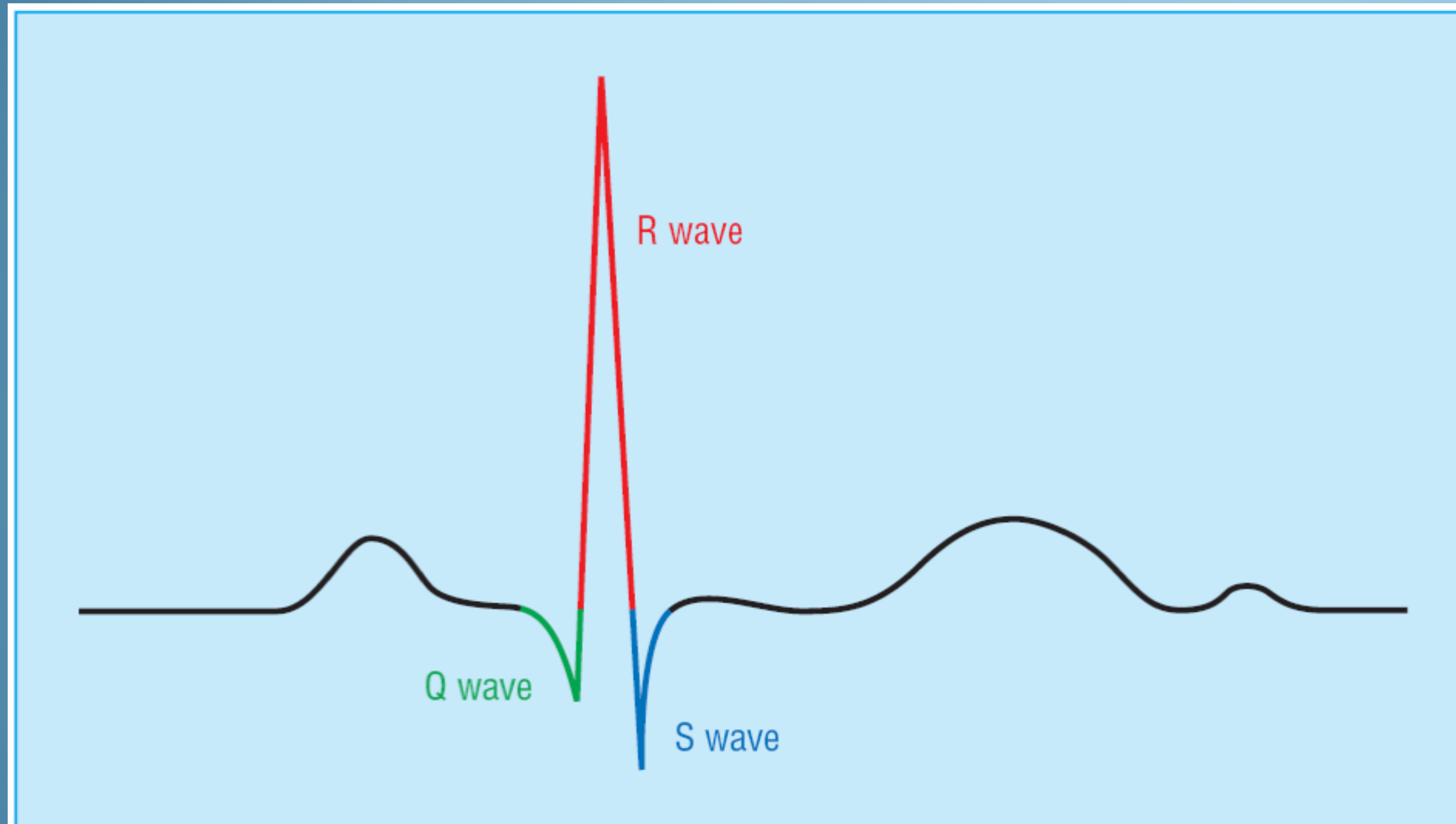
Normal duration of PR interval is 0.12-0.20 s (three to five small squares)

ECG Basics

Electrical Conduction System of Heart



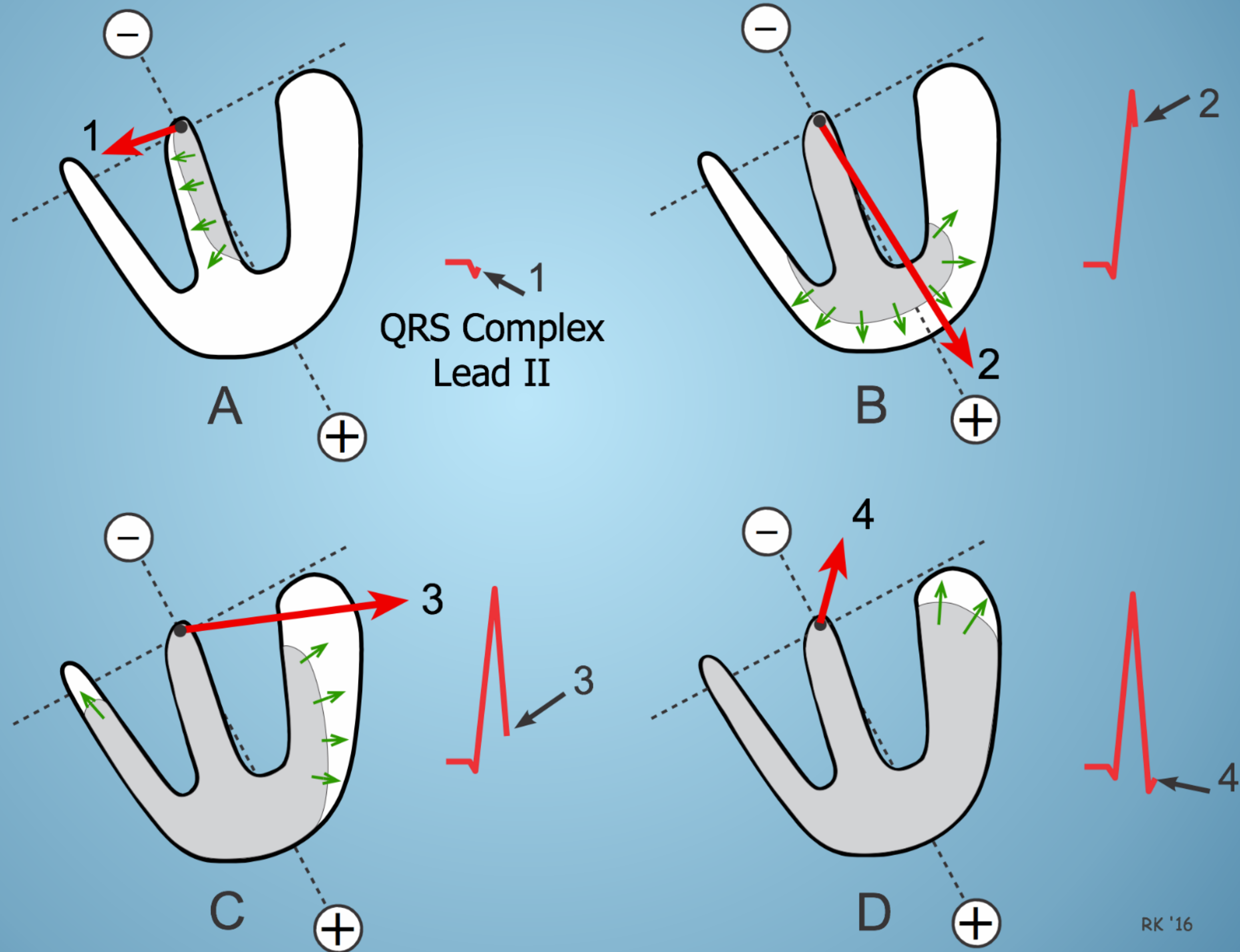
QRS Complex



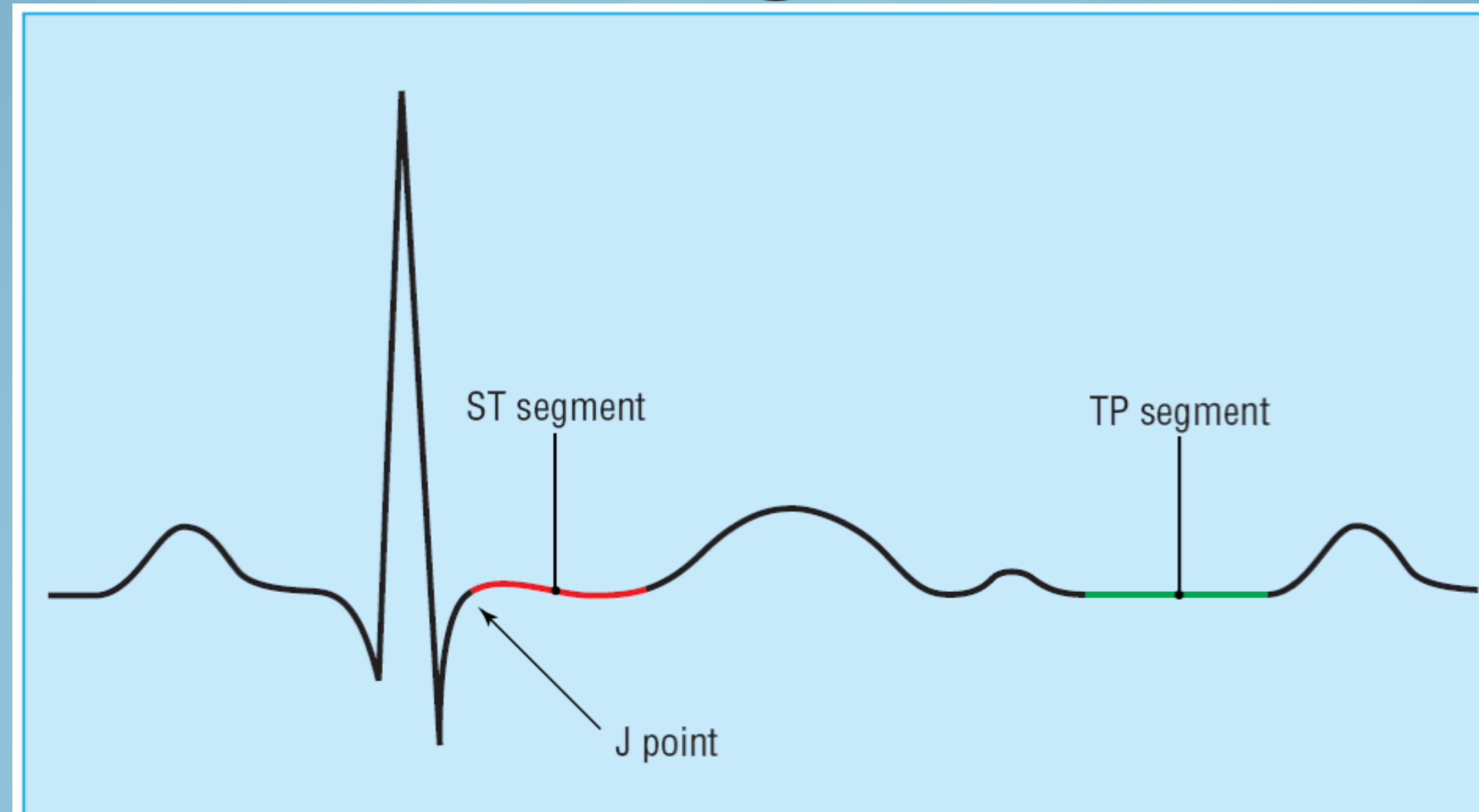
Composition of QRS complex

- **Q wave** – Any initial negative deflection
- **R wave** – Any positive deflection
- **S wave** – Any negative deflection after an R wave

QRS=Ventricular depolarization



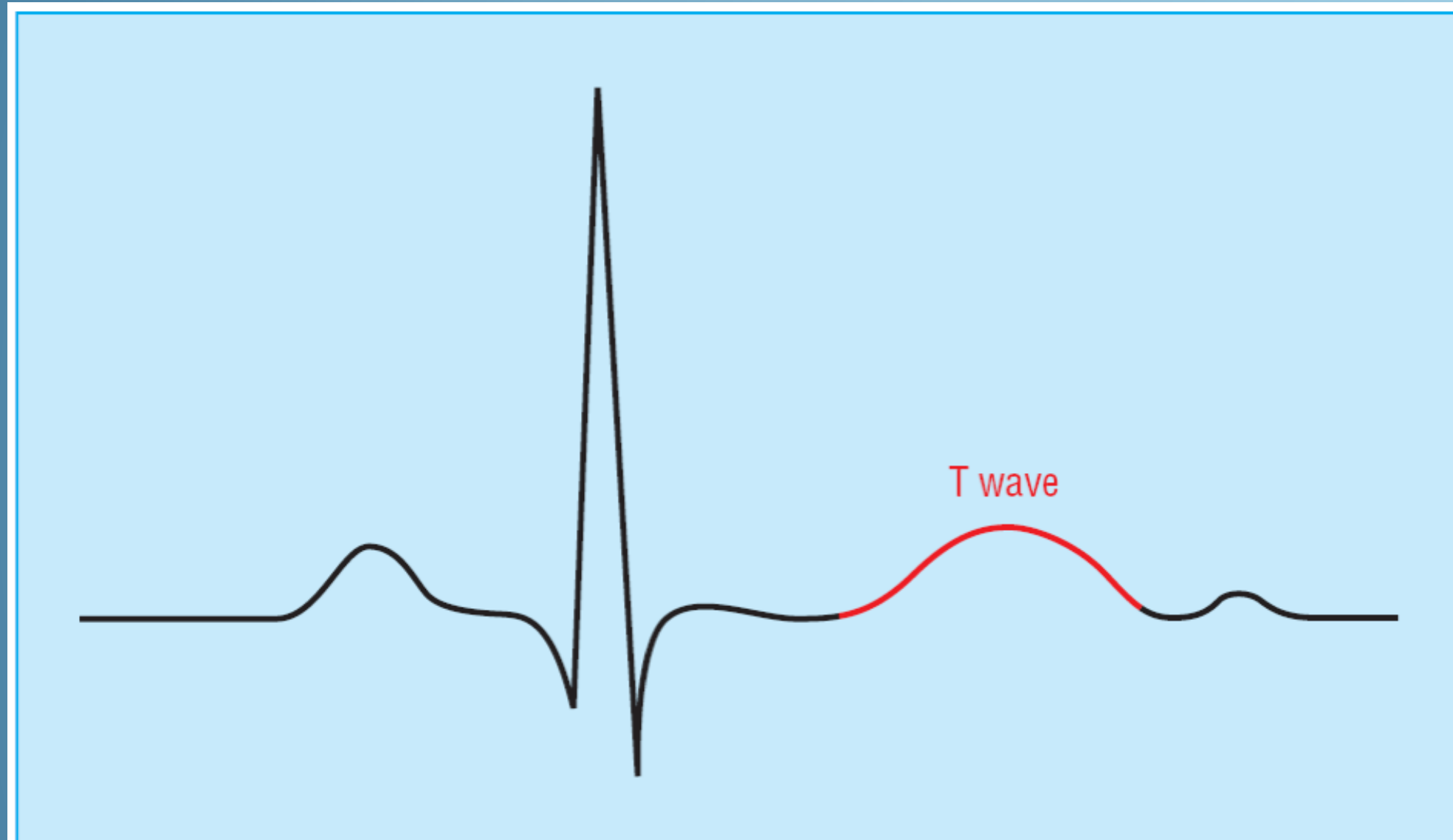
ST Segment



The ST segment should be in the same horizontal plane as the TP segment; the J point is the point of inflection between the S wave and ST segment

- Segment between end of QRS complex (J point) and beginning of T wave
 - Represents state of unchanged polarization between end of depolarization and beginning of repolarization
 - Should be on the same plane as the TP segment (between T wave and next P)

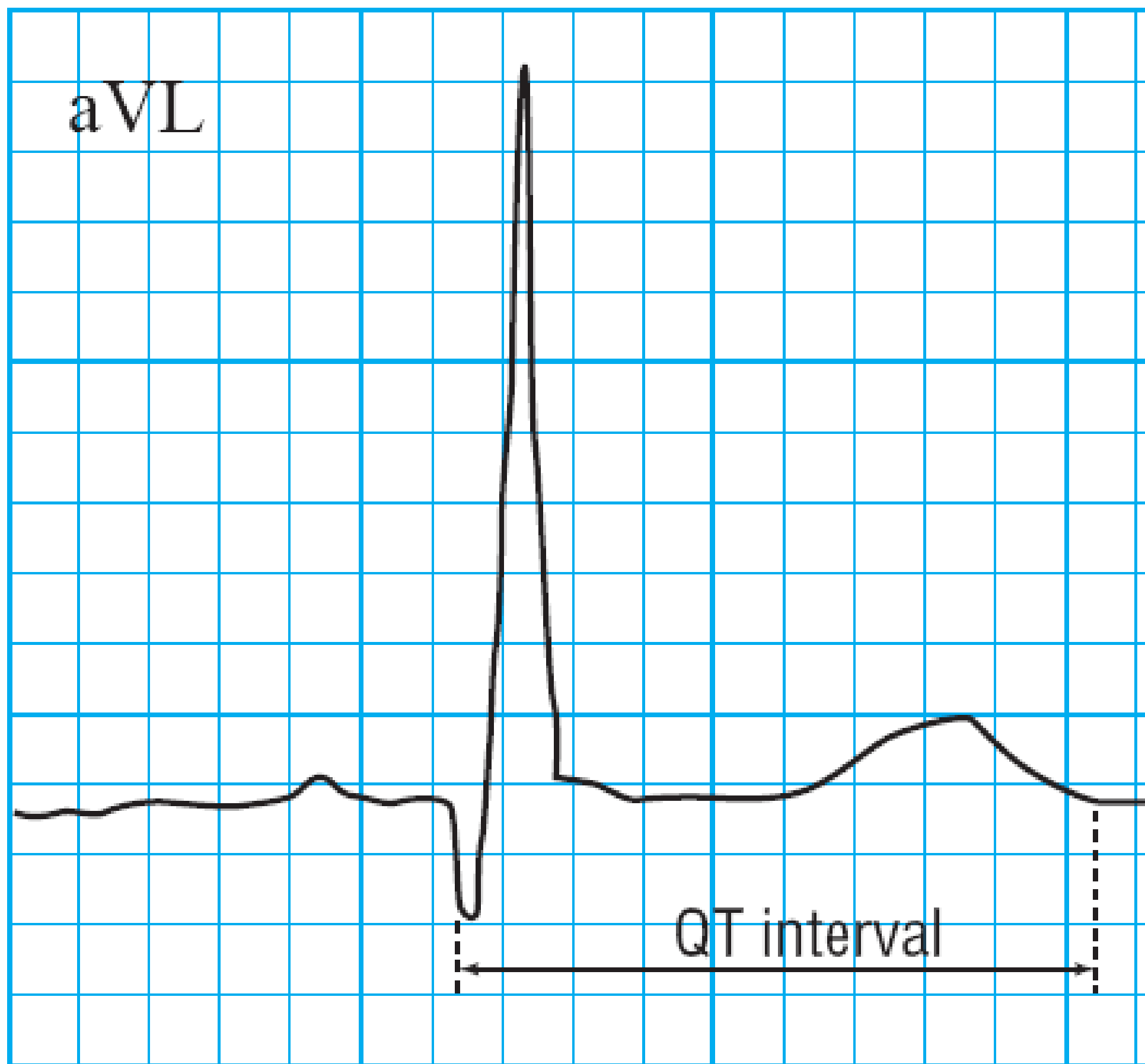
T Wave



Complex showing T wave highlighted

- Represents ventricular repolarization
 - Occurs in general direction of ventricular depolarization (QRS)
 - Upright in I, II, V5-V6
 - Inverted in aVR

QT Interval



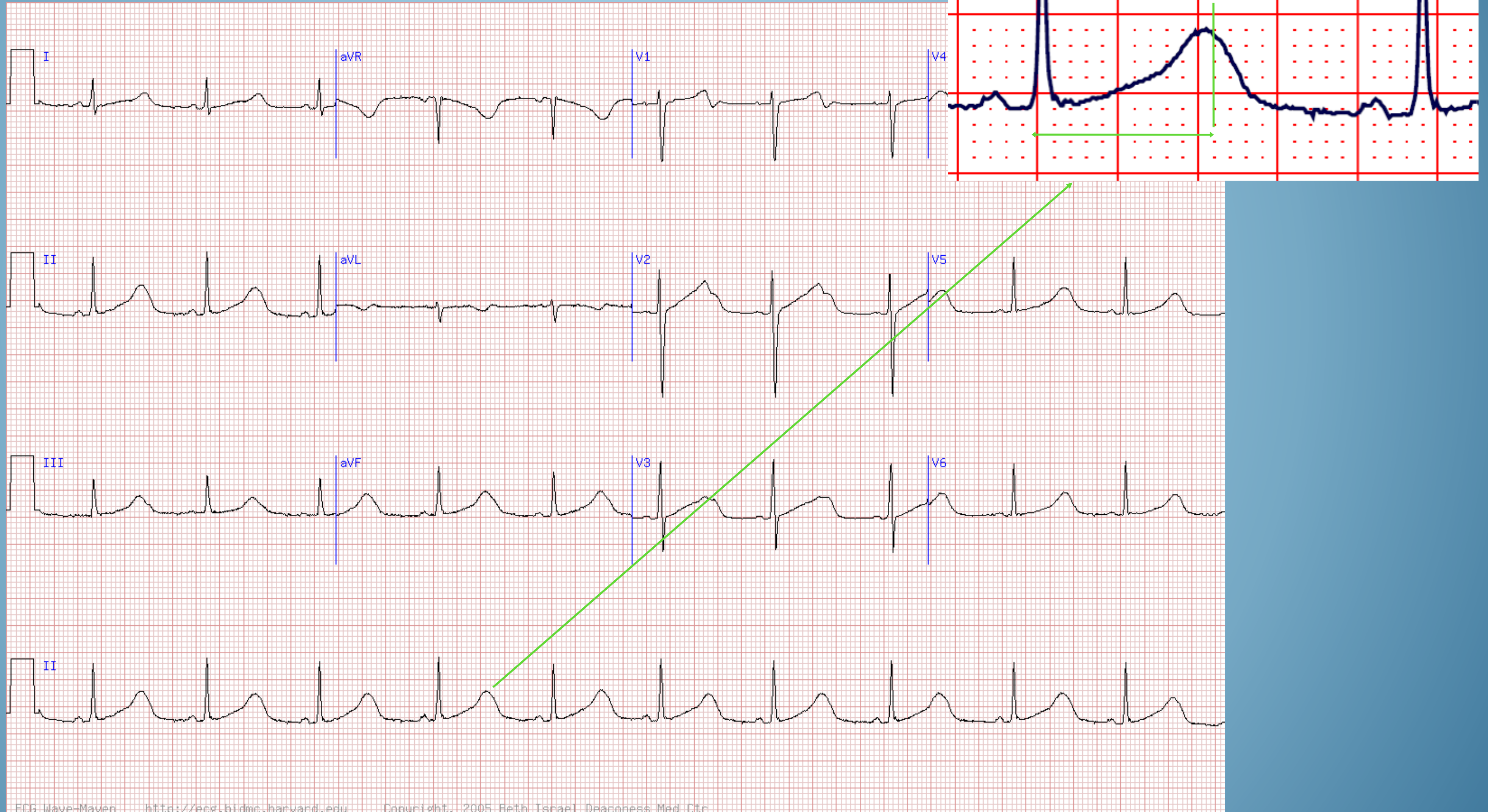
The QT interval is measured in lead aVL as this lead does not have prominent U waves (diagram is scaled up)

QT Interval

- Normal = 350 – 450 ms for HR=60
 - For every 10-beat increase or decrease of the rate, 20 ms is deducted or added to the QT
- Bazett's correction
 - $QT_c = \text{measured QT (secs)} \div \text{square root of RR interval (secs)}$
- Obvious abnormality if $QT > \frac{1}{2} \text{ RR interval}$ (extending more than 1/2 way to next QRS)
- Prolonged QT can lead to Torsades de pointes (the QRS complexes “twist” around the isoelectric line)



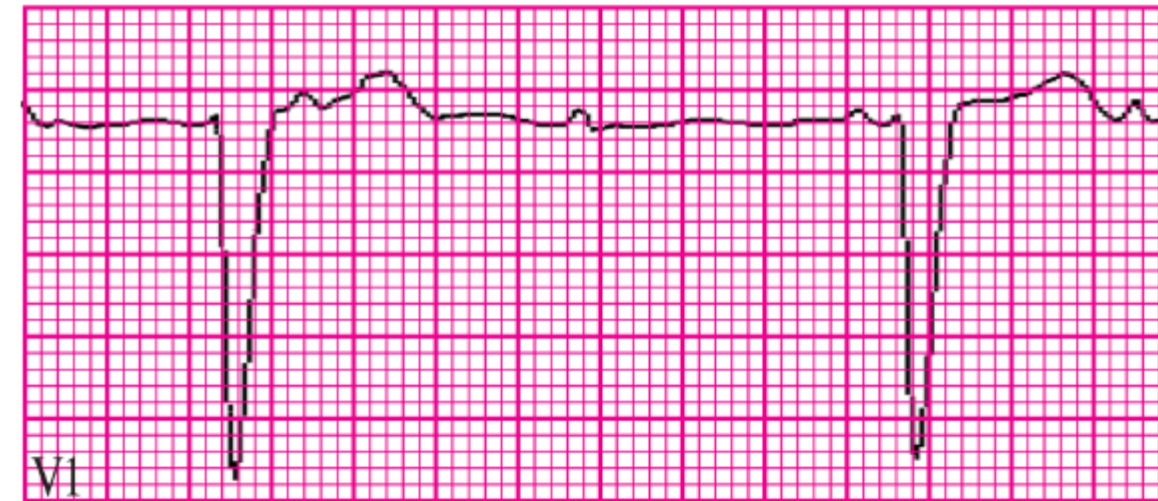
QT Interval



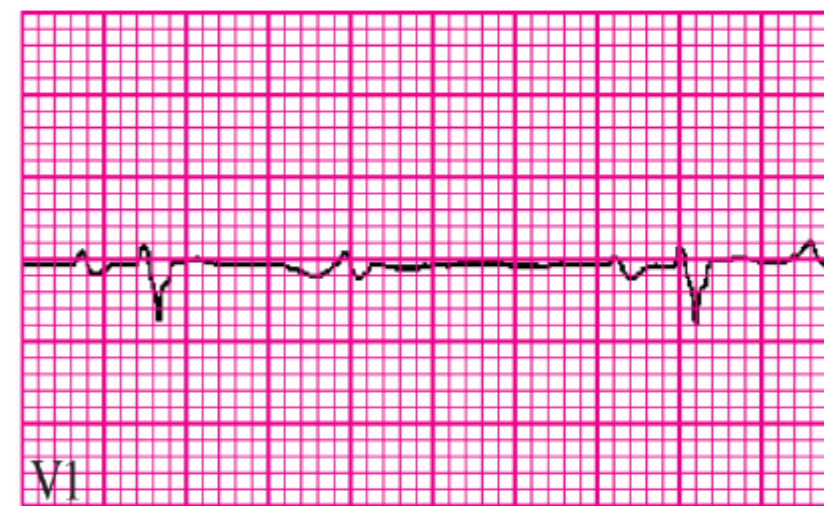
8-Step Method ECG Interpretation

1. ~~Rate~~
2. Rhythm
3. ~~Axis~~
4. ~~P wave~~
5. PR interval
6. QRS complex
7. QT interval
8. ST segment and T wave

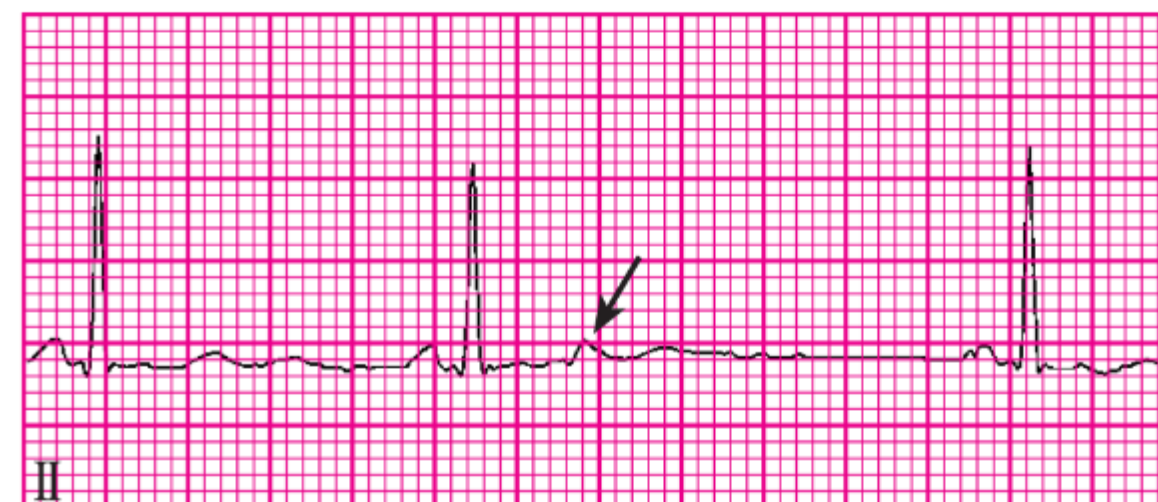
Heart Block



Complete Heart Block
No relationship between p wave and qrs



2nd degree heart block
Every other beat is dropped



nonconducted premature
atrial beat

The Heart Block Poem

- If the R is far from the P, then you have a 1st Degree



- PR gets longer, longer, longer, drop, it's a case of Wenckebach!



- If some R's don't get through, prepare to pace that Mobitz II!



- If the R's & P's don't agree, prepare to PACE that 3rd degree!



Rhythm



Atrial Flutter



Atrial Flutter

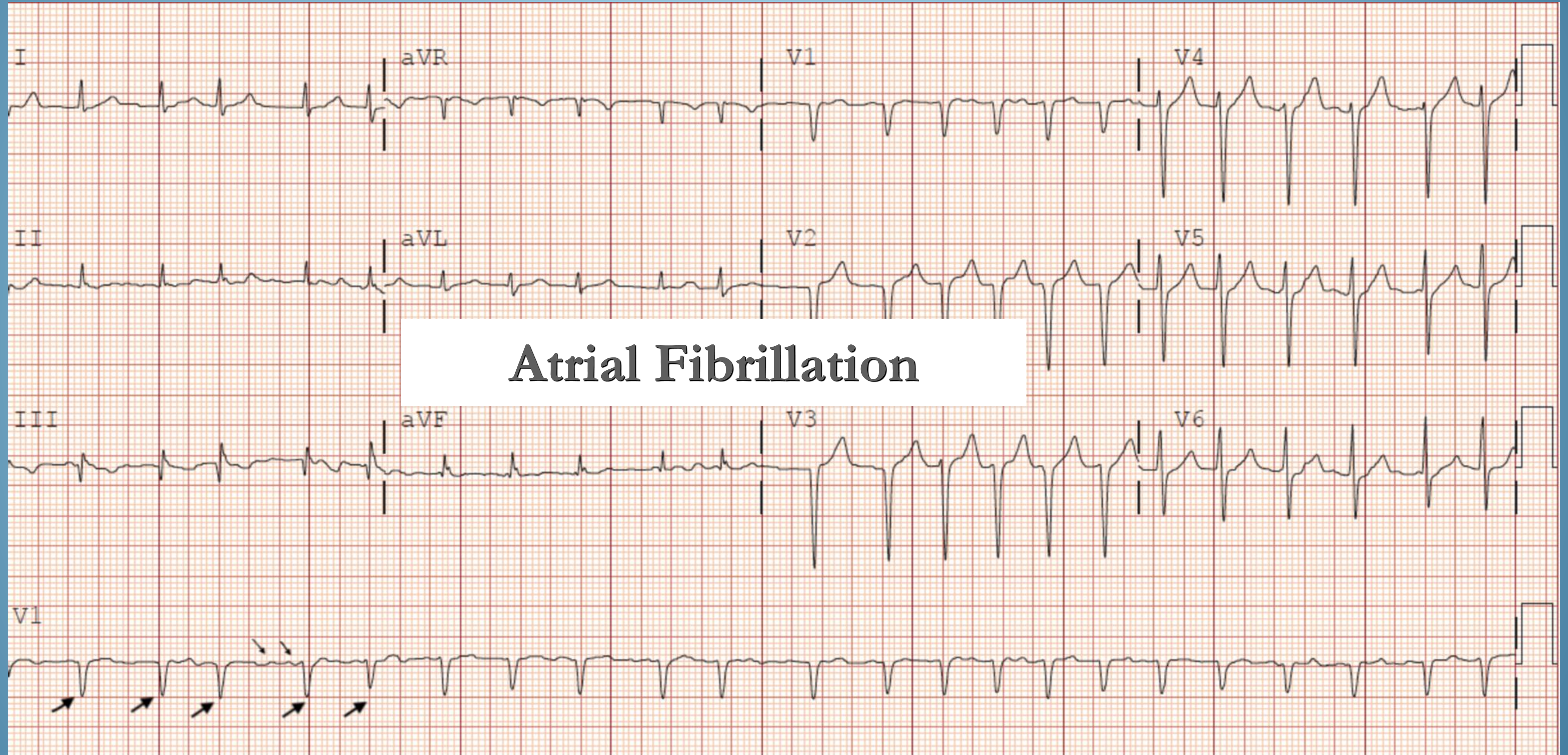


Sinus Tachycardia



Atrial Flutter

Irregularly irregular

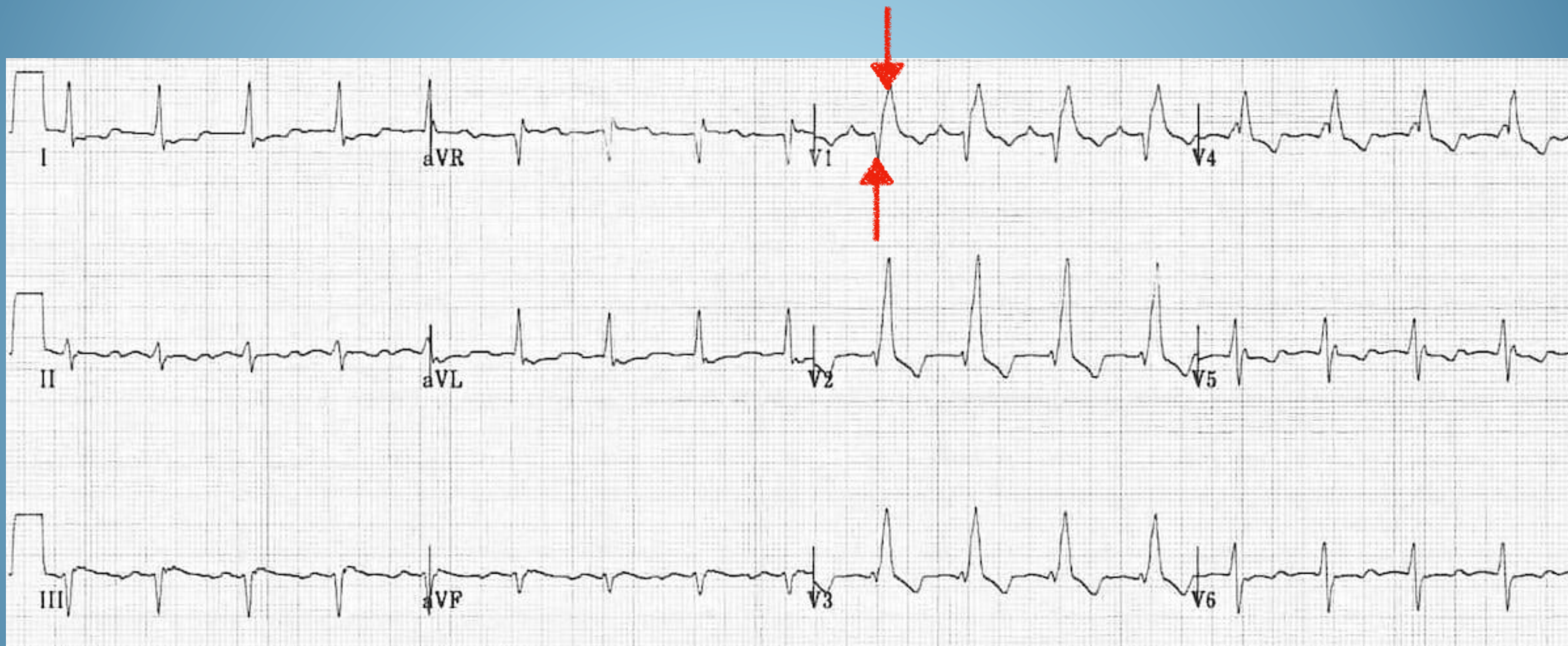


Right Bundle Branch Block

In RBBB, activation of the right ventricle is delayed as depolarisation has to spread across the septum from the left ventricle.

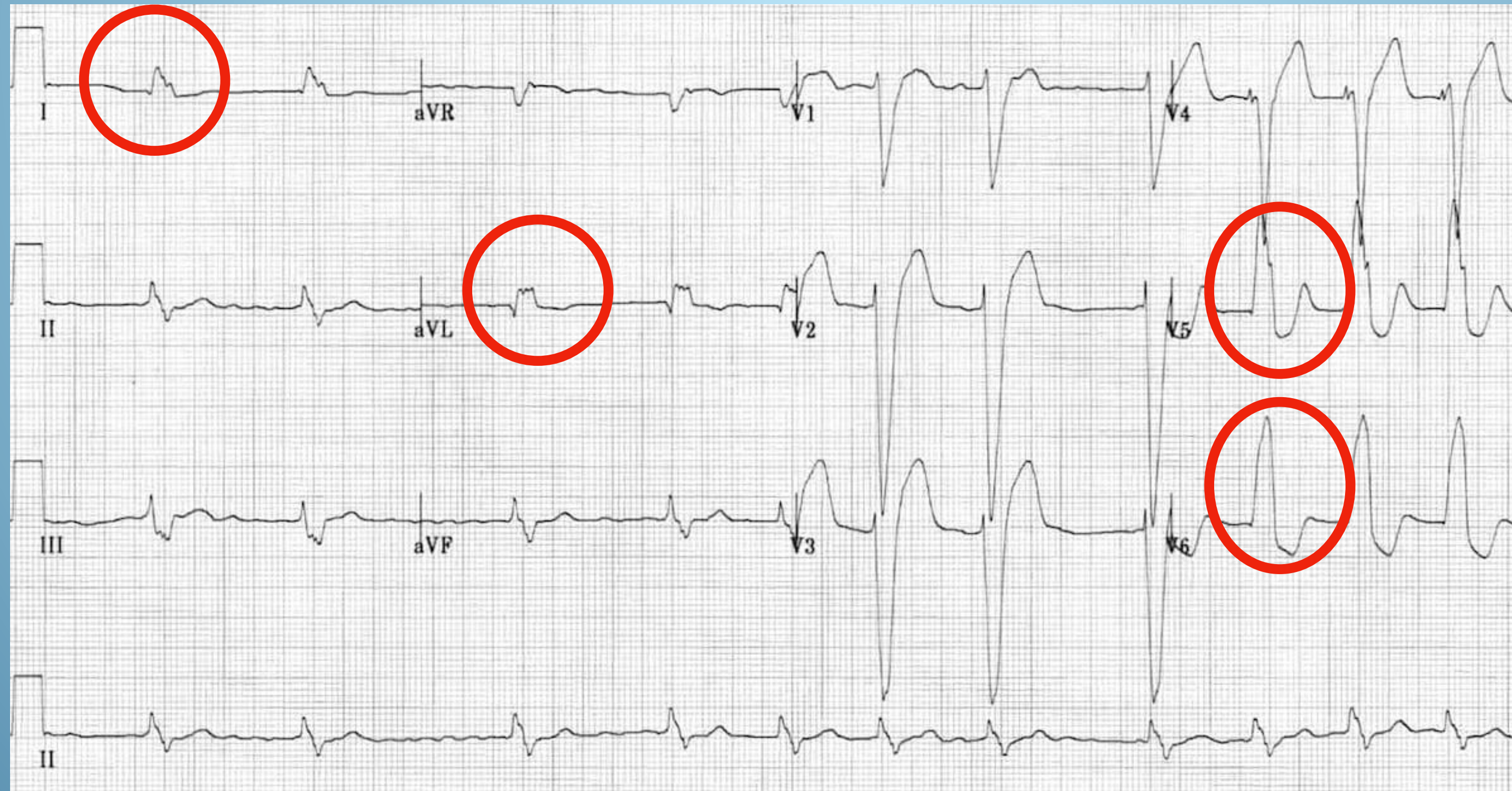
- The left ventricle is activated normally, meaning that the early part of the QRS complex is unchanged.
- The delayed right ventricular activation produces a secondary R wave (R') in the right precordial leads (V1-3) and a wide, slurred S wave in the lateral leads.
- Delayed activation of the right ventricle also gives rise to secondary repolarization abnormalities, with ST depression and T wave inversion in the right precordial leads.

Right bundle branch block



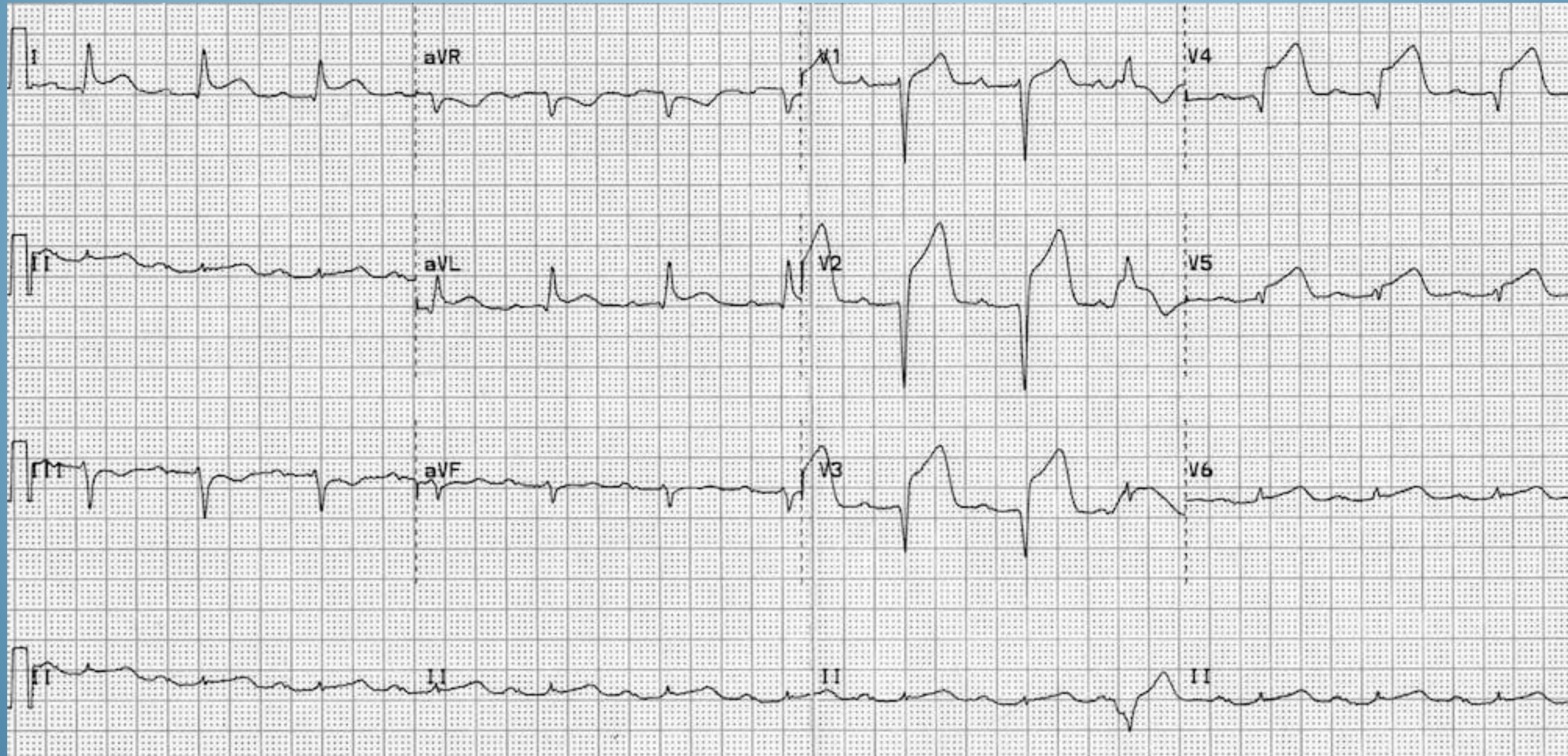
Left bundle branch block

- The overall direction of depolarization (from right to left) produces tall R waves in the lateral leads (I, V5-6) and deep S waves in the right precordial leads (V1-3), and usually leads to left axis deviation.
- As the ventricles are activated sequentially (right, then left) rather than simultaneously, this produces a broad or notched ('M'-shaped) R wave in the lateral leads.



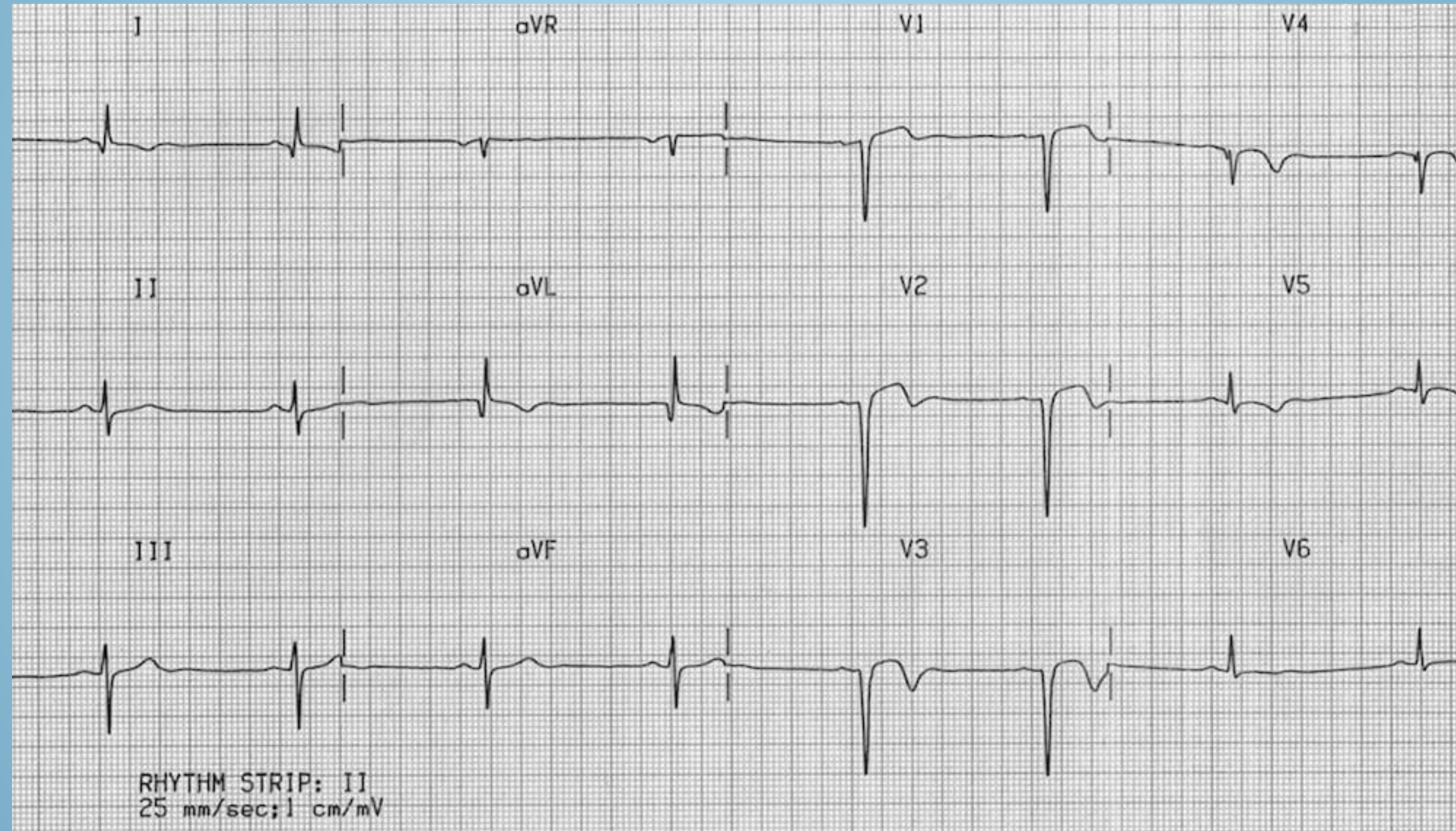
ST elevation

The most common cause is Myocardial infarction



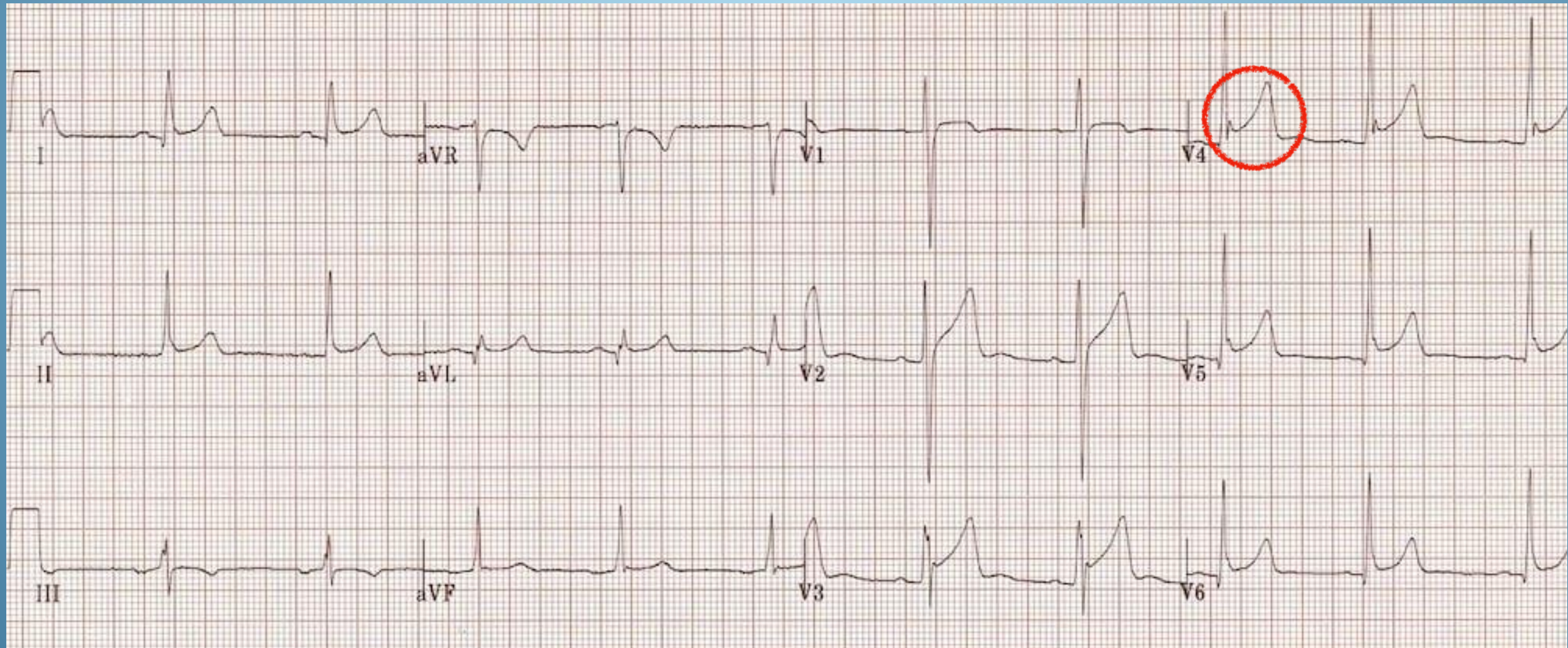
ST elevation

Ventricular aneurysm



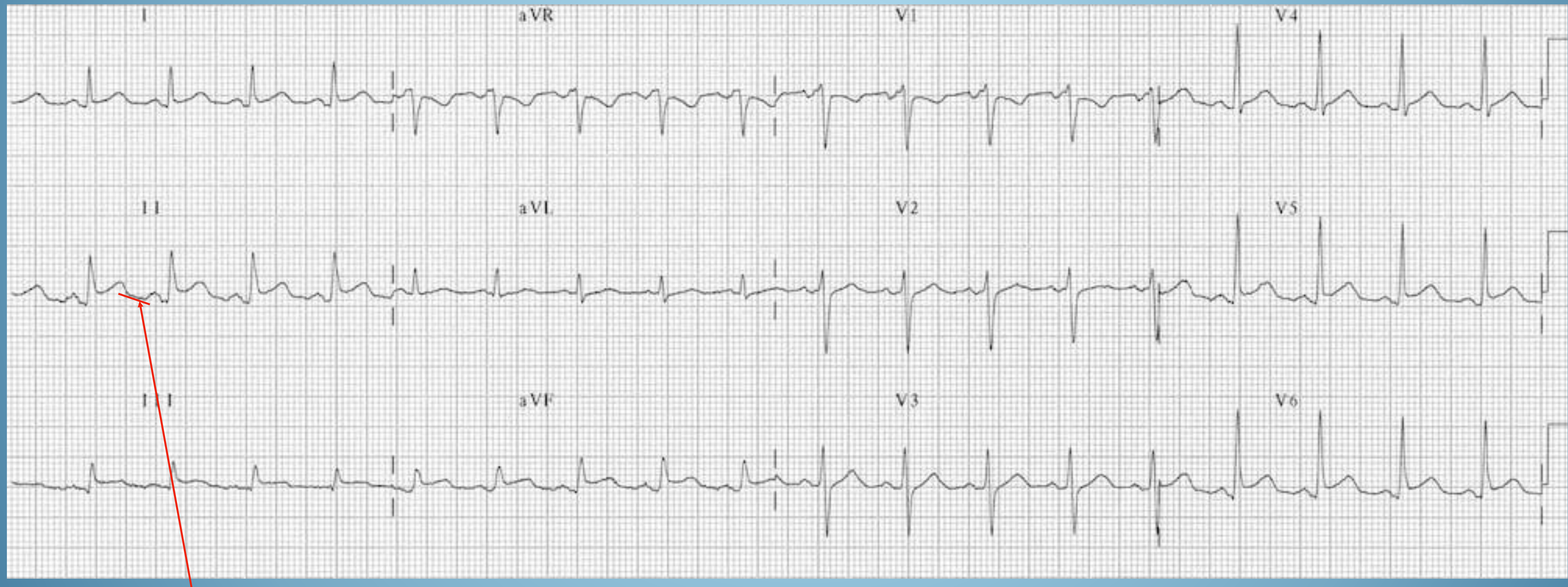
ST elevation

Early repolarization causes mild ST elevation with tall T-waves mainly in the precordial leads. There is often notching of the J-point — the “fish-hook” pattern.



ST Elevation

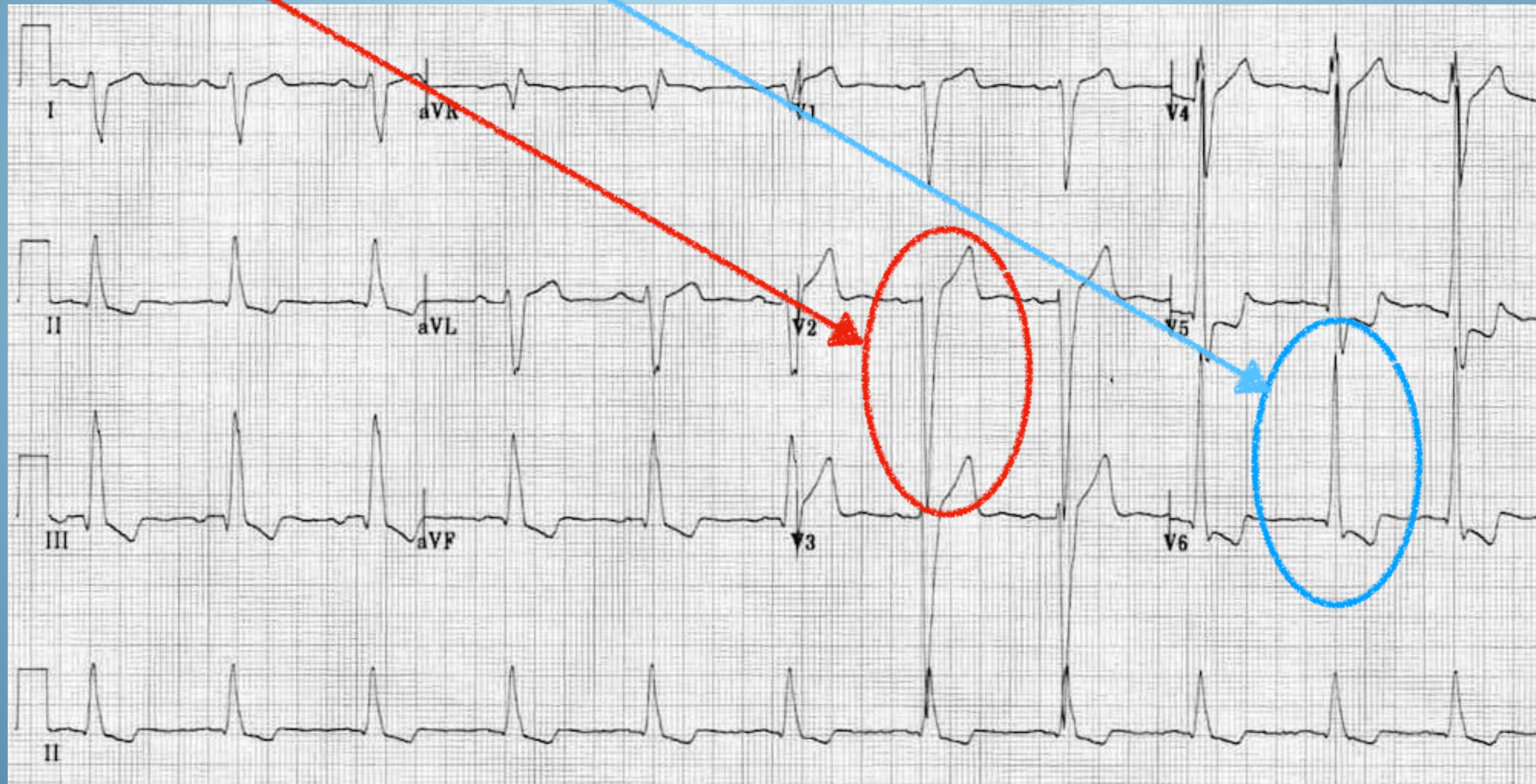
Acute Pericarditis causes widespread concave (“saddleback”) ST segment elevation with PR segment depression in multiple leads, typically involving I, II, III, aVF, aVL, and V2-6.



Spodick's sign Downsloping TP segment in patients with acute pericarditis

ST Elevation

Left Ventricular Hypertrophy (LVH) causes ST elevation in the leads with deep S-waves (usually V1-3) and ST depression/T-wave inversion in the leads with tall R waves (II, III, aVF, V5-6).

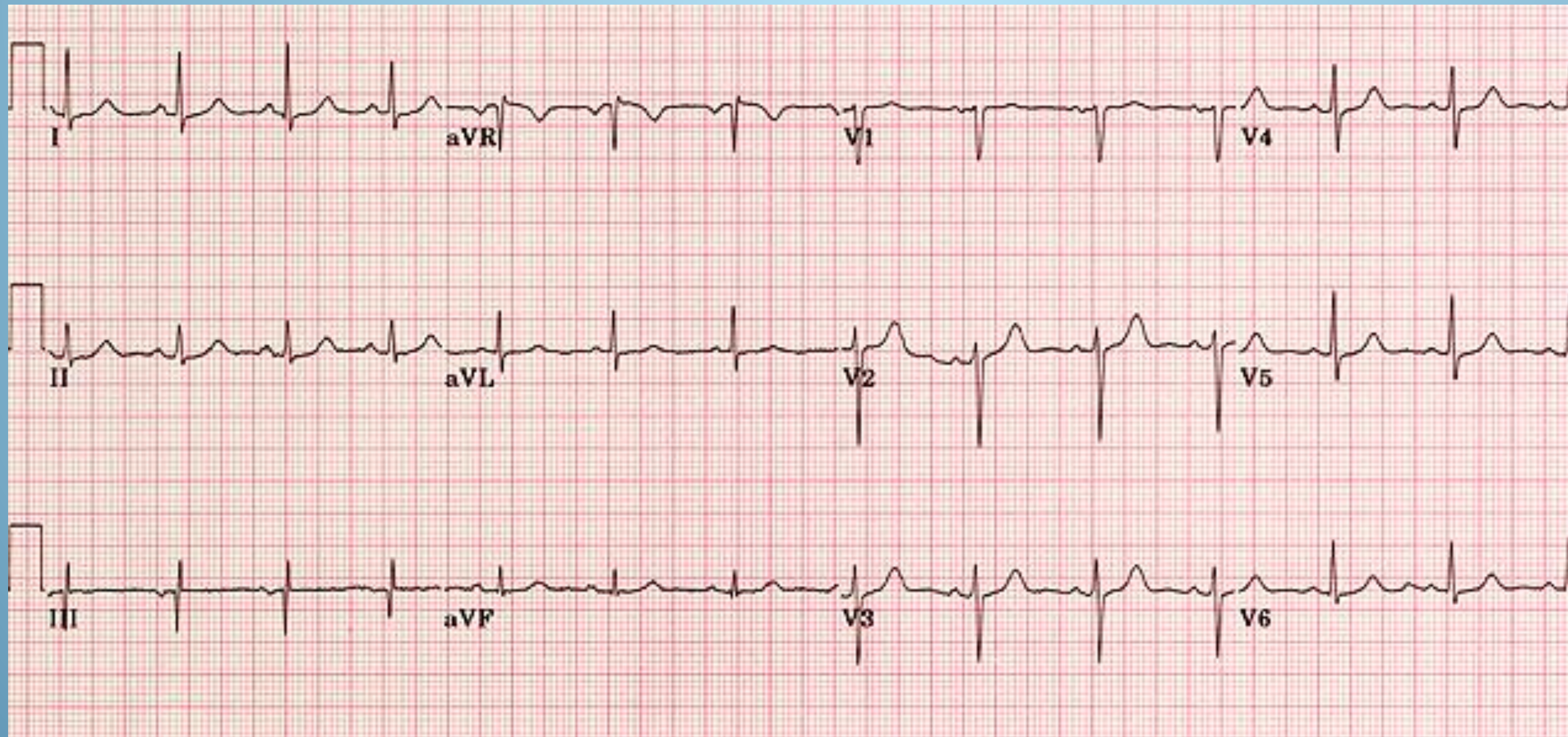


Definition of ST elevation MI

ST elevation of ? mm in contiguous leads except V2 and V3 • 1 mm

ST elevation of ? mm in men in leads V2 and V3 • 2 mm

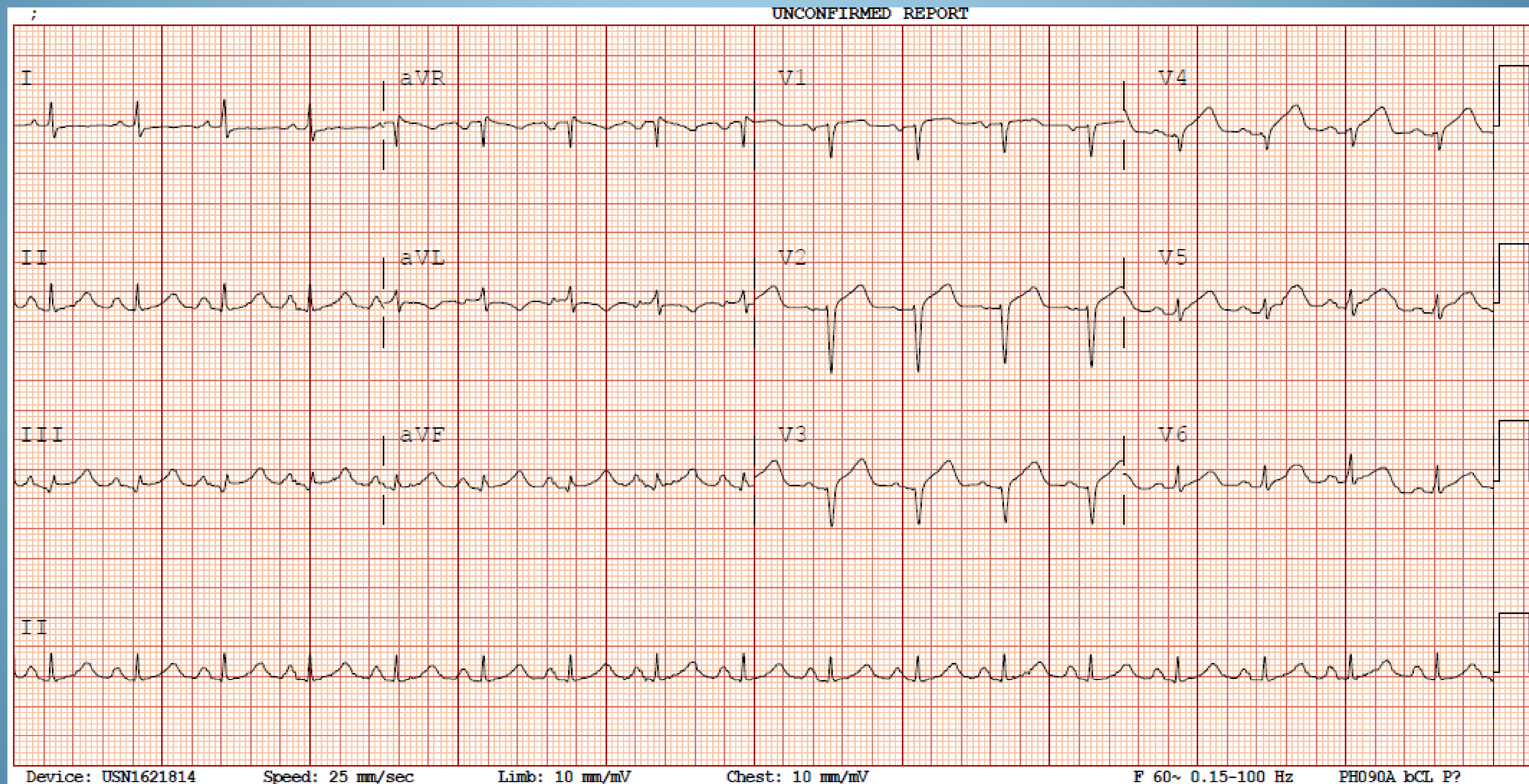
ST elevation of ? mm in women in leads V2 and V3 • 1.5 mm



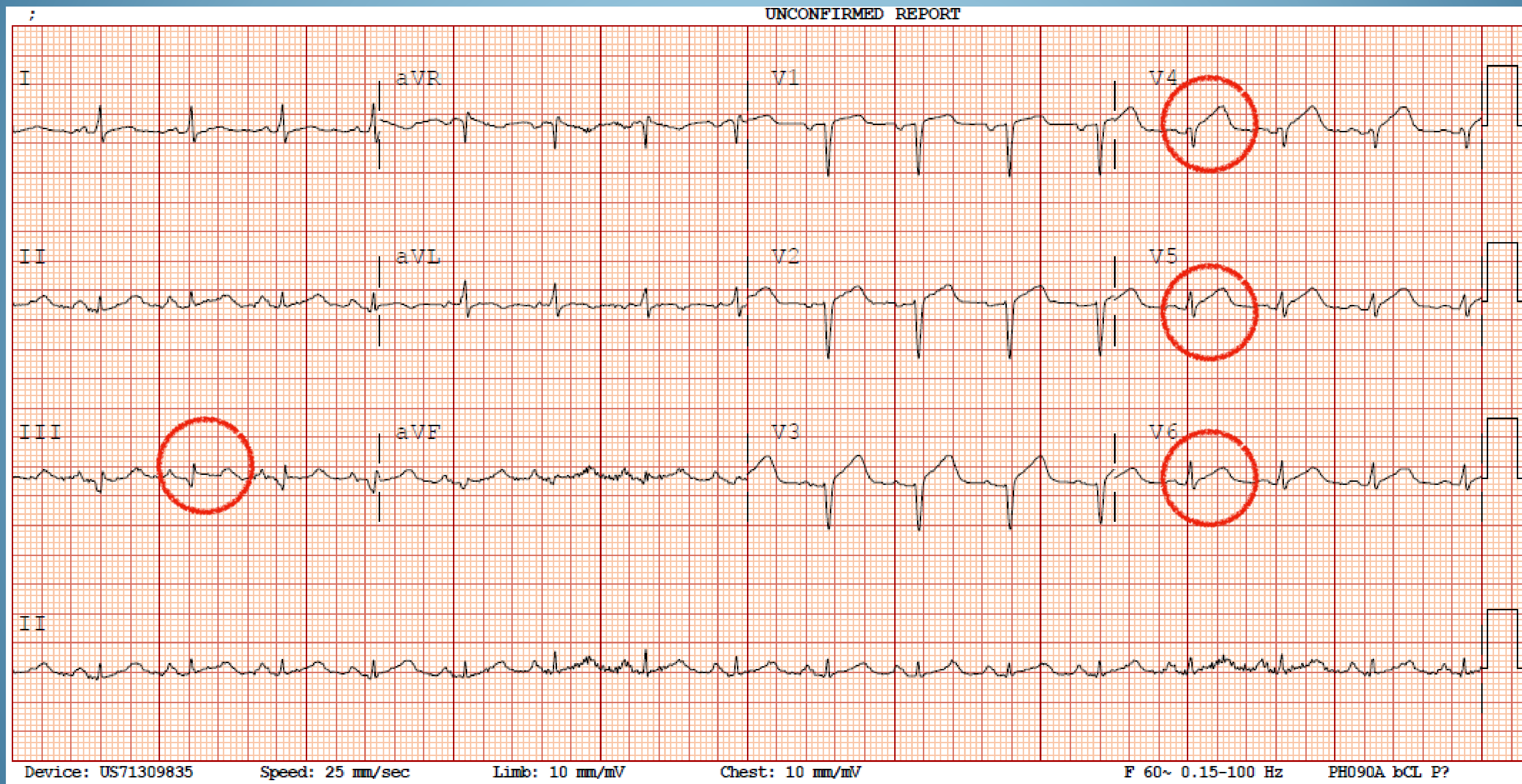
Clinical History

- 59 yo female presents to the Emergency Room complaining of shortness of breath for weeks, “has an appointment with PCP tomorrow but can’t wait”
- PMH: Diabetes, asthma, hypertension, hyperlipidemia, lymphedema

Initial EKG at 20:37



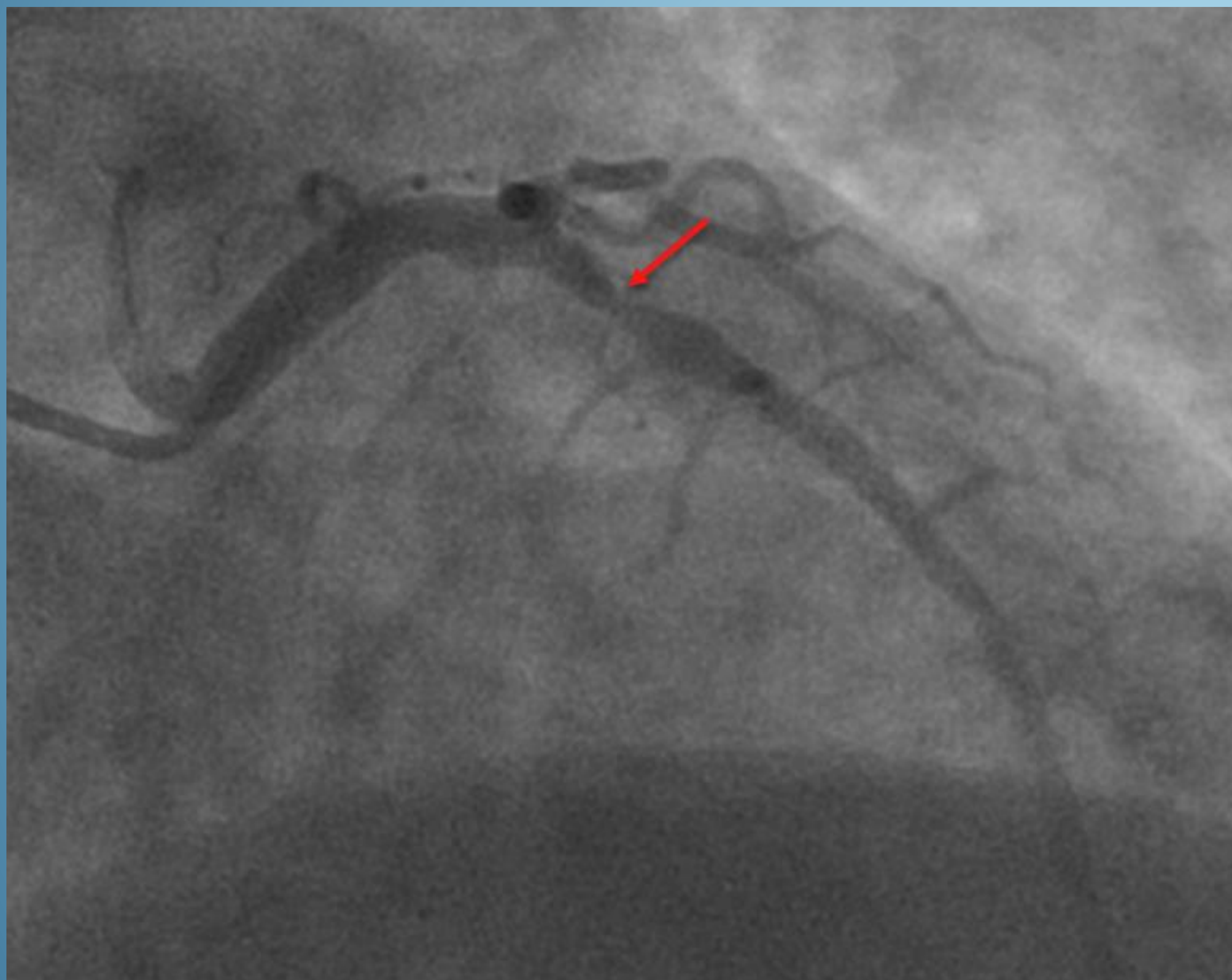
Second EKG at 22:49



Outcome Results

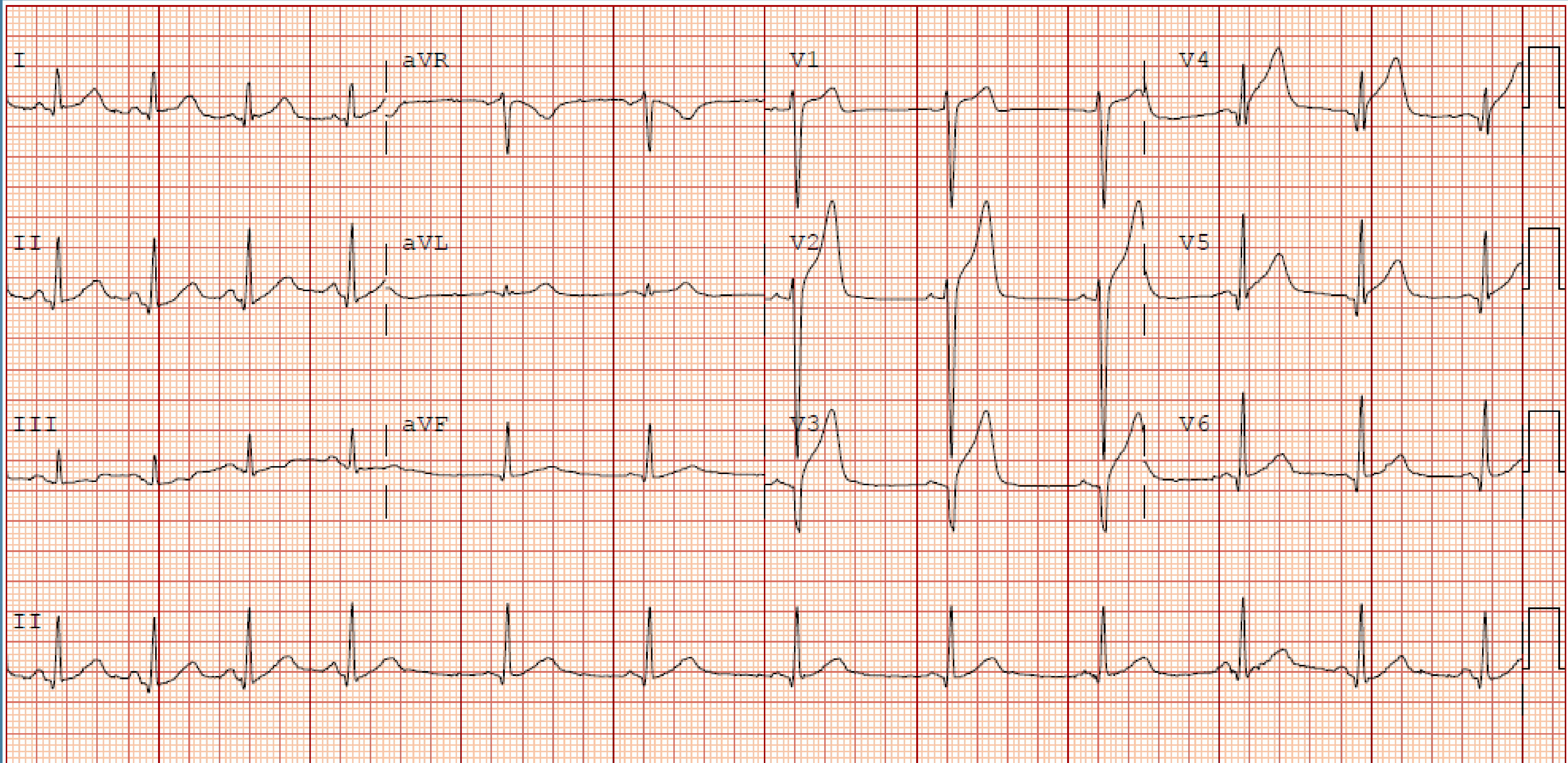
- STEMI activated off of second EKG
- Trop elevated at 2.78
- Emergently taken to cath lab: pt in acute cardiogenic pulmonary edema in the setting of recent, though more than 48 hours, acute anterior MI; successful treatment of a proximal hazy 80% thrombotic LAD lesion w/ stent
- Repeat echo was done 2 days after STEMI and showed an improved EF of 35-40%
- 4 day admission stay, discharged home

Cath Images



Clinical History

- 26 yo male presented to the Emergency Room
- Complaints of constant, severe, sharp chest pain 8/10, sudden onset during exercise class 1.5 hours prior
- Pain was initially across chest and now on left side
- Complaints of diaphoresis, nausea, dizziness, tingling in arms, shortness of breath
- Family Hx: CAD, grandpa died at age 48, multiple uncles with CAD, father coronary artery bypass at age 55
- No other PMH



Device: US71621389

Speed: 25 mm/sec

Limb: 10 mm/mV

Chest: 10 mm/mV

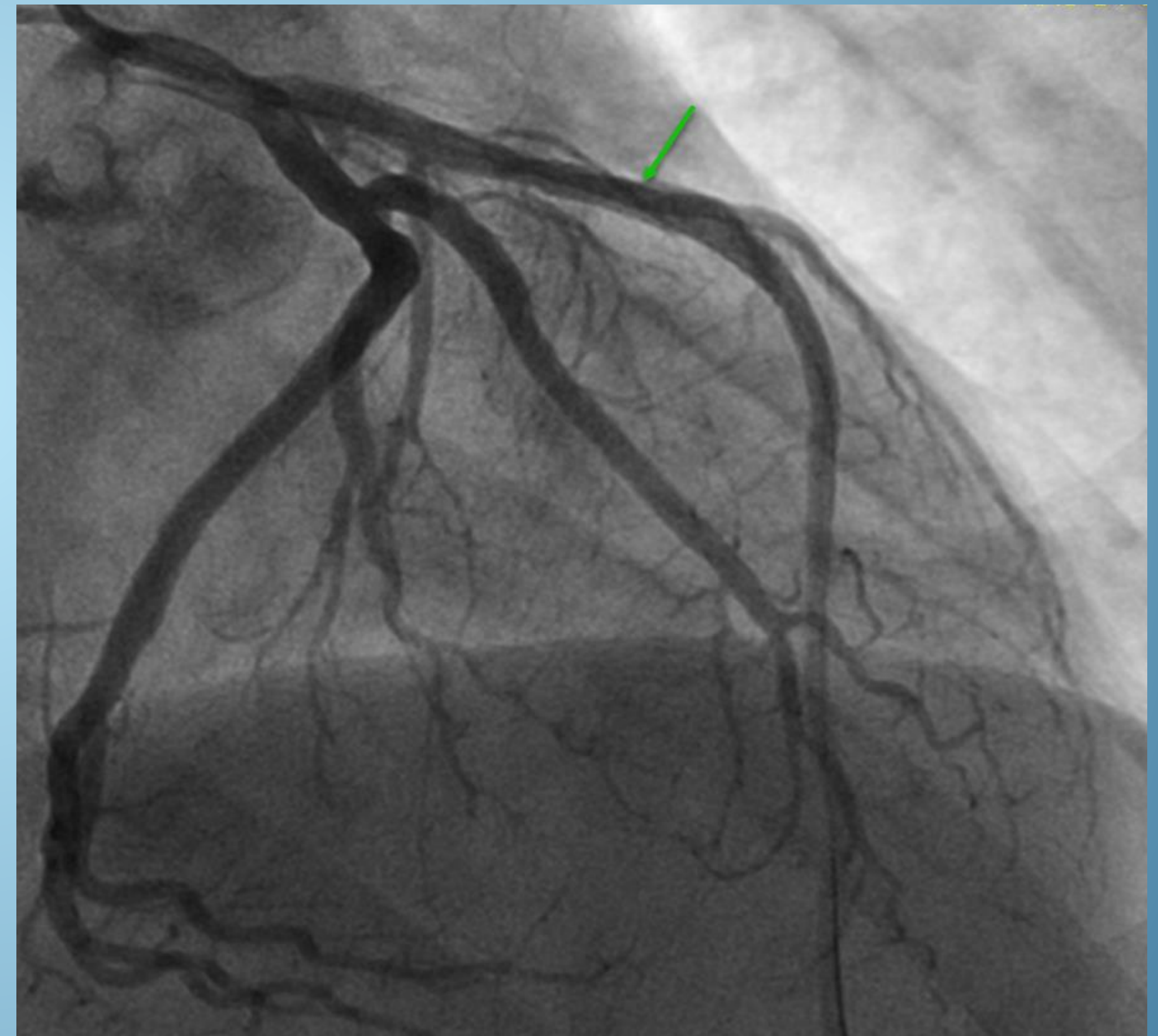
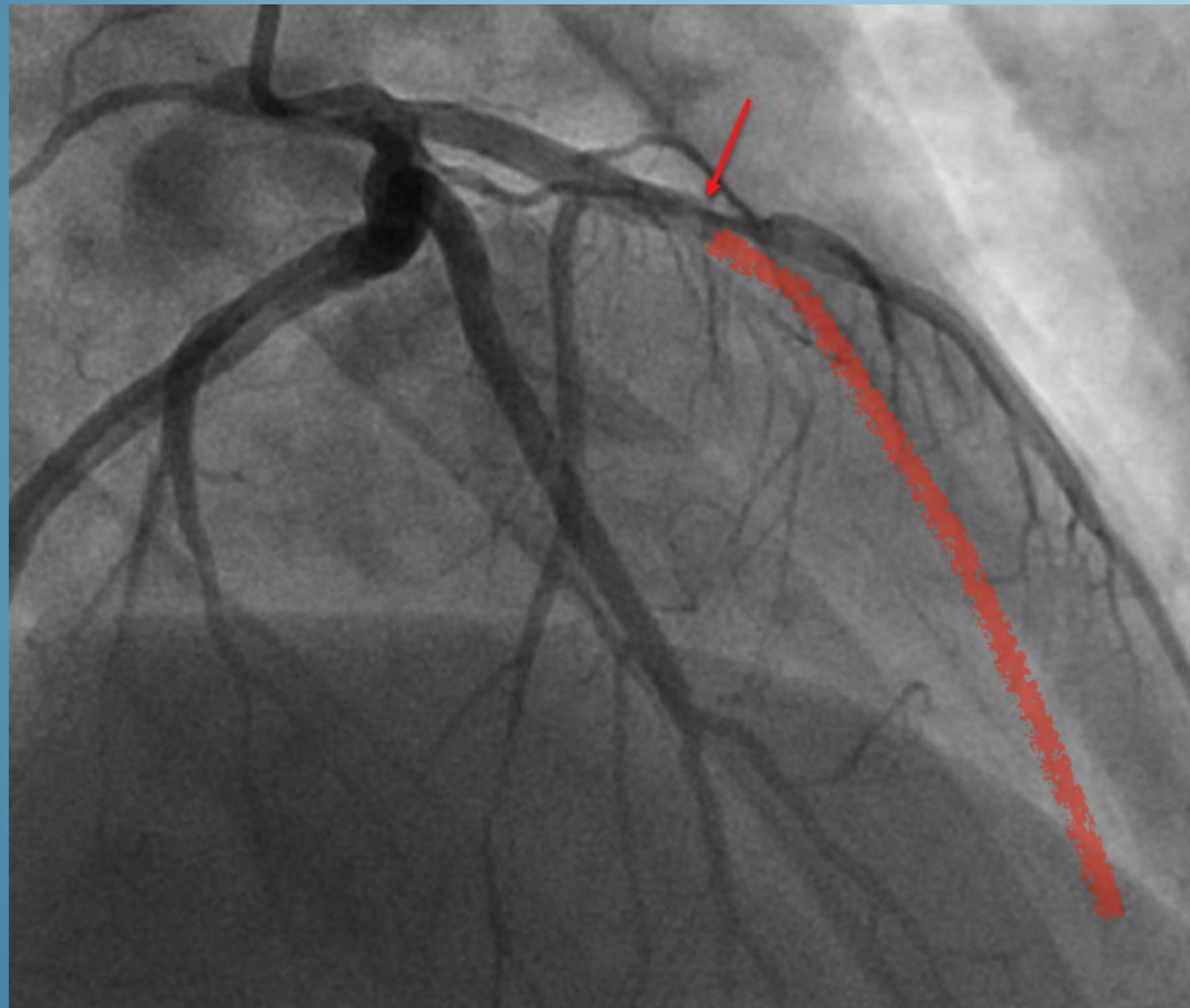
F 60~ 0.15-100 Hz

PH090A bCL P?

Would you send this patient emergently to the cath lab?

- A. Yes
- B. No
- C. Of course not; he's 26 years old

Cath Images

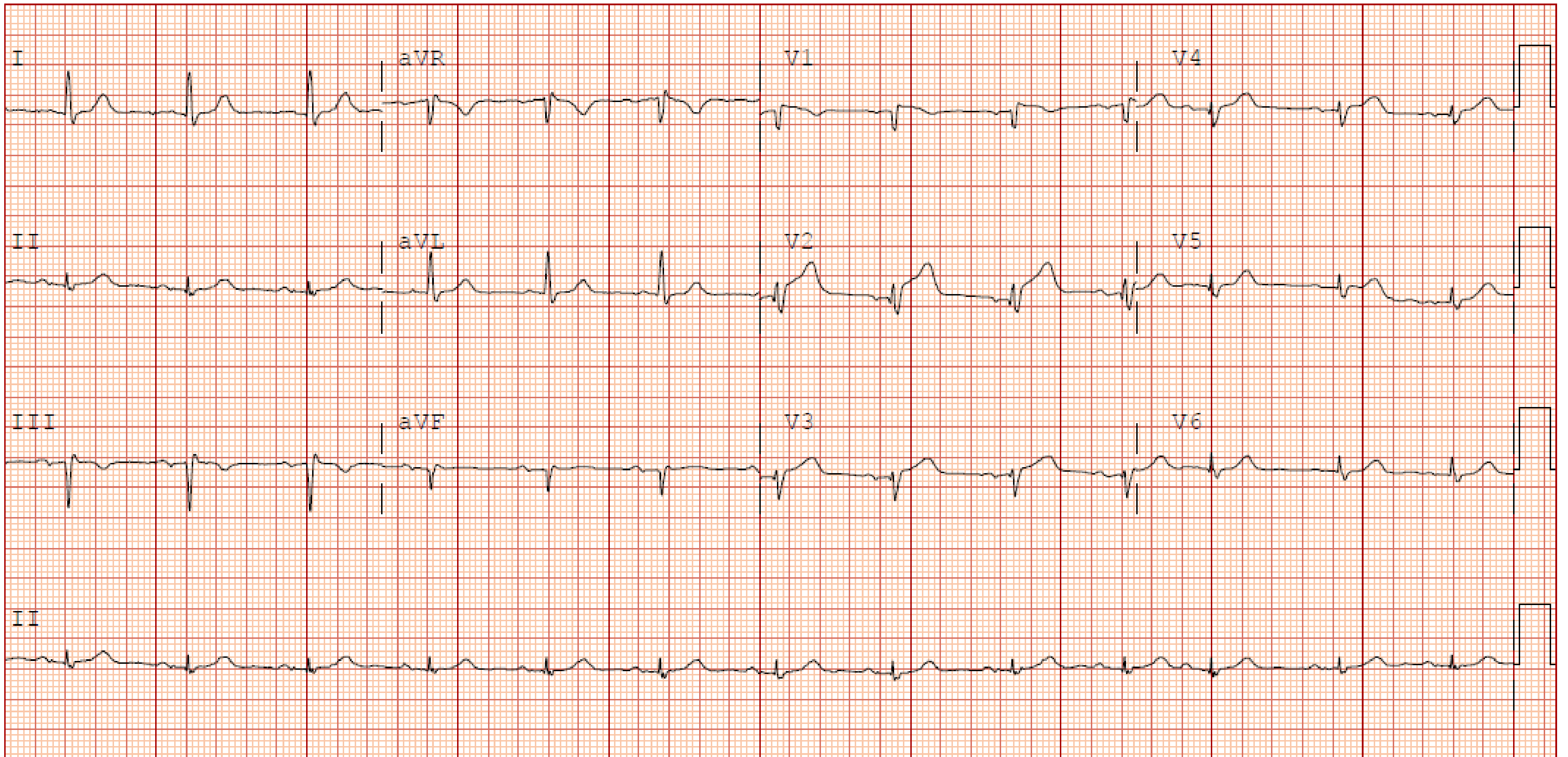


Outcome Results

- STEMI activated by Emergency Room (30 min after arrival)
- Initial Trop 0.23
- Elevated LDL at 249, there is a high chance for familial hypercholesteremia
- Echo performed resulting with a mild ischemic cardiomyopathy significant for an EF of 40% with LAD wall motion abnormalities
- 3 day admission stay
- EDUCATION POINTS
 - Less likely in younger age group, but bigger opportunity to make a difference

Clinical History

- 77 yo male presents to the Emergency Room c/o chest pain for 36-48 hours
- States pain is constant, pressure-like, radiating to the back, up to the jaw, intermittently to his left arm; pain improves with exertion
- PMH: HTN, HLD, DM, history of stroke



Device: US71621389

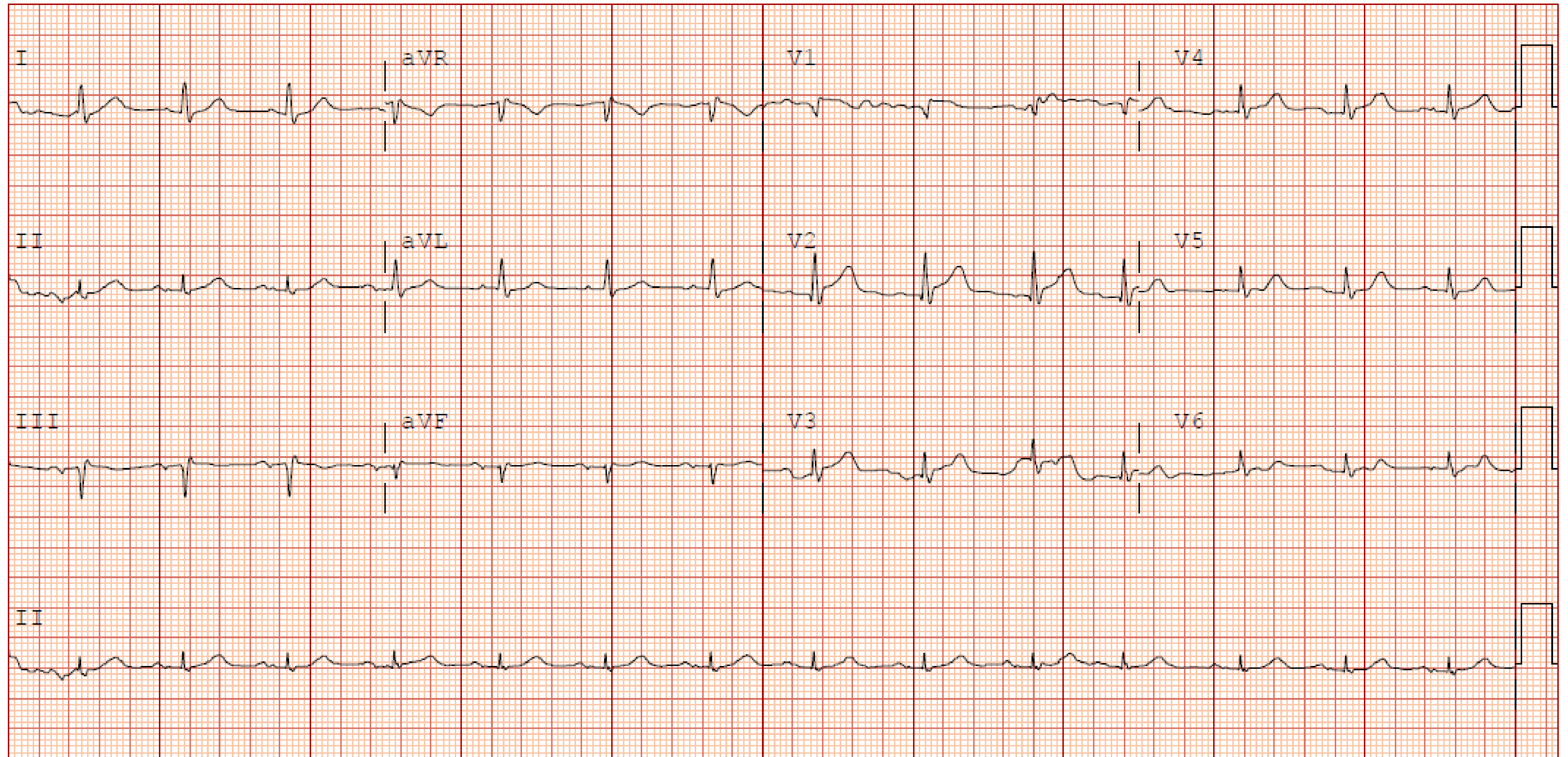
Speed: 25 mm/sec

Limb: 10 mm/mV

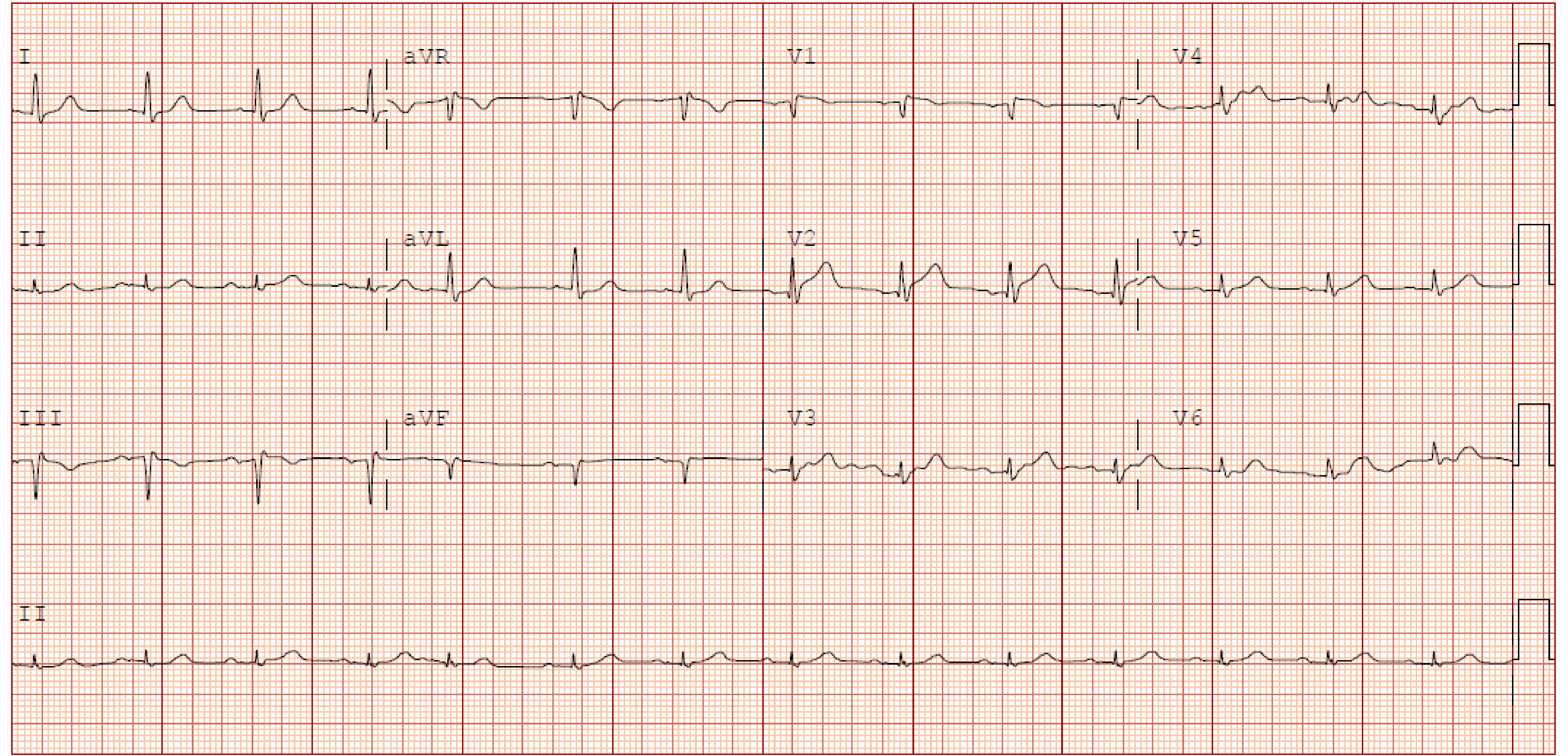
Chest: 10 mm/mV

F 60~ 0.15-100 Hz

PH090A bCL P?



UNCONFIRMED REPORT



Device: USD0903958 Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10 mm/mV F 60~ 0.15-100 Hz PH090A bCL P?

Outcome Results

- Pt was not STEMI activated; clinical impression was NSTEMI
- After review during admission, the ECG was felt to reflect STEMI

Cath Images



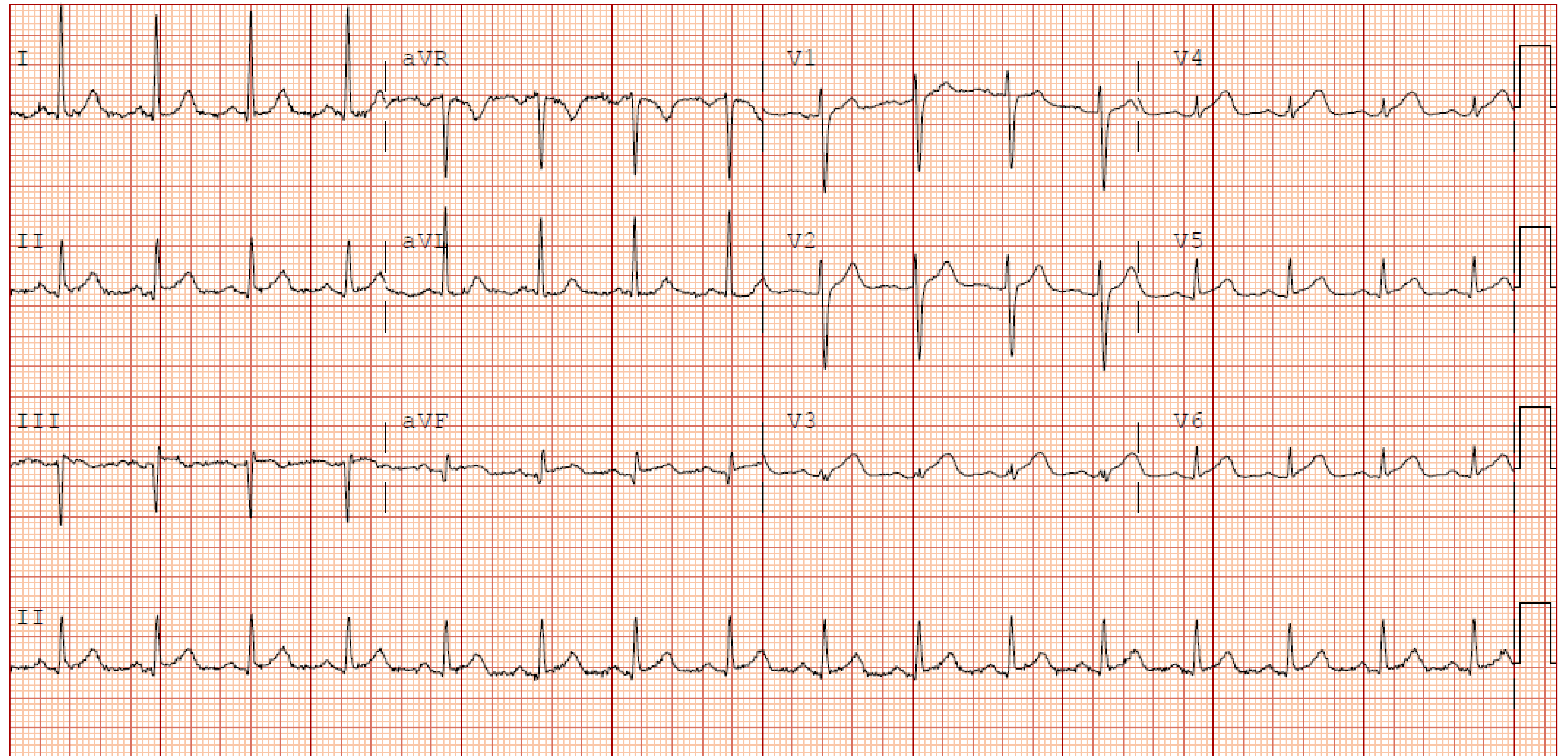
Outcome Results

- Left heart cath showed occluded LAD s/p stent placed
- Echo showed EF 60-65% with hypokinesis in septal wall
- Initial trop 1.44
- 2 day admission stay, discharged to home

Clinical History

- 47 yo female arrived to Emergency Room c/o chest pain up into her throat while cleaning approximately 30 mins prior to arrival, SOA and dizziness as well
- No significant PMH

UNCONFIRMED REPORT



Device: US71309835

Speed: 25 mm/sec

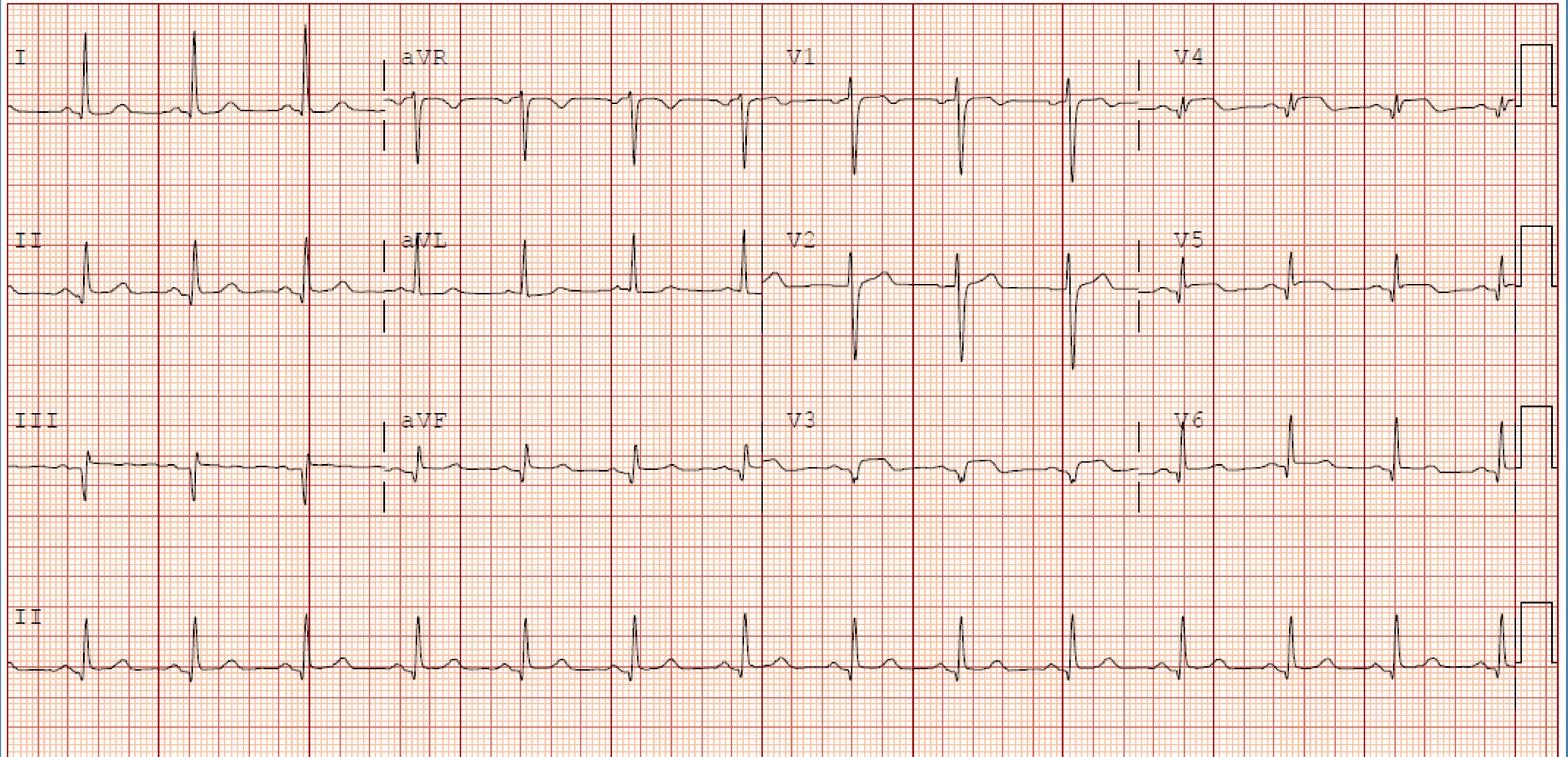
Limb: 10 mm/mV

Chest: 10 mm/mV

F 60~ 0.15-100 Hz

PH090A bCL P?

UNCONFIRMED REPORT



Device: USD0903958

Speed: 25 mm/sec

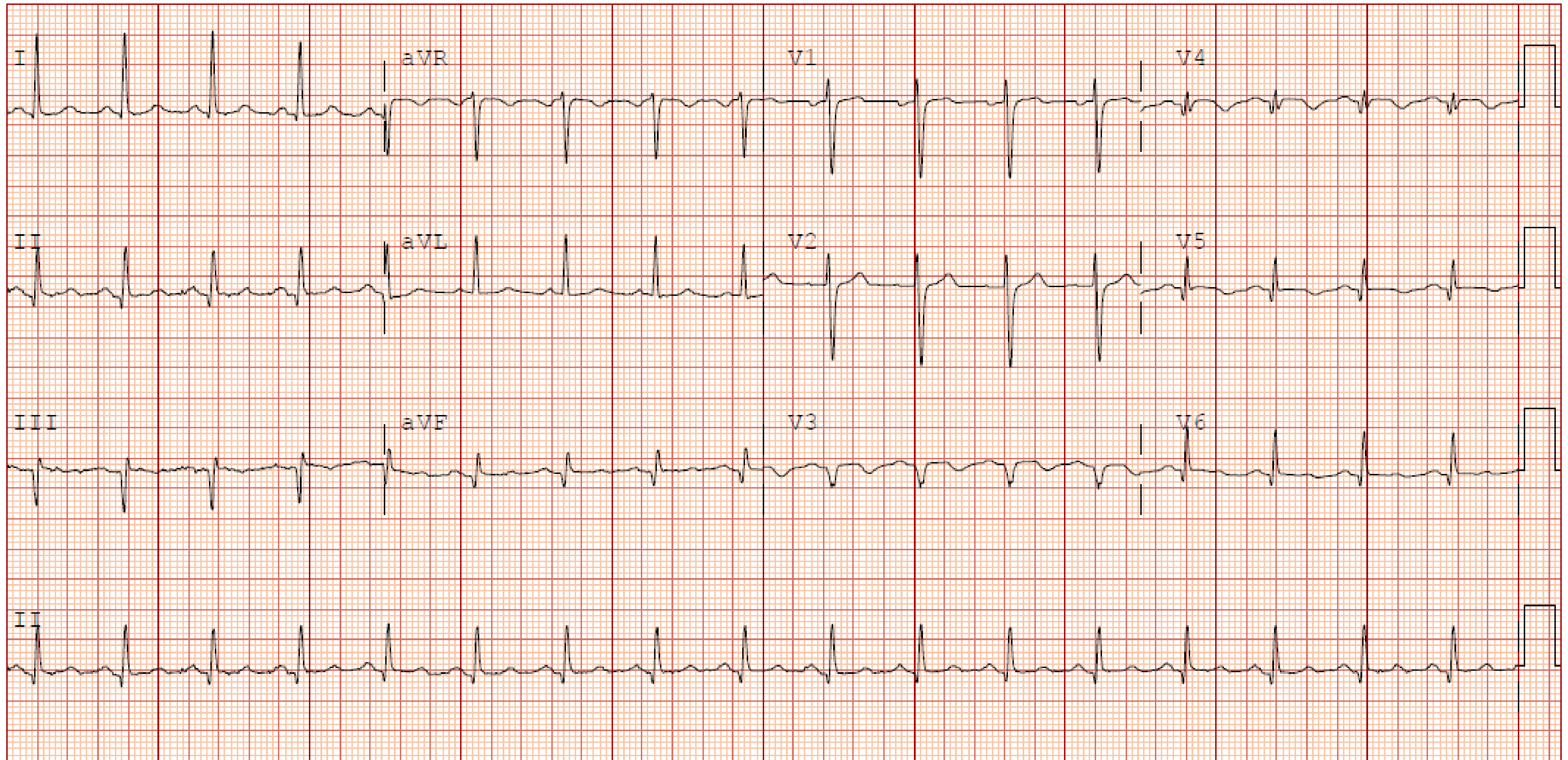
Limb: 10 mm/mV

Chest: 10 mm/mV

F 60~ 0.15-100 Hz

PH090A bCL P?

UNCONFIRMED REPORT



Device: USN1621814

Speed: 25 mm/sec

Limb: 10 mm/mV

Chest: 10 mm/mV

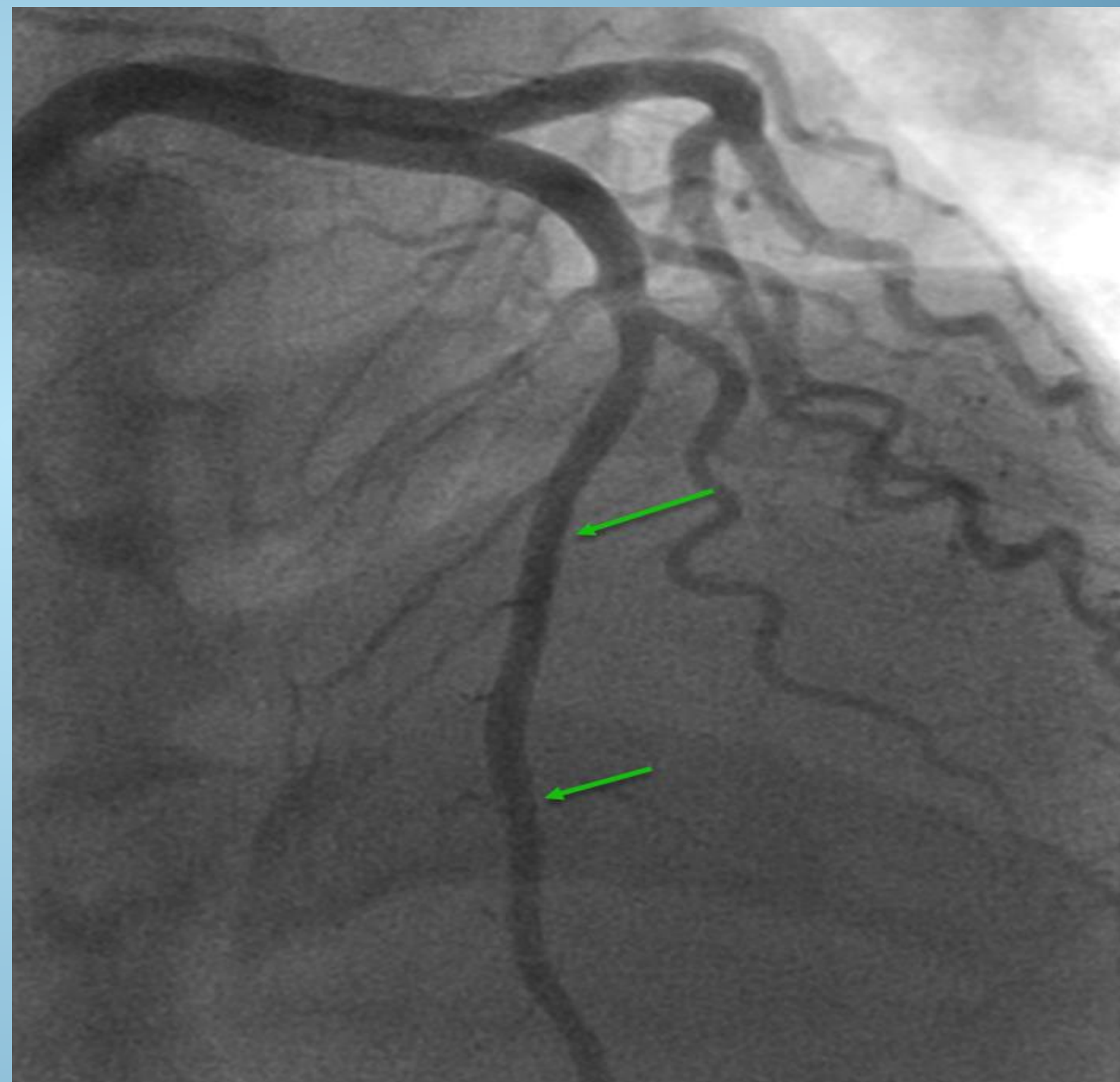
F 60~ 0.15-100 Hz

PH090A bCL P?

Outcome Results

- STEMI activated after second EKG by Emergency Room
- Sent to cath lab

Cath Images



Outcome Results

- Subtotal occlusion, 99% of the mid to distal LAD, s/p balloon angioplasty and 2 stents
- Initial Trop result 0.58
- Subsequent echo showed reduced ejection fraction of 40% and a thrombus in the LV
- 7 day admission stay, discharged to home

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Number 8

ELECTROCARDIOGRAPHIC DIAGNOSIS OF EVOLVING ACUTE MYOCARDIAL INFARCTION IN THE PRESENCE OF LEFT BUNDLE-BRANCH BLOCK

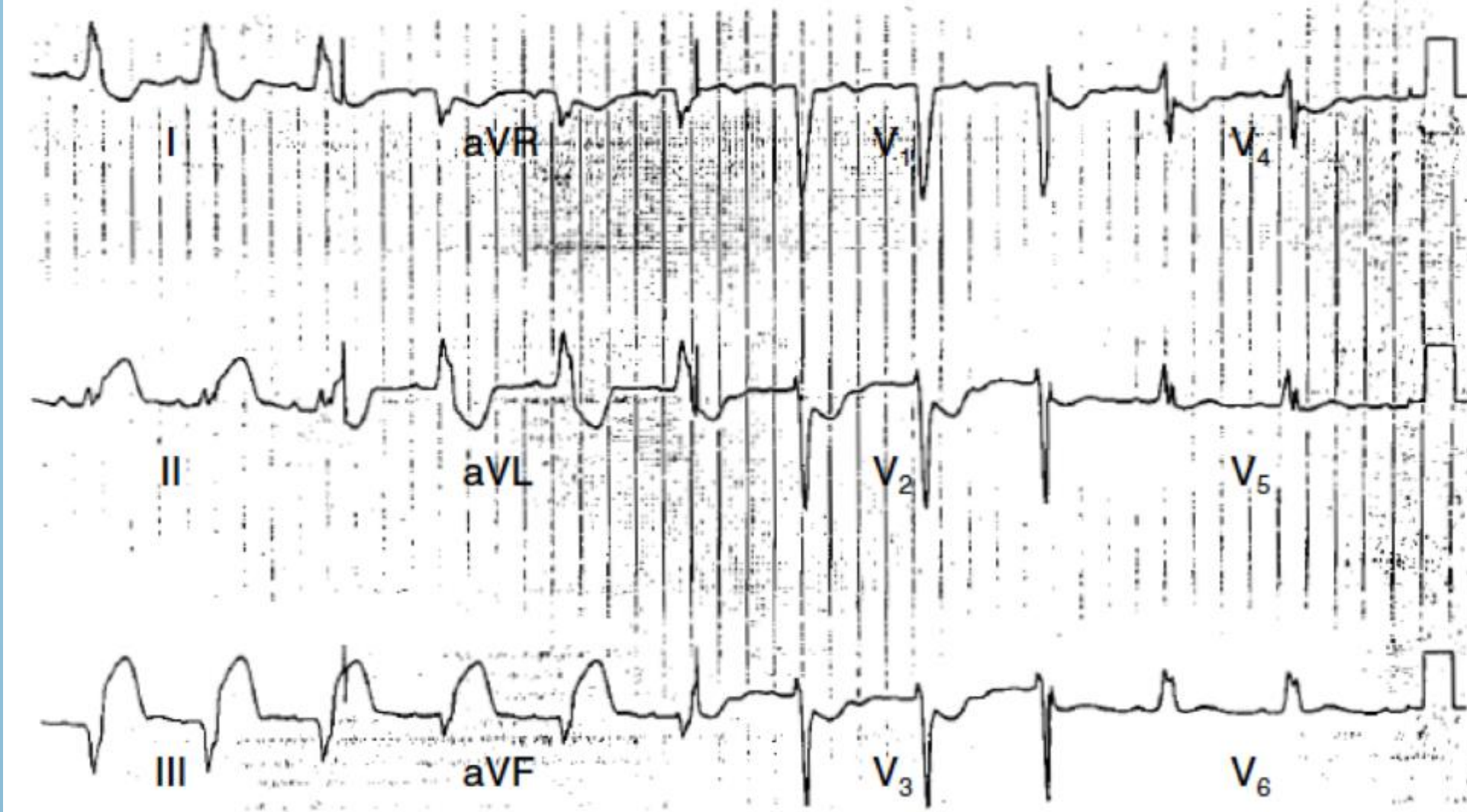
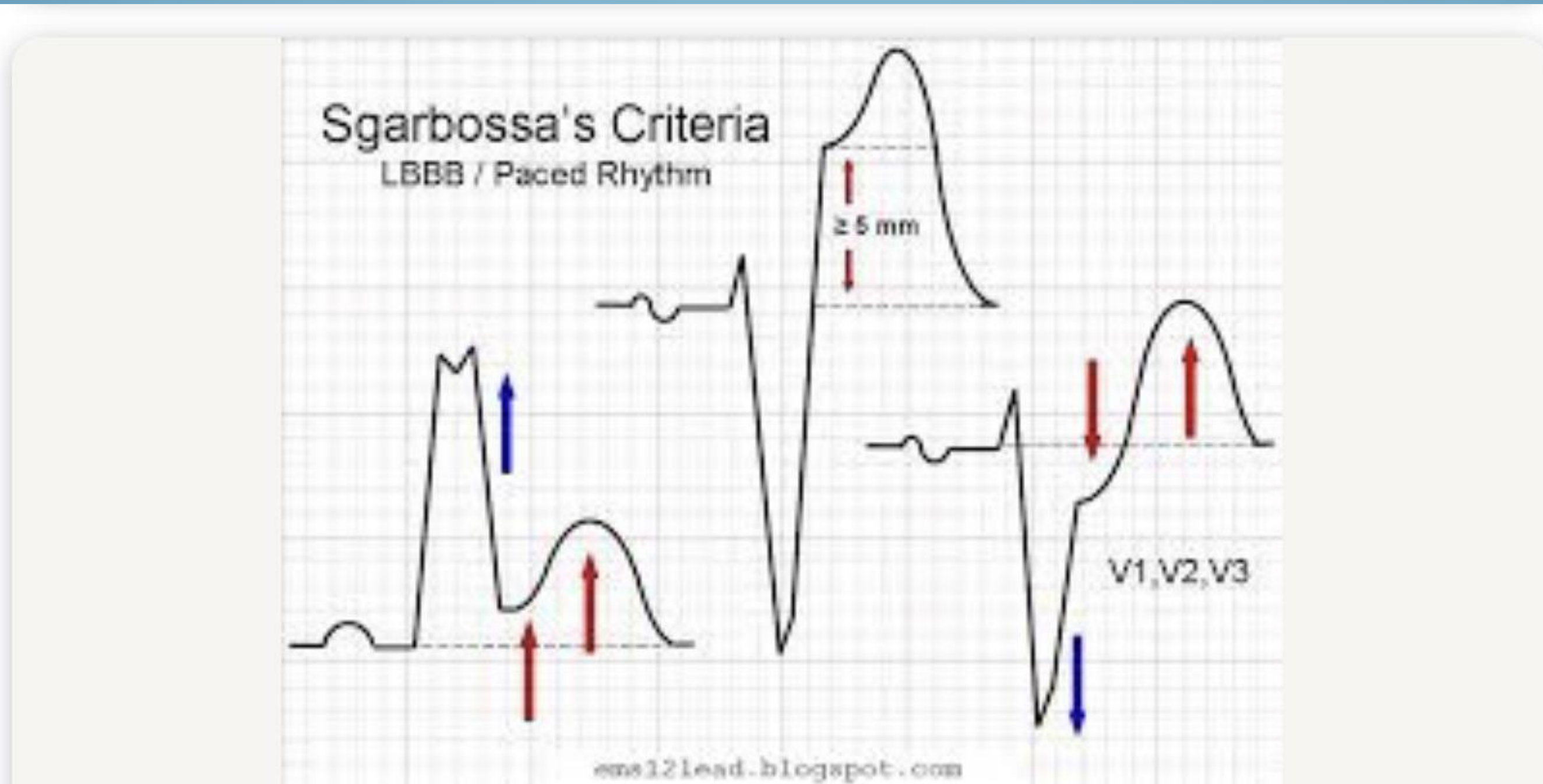


Figure 1. Electrocardiogram Meeting All Three Independent Criteria for the Diagnosis of Acute Myocardial Infarction in a Patient from the GUSTO Trial with Left Bundle-Branch Block.

The electrocardiogram shows ST-segment elevation of at least 1 mm that is concordant with the QRS complex (lead II), ST-segment depression of at least 1 mm in leads V₂ and V₃, and ST-segment elevation of at least 5 mm that is discordant with the QRS complex (leads III and aVF).



The original three **criteria** used to diagnose infarction in patients with **LBBB** are:

- Concordant ST elevation > 1 mm in leads with a positive QRS complex (score 5)
- Concordant ST depression > 1 mm in V1-V3 (score 3)
- Excessively discordant ST elevation > 5 mm in leads with a -ve QRS complex (score 2).

Nov 15, 2017

ID:D00893057

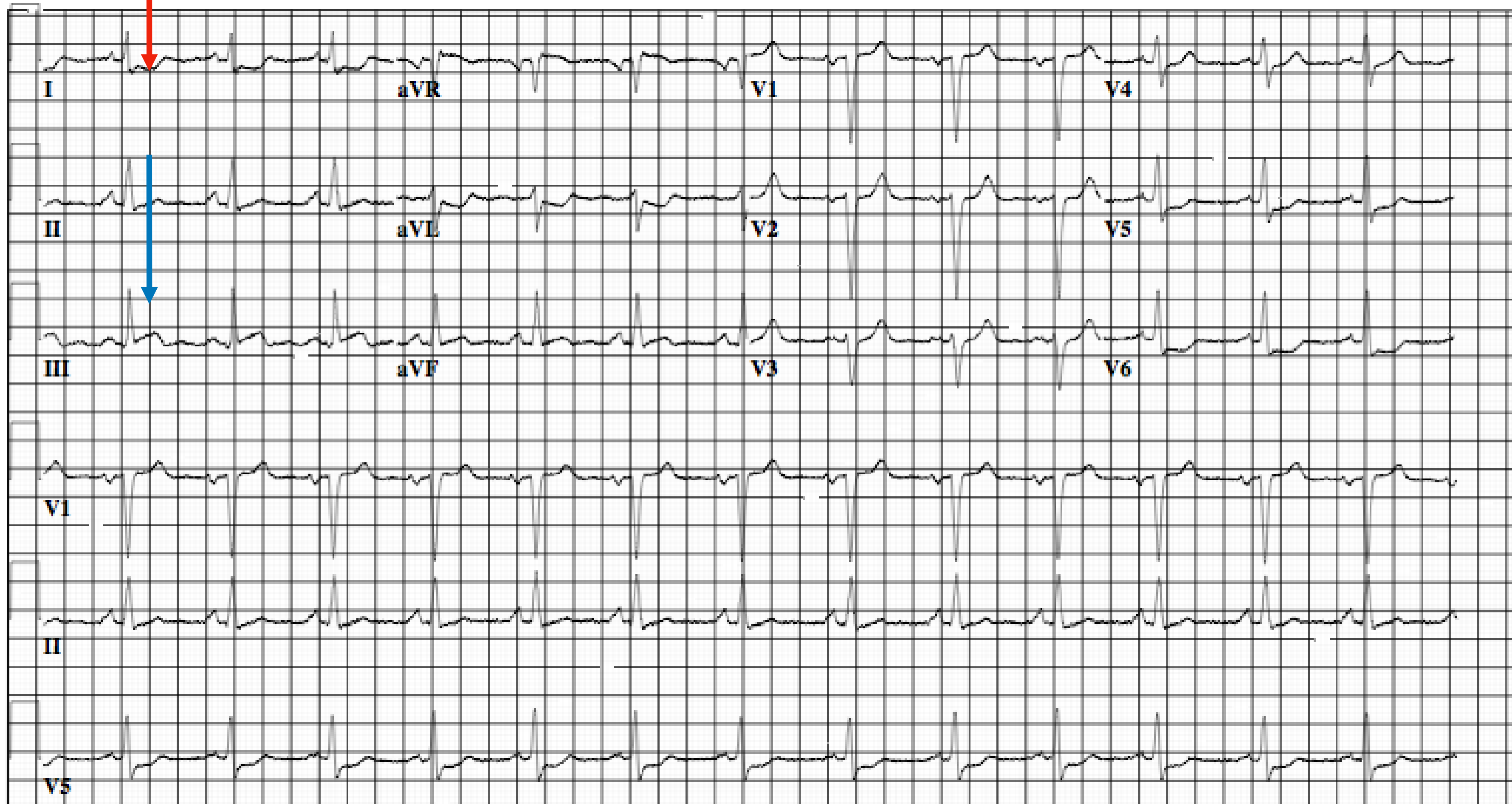
Vent. rate	82	BPM
PR interval	146	ms
QRS duration	98	ms
QT/QTc	352/411	ms
P-R-T axes	66 83	124

cardial injury

ST depression never takes precedence over ST elevation. If you see depression check contralateral leads

Referred by:

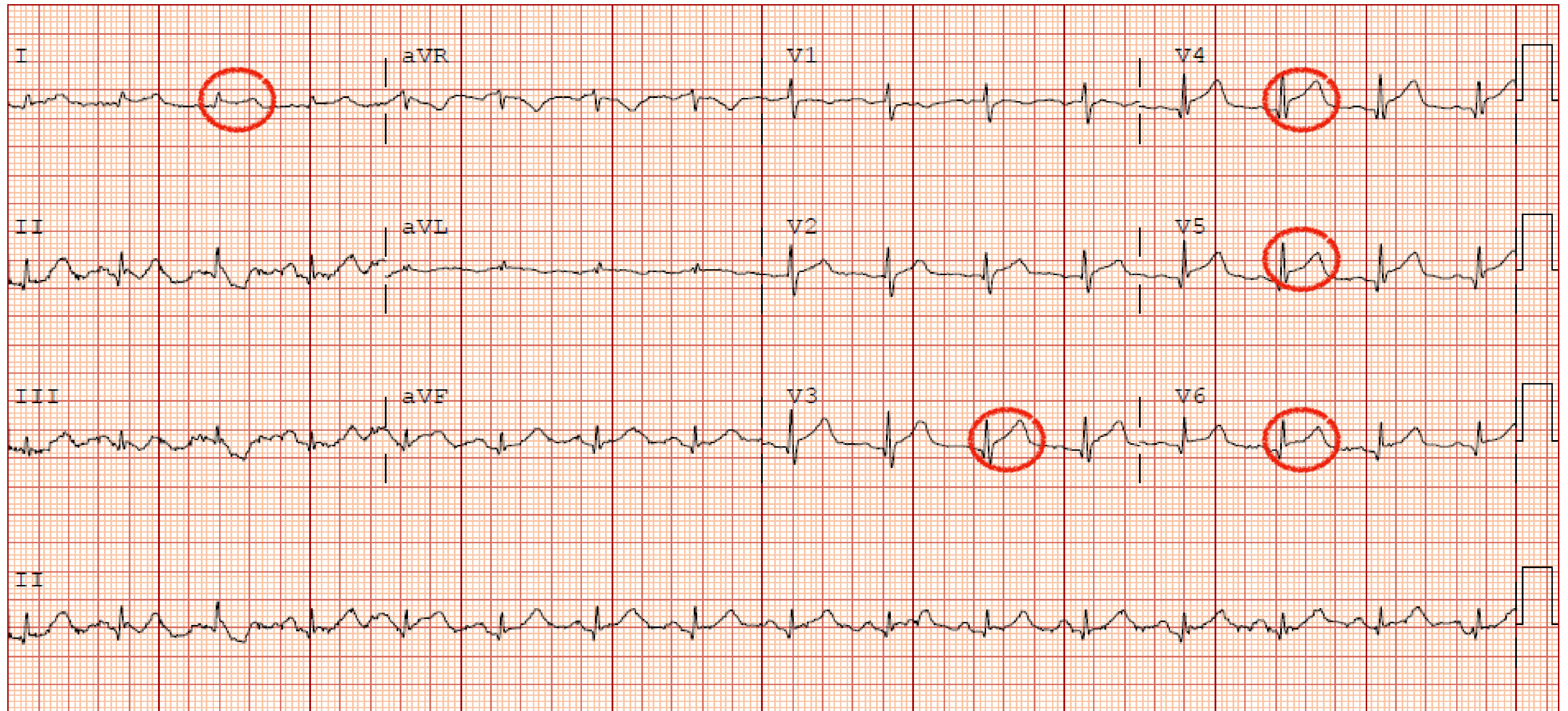
Confirmed By: JAMES EYNON, MD



Clinical History

- 60 yo male arrived to Emergency Room from nursing care facility with complaints of GI bleed, SOB; states having vomiting and abdominal pain.
- While en route, EMS obtained EKG and when questioning pt again about pain and specifically chest, pt states having "some" chest pain in mid chest rating it 8-9/10.
- Pt also hypotensive en route.
- PMH: Hepatitis C, HTN, hemorrhagic stroke. Has had decreased appetite the past few days

UNCONFIRMED REPORT



Device: US61106541

Speed: 25 mm/sec

Limb: 10 mm/mV

Chest: 10 mm/mV

F 60~ 0.15-100 Hz

PH100B bCL P?

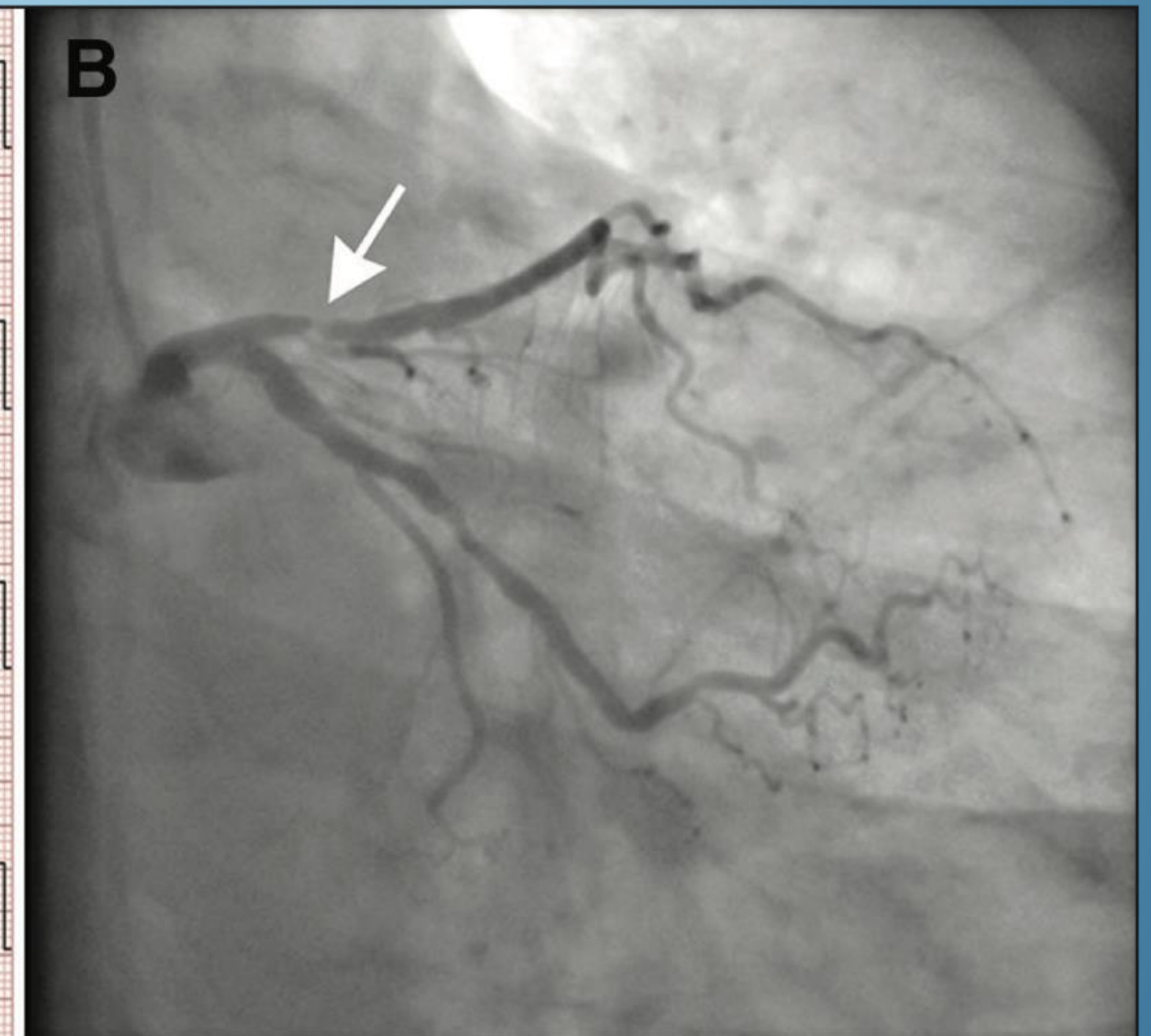
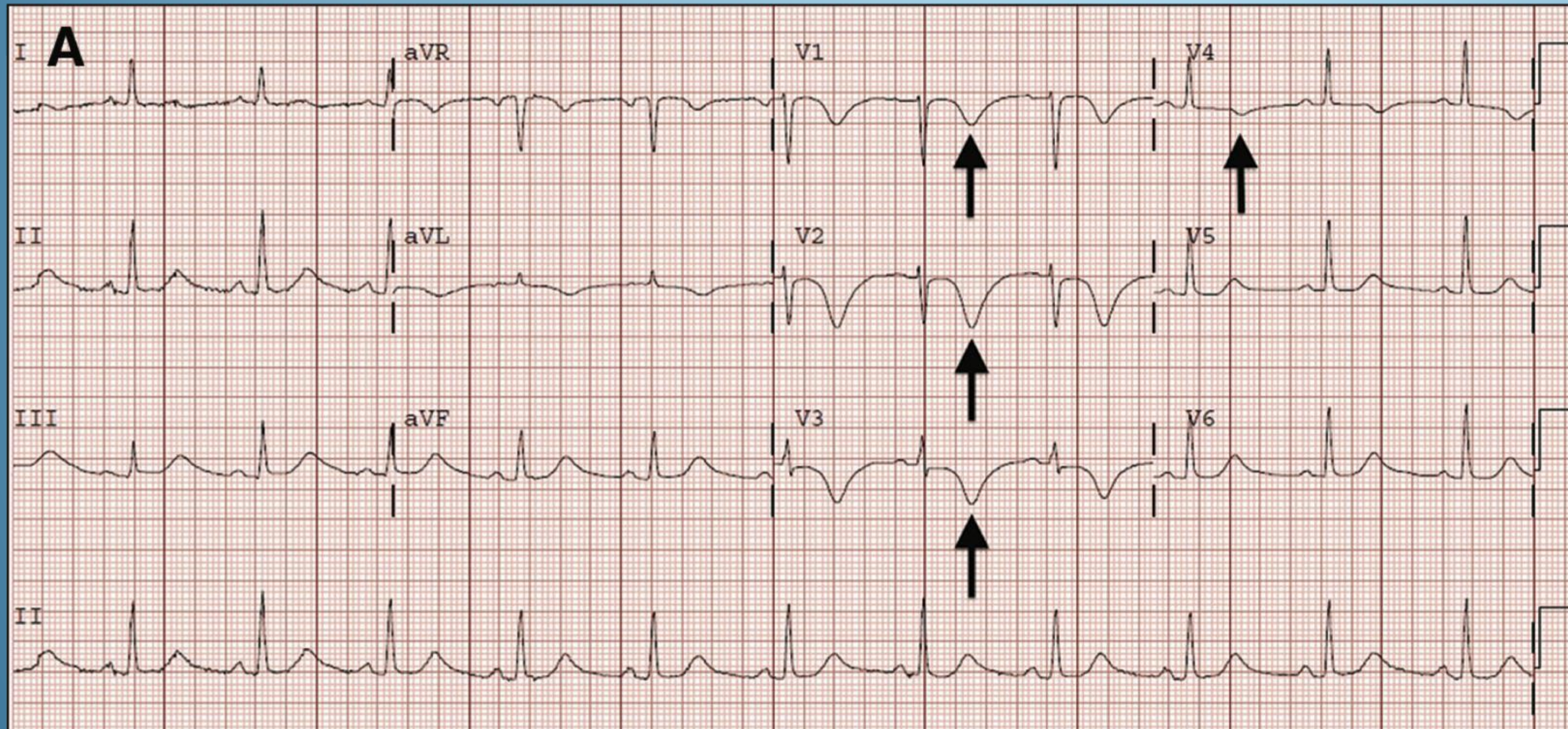
Outcome Results

- STEMI activated by EMS
- Pt emergently to cath lab: cardiogenic shock in the setting of takotsubo cardiomyopathy; IABP placed. Pt admitted to CICU.
- Dx: acute systolic and diastolic HFrEF, EF: 15%, Hypovolemic shock, on pressor support with Vasopressin; GI consulted for GI bleed/melena

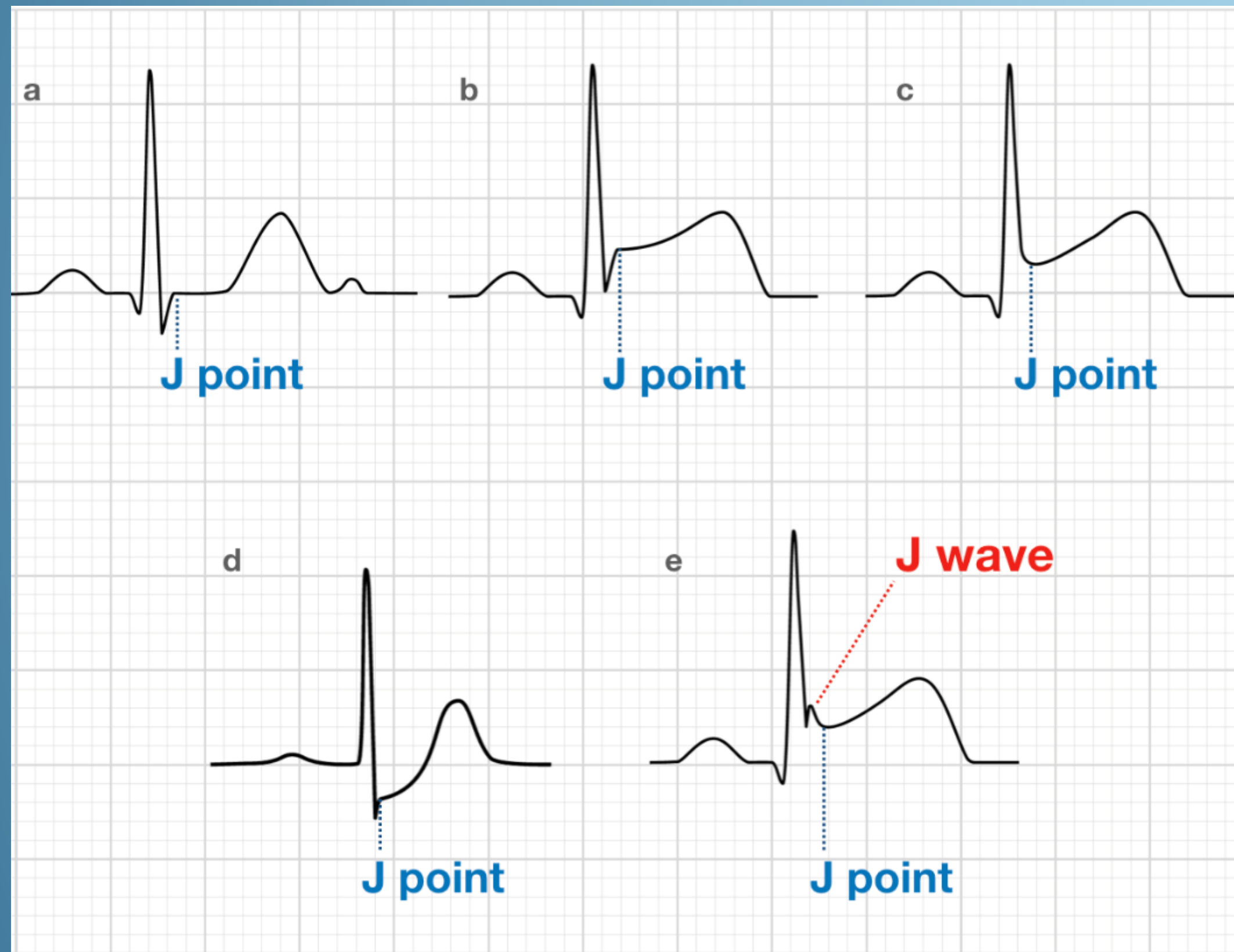
Other ST segment findings

Wellen's Syndrome

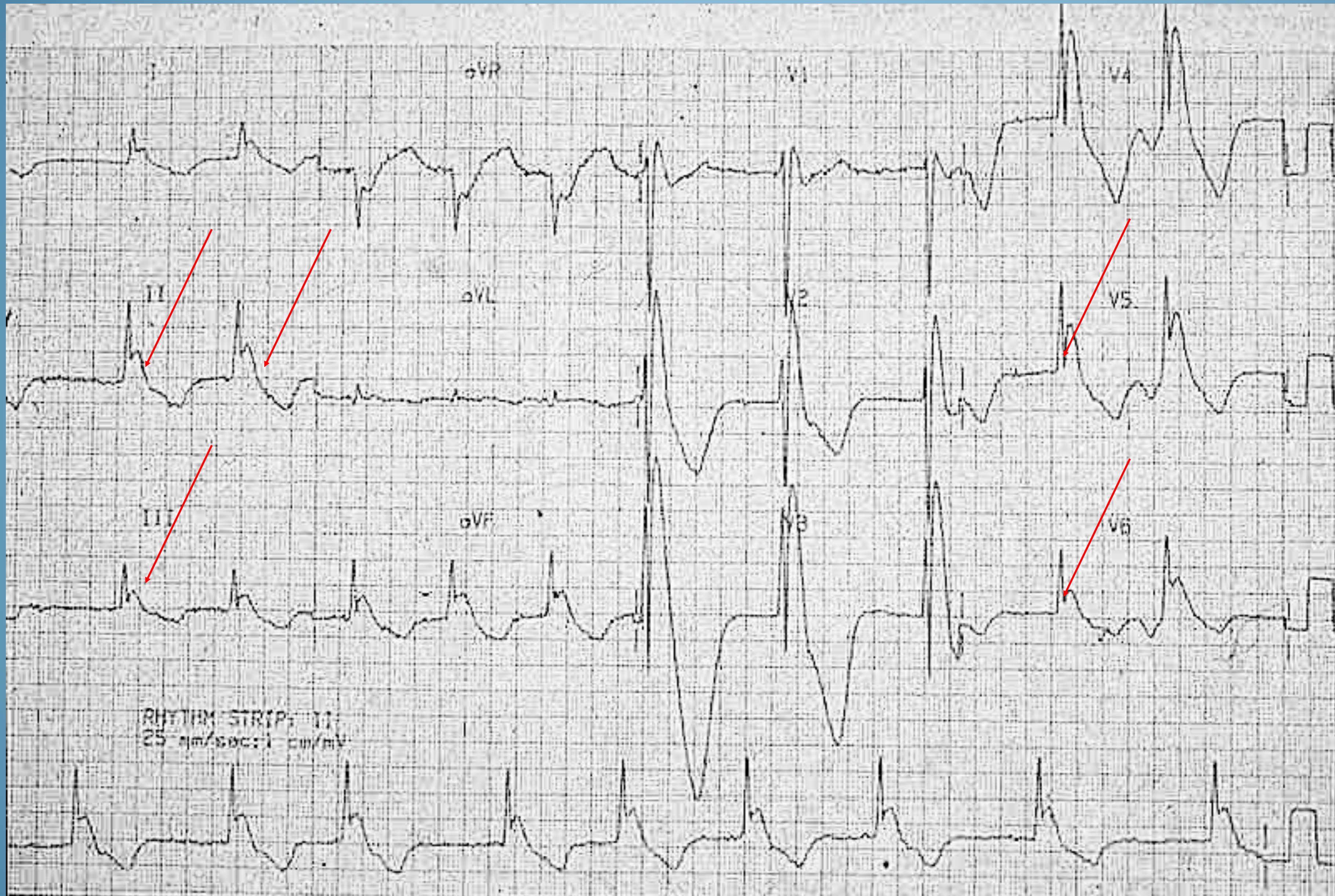
- Deep symmetric T waves or biphasic T waves anteriorly
- 89% specific for proximal Left Anterior Descending Stenosis



Hypothermia



- Classic ECG finding called Osborne Waves (J waves)
- J point is the spot marking the end of the QRS, and the start of the ST segment
- J waves occur just proximal to the J point, as a notch in the end of the QRS
- J waves are very rare, and originally described in hypothermia
- The height of the J wave correlates with the severity of the hypothermia ($<90^{\circ}$)



Aneurysm

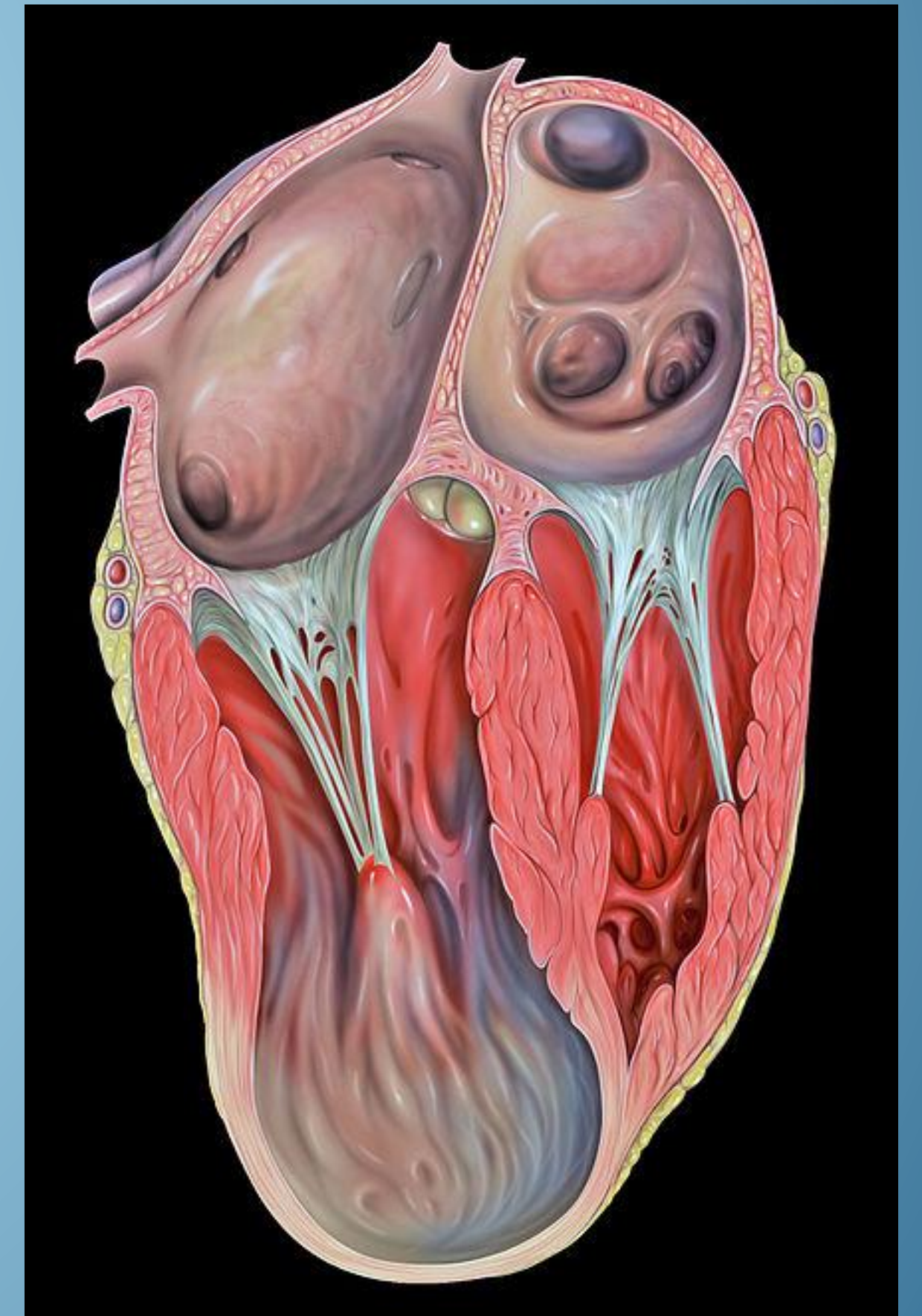
Scarred heart muscle that cannot contract and bulges out

Factors suggesting left ventricular aneurysm

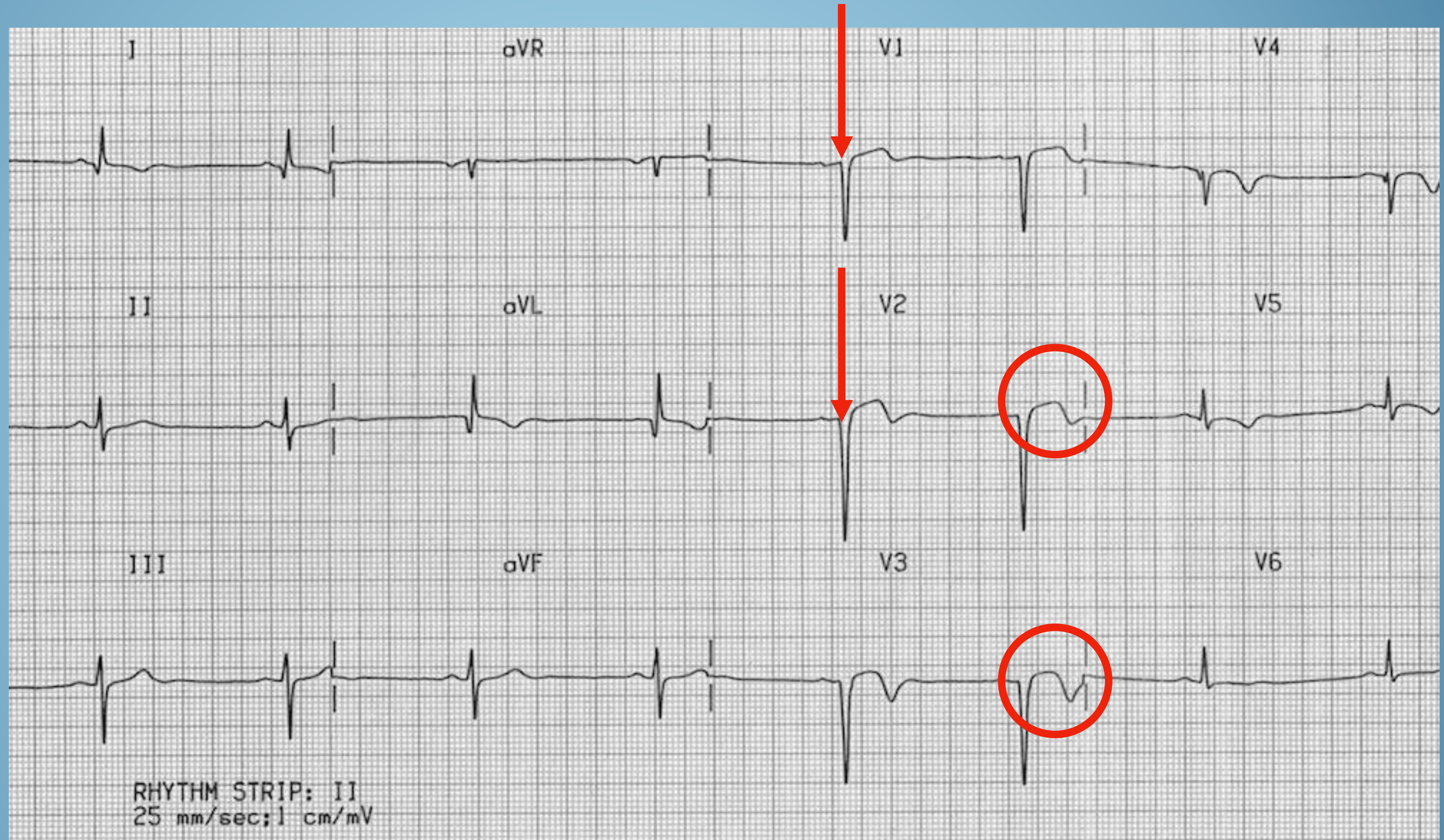
- ECG identical to previous ECGs (if available).
- Absence of dynamic ST segment changes.
- Absence of reciprocal ST depression.
- Well-formed Q waves.

Factors favoring acute STEMI

- New ST changes compared with previous ECGs.
- Dynamic / progressive ECG changes — the degree of ST elevation increases on serial ECGs.
- Reciprocal ST depression.
- High clinical suspicion of STEMI — ongoing ischemic chest pain, sick-looking patient (e.g. pale, sweaty), hemodynamic instability.



Aneurysmal



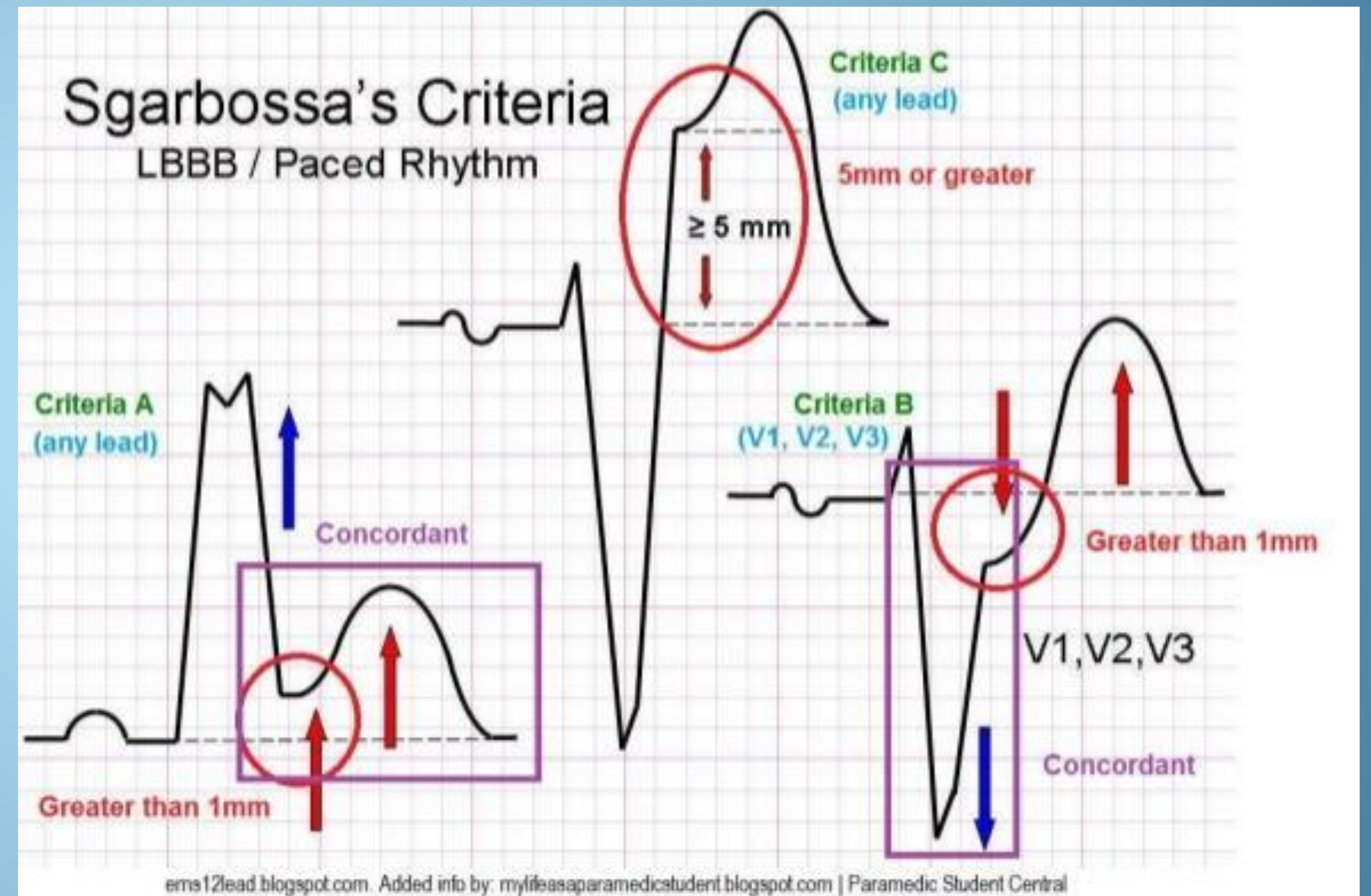
De Winter ECG pattern

- Anterior STEMI equivalent that presents without obvious ST segment elevation
- Upsloping ST depression/J point depression ($> 1\text{mm}$ at J-point) in the precordial leads V2-6, plus leads I & II.
- Peaked anterior T waves, with the ascending limb of the T wave starting below the isoelectric baseline.
- ST elevation in aVR $> 0.5\text{mm}$
- The de Winter pattern is seen in $\sim 2\%$ of acute LAD occlusions and is under-recognised by clinicians.



MI in left bundle branch block

- Discordant (opposite direction to major QRS direction) ≥ 5 mm ST elevation
- > 1 mm of ST elevation in same direction as QRS in any lead
- Concordant ST depression in V1-V3 < 1 mm



ECG Review 2020

Questions?