April 5, 2019

STEMIs & equivalents

SRPC CAEP Track
Casey Wong MD CCFP

Disclosures

- I have no disclosures to make

Outline

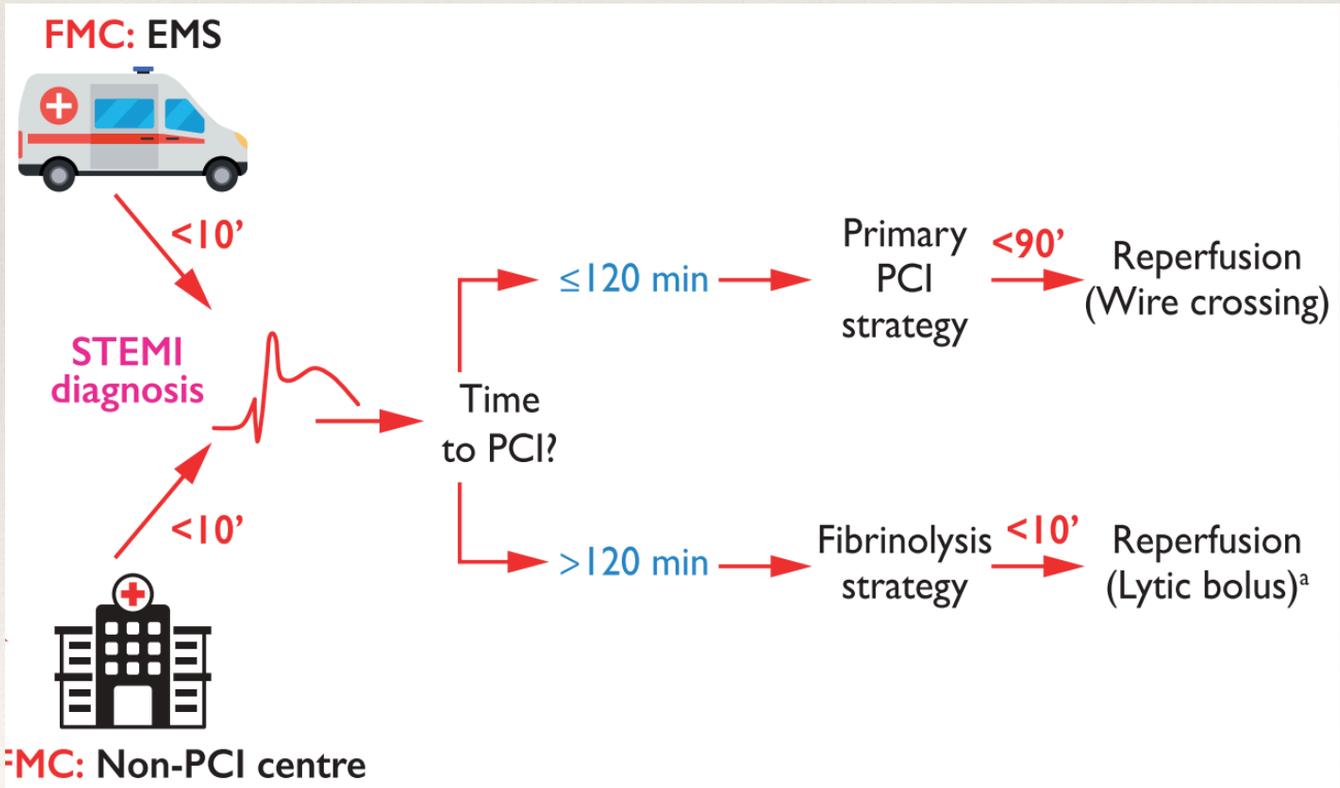
- ACCF / AHA 2013 vs ESC 2017 guidelines for Dx of STEMIs and STEMI-equivalents
- Can't miss STEMI diagnoses in the absence of ST elevation
- Novel ECG changes proposed ?future guideline material

Objective

- Identify non-“classic STEMI” /STEMI equivalent ECG patterns that require stat reperfusion and/or urgent cardiology consultation

Significance

- Timely diagnosis made **solely via ECG**
- Rural conference: how many of you would administer TNK in your centre for a STEMI?
- ESC 2017
  - Non-PCI centre contact —> STEMI Dx **<10mins**
  - STEMI Dx —> Fibrinolysis **<10mins = <20mins total**
- ACCF / AHA 2013
  - Non-PCI centre contact —> Fibrinolysis **<30mins**



2017 ESC STEMI guidelines

Significance

European Heart Journal
Acute Cardiovascular Care
EUROPEAN SOCIETY OF CARDIOLOGY®

Original scientific paper

European Heart Journal: Acute Cardiovascular Care
2015, Vol. 4(3) 241–253

DOI: 10.1177/2048872614548602
acc.sagepub.com
SAGE

Mortality and missed opportunities along the pathway of care for ST-elevation myocardial infarction: a national cohort study

AD Simms[1,2], CF Weston[3], RM West[4], AS Hall[1,5], PD Batin[6], A Timmis[7], H Hemingway[8], KAA Fox[9] and CP Gale[1,10]

- Is there room for improvement?
- Cohort study of 112,286 STEMI patients - Timely reperfusion (9.94%) most frequently missed opportunity for care

Significance

Evaluating clinical reason and rationale for not delivering reperfusion therapy in ST elevation myocardial infarction patients: Insights from a comprehensive cohort

Robert C. Welsh [a,b,*], Jessica Deckert-Sookram [c], Sunil Sookram [a], Shelley Valaire [c], Neil Brass [a,d]

[a] *University of Alberta, Canada*
[b] *Mazankowski Alberta Heart Institute, Canada*
[c] *Alberta Health Services, Canada*
[d] *Royal Alexandra Hospital, Canada*

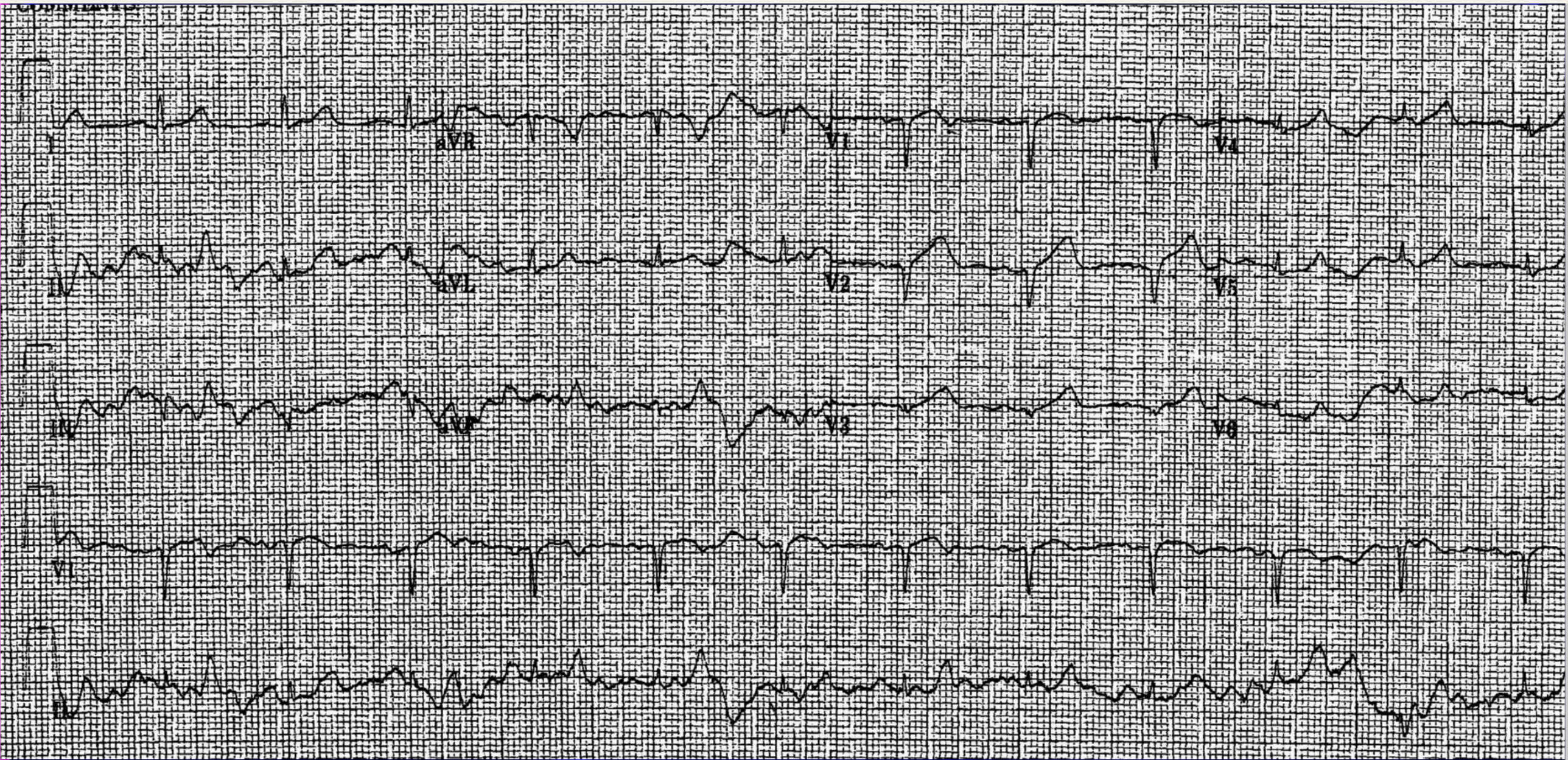
- 8.2% of cases:
  1. STEMI Dx missed, or
  2. Although STEMI Dx made, no acute reperfusion therapy delivered AND no valid rationale apparent (i.e. no contraindications, not outside 12 hrs, etc.)

Defining a STEMI

- ACCF/AHA 2013:
  - In the *absence of LVH or LBBB*, ≥2 contiguous leads of STE…
    - ≥2mm (male) or ≥1.5mm (female) in V2-3 and/or
    - ≥1mm in all other leads
- ESC 2017:
  - In the *absence of LVH or LBBB*, ≥2 contiguous leads of STE…
    - **≥2.5mm (male<40y), ≥2mm (male≥40y)** or ≥1.5mm (female) in V2-3 and/or
    - ≥1mm in all other leads

Case 1

- 68yF presents with 45 mins of vague fatigue, SOB.



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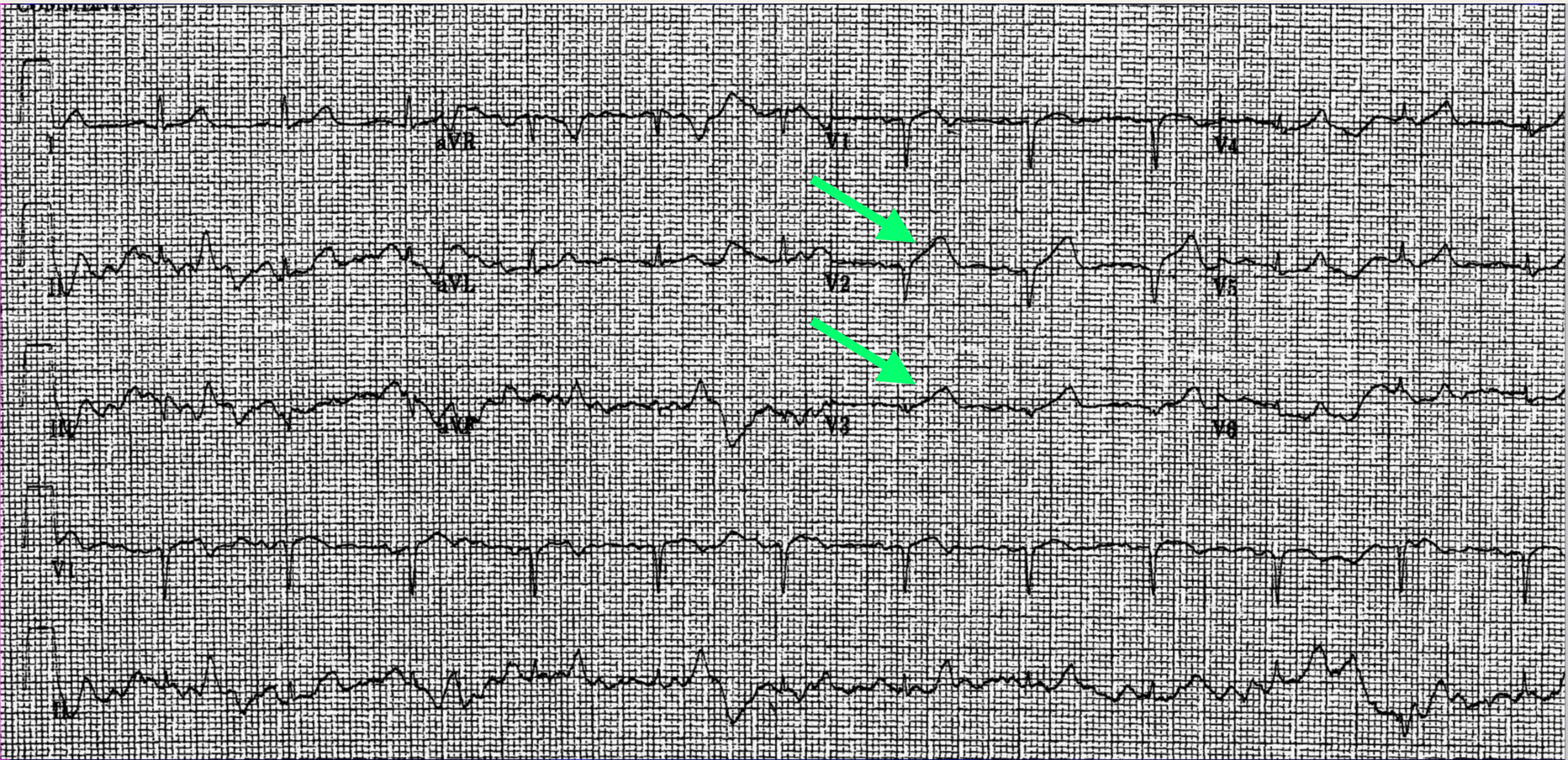


Hyperacute T waves

- Classically described as newly *tall & symmetric* T waves in 2 continuous leads (often precordial)
  - Reported within minutes of complete coronary occlusion
  - Transient and often **<u>precede STE</u>**
- However, T-waves may be *asymmetric* when the ST segment starts to elevate as the infarction progresses

Ge, Podrid, Dudzinski Am J Med 2015

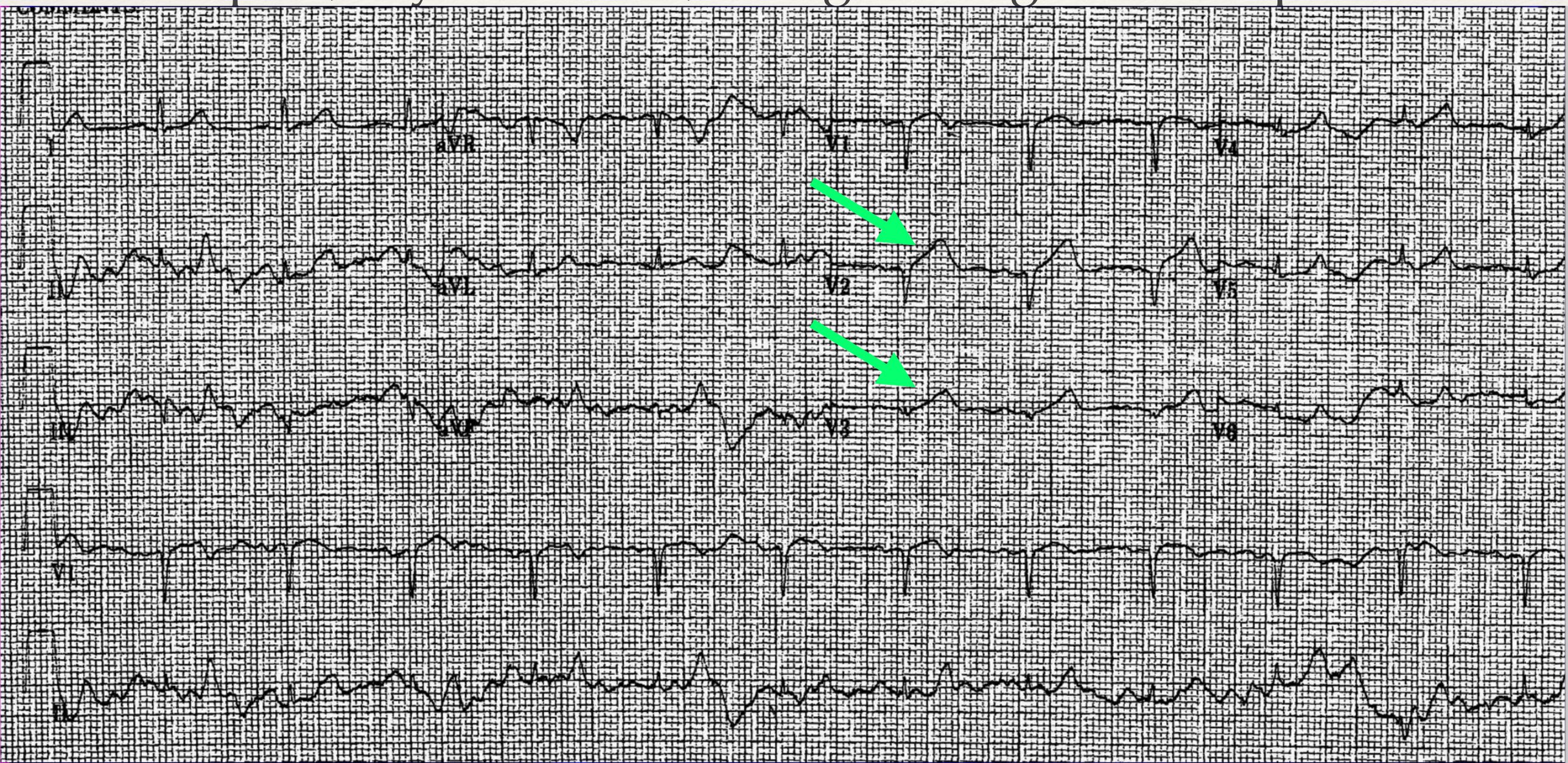
Hyperacute T waves

- Characteristics to consider:
  - Big, tall, broad-based
  - Asymmetry
  - Straightening of the initial portion of T-wave
  - T-wave taller than QRS complex
- *ESC 2017*: "…initial ECG without ST-segment elevation, sometimes because they are seen very early after symptom onset (in which case, one should look for **hyper-acute T-waves**, which **may precede ST-segment elevation**)"
  - Recommendation: repeat ECG

Ge, Podrid, Dudzinski Am J Med 2015

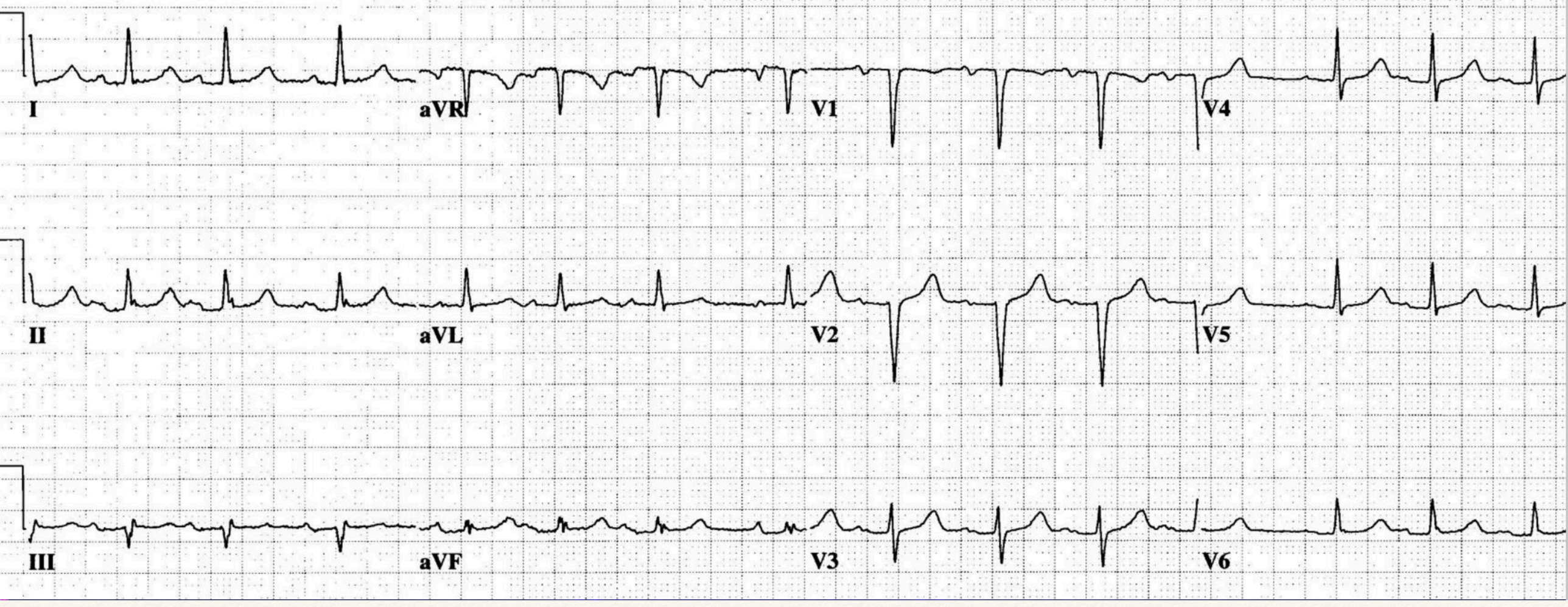
Case 1

- Let's have another look at these Ts…taller than QRS complex, asymmetrical, straightening of initial portion



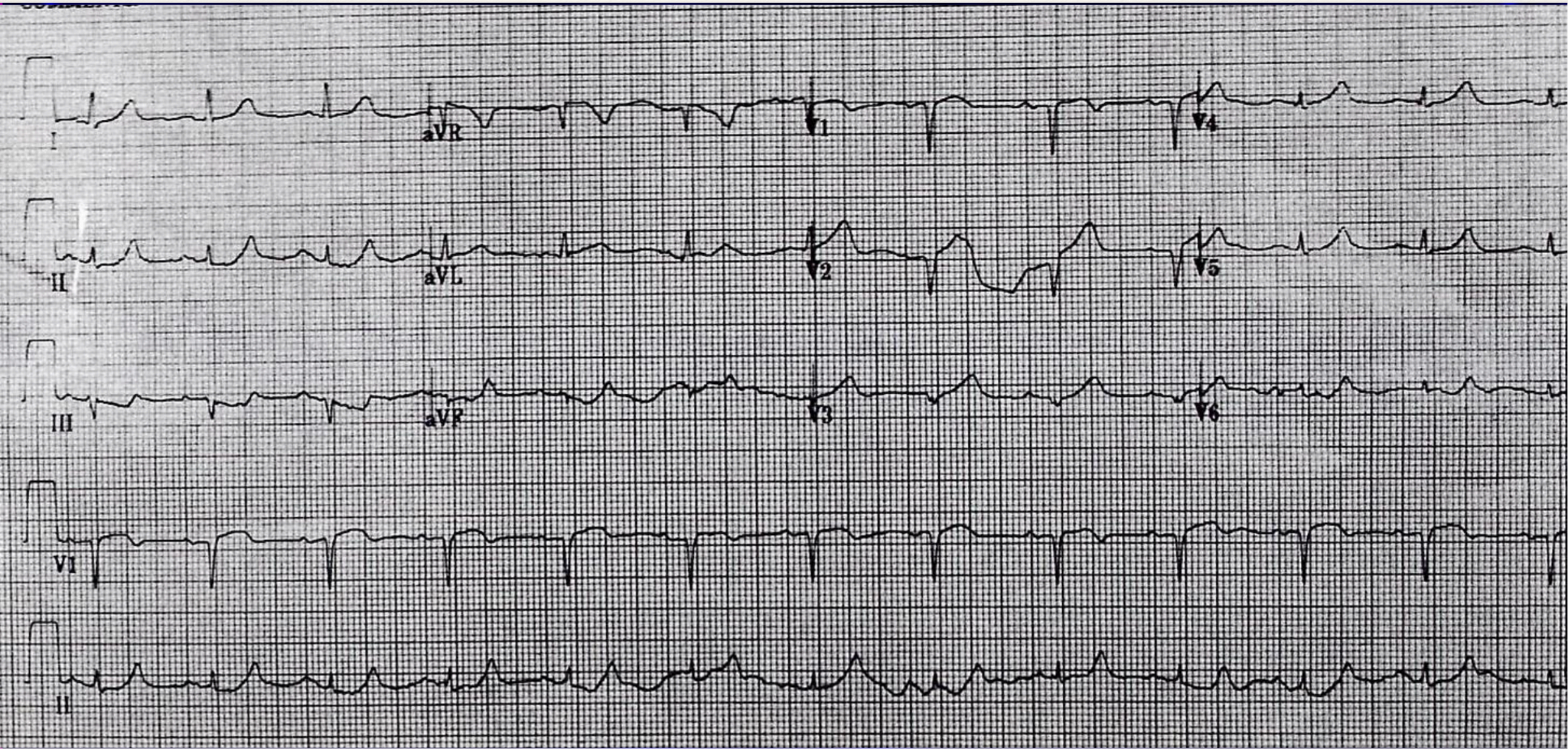
Case 1

- Baseline ECG - note the more symmetrical T wave, fits easily inside the QRS complex



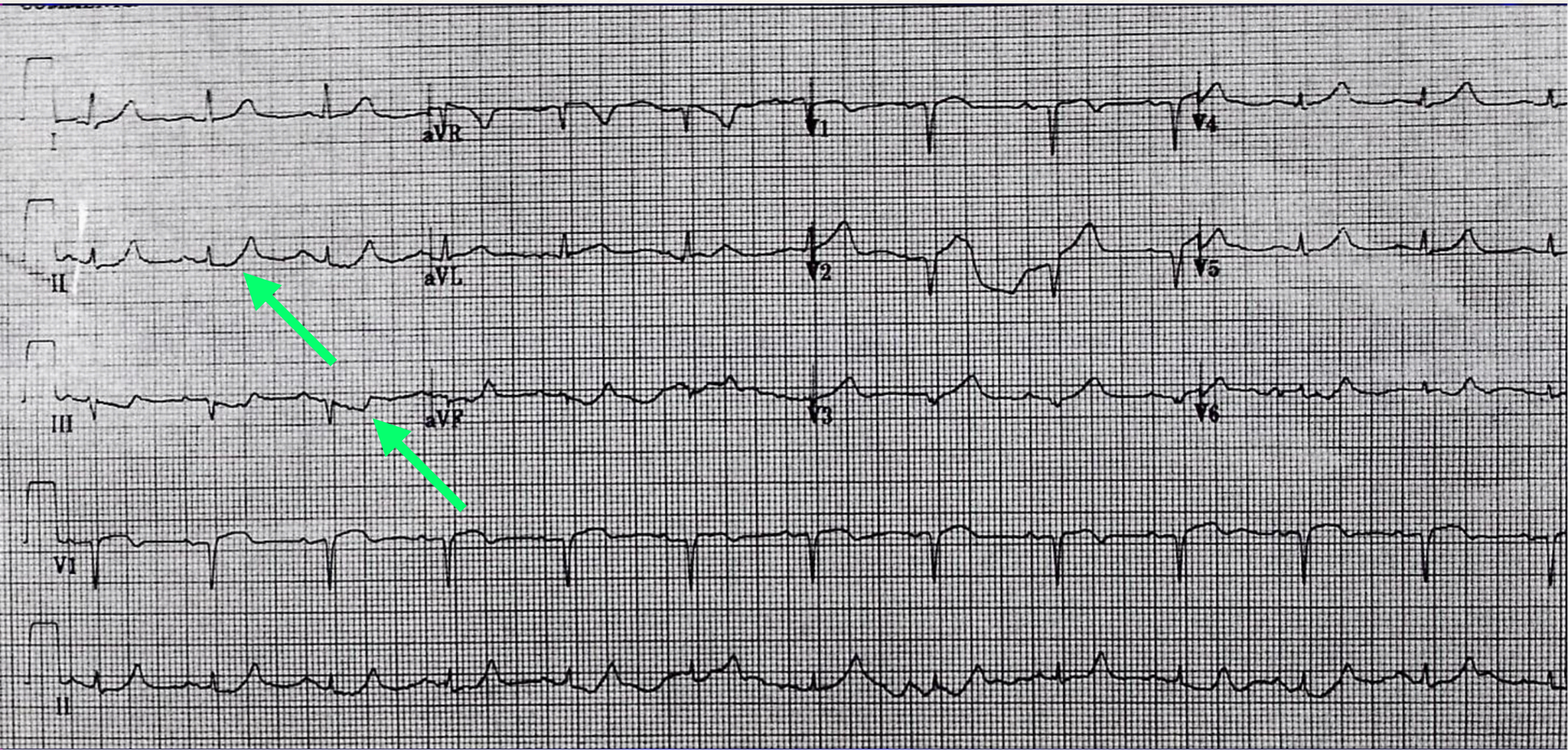
Case 1

- Repeat ECG



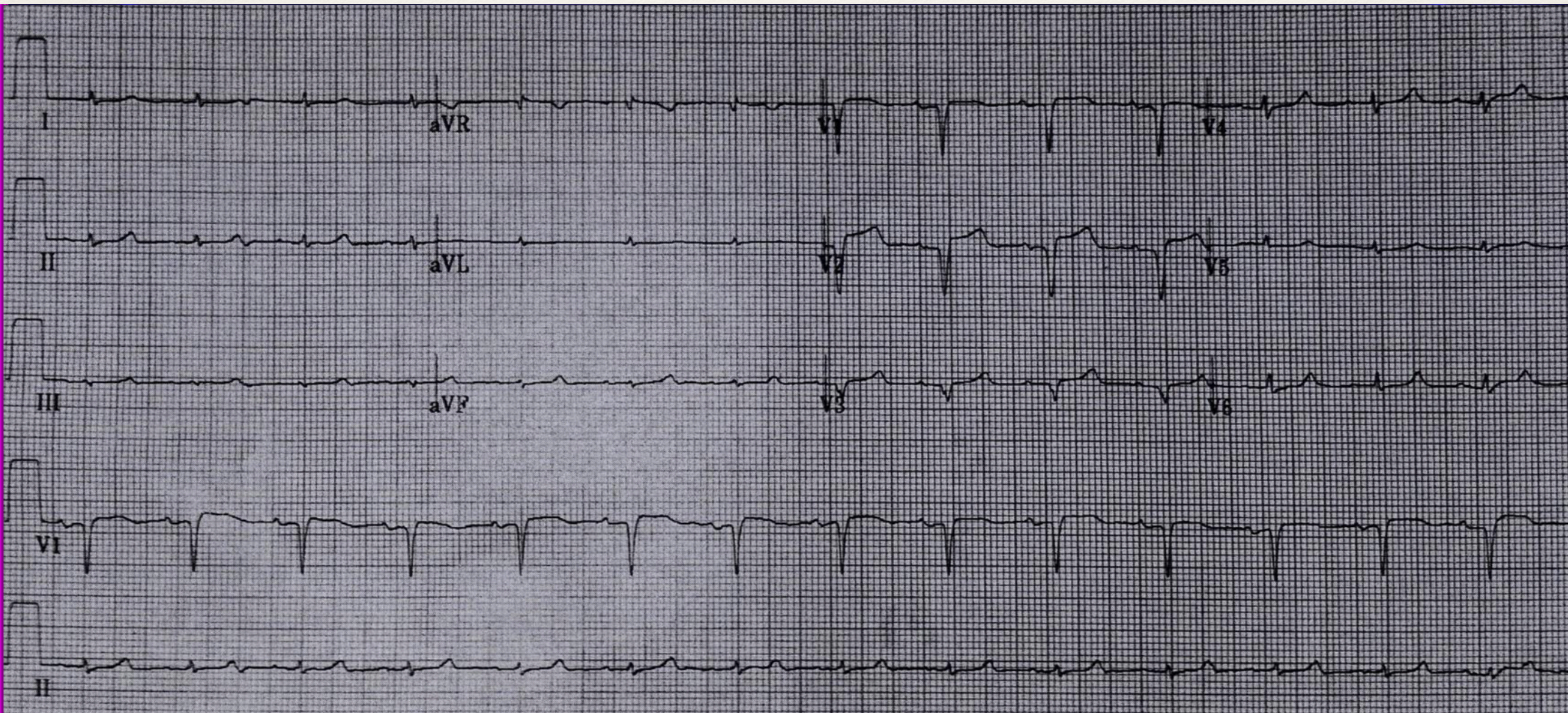
Case 1

- Repeat ECG —> reciprocal ST depression, inferior leads



Case 1

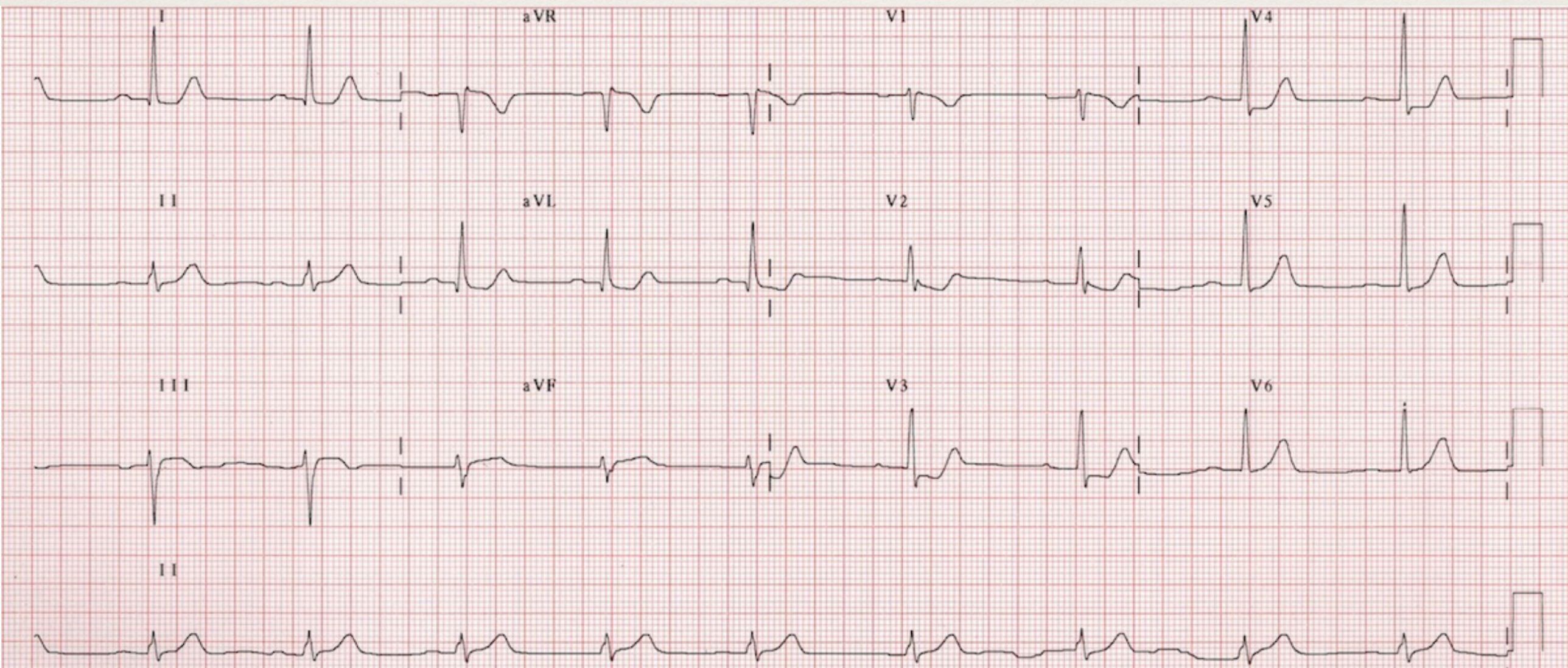
- Few hours later, STE & Q waves V2/3 —> PCI+stent LAD



litfl.com, accessed Jan 2019

Case 2

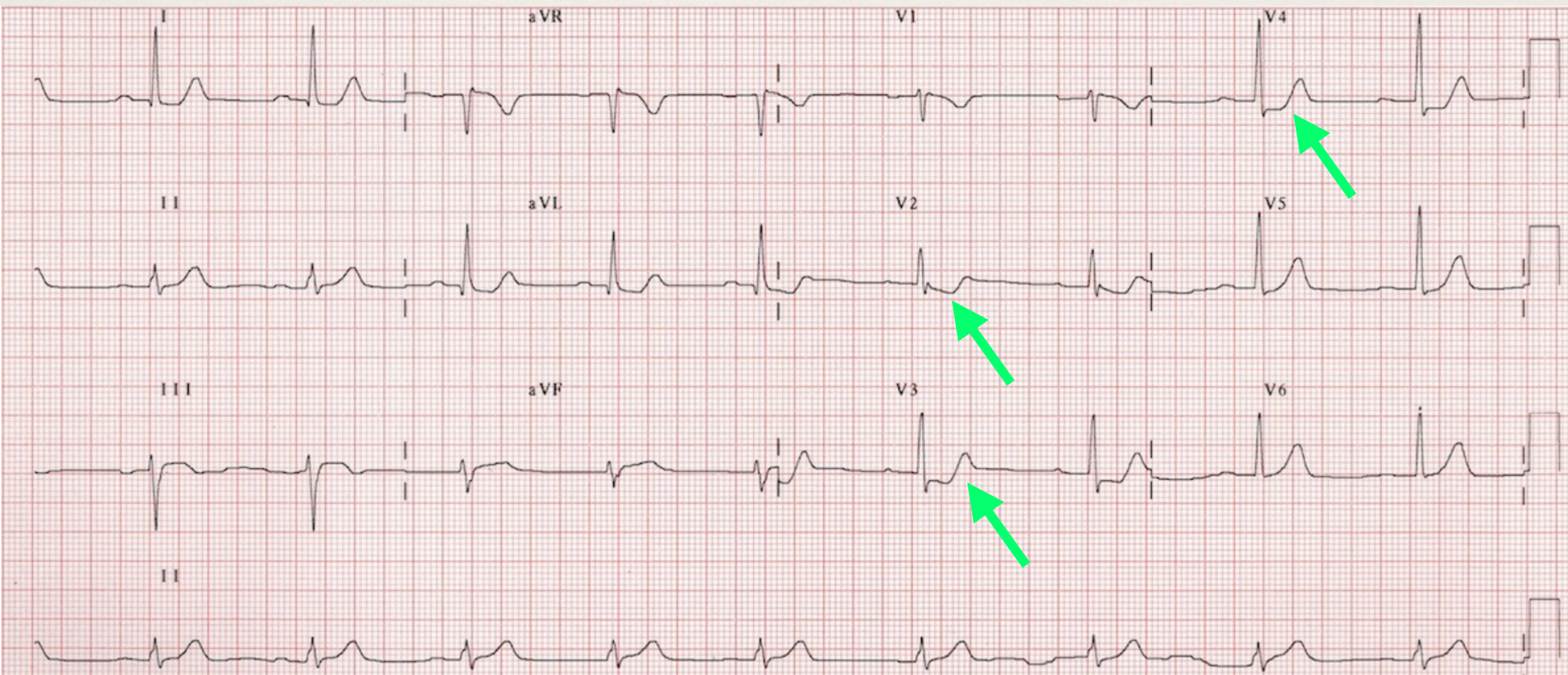
- 49yM with 4 hours of R sided CP radiating to neck, SOB



litfl.com, accessed Jan 2019

Case 2

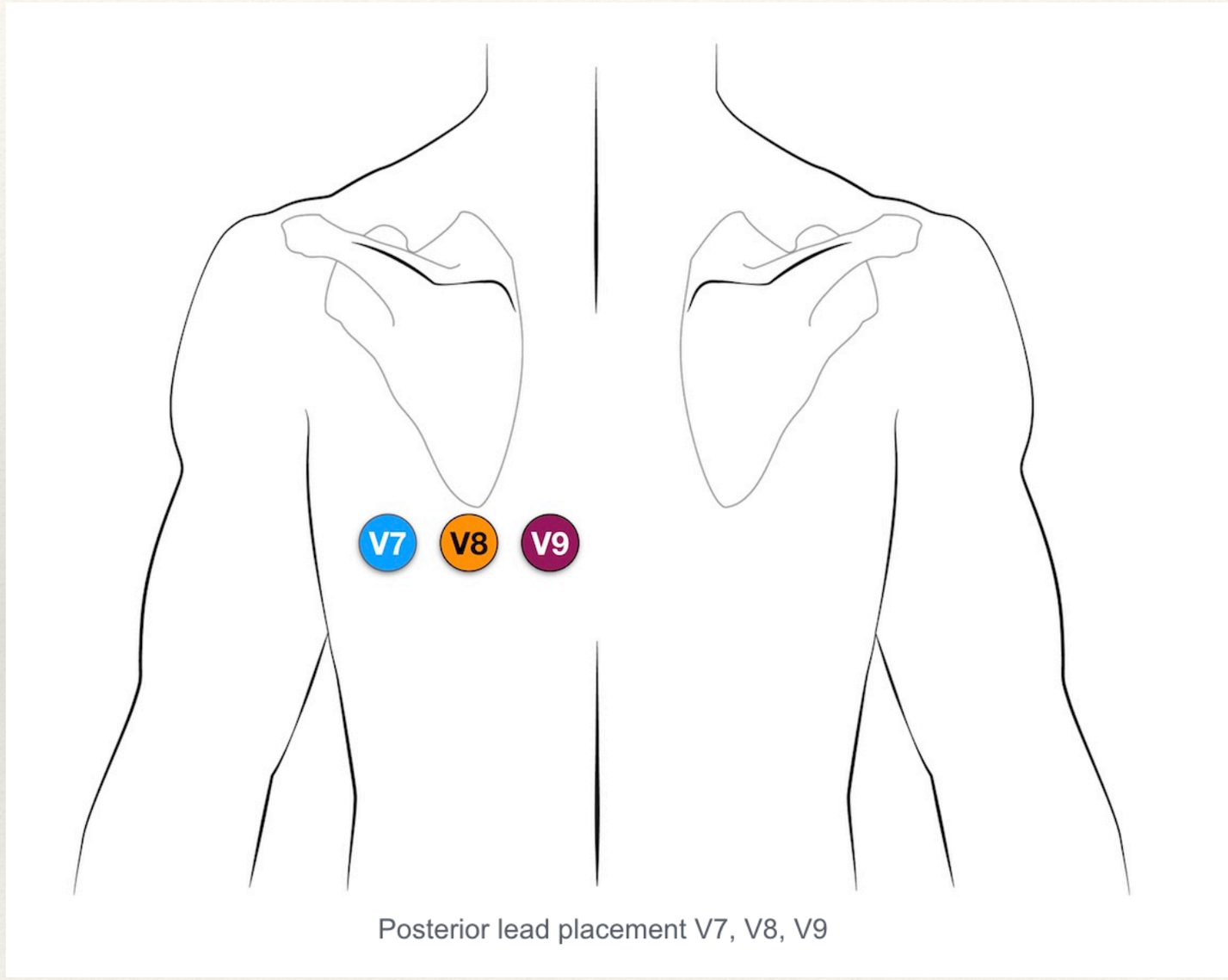
- STD V2/3/4, anything else you want?



litfl.com, accessed Jan 2019

Case 2

- Posterior lead placement: same horizontal level as V6
- V7: posterior axillary line
- V8: inferior angle L scapula
- V9: L paraspinal area

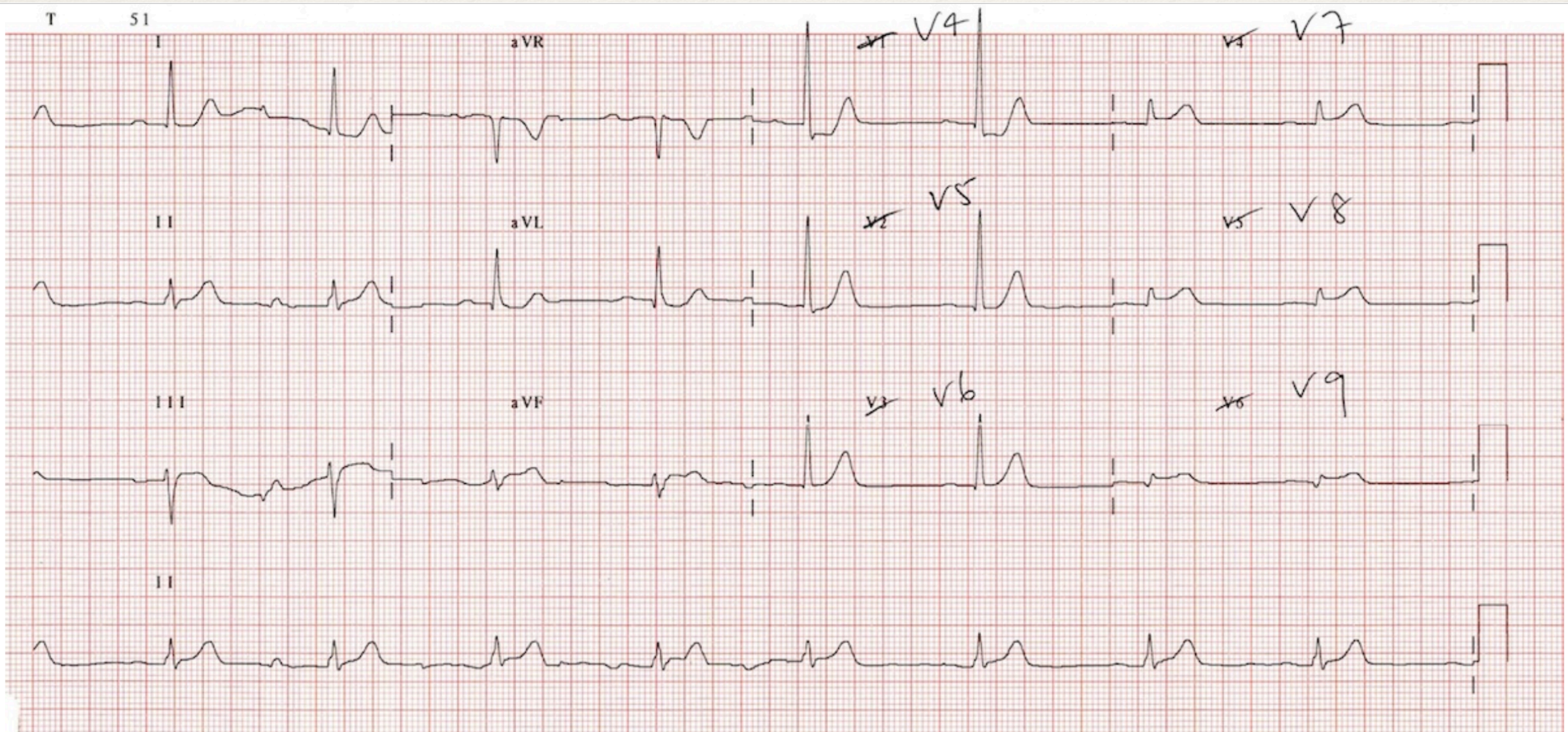


Posterior lead placement V7, V8, V9

litfl.com, accessed Jan 2019

Case 2

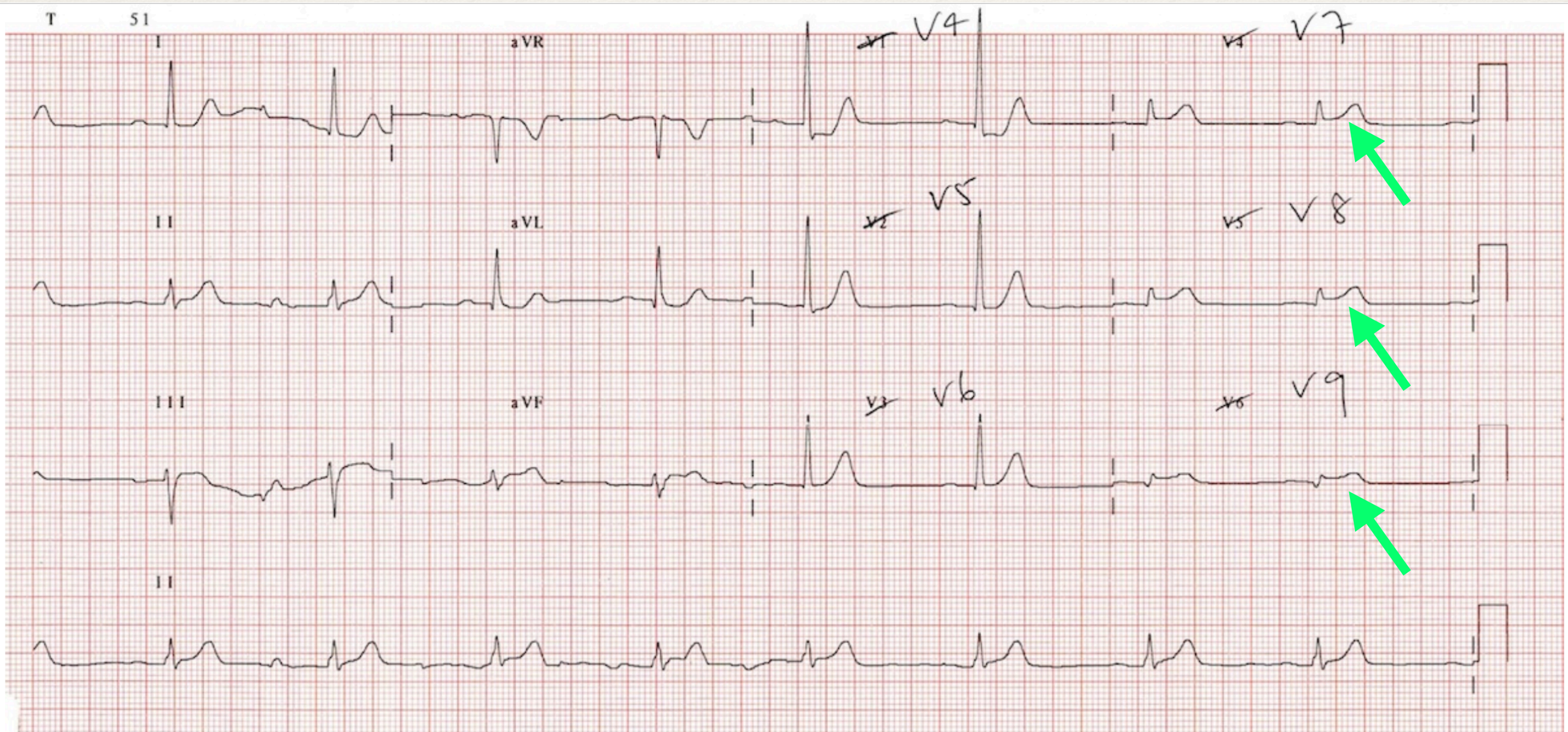
- Posterior leads



litfl.com, accessed Jan 2019

Case 2

- STE in V7/8/9



Lipinski et al. Cardiol Clin 2018

Isolated posterior MIs

- Most commonly missed type of STEMI —> ≥50% don't get acute reperfusion
- True isolated posterior AMI account for 3-11% of all STEMIs (occlusion of L circumflex)
  - Not in conjunction with STE in other leads (e.g. posterolateral, posteroinferior)

Lipinski et al. Cardiol Clin 2018

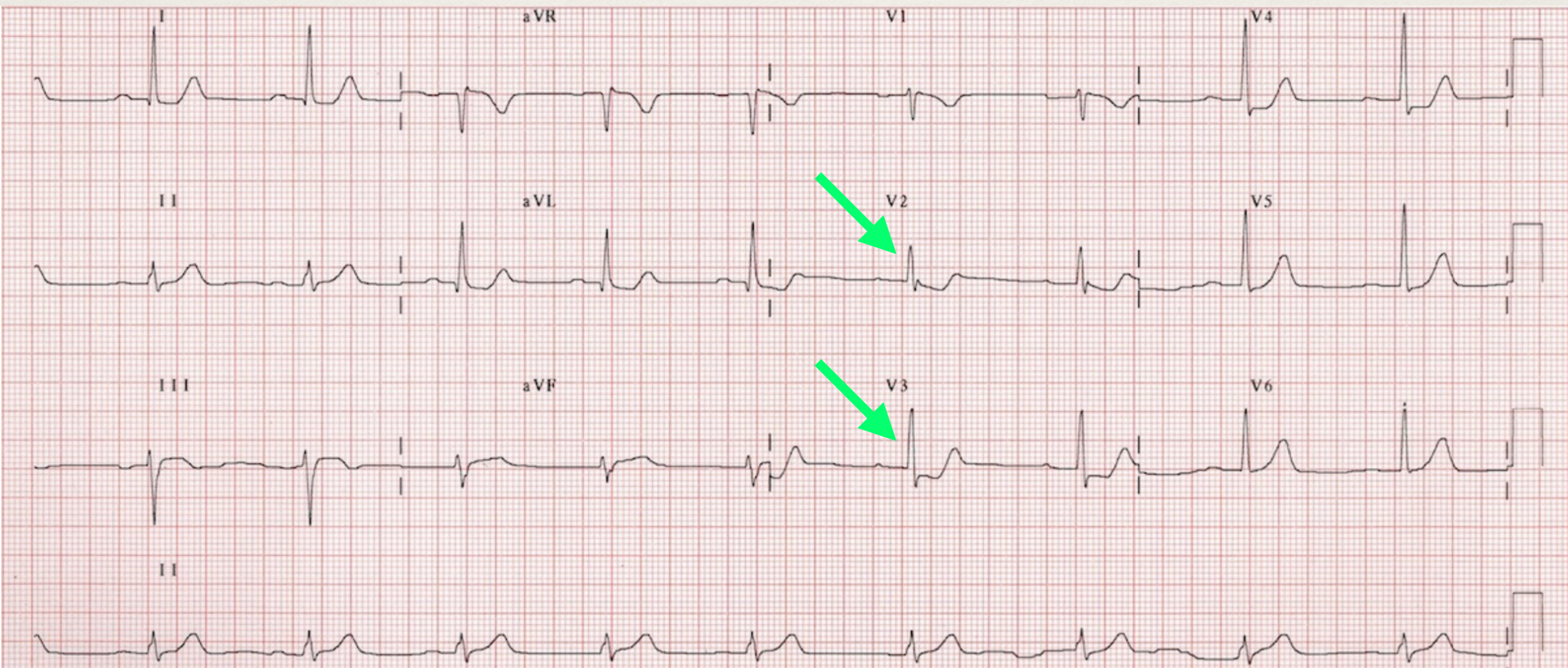
Isolated posterior MIs

- *ESC 2017* - STD V1-3 ≥0.5mm, especially when terminal T wave is positive + confirmation by STE **≥0.5mm** in V7-9 (≥1mm in men, <40y) = posterior STEMI
- *ACCF/AHA 2013* - "ST depression in ≥2 precordial leads (V1–V4) may indicate transmural posterior injury"
- Tall R waves V1 or V2 + Q waves posterior leads (50% specificity)
  - STD V1-3 (61-92% specific)
  - STE V7-9 (91-100% specific)

litfl.com, accessed Jan 2019

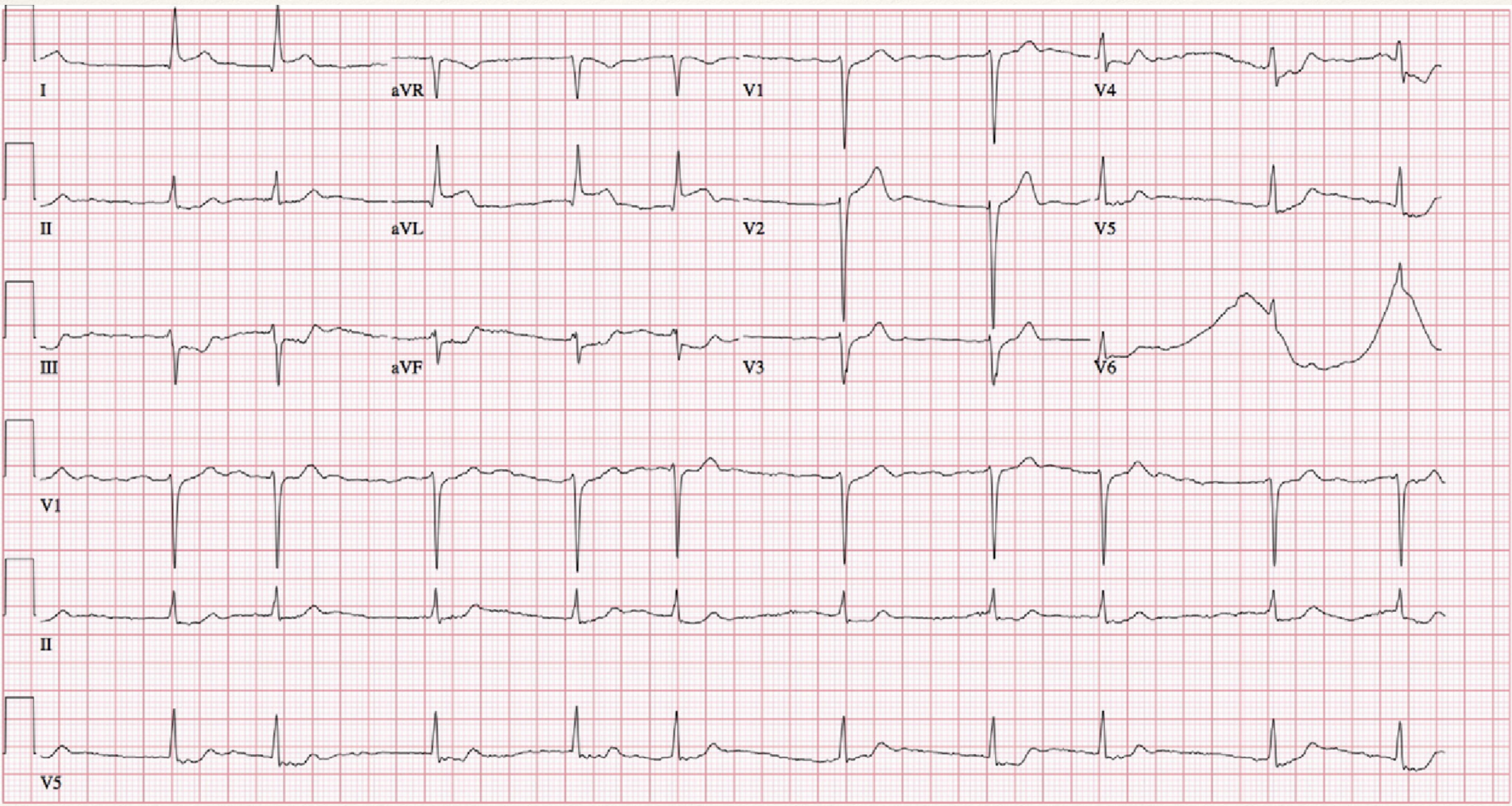
Case 2

- …also tall R waves in V2/3



Case 3

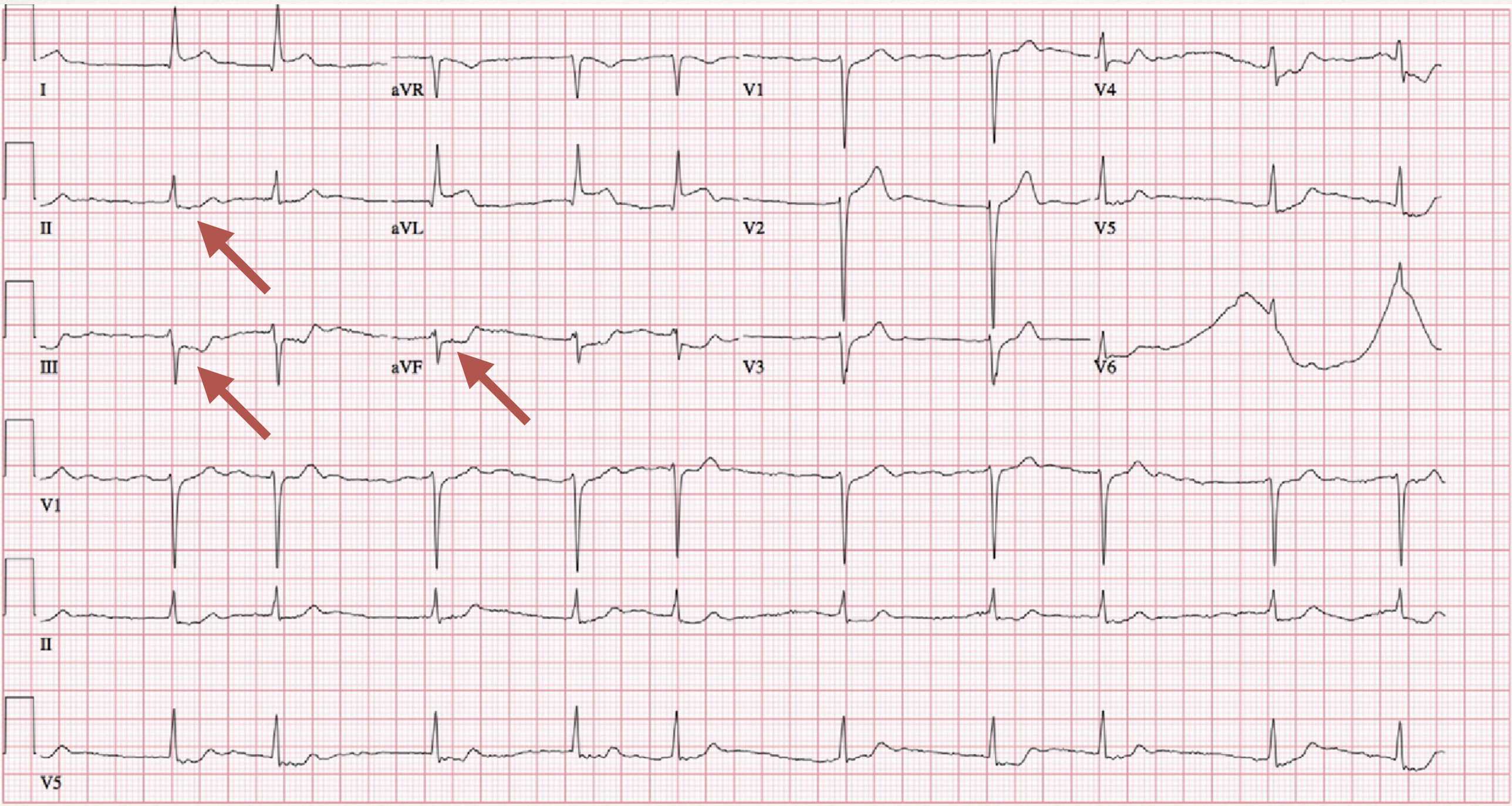
- 71yF with sudden onset fatigue and weakness



Durant, Singh Am J Emerg Med 2015

- STD II/III/aVF

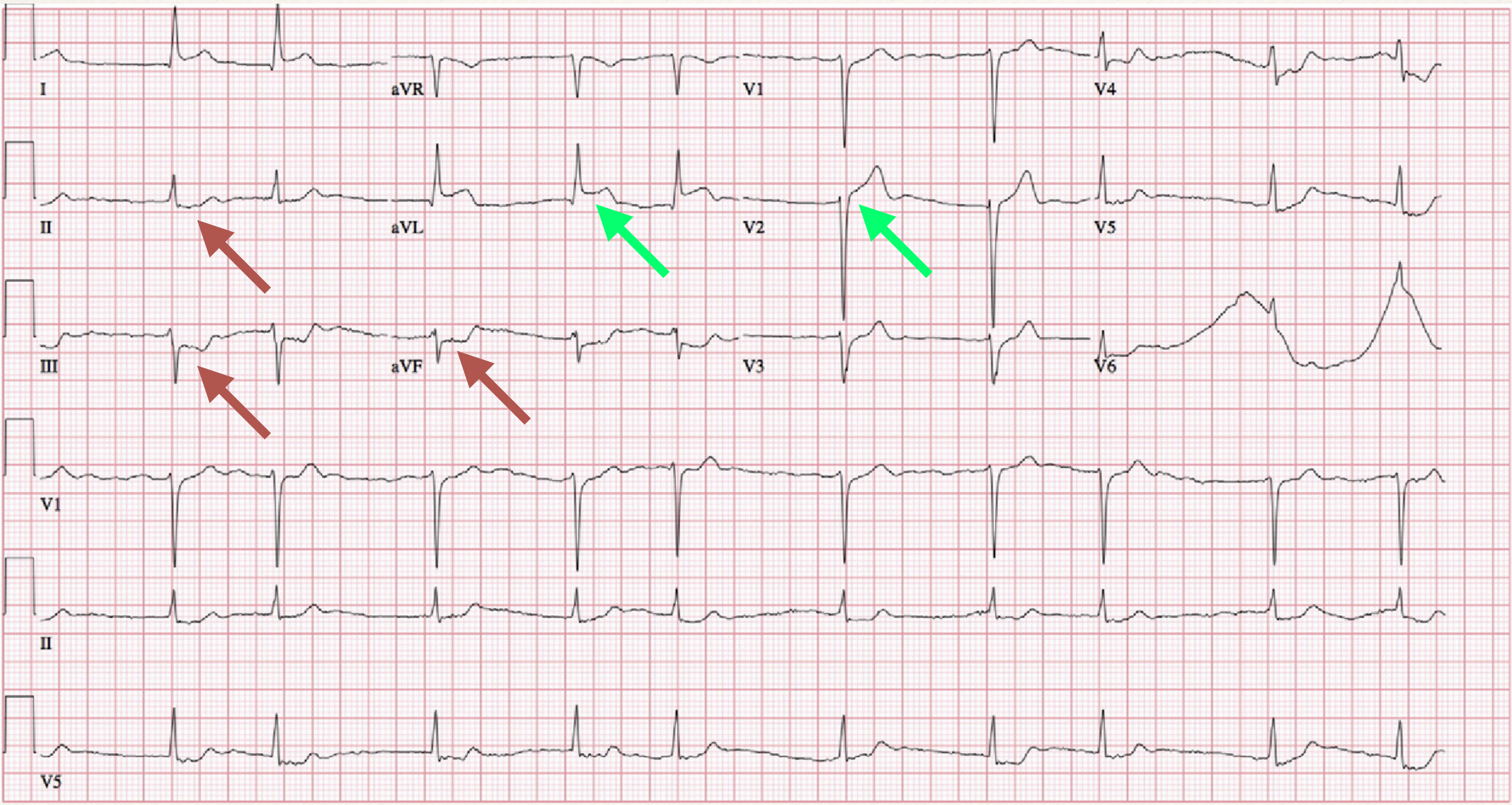
Case 3



Durant, Singh Am J Emerg Med 2015

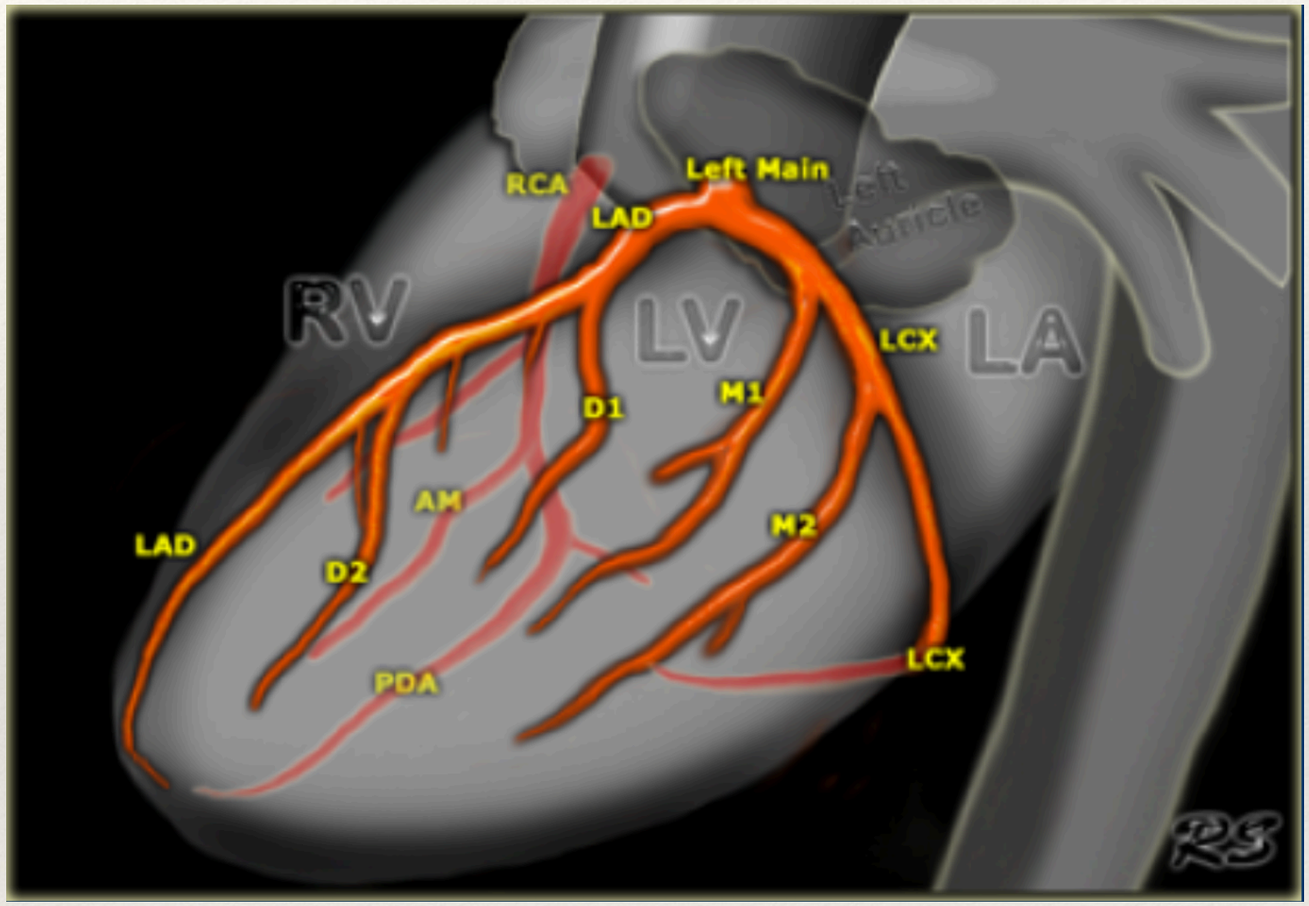
- STD II/III/aVF
- **STE in II & aVL**

Case 3



Non-anatomic STE

- LAD is the most common culprit artery in MIs
- Correlation: STE in leads that aren't anatomically contiguous & occlusion of branches of LAD
  - First diagonal branch of the LAD (D1) perfuses large portion of LV (anterolateral wall)



radiologyassistant.nl, accessed Apr 2019

Durant, Singh Am J Emerg Med 2015

Non-anatomic STE

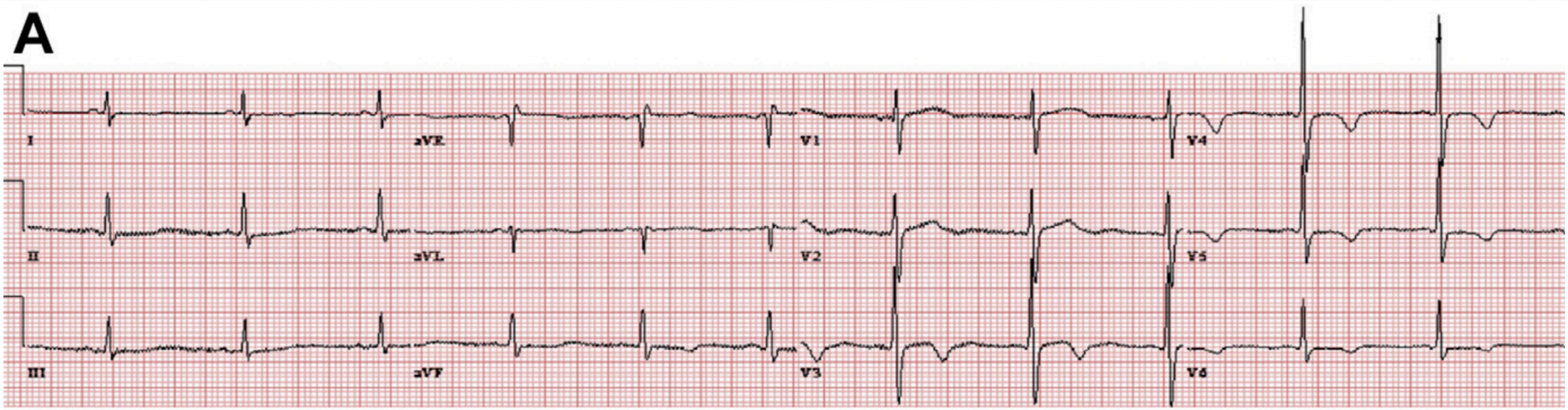
- Occlusion of D1 can present with STE≥1mm in aVL and V2 i.e. non-anatomically contiguous leads
  - STD in inferior and/or lateral leads
  - Variable STE in lead I
- STE in aVL & V2 = positive predictive value 89%
- *"ST elevations in **aVL and V2** (with concurrent inferior ST depressions) should prompt the ER physician to recognize this pattern as a STEMI equivalent and initiate emergent reperfusion therapy in the appropriate patient."*

Durant, Singh Am J Emerg Med 2015

Sclarovsky et al. Int J Cardiol 1994

Case 4

- 67yF with HTN/DLP, 3 hours intermittent CP now asymptomatic



Case 4

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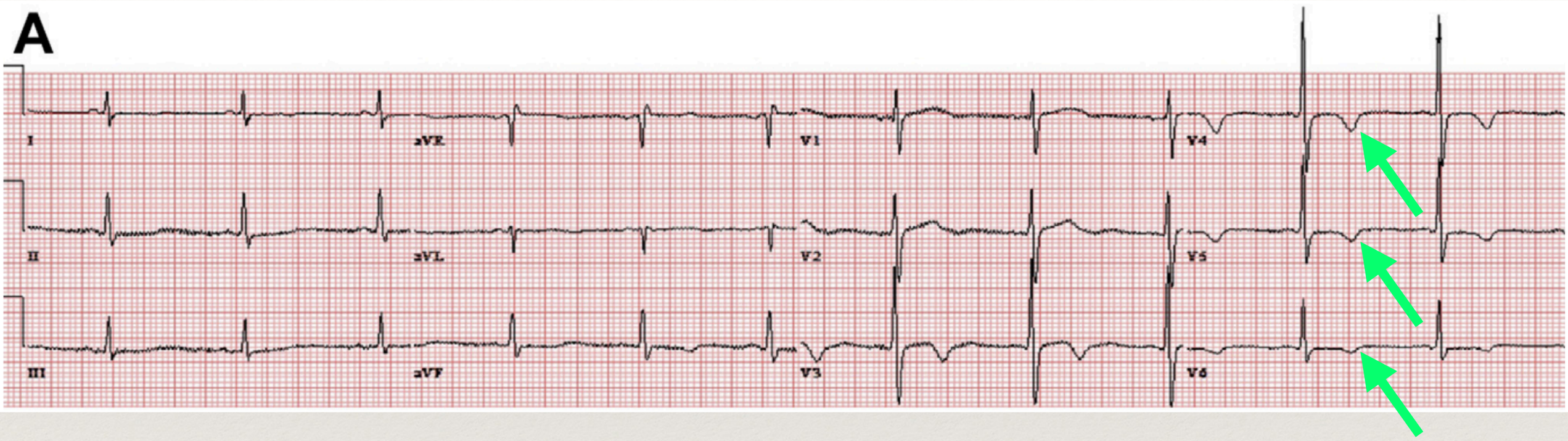
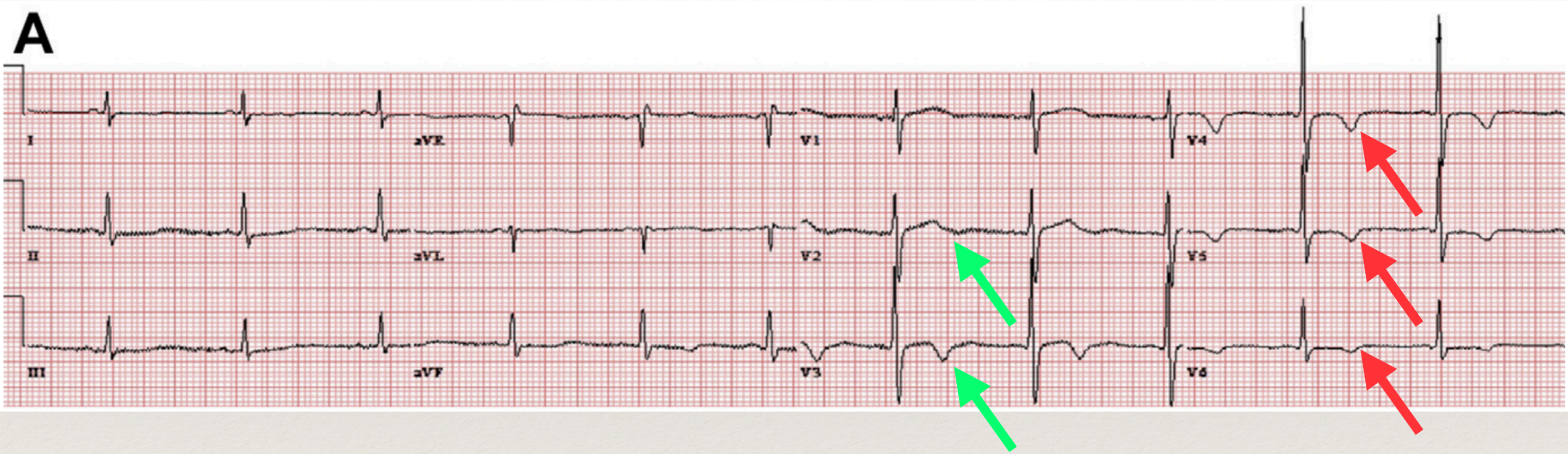


Case 4

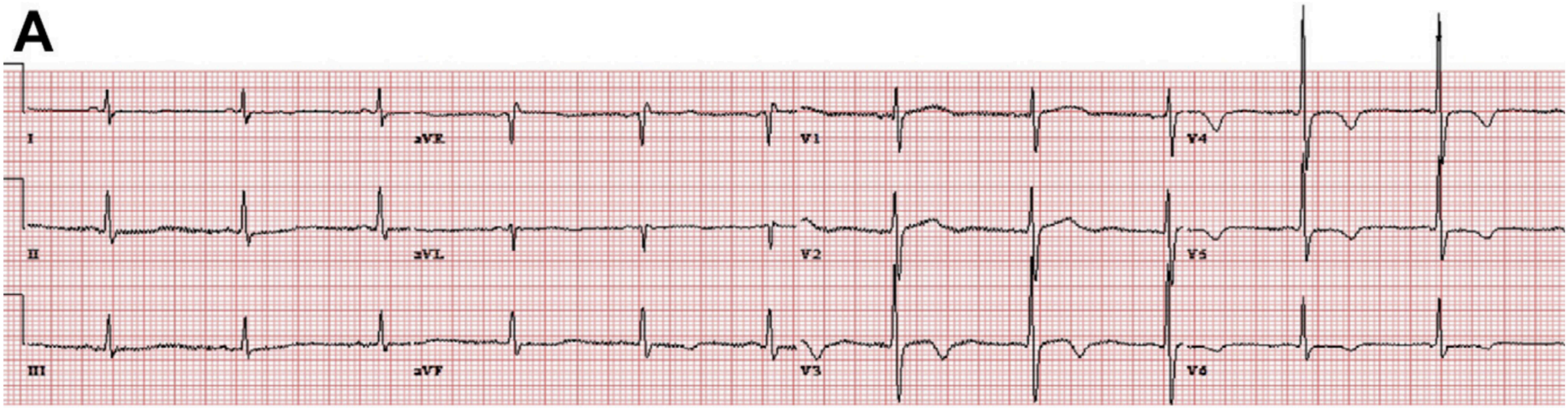
- 67yF with HTN/DLP, 5 hours intermittent CP now asymptomatic



Lipinski et al. Cardiol Clin 2018

Case 4

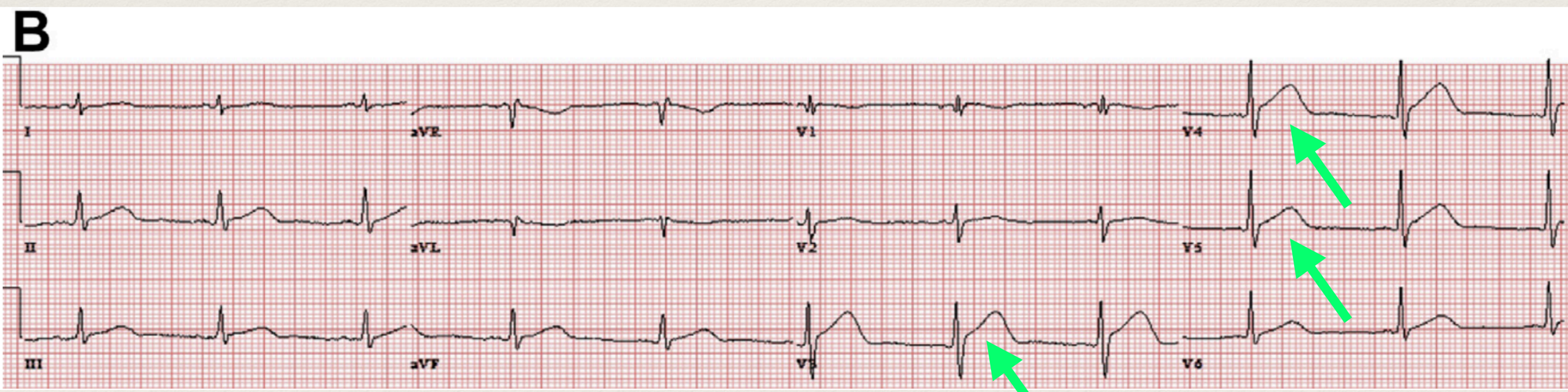
- Next steps??
- Troponin negative
- Still pain-free



Lipinski et al. Cardiol Clin 2018

Case 4

- CP again 1 hour later, rpt ECG —> anterior STEMI, proximal LAD occlusion 99%



Wellens syndrome

- Wellens T waves (14% of patients with unstable angina, all had ≥50% stenosis of LAD)
  - Type A (~25%): biphasic TWI in V2 or V3 with an initial positive deflection, terminal negative deflection
  - Type B (~75%): symmetric, deeply inverted often >2mm, TWI in anterior leads (V2/3 often V4 as well, rarely V1)
- Wellens T waves typically develops <u>AFTER</u> CP resolves - scary!
  - Recurrence of CP produces either: ST elevation OR normalization ST and T wave
- Highly suggestive of **<u>critical</u>** proximal LAD stenosis

de Zwaan, Bar, Wellens. Am J Heart 1982

de Zwaan et al. Am J Emerg Med 2002

Wellens syndrome

- Not considered a STEMI equivalent, rather a precursor to anterior AMI
- High percentage of Wellens develop AMI and death without revascularization despite treatment with medical therapy
- Strongly consider consulting with cardio for urgent/ emergent cath referral to avoid progression
- *No note of Wellens in either guideline

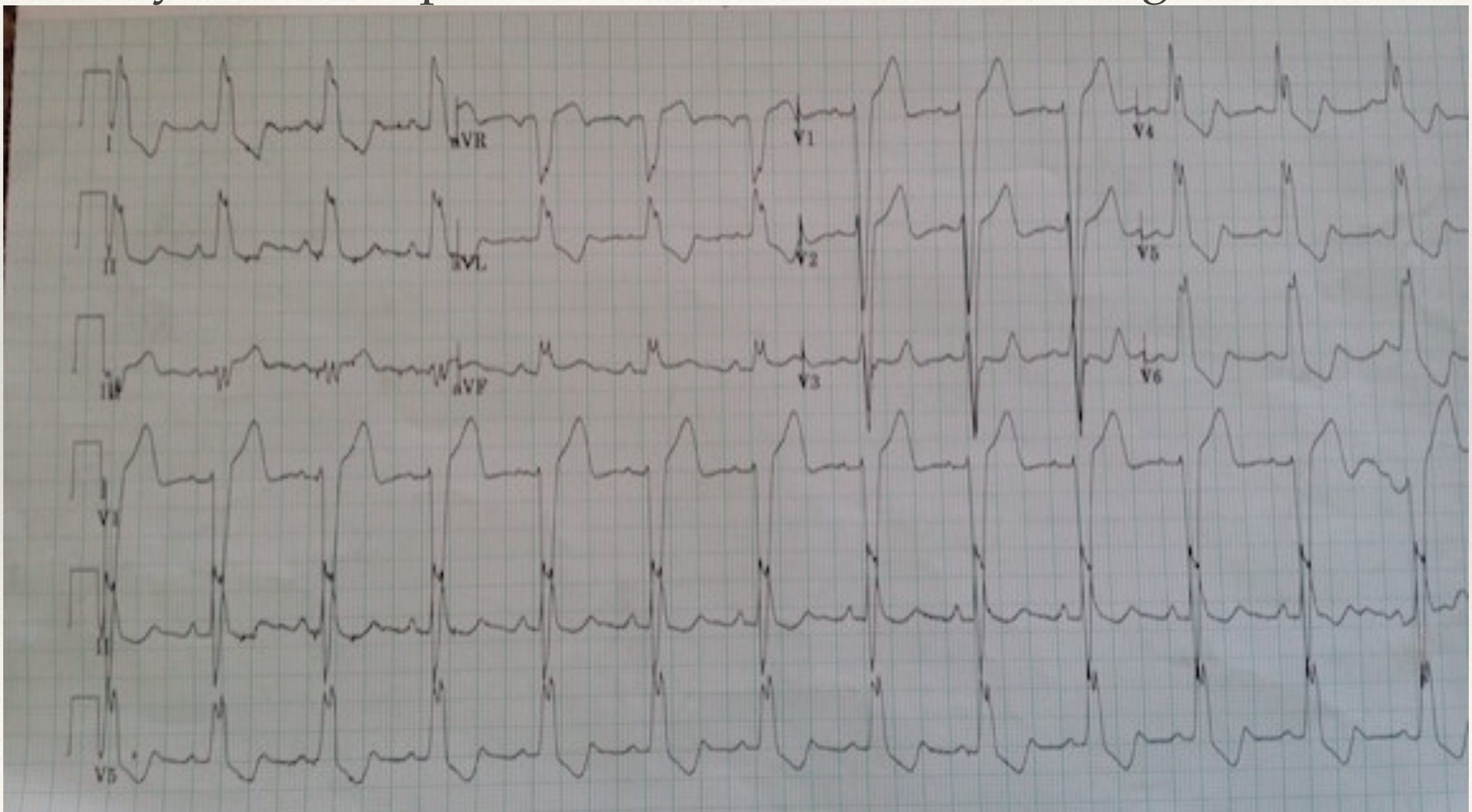
de Zwaan, Am Heart J, 1989

Lipinski et al. Cardiol Clin 2018

epmonthly.com, accessed Jan 2019

Case 5

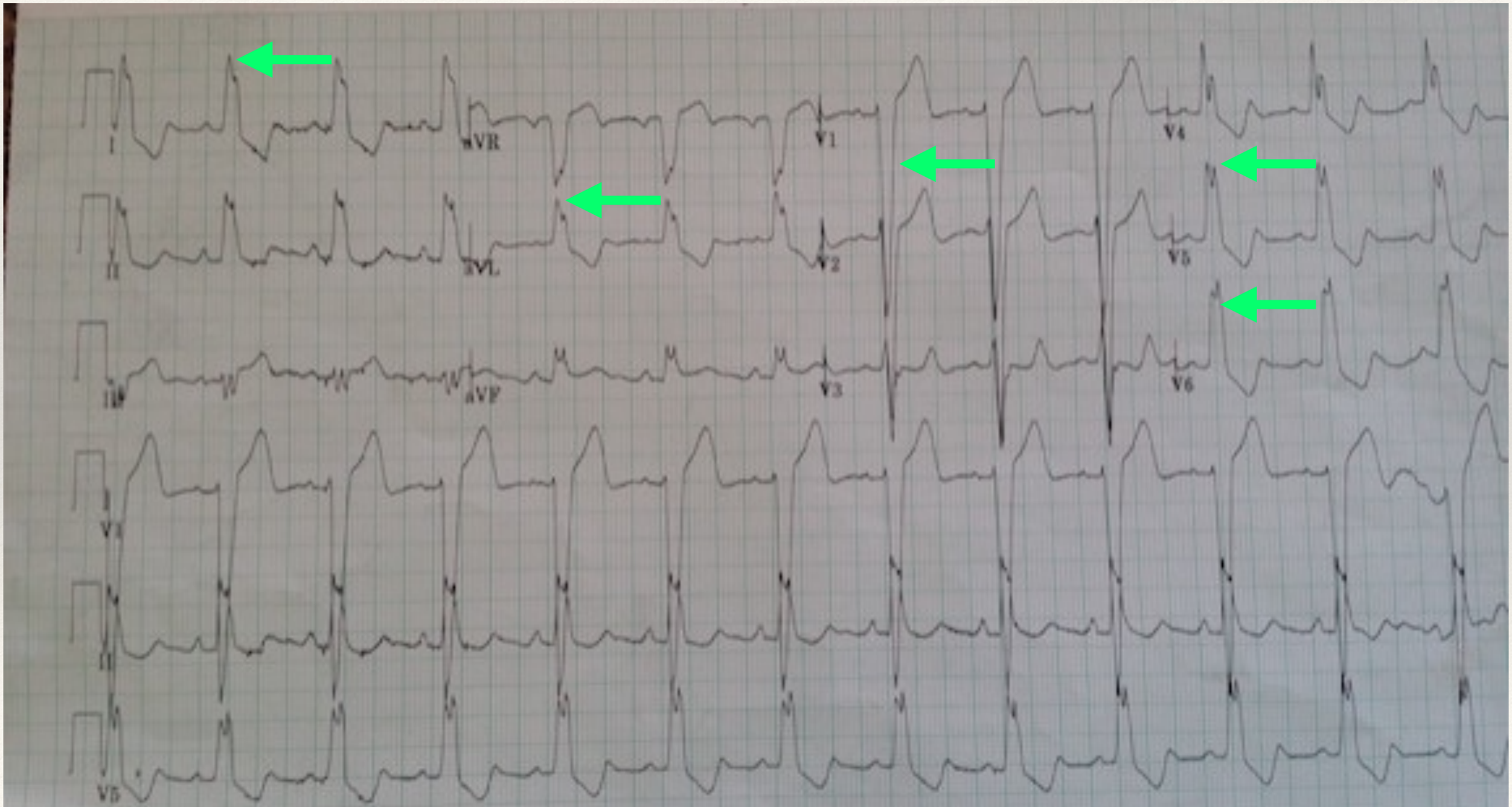
- 54yM woke up with substernal CP 2 hours ago.



epmonthly.com, accessed Jan 2019

LBBB

- Wide QRS
- Dominant S in V1
- Broad monophasic R wave lateral leads
- No Q wave lateral leads (small Q waves allowed in aVL)
- Prolonged R wave peak time >60ms in V5/V6



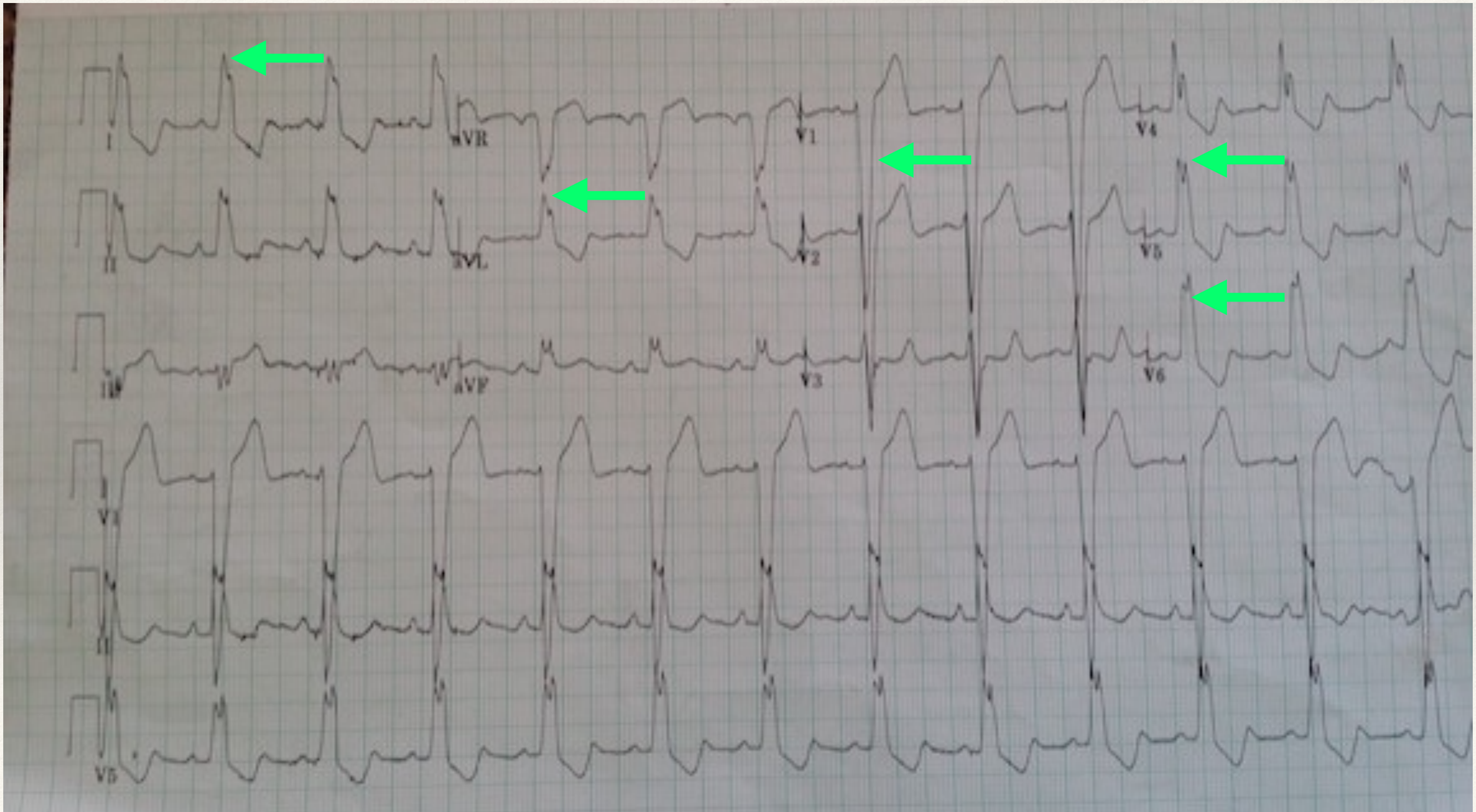
epmonthly.com, accessed Jan 2019

LBBB

- Wide QRS
- Dominant S in V1
- Broad monophasic R wave lateral leads
- No Q wave lateral leads (small Q waves allowed in aVL)
- Prolonged R wave peak time >60ms in V5/V6

Other features

- Appropriate **discordance**: ST and T waves go in opposite direction to main QRS vector
- Poor R wave progression precordial leads
- Left axis deviation



?New LBBB

- What about "new" LBBB?

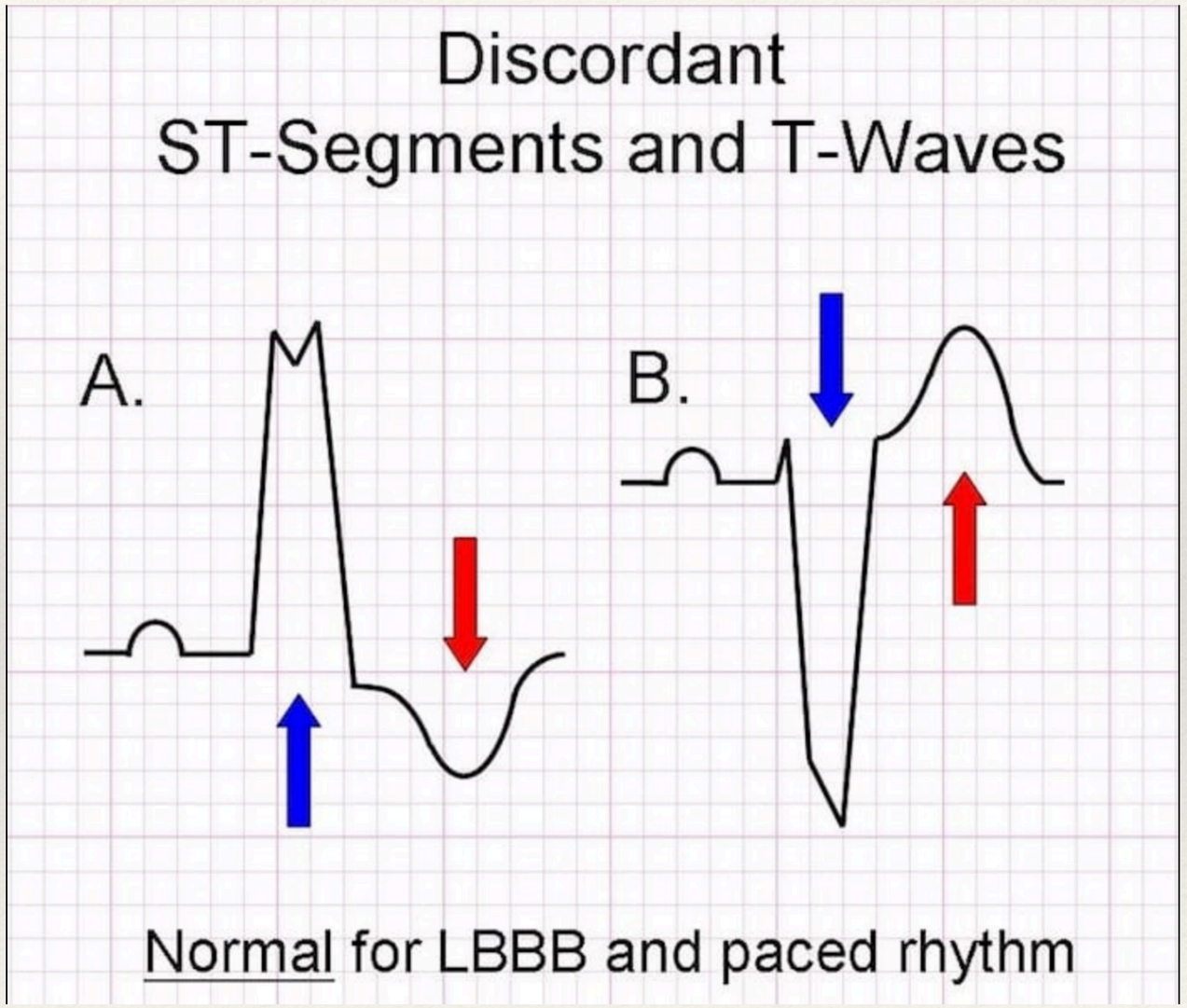
"New or presumably new LBBB has been considered a STEMI equivalent. Most cases of LBBB at time of presentation, however, are "not known to be old" because of prior electrocardiogram (ECG) is not available for comparison. **New or presumably new LBBB** at presentation occurs infrequently, may interfere with ST-elevation analysis, and **should not be considered diagnostic of acute myocardial infarction (MI) in isolation**." -ACCF/AHA 2013

"Patients with a clinical suspicion of ongoing myocardial ischaemia and LBBB should be managed in a way similar to STEMI patients, regardless of whether the LBBB is previously known. It is important to remark that the **presence of a (presumed) new LBBB does not predict an MI per se**." -ESC 2017

litfl.com, accessed Apr 2019

Concordance vs discordance?

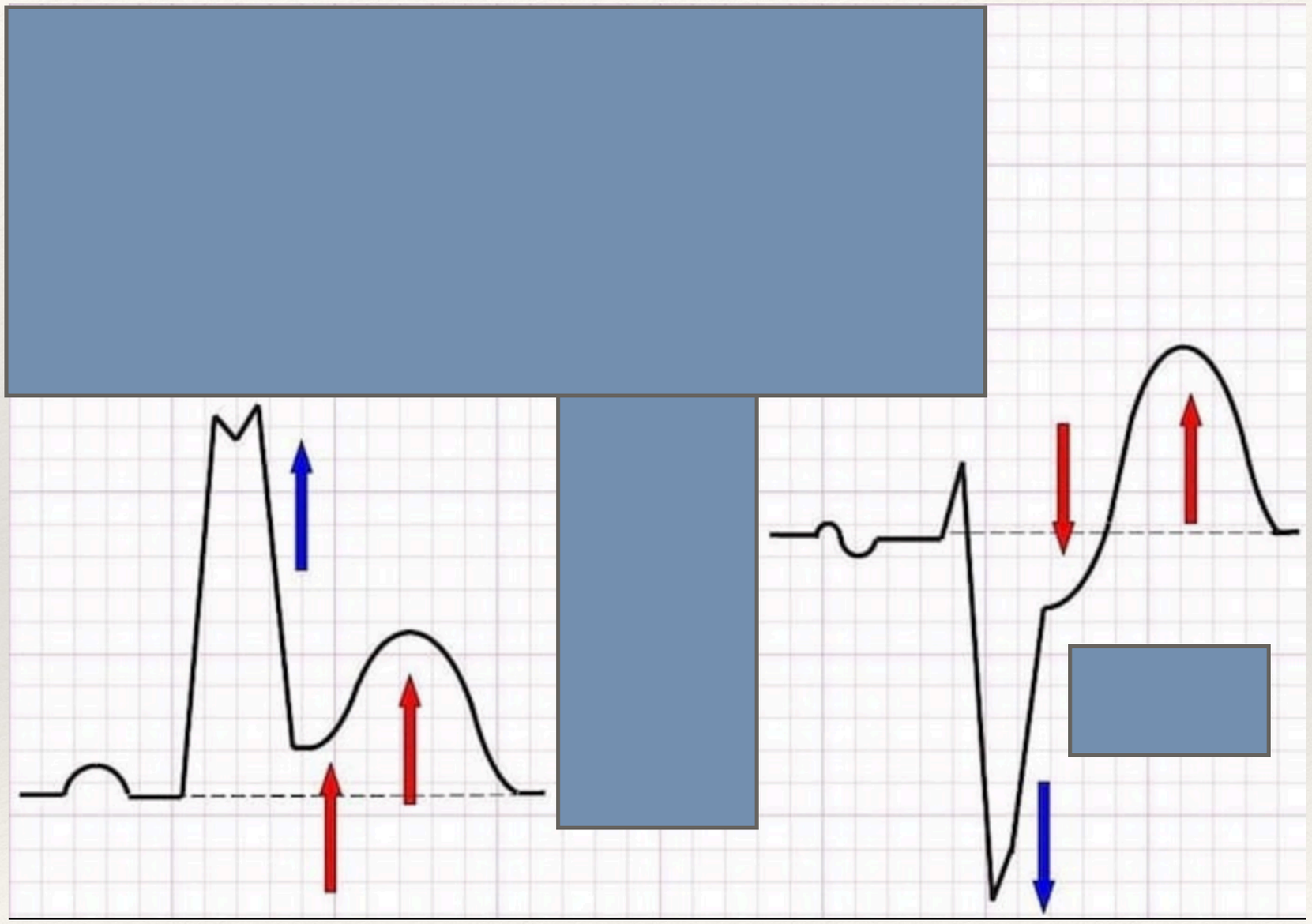
- In LBBB, the norm an ST segment and T wave in the opposite direction of the main QRS vector i.e. **discordance**



litfl.com, accessed Apr 2019

Concordance vs discordance?

- ST segment and T wave in the **same** direction as the main QRS vector = **concordance**
- **Not** normal for LBBB and paced rhythms



Original Sgarbossa criteria

ACS in underlying LBBB?

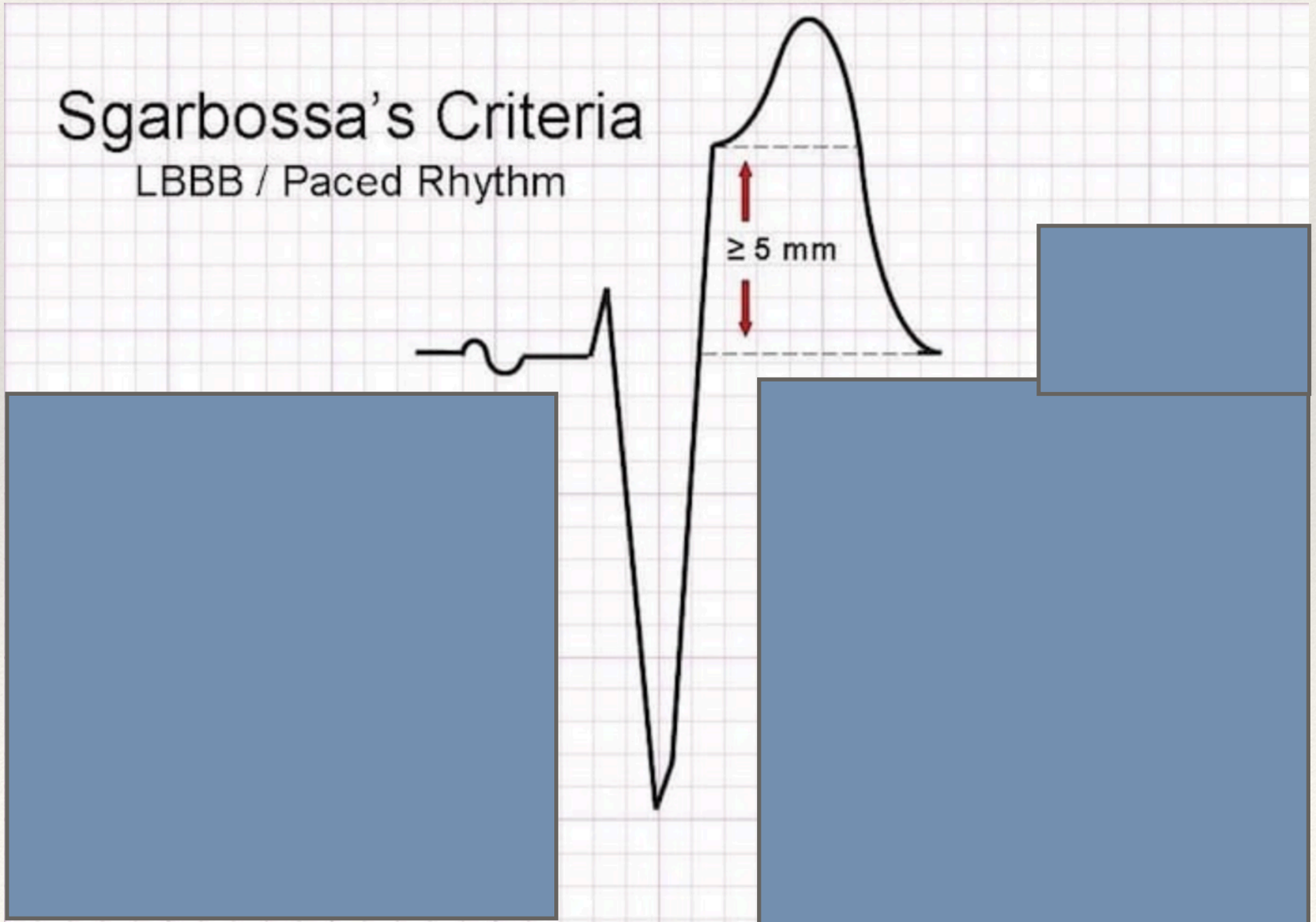
1. Concordant STE ≥1mm (Odds Ratio 25) = 5 points
2. Concordant STD ≥1mm in V1-3 (OR 6) = 3 points
3. STE ≥5mm discordant from QRS (OR 4) = 2 points, less specific than #1/2

At least 3 points to Dx AMI: Sens 36% Spec 96%

litfl.com, accessed Apr 2019

Sgarbossa criteria #3

3. STE≥5mm discordant from QRS



Smith et al. Ann Emerg Med 2012

Modified Sgarbossa criteria

ACS in underlying LBBB?

1. Concordant STE ≥1mm (OR 25)
2. Concordant STD ≥1mm in V1-3 (OR 6)
3. **STE (discordance) with ST/S ratio ≤ - 0.25 (i.e. STE greater than 25% of the height of the QRS)**

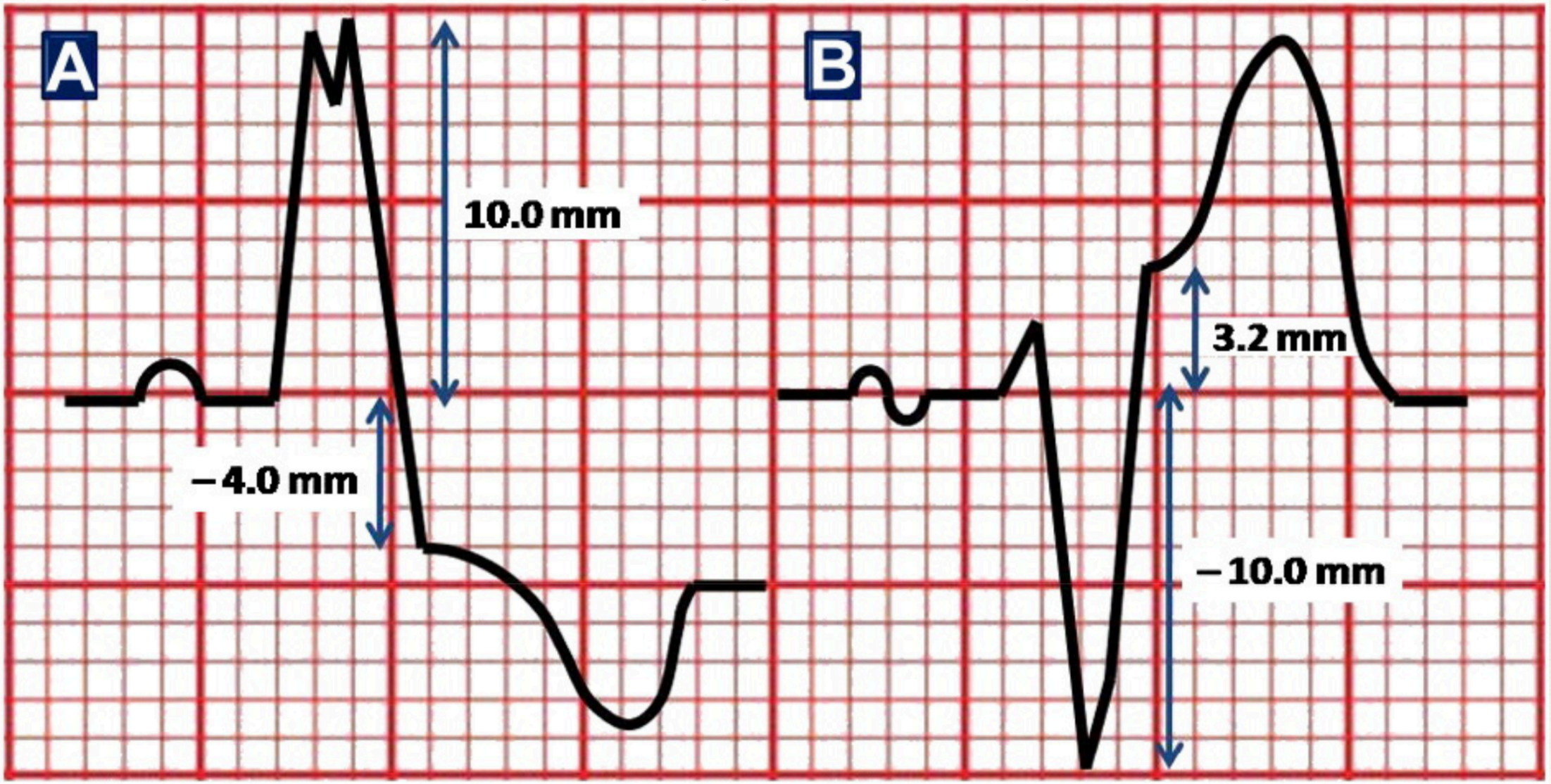
*Unweighted (i.e. no point system) Sens **91%** Spec **90%***

- Alternatively, same as above except excessive discordance in either direction (STE or STD) = *Sens **~100%**, Spec **86%***
- Modified criteria **NOT** incorporated into any guidelines yet

Cai et al. Am Heart J 2013

Modified Sgarbossa criteria #3

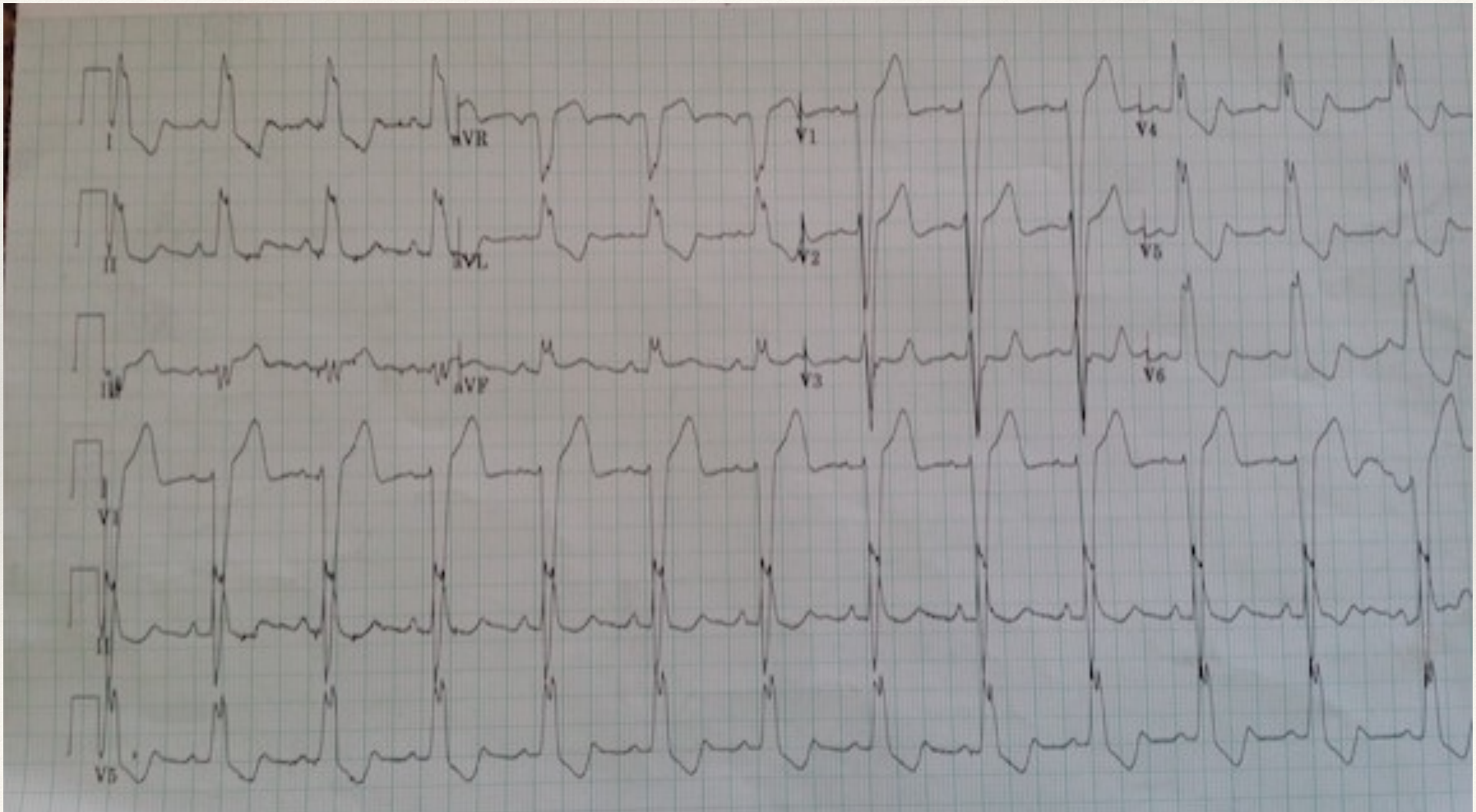
3. STE (discordance) with ST/S ratio ≤ - 0.25 (i.e. STE greater than 25% of the height of the QRS)



epmonthly.com, accessed Jan 2019

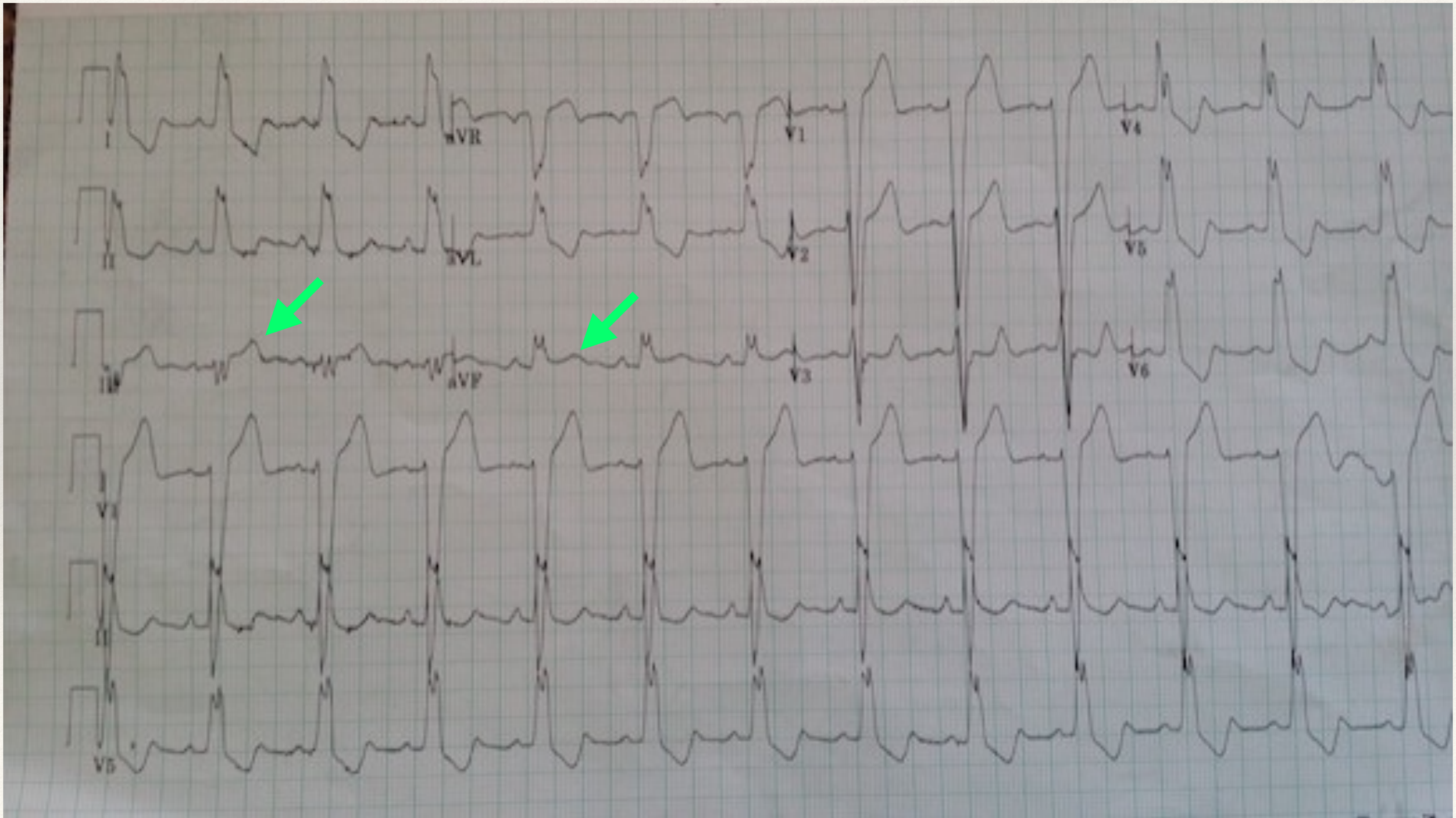
Case 5

- Back to the case…



Case 5

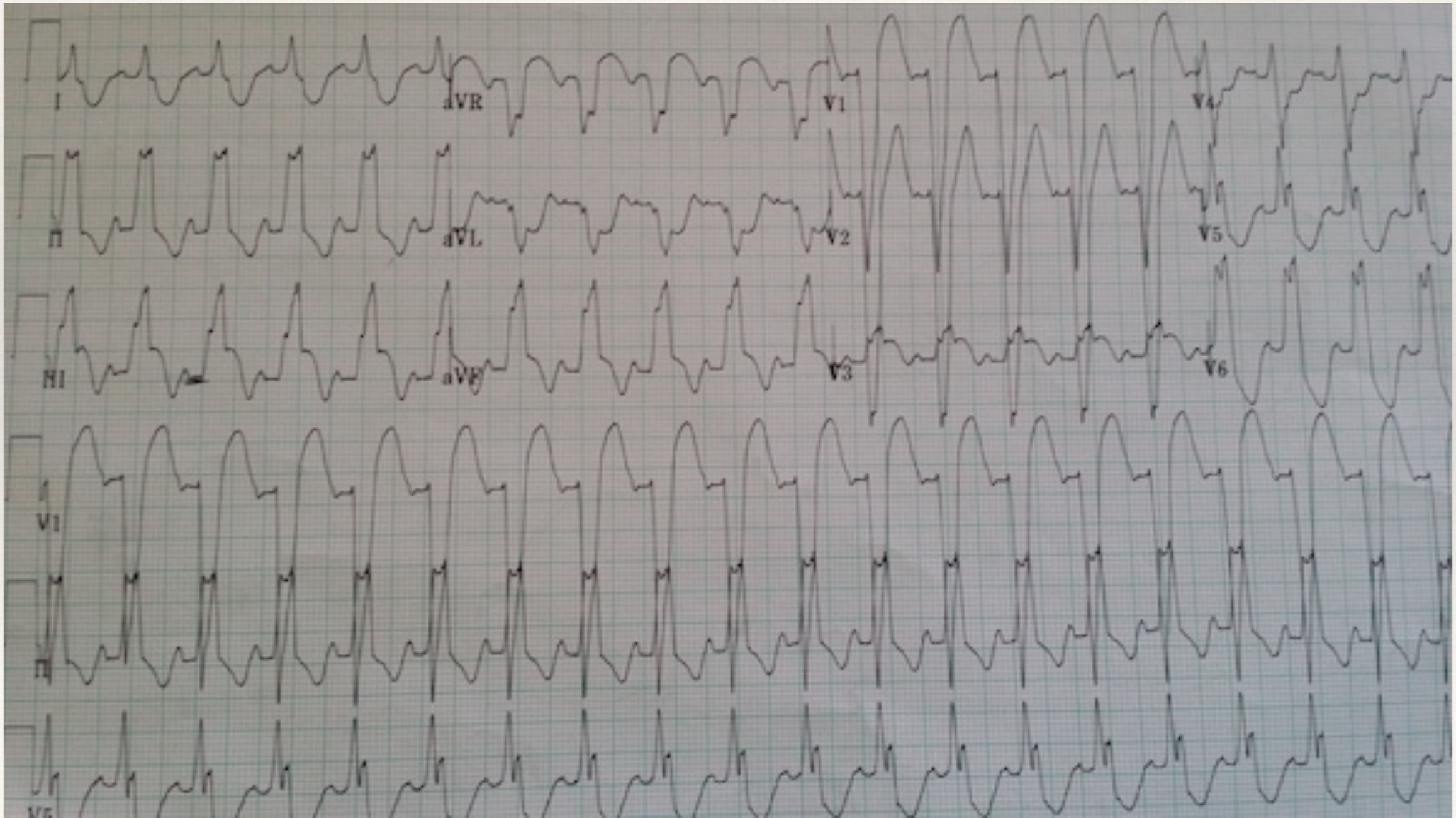
- …excessively discordant STE in III (revised criteria 3), concordant STE in aVF (criteria 1)



epmonthly.com, accessed Jan 2019

Case 5

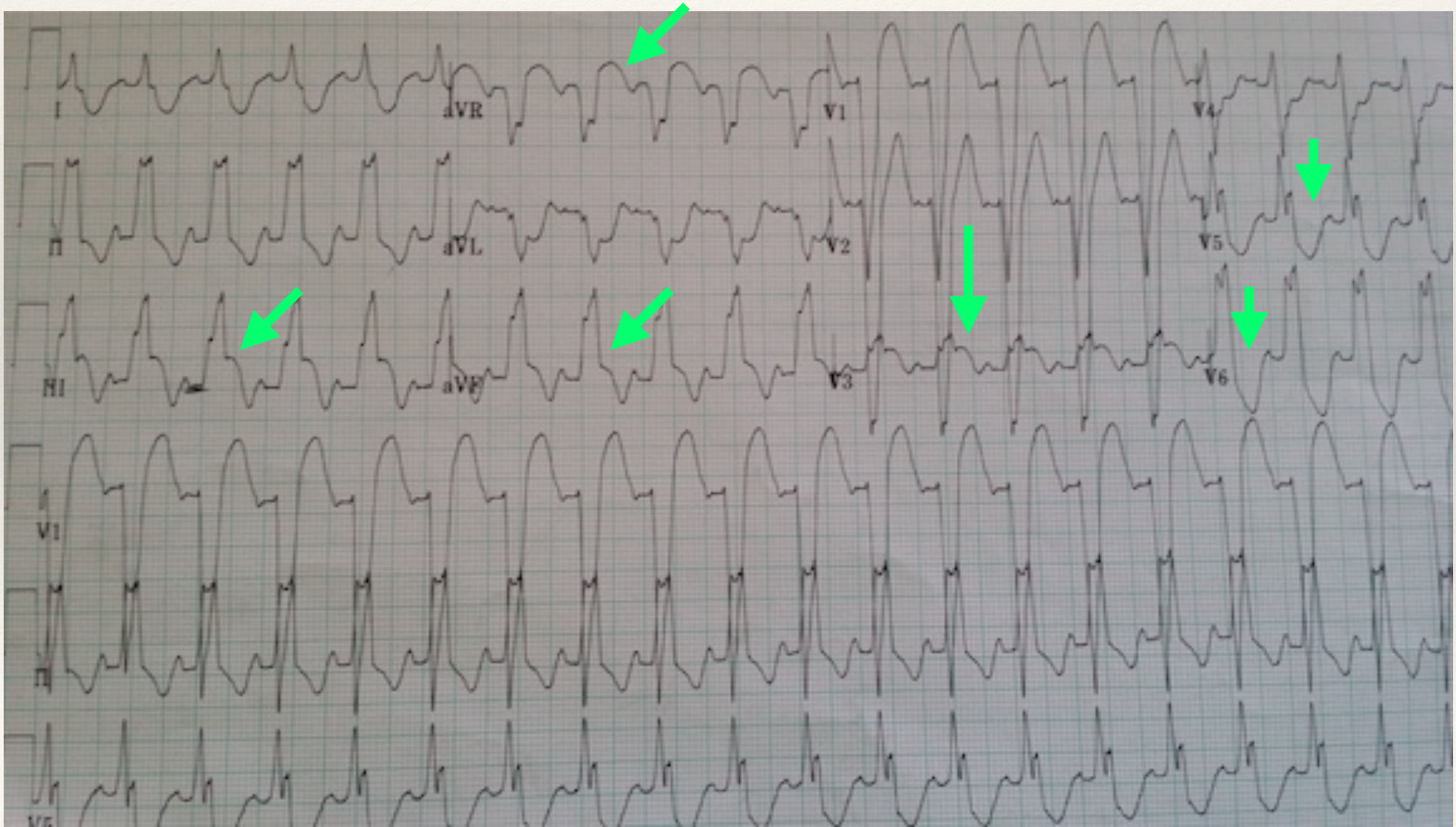
- Minutes later…Vfib arrest, post-ROSC ECG below



epmonthly.com, accessed Jan 2019

Case 5

- Tachy can exaggerate discordant STE but….concordant STE in III/aVF and V3, excessive discordant STE in aVR & excessive discordant STD in V5/6



LBBB w/ AMI

- ESC 4th Universal Definition of MI 2018: "In patients with LBBB, ST-segment elevation ≥1 mm concordant with the QRS complex in any lead may be an indicator of acute myocardial ischaemia."
  - i.e. any **solitary** lead (contiguous not a requirement)

- ESC 2017 and ACCF / AHA 2013 reference the classic Sgarbossa criteria as well

Bundle branch block

Criteria that can be used to improve the diagnostic accuracy of STEMI in LBBB[50]:

- Concordant ST-segment elevation ≥1 mm in leads with a positive QRS complex
- Concordant ST-segment depression ≥1 mm in V_1–V_3
- Discordant ST-segment elevation ≥5 mm in leads with a negative QRS complex

The presence of RBBB may confound the diagnosis of STEMI

Jothieswaran et al. Emerg Med J 2016

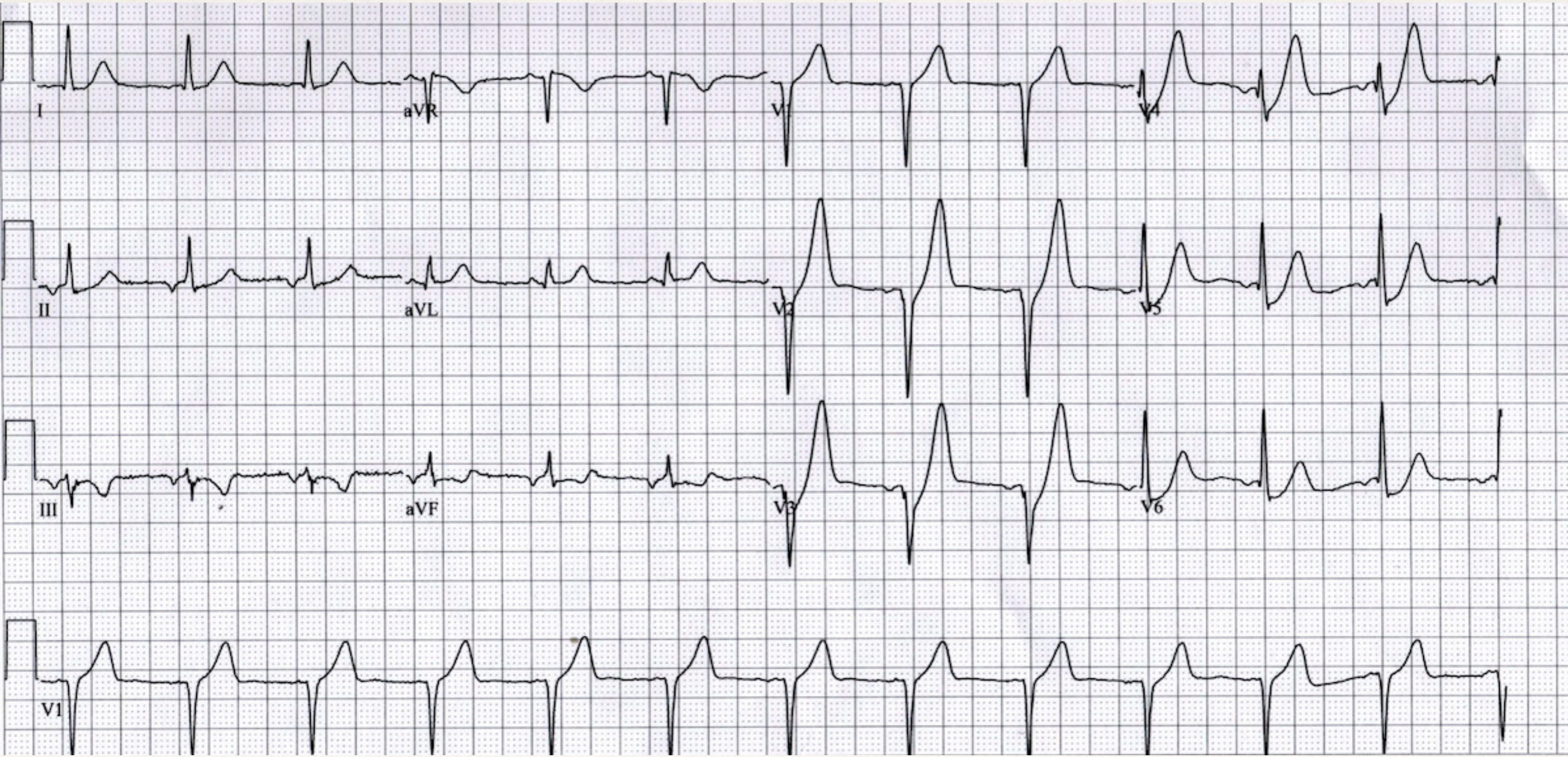
Ventricular pacing

- Sgarbossa criteria may be helpful in identifying AMI in ventricular paced rhythms, but less specific
- ESC 2017: “Reprogramming the pacemaker - allowing an evaluation of ECG changes during intrinsic heart rhythm—may be considered in patients who are not dependent on ventricular pacing…”

litfl.com, accessed Jan 2019

Case 6

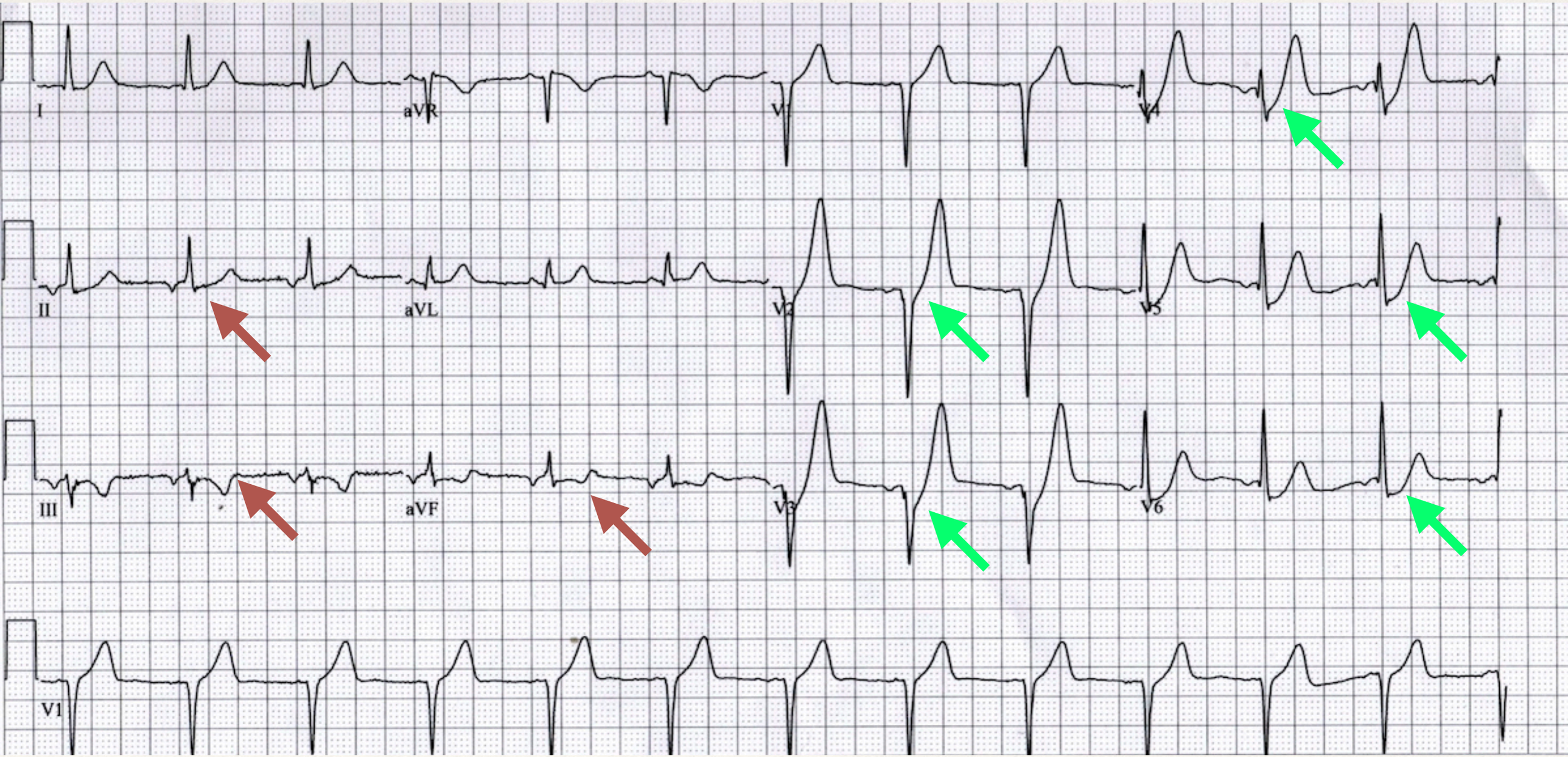
- 44yM with DLP, severe back pain radiating to chest



litfl.com, accessed Jan 2019

Case 6

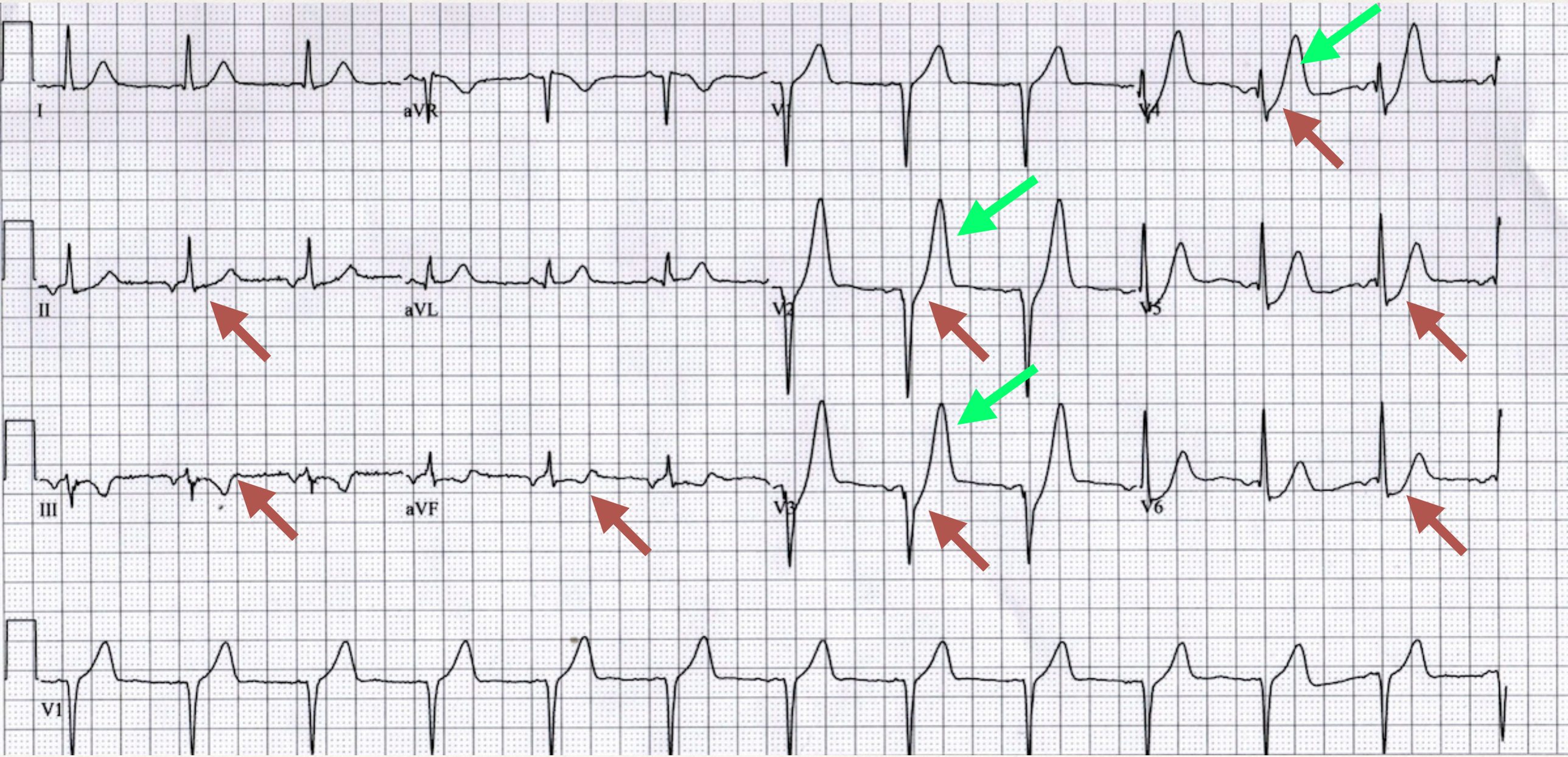
- STD II/III/aVF and V2-6



litfl.com, accessed Jan 2019

Case 6

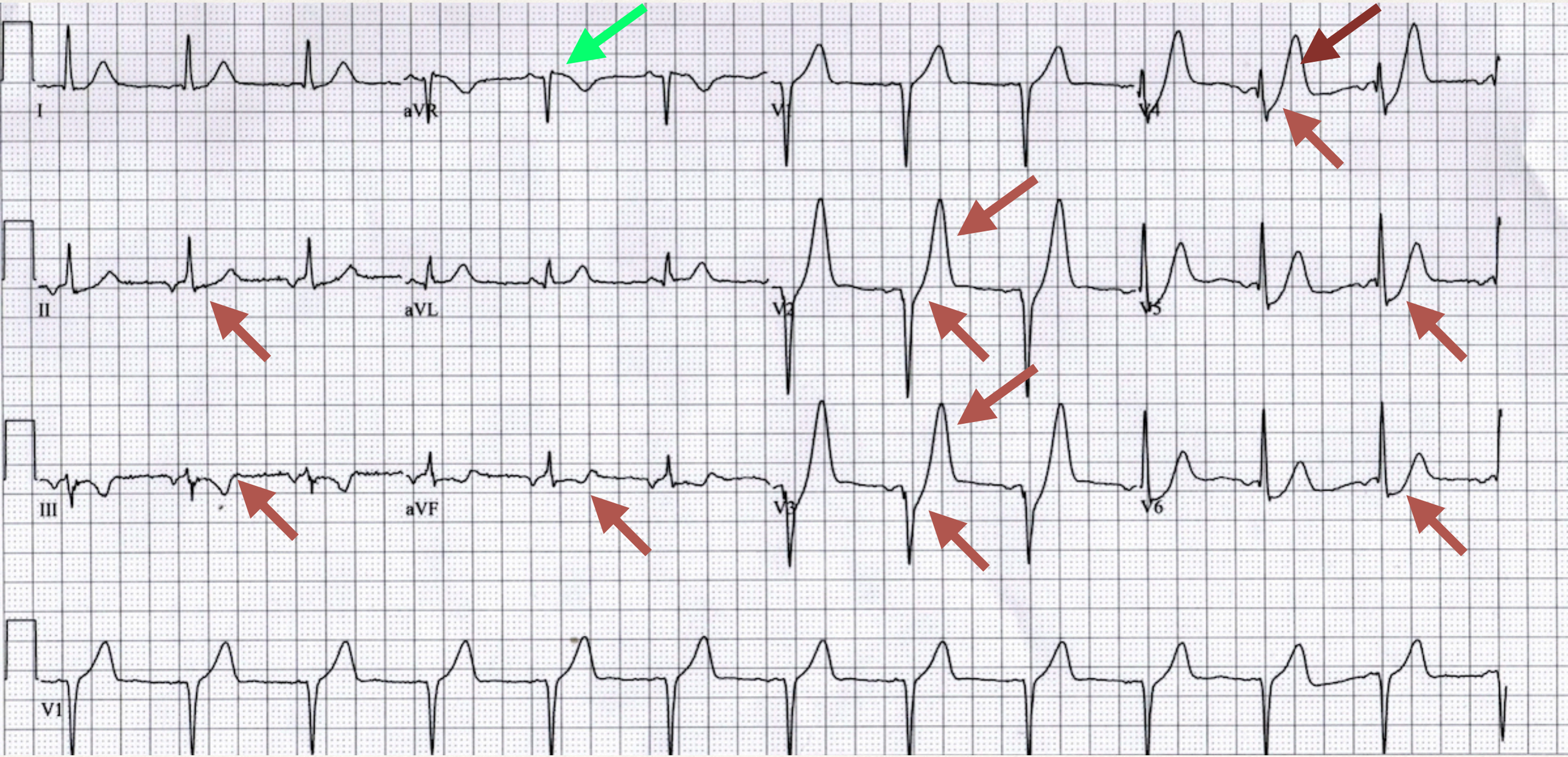
- STD II/III/aVF and V2-6
- **Peaked T waves V2/3/4**



litfl.com, *accessed Jan 2019*

Case 6

- STD II/III/aVF and V2-6
- Peaked T waves V2/3/4
- **STE aVR**



de Winter ECG pattern

- Upsloping STD ≥1mm in precordial leads
- Continuation of STD into tall/prominent/symmetric T waves in the same leads
- Often concurrent STE 0.5-2mm in aVR
- Absence of other STE

de Winter et al. N Engl J Med 2008
de Winter et al. J Electrocardiol 2016

de Winter ECG pattern

- Proposed as an anterior STEMI equivalent, associated with acute proximal LAD occlusion
- Pts tend to be male, younger, dyslipidemic
- Pattern found in 2% of pts with acute LAD occlusion
- Original reports: ECG pattern didn't evolve until revascularized
  - Subsequently, cases of de Winter pattern developing after or evolving into a classic anterior STEMI

de Winter et al. N Engl J Med 2008
de Winter et al. J Electrocardiol 2016

Birnbaum et al. J Electrocardiol 2013

de Winter ECG pattern

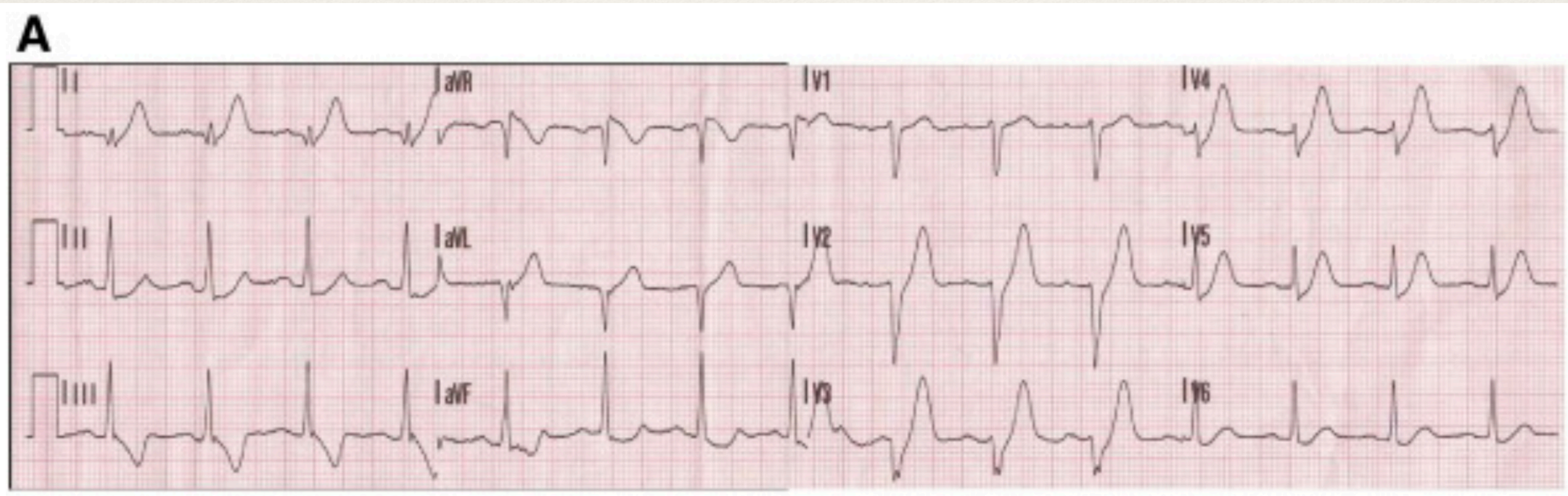
ESC 2018: "Absence of ST-elevation in the precordial leads, tall, prominent, symmetrical T waves in the precordial leads, upsloping ST-segment depression > 1 mm at the J-point in the precordial leads, and in most cases ST-segment elevation (> 1 mm) in lead aVR…associated with significant left anterior descending artery (LAD) occlusion."

- ACCF/AHA 2013 - not mentioned
- Increasing movement to include as future guideline material
- Urgent PCI should strongly be considered

de Winter et al. J Electrocardiol 2016

de Winter ECG pattern

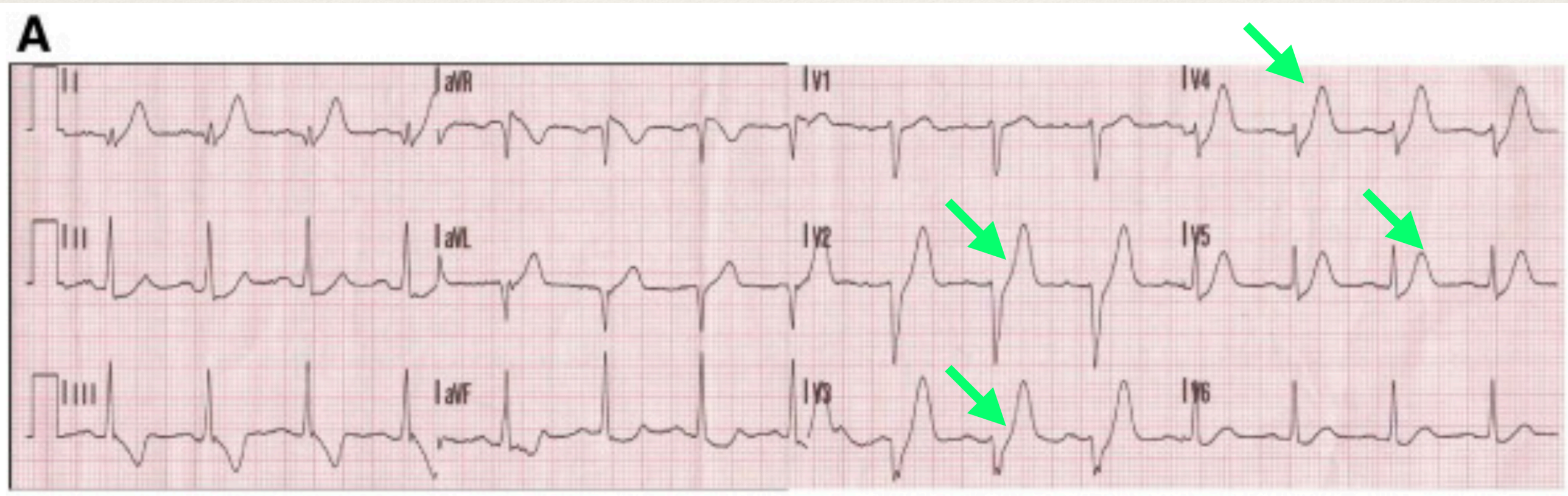
- Another case…41yM Hx CAD, in with severe CP rad to L arm



de Winter et al. J Electrocardiol 2016

de Winter ECG pattern

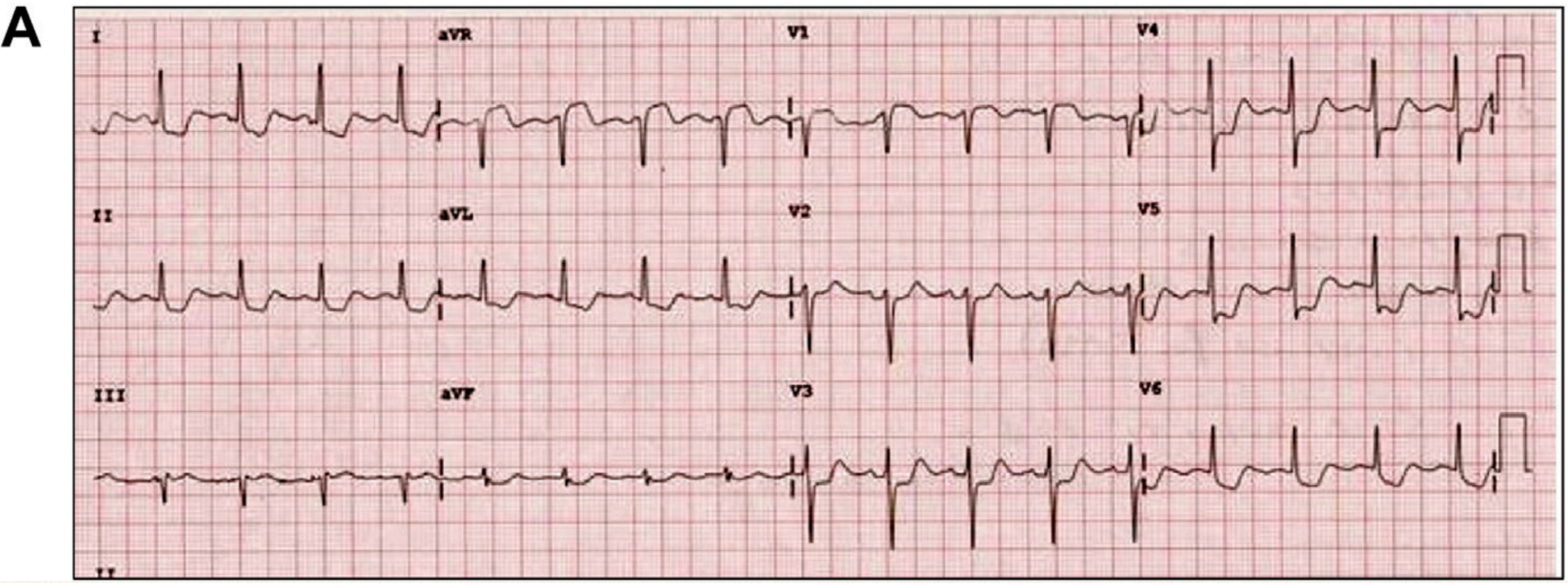
- …STD V2-5 with tall/symmetric T waves and STE aVR
- Also, reciprocal change in II/III/aVF



Lipinski et al. Cardiol Clin 2018

Case 7

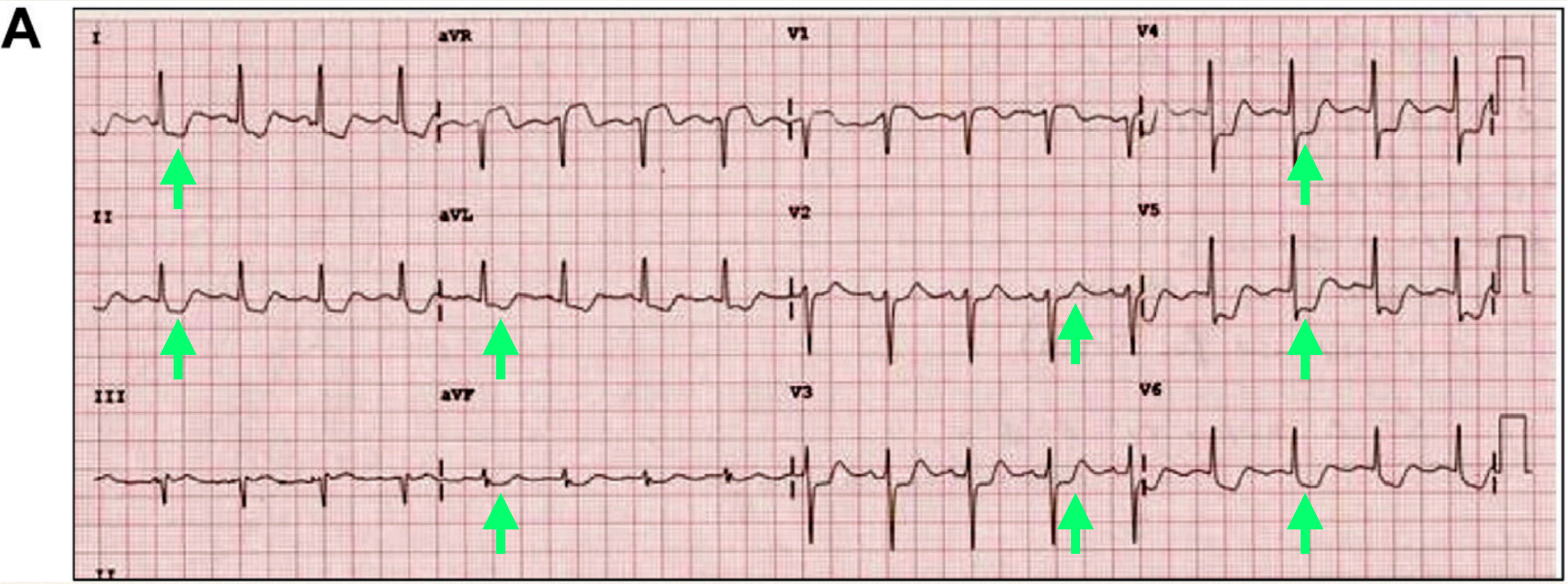
- 59yF with fatigue, SOB



Lipinski et al. Cardiol Clin 2018

Case 7

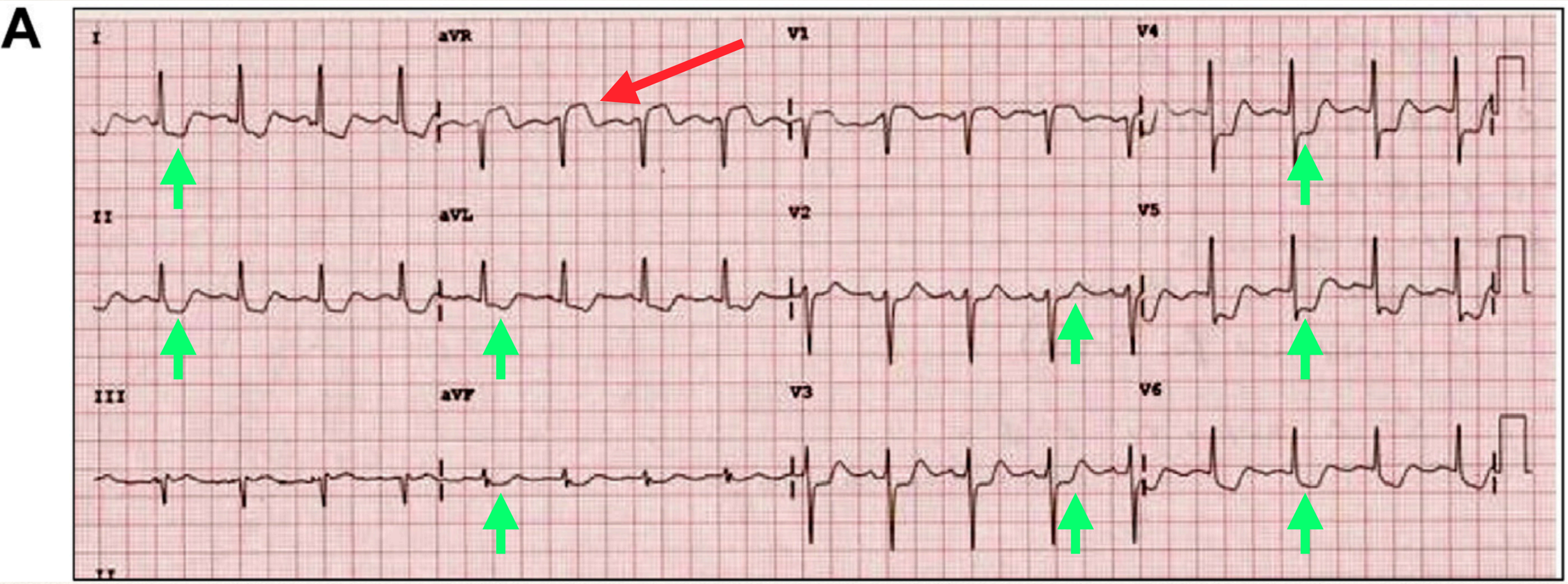
- STD in I, II, aVL, aVF, V2-6
- Anything else?



Lipinski et al. Cardiol Clin 2018

Case 7

- STE in aVR



ST elevation in aVR + diffuse STD

- ESC 2017: STD ≥1mm in 8 or more leads + STE in aVR and/or V1 suggests triple vessel ischemia or L main coronary obstruction
  - Should prompt primary PCI strategy in patients with ongoing symptoms suggestive of AMI
- ACCF/AHA 2013: "…multilead ST depression with coexistent ST elevation in lead aVR…in patients with left main or proximal LAD artery occlusion."

STE aVR

- STE aVR is associated with severe LMCA disease
- BUT caution with poor specificity of STE in aVR in isolation, long DDx (many of which are associated with global ischemia)
  - LMCA disease, aortic dissection, large PE, coronary vasospasm/cocaine, significant metabolic or electrolyte disturbance (e.g. post-ROSC), and more…

Ducas et al. Int J Cardiol 2013
Lipinski et al. Cardiol Clin 2018

Summary

- Hyperacute T waves - guidelines ✓, not a STEMI equivalent but **REPEAT** ECGs
- Isolated posterior MI - guidelines ✓, most commonly missed STEMI
- Non-anatomic STE - guidelines **X**, ischemic urgency for large portion of LV
- Wellens - guidelines **X**, not a STEMI equivalent but serious herald for anterior MI, **REPEAT** ECGs/monitor
- LBBB + Sgarbossa (and paced rhythms to lesser extent) - guidelines ✓, future revision to Sgarbossa criteria??
- de Winter pattern - guidelines mentioned, but not a STEMI equivalent yet; significant LAD occlusion
- STE in aVR + diffuse STD - guidelines ✓, severe LMCA disease
- Questions?