London Health Sciences Centre
Southwest Ontario Regional Base Hospital Program

12-Lead ECG & STEMI

Dr. Karalyn Church
Emergency Medicine
Resident, PGY5

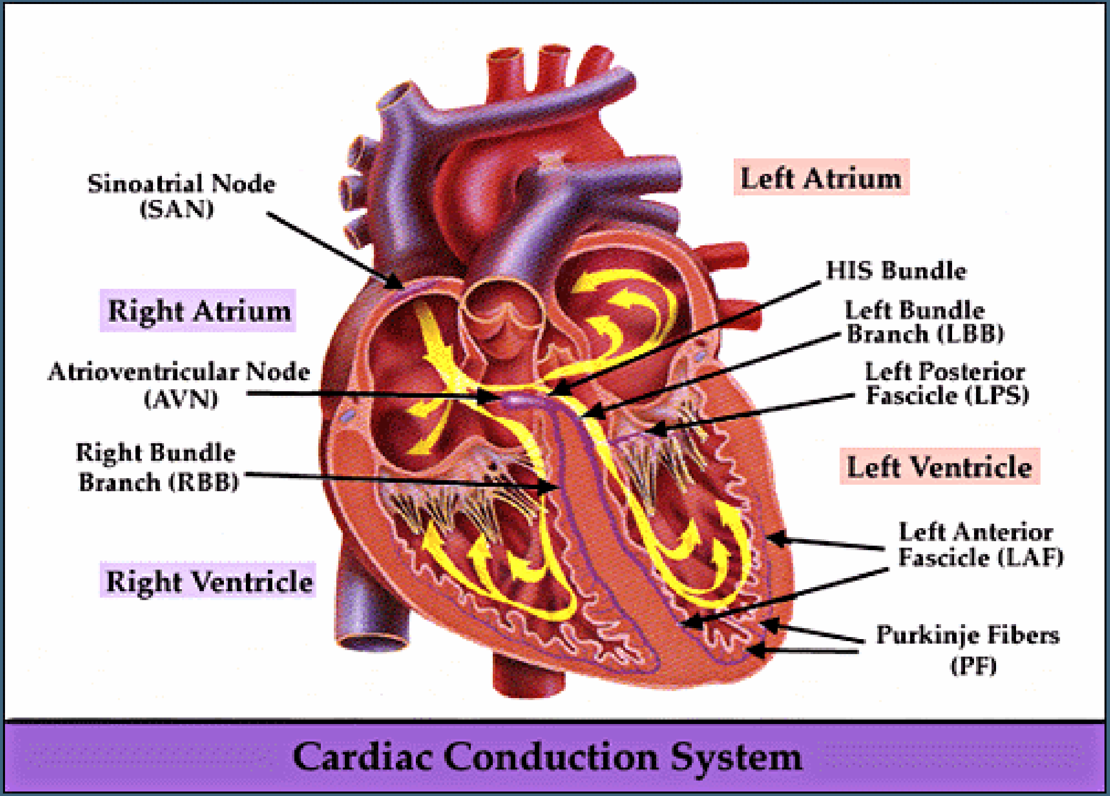
Objectives

Given this Webinar Presentation, the Paramedic will be able to:

- Describe the anatomy and pathophysiology associated with cardiac ischemia, injury and infarct.
- Relate the appropriate steps for acquisition of a 12 Lead ECG.
- Identify the presence of a STEMI and determine the location of the MI on 12 Lead ECGs

Anatomy & Pathophysiology

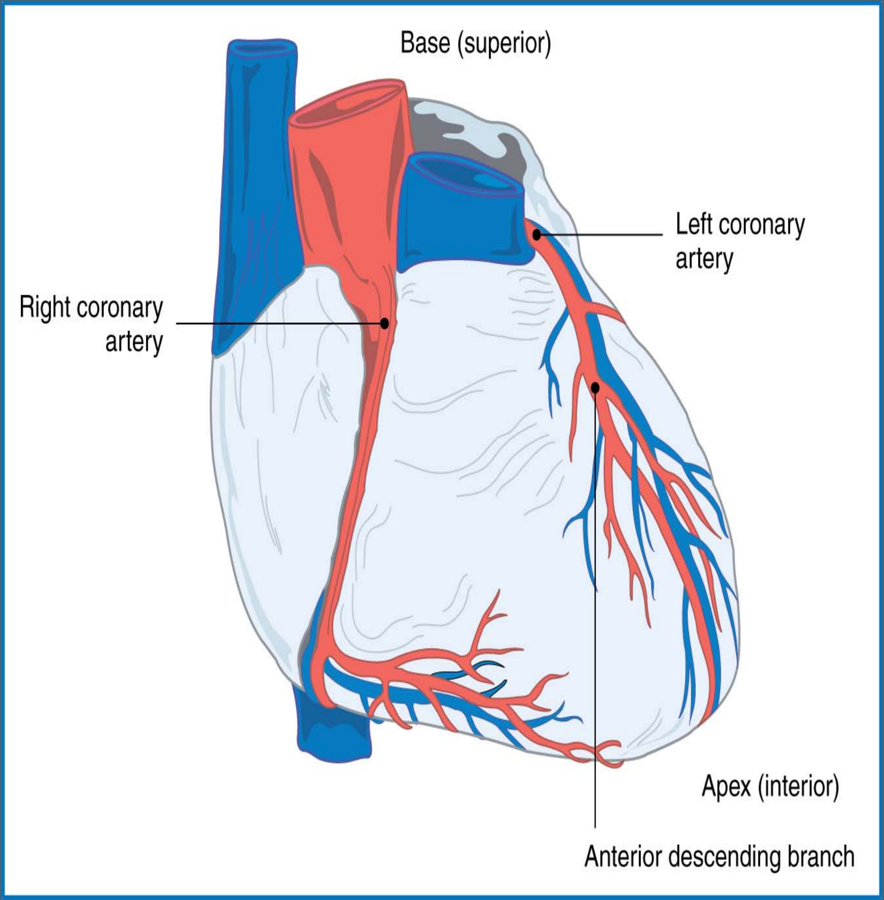
Conduction Pathway



Anatomy & Pathophysiology

Coronary Arteries

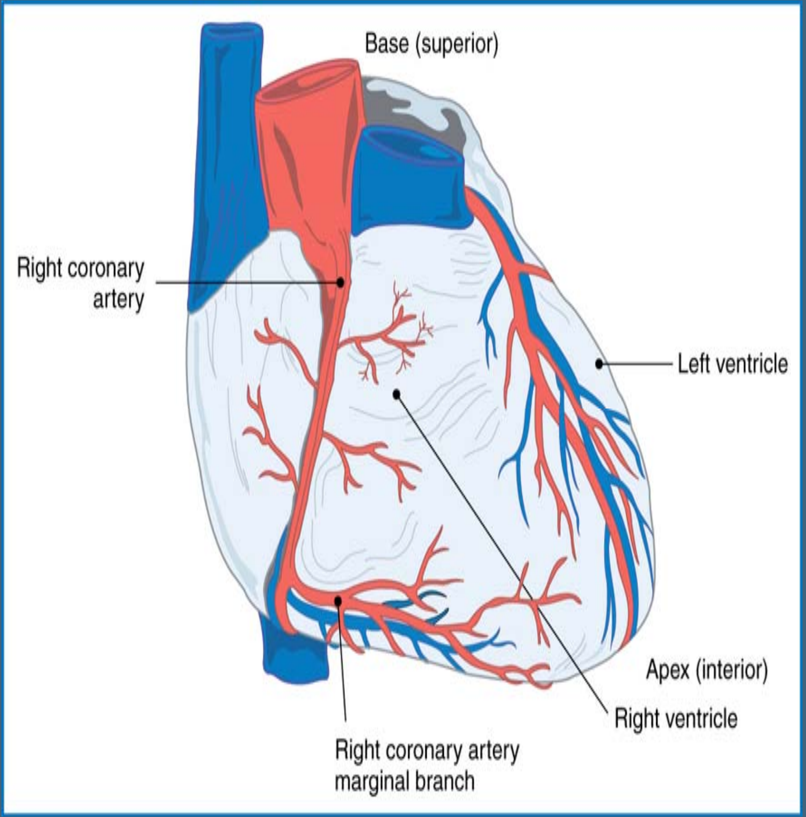
- Branch off of the Aorta, above the Aortic Valve
- Two major arteries, plus main branches
- Look at 3 specific arteries – Right Marginal Artery, Left Anterior, and Left Circumflex
- Each supplies a specific area



Anatomy & Pathophysiology

Right Marginal Artery

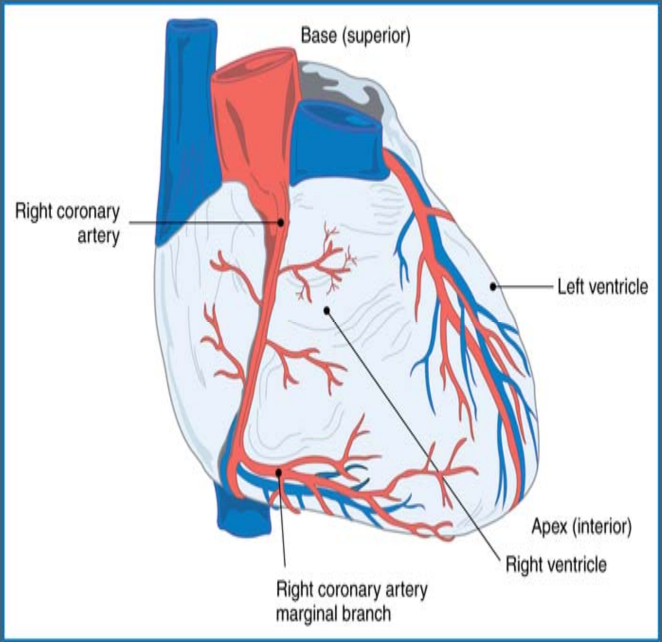
- Inferior wall of Left Ventricle
- Posterior Left Ventricle
- Right Ventricle
- Posterior fascicle of LBB
- SA (40-50%) & AV Node (85-90%) of population



Anatomy & Pathophysiology

Left Anterior Descending

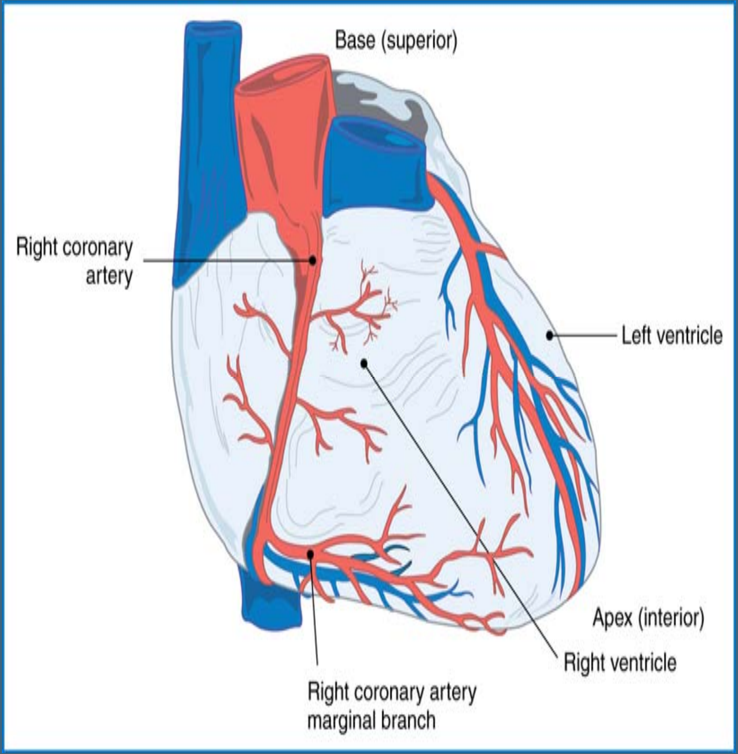
- Anterior and part of lateral wall of Left Ventricle
- Major pumping mass of Left Ventricle
- Septum
- Bundle Branches
- Sudden occlusion of the LMCA leads to sudden death (from massive infarction)



Anatomy & Pathophysiology

Left Circumflex Artery

- Upper lateral wall of LV (I and aVL)
- SA Node in 45%
- AV Node in 10%
- Posterior fascicle of LBB



Anatomy & Pathophysiology

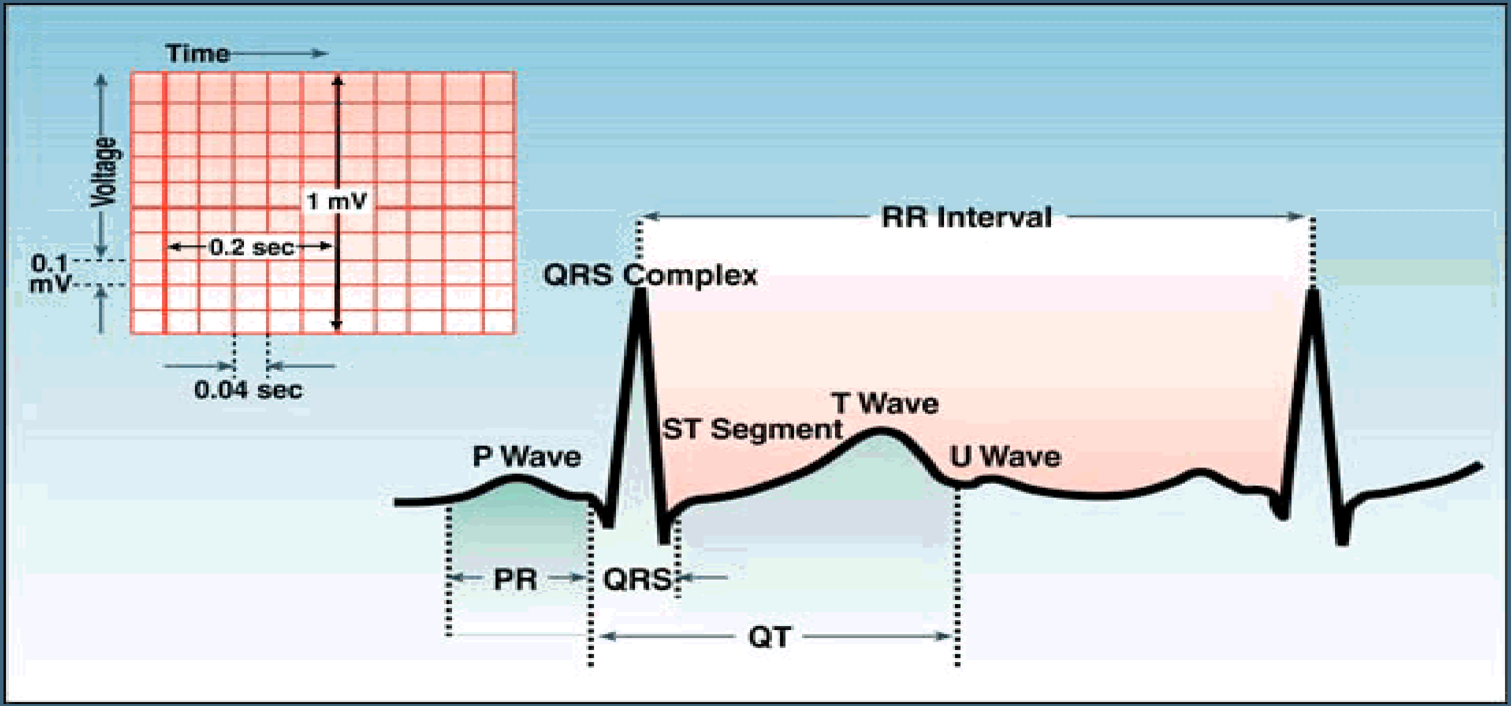
Electrical Flow

- Towards the +ve electrode: Upward Deflection on ECG
- Away from the +ve electrode: Downward Deflection on ECG

ECG Review

ECG Paper

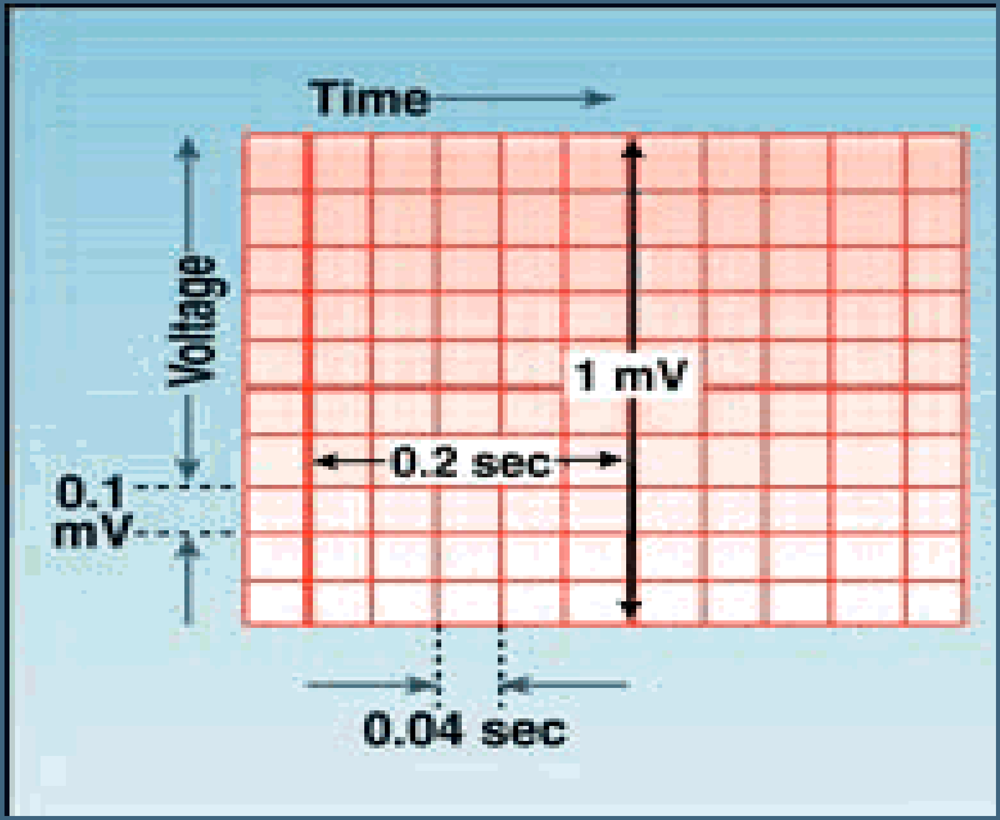
- Vertical Lines: Time (ms) in mm
- Horizontal Lines: Voltage (mV) in mm



London Health Sciences Centre
Southwest Ontario Regional Base Hospital Program

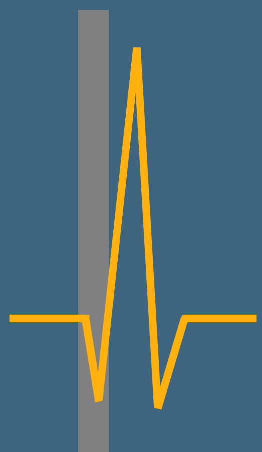
ECG Review

- Light lines/small boxes are 0.04s (1mm) apart
- Dark lines/large boxes are 0.2s (5mm) apart
- 5 Dark squares are 1s (small lines at the top of the ECG paper)



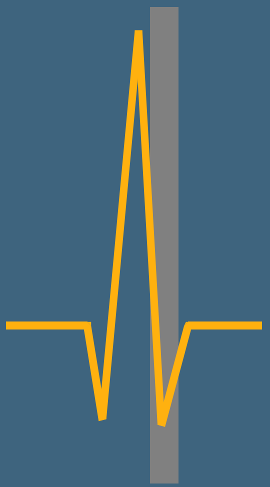
ECG Review

Q Wave



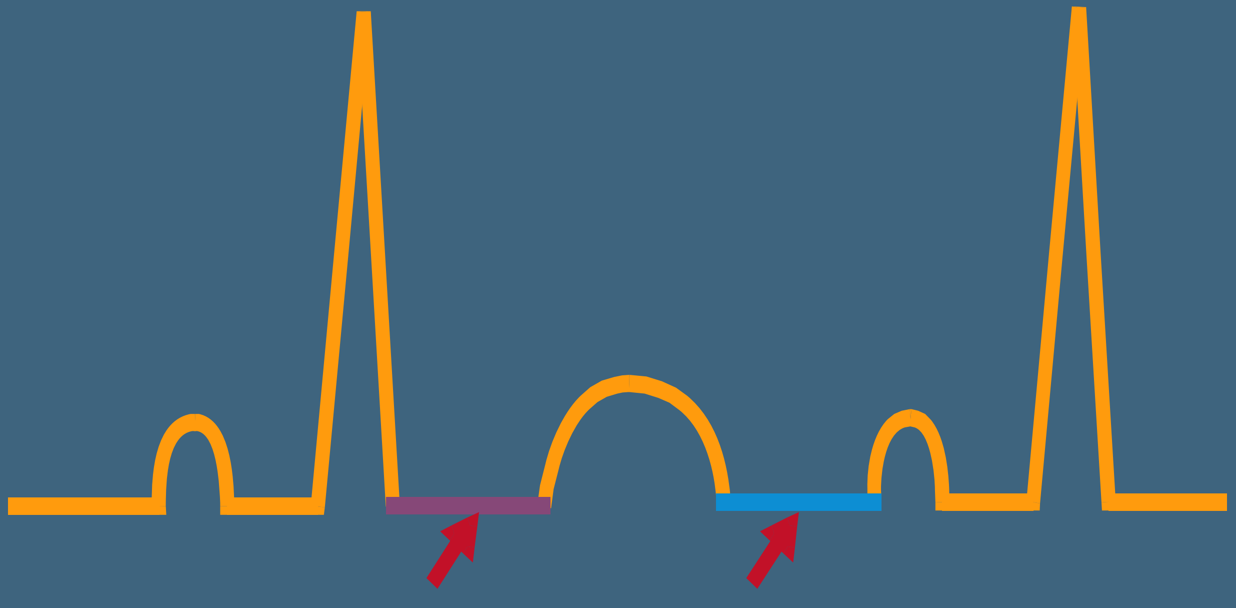
R Wave

S Wave



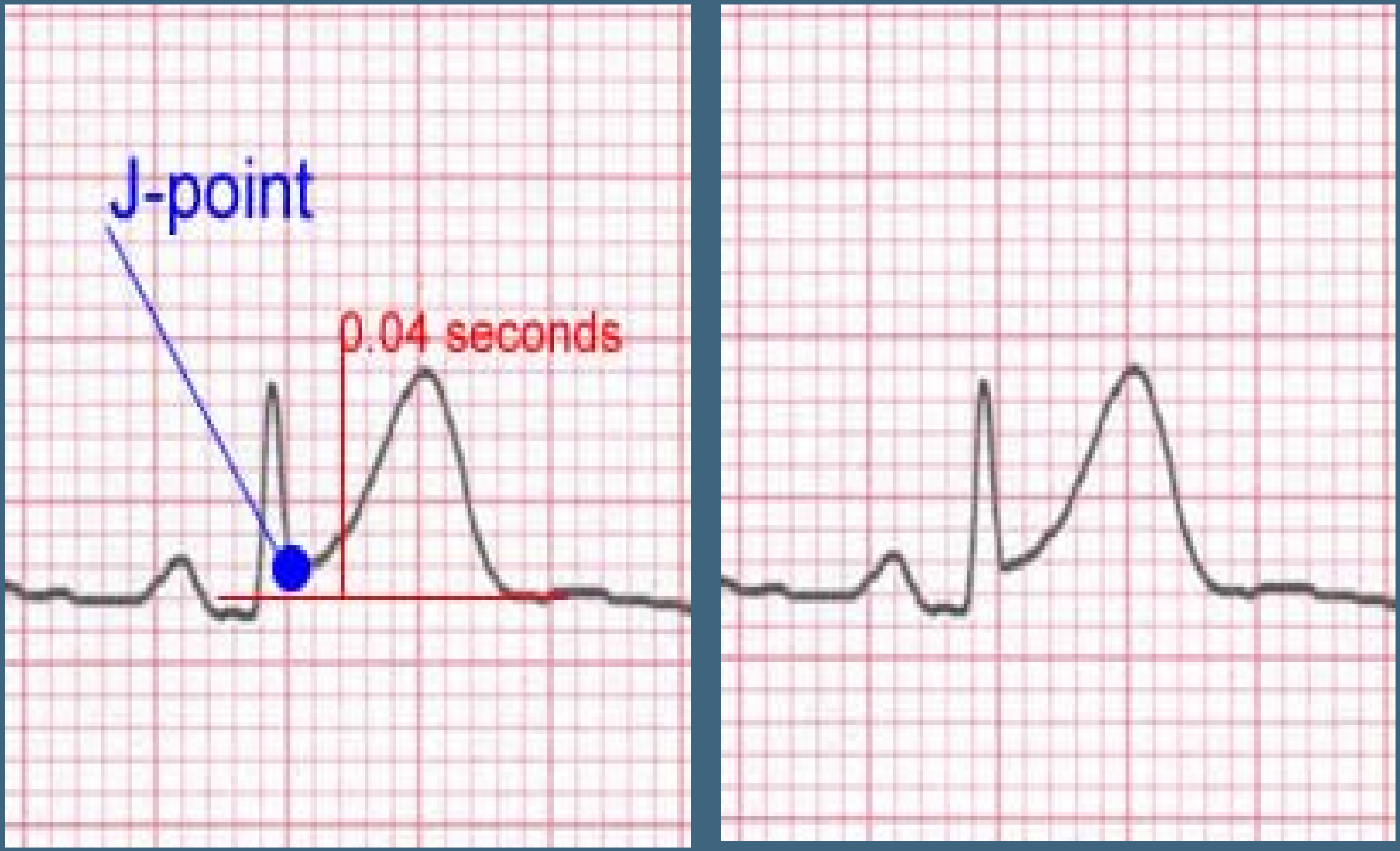
ECG Review

TP Segment



ECG Review

ST Segment



ECG Review

What to look for

ST Segment Elevation

- $\geq$ 1mm in limb leads
- $\geq$ 2mm in chest leads
- Present in 2 anatomically contiguous leads

ECG Review

Contiguous Leads

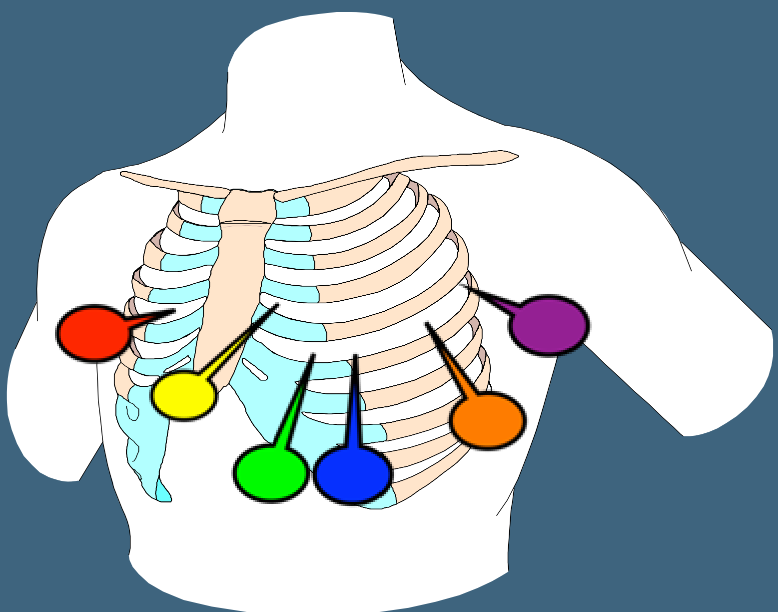
- Limb leads that “look’ at the same area of the heart

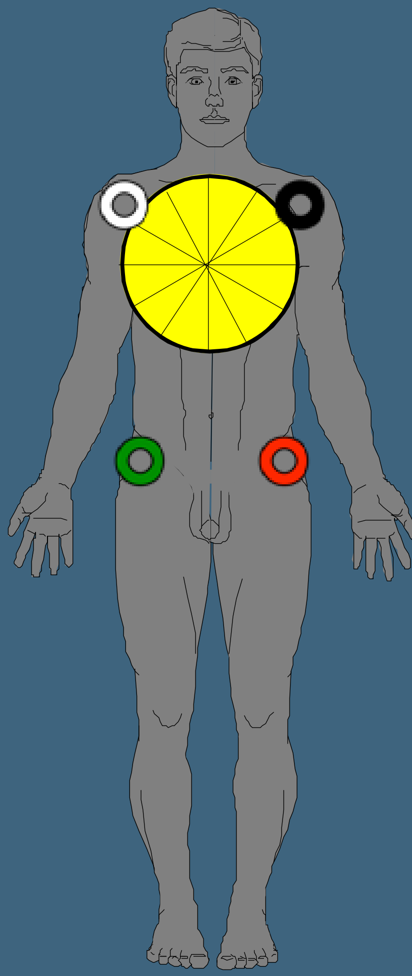
OR

- Numerically consecutive chest leads

ECG Review

Electrode Placement





ECG Review

Electrode Placement

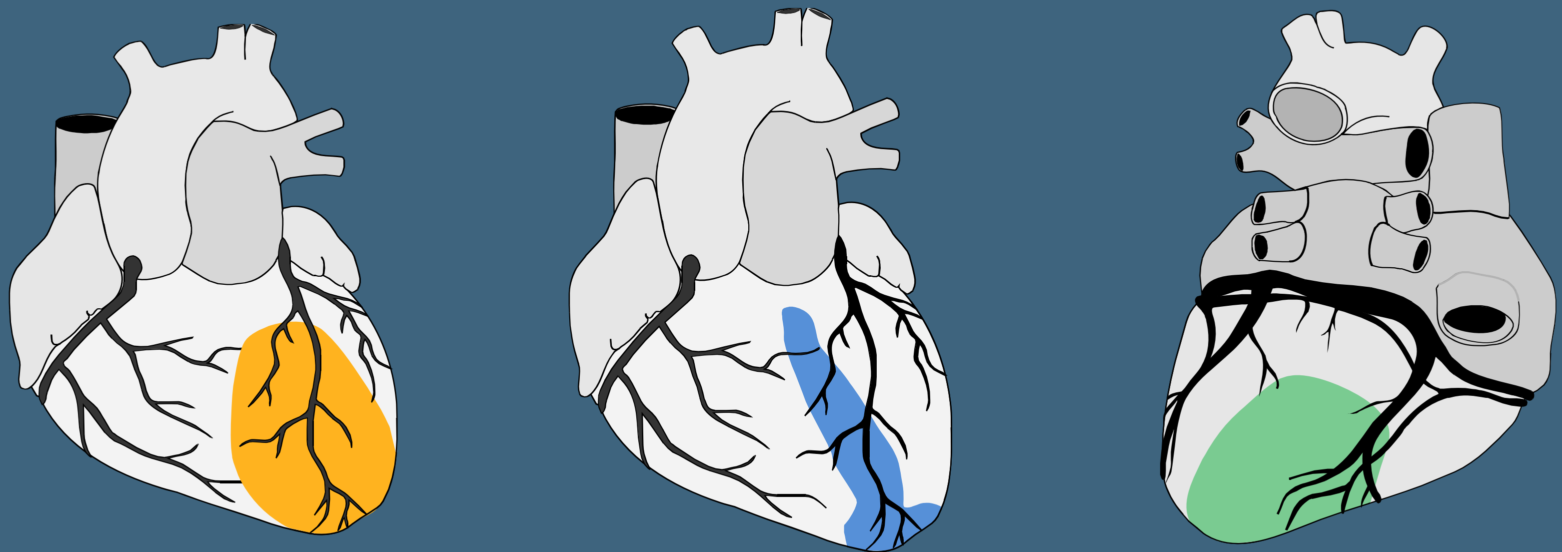
- V1 – 4th intercostal space to the right of the sternum
- V2 – 4th intercostal space to the left of the sternum
- V3 - directly between leads V2 and V4
- V4 – 5th intercostal space at the midclavicular line
- V5 - level with lead V4 at left anterior axillary line
- V6 - level with lead V5 at left midaxillary line

12 Lead

- S-Septal – V1, V2
- A-Anterior – V3, V4
- L-Lateral – V5, V6, aVL, I
- I-Inferior – II, III, aVF

I **High Lateral** Reciprocal changes II, III, aVF	**aVR**	**V1** **Septal** Reciprocal changes I, III, aVF	**V4** **Anterior** Reciprocal changes II, III, aVF
II **Inferior** Reciprocal changes I, aVL, v-leads	**aVL** **High Lateral** Reciprocal changes II, III, aVF	**V2** **Septal** Reciprocal changes II, III, aVF	**V5** **Lateral** Reciprocal changes II, III, aVF
III **Inferior** Reciprocal changes I, aVL, V-leads	**aVF** **Inferior** Reciprocal changes I, aVL, V-Leads	**V3** **Anterior** Reciprocal changes II, III, aVF	**V6** **Lateral** Reciprocal Changes II, III, aVF

AMI Localization

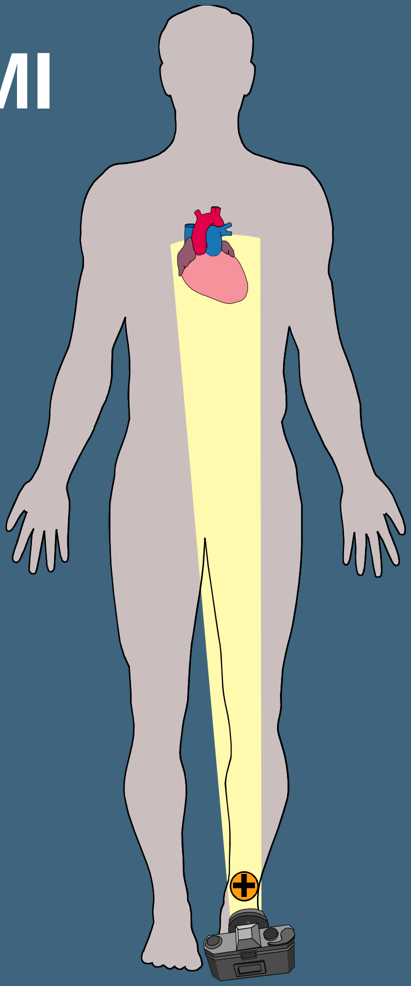


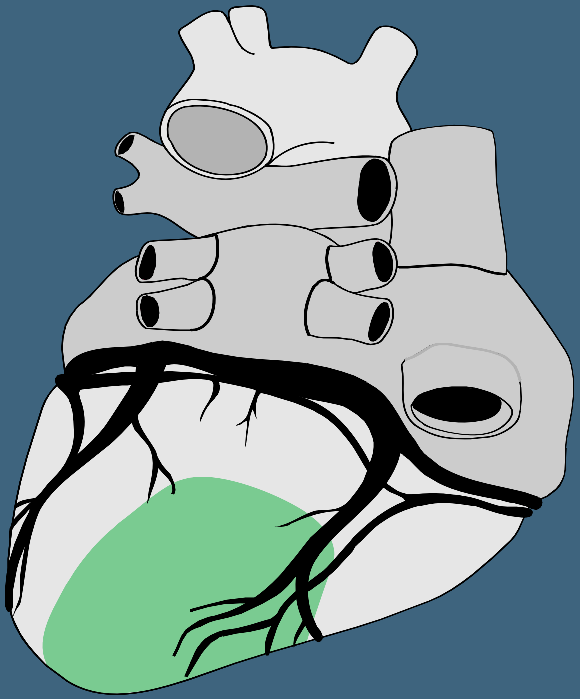
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

AMI Localization

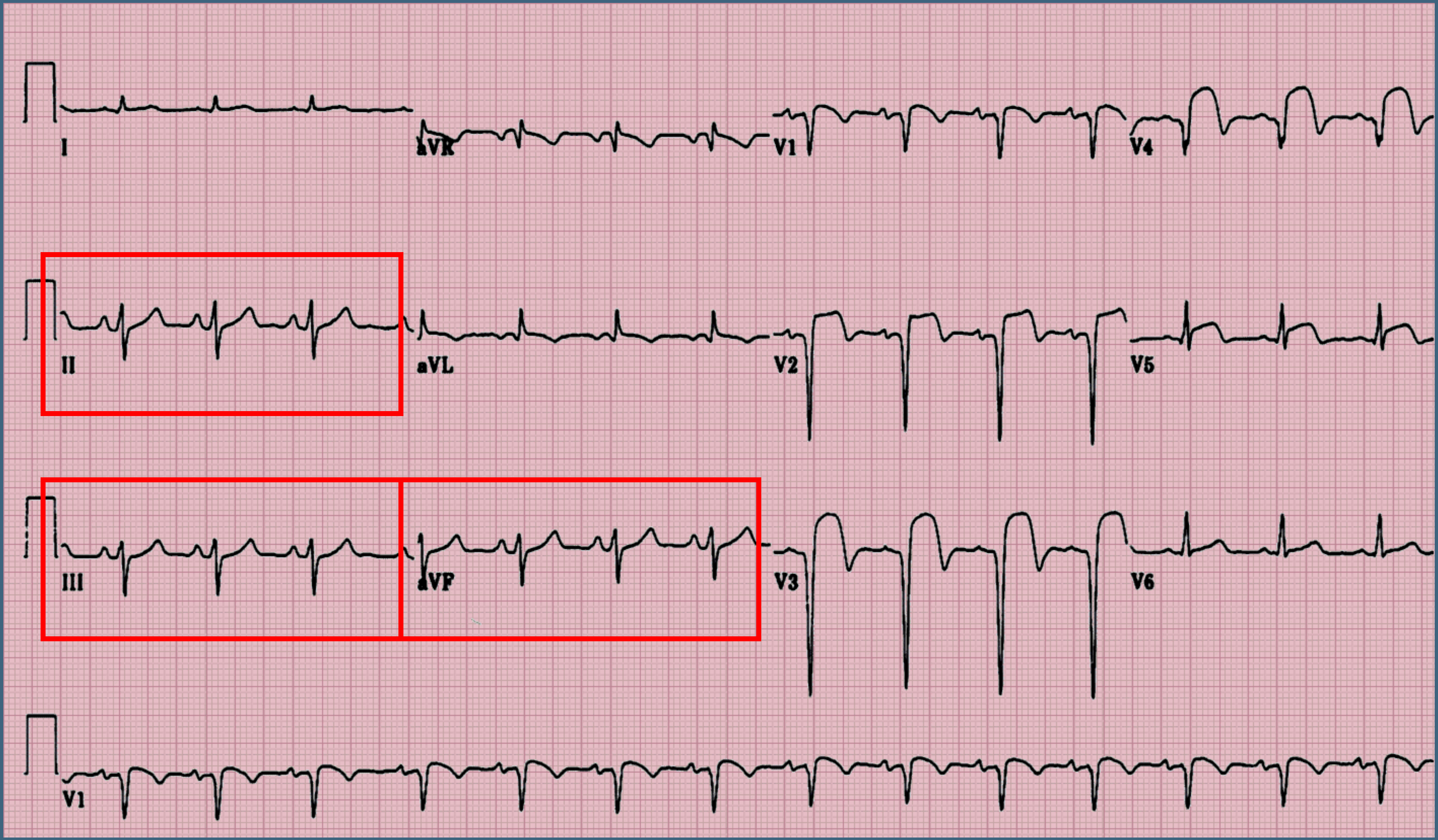
Inferior Wall MI

- II, III, aVF
- Left Leg





Inferior Wall

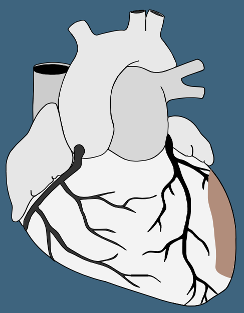


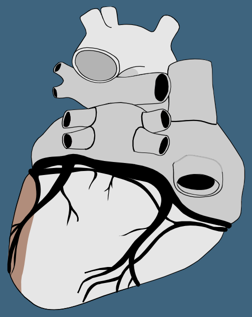
AMI Localization

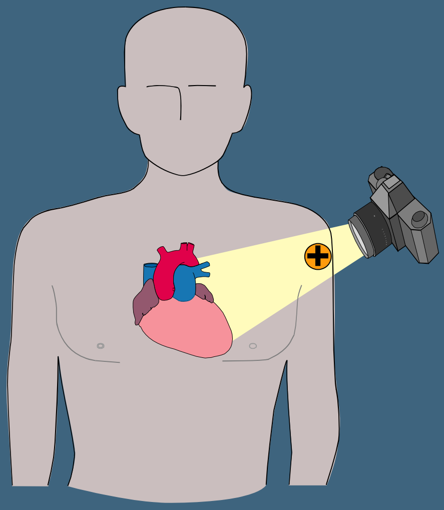
Lateral Wall

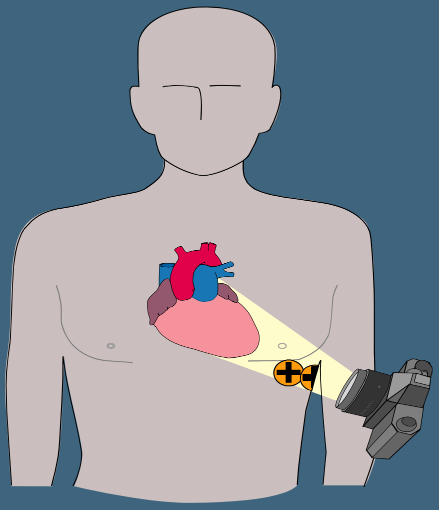
- I, aVL
- Left arm

- V5, V6
- Left lateral chest

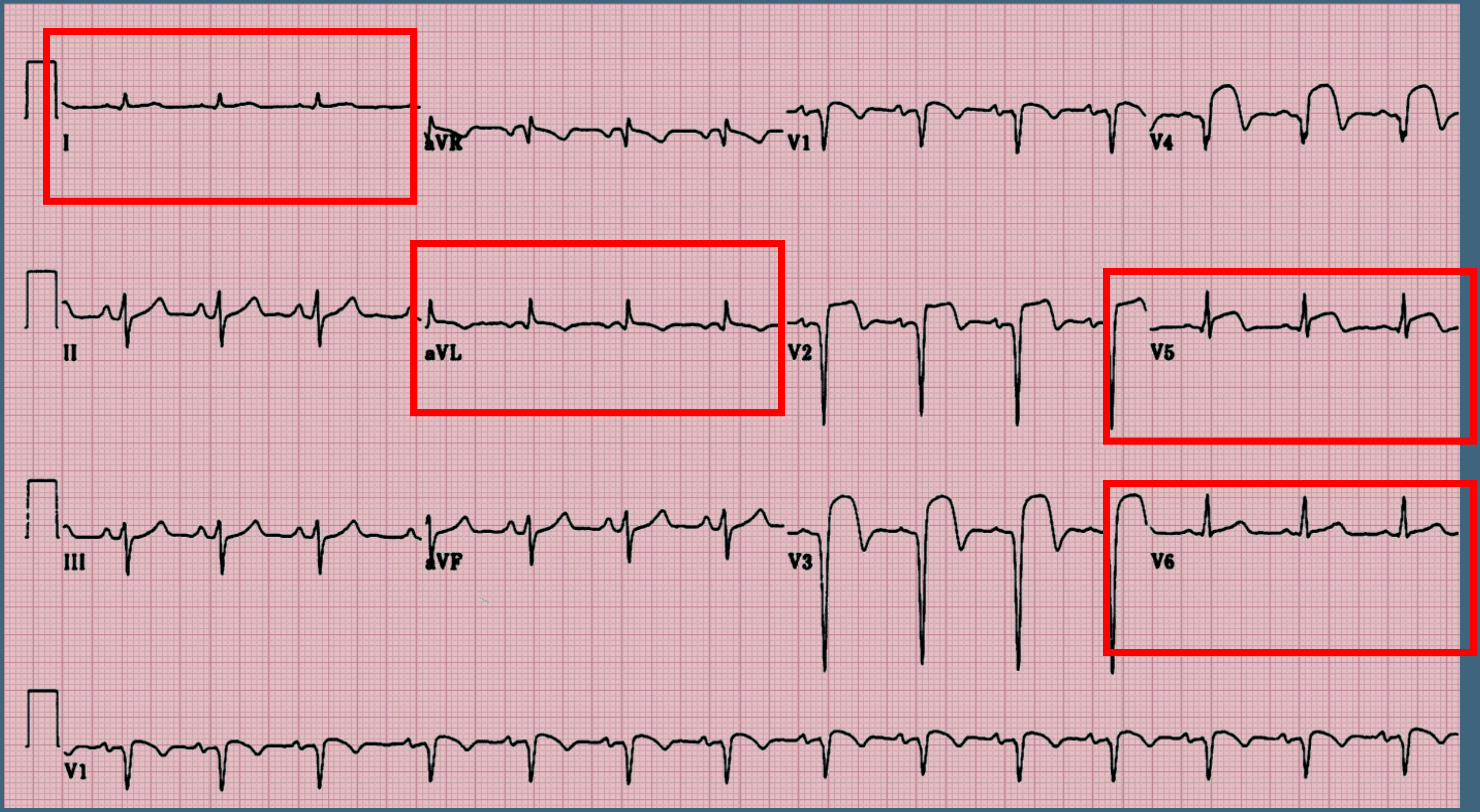








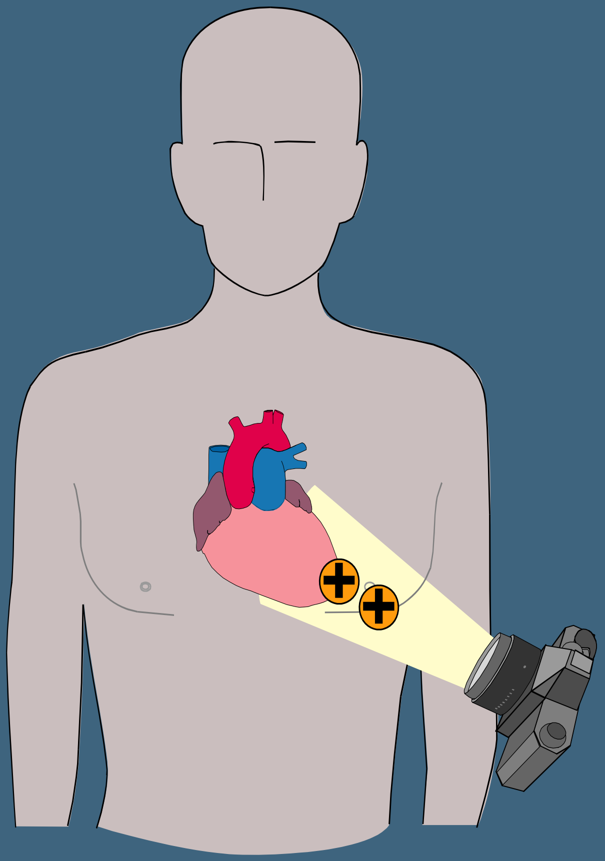
Lateral Wall

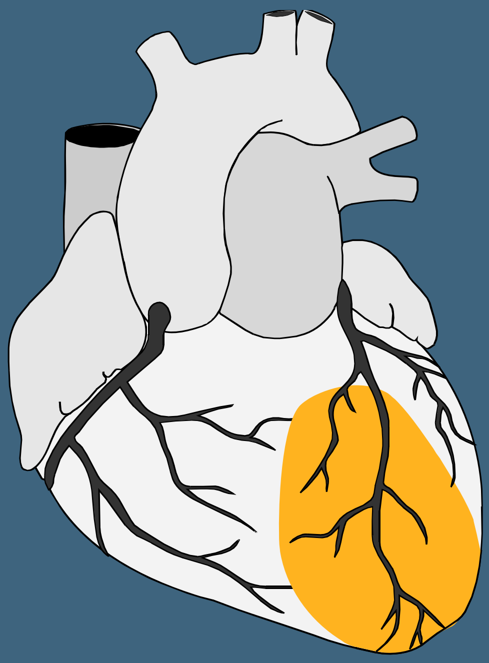


AMI Localization

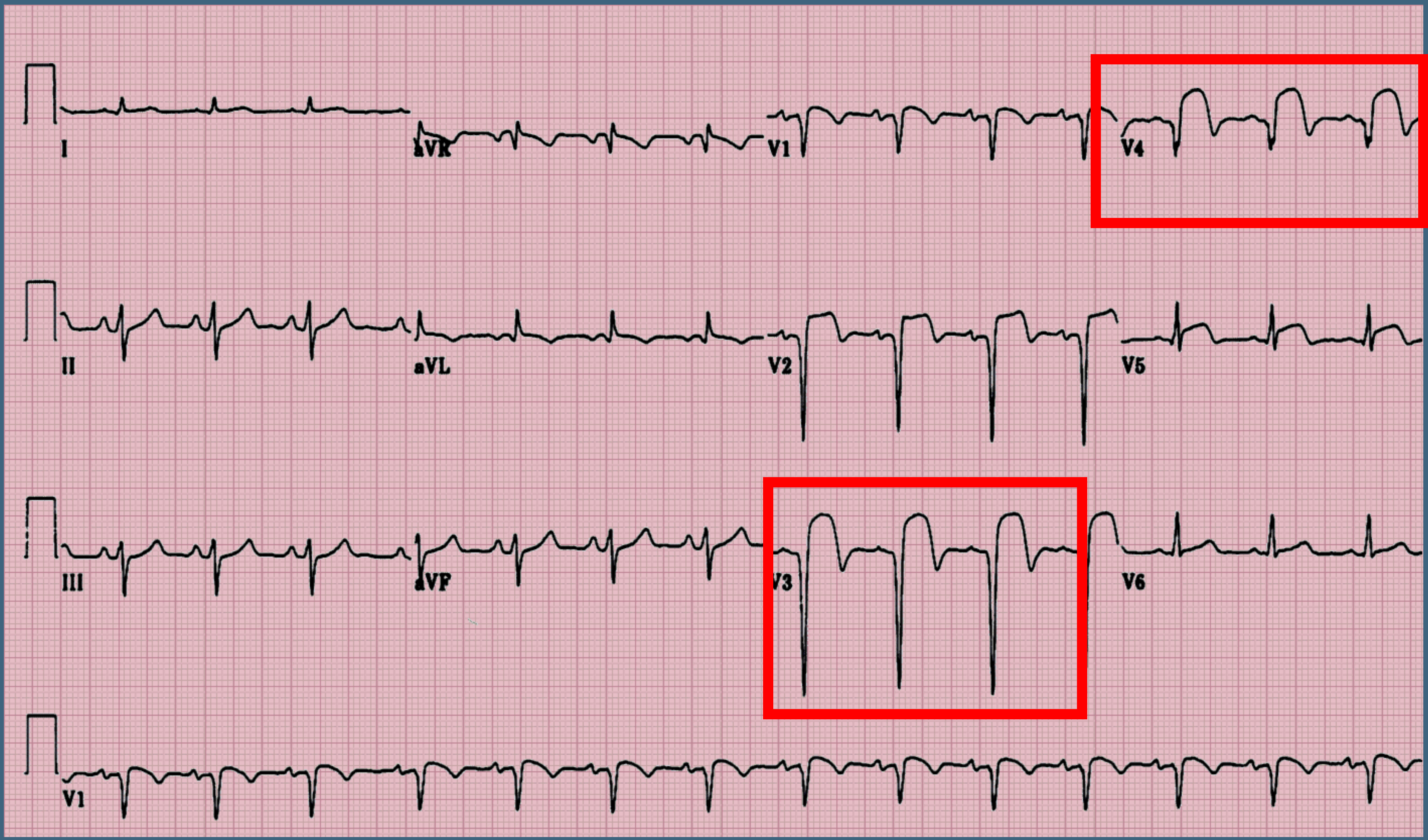
Anterior Wall

- V3, V4
- Left anterior chest





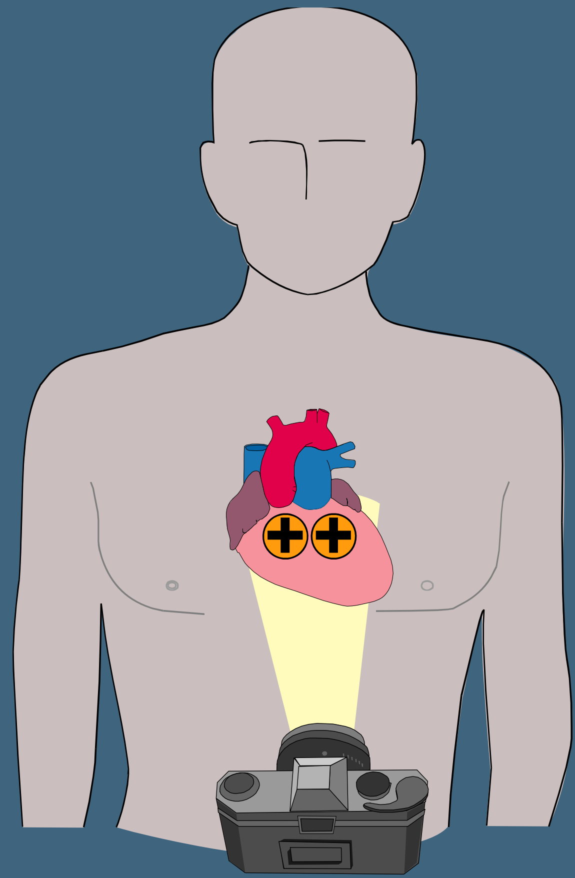
Anterior Wall

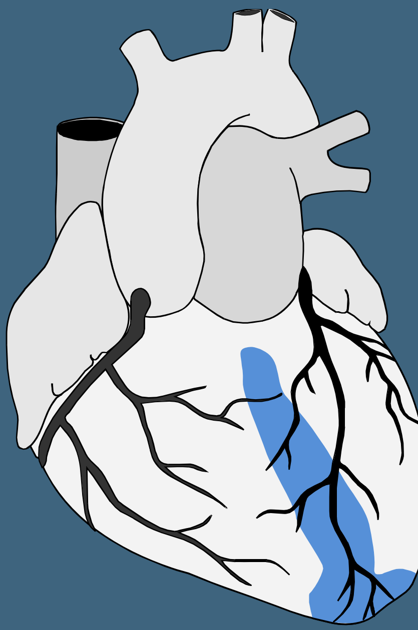


AMI Localization

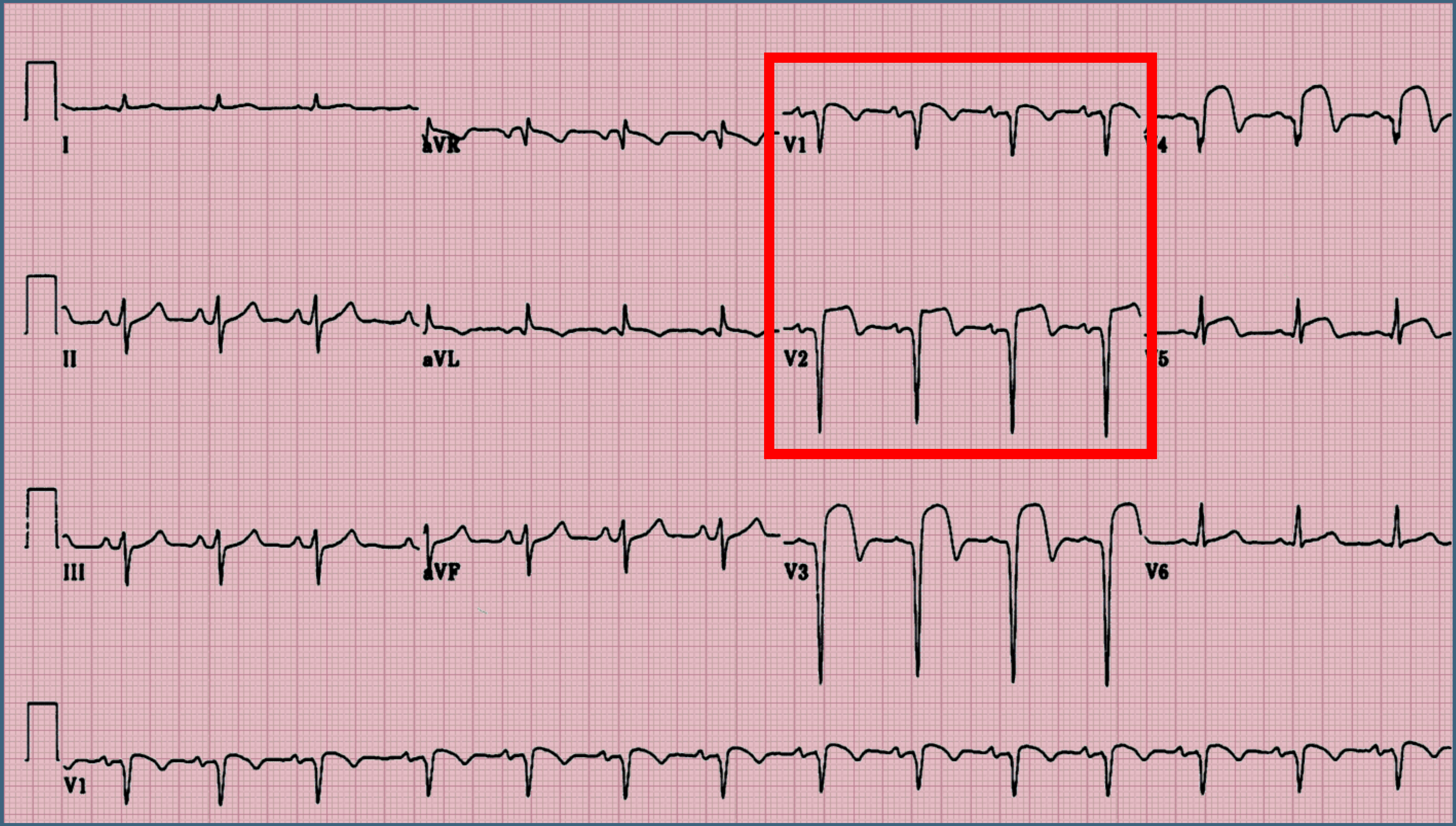
Septal Wall

- V1, V2
- Along sternal borders



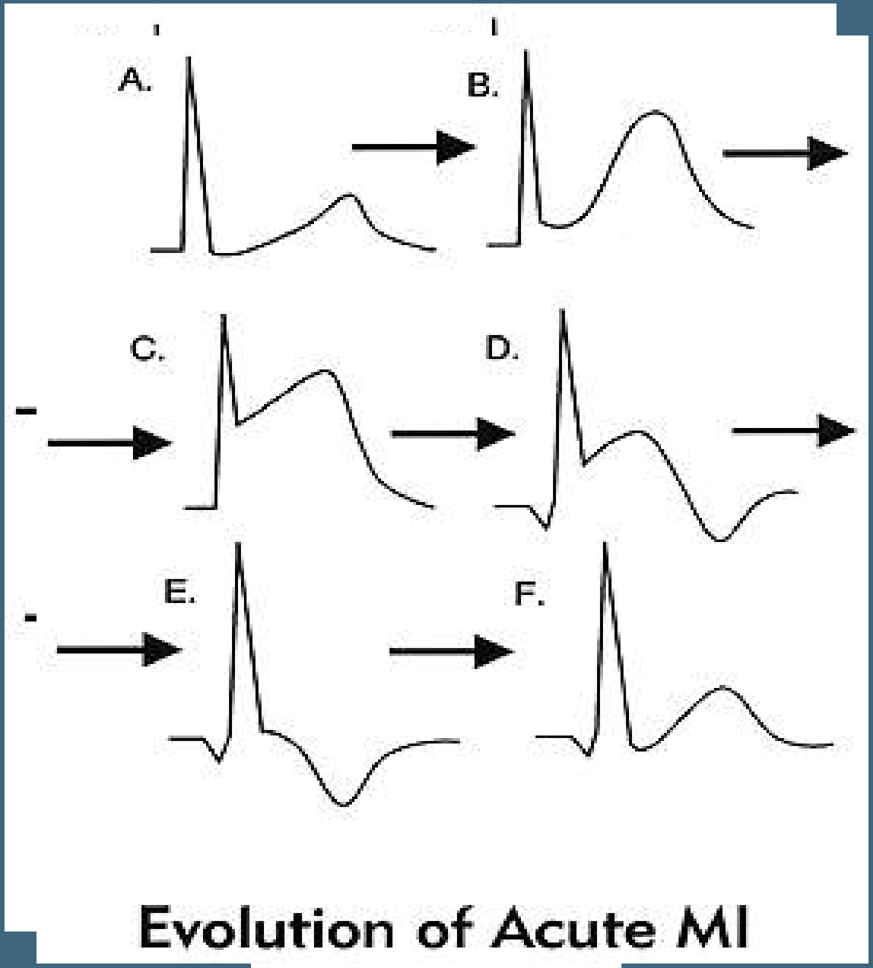


Septal Wall



AMI Progression

- A – Normal
- B – Initial ischemia
- C – Injury
- D – Infarct
- E – Reperfusion with residual ischemia
- F – New Normal



Evolution of Acute MI

AMI Progression

- Peaked T wave
- ST Depression
  - T wave inversion
- ST Elevation
- Q wave

AMI Progression

Hyper Acute T Waves

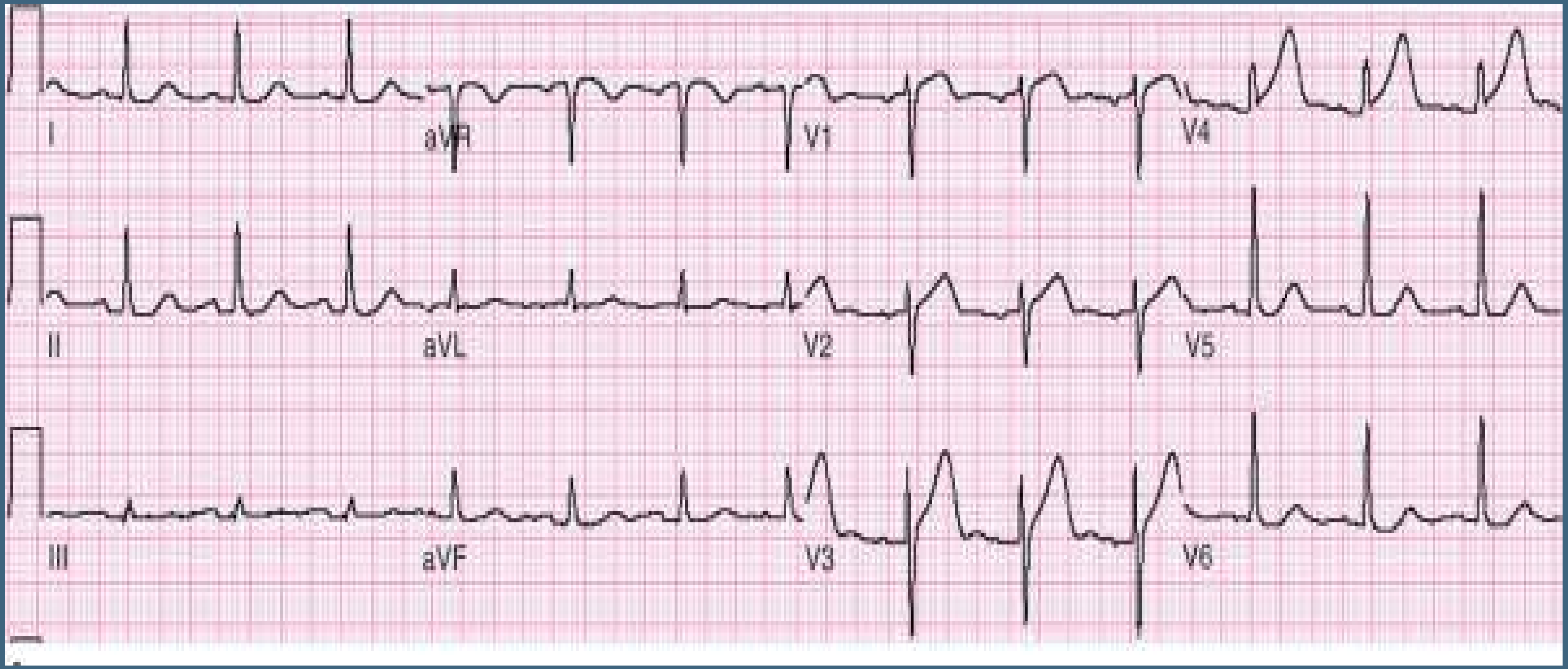
- Tall and peaked within minutes of blood flow interruption
- Earliest ECG sign of AMI
- Could manifest as ST depression or inverted T waves

Differential Dx:

- hyperkalemia
- BER
- LVH

AMI Progression

Hyper Acute T Waves



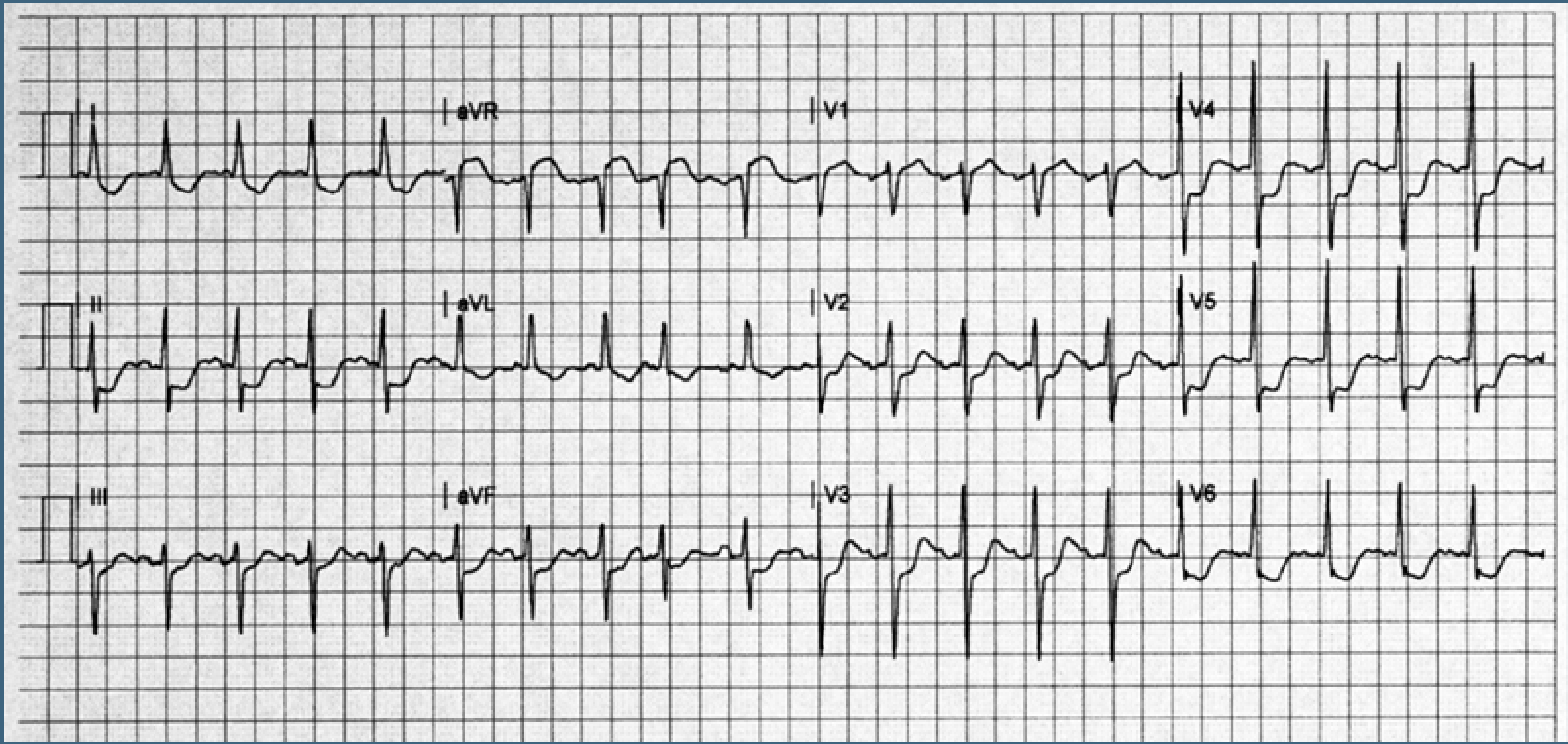
Ischemia, Injury & Infarct

Ischemia

- Inadequate oxygen to tissue
- Subendocardial
- Represented by ST depression or T inversion
- May or may not result in infarct

Ischemia, Injury & Infarct

Ischemia – ST Depression



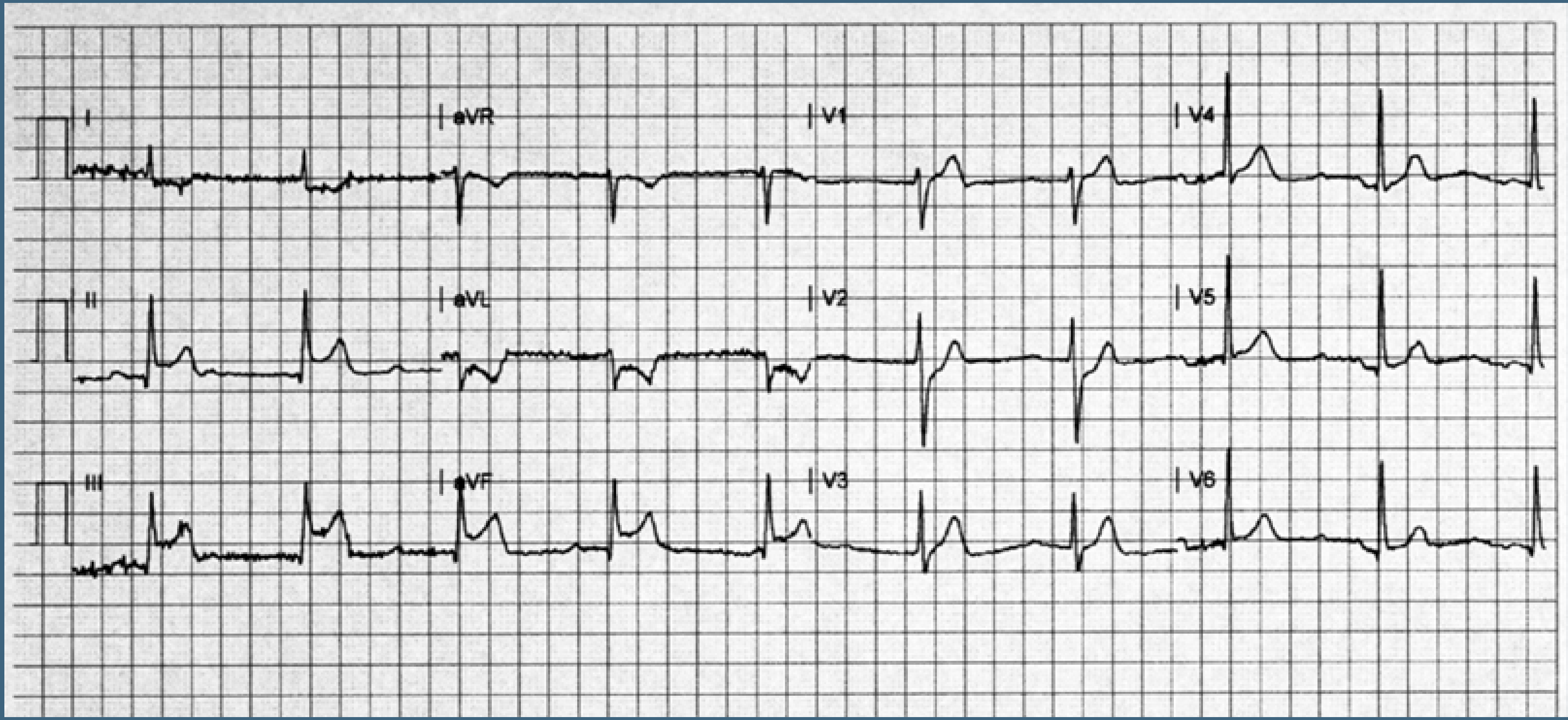
Ischemia, Injury & Infarct

Injury

- Prolonged ischemia
- Transmural
- Represented by ST elevation
- Usually results in infarct

Ischemia, Injury & Infarct

Injury



Ischemia, Injury & Infarct

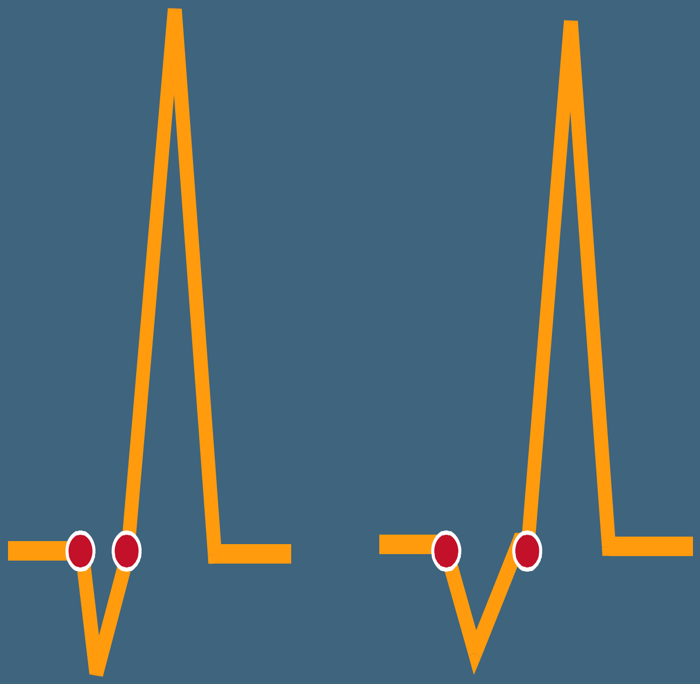
Infarct

- Death of tissue
- Represented by Q wave
- Not all infarcts develop Q waves

Ischemia, Injury & Infarct

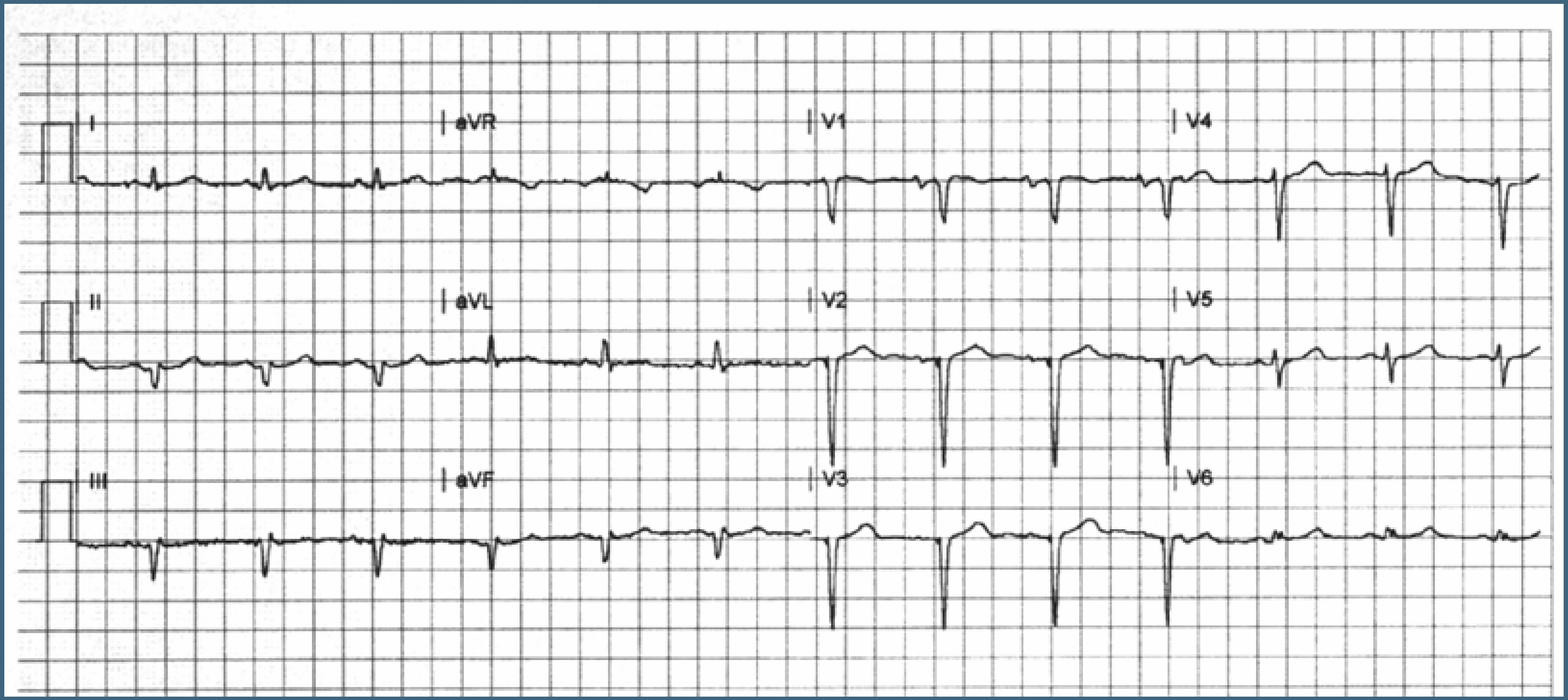
Q Waves

- Physiologic Q waves
  - < .04 sec (40ms)
- Pathologic Q waves
  - ≥.04 sec (40 ms)



Ischemia, Injury & Infarct

Q Waves



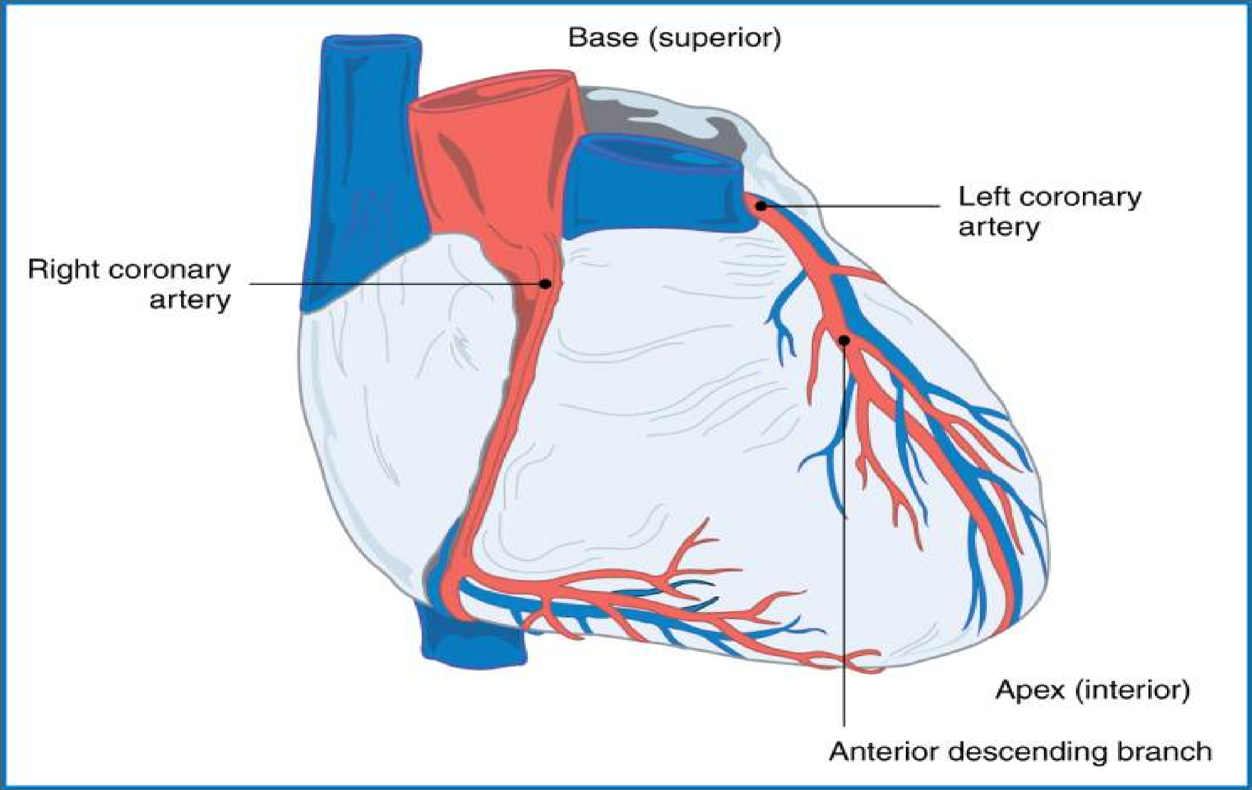
Ischemia, Injury & Infarct

Reciprocal Changes (RC)

- Occur in larger MI
  - Able to “see” the MI on the opposite side because it is larger
- RC’s make the STE more likely to be due to AMI

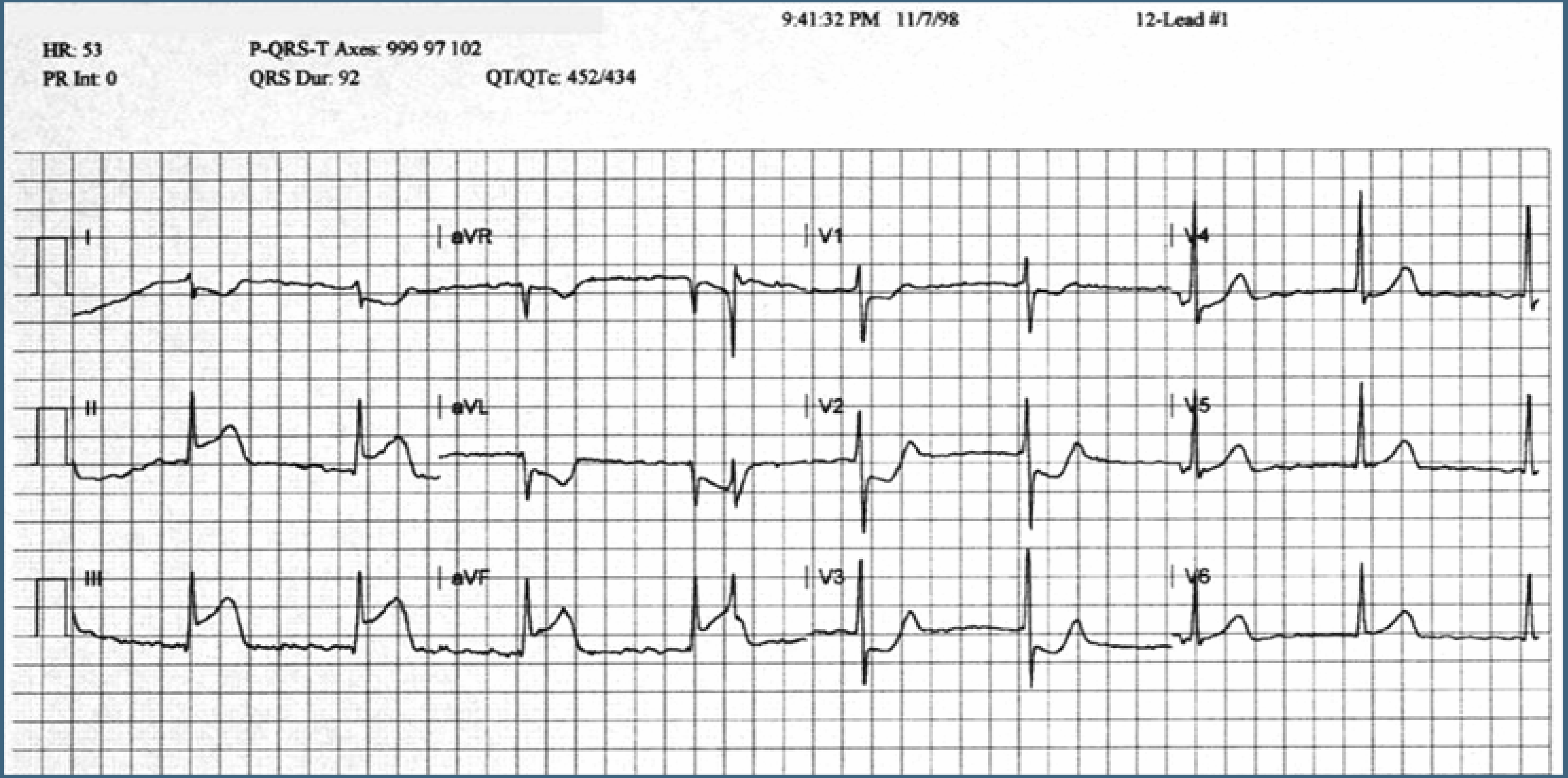
Ischemia, Injury & Infarct

Reciprocal Changes



Ischemia, Injury & Infarct

Reciprocal Changes



Ischemia, Injury & Infarct

A “normal” 12-lead ECG ***DOES NOT*** rule out AMI

- Early AMI may have no STE but may evolve over time
- Non STEMI AMI have non specific but abnormal ECGs

Ischemia, Injury & Infarct

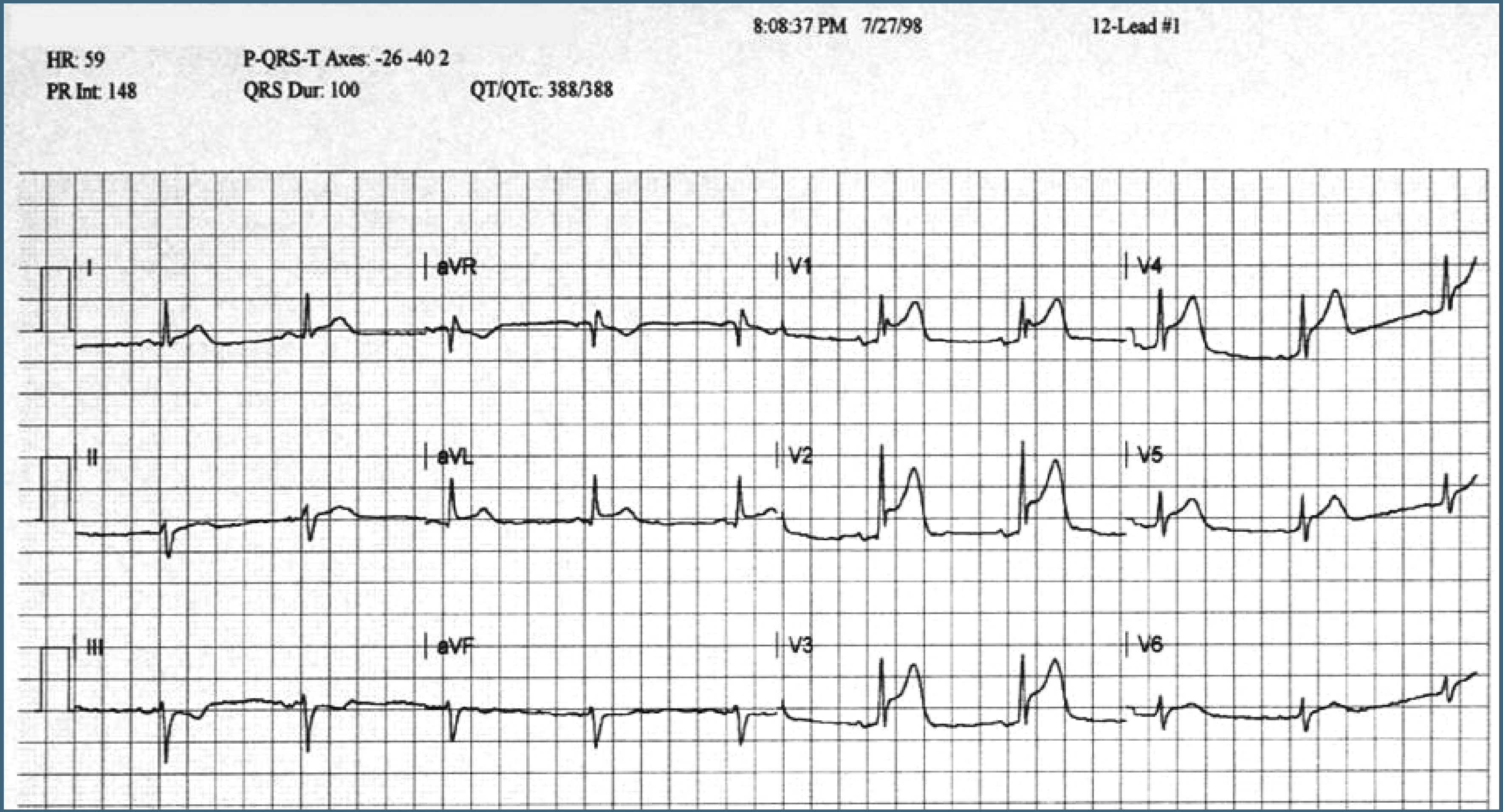
Why can’t AMI be ruled out?

- PHECG has high specificity for STEMI = 97%*****
- Meaning = when PHECG shows STEMI it almost always turns out to be an AMI.
- PHECG has only moderate sensitivity for AMI = 68%

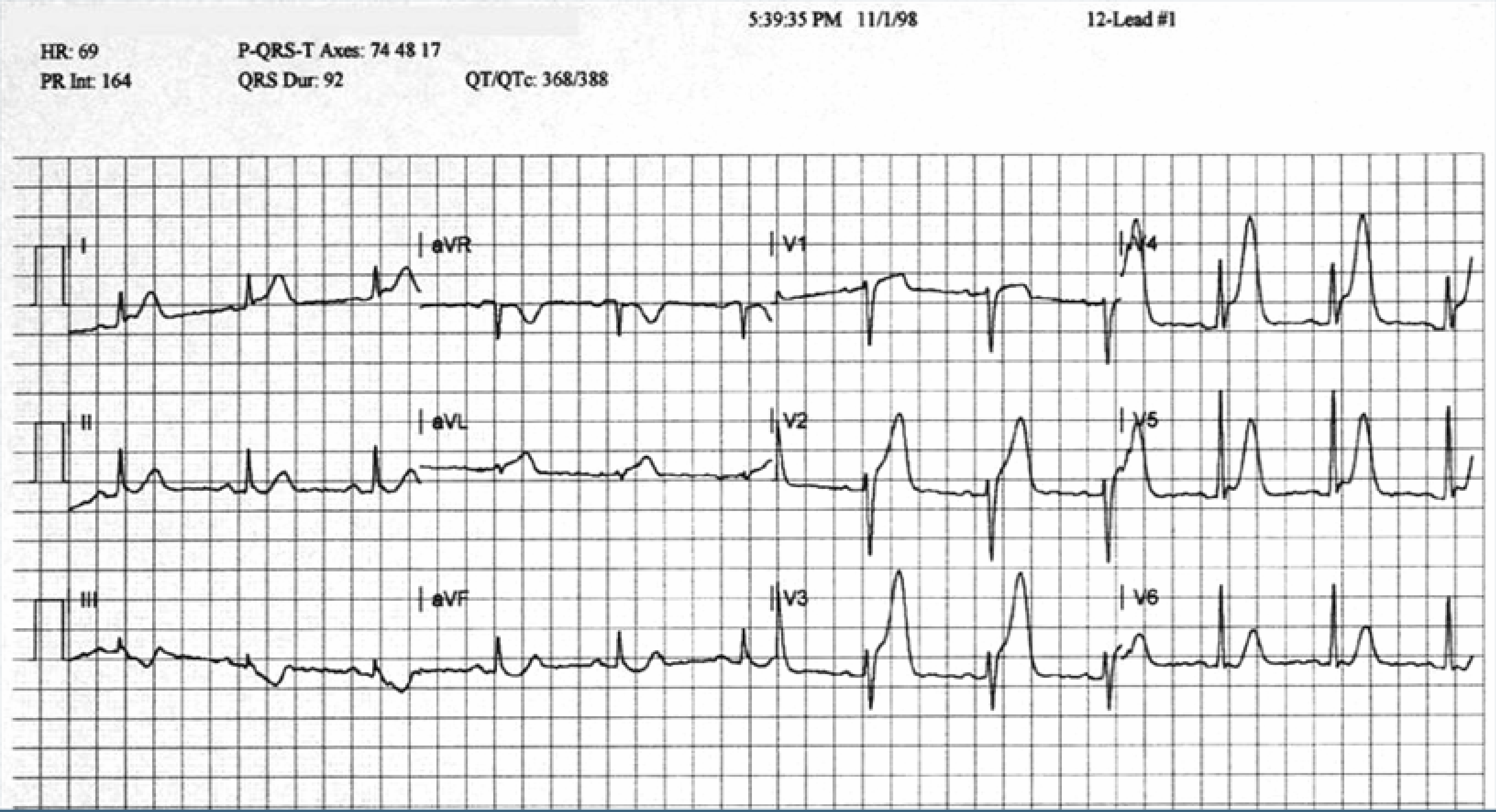
- No STEMI on PHECG - 68% = NO AMI

Source: Ioannides JA et al. Accuracy & clinical effect of out-of-hospital ECG in the diagnosis of acute cardiac ischemia: a meta-analysis. *Annals of Emergency Medicine 2001;37.*

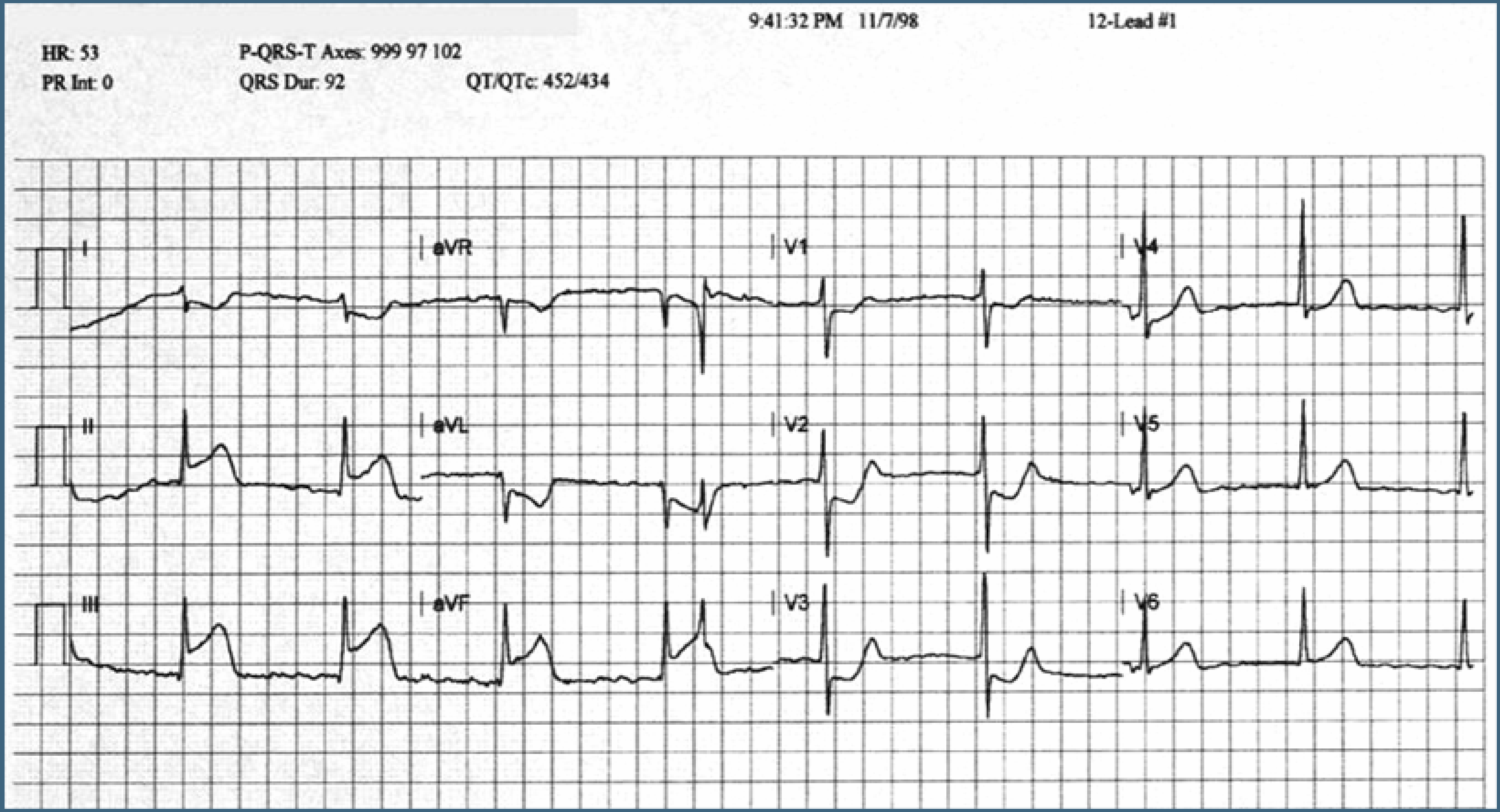
12 Lead Practice



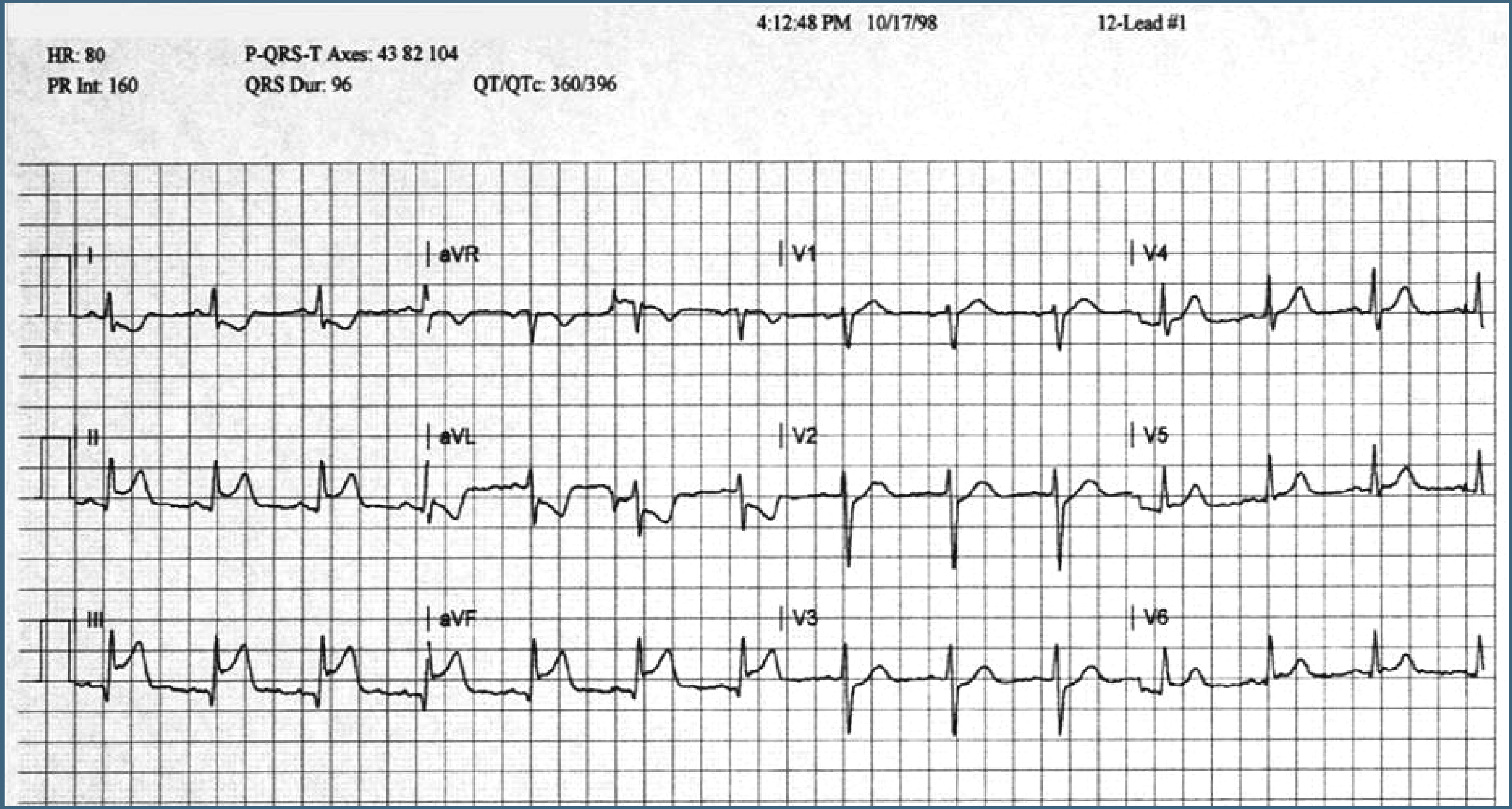
12 Lead Practice



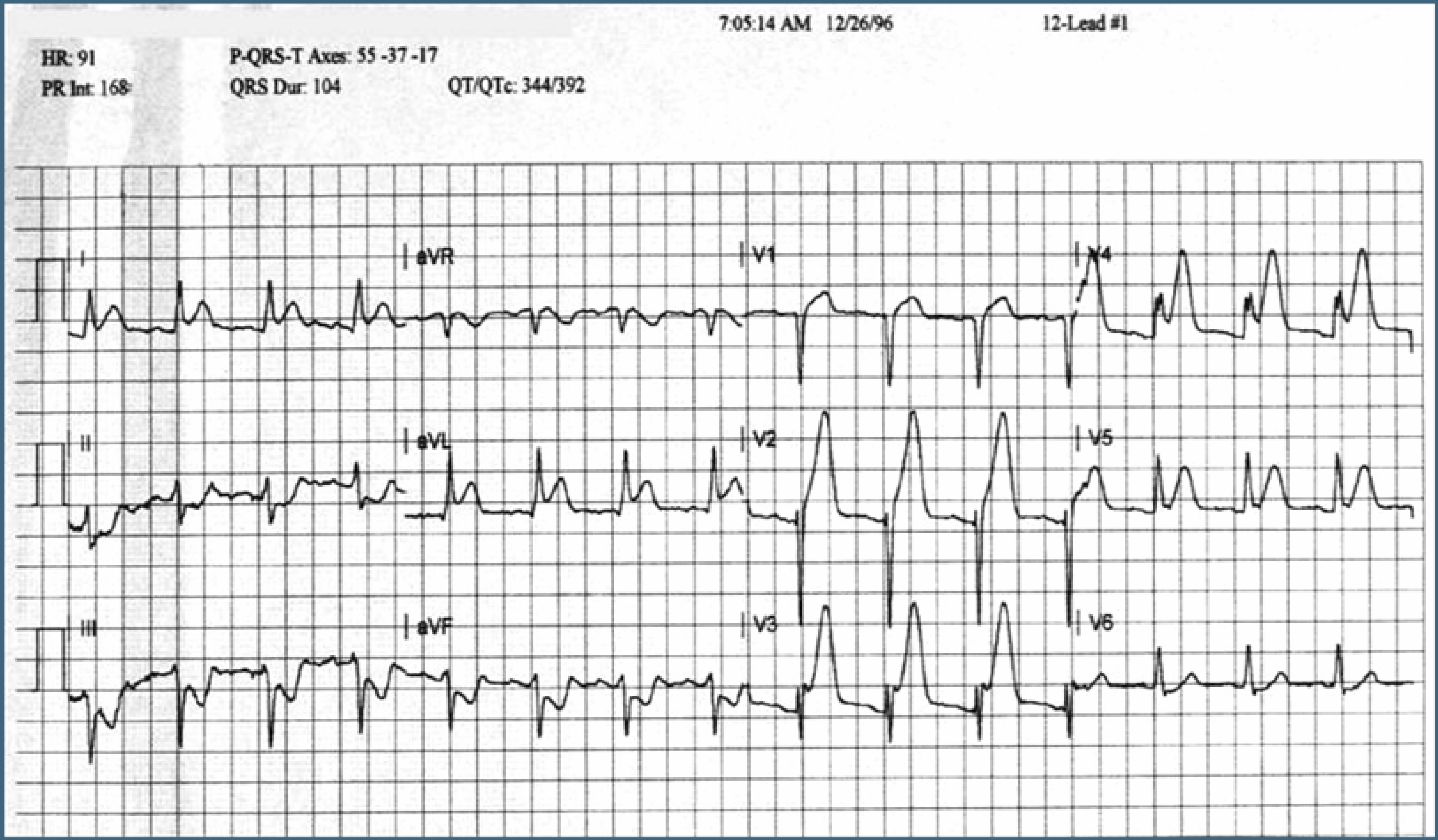
12 Lead Practice



12 Lead Practice



12 Lead Practice



12 Lead Summary

What are you looking for?

- ≥ 1mm of ST elevation in limb leads
- ≥ 2mm of ST elevation in chest leads
- Two contiguous leads
- Know where you are looking
- Positive electrode as an "eye"
- Memorize lead locations

AMI Recognition

Imitators:

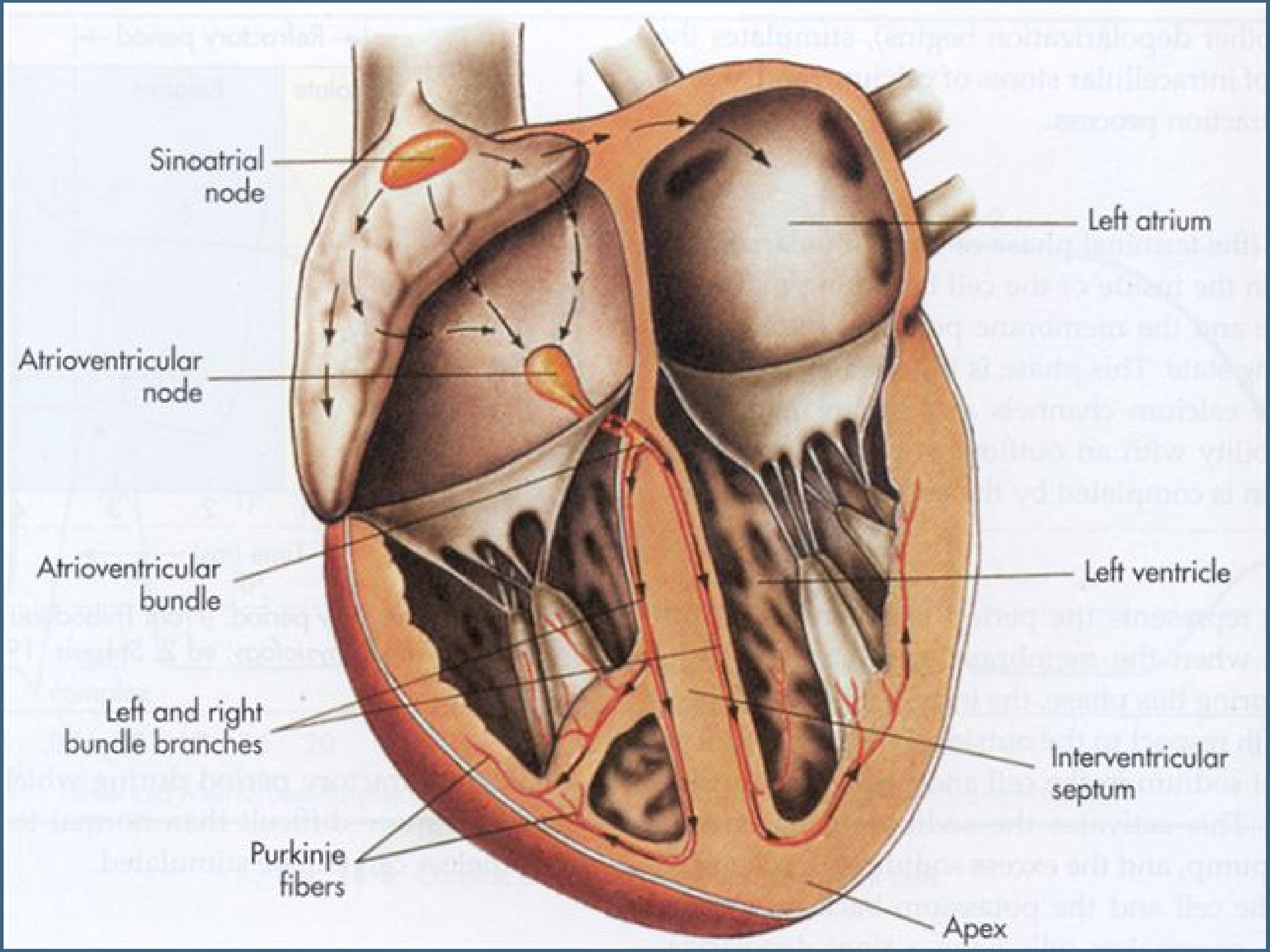
- BBB
- LVH
- Ventricular beats
- Pericarditis
- Early Repolarization
- Others

AMI Recognition

Bundle Branch Block

•Unaffected bundle branch depolarizes normally
•Diseased bundle branch does not deliver the impulse to the ventricle
•Wave of depolarization spreads from the unaffected side, to the other ventricle
•It takes longer to depolarize in this fashion, so the QRS is widened

Conduction System



AMI Recognition

Bundle Branch Block – Identification

•Supraventricular rhythm in origin

•Wide QRS (120ms or more)

AMI Recognition

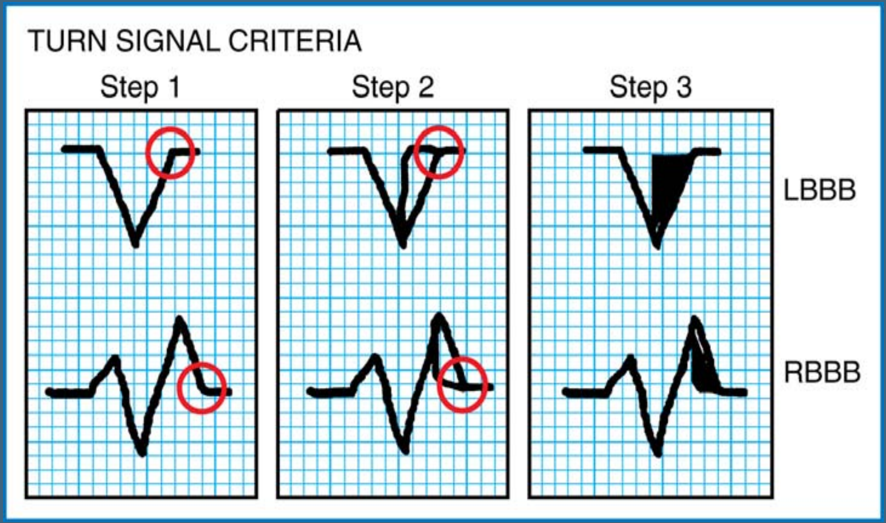
Bundle Branch Block

- Wide looking QRS with <u>notching</u>
- Look for QRS duration in 12 Lead info section at top of printout
- Determine LBBB or RBBB in a wide complex SVT by using VI

AMI Recognition

Bundle Branch Block

- Use VI
- Circle the J point
- Find the terminal deflection
- Shade in an arrowhead pointing up or down
- Apply “turn signal”



STEMI Bypass Protocol

- **May vary depending on locality**
- **Will be provided to each service as they enter into STEMI Bypass agreements**

Questions

- Contact SWORBHP
  - 519-667-6718
  - ParamedicEducation@lhsc.on.ca

References

- Material and graphics adapted with permission from:

12-Lead ECG Interpretation
Patricia Pratt, NR-LP
Charles Garoni, NR-EMT-P
Department of EMT
University of Texas Health Science Center