ECG - MI

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FOR

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Acute Coronary Syndromes

- Unstable Angina (UA)
- Non-ST-segment Elevation MI (NSTEMI)
- ST-segment Elevation MI (STEMI)

Acute Coronary Syndromes

Excessive demand or inadequate supply of oxygen and nutrients to the heart muscle

Associated with:

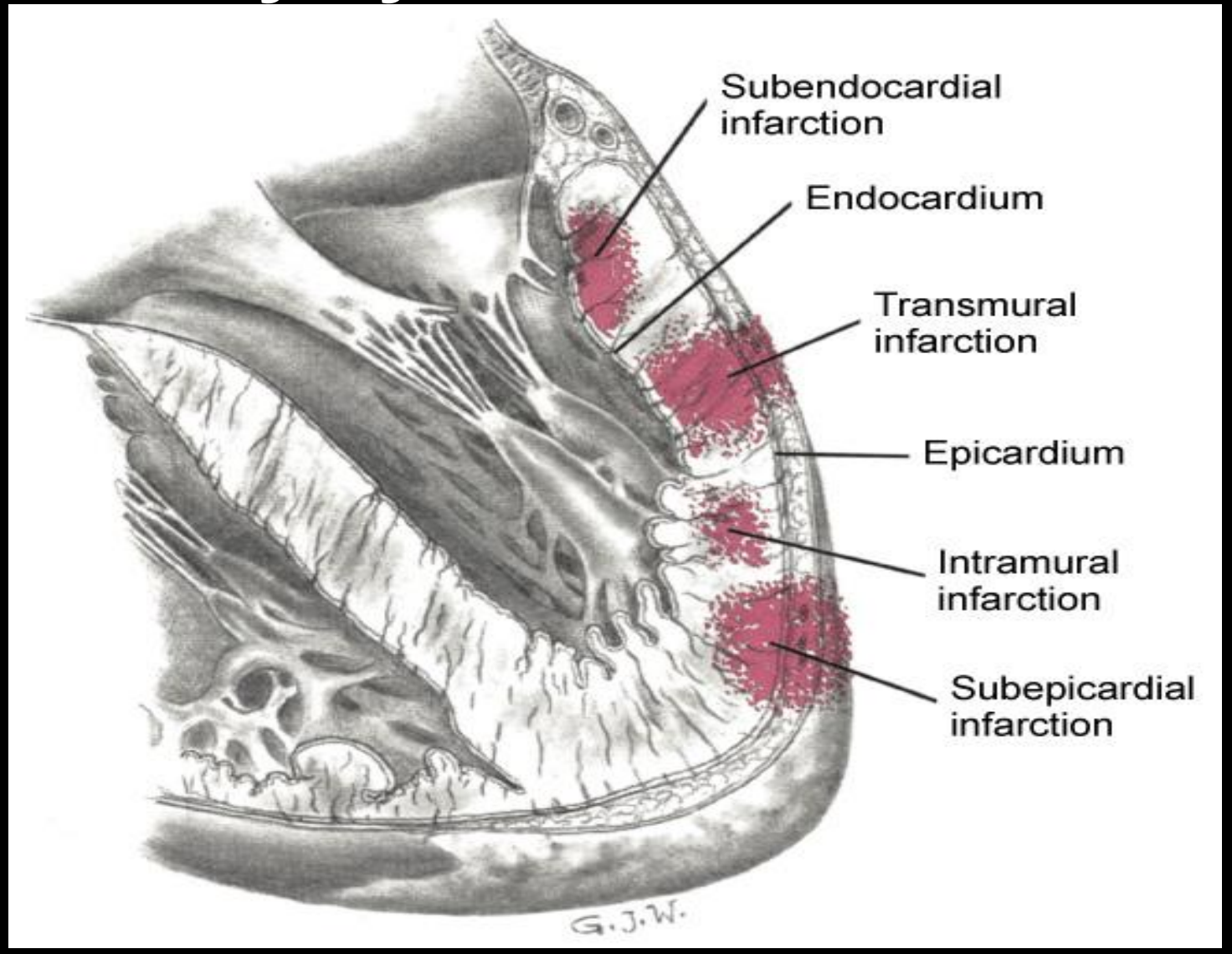
- ✔ Plaque disruption
- ✔ Thrombus formation
- ✔ Vasoconstriction

Coronary Artery Occlusion

Patient's clinical presentation and outcome depend on factors including:

- Amount of myocardium supplied by affected artery
- Severity and duration of myocardial ischemia
- Electrical instability of the ischemic myocardium
- Degree and duration of coronary obstruction
- Presence (and extent) or absence of collateral coronary circulation

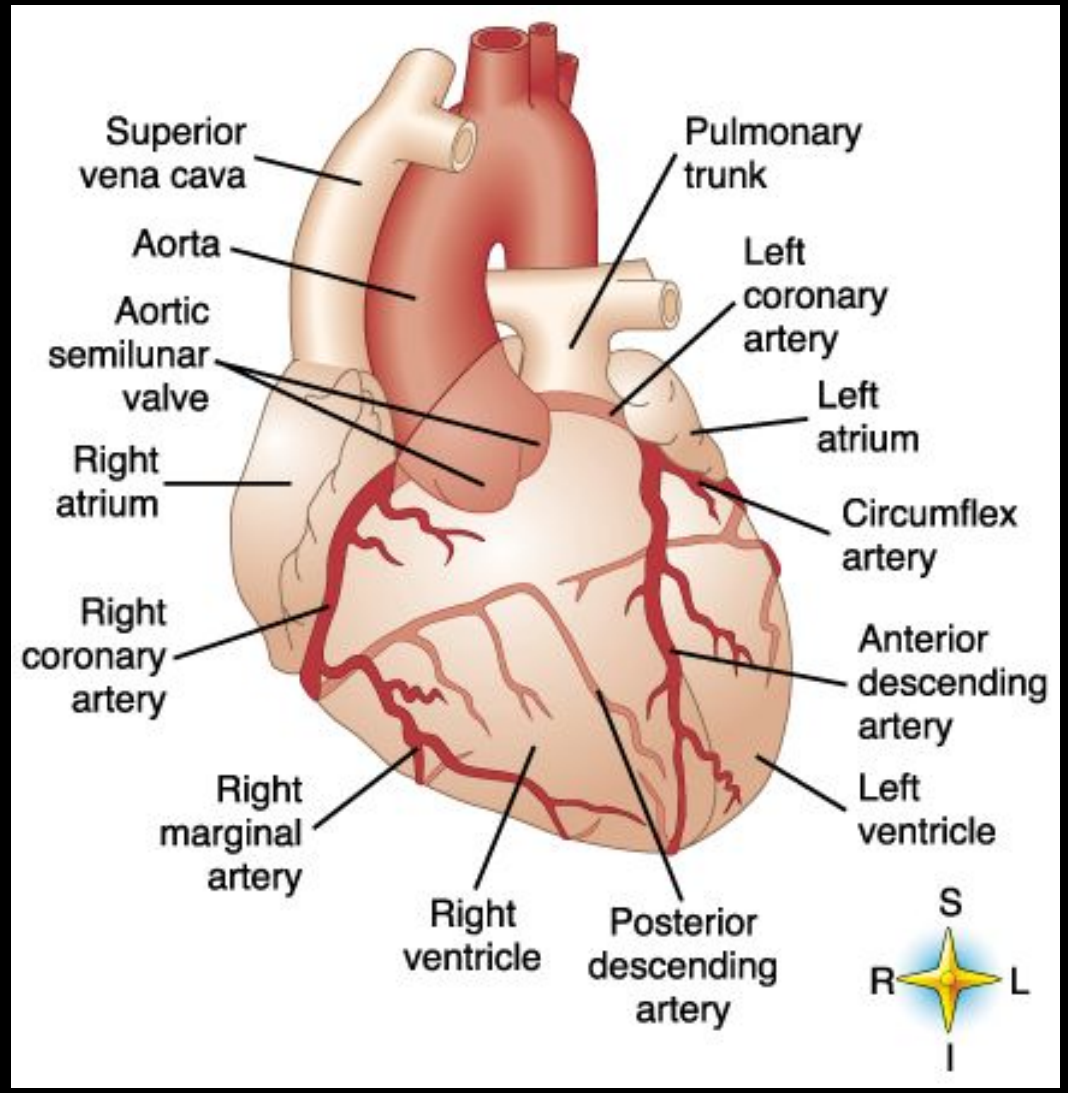
Acute Coronary Syndromes



Ischemia, Injury, and Infarction

Main coronary arteries lie on the epicardial surface of the heart

This area is fed first before supplying the inner layers with oxygenated blood



Ischemia, Injury, and Infarction

Myocardial ischemia

Imbalance between the metabolic needs of the myocardium (demand) and the flow of oxygenated blood to it (supply)

Angina: The pain resulting from an imbalance between myocardial oxygen supply and demand

1. Characteristic Quality and Duration: Retrosternal: Jaw, Left Arm, Neck
2. Provoked by Exertion or Emotional Stress
3. Relieved by Rest or Nitroglycerin

Ischemia, Injury, and Infarction

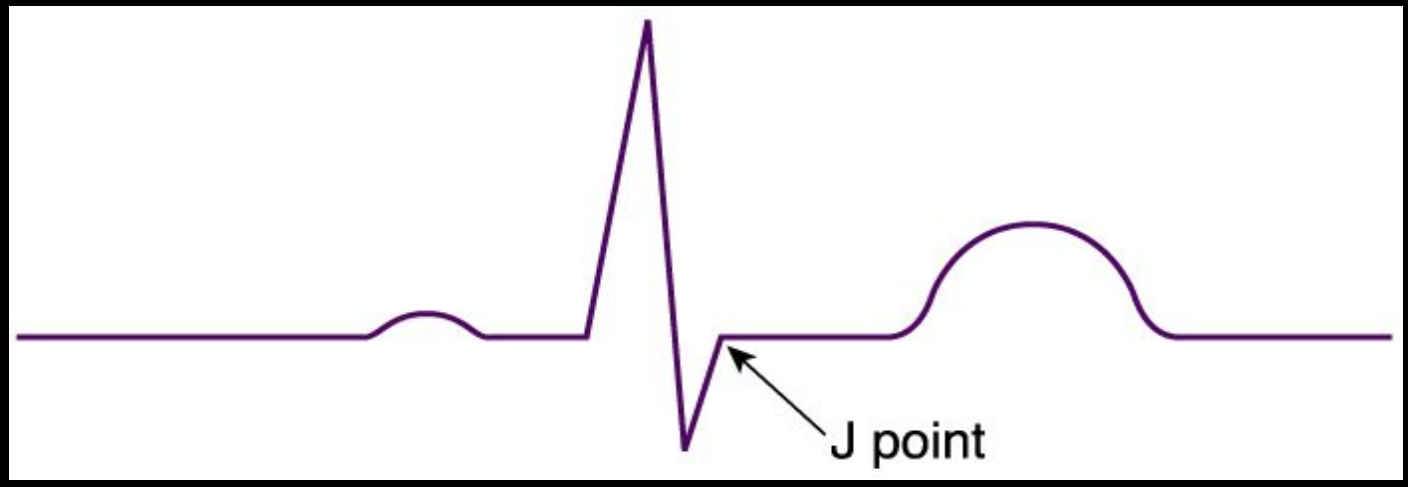
Myocardial ischemia delays repolarization

ECG changes include temporary changes in the ST-segment and T wave

When looking for evidence of infarction, most of the information is obtained from analyzing a single, representative complex in each lead.

Ischemia, Injury, and Infarction

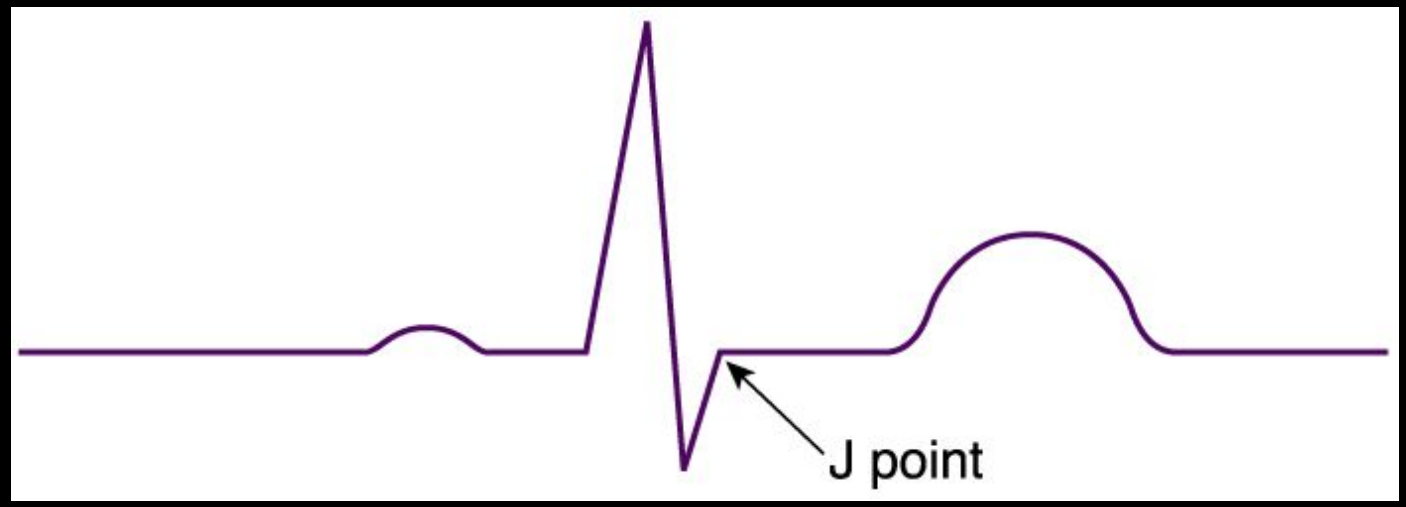
ST-segment depression is significant when the ST-segment is more than ½ mm below the baseline at a point 0.04 sec to the right of the J-point and is seen in two or more leads facing the same anatomic area of the heart



Ischemia, Injury, and Infarction

Locate J-point

Compare ST-segment deviation to isoelectric line



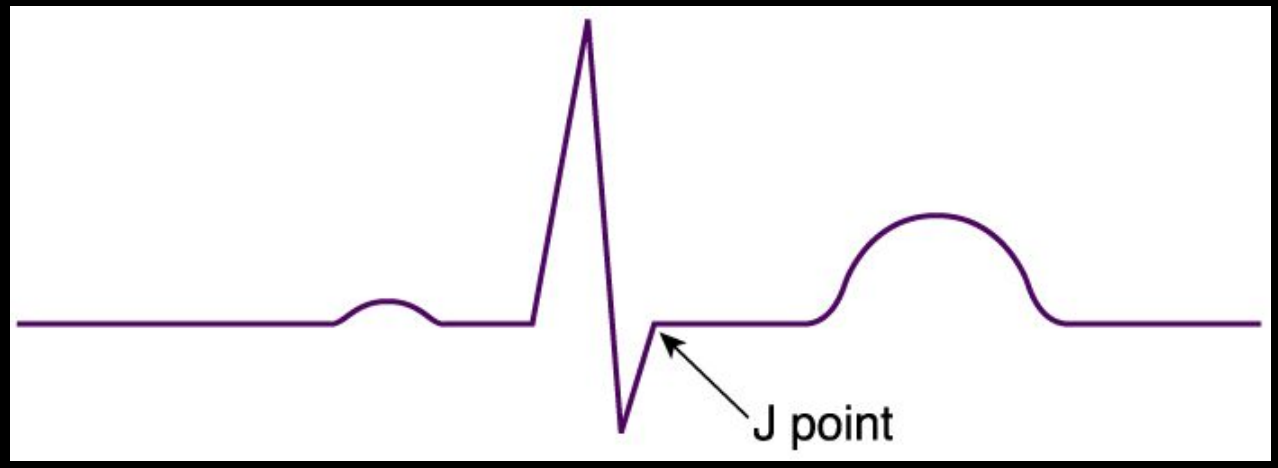
Ischemia, Injury, and Infarction

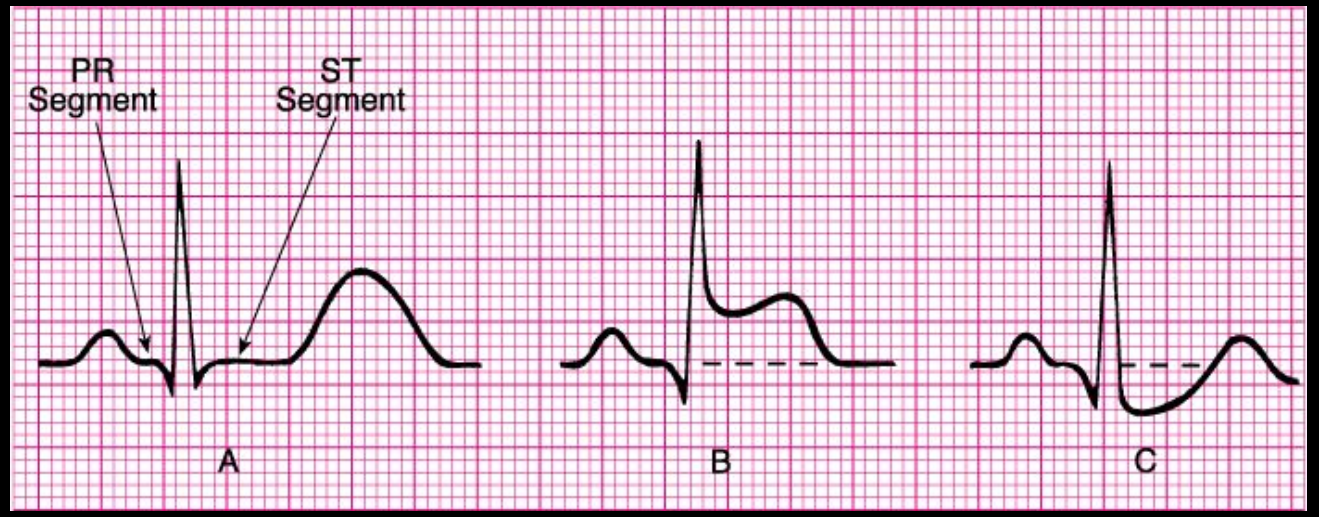
Injured cells will die unless blood flow is quickly restored

Myocardial injury is viewed on the ECG as ST-segment elevation in the leads facing the affected area

Ischemia, Injury, and Infarction

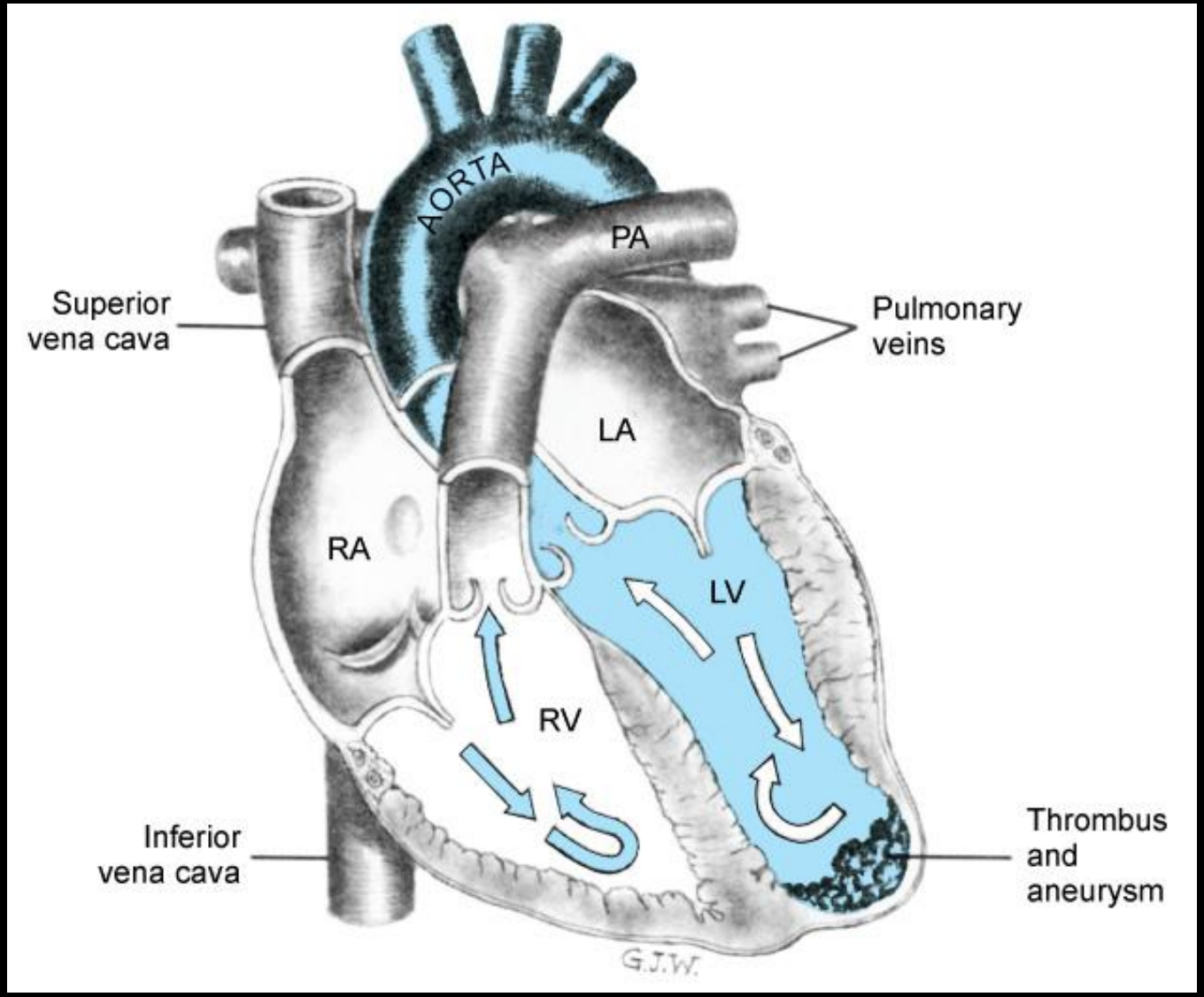
Injured cells will show ST-segment elevation in leads facing the affected area





Ischemia, Injury, and Infarction

Suspect ventricular aneurysm if ST-segment elevation persists for more than a few months after MI



Ischemia, Injury, and Infarction

Infarction occurs when blood flow to the heart muscle stops or is suddenly decreased long enough to cause cell death

Infarcted cells:

- Cannot respond to an electrical stimulus
- Do not provide any mechanical function

Myocardial Infarction—Diagnosis

Typical rise and gradual fall (troponin) or more rapid rise and fall (CK-MB) of biochemical markers of myocardial necrosis with at least one of the following:

- ✔ Ischemic symptoms
- ✔ Development of pathologic Q waves on ECG
- ✔ ECG changes (ST-segment elevation or depression)
- ✔ Or coronary artery intervention

Pathologic findings of an acute MI

Infarction—ECG Changes

- Non-ST-segment elevation MI (NSTEMI)
  - ST-segment depression in leads facing the affected area
  - MI diagnosed if ECG changes are accompanied by elevations of serum cardiac markers

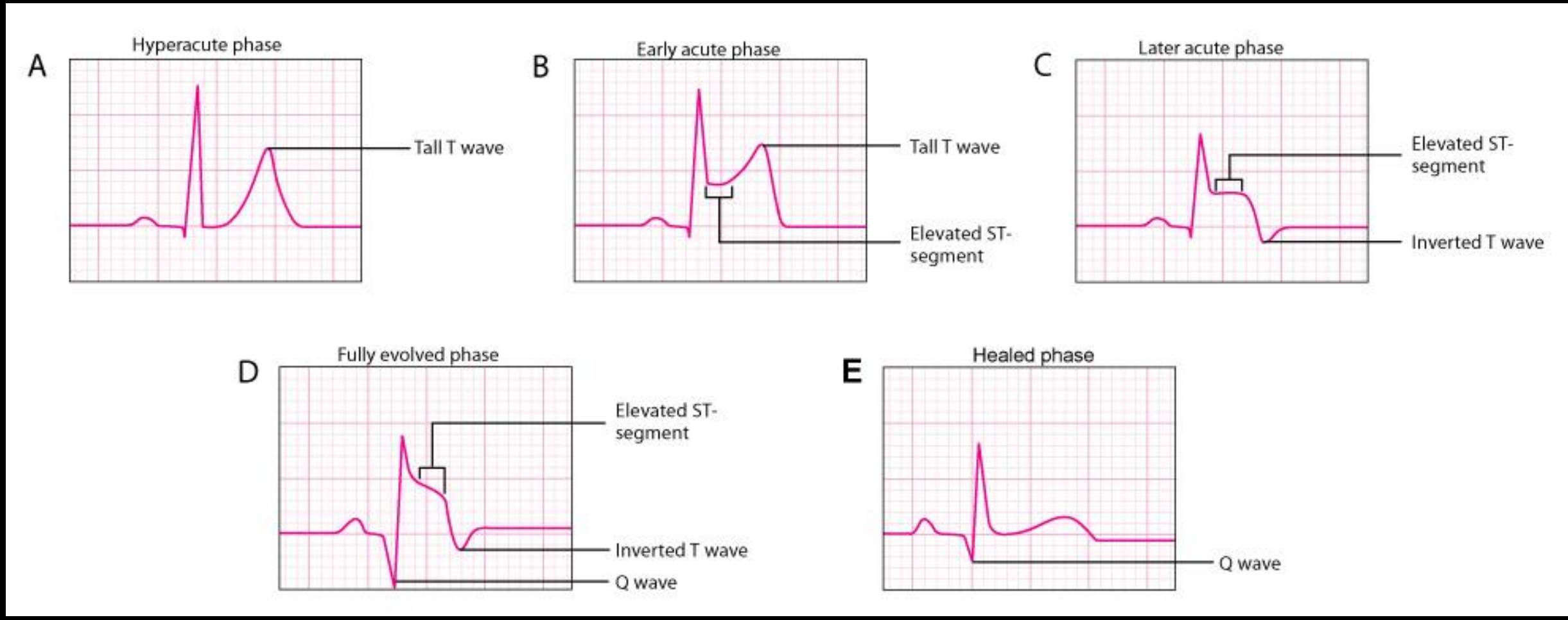
Infarction—ECG Changes

Most patients with ST-segment elevation MI will develop Q-wave MI

Abnormal (pathologic) Q wave

- >0.04 sec in duration and >1/3 the amplitude of the following R wave in that lead
- Indicates dead myocardial tissue, loss of electrical activity

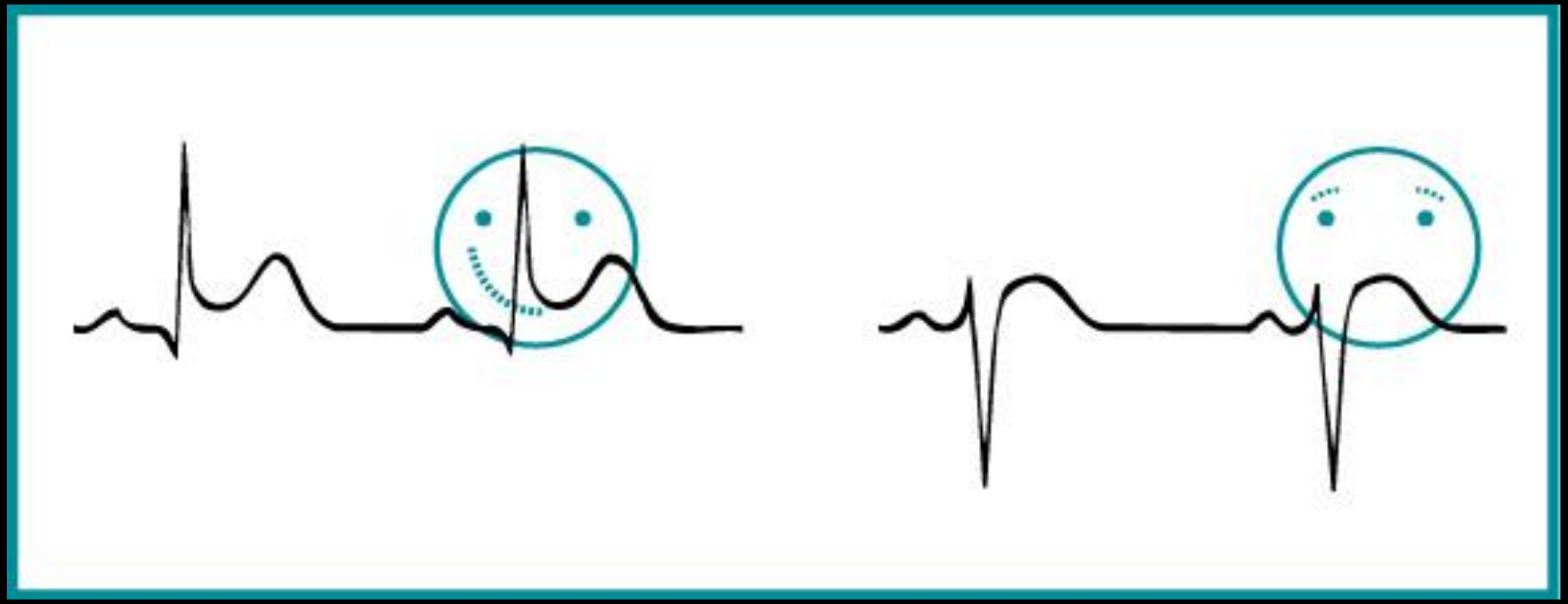
Infarction—Indicative ECG Changes



Infarction—ECG Changes

ST-segment elevation

- “Smiley” face (upward concavity) is usually benign
- Coved (“frowny face”) elevation is called an *acute injury pattern*

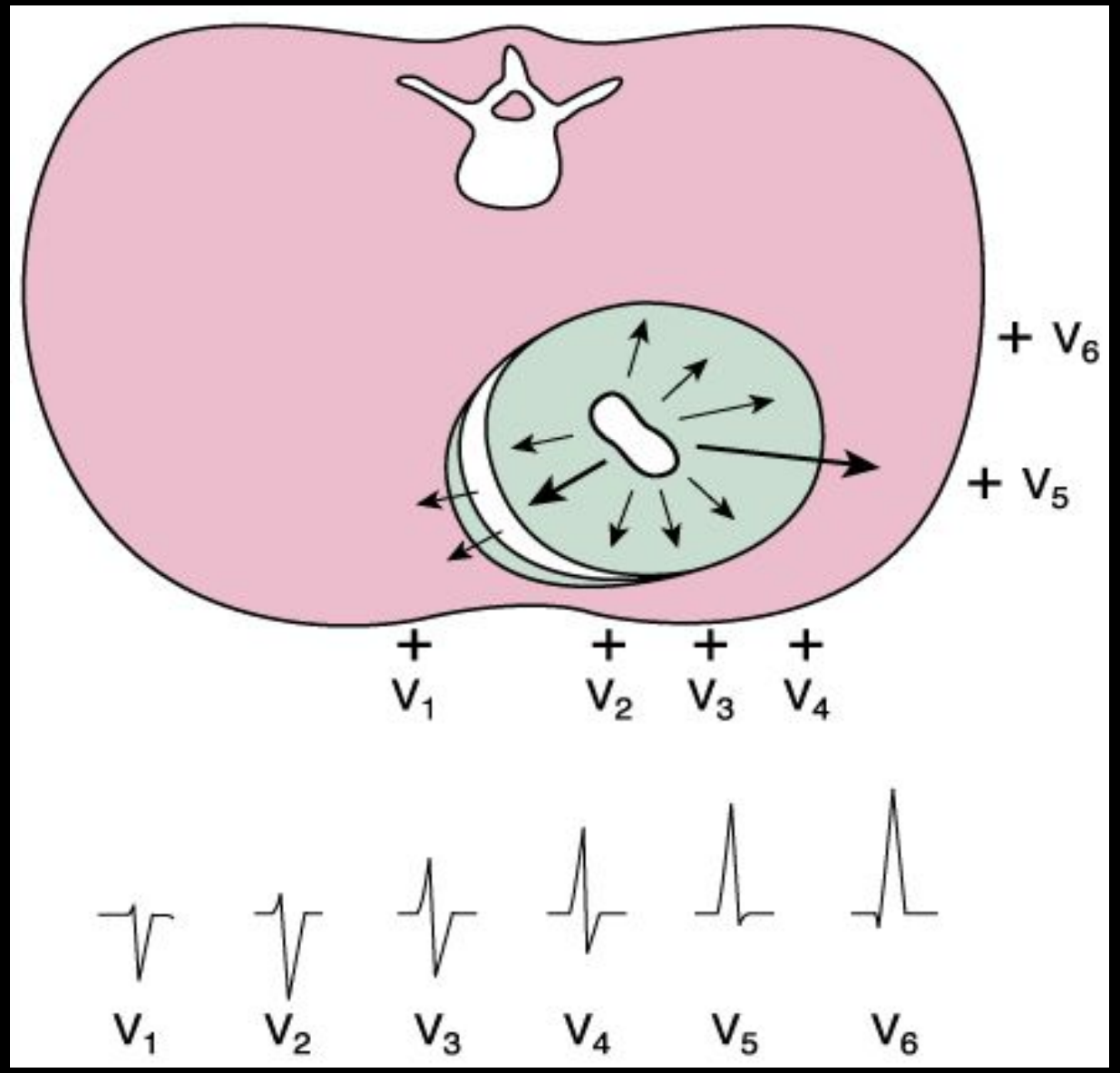


R-Wave Progression

Chest leads in a normal heart

As the electrode is moved from right to left:

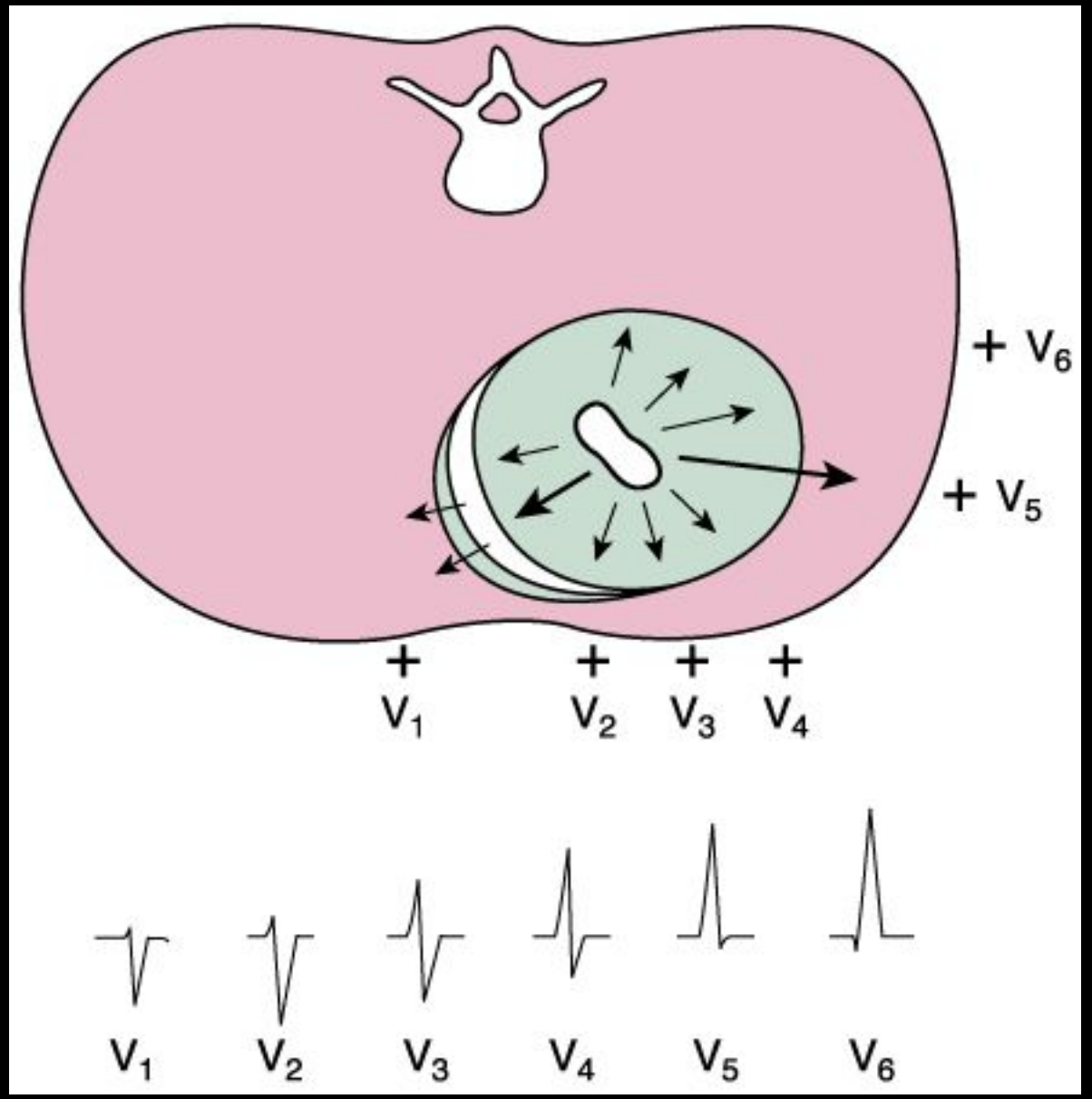
- R wave becomes taller
- S wave becomes smaller



R-Wave Progression

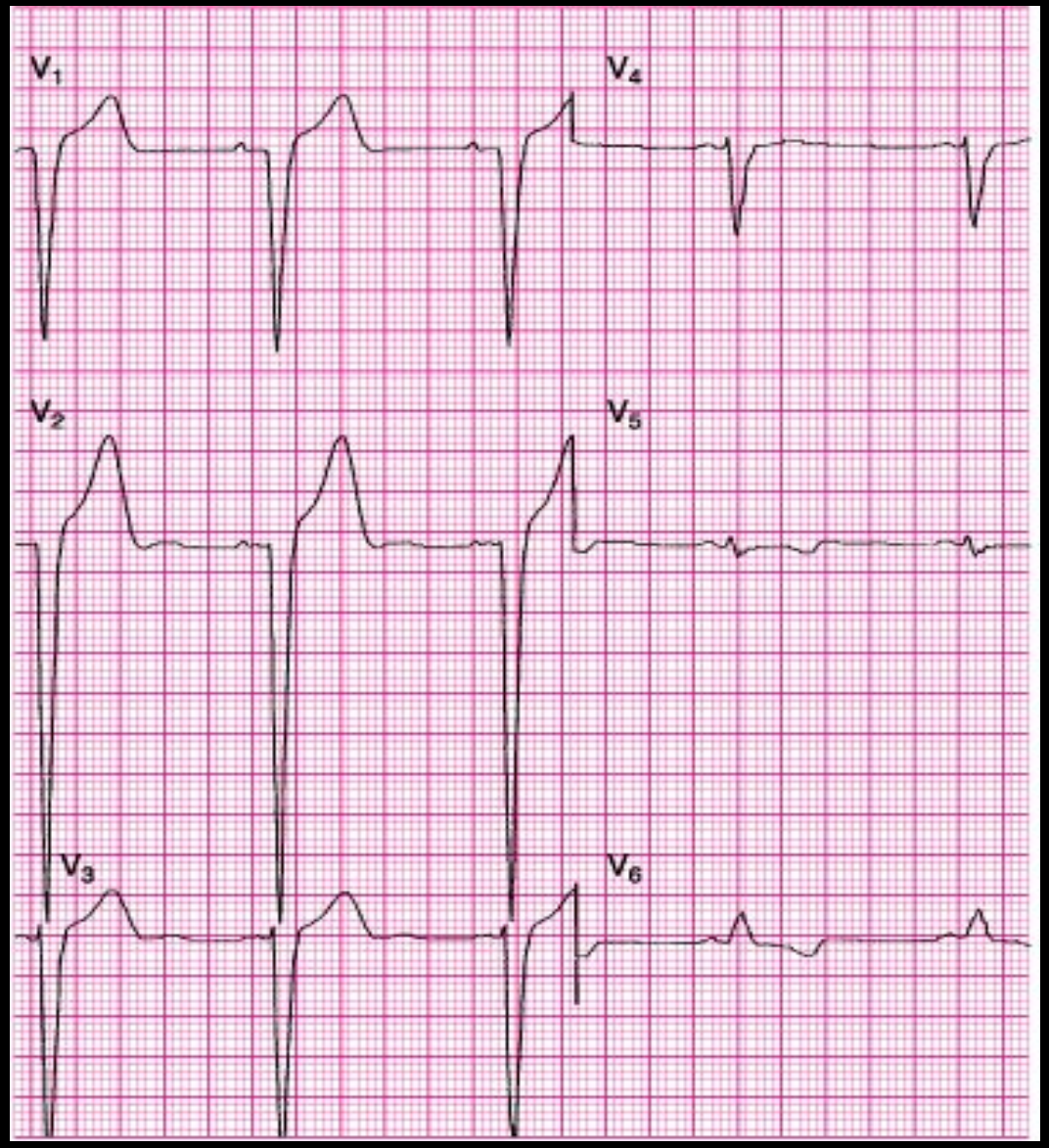
V_3 and V_4 normally record an equiphasic (equally positive and negative) RS complex

Transitional zone



Poor R-Wave Progression

A phrase used to describe R waves that decrease in size from V_1-V_4



Layout of the 12-Lead ECG

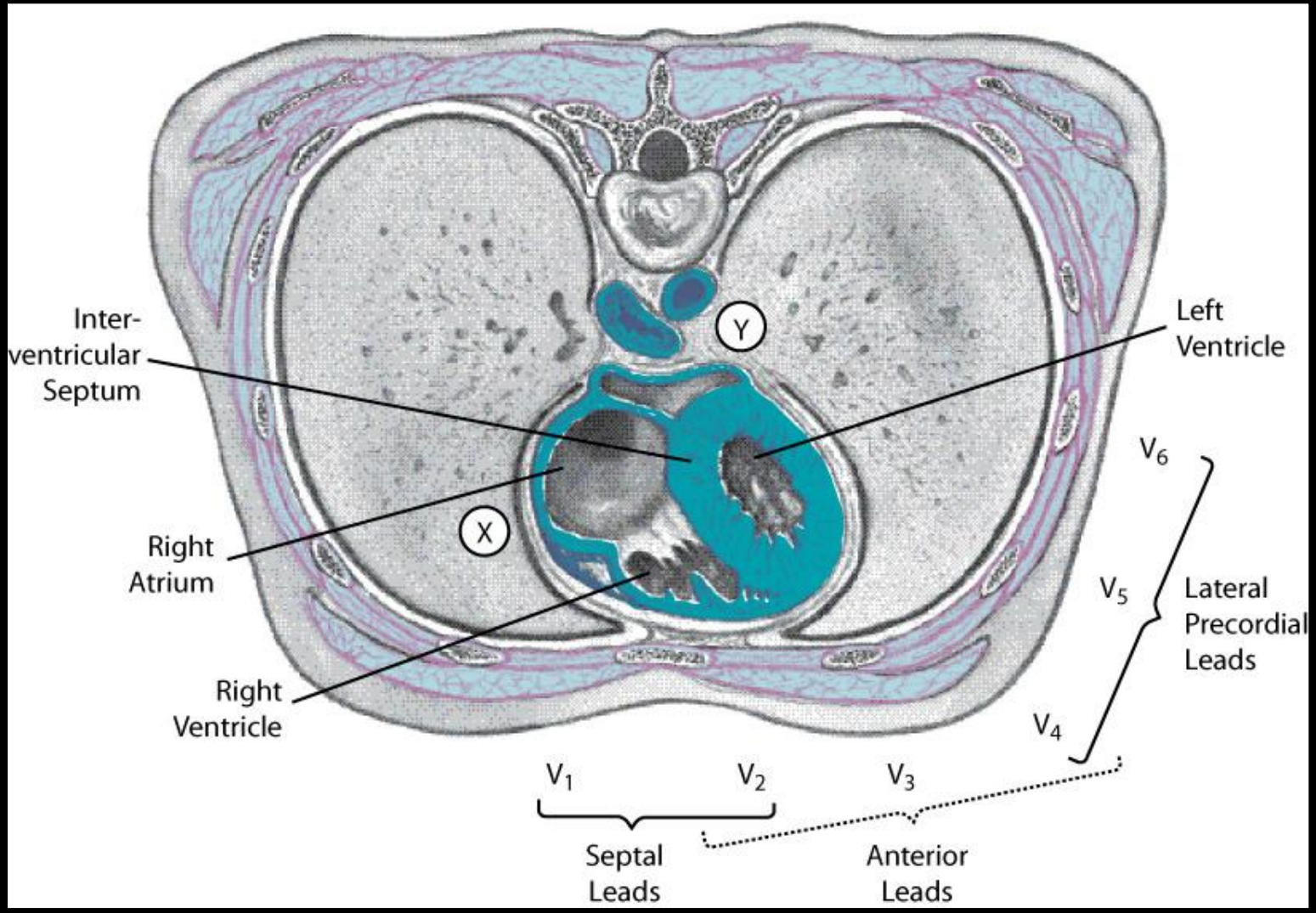
Indicative ECG Changes

Indicative changes are significant when they are seen in two *anatomically contiguous* leads

Two leads are contiguous if:

- They look at the same area of the heart
- Or they are numerically consecutive *chest* leads

Indicative ECG Changes



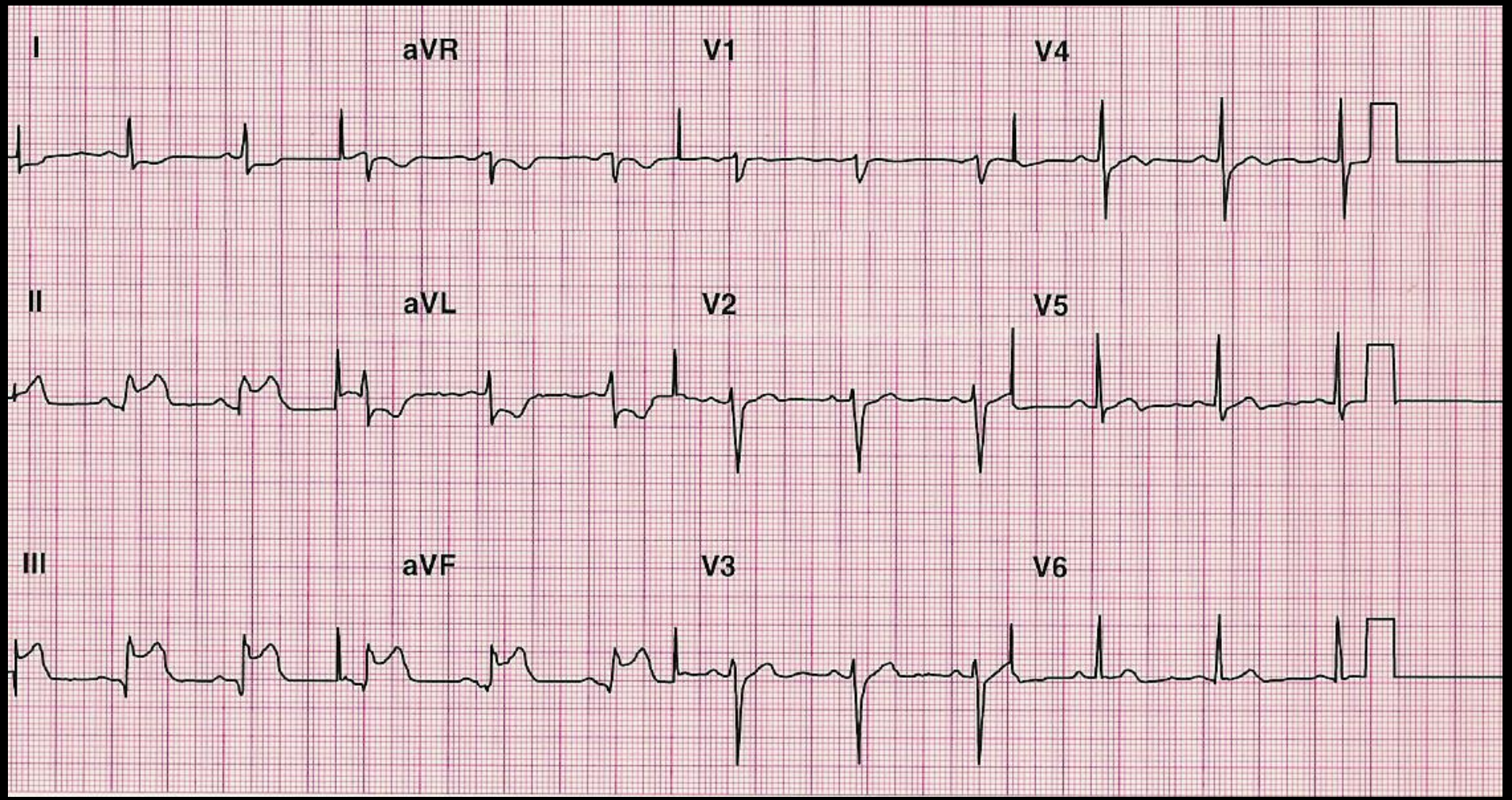
Indicative ECG Changes

Which leads of a standard 12-lead ECG look at the inferior wall of the left ventricle?

I: lateral	**aVR: none**	**$V_{1:}$ septum**	**V_4: anterior**
II: inferior	**aVL: lateral**	**V_2: septum**	**$V_{5:}$ lateral**
III: inferior	**aVF: inferior**	**$V_{3:}$ anterior**	**$V_{6:}$ lateral**

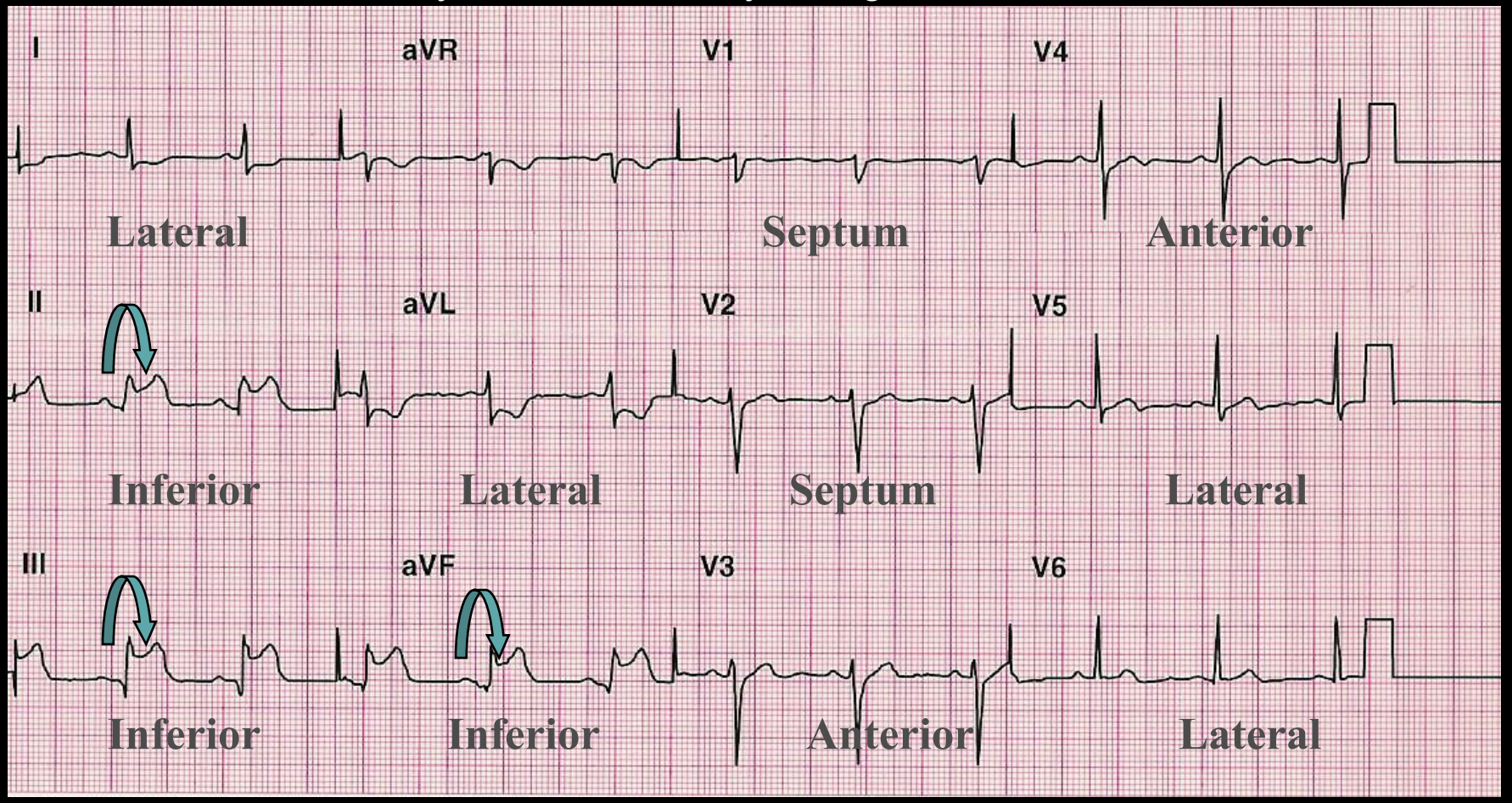
Which Leads Show ST-Segment Elevation?

Are they anatomically contiguous leads?

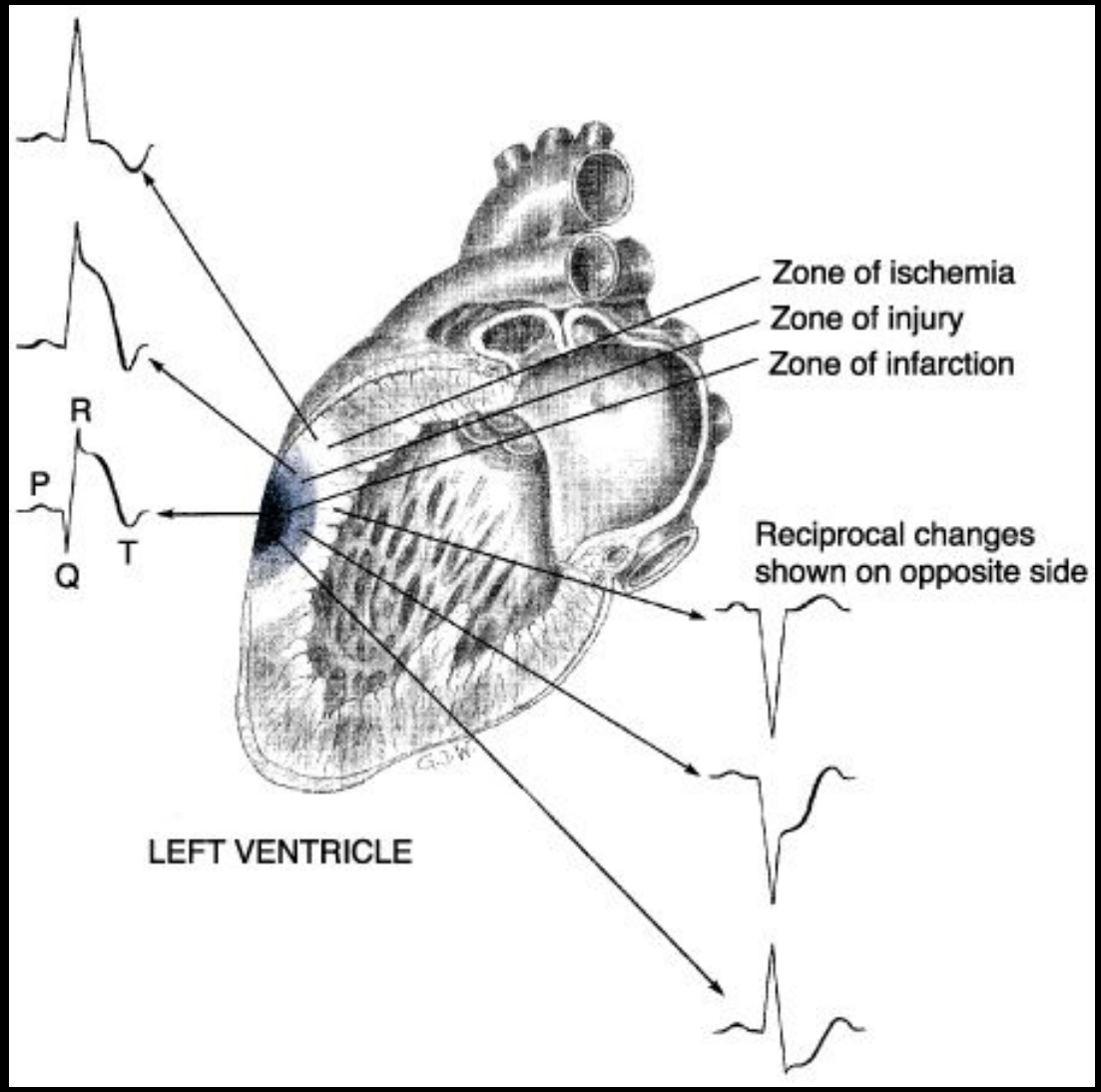


ST-Segment Elevation is Present in II, III, aVF

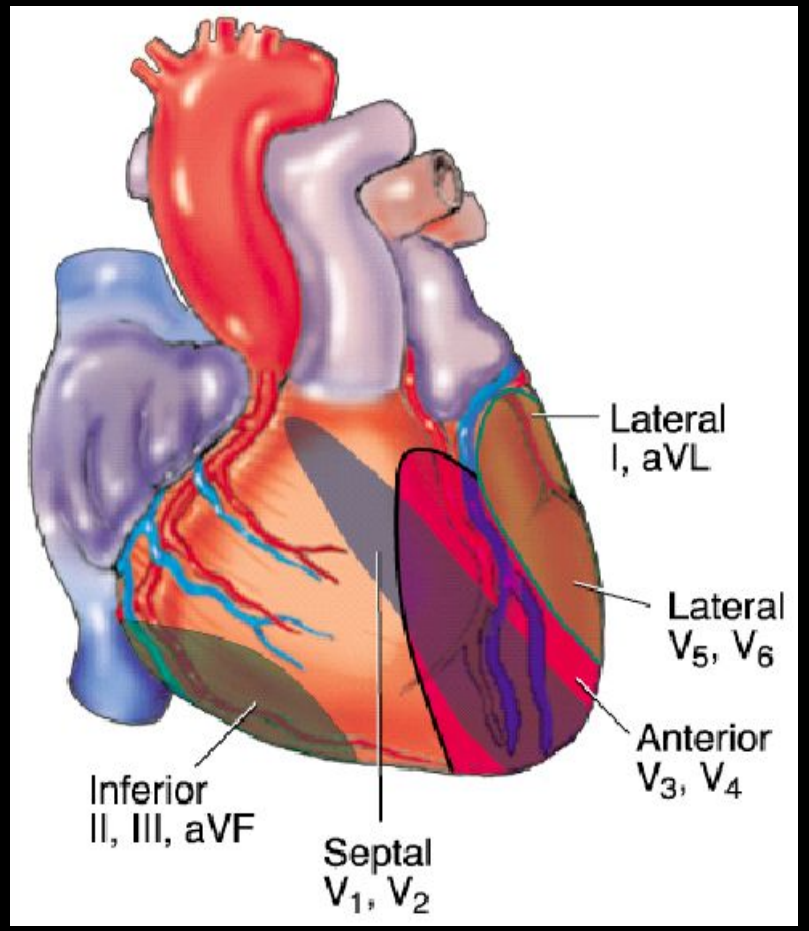
They <u>are</u> anatomically contiguous; inferior MI



Reciprocal Changes



Localization of Infarction



Predicting the Site of Coronary Artery Occlusion

- Leads II, III, and aVF = inferior wall
  - Supplied by RCA in most of the population

- Leads viewing areas supplied by the left coronary artery:
  - I, aVL, V_5, V_6 – lateral wall
  - V_1-V_2 – septum
  - V_3-V_4 – anterior wall

Assessing the Extent of Infarction

- Evaluate how many leads are showing indicative changes
  - Changes in only a few leads suggests a smaller infarction
- In general, the more proximal the occlusion:
  - The larger the infarction
  - The greater the number of leads showing indicative changes

Specific Types of MIs

Anterior Wall MI (AWMI)

Leads V_3 and V_4 face anterior wall of left ventricle

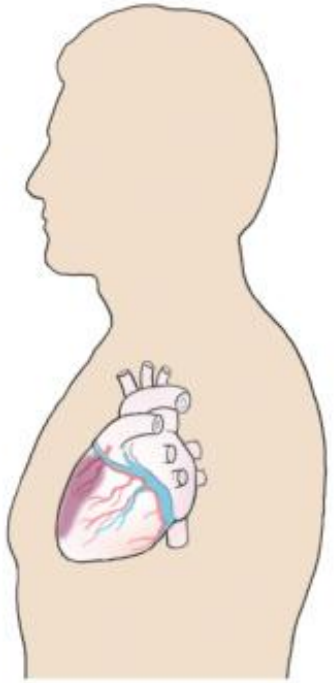
Left main coronary artery supplies:

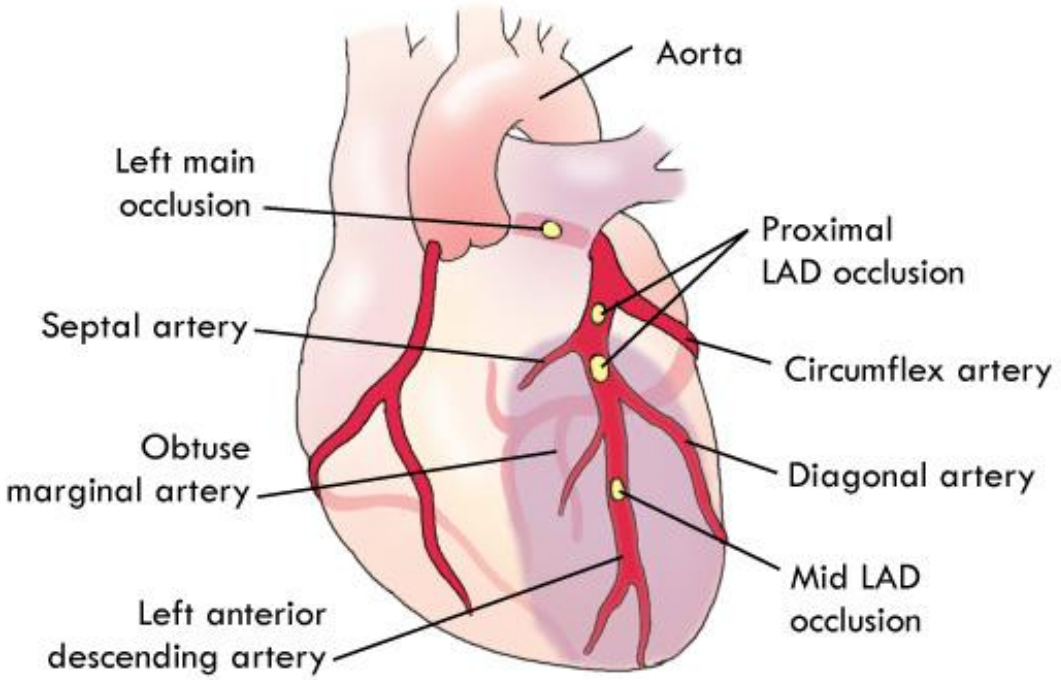
- Left anterior descending artery (LAD)
- Circumflex artery

Left main coronary artery occlusion

- “Widow maker”
- Often leads to cardiogenic shock and death without prompt reperfusion

Anterior Wall MI (AWMI)





I Lateral	aVR	V_1 Septum	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septum	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

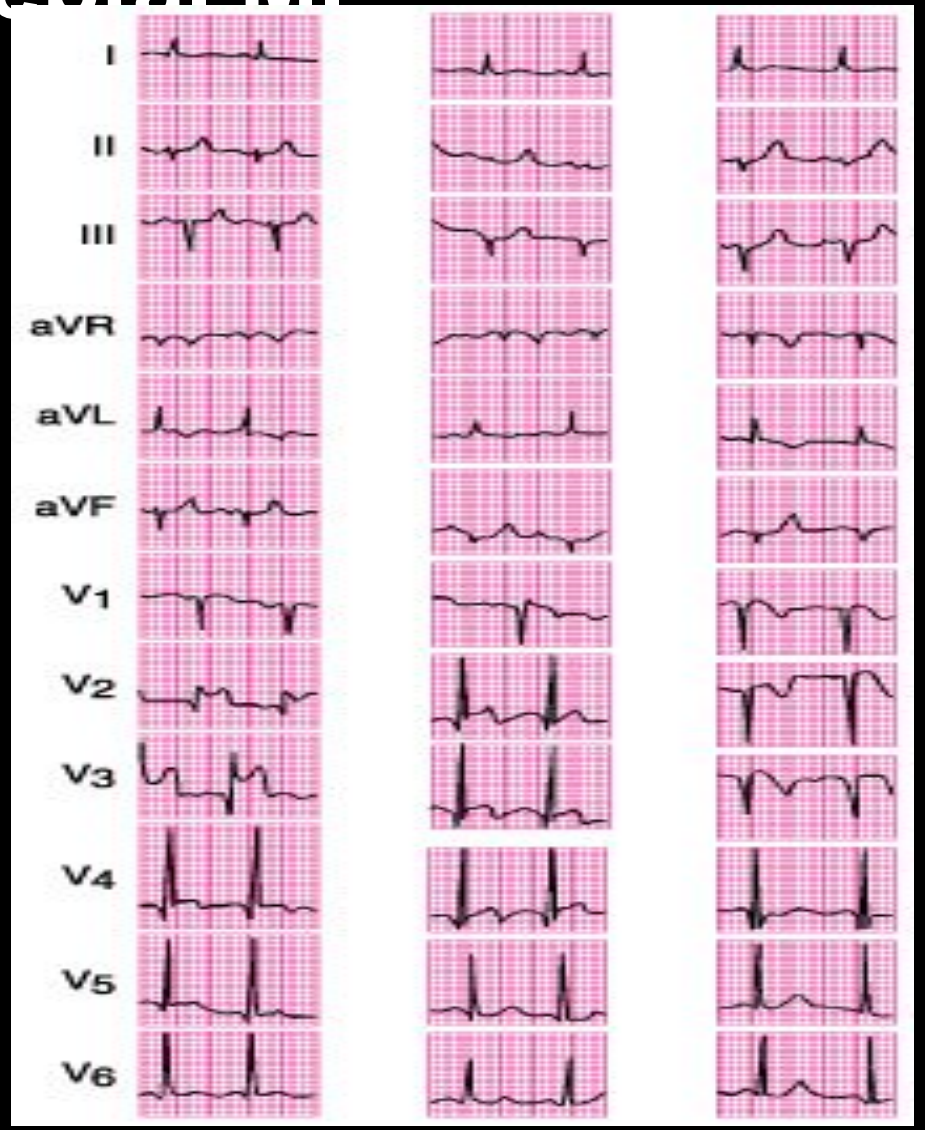
Evolution of Anteroseptal MI

Indicative changes in leads V_{2-4}

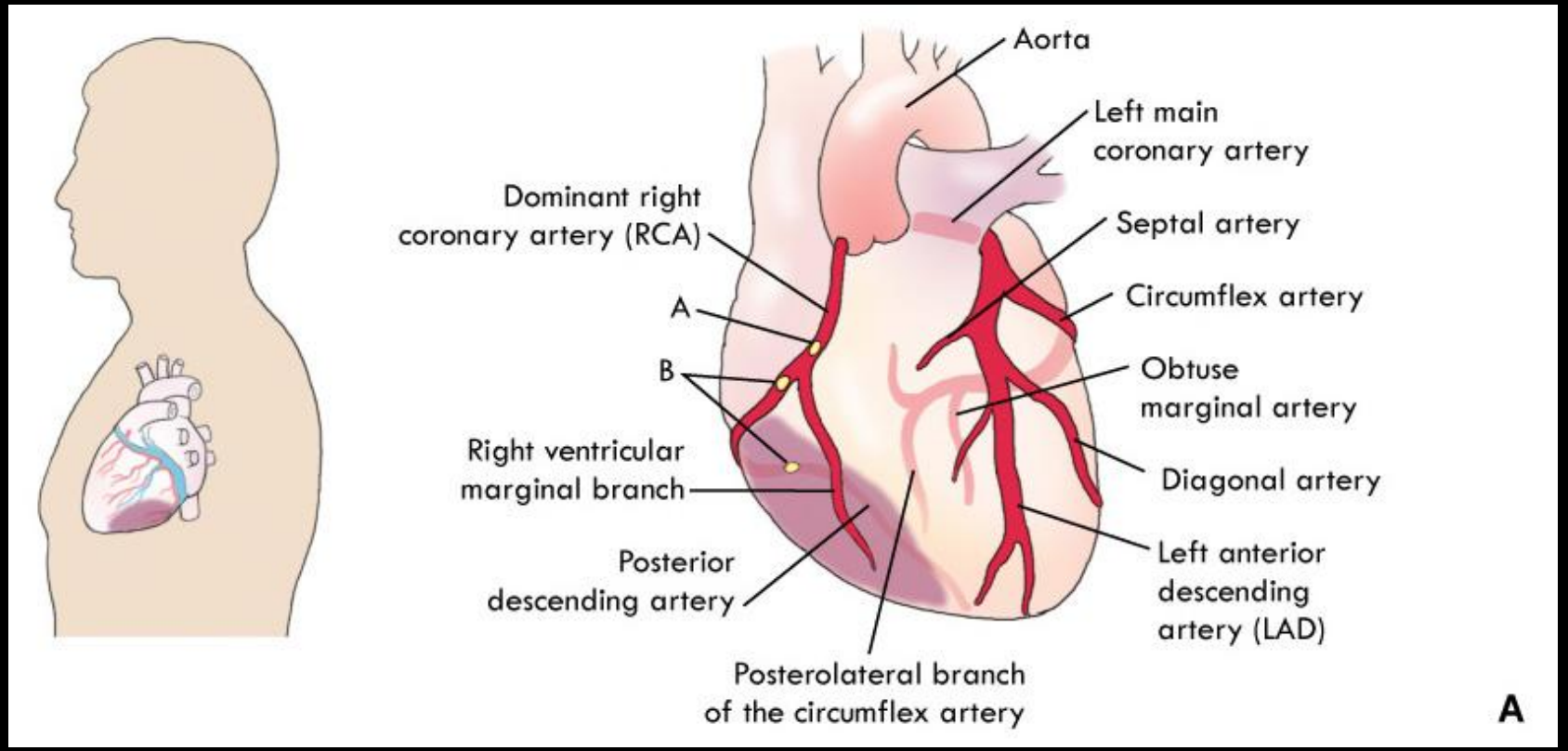
Left: At admission, hyperacute phase is reflected by ST-segment elevation

Middle: At 24 hours

Right: At 48 hours, pathologic Q waves



Inferior Wall MI (IWMI)



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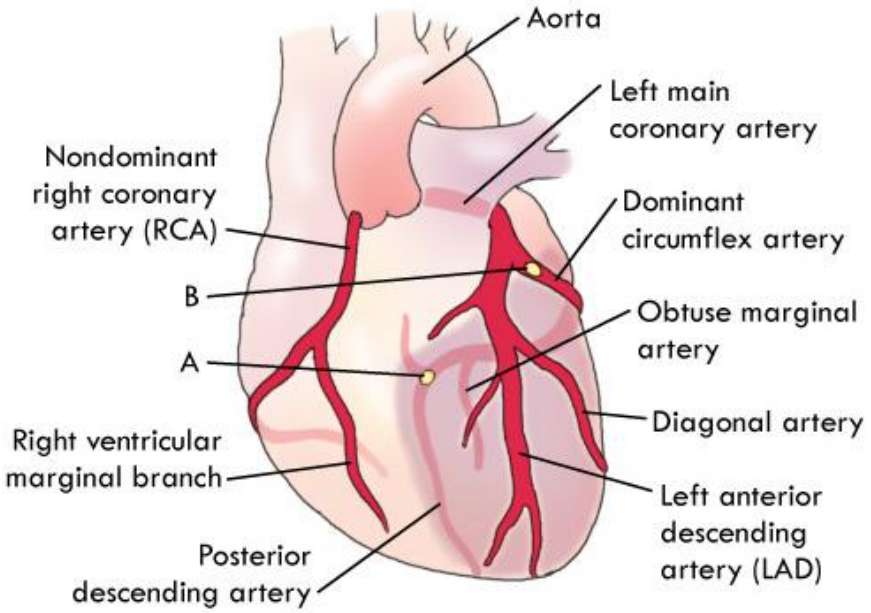

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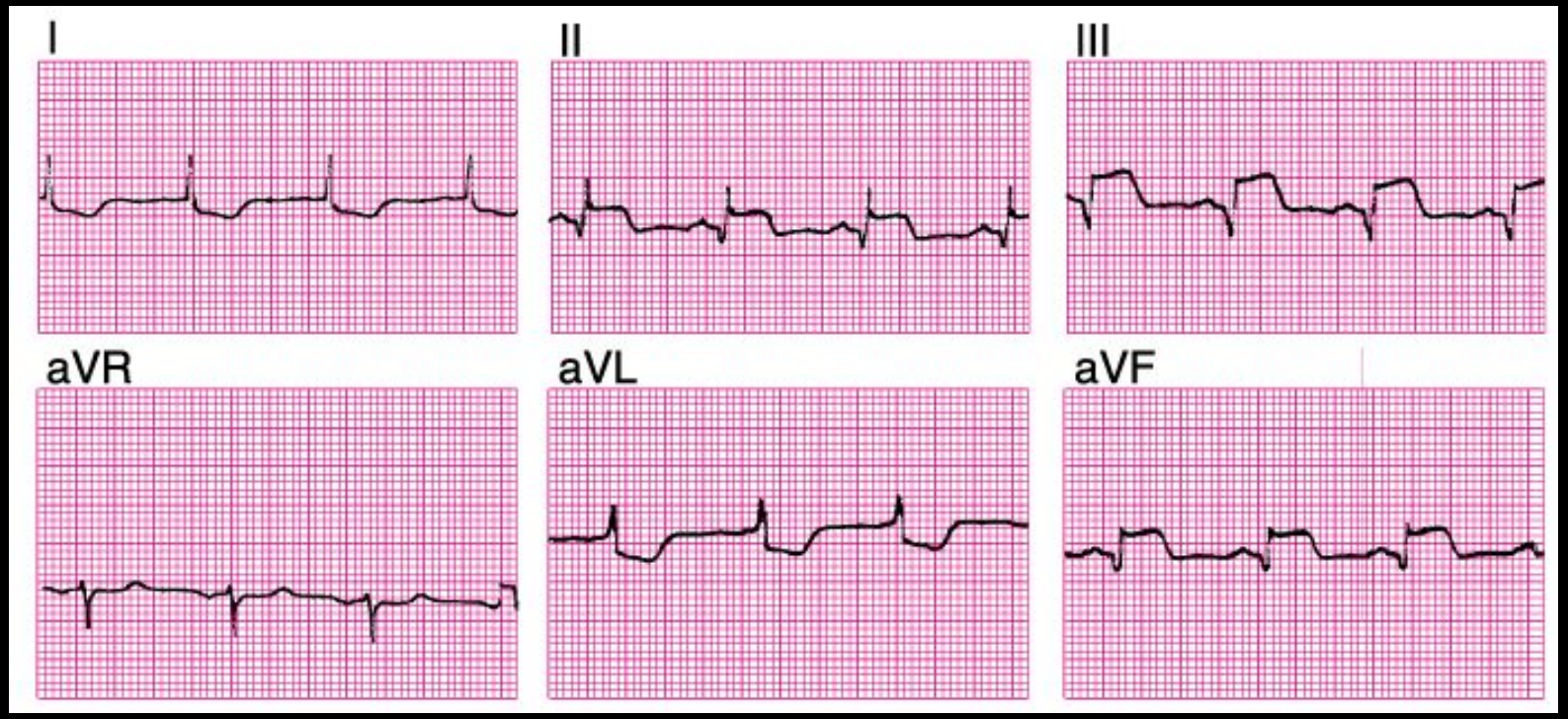
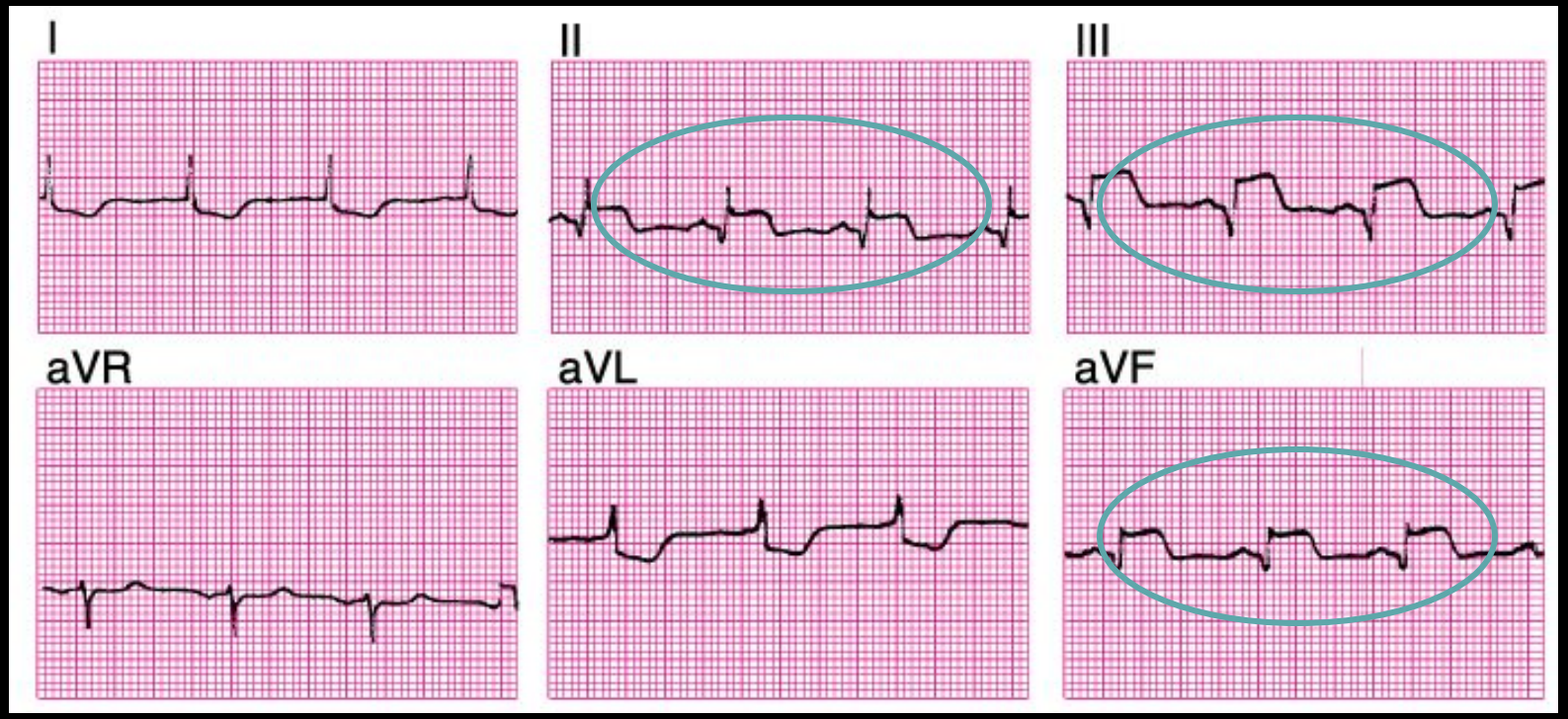
Inferior Wall MI (IWMI)

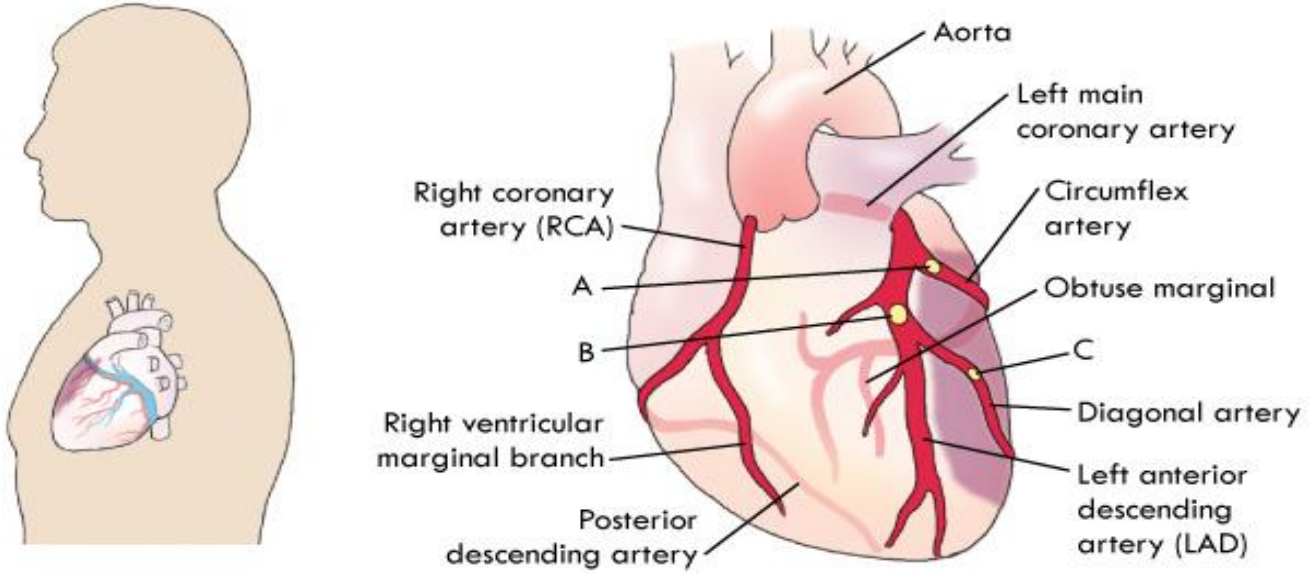


Inferior Wall MI (IWMI)



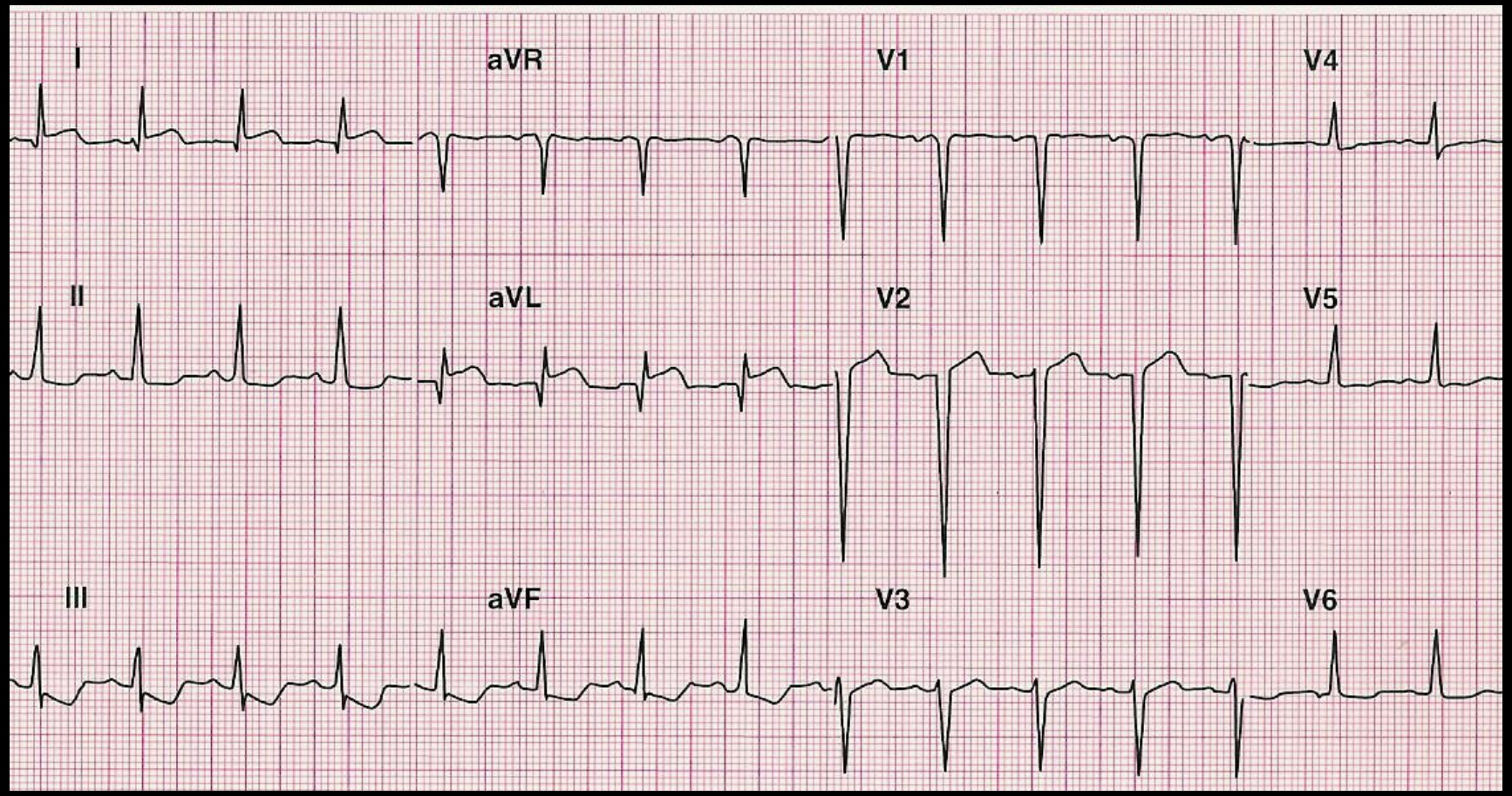
Lateral Wall MI (LWMI)

Leads I, aVL, V_5, and V_6 view the lateral wall

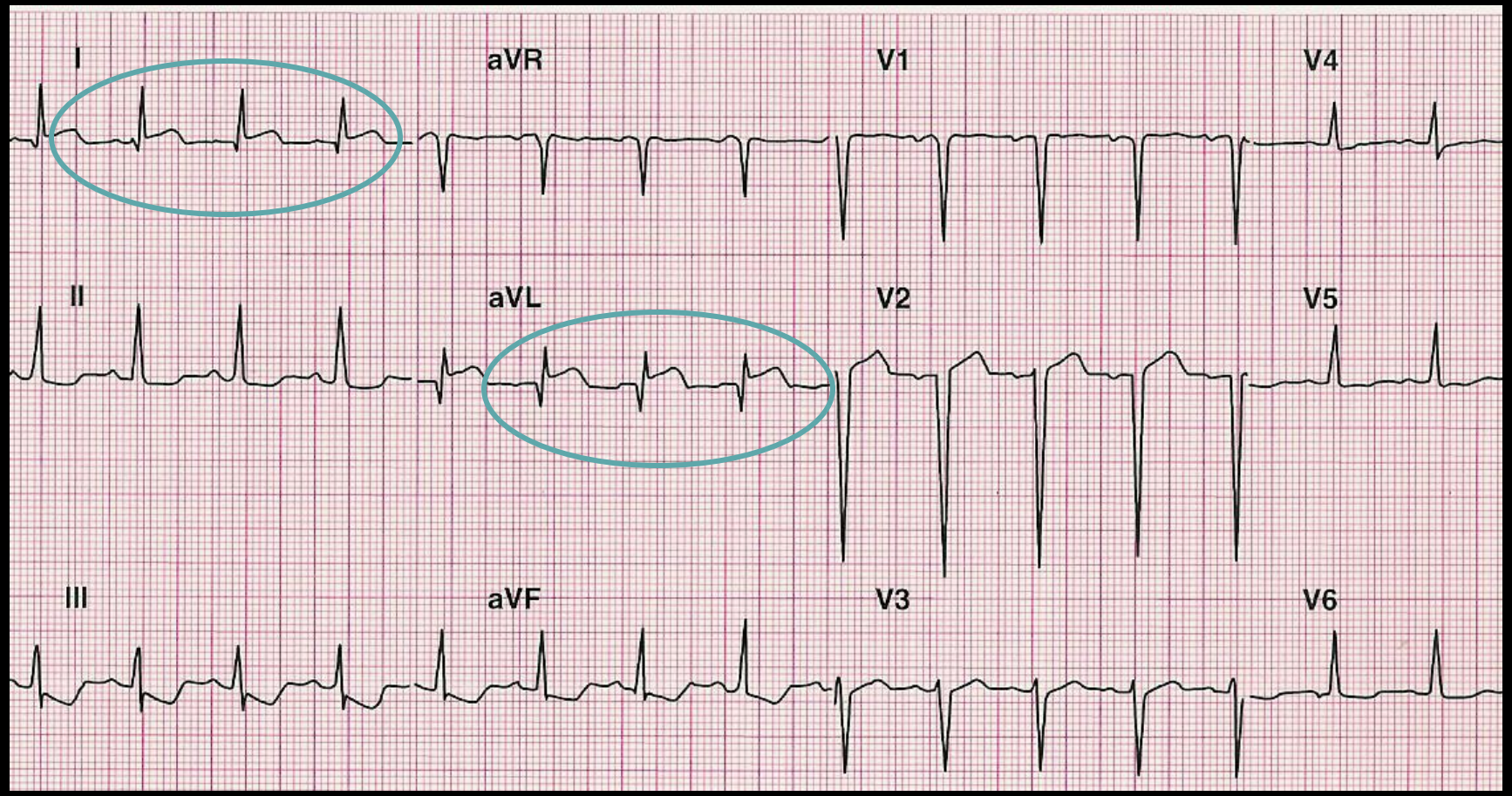


I Lateral	aVR	V_1 Septum	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septum	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

Lateral Wall MI (LWMI)

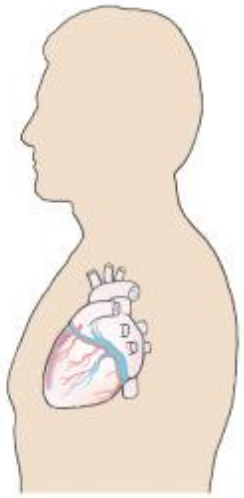


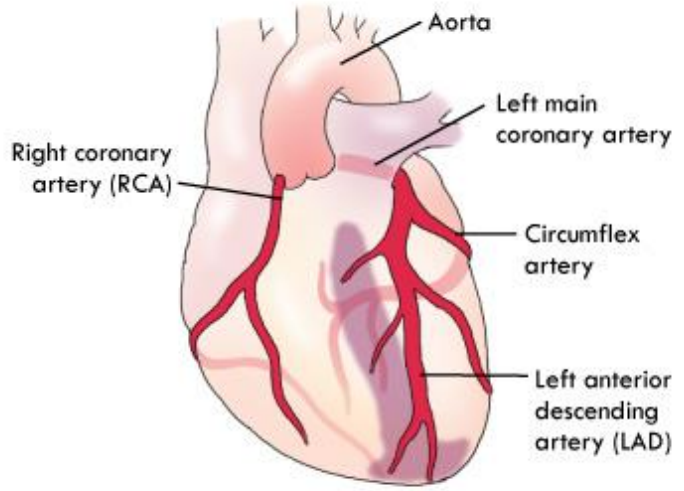
Lateral Wall MI (LWMI)



Septal MI

Leads V_1 and V_2 face the septal area of the left ventricle.





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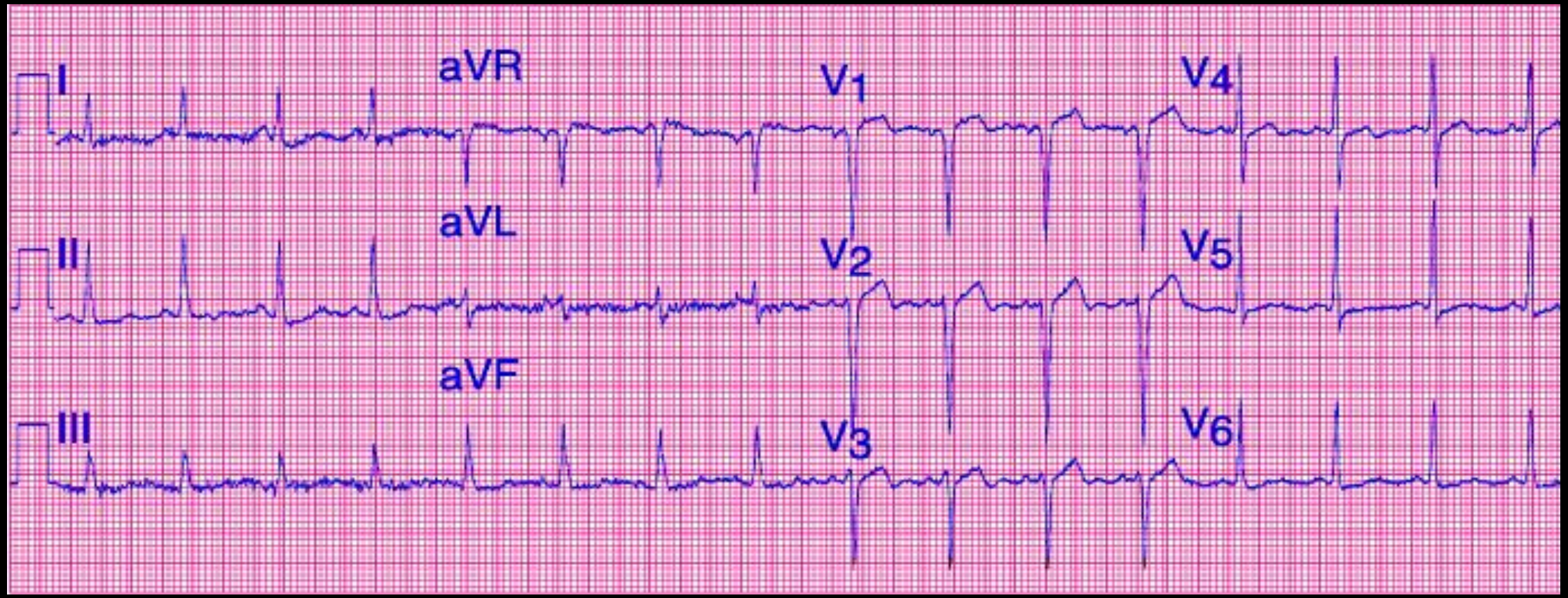
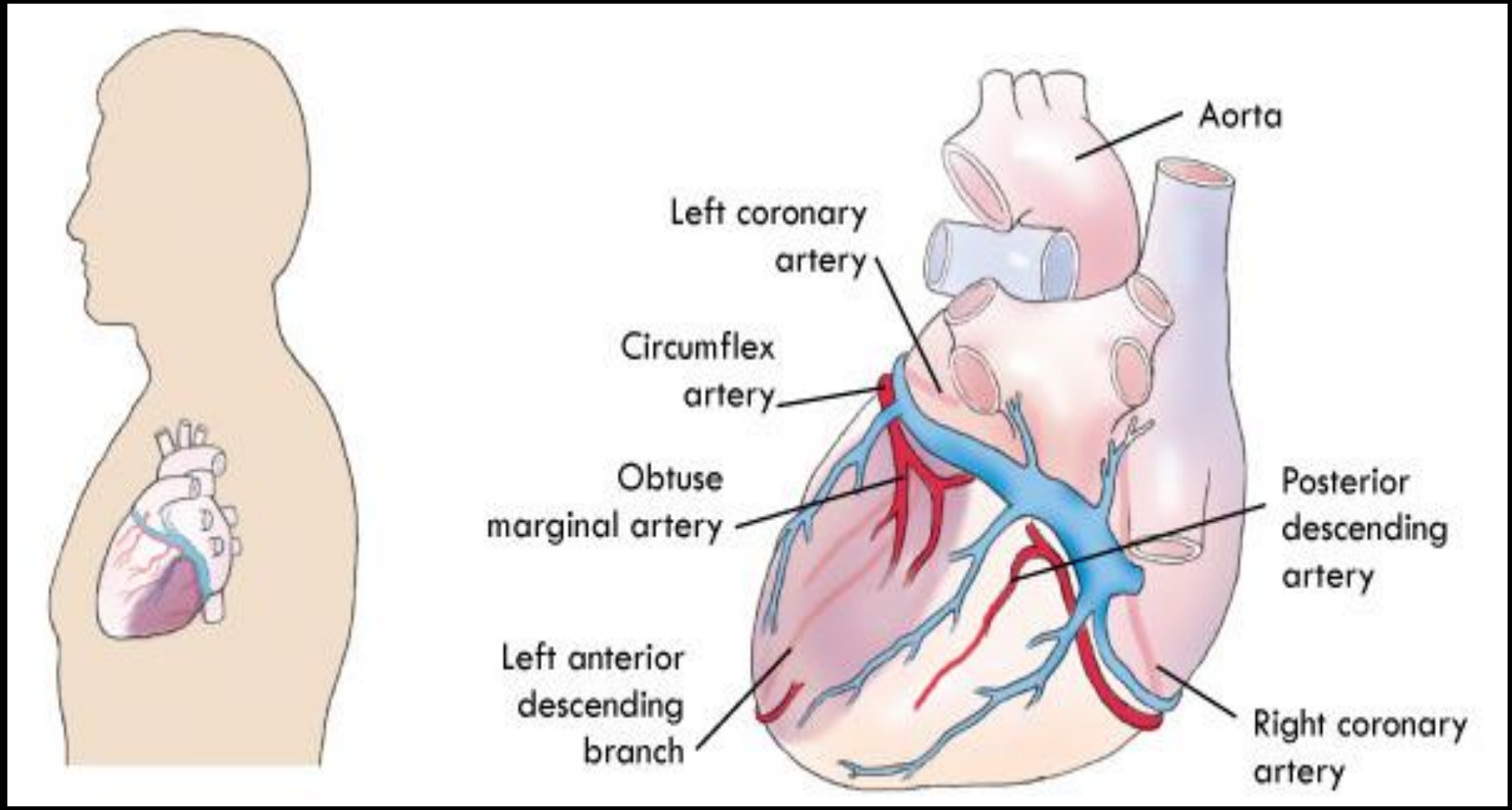
II Inferior	aVL Lateral	V_2 Septum	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

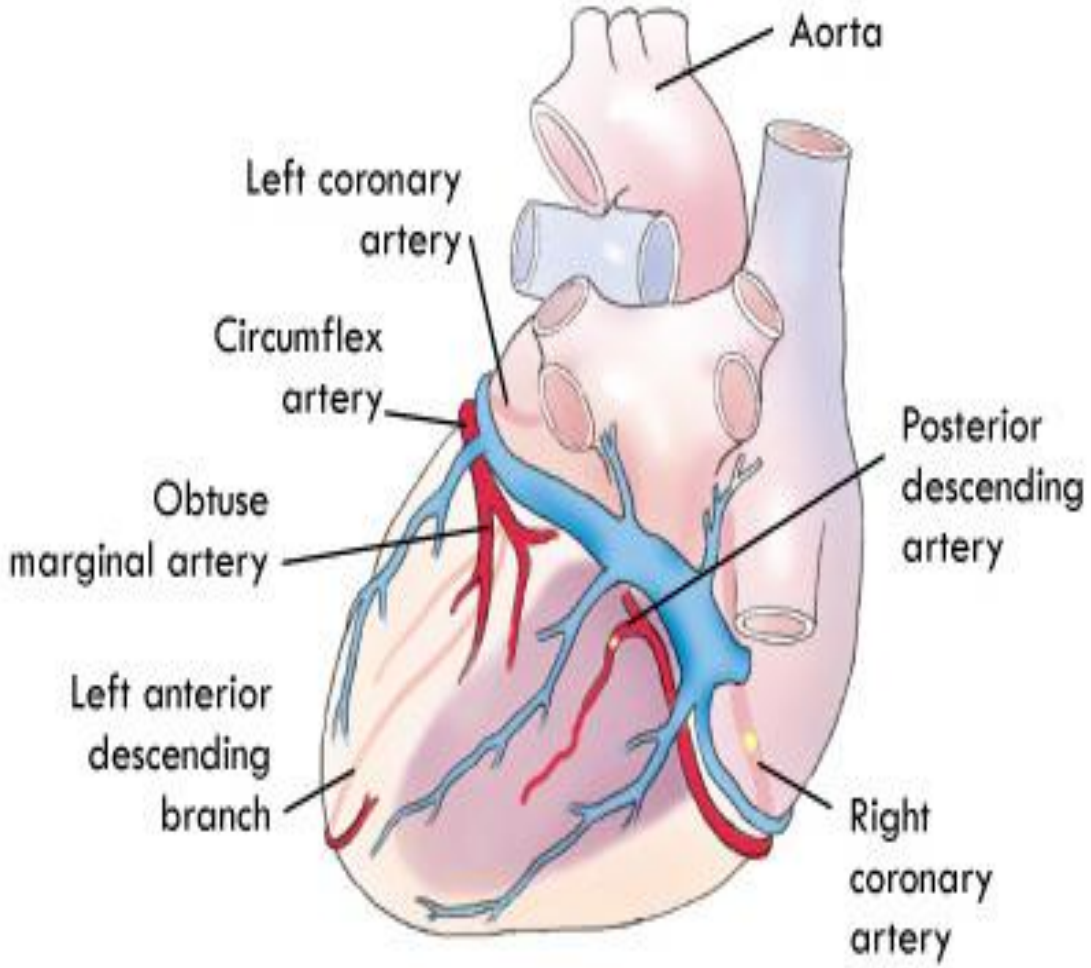
Septal Infarction
Poor R-wave Progression



Posterior MI

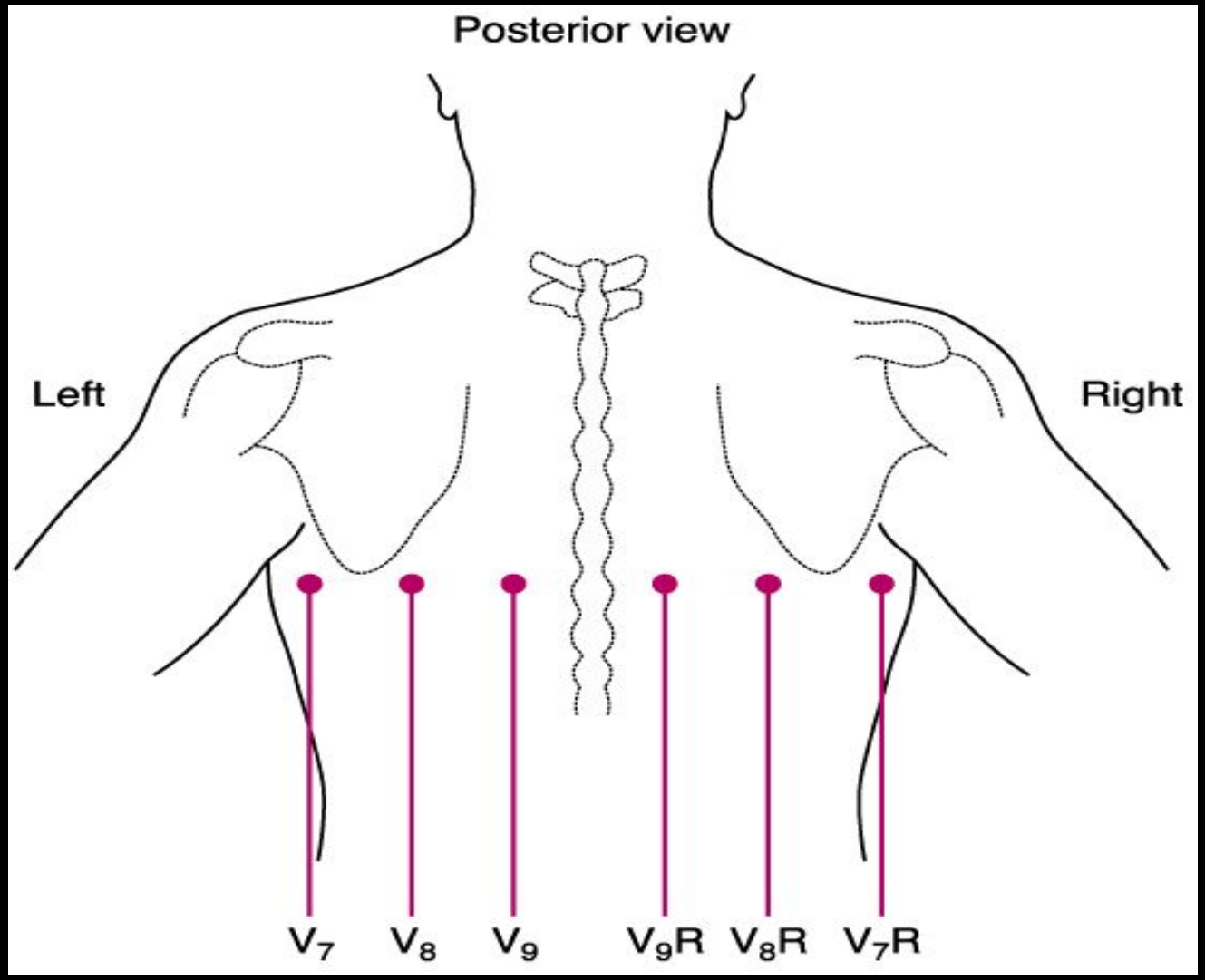


Posterior MI



I Lateral	aVR	V_1 Septum	V_4 Anterior	V_7 Posterior
II Inferior	aVL Lateral	V_2 Septum	V_5 Lateral	V_8 Posterior
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral	V_9 Posterior

Posterior Chest Lead Placement



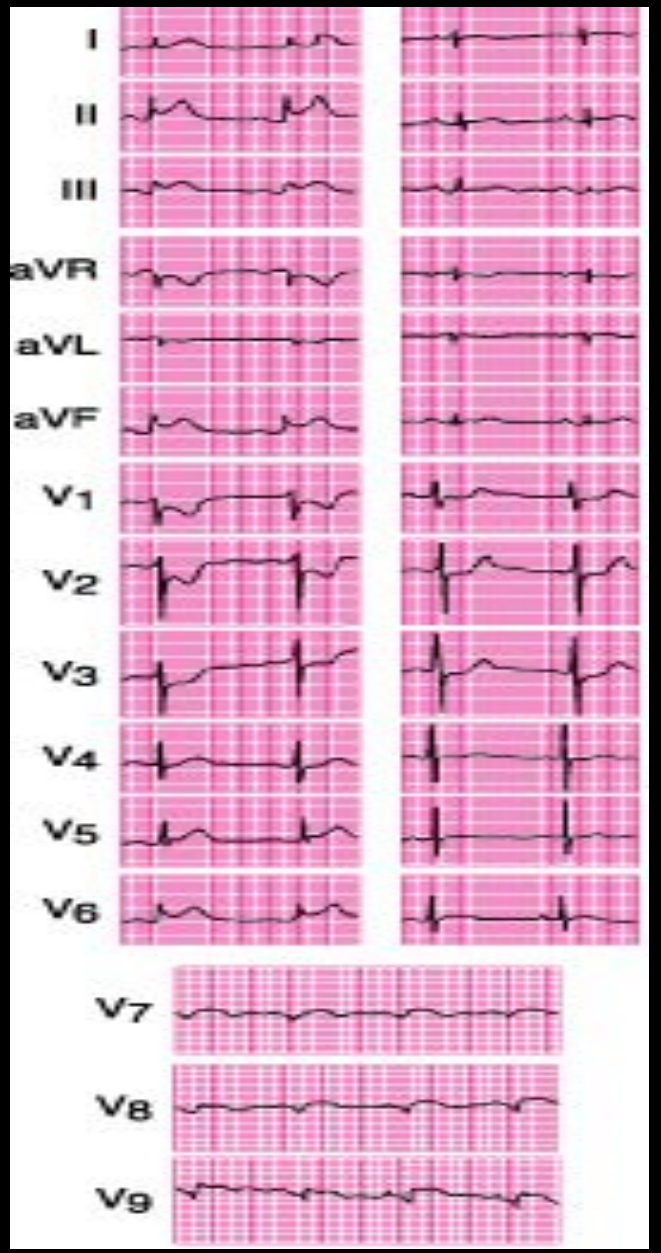
Posterior Infarction

Evolutionary changes in inferior and posterior MI

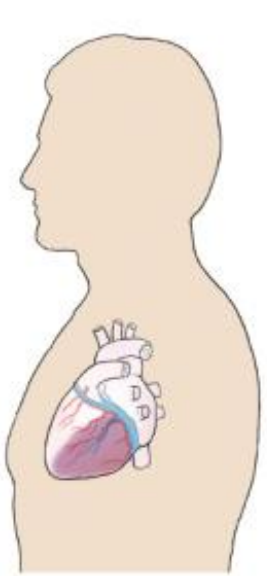
Left: Acute inferior and apical injury

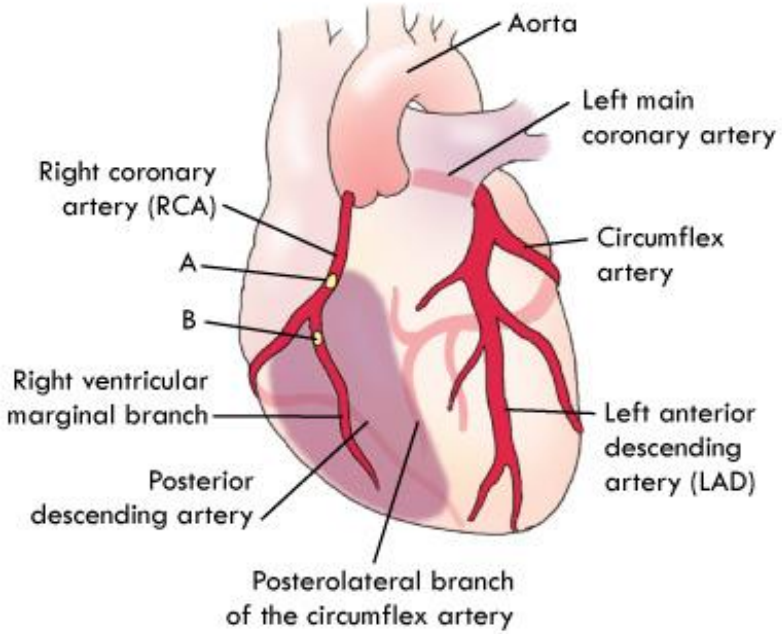
Right: At 24 hours: Note tall R wave in lead V_1 not present in A, suggesting posterior MI

Bottom: (V_{7-9}) Posterior infarction confirmed



Right Ventricular Infarction



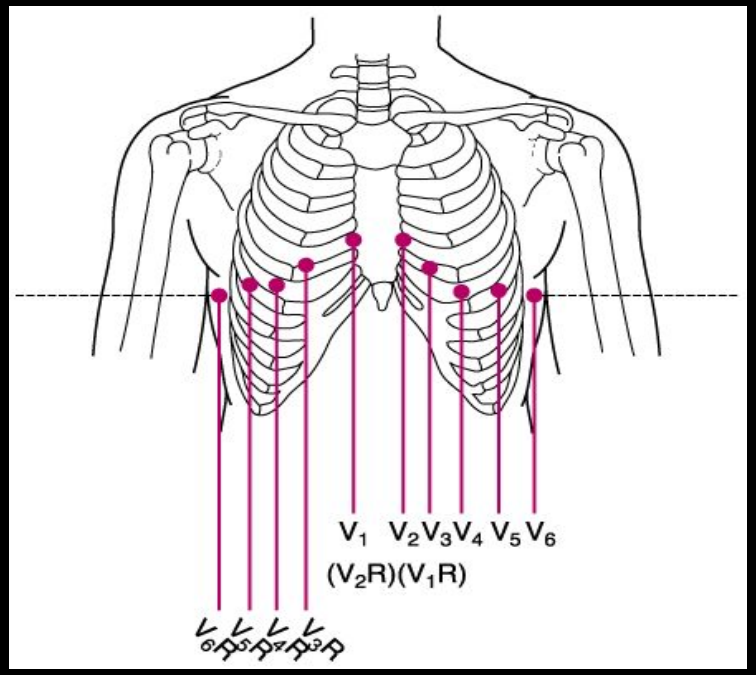


I Lateral	aVR	V_1 Septum	V_4 Anterior	V_4R Rt ventricle
II Inferior	aVL Lateral	V_2 Septum	V_5 Lateral	V_5R Rt ventricle
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral	V_6R Rt ventricle

Right Chest Leads

Right chest leads used to view right ventricle

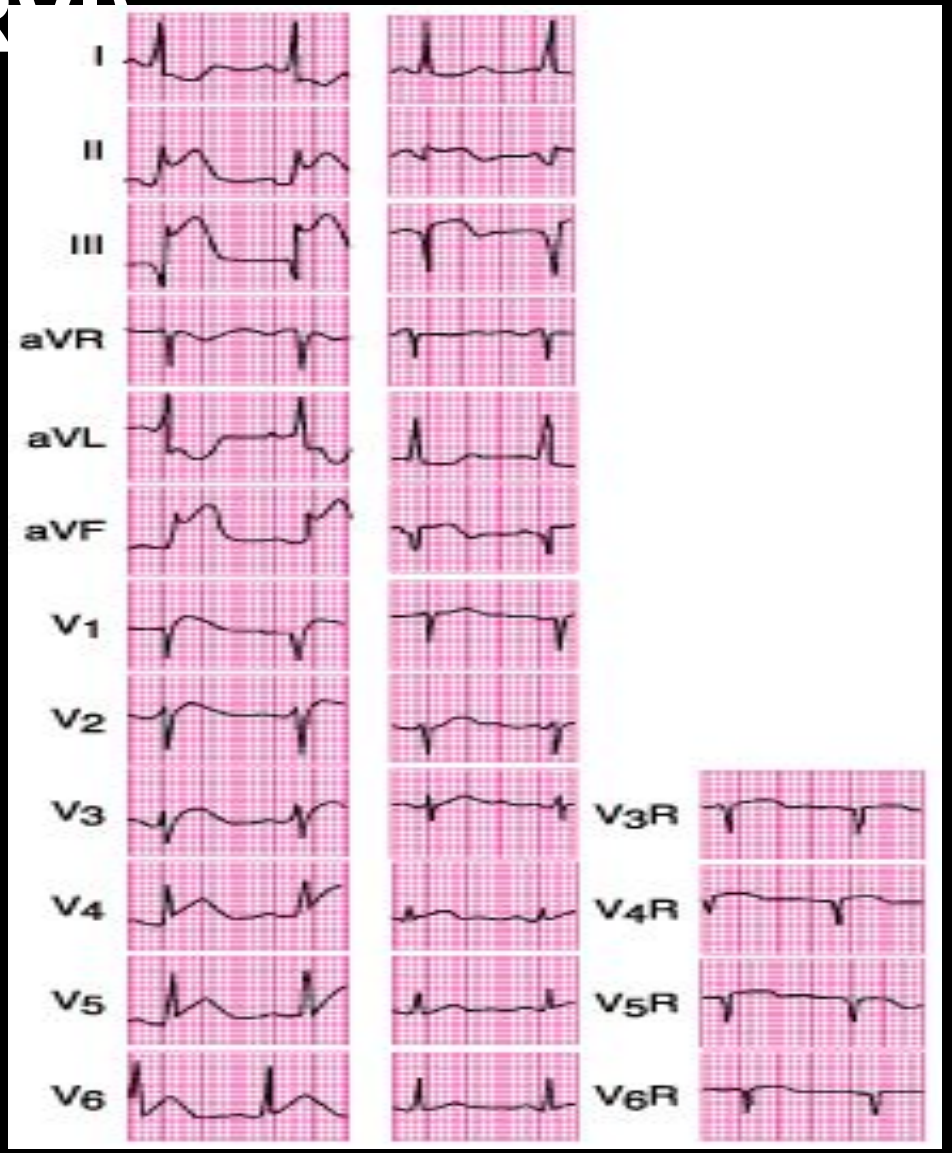
If time does not permit obtaining all of the right chest leads, V_4R is lead of choice



Right Ventricular Infarction (RVI)

Evolutionary changes in inferior and right ventricular infarction

- Left – At admission – acute phase
- Middle – At 12 hours
- Right – Right chest leads showing RVI



Right Ventricular Infarction (RVI)

Clinical triad of RVI:

- Hypotension
- Jugular venous distention
- Clear breath sounds

Only 10-15% of patients with RVI present with these signs and symptoms