Section 3

Axis Determination

Objectives

- At the conclusion of this presentation the participant will be able to
  - Outline a systematic approach to 12 lead ECG interpretation
  - Dysrhythmias
  - **Demonstrate the process for determining axis**
  - List criteria for LVH, RVH, RAE, LAE LBBB, RBBB, Bifasicular and trifasicular block, acute and chronic MI changes
  - Define QTc significance and other EKG Abnormalities

Objectives

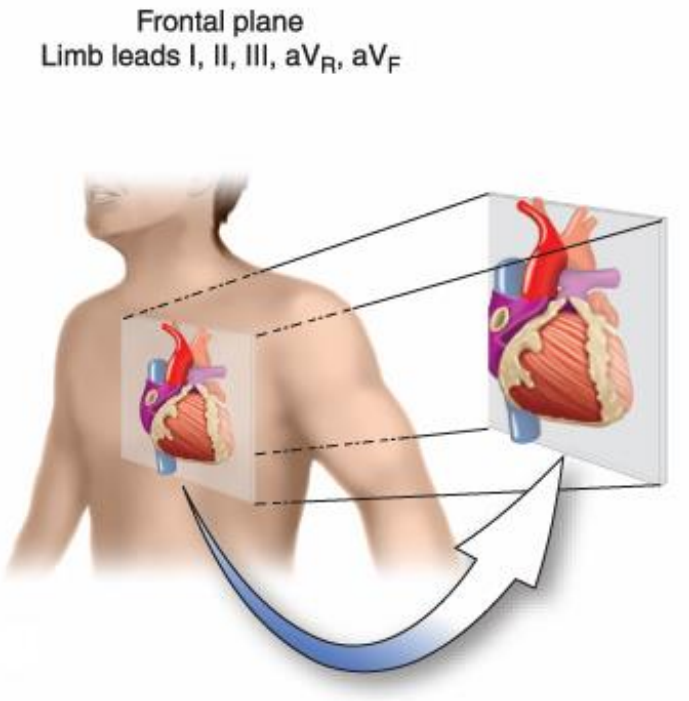
- At the conclusion of this presentation the participant will be able to
  - Outline a systematic approach to 12 lead ECG interpretation
  - Demonstrate the process for determining axis
  - List criteria for LVH, RVH, LBBB, RBBB, Bifasicular and trifasicular block, acute and chronic MI changes
  - Define QTc significance

ECG Lead System

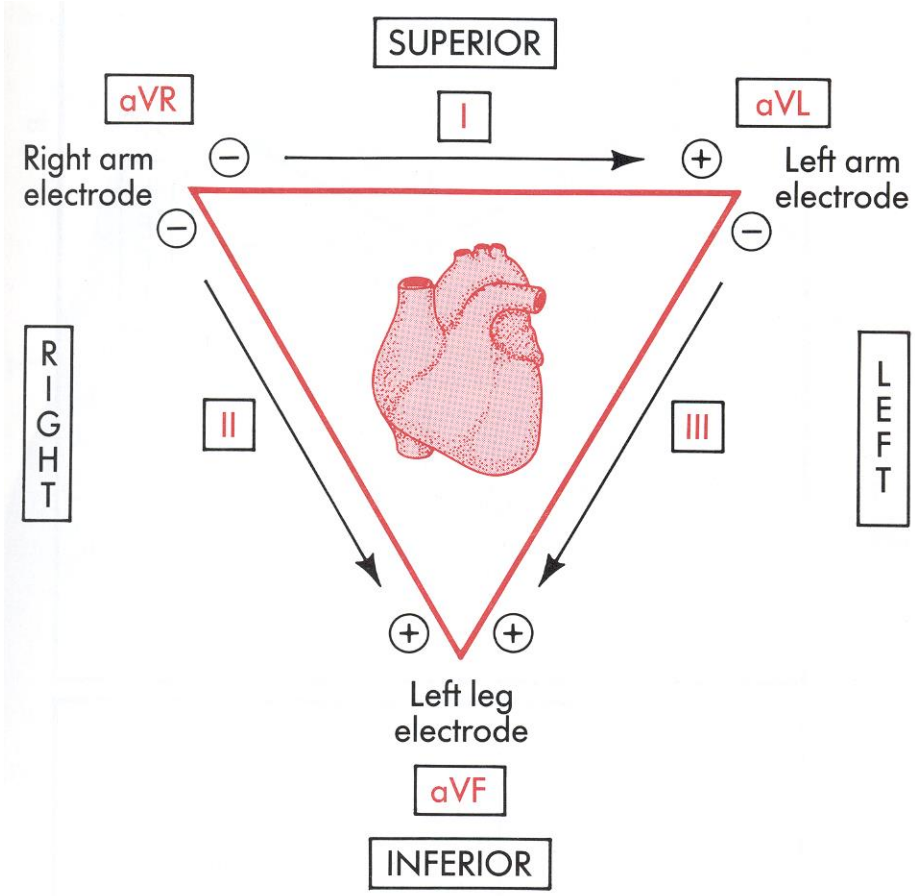
- Standard 12 lead system
  Six limb leads or frontal leads
  Six precordial leads or horizontal leads
  (R wave Progression)
- Additional leads: 18 leads
  Posterior leads
  Right sided leads
- A point of view
  Depolarization towards that lead or the action potential

Limb Leads

- View the frontal plane
- Include leads I, II, III, aV_R, aV_L and aV_F
- Provide inferior, superior, and lateral views of heart

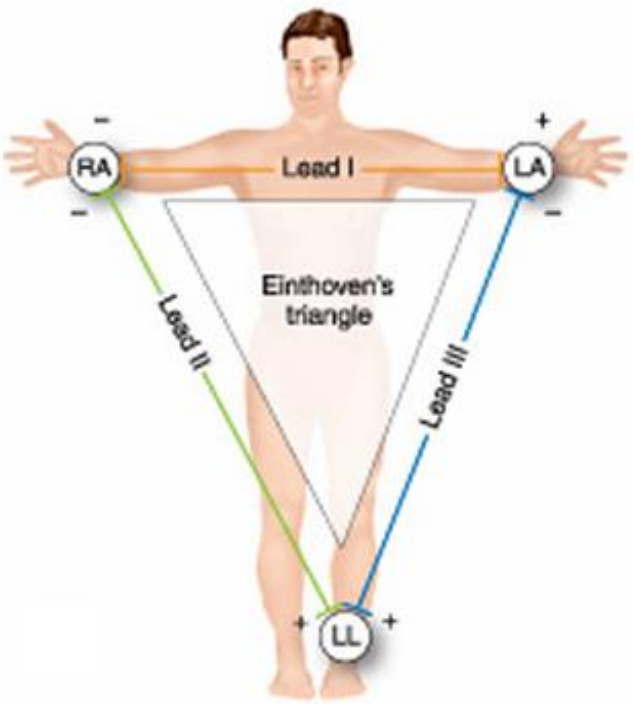


Frontal Leads



Bipolar Leads

- Record difference in electrical potential between a positive and negative electrode
- Uses a third electrode called a ground
- Include leads I, II and III



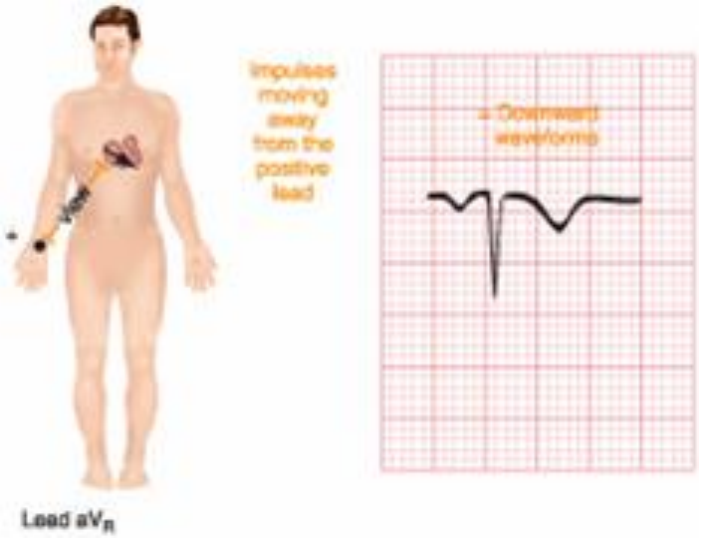
I

Limb Leads - Augmented Leads

- Includes aV_R, aV_L and aV_F
- Unipolar
- Enhanced by ECG machine because waveforms produced by these leads are normally small

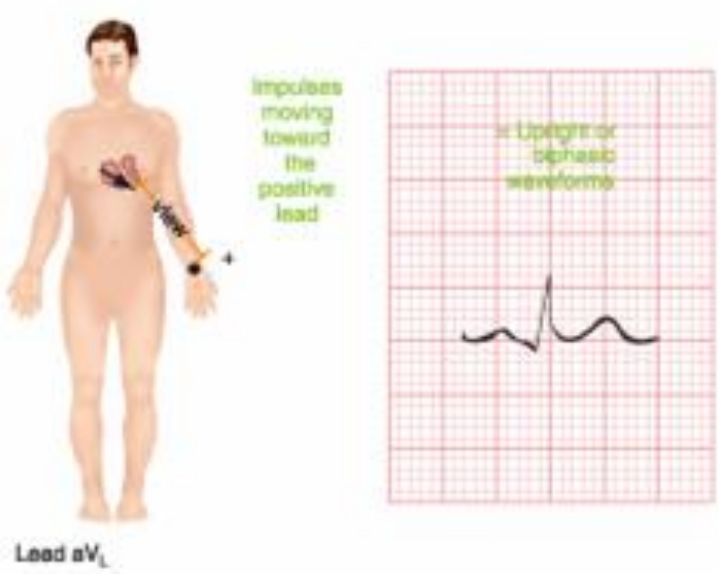
I

Limb Leads - Lead aV_R



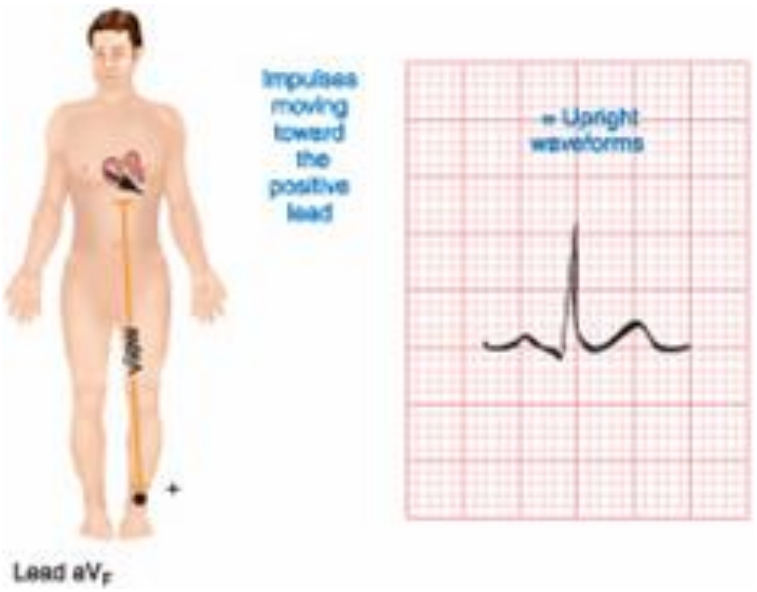
- Positive electrode placed on right arm
- Waveforms have negative deflection

Limb Leads - Lead aV_L



- Positive electrode placed on left arm
- Waveforms have positive deflection

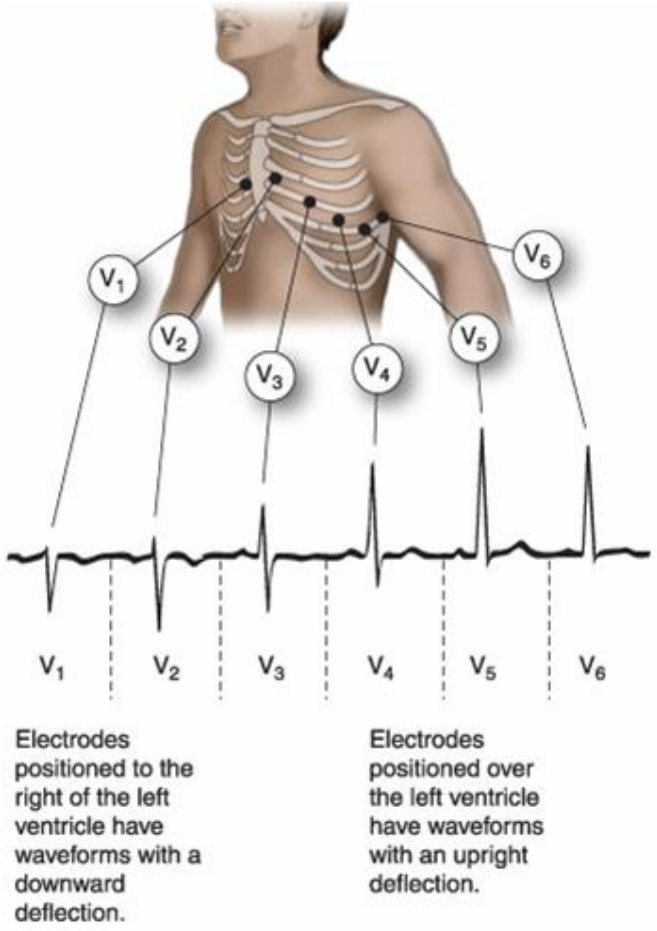
Limb Leads - Lead aV_F



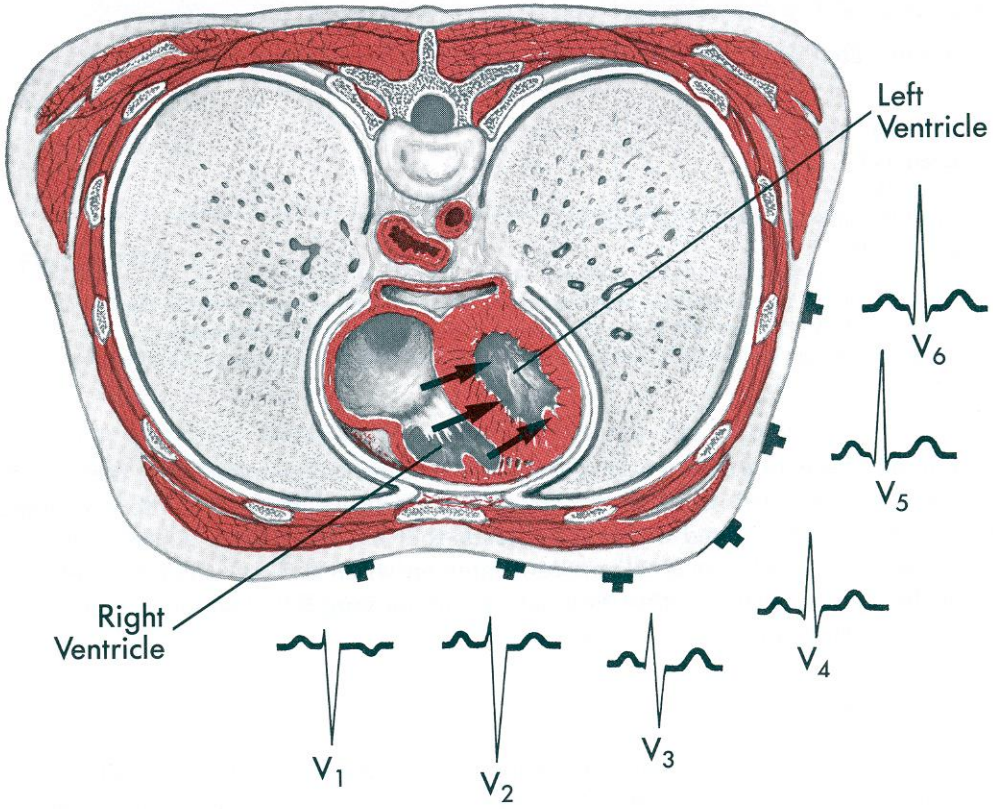
- Positive electrode located on left leg
- Waveforms have a positive deflection

Precordial Leads

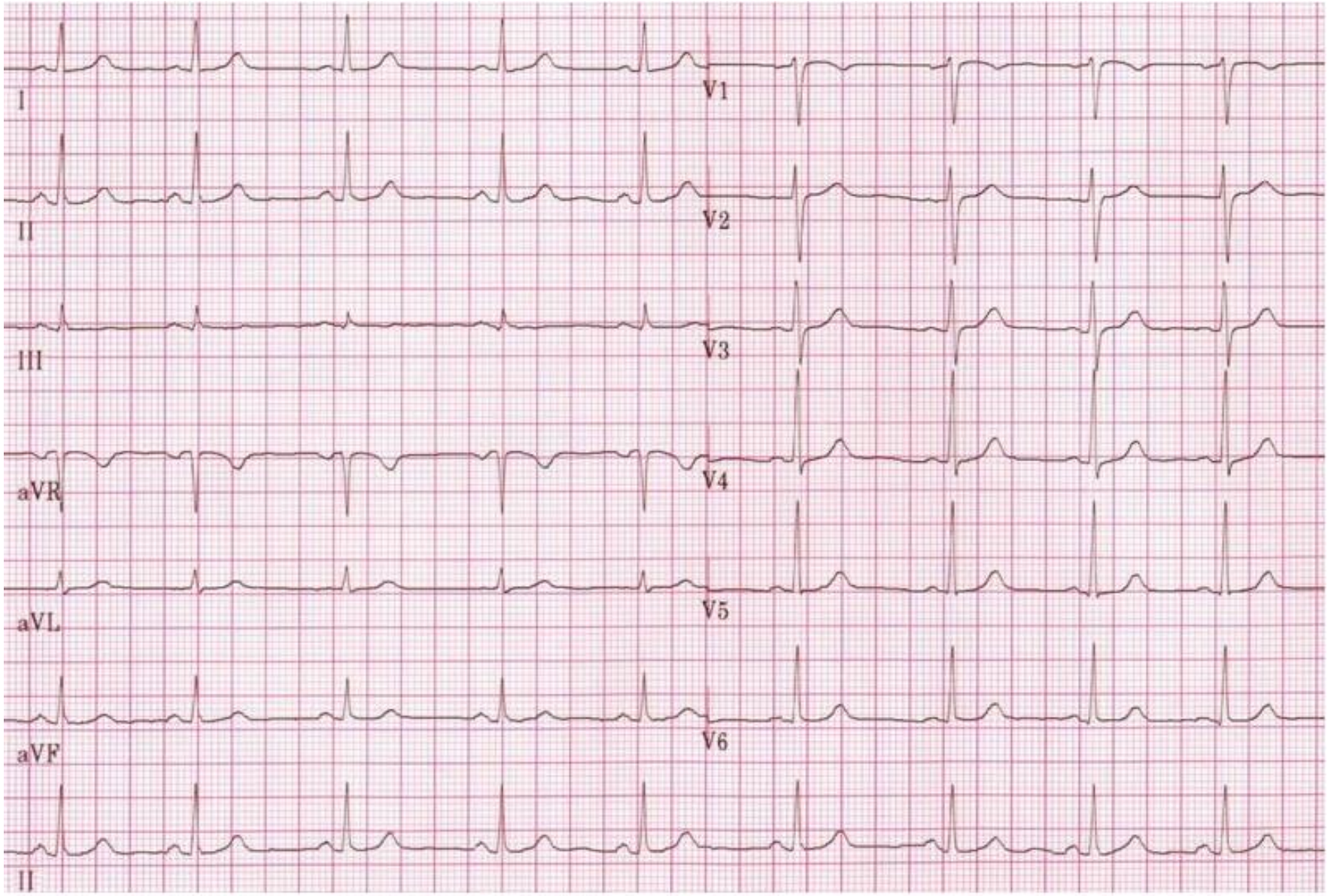
- Includes leads V_1, V_2, V_3, V_4, V_5 and V_6
- Positioned in order across the chest
- Unipolar
  - Opposing pole is center of heart as calculated by ECG



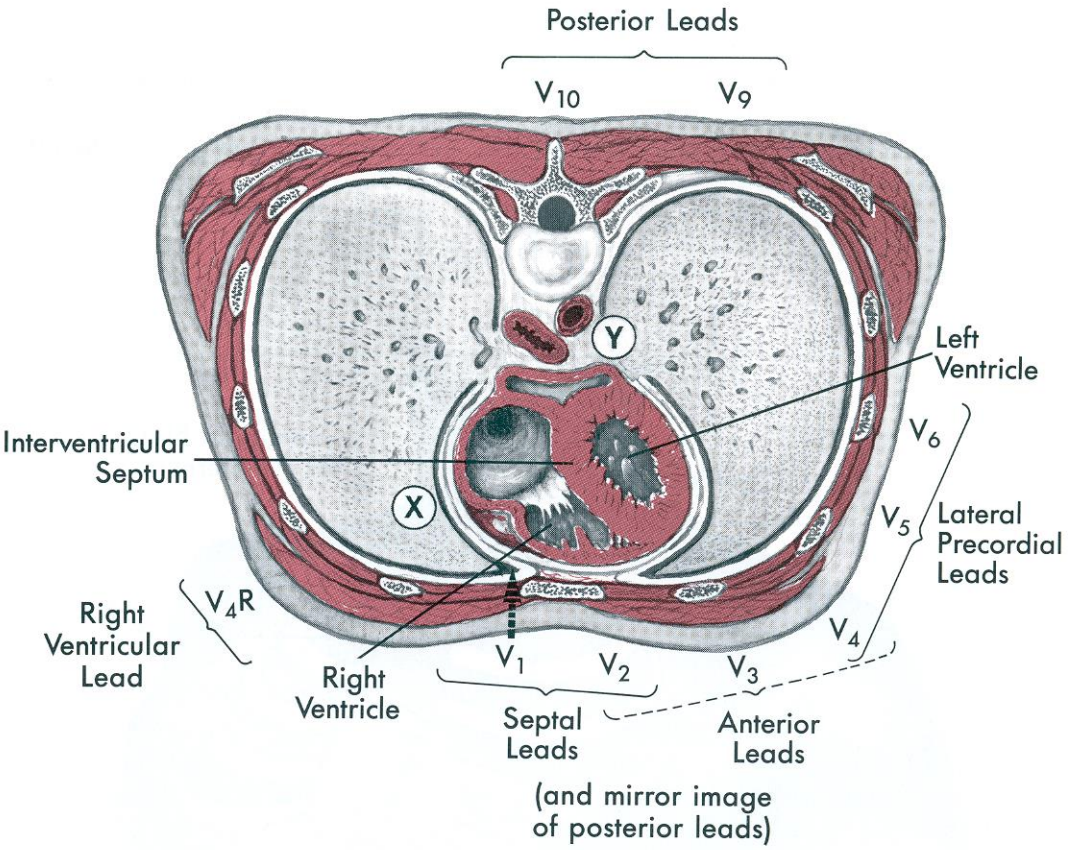
Precordial or Horizontal leads



Normal Sinus Rhythm

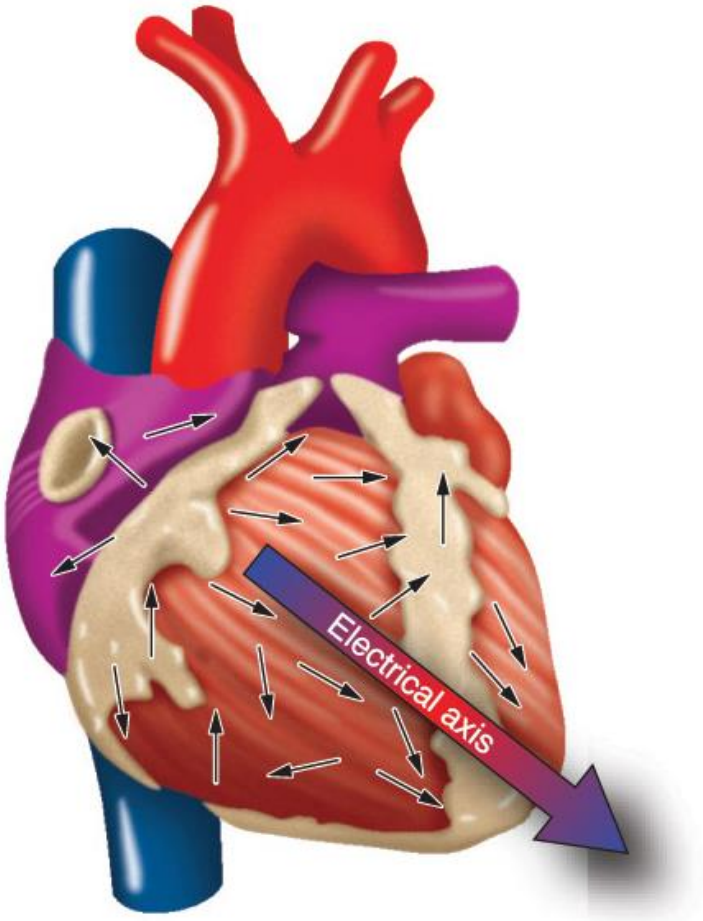


Additional Leads



Mean Electrical Axis

- Direction of the mean vector called the *mean electrical axis*
- Axis is defined in the frontal plane only



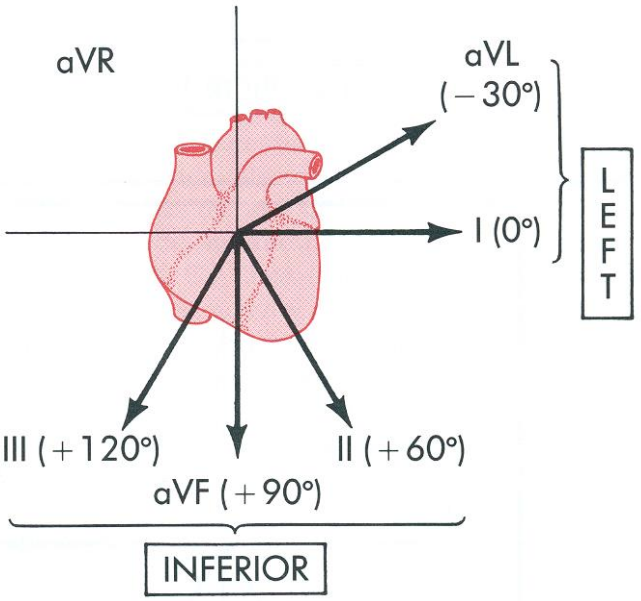
Ventricular Depolarization and Mean QRS Axis

- Interventricular septum depolarization represents the first cardiac vector associated with ventricular depolarization
- A sequence of vectors is produced as the Purkinje fibers carry the impulse from the endocardial lining of the RV and LV through the ventricular wall toward the epicardium

Position of the Mean QRS Axis

- Limb leads provide information about the frontal plane and are used to determine the position of the mean QRS axis
- Described in degrees within an imaginary circle drawn over the patient's chest

Vectors of Limb Leads



12 Lead Point of View

- 12 lead records electrical activity between two points.

- There are two types of leads:

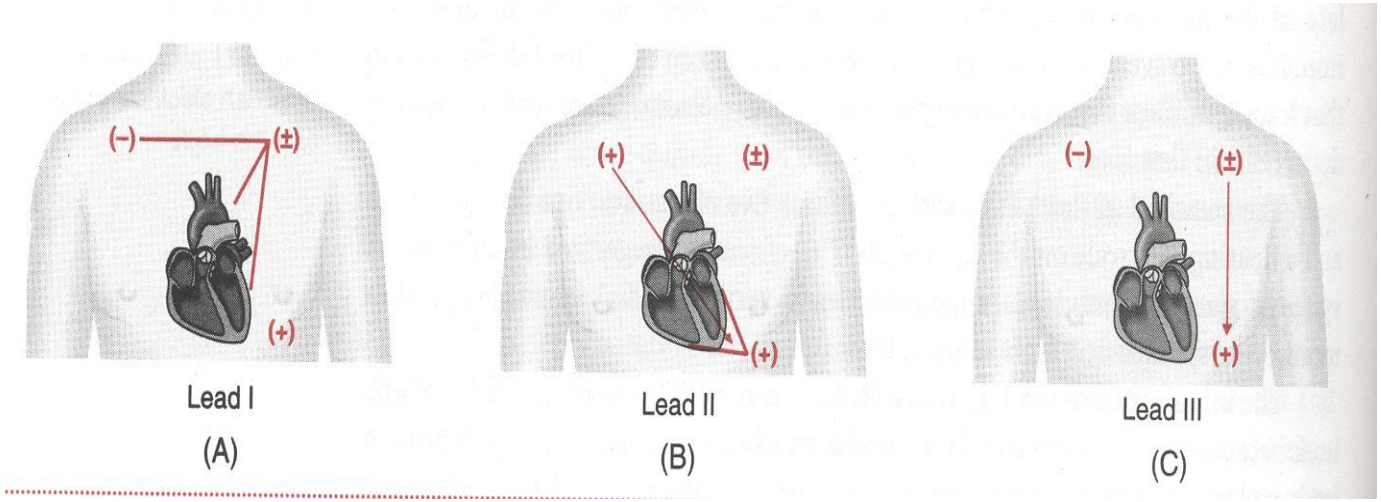
  Bipolar: Negative and positive lead (limb leads).

  Unipolar: Positive lead and neutral reference point (all other leads).

ECG Lead System

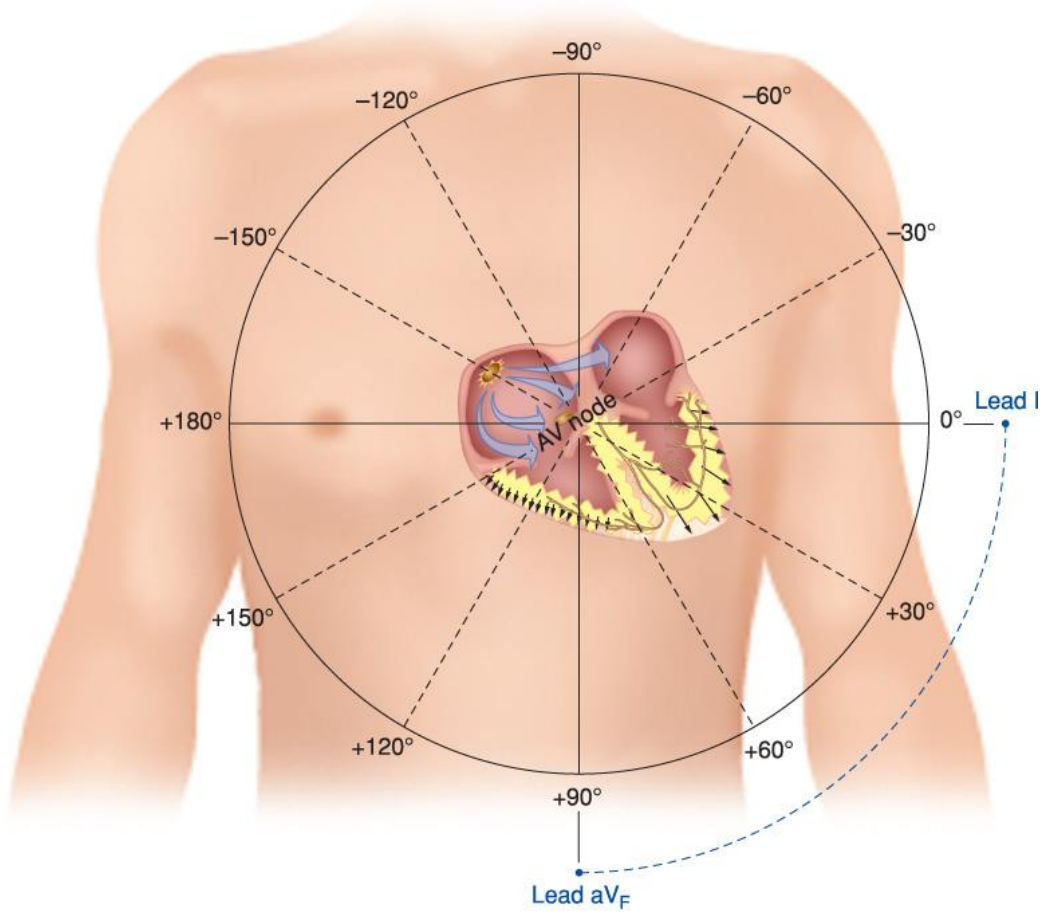
- Limb leads and Axis determination
- Axis: where the cardiac vector is headed
- Made up from the Einthoven triangle and bipolar standard limb leads

Limb Lead Vectors

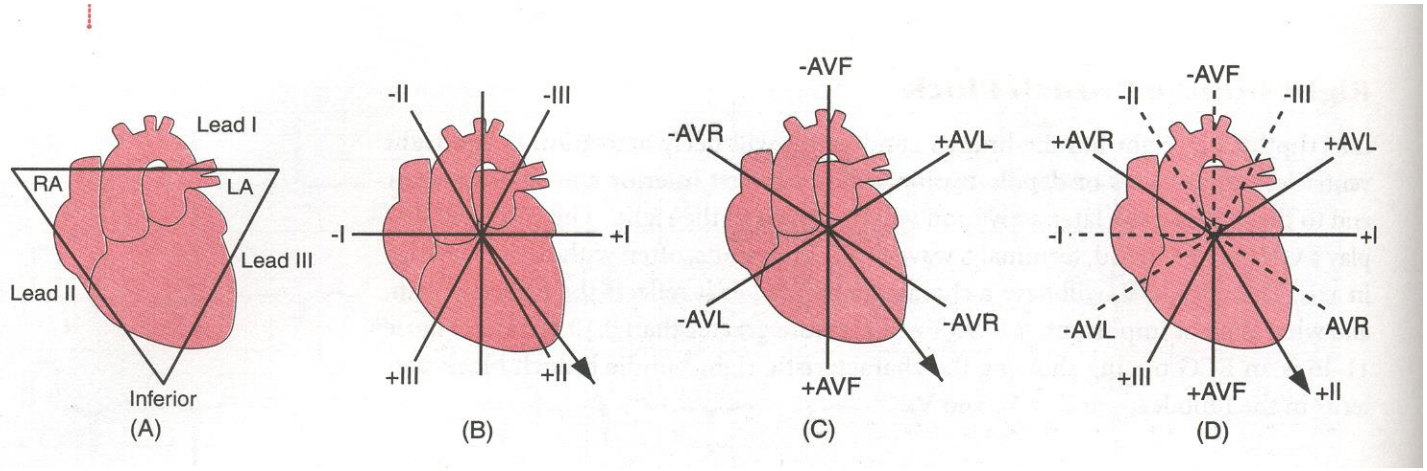


Position of the Mean QRS Axis

- AV node is center of circle
- Intersection of all lines divides circle into equal, 30-degree segments
- Lead I starts at +0 degrees and is located at the three o’ clock position
- Lead aV_F starts at +90 degrees and is located at the six o’ clock position

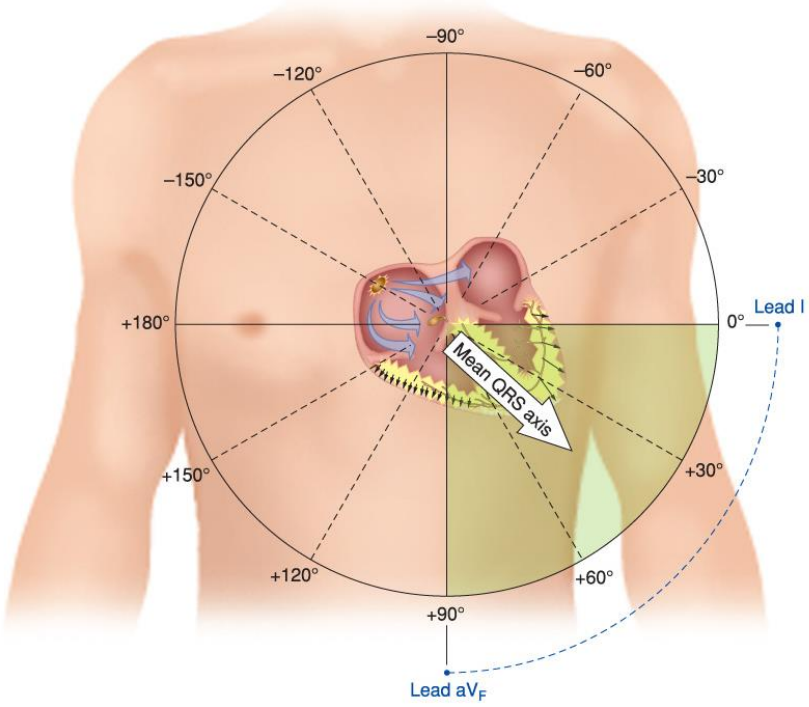

–90°
–120°
–60°
–150°
–30°
+180°
0°
Lead I
AV node
+150°
+30°
+120°
+60°
+90°
Lead aV$_F$

Einthoven's Triangle



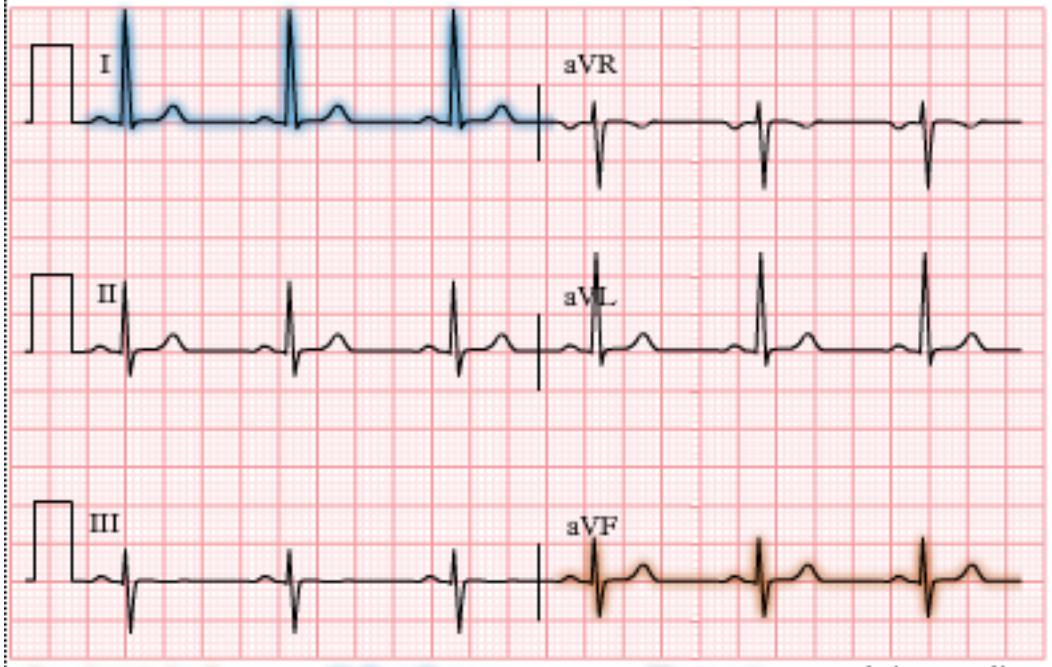
Position of the Mean QRS Axis

- Mean QRS axis normally points downward and to patient's left (between 0 and +90 degrees)

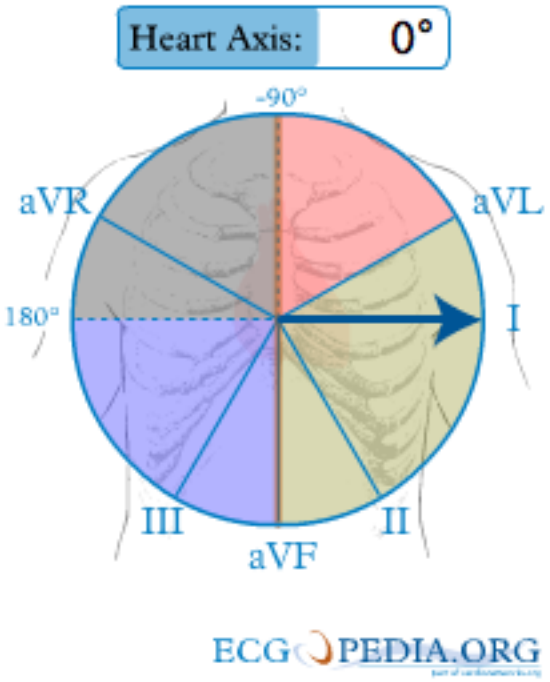


Determining Electrical Axis

- Use leads I and aV_F
  - The two leads that can best detect variations in the heart's electrical axis

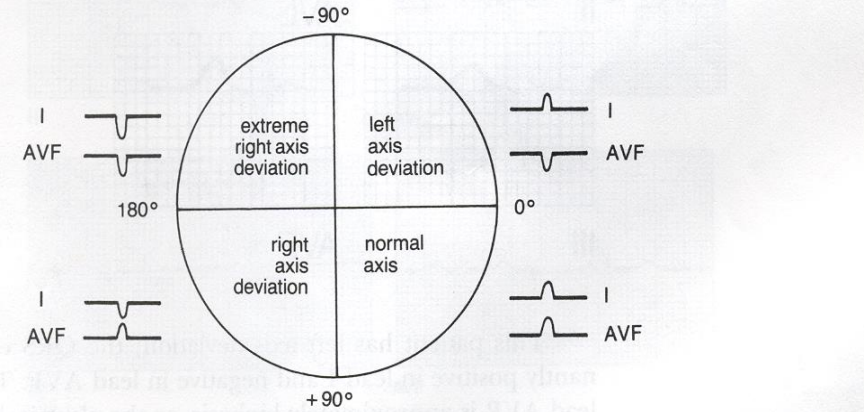


Iso-electric lead: aVF Tallest R wave: I Heart axis: normal (intermediate)

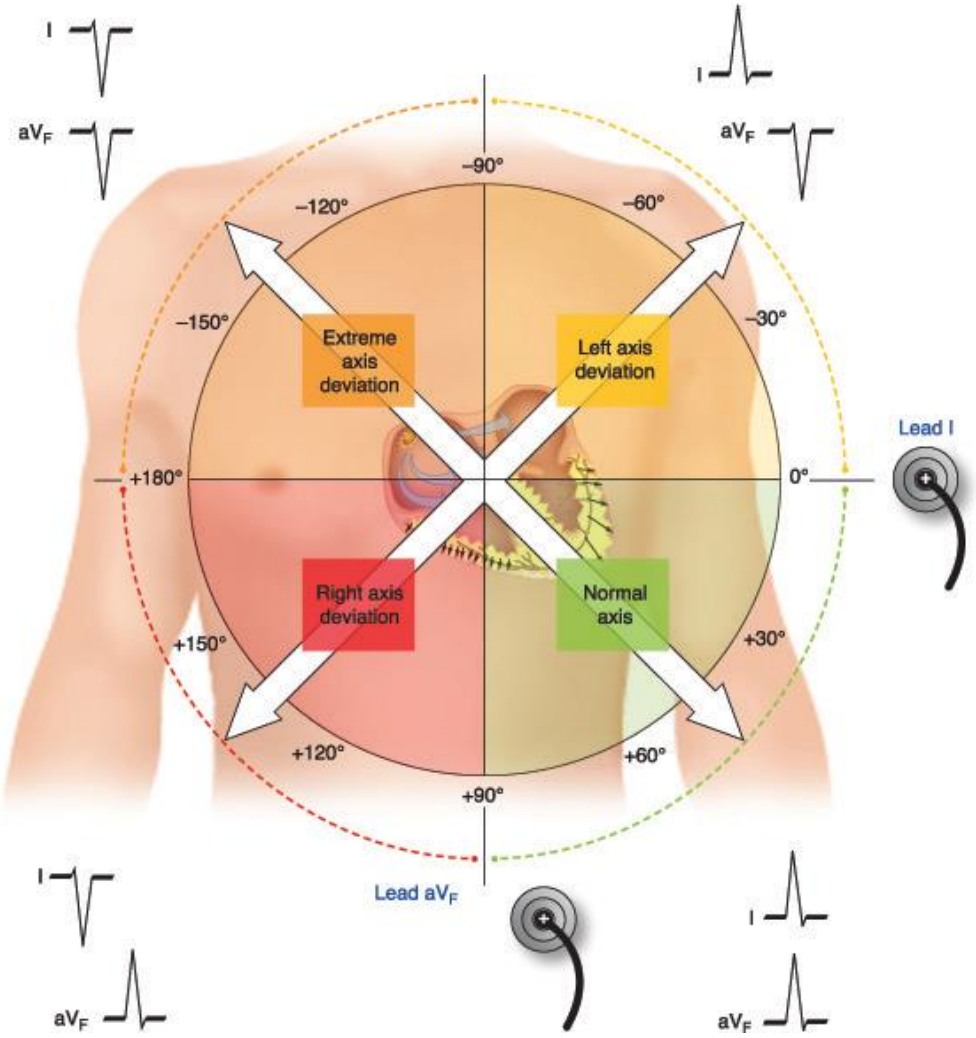


Quick Axis Determination

Axis	*Lead I*	*Lead AVF*
Normal axis	Positive	Positive
Left axis deviation	Positive	Negative
Right axis deviation	Negative	Positive
Extreme right axis deviation	Negative	Negative

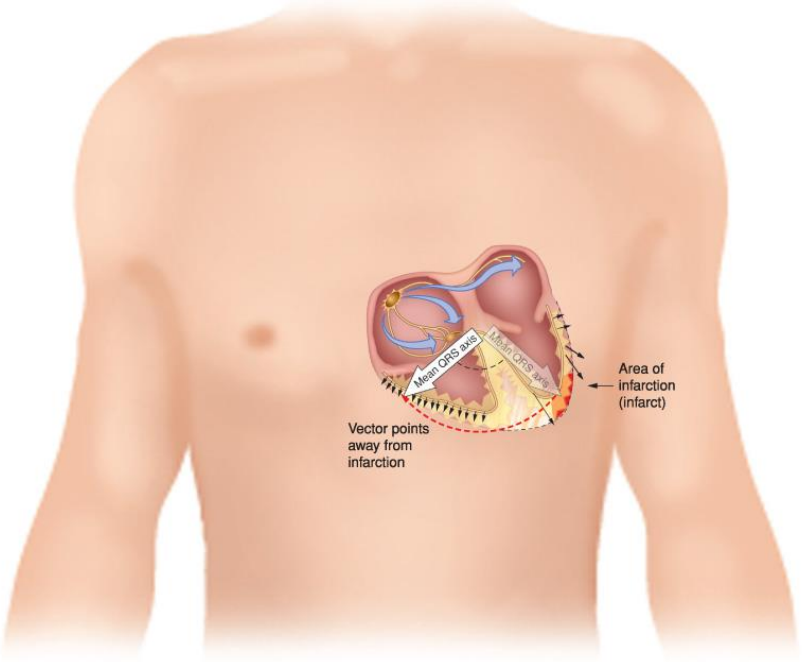


Determining Electrical Axis



Determining Electrical Axis

- Location of axis influenced by:
  - Heart's position in the chest
  - Heart size
  - Patient's body size
  - Conduction pathways
  - Force of electrical impulses being generated



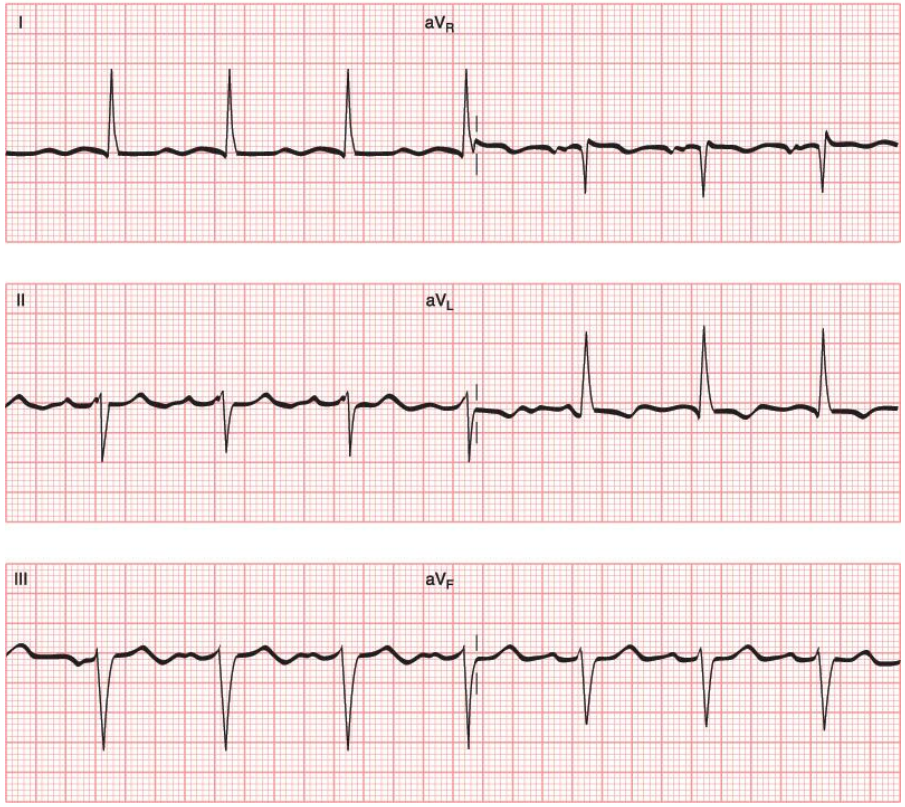
ECG

Potential causes of Axis deviation

- **Right axis deviation**
  - **Normal**
  - **RVH**
  - **Conduction disturbances**
  - **MI**
  - **Valvular Disease**
  - **Pulmonary HTN**
  - **Congenital**
  - **Pulmonary disease**
- **Left Axis deviation**
  - **Normal**
  - **LVH**
  - **Conduction disturbances**
  - **MI**
  - **Valvular Disease**
  - **Systemic HTN**
  - **Congenital**
  - **Other**

Practice Makes Perfect

- Determine if the mean QRS is normal or if there is axis deviation

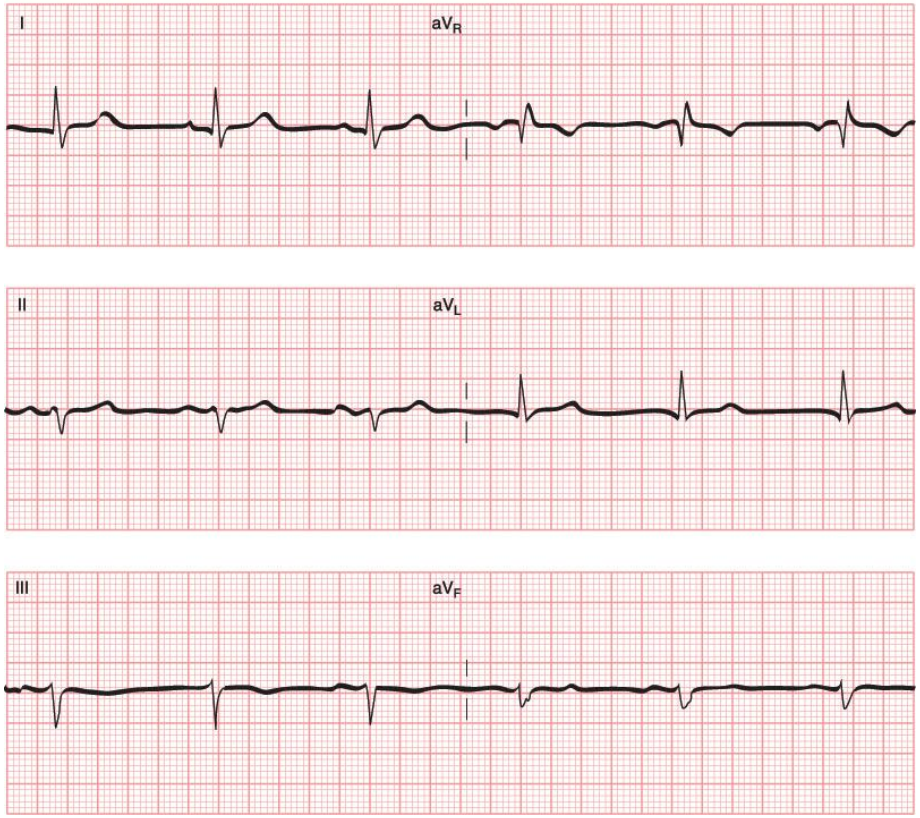


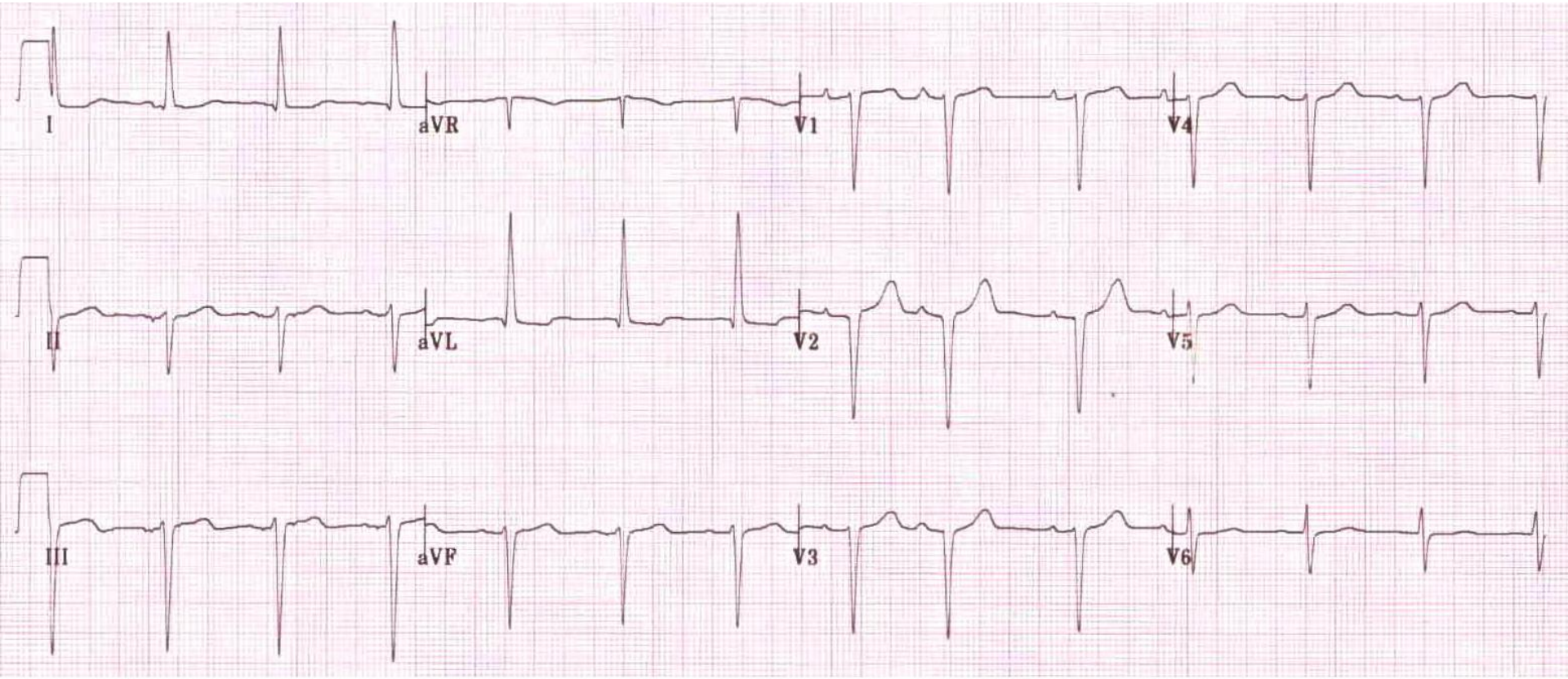
Practice Makes Perfect

- Determine if the mean QRS is normal or if there is axis deviation

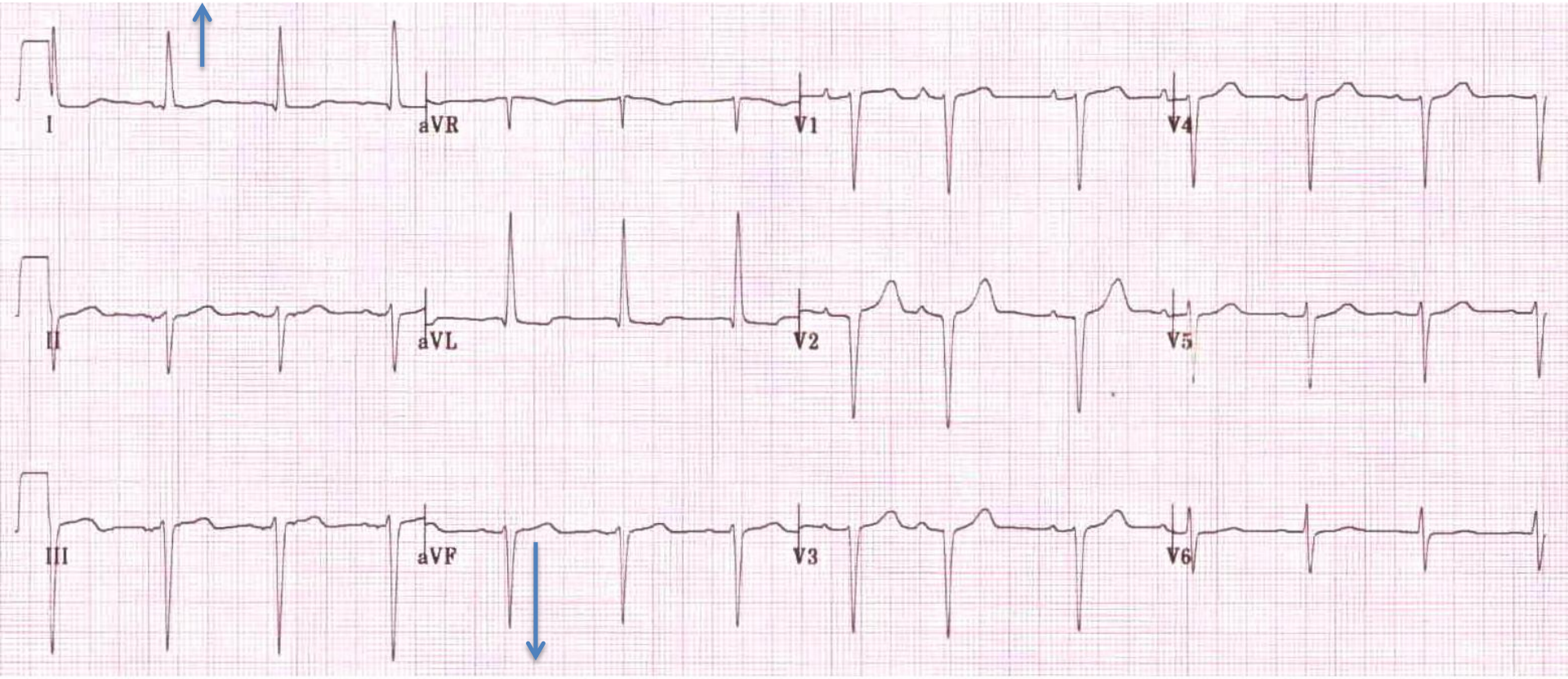
Practice Makes Perfect

- Determine if the mean QRS is normal or if there is axis deviation

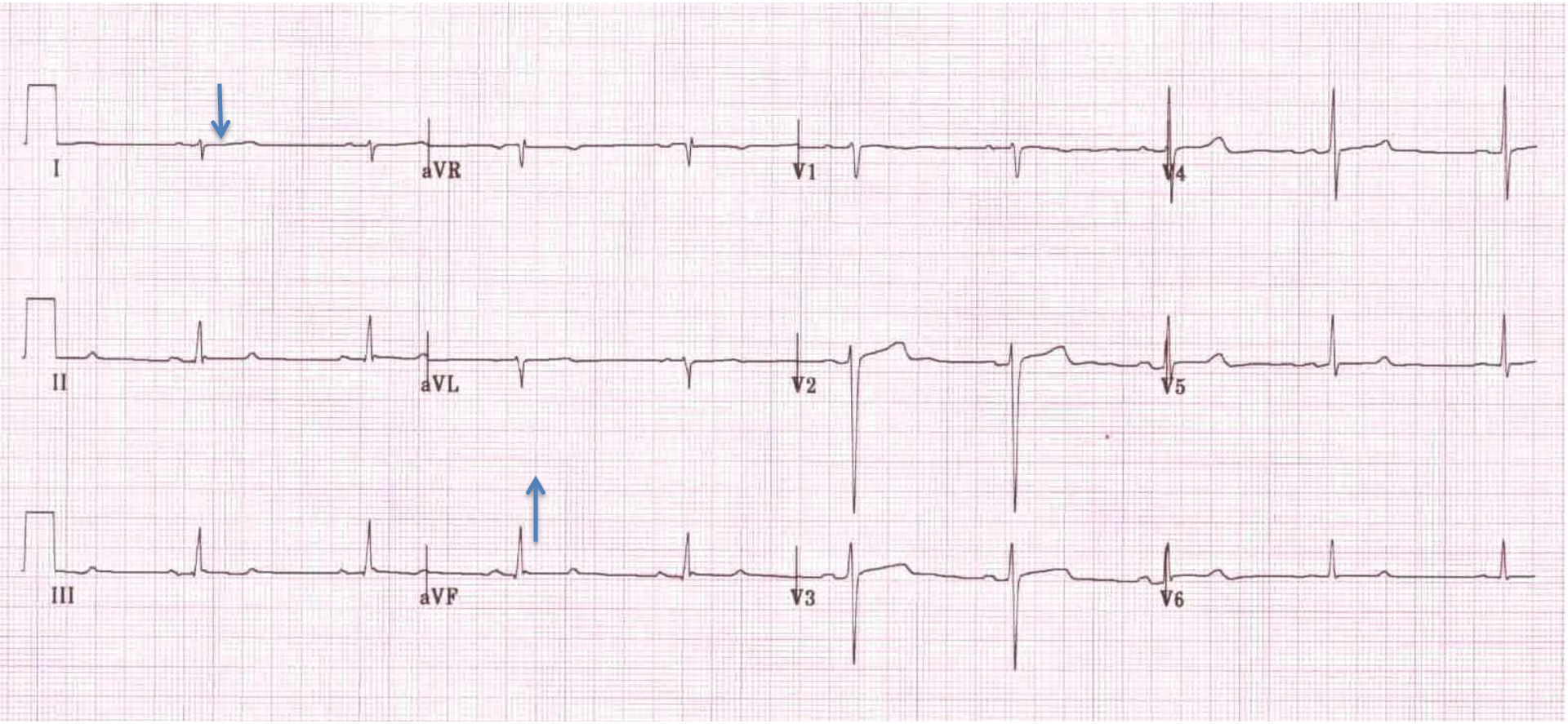



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

Left Axis Deviation



Right Axis Deviation



Section 4

Hypertrophy

Hypertrophy

- Condition in which muscular wall of the ventricle(s) becomes thicker than normal

Dilation or Enlargement

- Occurs as result of volume overload where chamber dilates to accommodate increased blood volume

Hypertrophy or Enlargement

- Enlargement associated with atria
  - P wave changes used to identify atrial enlargement
- Hypertrophy associated with ventricles
  - QRS complex changes used to identify ventricular hypertrophy

ECG
Structure

- Hypertrophy or enlargement

  Atrial and ventricular

- ECG will show changes in duration and amplitude of wave forms

- Electrical activity takes longer to activate muscle

Hypertrophy
Atrial

- **RAE**

  Pulmonary HTN

  Pulmonary emboli

  COPD

  Tricuspid/Pulmonary valve disease

  Some congenital heart disease

- **LAE**

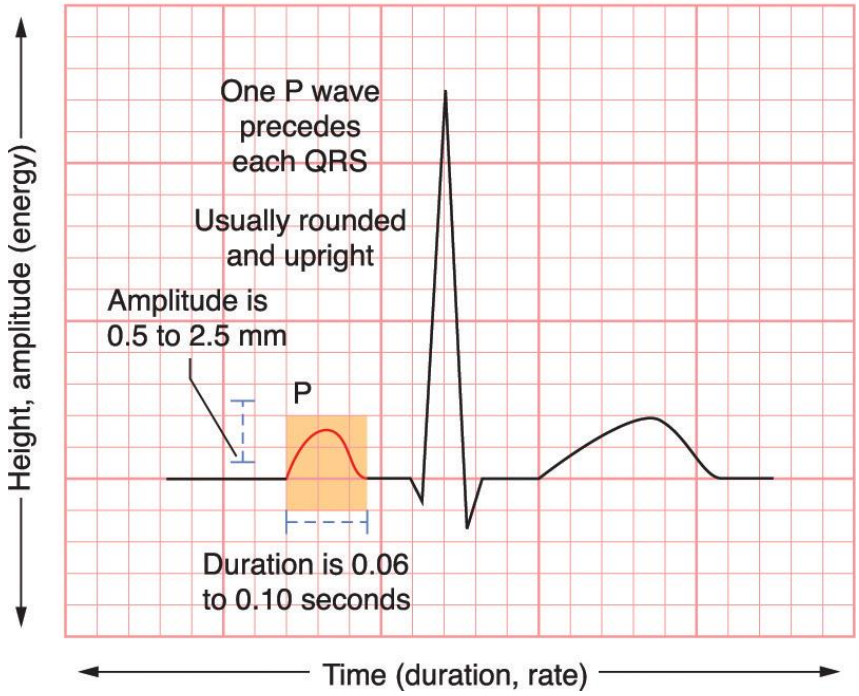
  Systemic HTN

  Aortic and Mitral disease

  Left ventricular failure

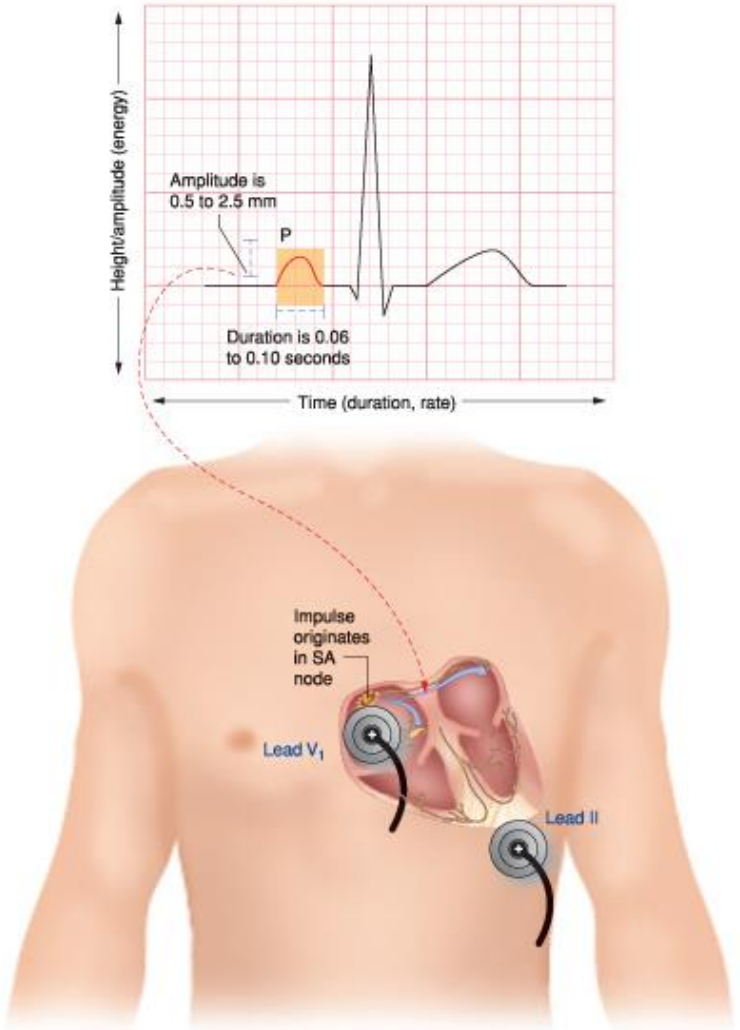
Normal P Wave

- Duration 0.06 – 0.10 seconds
- Amplitude 0.5 – 2.5 mm
- First portion represents right atrial depolarization
- Terminal portion represents left atrial depolarization



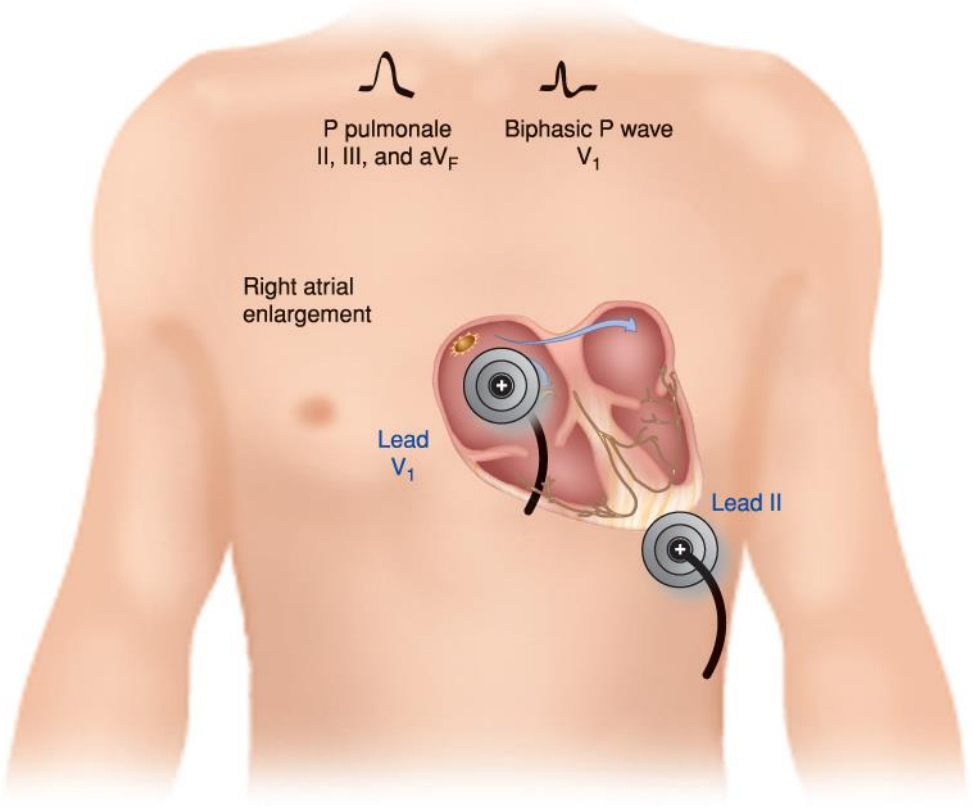
Atrial Enlargement

- Leads II and V_1 used to assess atrial enlargement



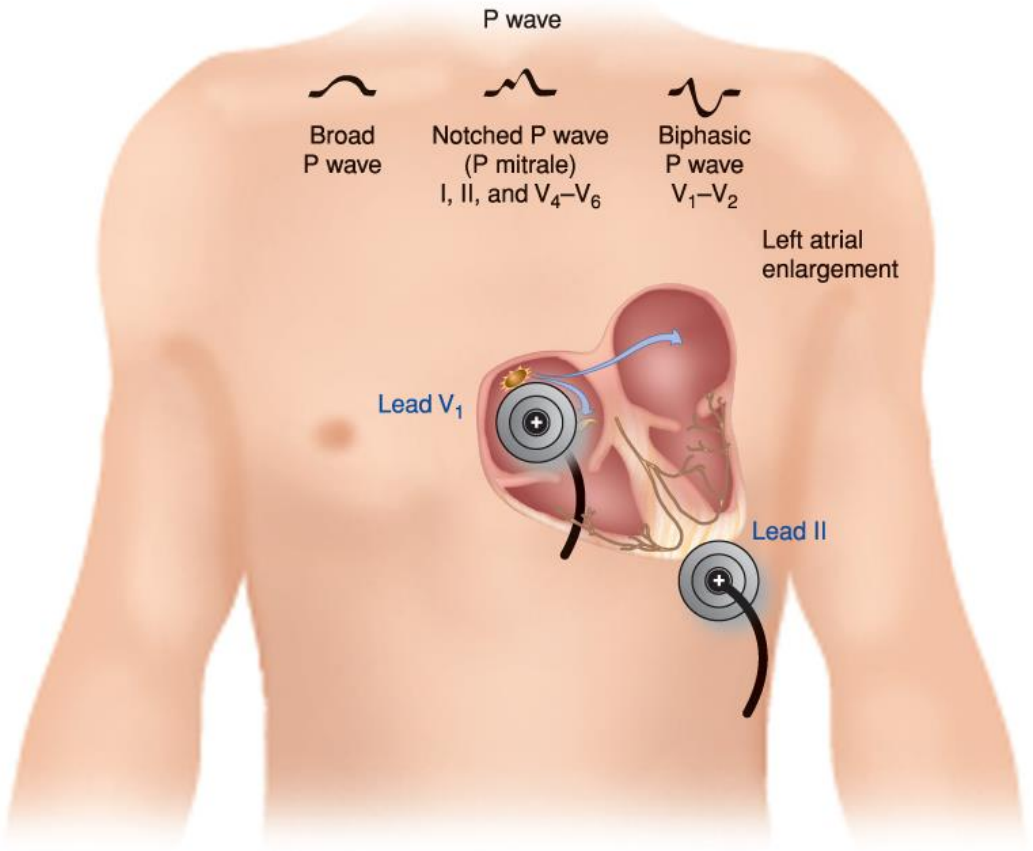
Right Atrial Enlargement

- Increase in amplitude of the first part of the P wave



Left Atrial Enlargement

- Increased amplitude in the terminal portion of the P wave in V_1
- Increased duration or width of the P wave



Criteria for RAE & LAE

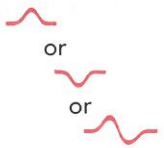
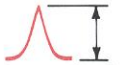
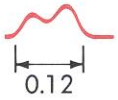
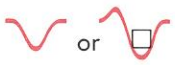
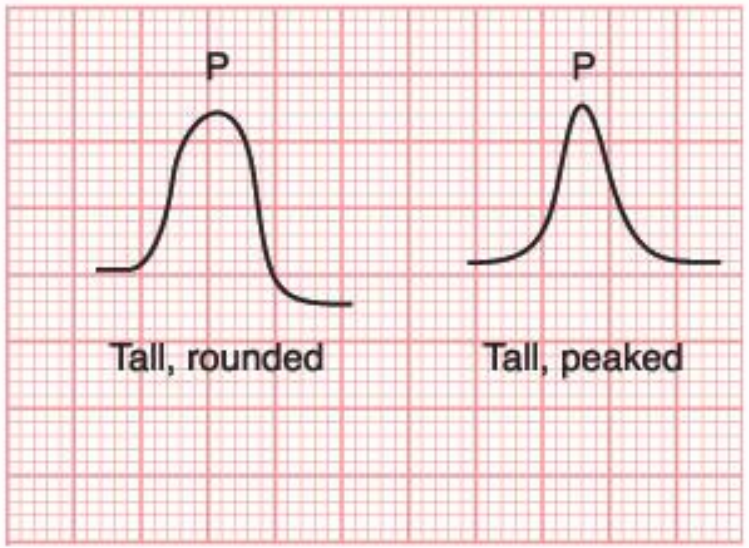
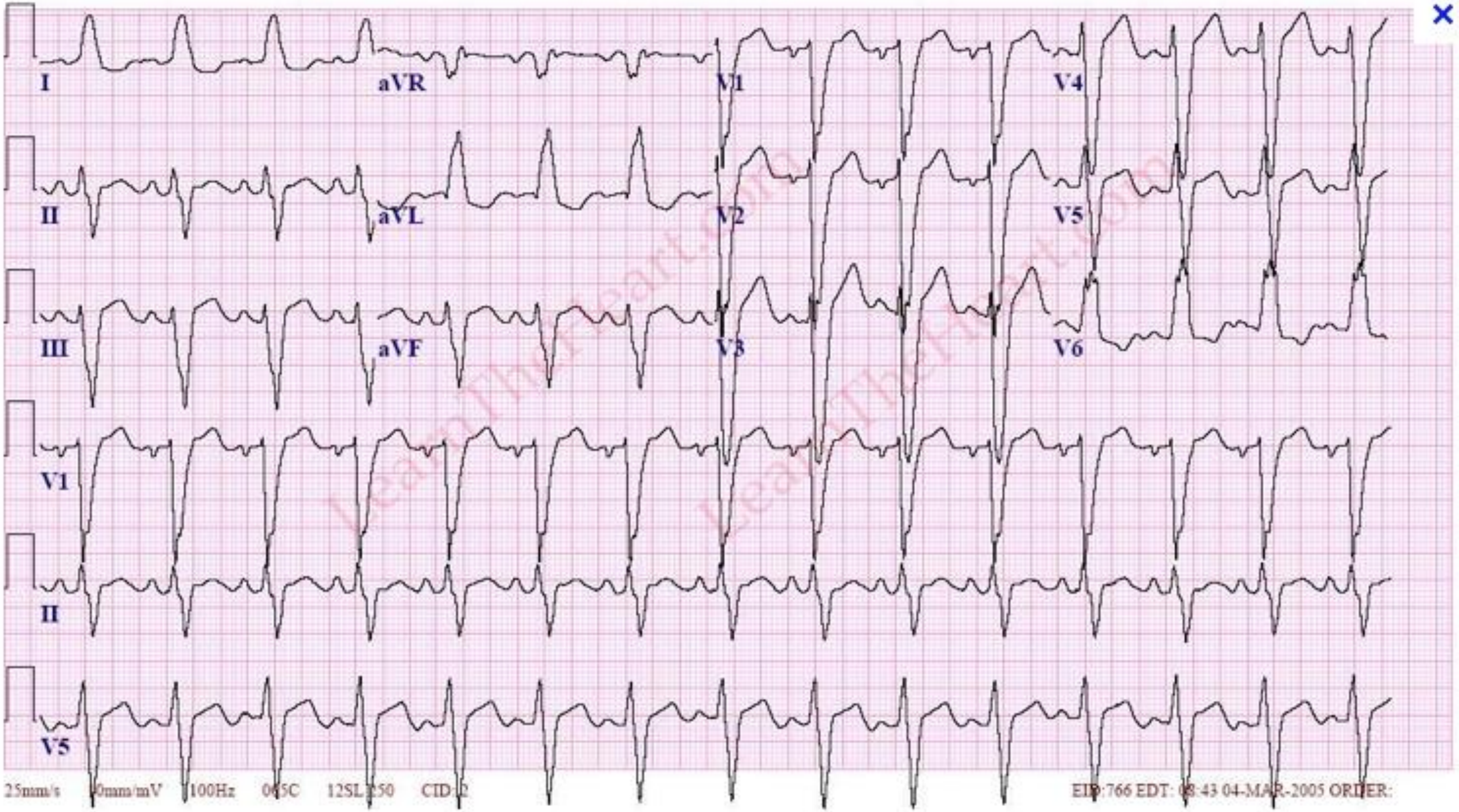
Condition	P Wave Appearance		Mnemonic Features
	Lead II	Lead V_1	
Normal Sinus Rhythm (NSR)			The P should be upright in lead II if there is sinus rhythm The P wave may be upright, negative, or biphasic in lead V_1 with sinus rhythm
RAA (= **P** **P**ulmonale)			**P**rominent (≥ 2.5 mm tall) **p**eaked P waves in the **p**ulmonary leads (II, III, and aVF)
LAA (= P **M**itrale)			**M**-shaped, widened (≥ 0.12 second) P waves in one or more of the **m**itral leads (I, II, or aVL) Deep, negative component to the P wave in lead V_1

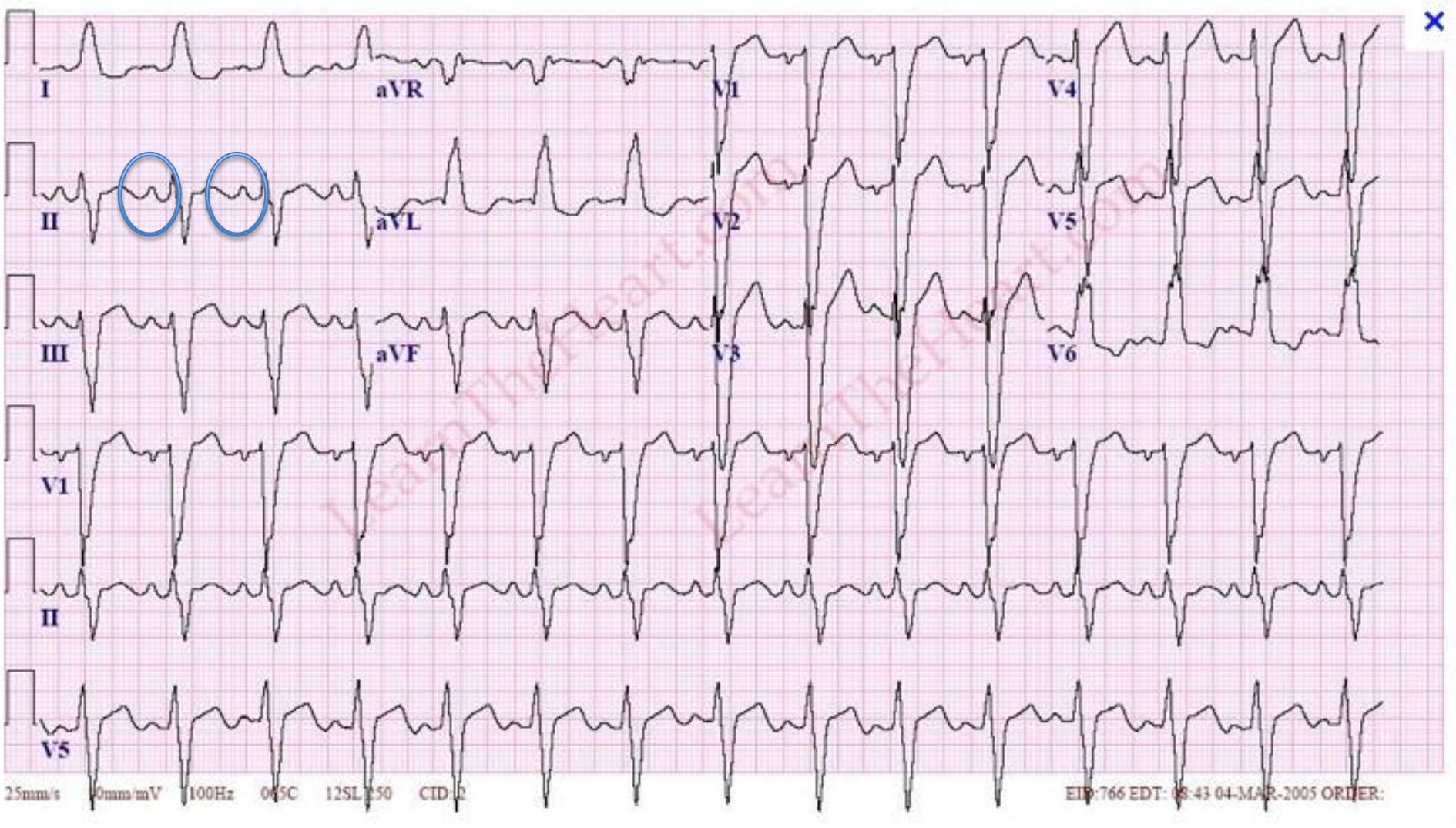
Figure 9-2. ECG criteria for diagnosis of RAA and LAA.

Different Looking Sinus P Waves

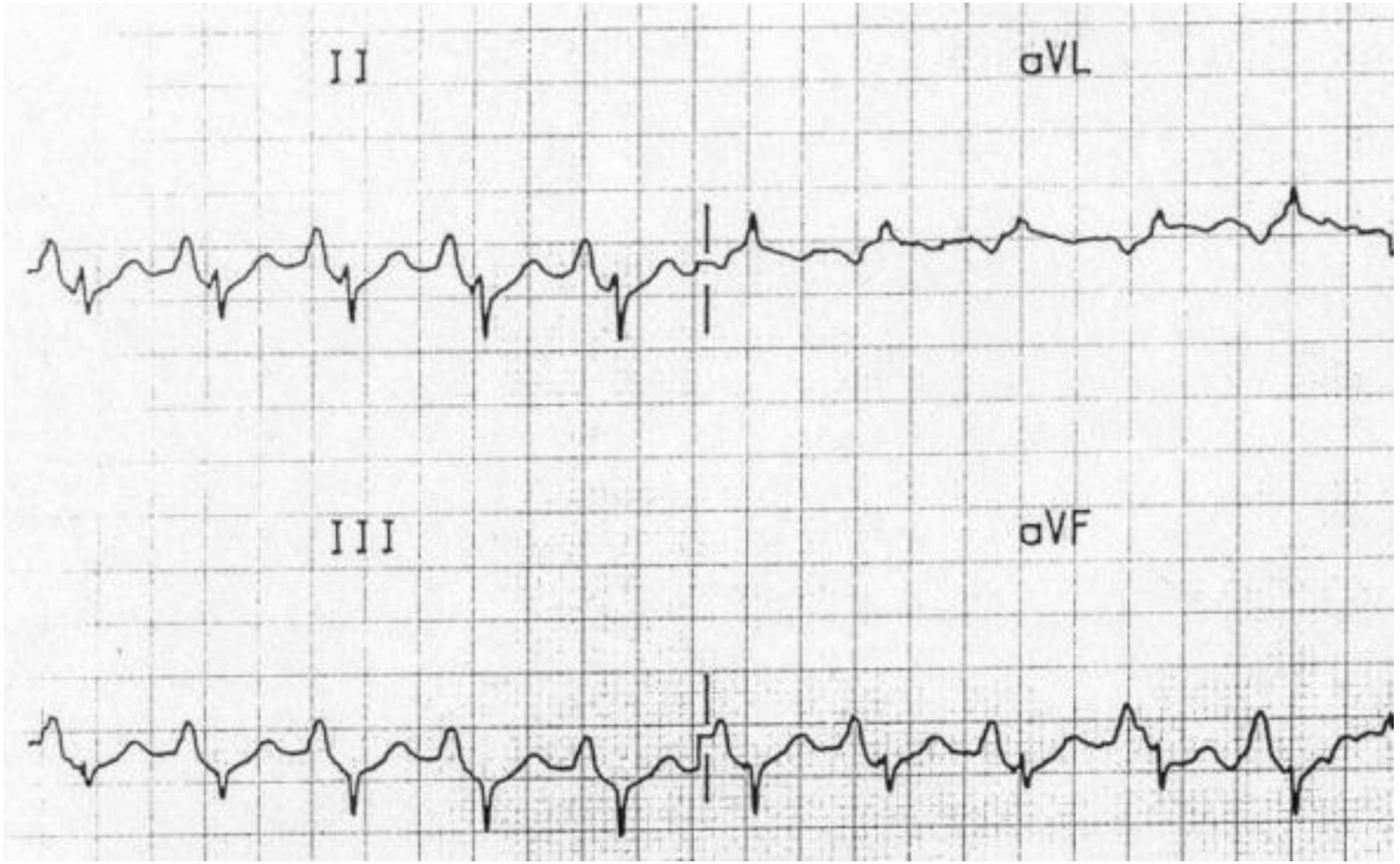
- Tall, rounded or peaked P waves may be seen with increased right atrial pressure and right atrial dilation



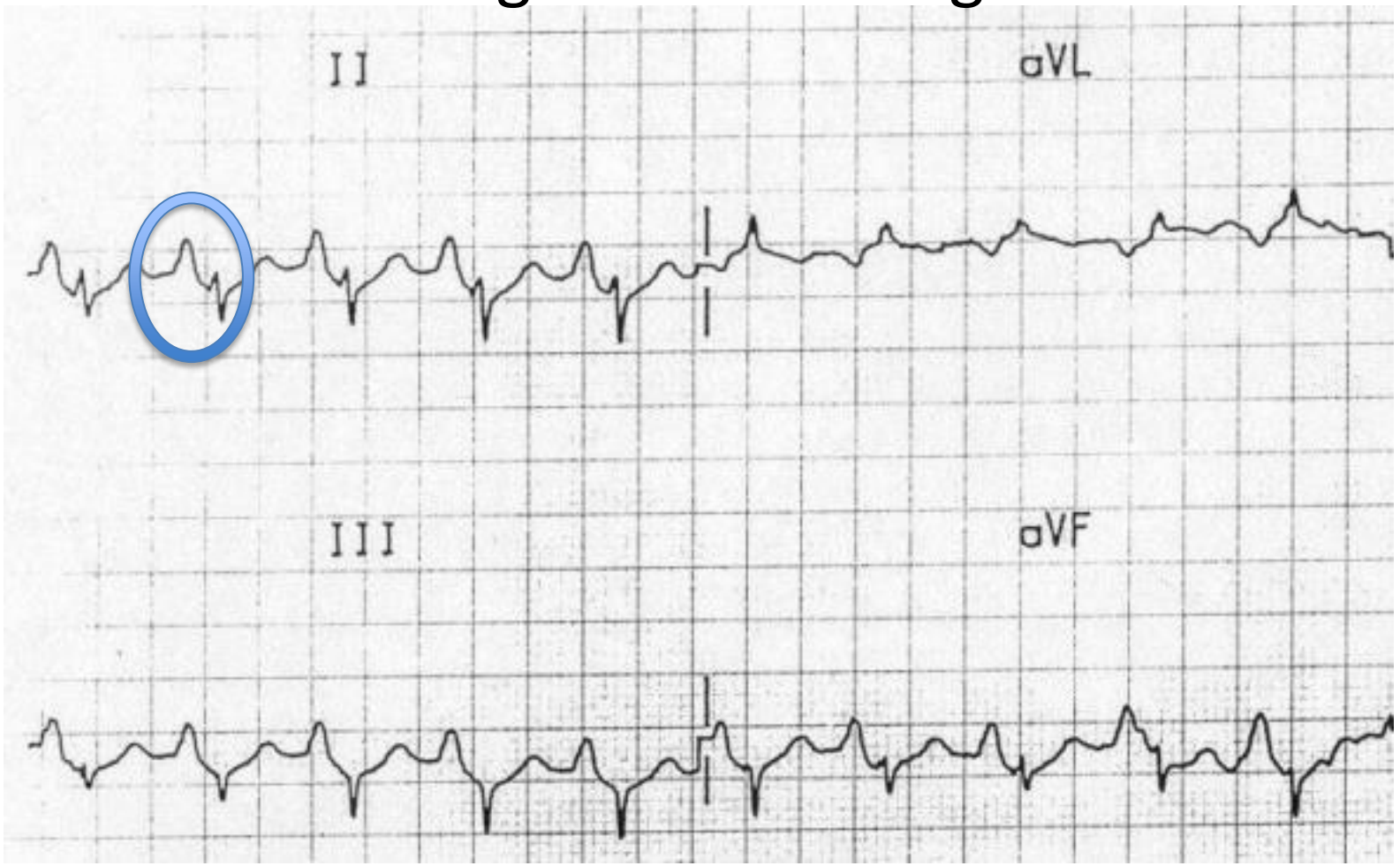

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s
100Hz
12SL
EID:766 EDT: 04-MAR-2005 ORDER:



Right Atrial Enlargement

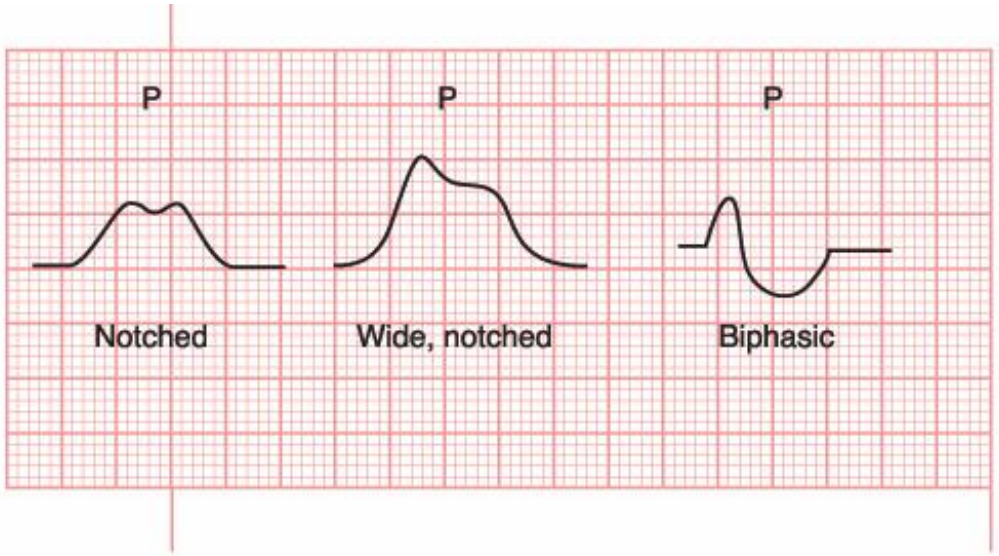

II
aVL
III
aVF

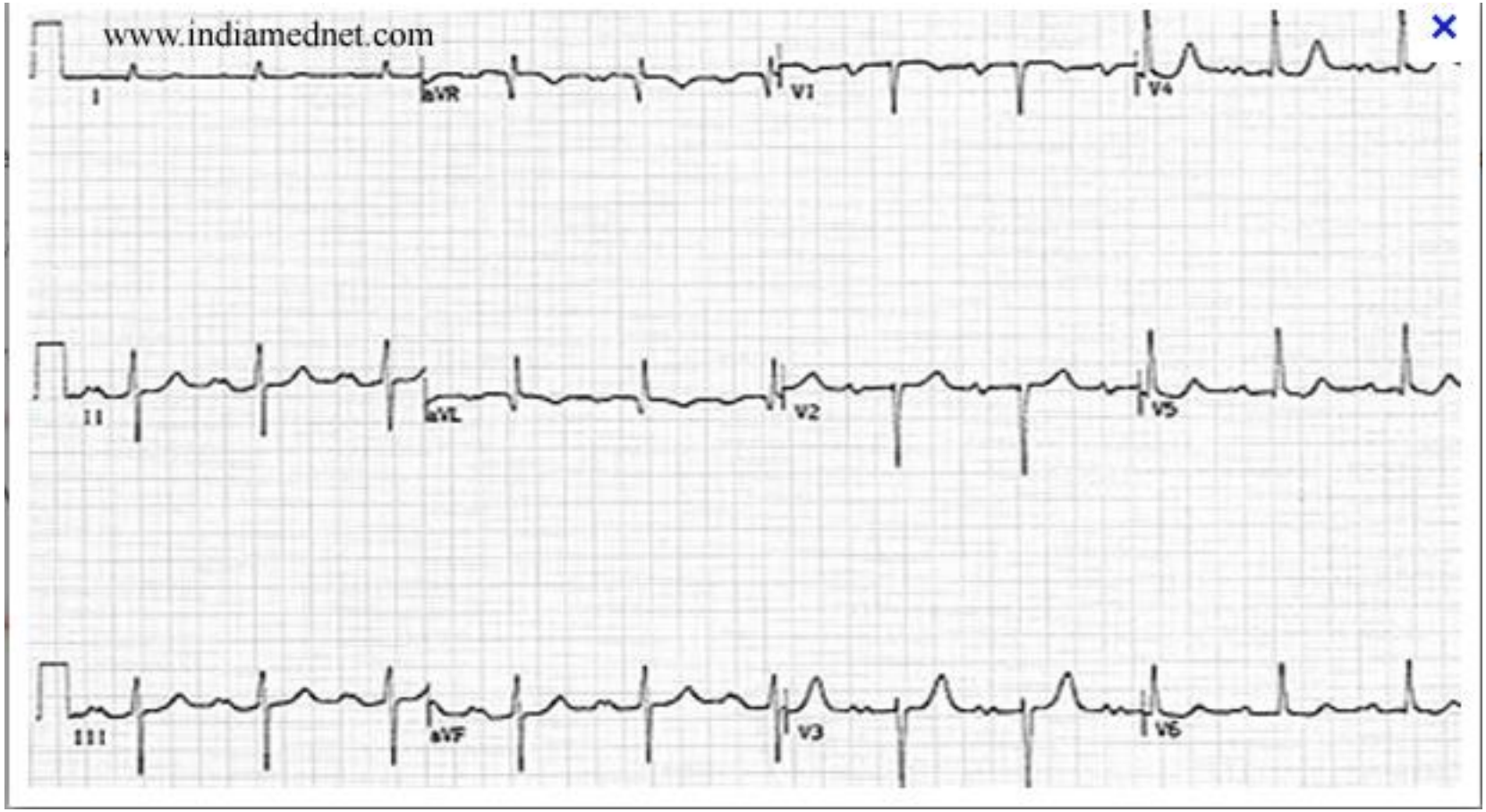
Right Atrial Enlargement



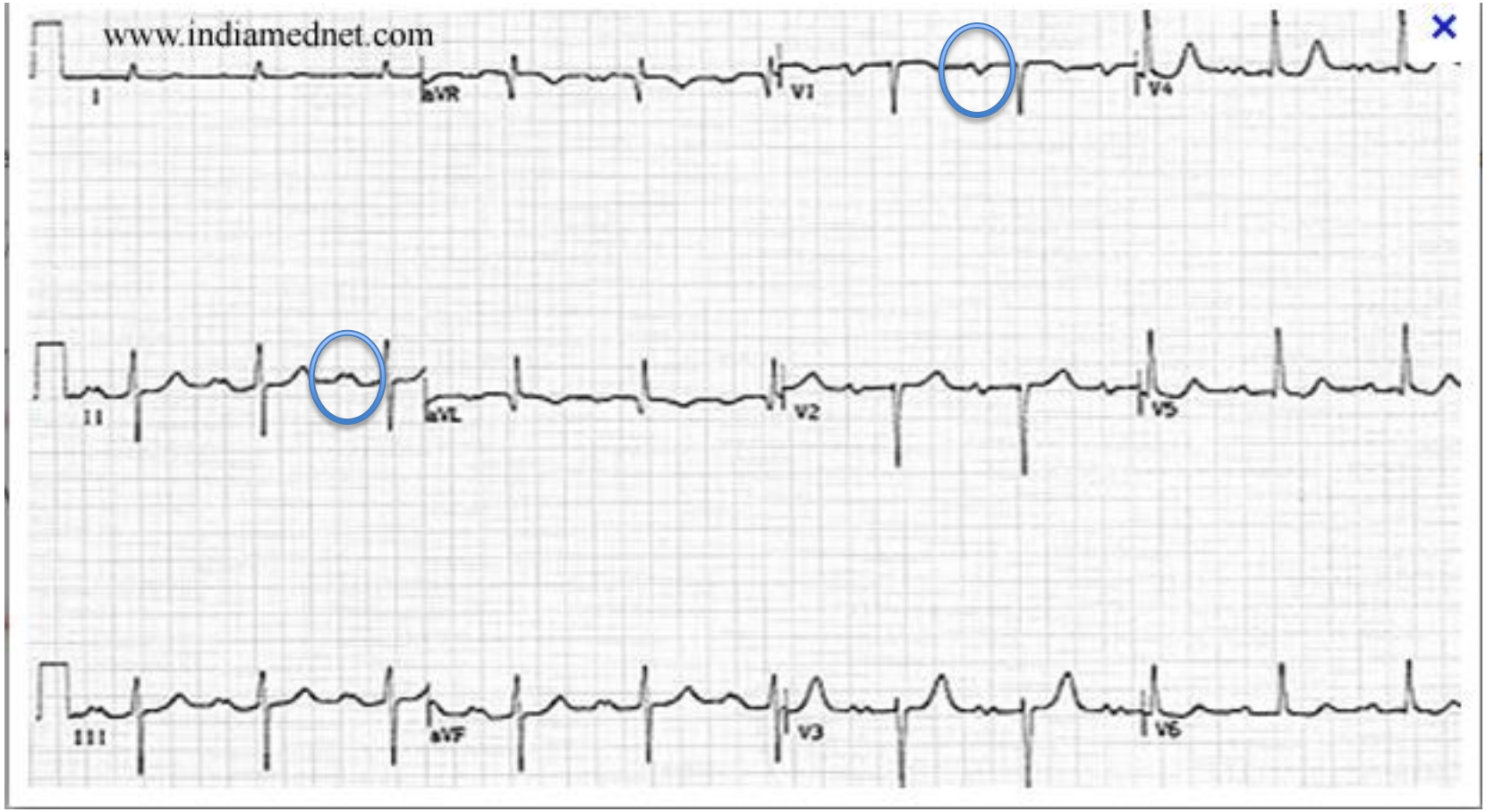
Different Looking Sinus P Waves

- Notched, wide (enlarged) or biphasic P waves may be seen in increased left atrial pressure and left atrial dilation

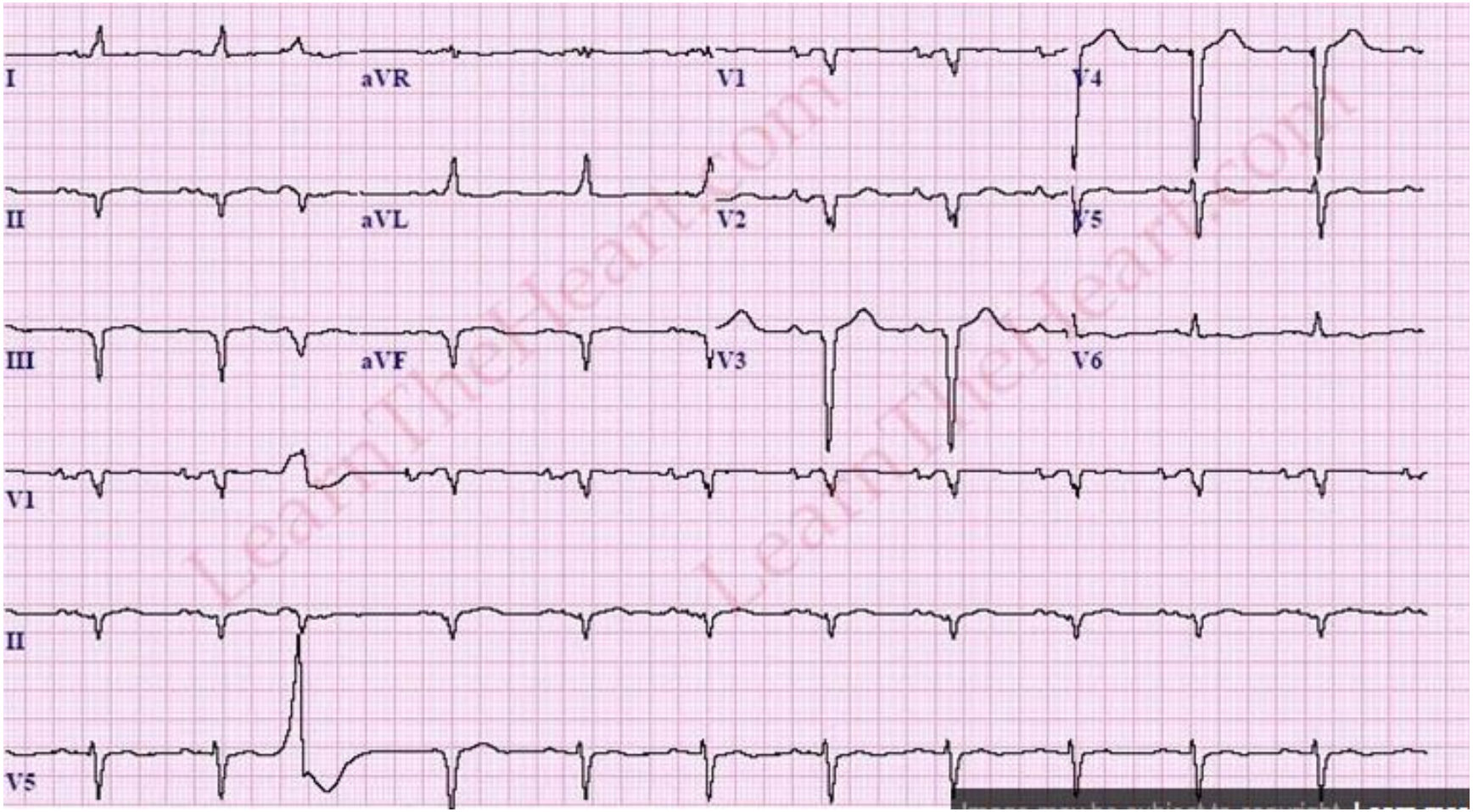



www.indiamednet.com
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

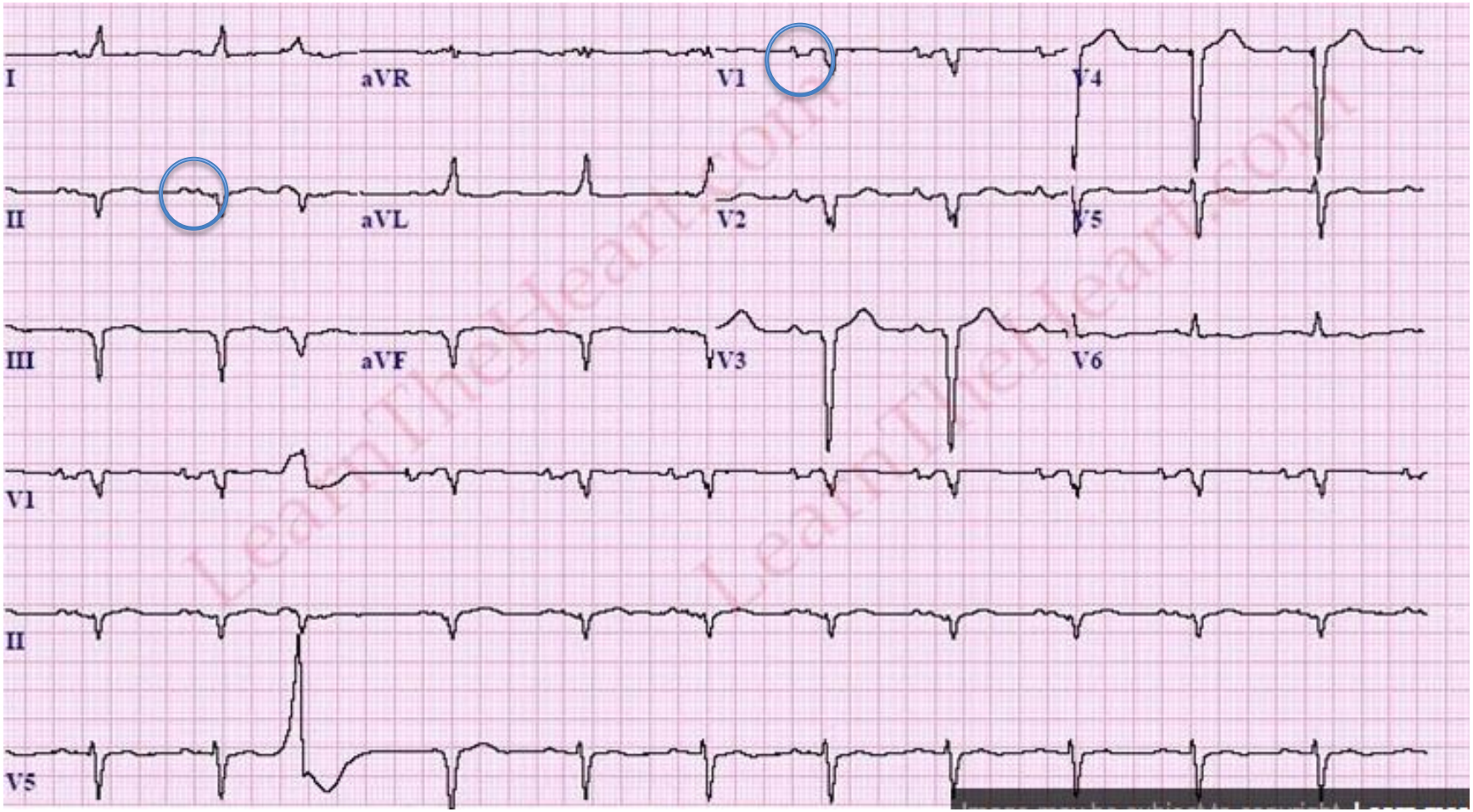
Left Atrial Enlargement



What's your diagnosis?



Left atrial enlargement



Ventricular Hypertrophy

- Commonly caused by chronic, poorly treated hypertension
- Because there is more muscle to depolarize there is more electrical activity occurring in the hypertrophied muscle
  - Reflected by changes in the amplitude of portions of the QRS complex

Ventricular Hypertrophy

- RVH

  Pulmonary HTN, COPD, PE

  Mitral valve disease

  Pulmonary valve stenosis

  VSD

  Congenital heart disease with right ventricular overload

Ventricular Hypertrophy continued

- LVH

  Systemic HTN

  Aortic Stenosis/insufficiency

  Hypertrophic cardiomyopathy (IHSS, HOCM)

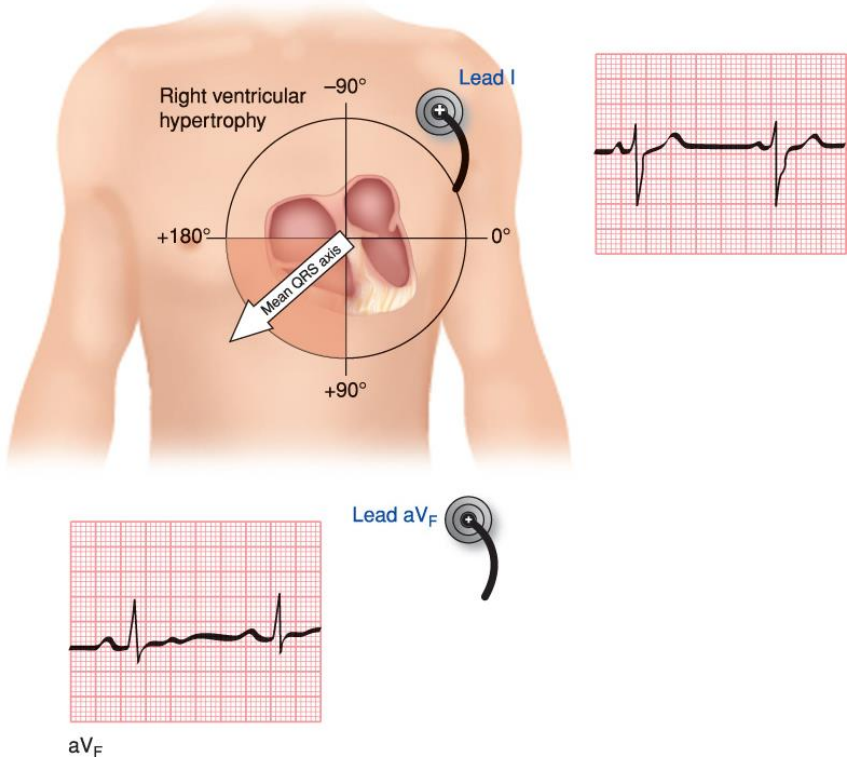
  Cardiomyopathies

Criteria for RVH

- RAE
- RAD or indeterminate axis
- Incomplete RBBB (or an rSr’ in lead V1)
- Low voltage
- Persistent precordial S waves
- Right Ventricular strain (ST, T wave changes in right sided leads)
- Tall R wave in lead V1

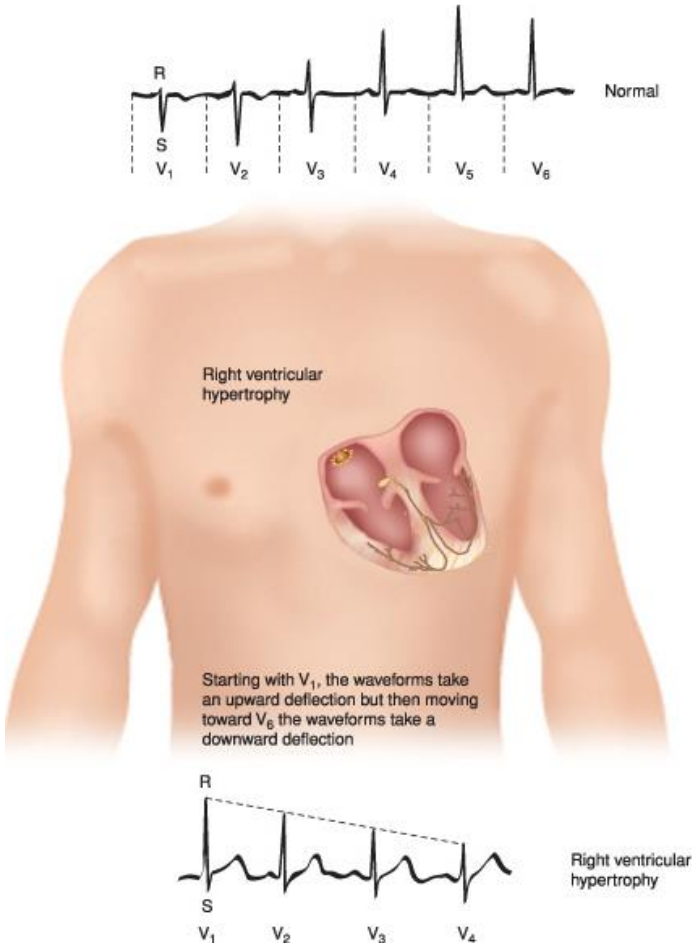
Right Ventricular Hypertrophy

- Most common characteristic in limb leads is right axis deviation

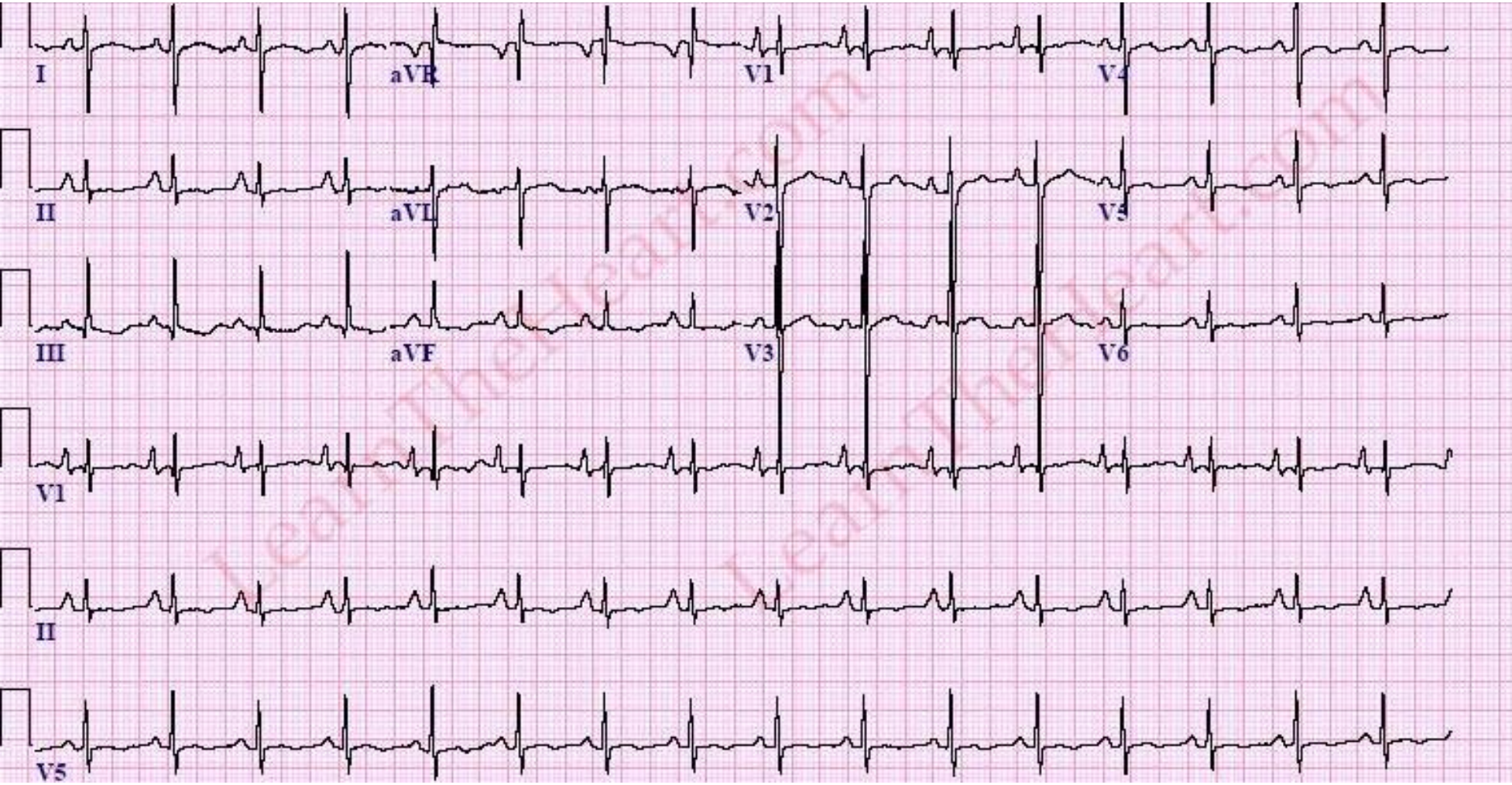


Right Ventricular Hypertrophy

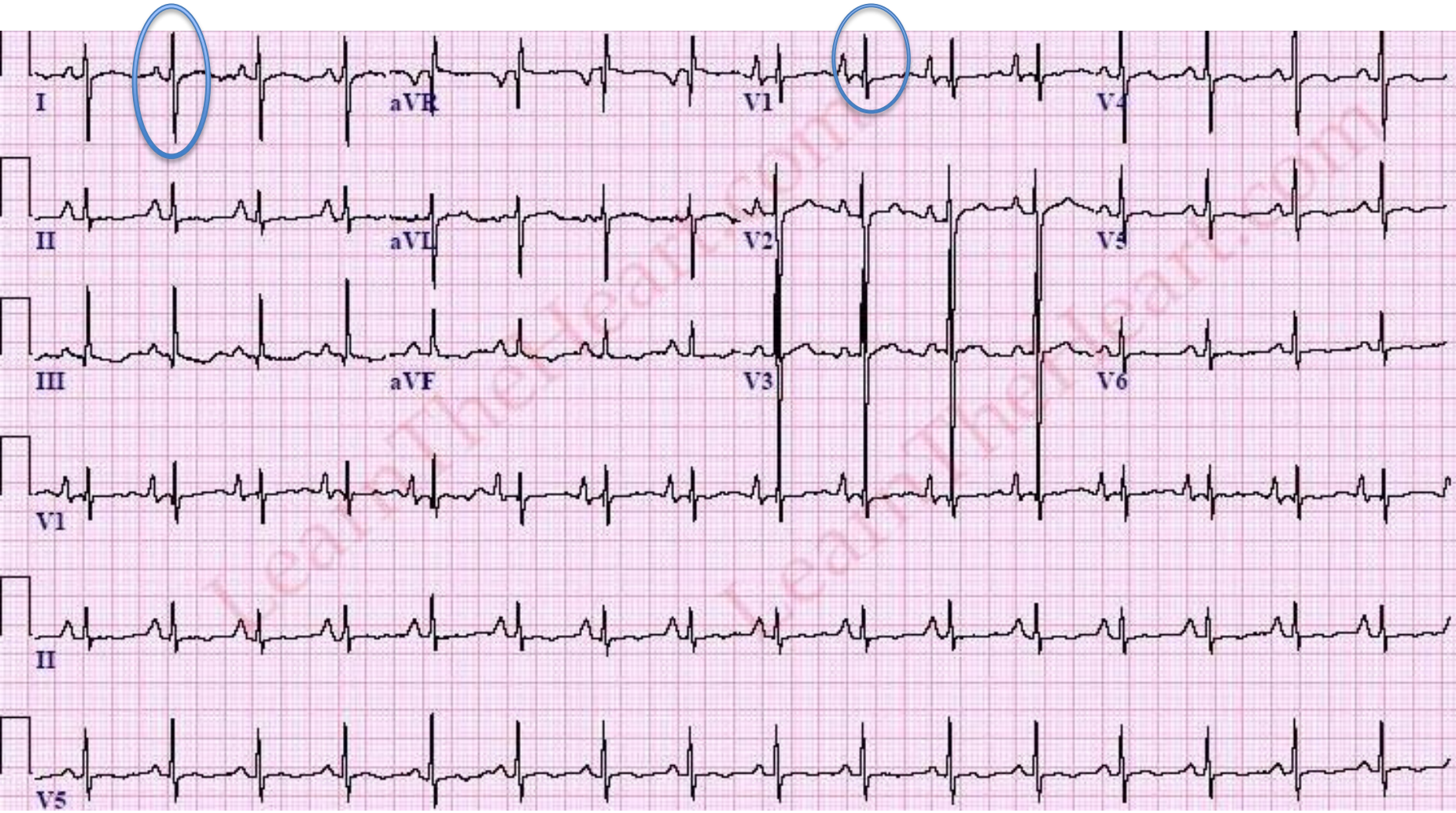
- In precordial leads R waves are more positive in leads which lie closer to lead V_1



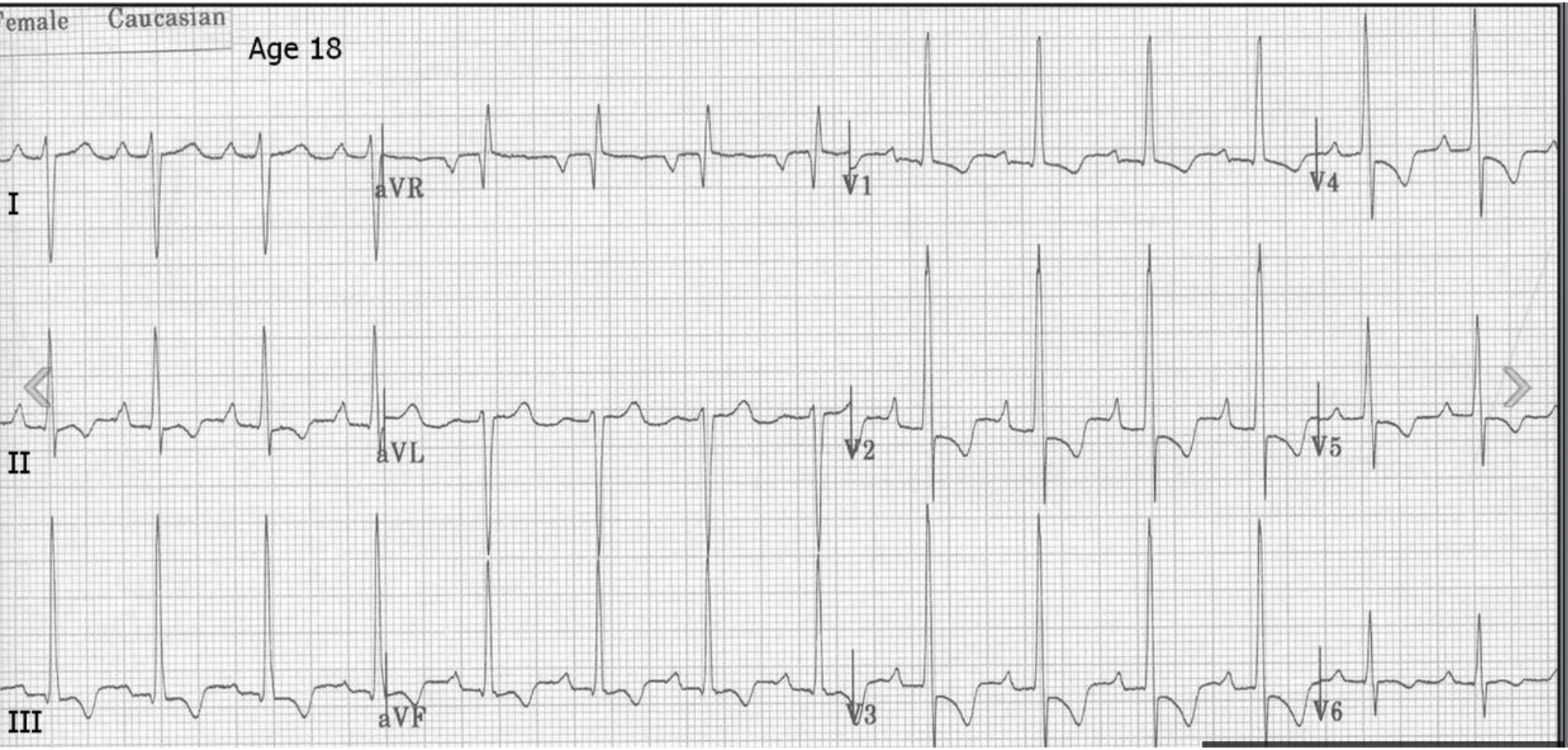
ECG Example RVH



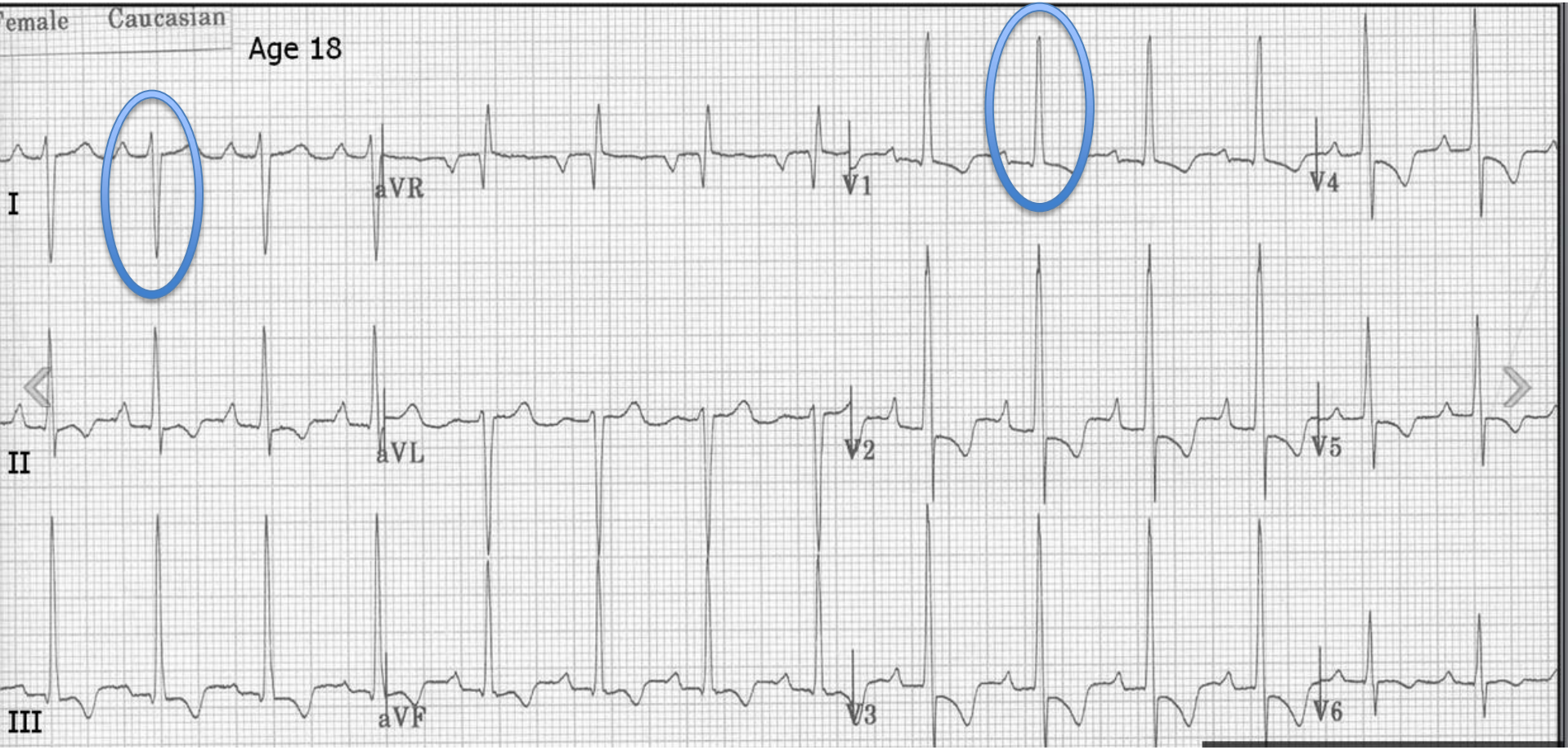
ECG Example RVH



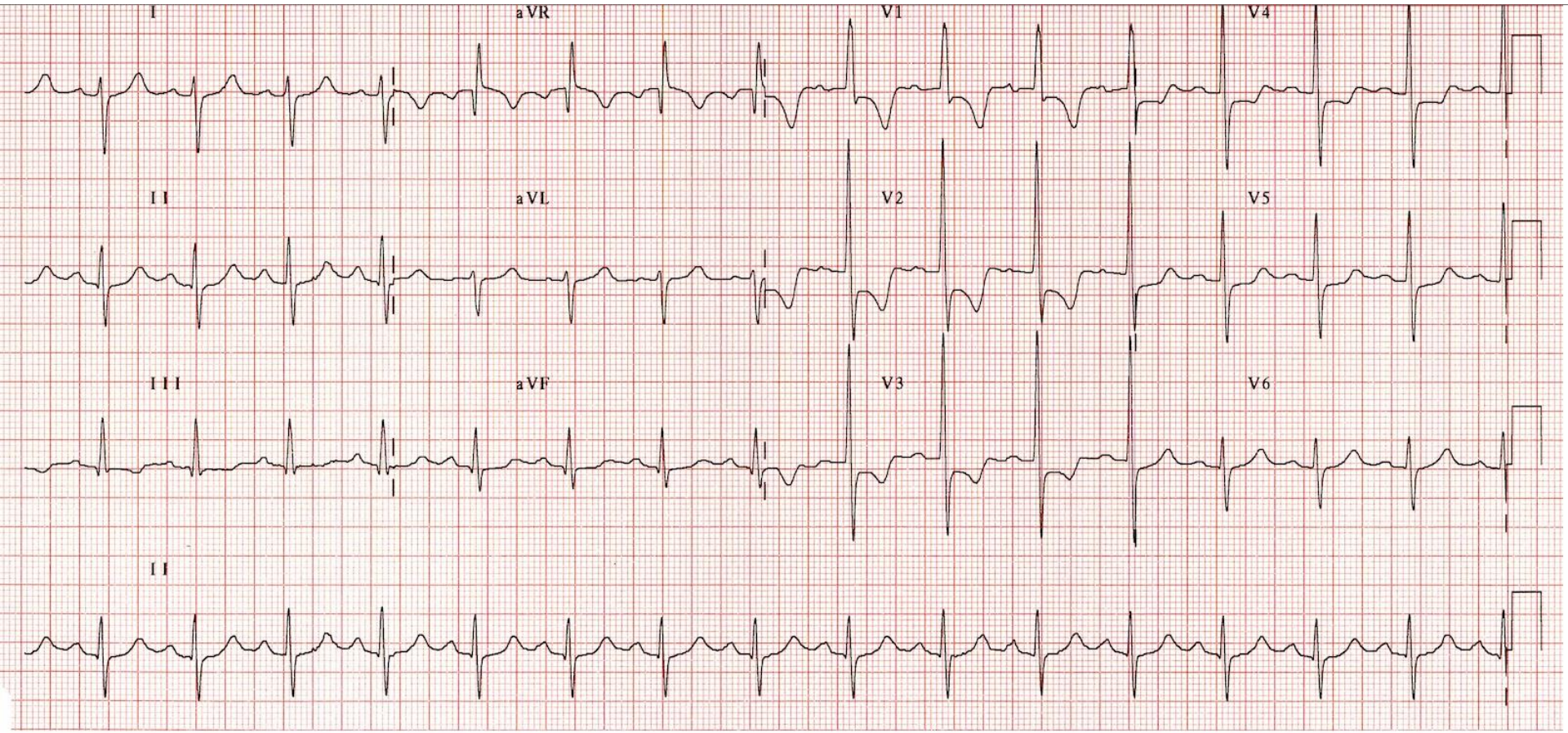
What's the Diagnosis?



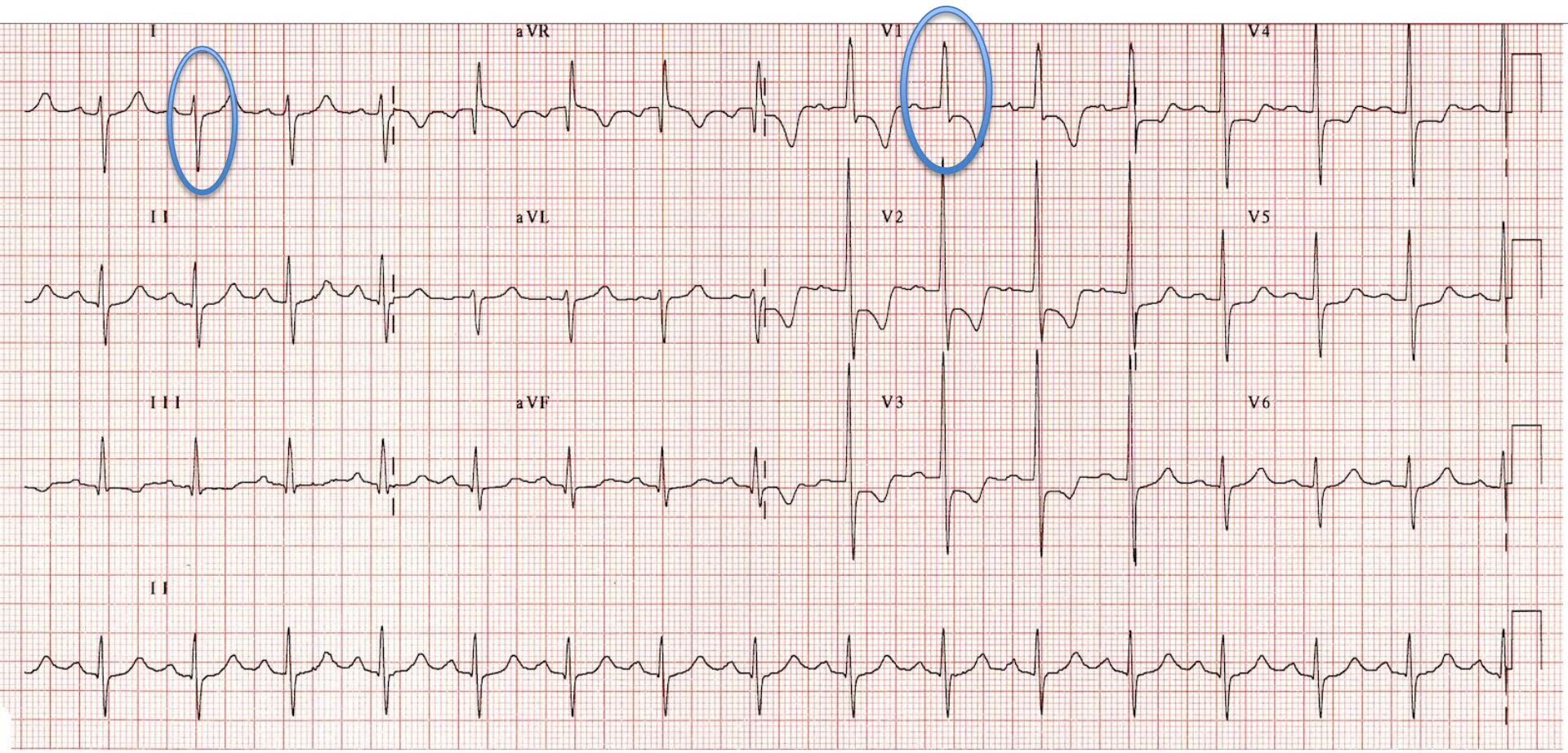
ECG Example RVH



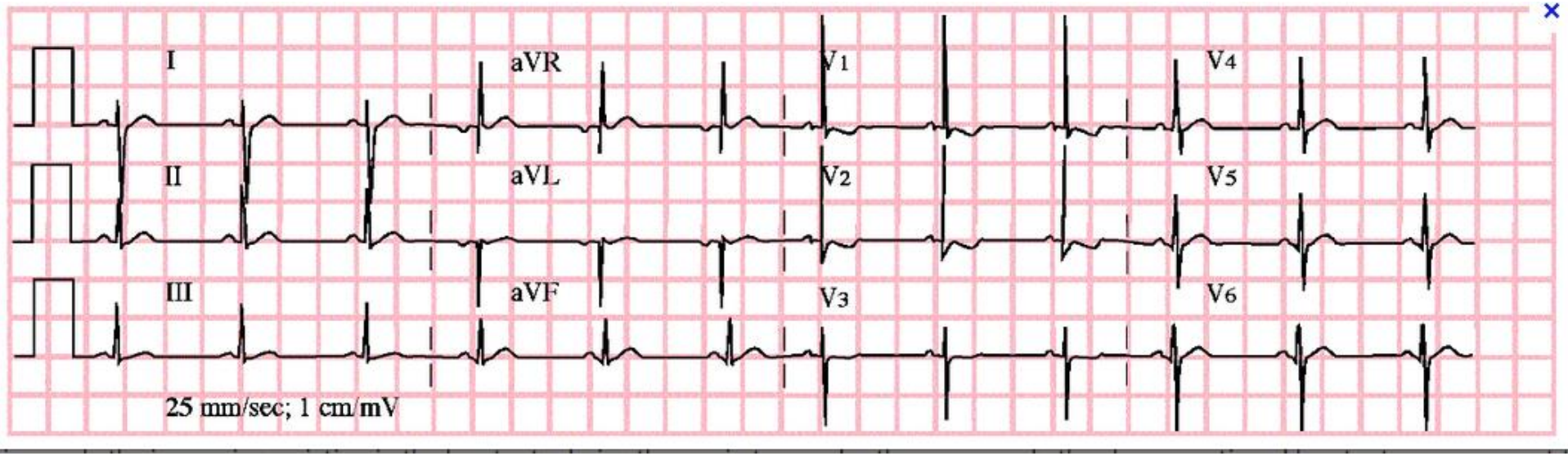
What's your diagnosis?



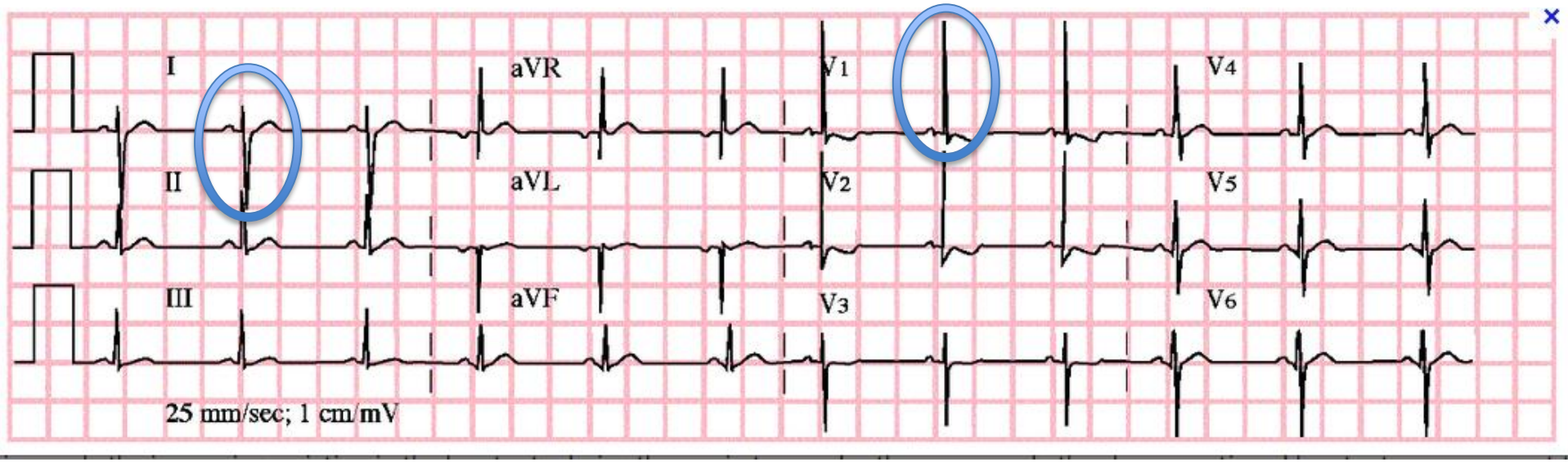
What's your diagnosis?



What's your Diagnosis?



What's your Diagnosis?



Criteria for LVH

- Deepest S wave in lead V1 or V2, plus tallest R wave in lead V5 or V6 ≥ 35mm
- R in lead aVL ≥ 12mm
- Patient ≥ 35 years old
- “Strain” in left sided leads

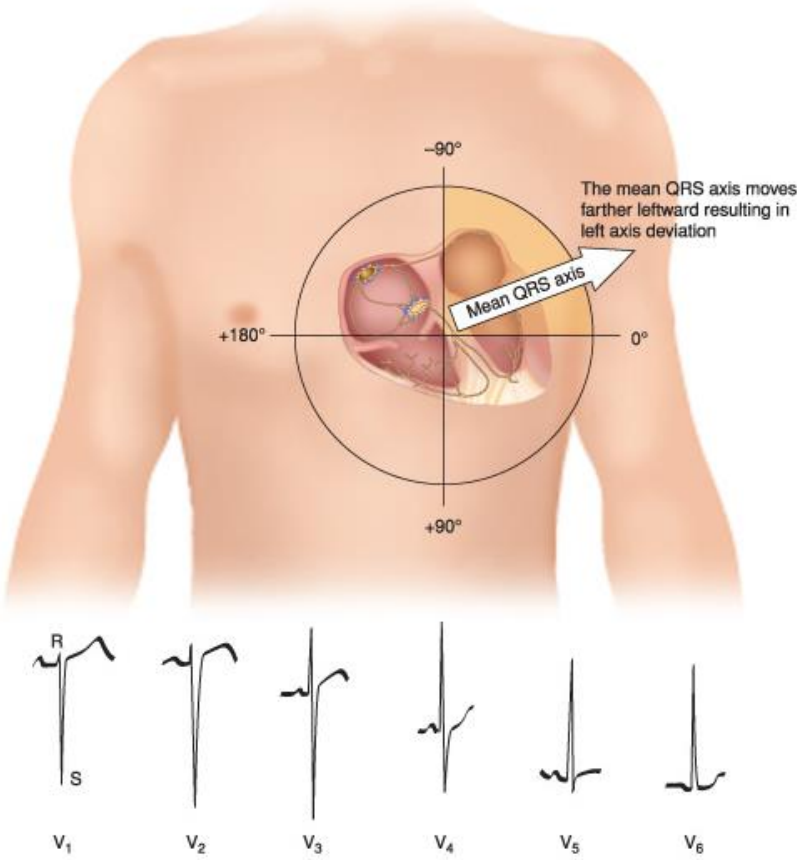
Criteria of LVH by the Cornell Method

- Cornell Voltage Criteria
  - S in V3 + R in aVL > 28 mm (men)
  - S in V3 + R in aVL > 20 mm (women)

  - 23% Sensitivity
  - 96% Specificity

Left Ventricular Hypertrophy

- Increased R wave amplitude in precordial leads over LV
- S waves that are smaller in leads over LV (lead V_6) but larger in leads over RV (lead V_1)

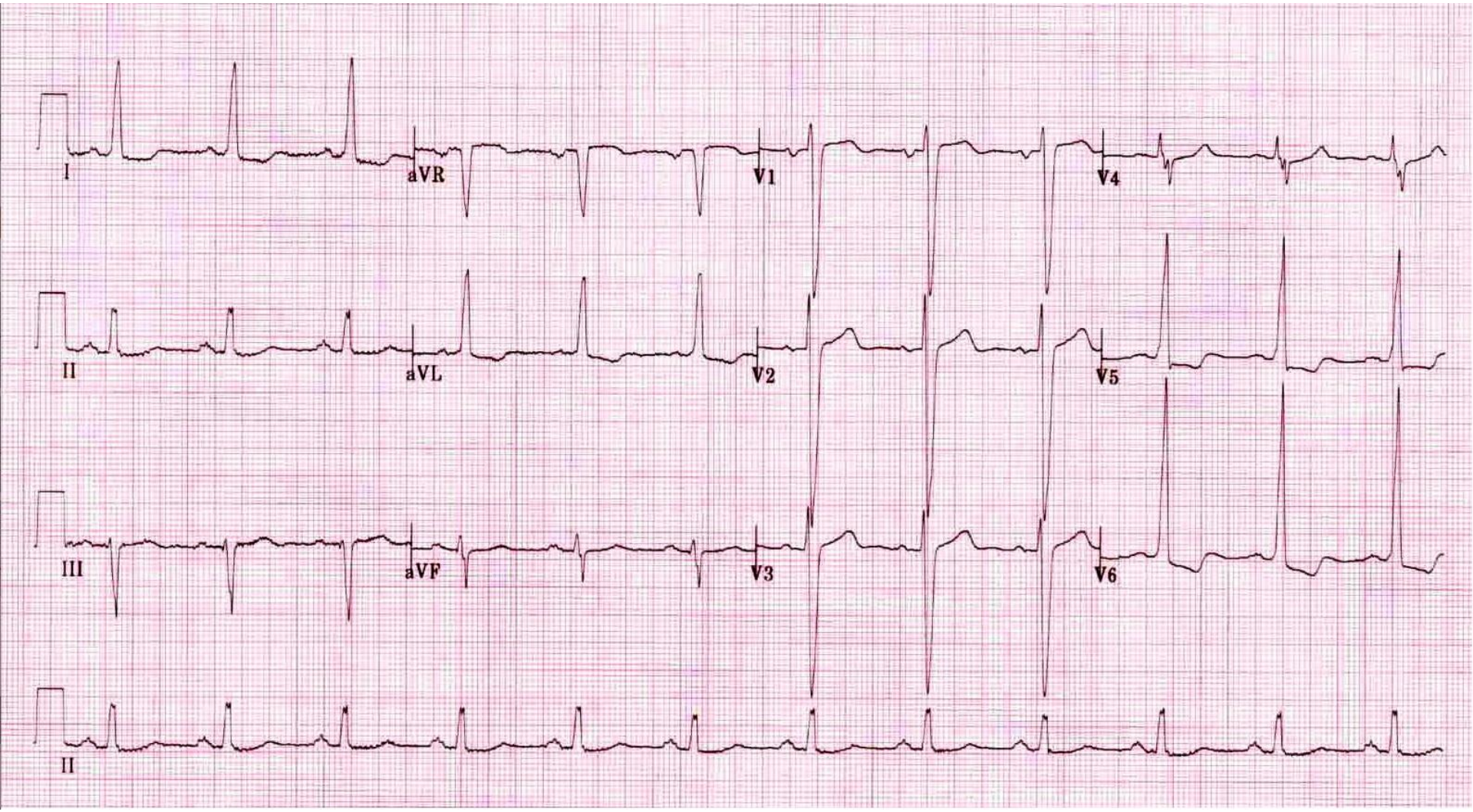


There is increased R wave amplitude over those leads overlying the left ventricle, and the S waves are smaller in the leads overlying the left ventricle but larger in the leads overlying the right ventricle.

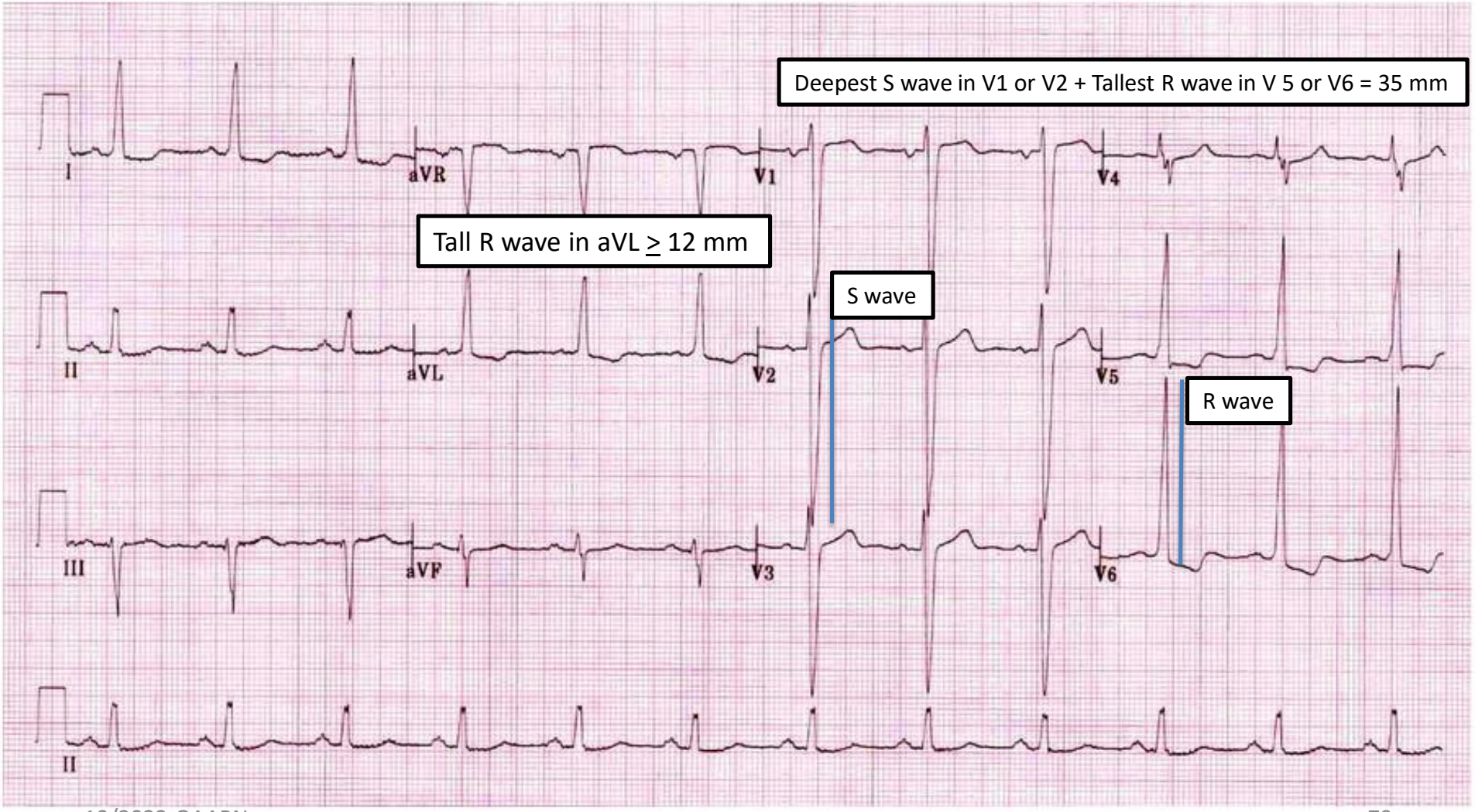
Other Criteria for LVH determination

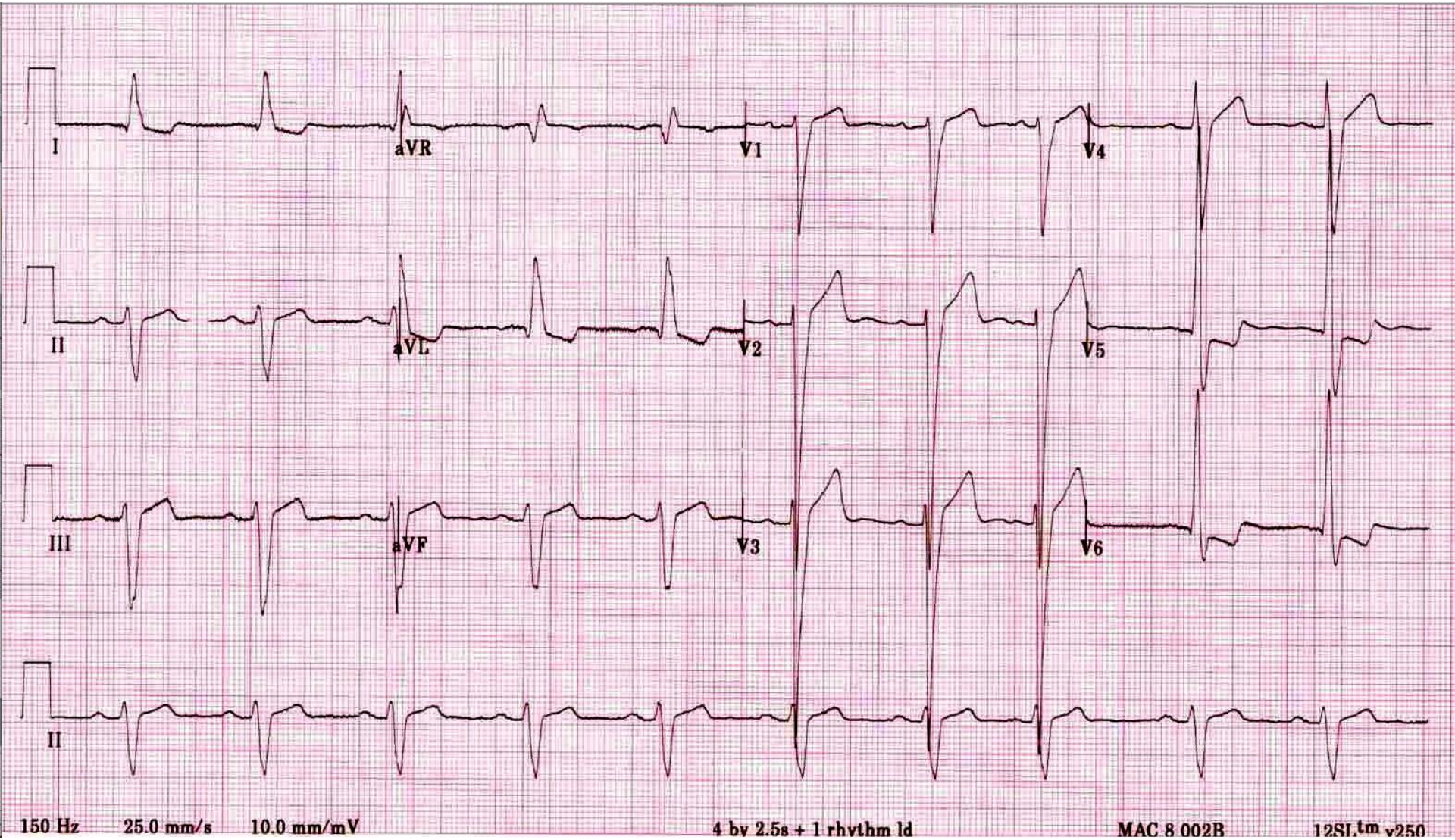
- An R wave ≥ 20 mm in any of the other inferior leads (II, III, aVF)
- Deep S waves (≥ 20-25mm) in lead V1 or V2
- An R wave ≥ 25mm in lead V5
- An R wave ≥ 20mm in lead V6

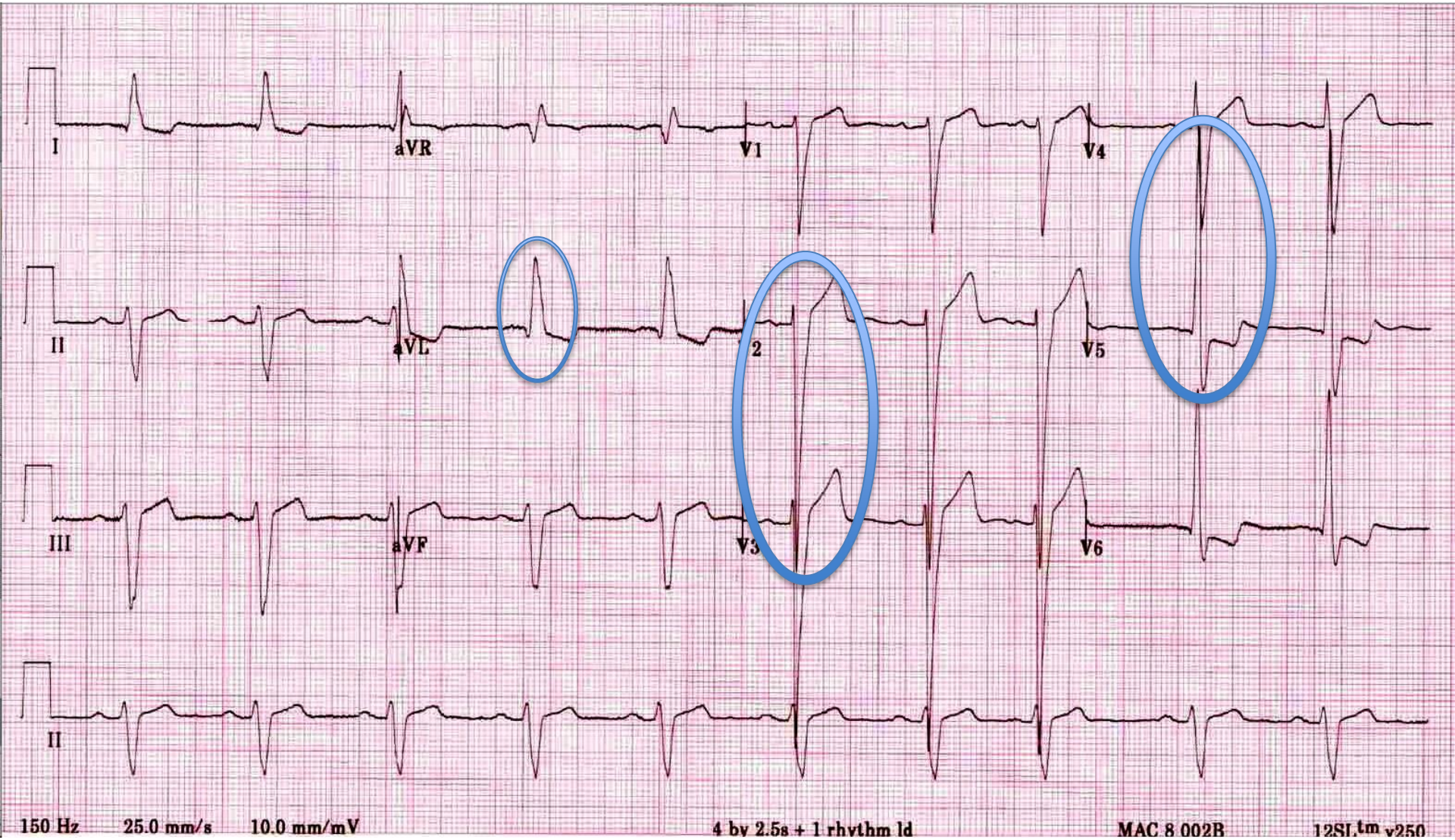
What's your Diagnosis



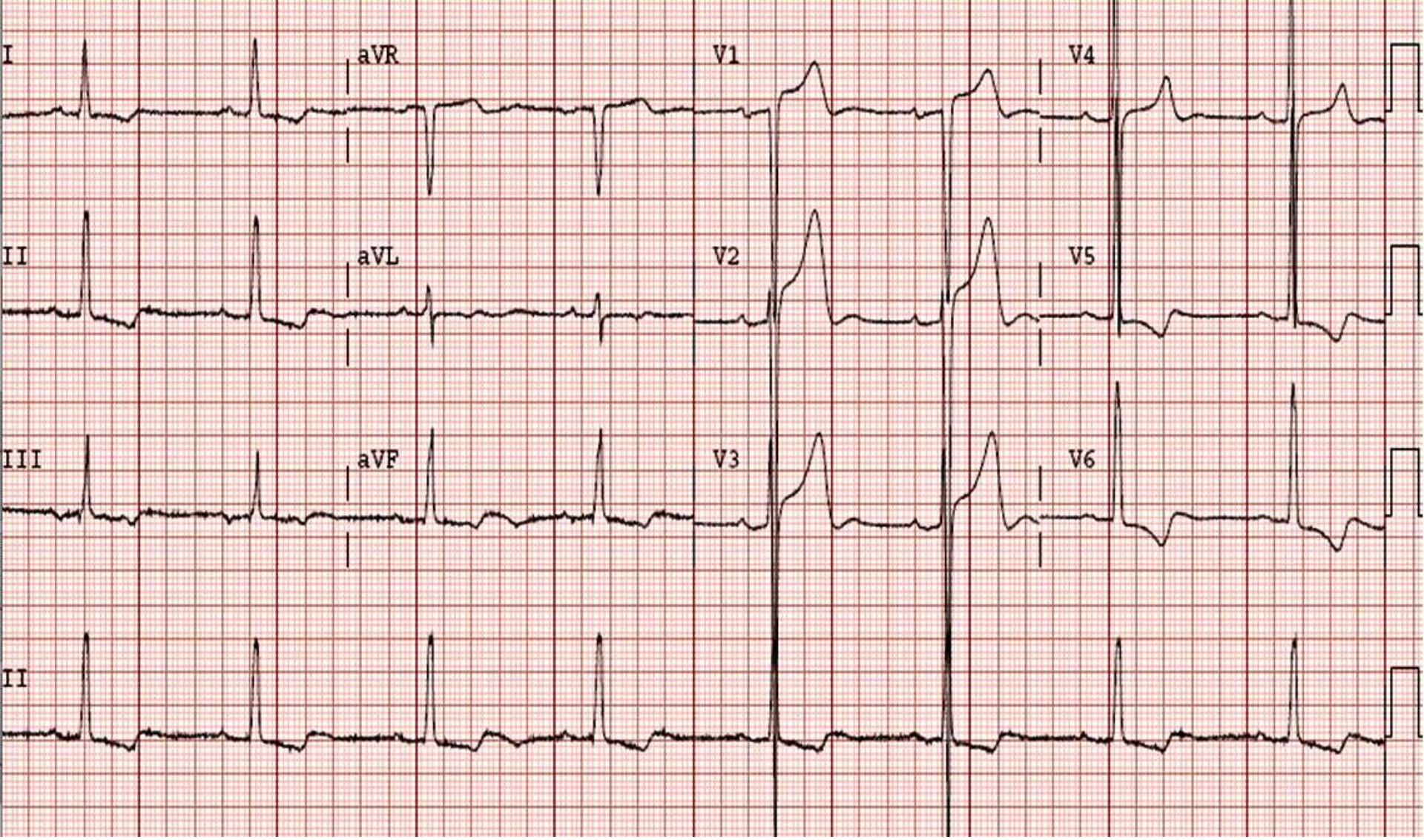
Example ECG LVH



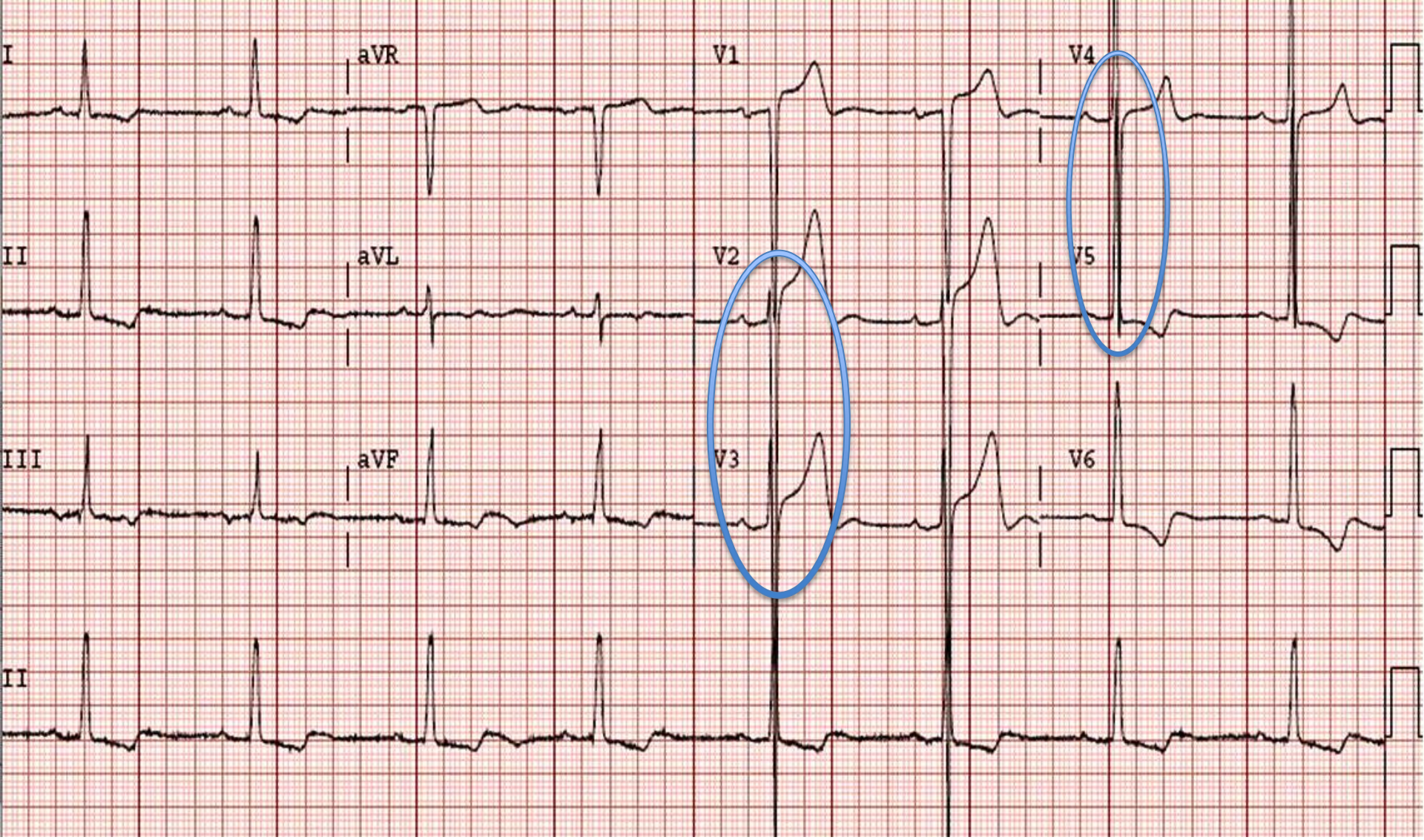

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
150 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 1 rhythm ld
MAC 8 002B
12SL tm v250



Example of LVH



What's your diagnosis?



What's your diagnosis?