

## Section 3

### Axis Determination

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## 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, Bifascicular and trifascicular block, acute and chronic MI changes
  - Define QTc significance and other EKG Abnormalities

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## Objectives

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  - Define QTc significance

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## 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

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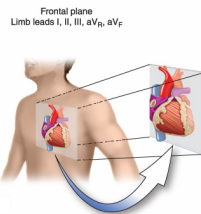
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## Limb Leads

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



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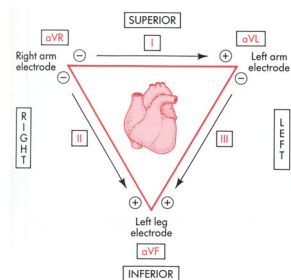
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## Frontal Leads



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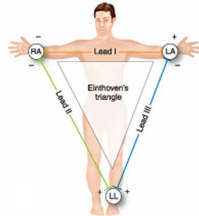
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## Bipolar Leads

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



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## 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

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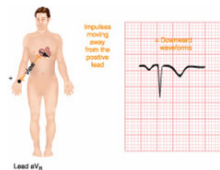
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## Limb Leads - Lead $aV_R$



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

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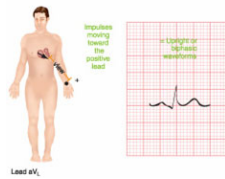
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### Limb Leads - Lead aV<sub>L</sub>



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

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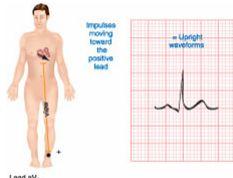
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### Limb Leads - Lead aV<sub>F</sub>



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

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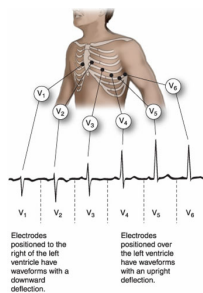
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### Precordial Leads

- Includes leads V<sub>1</sub>, V<sub>2</sub>, V<sub>3</sub>, V<sub>4</sub>, V<sub>5</sub> and V<sub>6</sub>
- Positioned in order across the chest
- Unipolar
  - Opposing pole is center of heart as calculated by ECG



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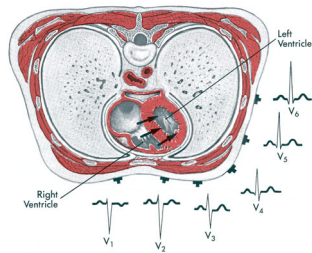
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## Precordial or Horizontal leads



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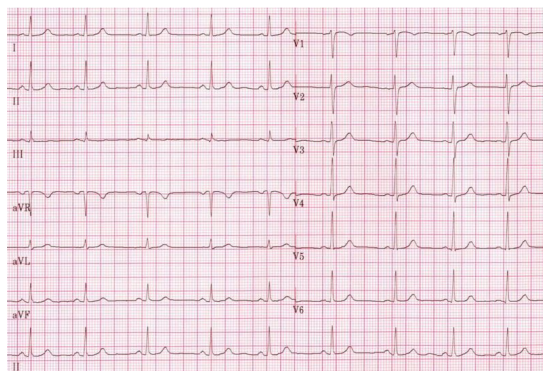
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## Normal Sinus Rhythm



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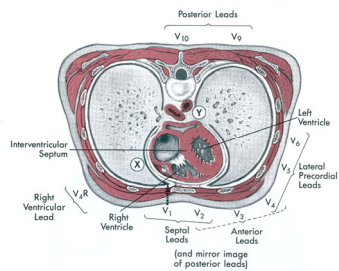
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## Additional Leads



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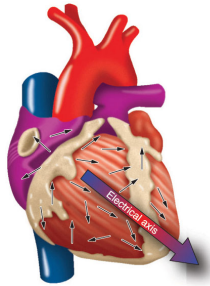
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### Mean Electrical Axis

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



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### 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

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### 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

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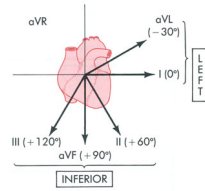
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## Vectors of Limb Leads



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## 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).

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## 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

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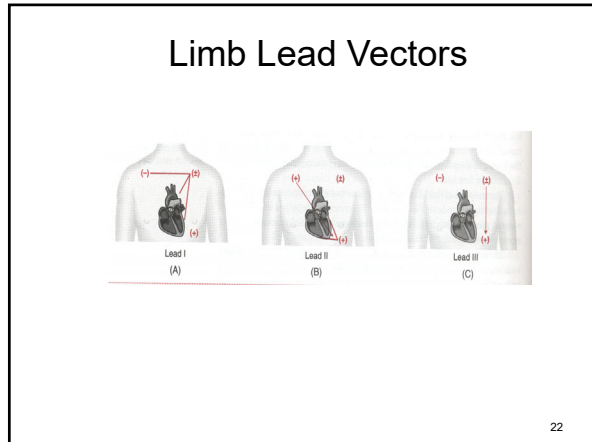
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### Position of the Mean QRS Axis

- 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<sub>F</sub> starts at +90 degrees and is located at the six o'clock position

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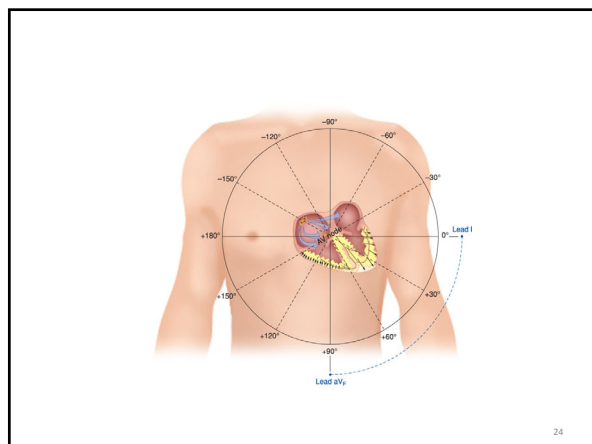
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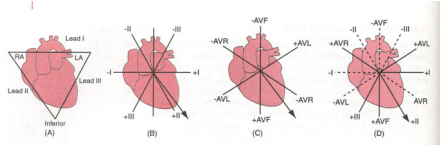
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## Einthoven's Triangle



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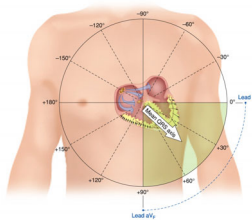
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## Position of the Mean QRS Axis

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



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## Determining Electrical Axis

- Use leads I and aV<sub>F</sub>
  - The two leads that can best detect variations in the heart's electrical axis

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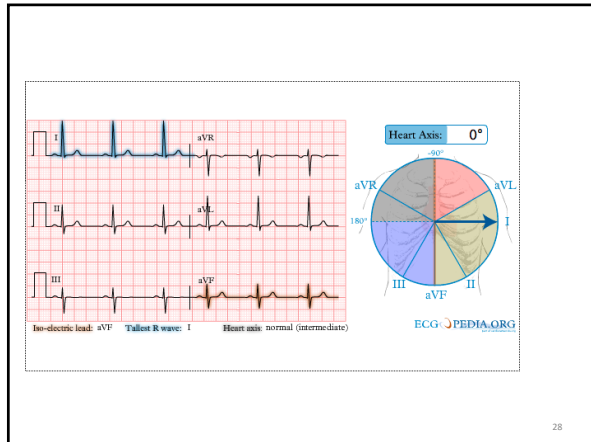
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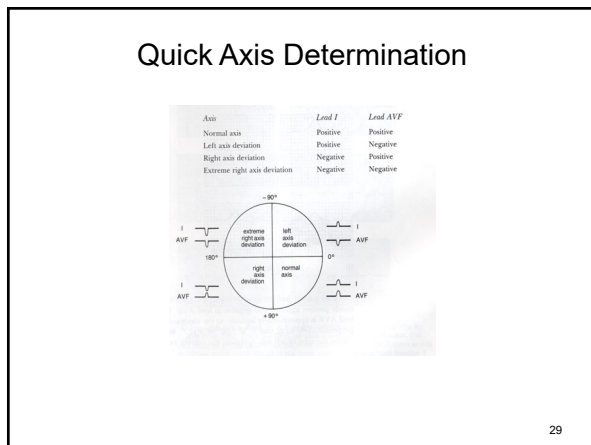
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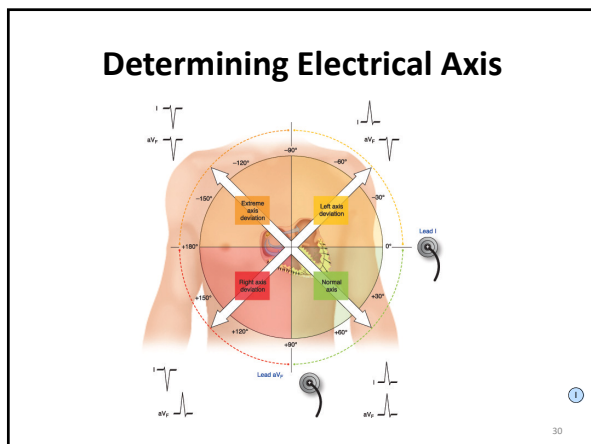
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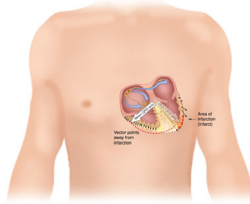
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## Determining Electrical Axis

- 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



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## ECG

Potential causes of Axis deviation

- |                               |                              |
|-------------------------------|------------------------------|
| • <b>Right axis deviation</b> | • <b>Left Axis deviation</b> |
| Normal                        | Normal                       |
| RVH                           | LVH                          |
| Conduction disturbances       | Conduction disturbances      |
| MI                            | MI                           |
| Valvular Disease              | Valvular Disease             |
| Pulmonary HTN                 | Systemic HTN                 |
| Congenital                    | Congenital                   |
| Pulmonary disease             | Other                        |

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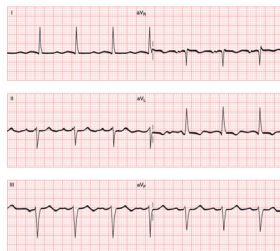
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## Practice Makes Perfect

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



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### Practice Makes Perfect

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



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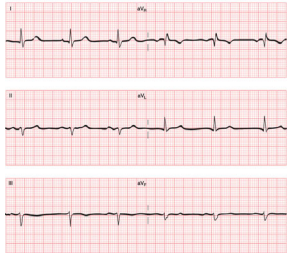
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### Practice Makes Perfect

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



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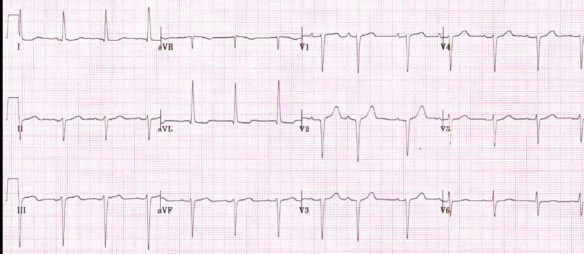
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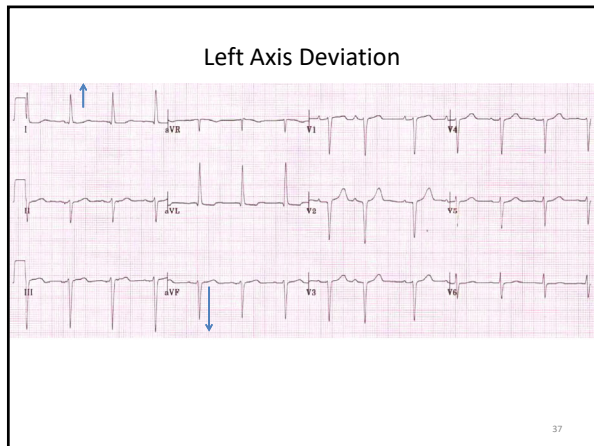
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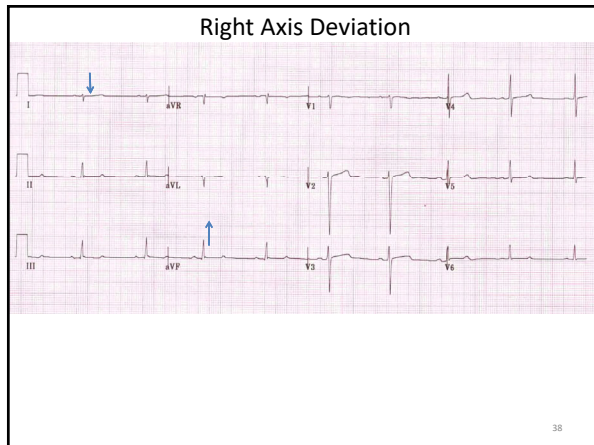
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## Section 4

### Hypertrophy

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### Hypertrophy

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

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### Dilation or Enlargement

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

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### 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

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## 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

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## Hypertrophy Atrial

- |                                      |                              |
|--------------------------------------|------------------------------|
| • <b>RAE</b>                         | • <b>LAE</b>                 |
| Pulmonary HTN                        | Systemic HTN                 |
| Pulmonary emboli                     |                              |
| COPD                                 |                              |
| Tricuspid/Pulmonary<br>valve disease | Aortic and Mitral<br>disease |
| Some congenital heart<br>disease     | Left ventricular failure     |

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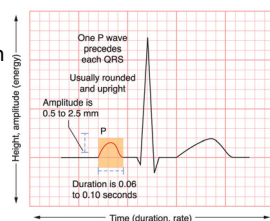
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## Normal P Wave

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



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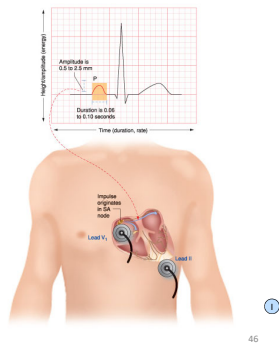
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## Atrial Enlargement

- Leads II and  $V_1$  used to assess atrial enlargement



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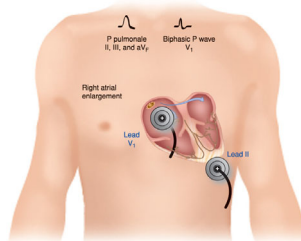
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## Right Atrial Enlargement

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



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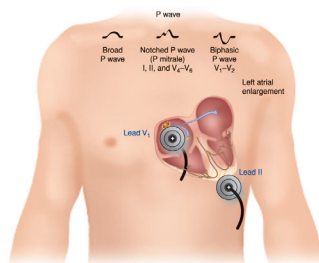
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## Left Atrial Enlargement

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



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## Criteria for RAE & LAE

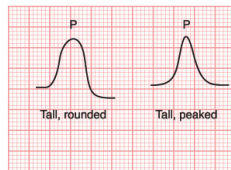
Condition	P Wave Appearance		Mnemonic Features
	Lead II	Lead V <sub>1</sub>	
Normal Sinus Rhythm (NSR)			The P should be upright in lead II if there is sinus rhythm. The P wave may be upright, negative, or biphasic in lead V <sub>1</sub> with sinus rhythm.
RAA (= P Pulmonale)			Prominent ( $\geq 2.5$ mm tall) peaked P waves in the pulmonary leads (II, III, and aVF).
LAA (= P Mitrale)			M-shaped, widened ( $\geq 0.12$ sec) P waves in one or more of the mitral leads (I, II, or aVL). Deep, negative component to the P wave in lead V <sub>1</sub> .

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

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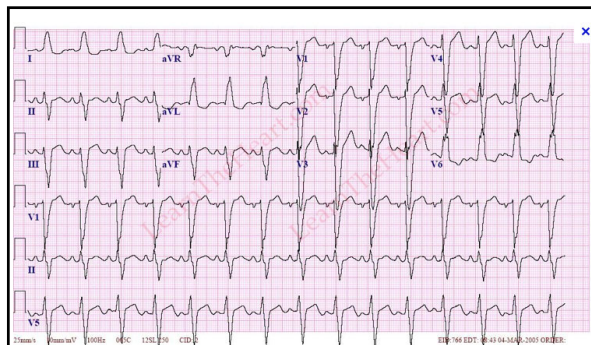
## Different Looking Sinus P Waves

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

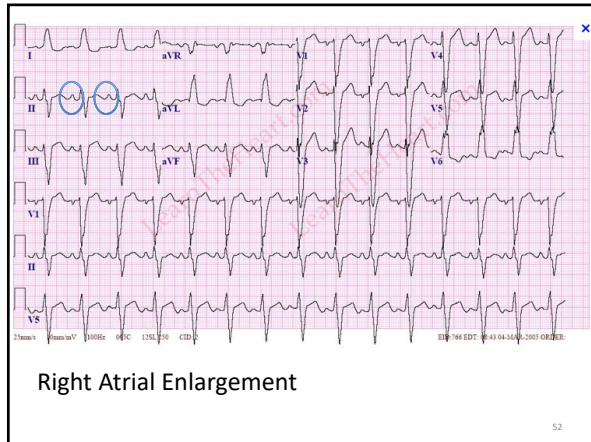


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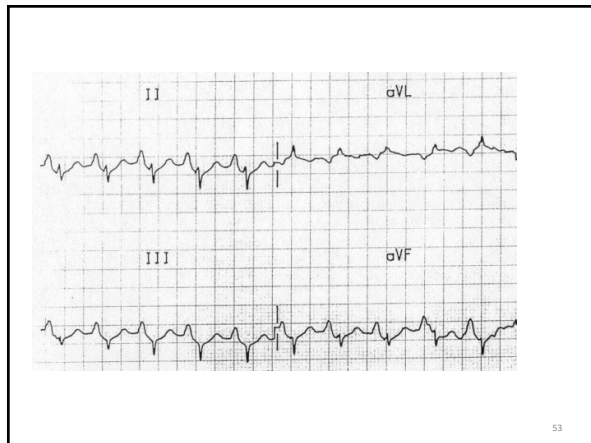
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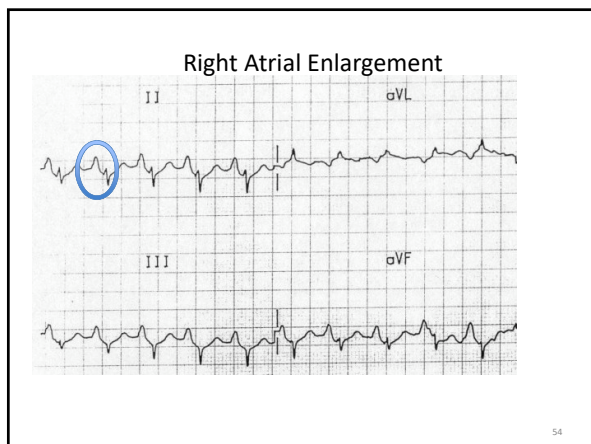
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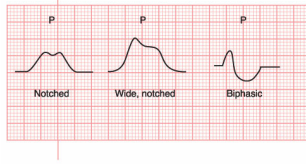
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## Different Looking Sinus P Waves

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



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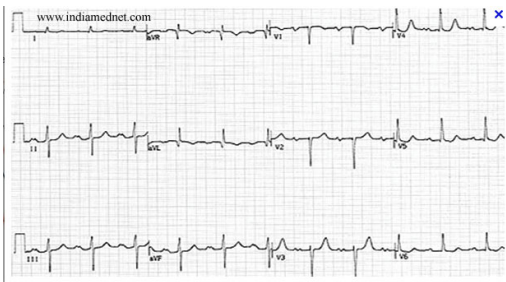
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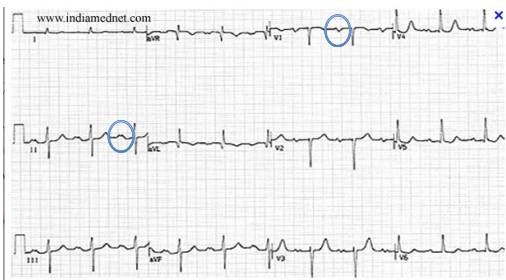
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## Left Atrial Enlargement



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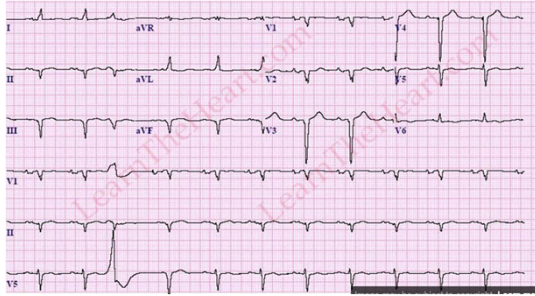
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### What's your diagnosis?



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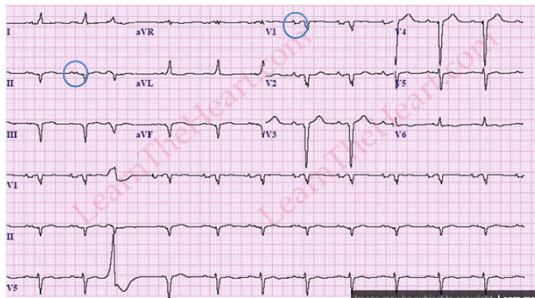
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### Left atrial enlargement



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### 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

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## Ventricular Hypertrophy

- RVH
  - Pulmonary HTN, COPD, PE
  - Mitral valve disease
  - Pulmonary valve stenosis
  - VSD
  - Congenital heart disease with right ventricular overload

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## Ventricular Hypertrophy continued

- LVH
  - Systemic HTN
  - Aortic Stenosis/insufficiency
  - Hypertrophic cardiomyopathy (IHSS, HOCM)
  - Cardiomyopathies

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## 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

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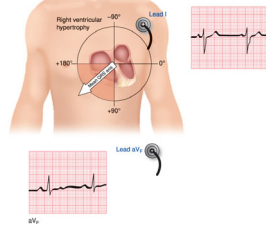
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## Right Ventricular Hypertrophy

- Most common characteristic in limb leads is right axis deviation



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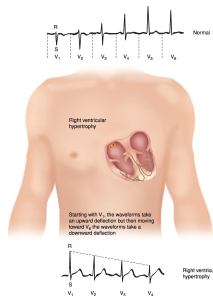
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## Right Ventricular Hypertrophy

- In precordial leads R waves are more positive in leads which lie closer to lead V<sub>1</sub>



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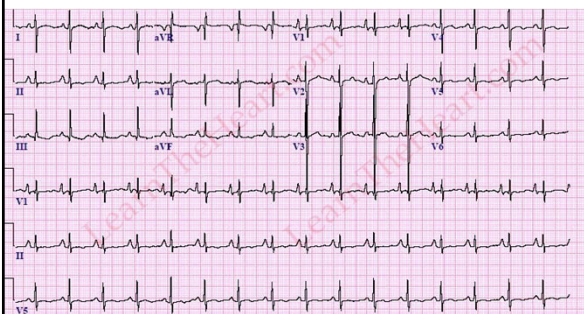
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## ECG Example RVH



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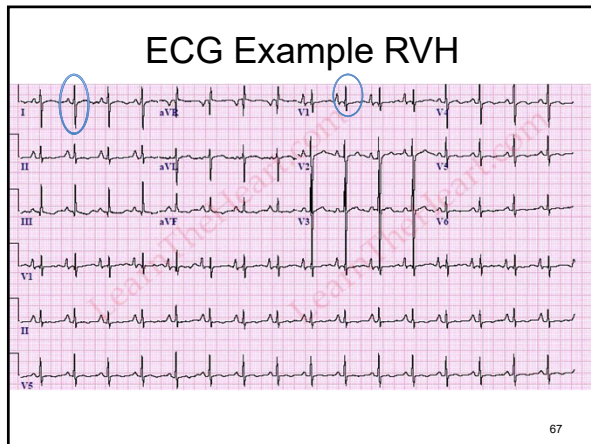
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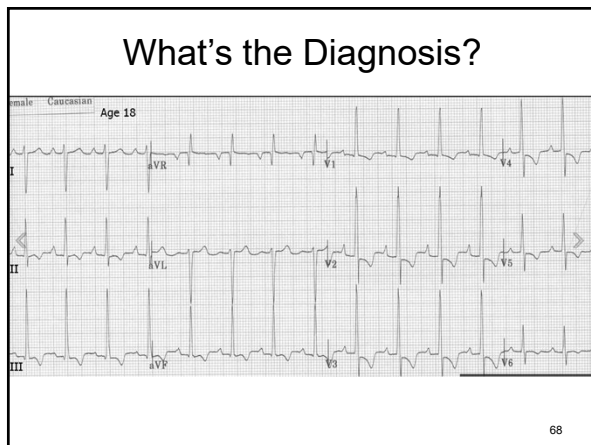
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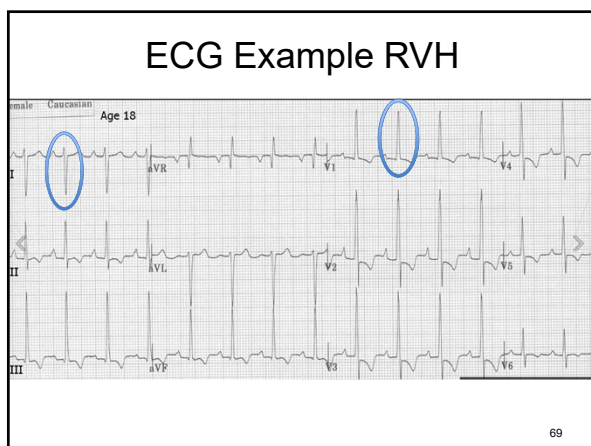
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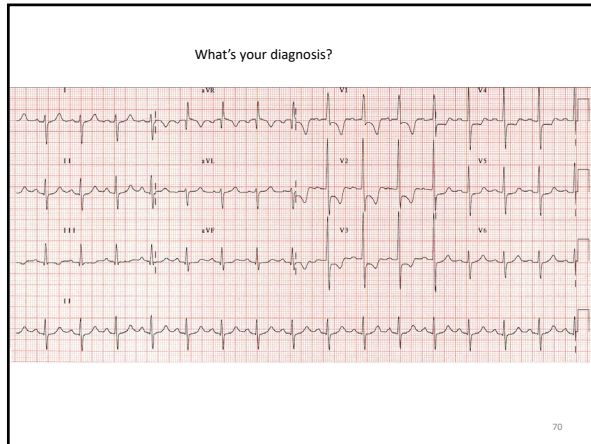
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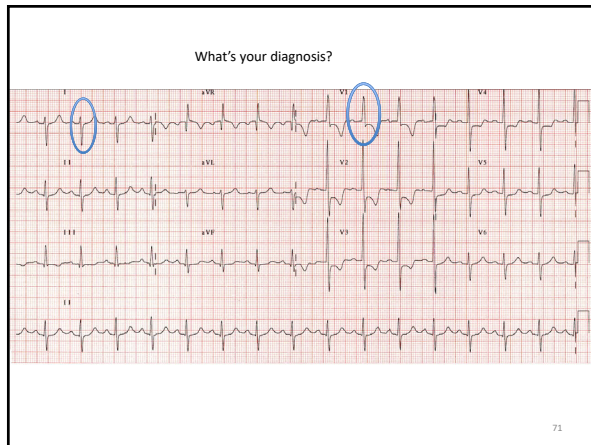
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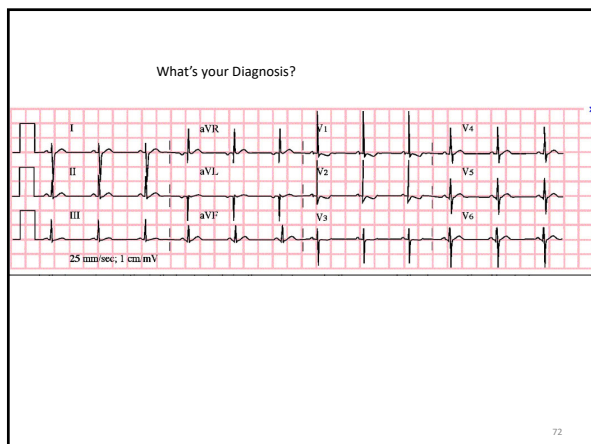
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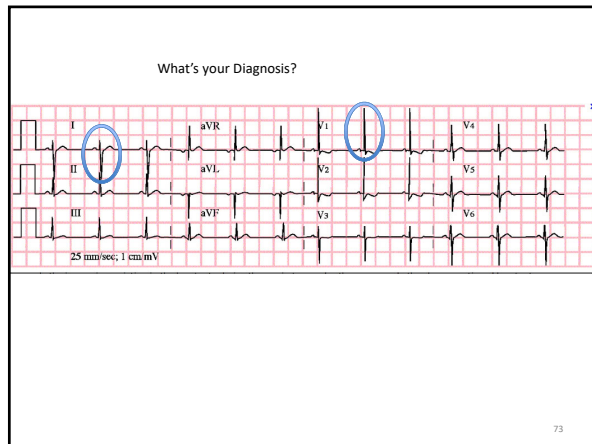
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### Criteria for LVH

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

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### Criteria of LVH by the Cornell Method

- Cornell Voltage Criteria
  - S in V3 + R in aVL  $> 28\text{ mm}$  (men)
  - S in V3 + R in aVL  $> 20\text{ mm}$  (women)
  - 23% Sensitivity
  - 96% Specificity

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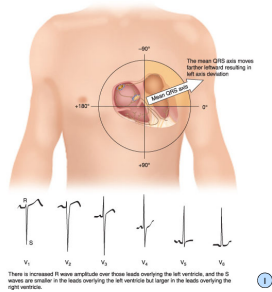
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## Left Ventricular Hypertrophy

- 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  $V_1$ )



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## Other Criteria for LVH determination

- An R wave  $\geq 20$  mm in any of the other inferior leads (II, III, aVF)
- Deep S waves ( $\geq 20$ -25mm) in lead  $V_1$  or  $V_2$
- An R wave  $\geq 25$ mm in lead  $V_5$
- An R wave  $\geq 20$ mm in lead  $V_6$

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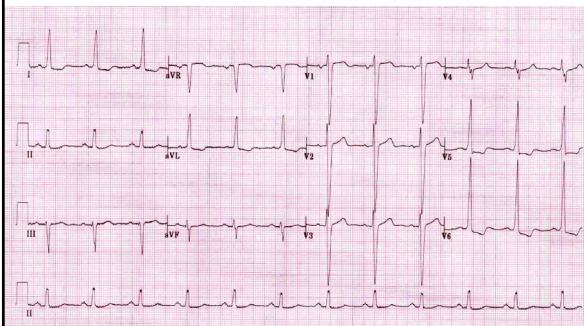
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What's your Diagnosis



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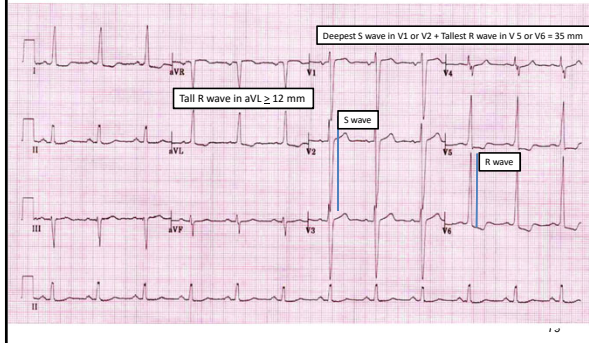
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## Example ECG LVH




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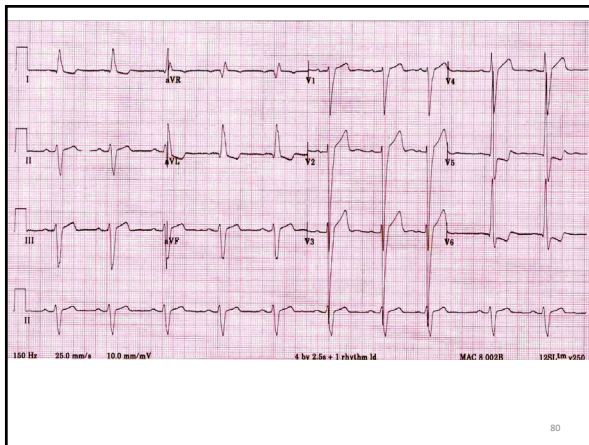
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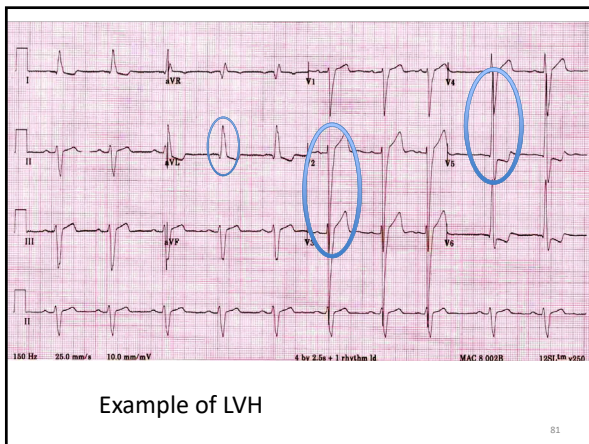
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## Example of LVH

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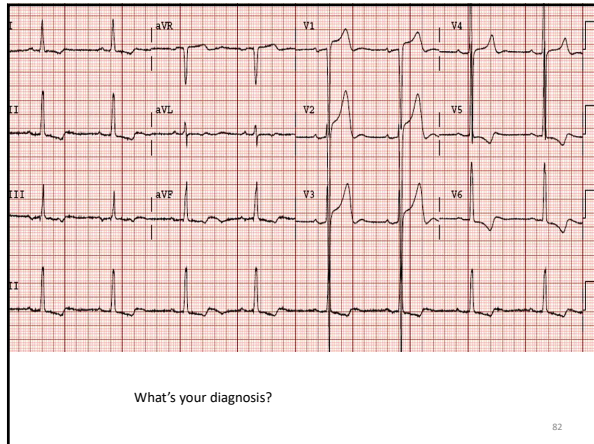
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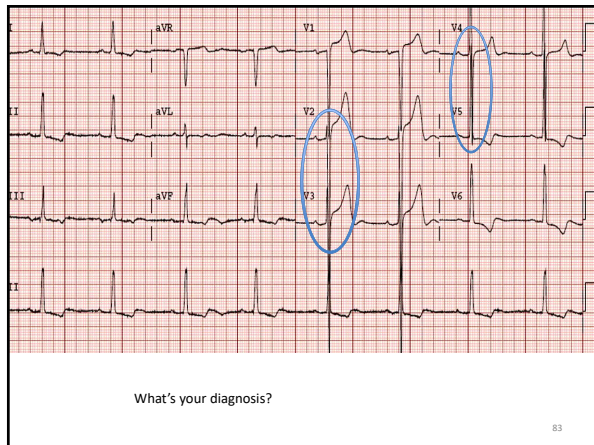
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