

**INTRODUCTION TO  
THE 12-LEAD EKG: I  
JUST DON'T GET  
THESE SQUIGGLY  
LINES**

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DFAAPA**



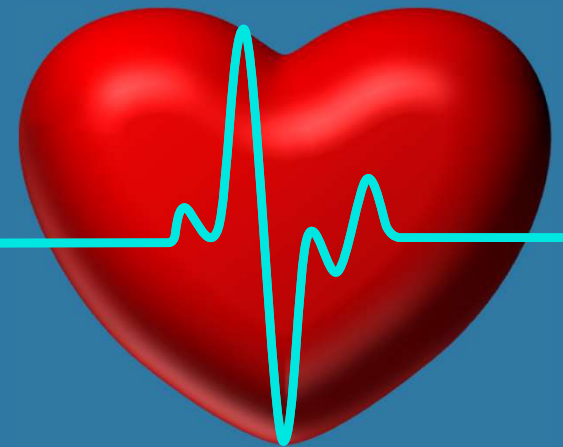
# DISCLOSURES

No relevant commercial  
relationships to disclose

# OBJECTIVES

At the conclusion of this lecture, participants will be able to:

- Apply a systematic approach to the interpretation of EKG's.
- Identify components of the EKG waveform
- Describe 12-lead EKG features of ischemia, injury, and infarction.
- Differentiate normal versus pathologic Q-waves



# A QUICK REVIEW



A-fib



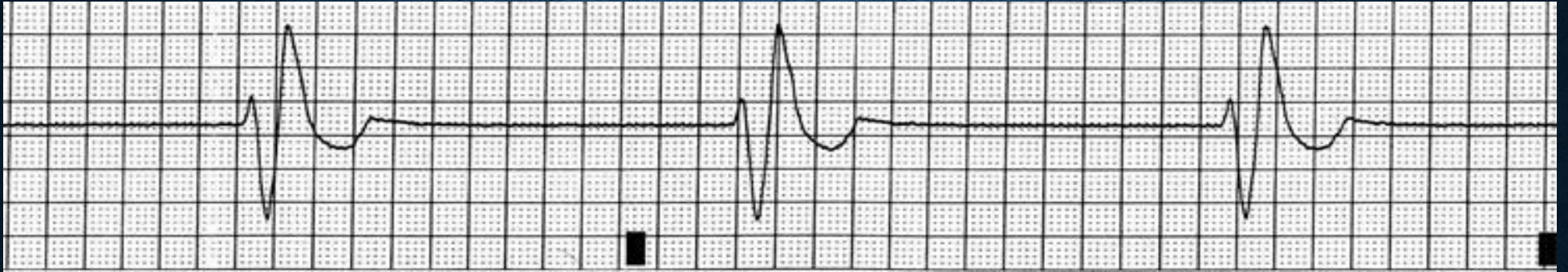
Junctional Tachycardia



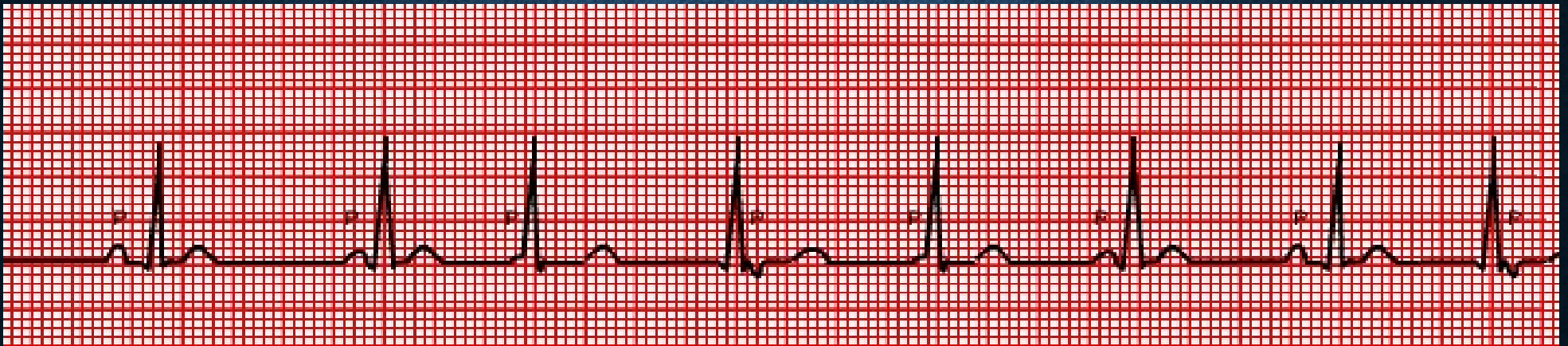
PAC



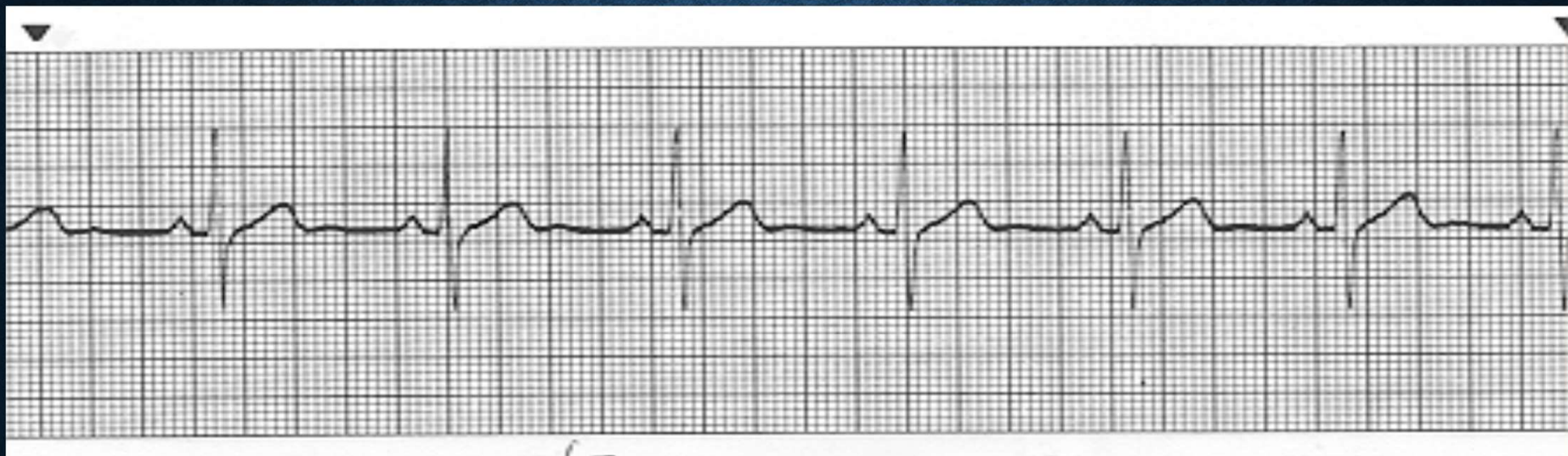
PJC



Idioventricular Rhythm



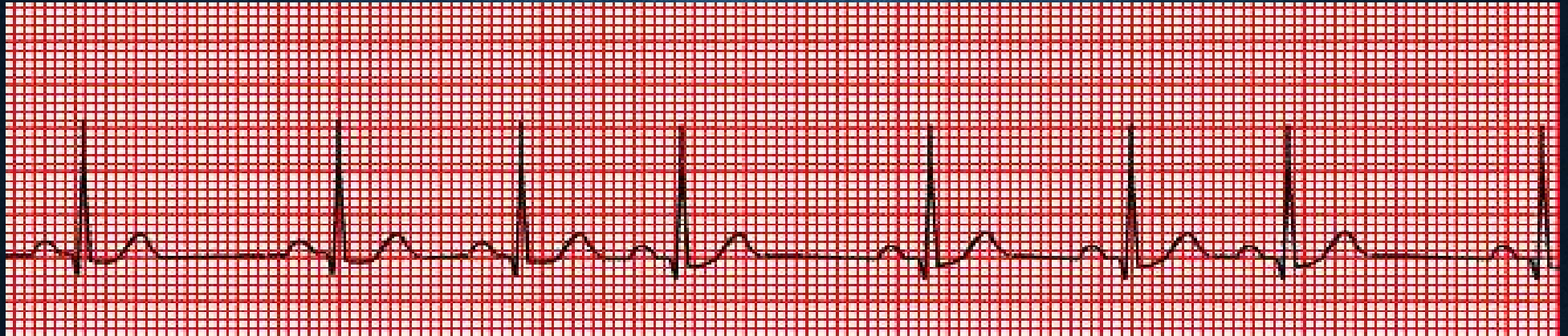
Wandering Pacemaker



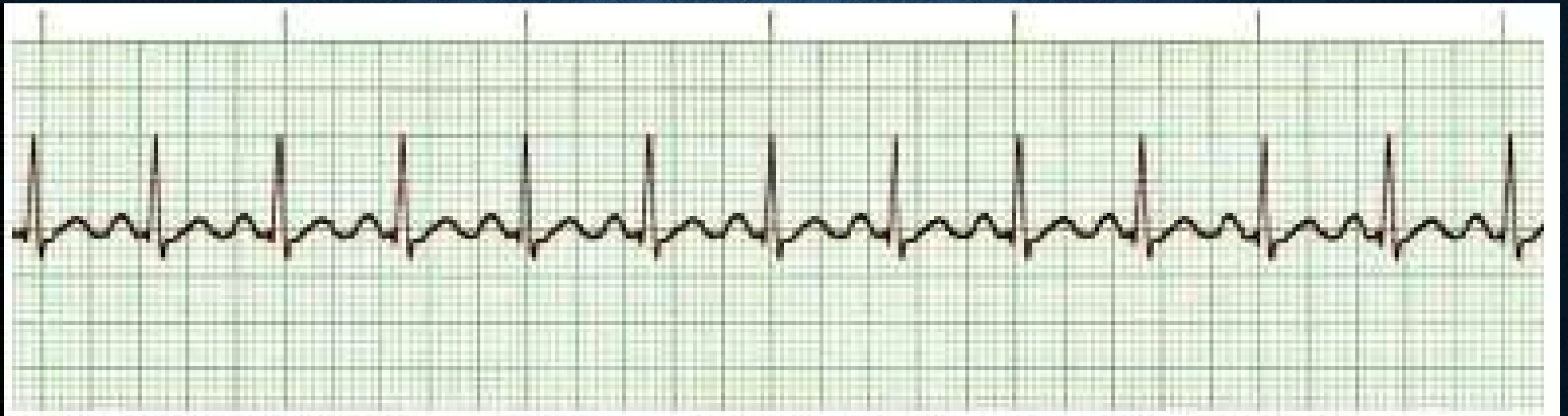
Normal Sinus Rhythm



Sinus Rhythm with Bigeminy

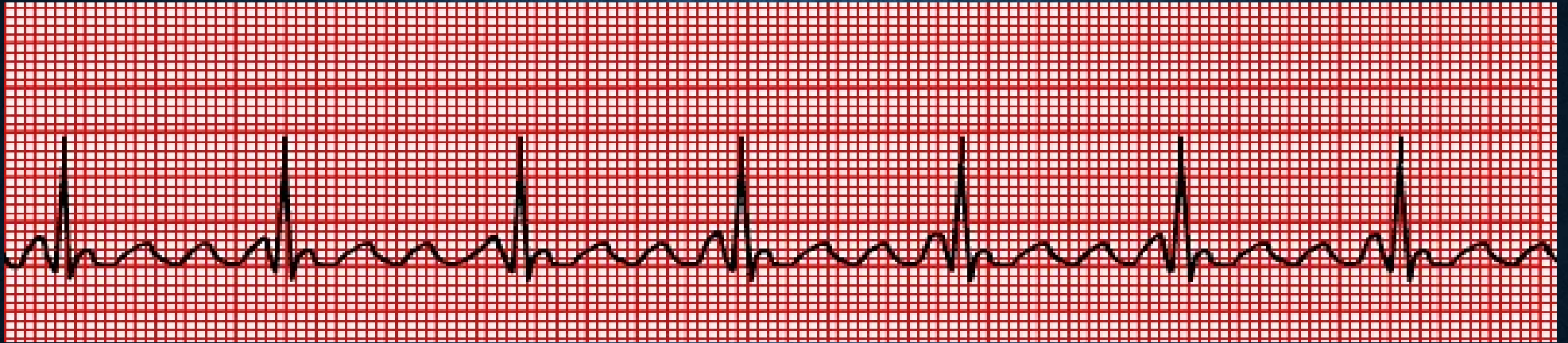


Sinus Arrhythmia



Sinus Tachycardia

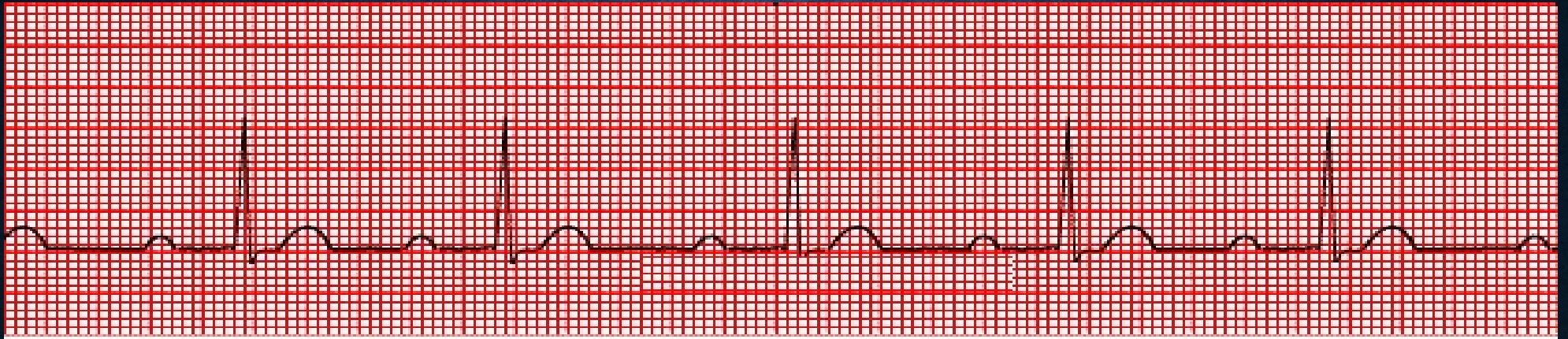




Atrial Flutter



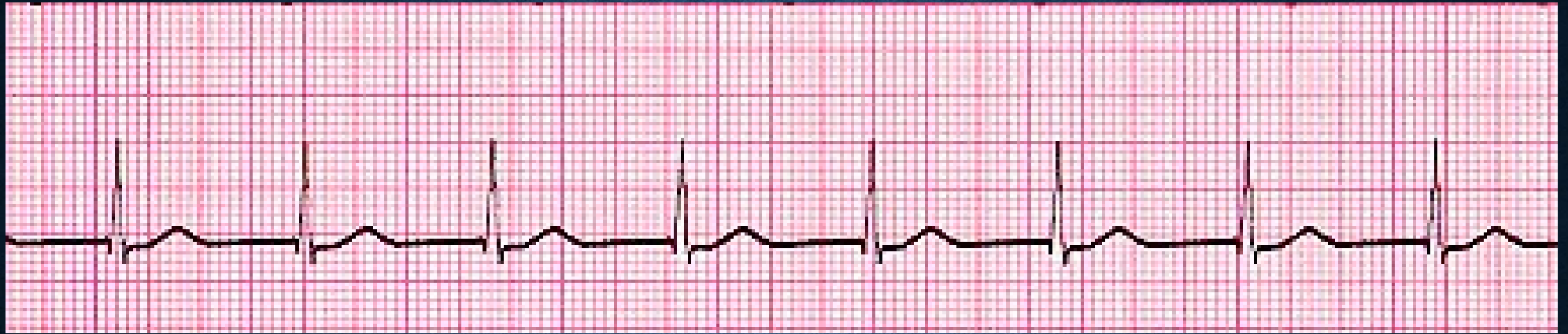
3<sup>rd</sup> Degree AV Block



1<sup>st</sup> Degree AV Block



Ventricular Tachycardia



Accelerated Junctional Rhythm



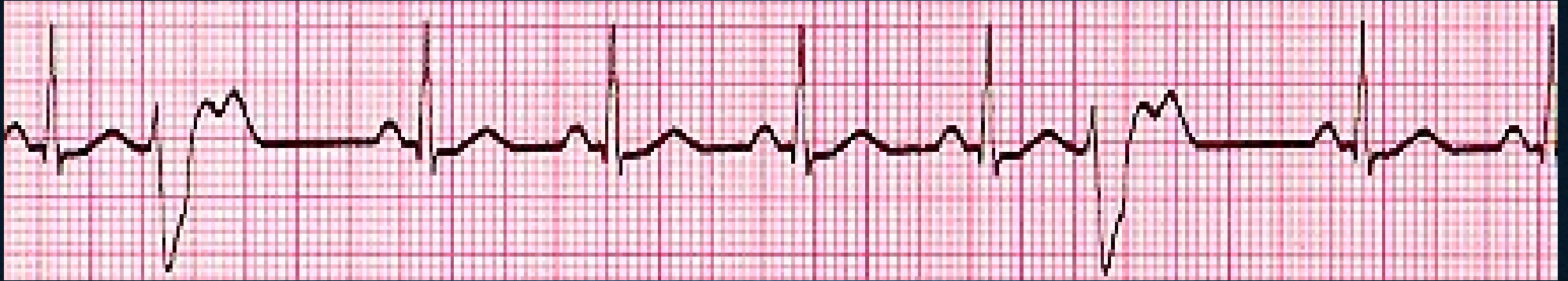
Supraventricular Tachycardia



Atrial Fibrillation (again)



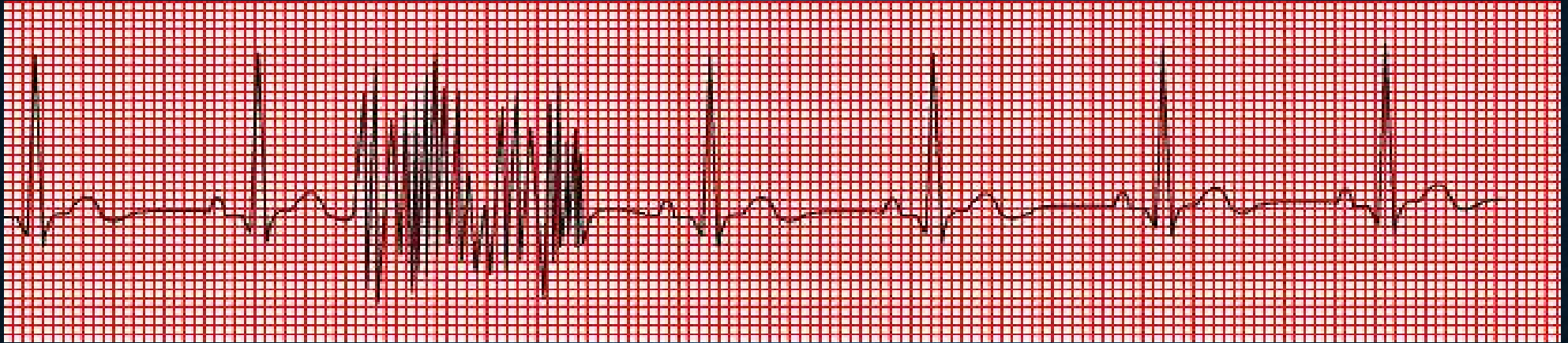
2<sup>nd</sup> Degree AV Block type I (Wenchebach)



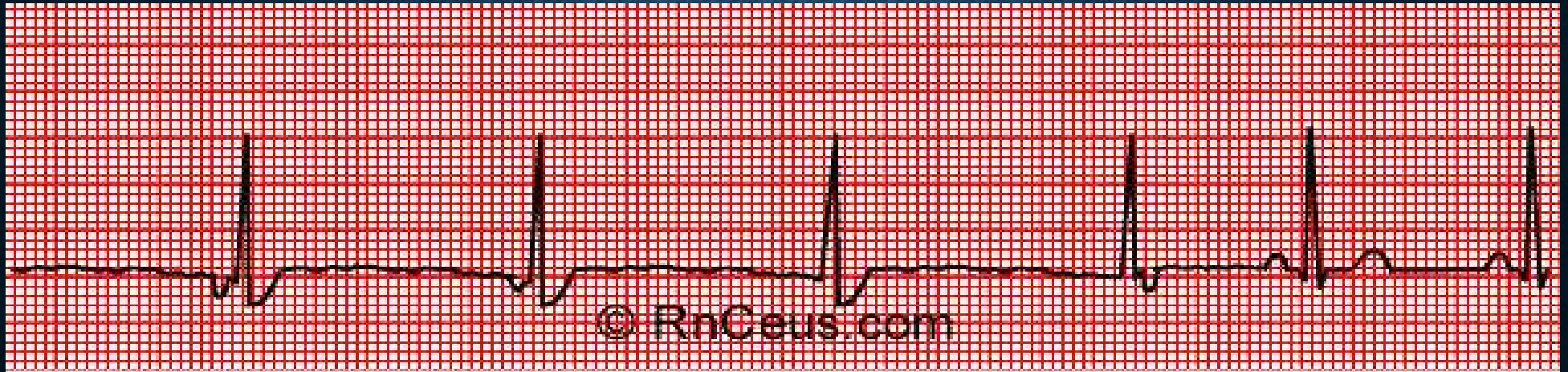
Sinus Rhythm with Unifocal PVC's



Torsade de Pointes



Sinus Rhythm with Artifact



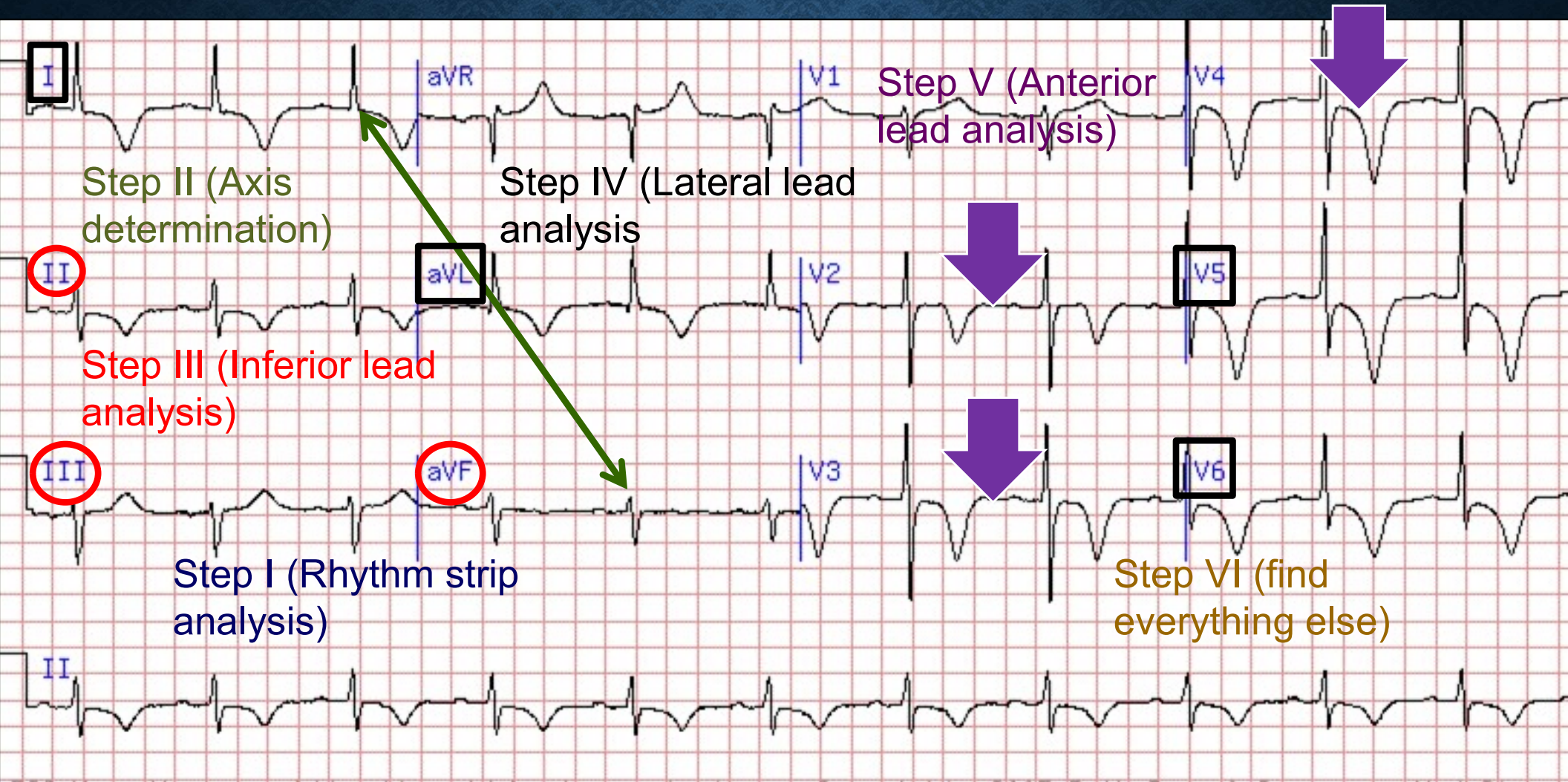
Junctional Escape Rhythm

# STEPS IN INTERPRETING THE 12-LEAD

1. Assess the rate (atrial and ventricular) and regularity of the underlying rhythm.
  - a) Assess the usual intervals and widths: PR interval, QRS width, QT interval.
  - b) Interpret the rhythm itself.
2. Determine the axis.
3. Grouped lead analysis
  - a) Look for signs of infarct vs. ischemia in all grouped leads
4. Look for any other abnormality



# ASSESSING THE EKG



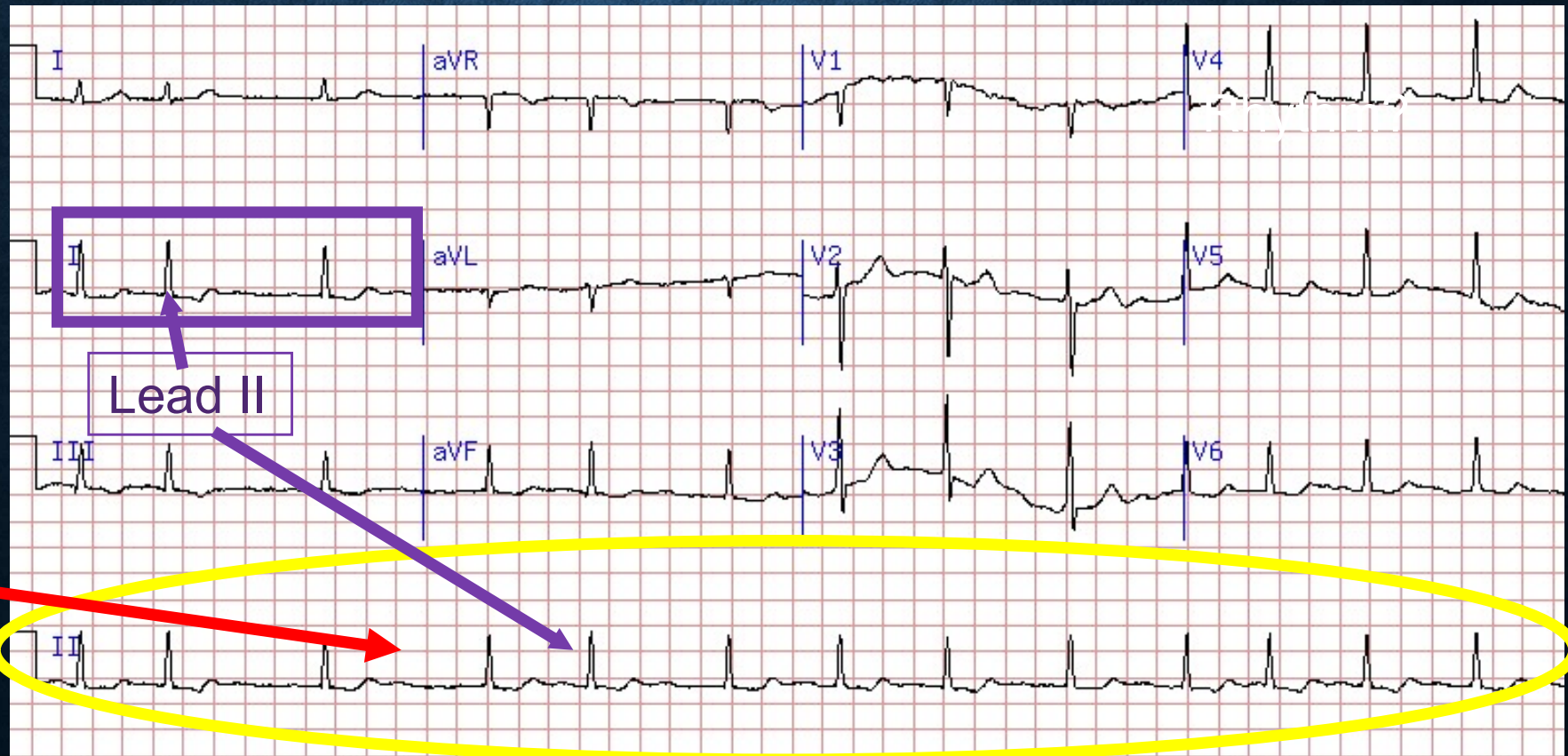


# ASSESSING THE EKG RHYTHM

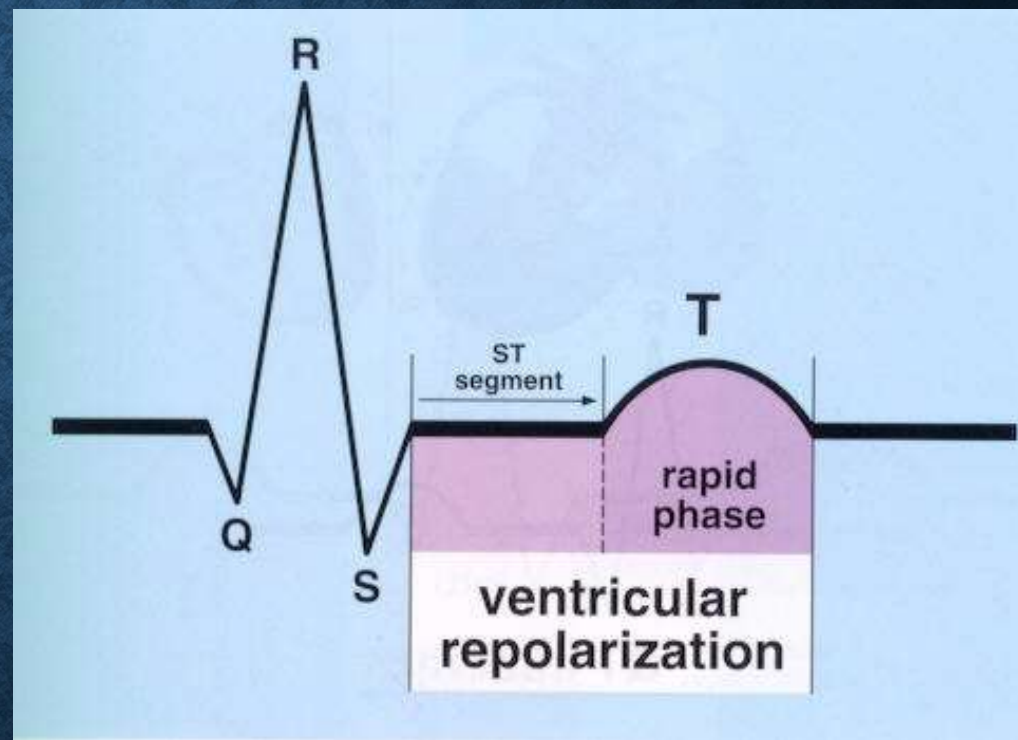
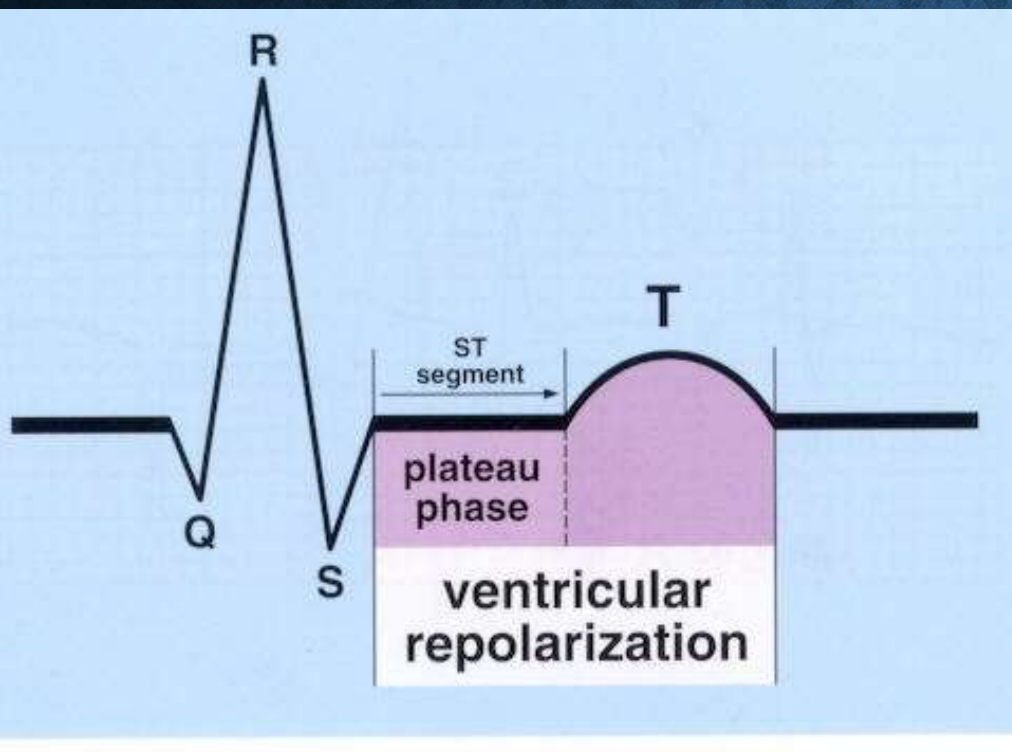
**Tip:** the rhythm strip portion of the 12-lead EKG is a good place to look at when trying to determine the rhythm because the 12 leads only capture a few beats.

*Atrial fibrillation*

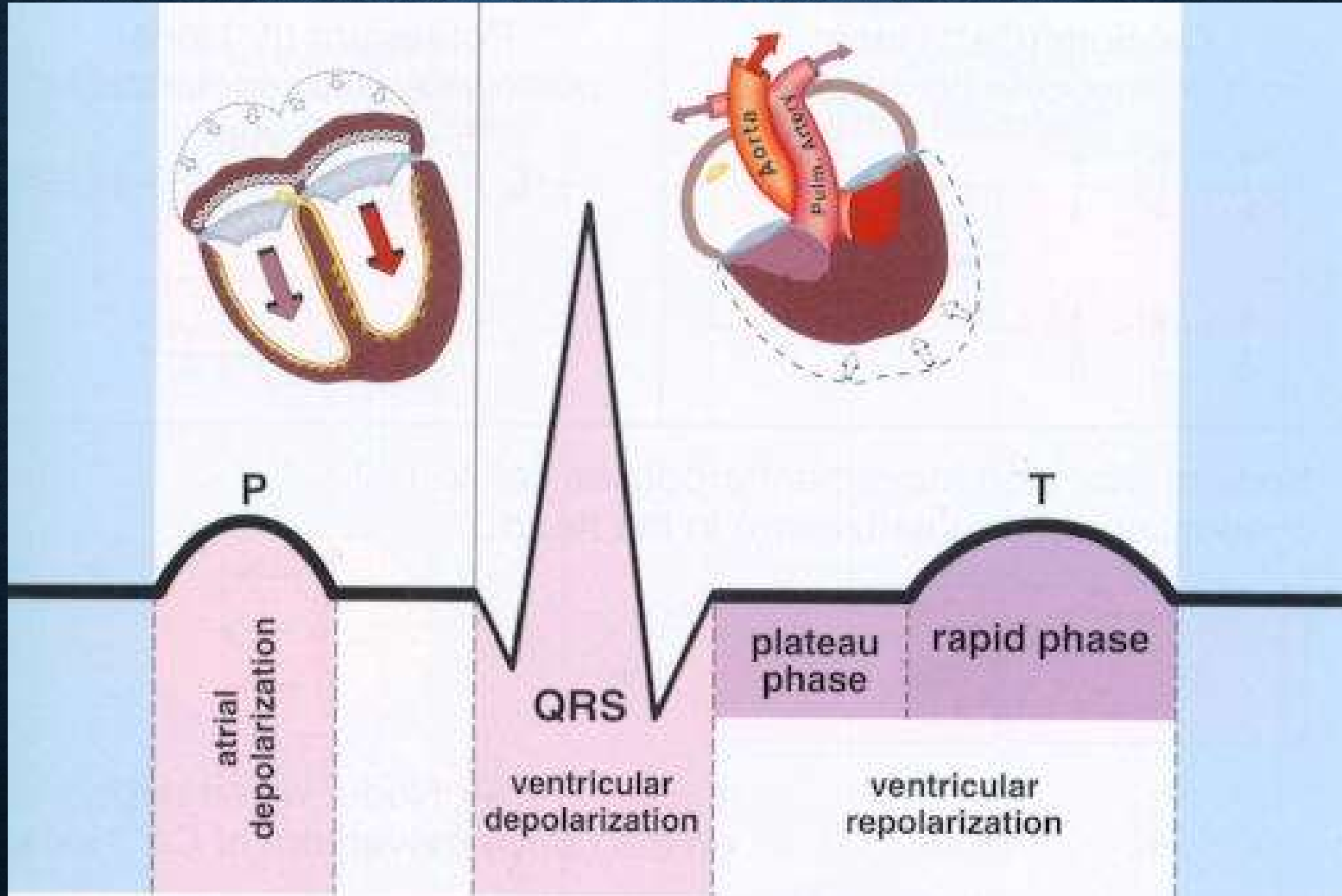
*Rhythm strip*



# PLATEAU & RAPID PHASES OF REPOLARIZATION



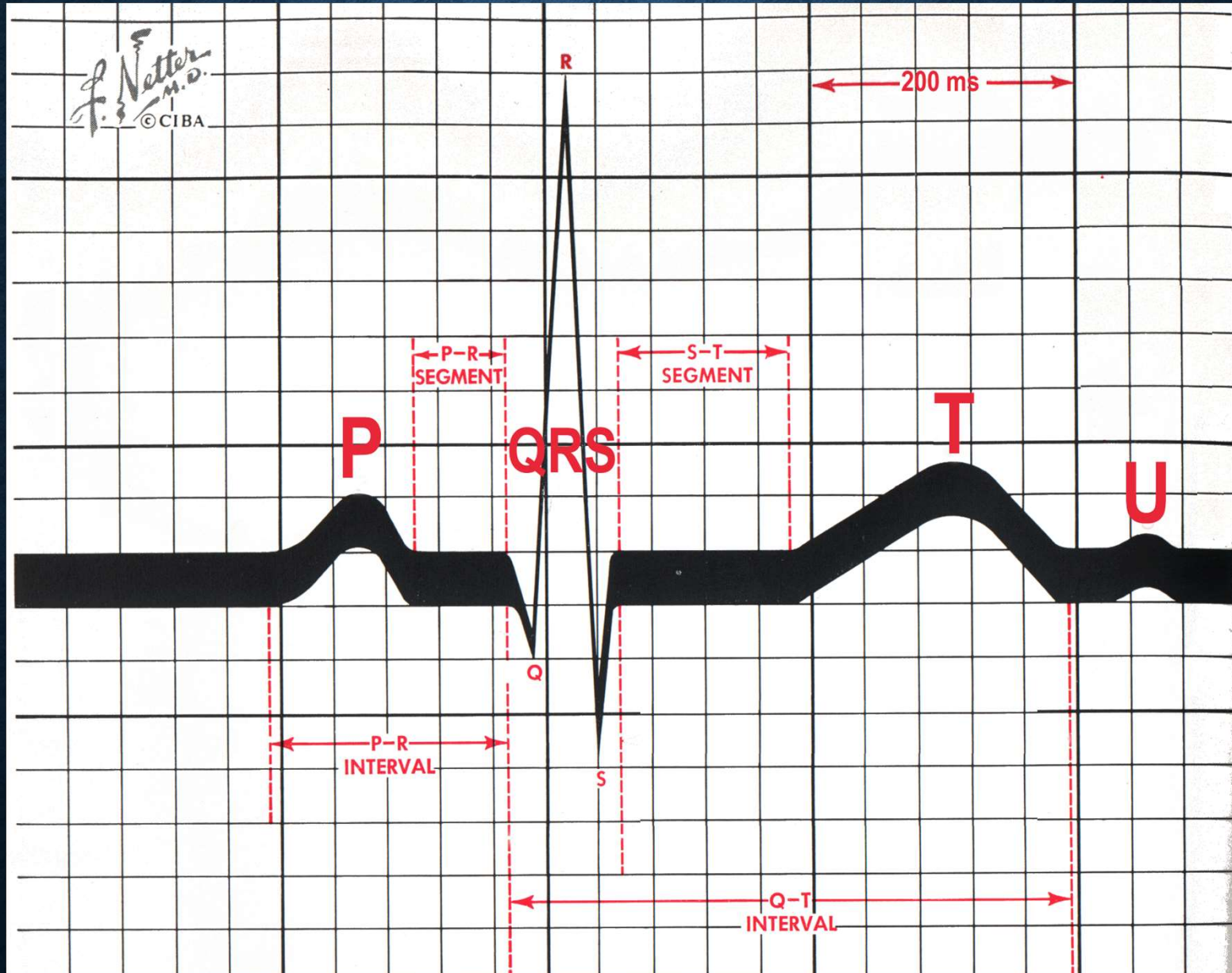
# COMPLETE CARDIAC CYCLE



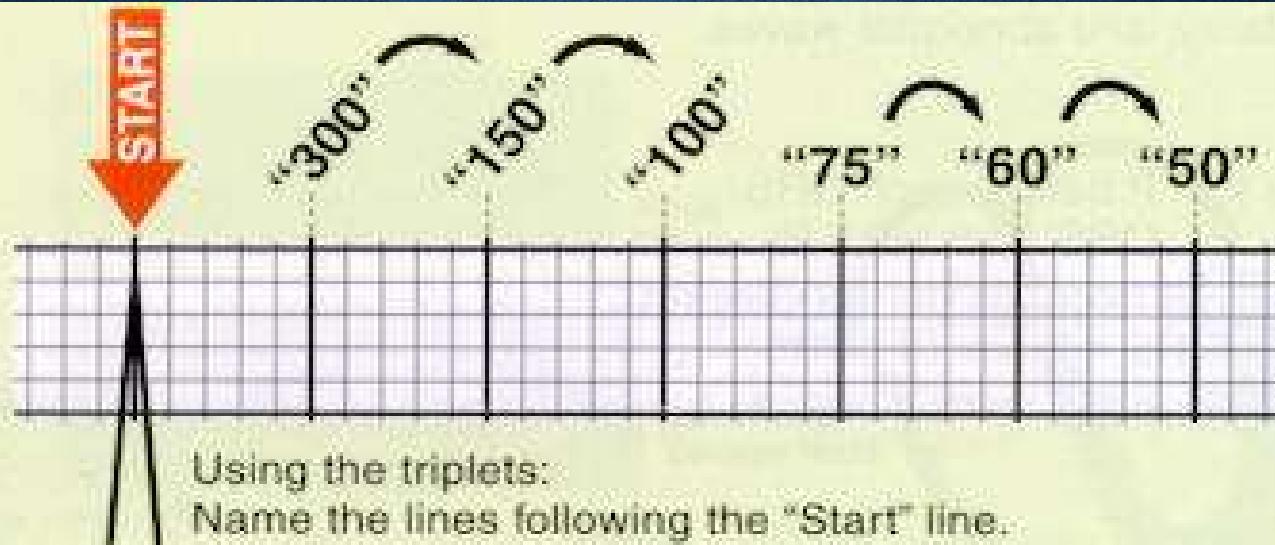
# U WAVE

- The U wave is a medical curiosity.
- It is not clear what relationship it has with cardiac activity but it is thought to represent the repolarization of the His-Purkinje complex.
- Becomes taller in hypokalemia and pts taking Quinidine
- Can flip in CAD.
- Usually follows the direction of the T wave and is best seen in lead V3.
- Due to the weakness of the signal, the U-wave is often not seen on the ECG.

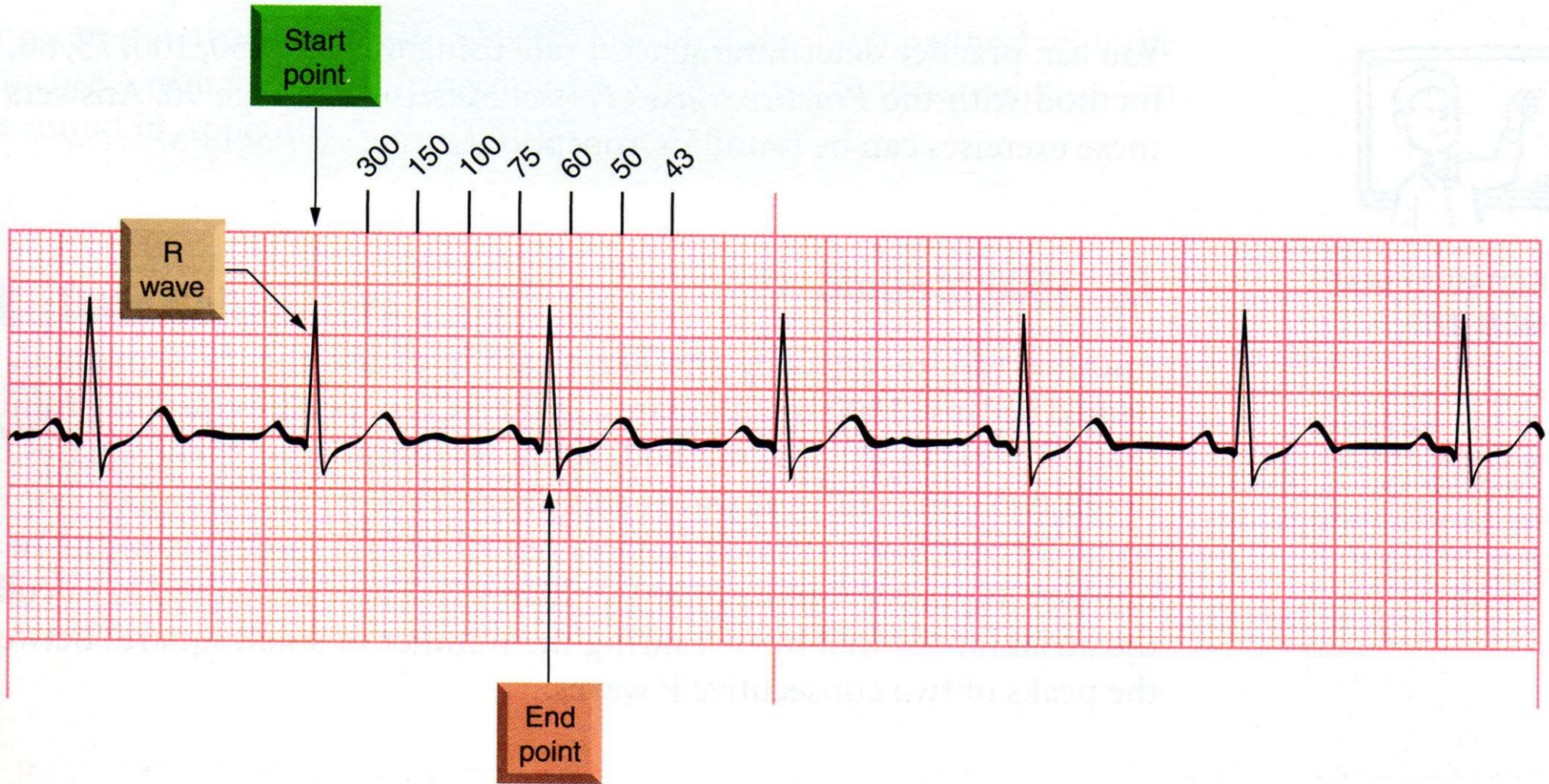
# U-WAVE



# RHYTHM COUNTING

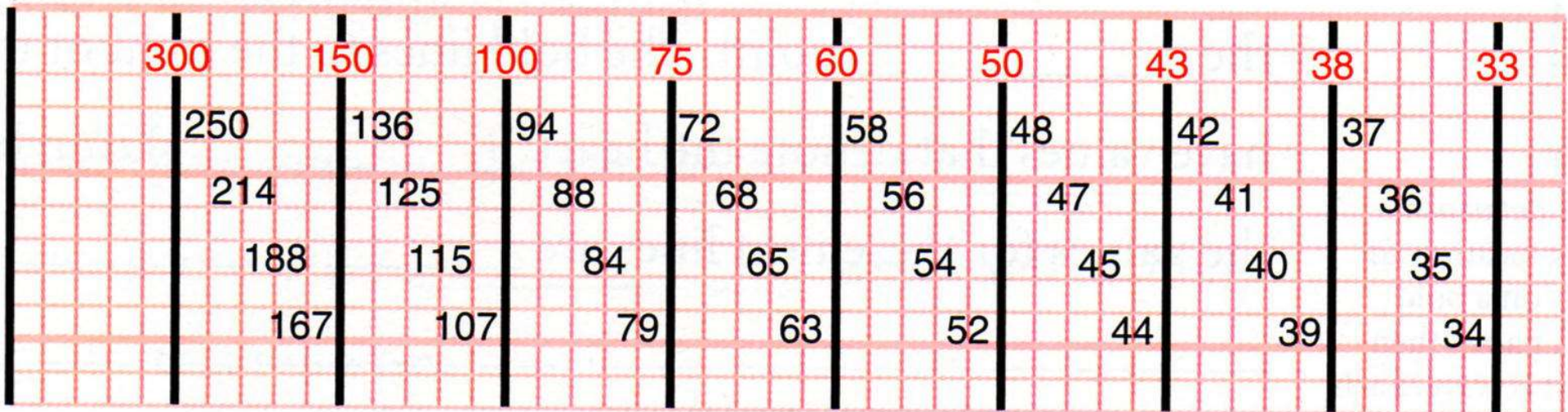


# FINER RHYTHM COUNTING



# FINER RHYTHM COUNTING

Start point





O

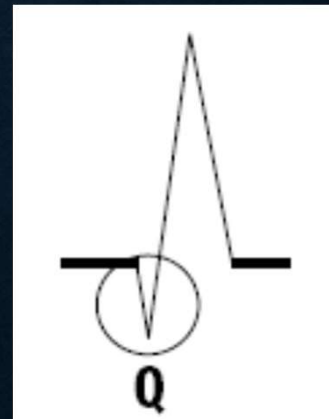


**-WAVES**

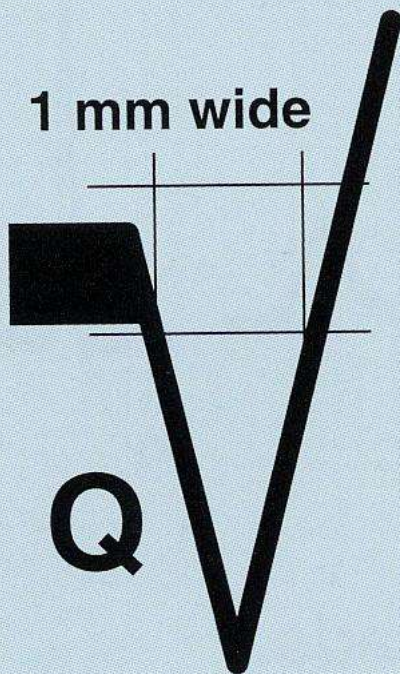


# Q WAVE = NECROSIS (SIGNIFICANT Q'S ONLY)

- Significant Q wave is one millimeter (one small square) wide, which is .04 sec. in duration...
- ... or is a Q wave 1/3 the amplitude (or more) of the QRS complex.
- Note those leads (omit AVR) where significant Q's are present
  - \* A Q wave in lead III alone is not diagnostic of infarction, even if it is otherwise "significant" in size and width. Qs in III are ignored unless other abnormalities are seen b/c they usually represent.....
- Old infarcts: significant Q waves (like infarct damage) remain for a lifetime.

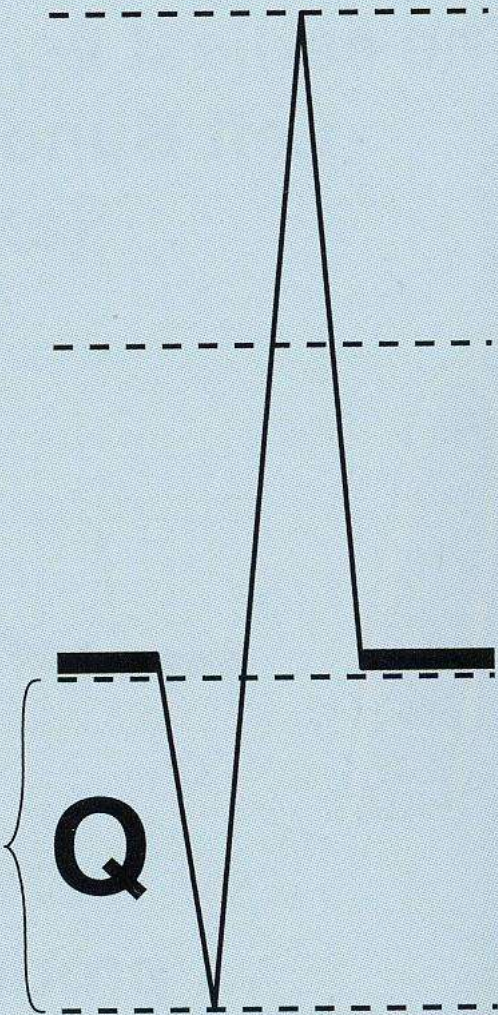


# Significant Q waves

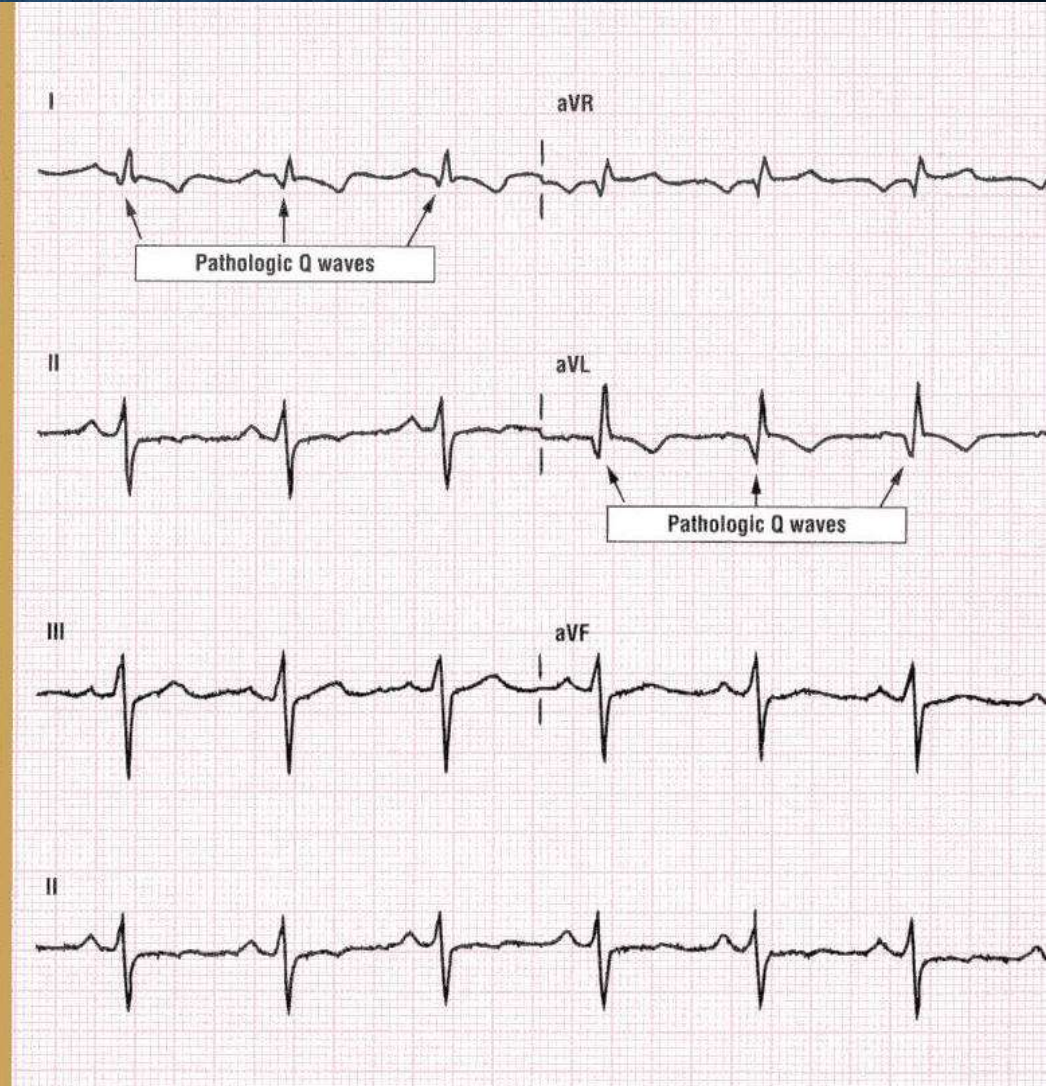
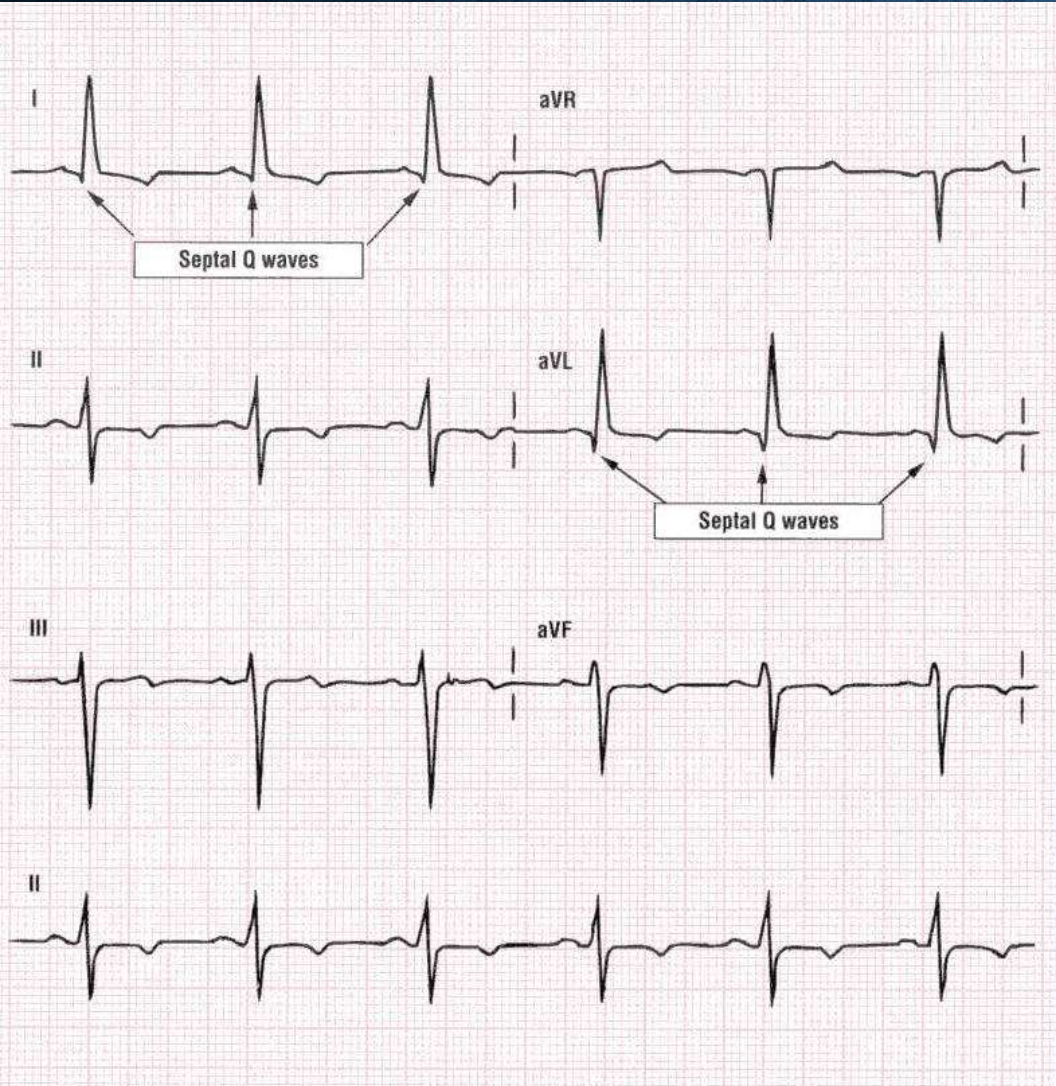


or

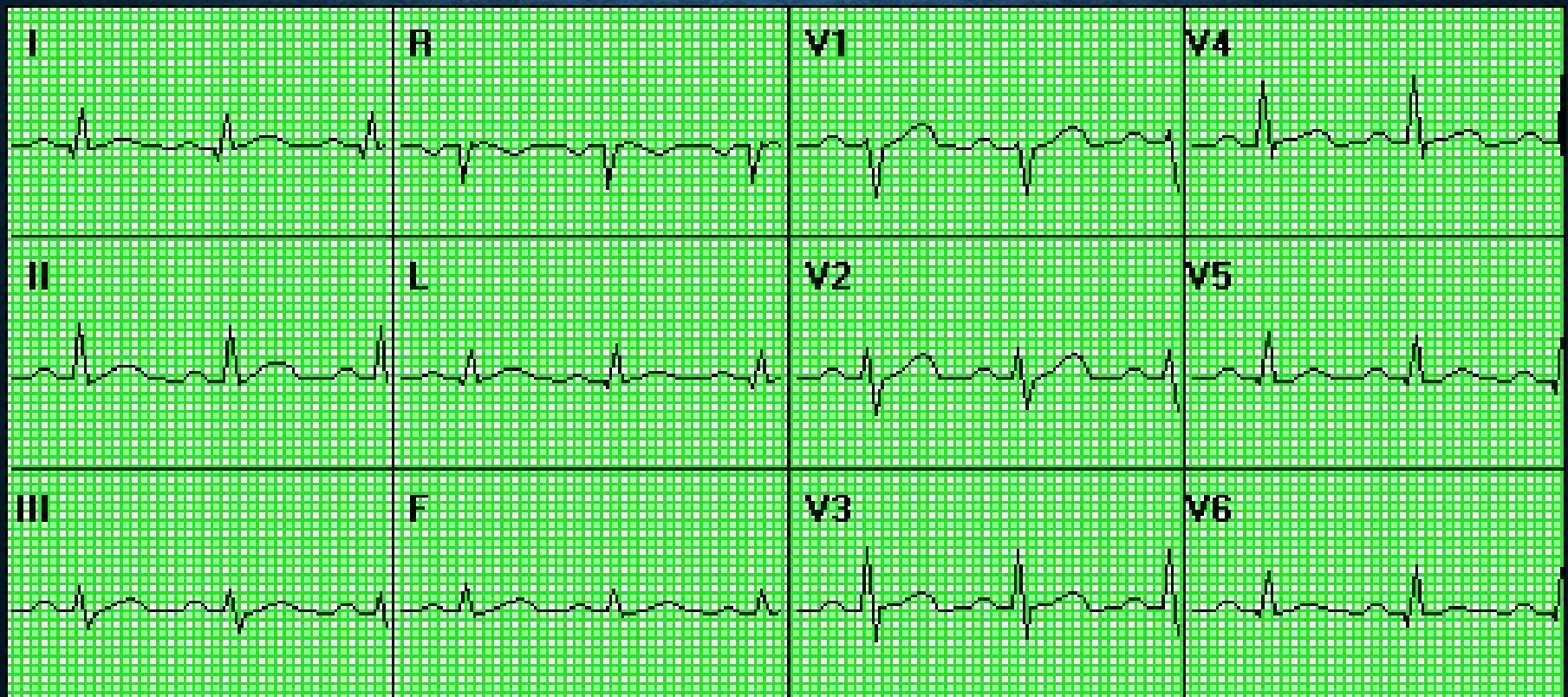
$\frac{1}{3}$  of QRS amplitude



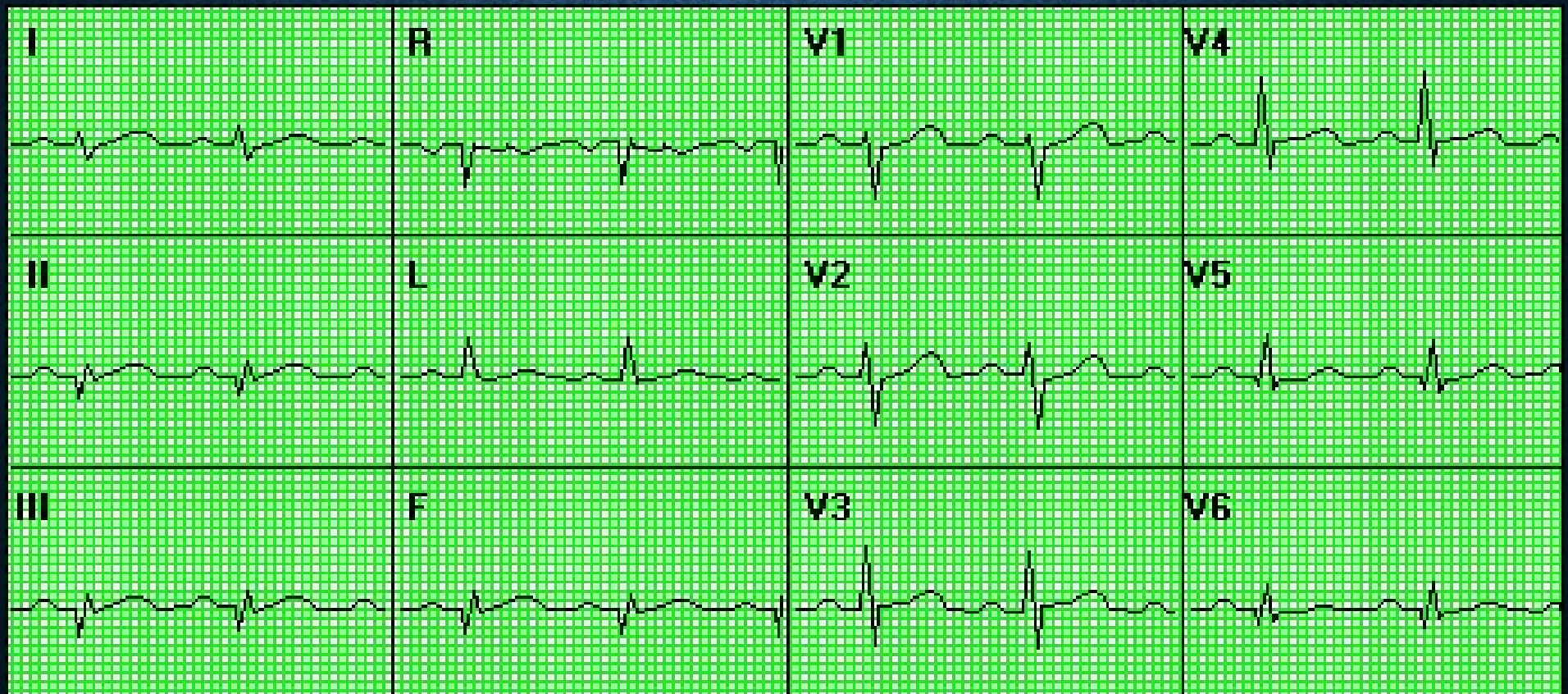
# NORMAL VS. ABNORMAL Q-WAVES



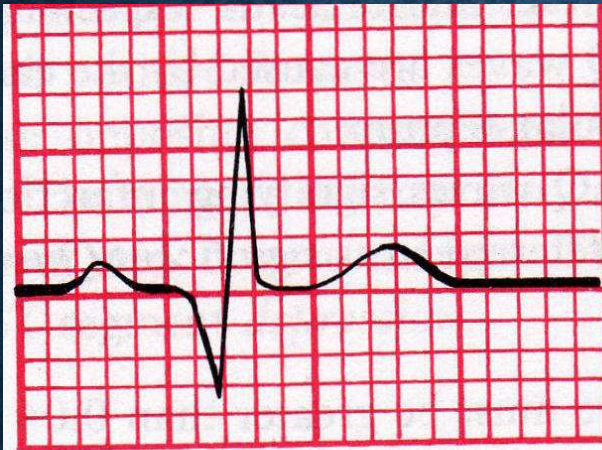
# EKG SHOWING NORMAL QS IN I, AVL, V5 AND V6



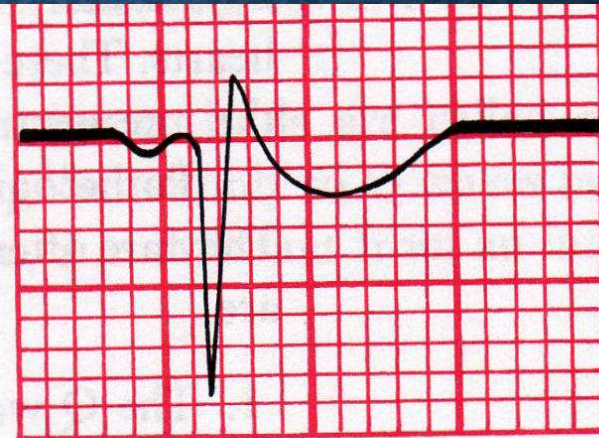
# Q WAVES OF OLD INFARCTION IN II, III, AND AVF



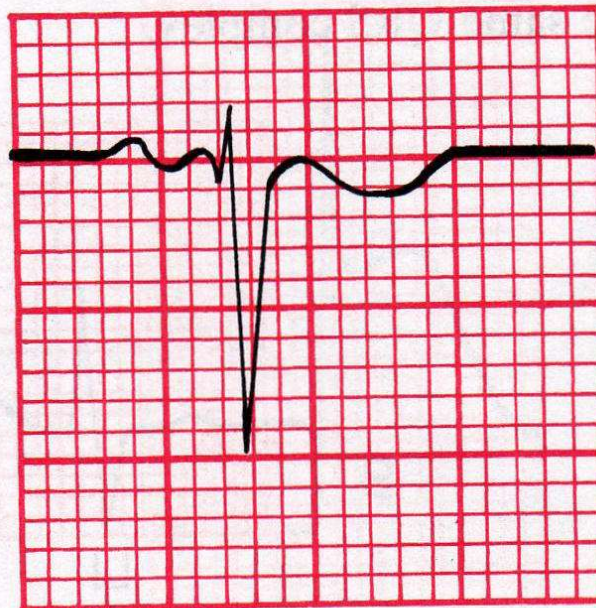
# SIGNIFICANT OR NOT?



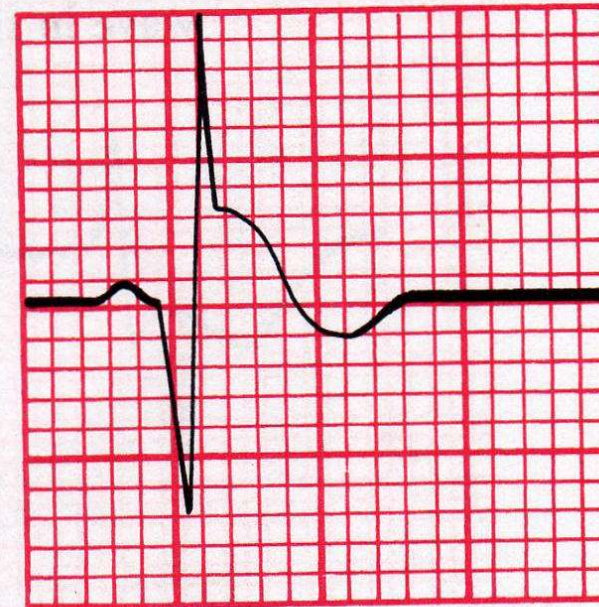
I



AVR

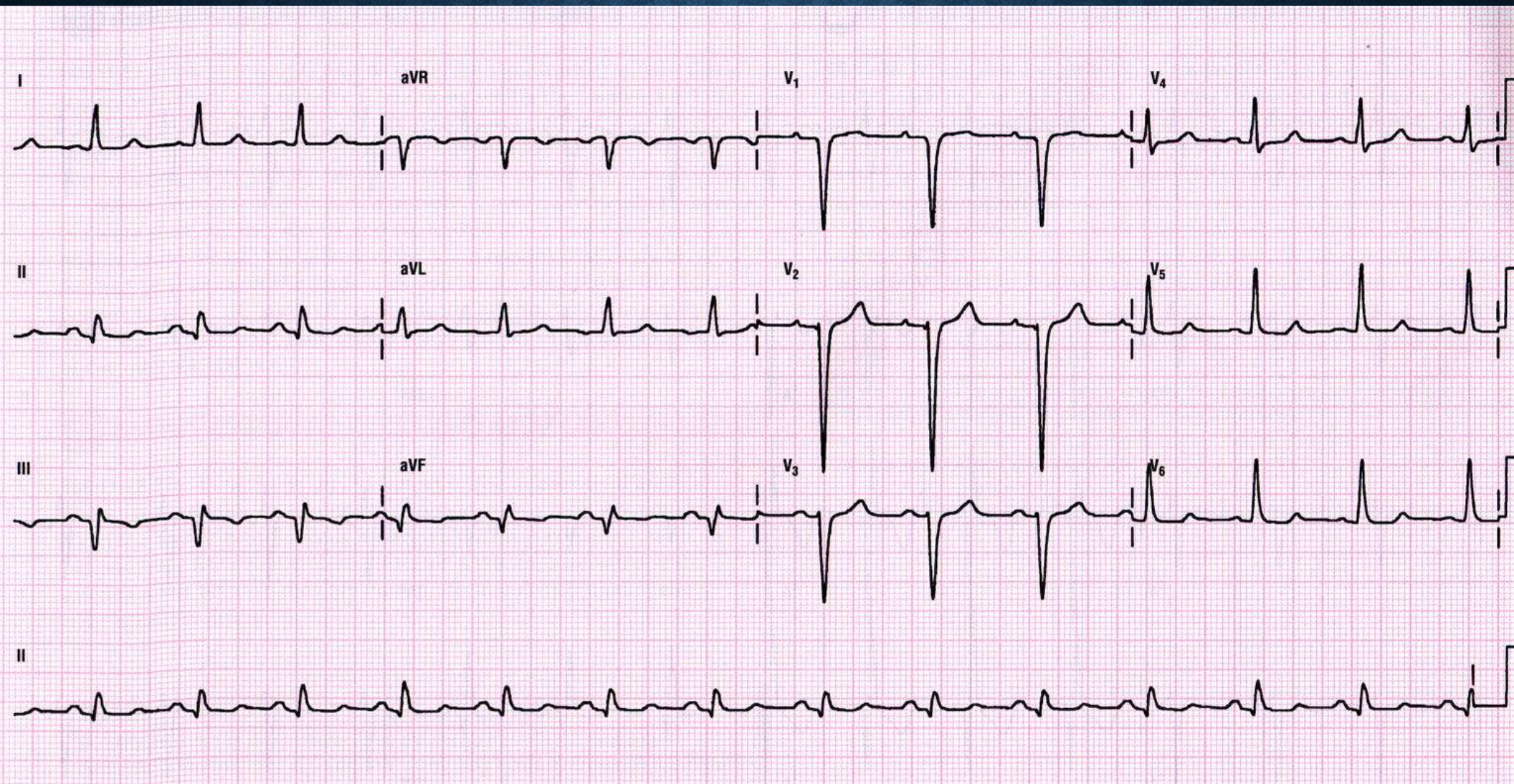


V<sub>2</sub>



AVF

# ANY SIGNIFICANT Q'S?



Yes, in leads III & AVF only



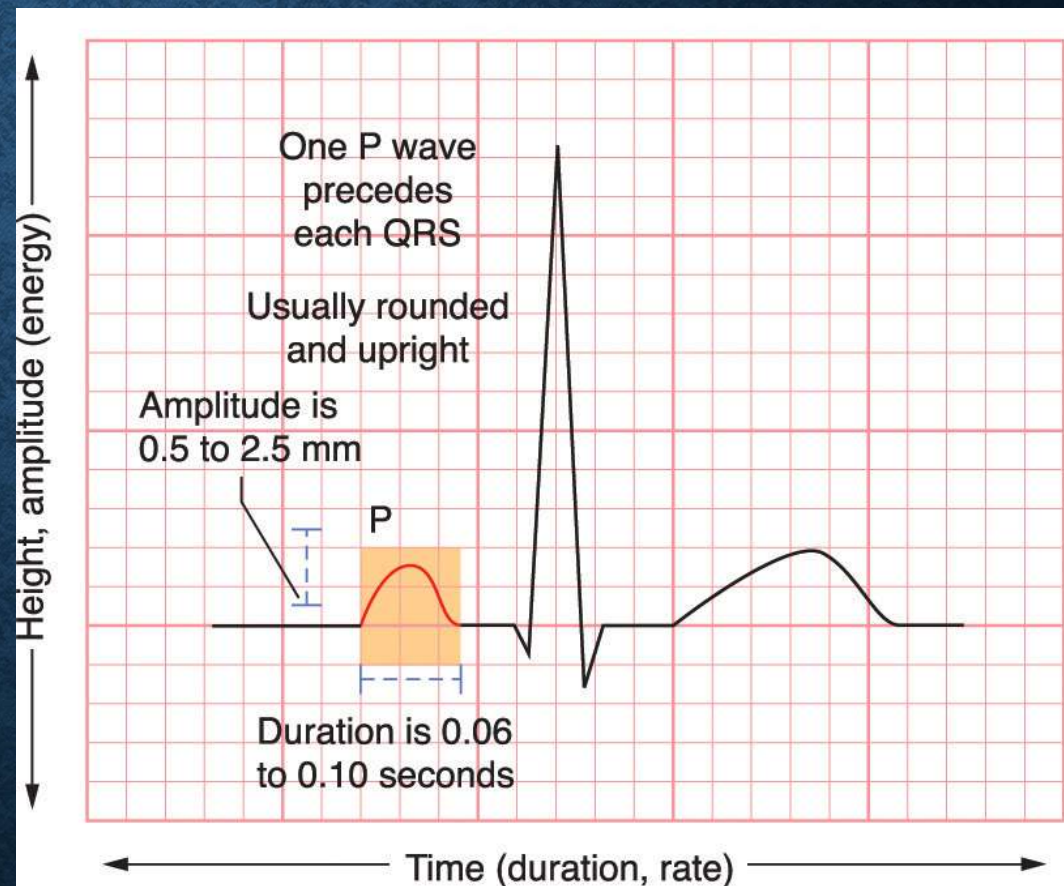
# RIGHT ATRIAL ENLARGEMENT

- Diagnosed by looking for a:
  - Biphasic P-wave in lead V1 &
  - P wave 2.5 millimeters or greater in height in lead II
- Causes of right atrial enlargement include COPD, mitral stenosis, mitral regurgitation, or pulmonary emboli.
- Because RAE is so frequently seen in chronic pulmonary disease, the peaked P wave is often called “P pulmonale.”

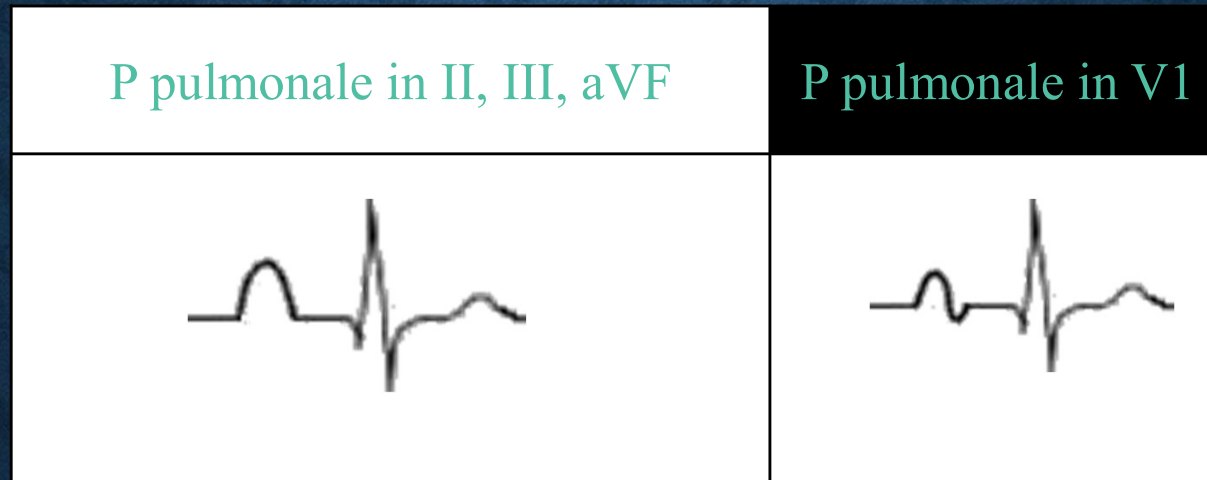


# NORMAL P WAVE

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

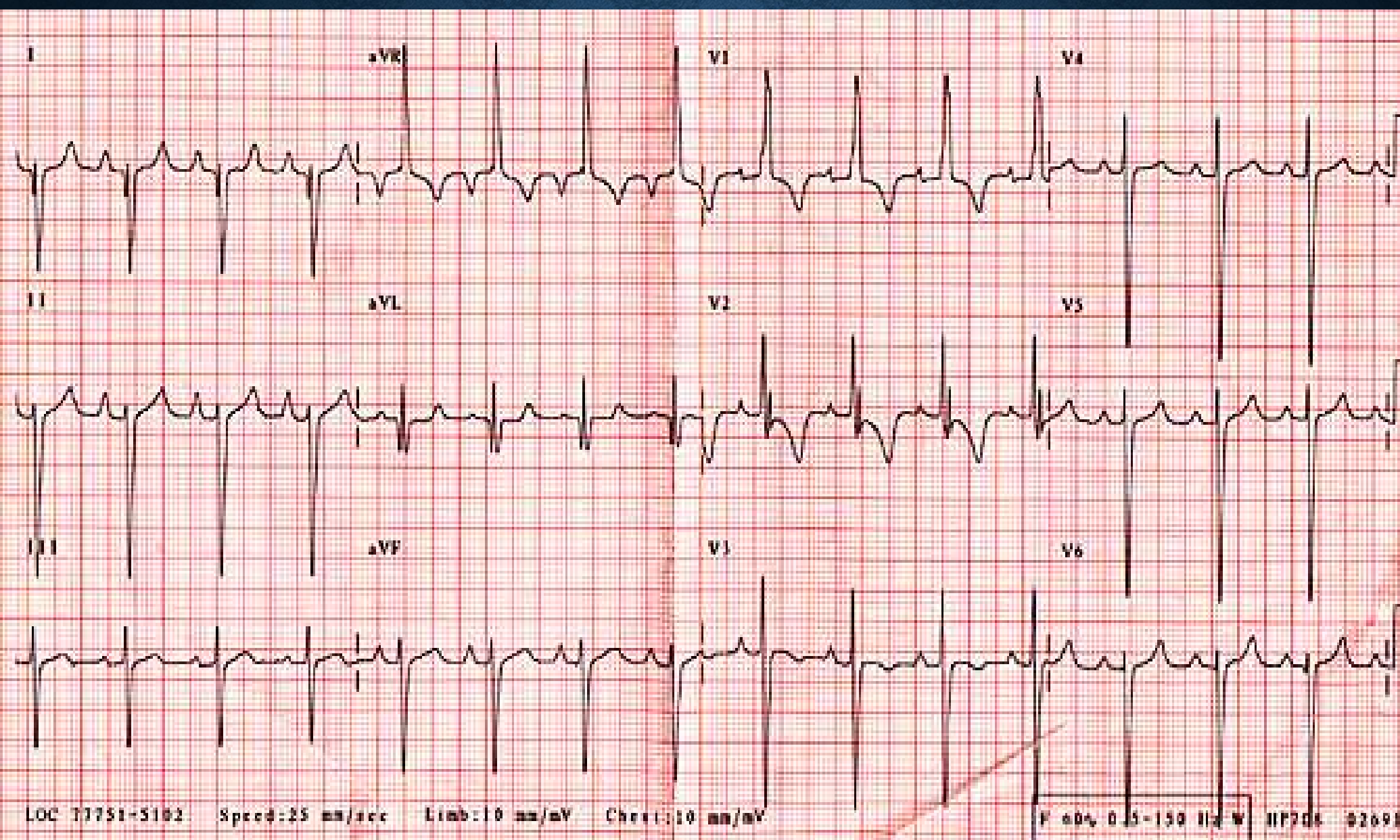


# P-PULMONALE PATTERN



Classic finding in Severe Right Atrial Enlargement (RAE)

Tall **P**eaked and **P**ointed **P** waves in the **P**ulmonary leads (II, III, aVF). If the **P** wave looks "uncomfortable to sit on", think **RAE!!!**





# LEFT ATRIAL ENLARGEMENT

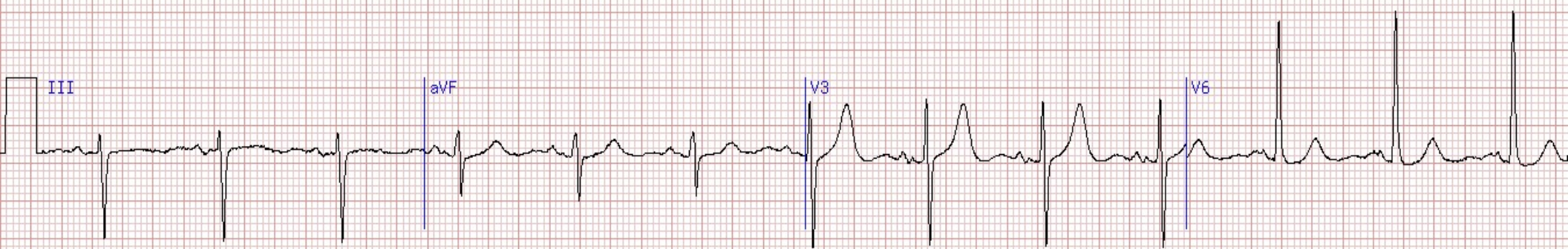
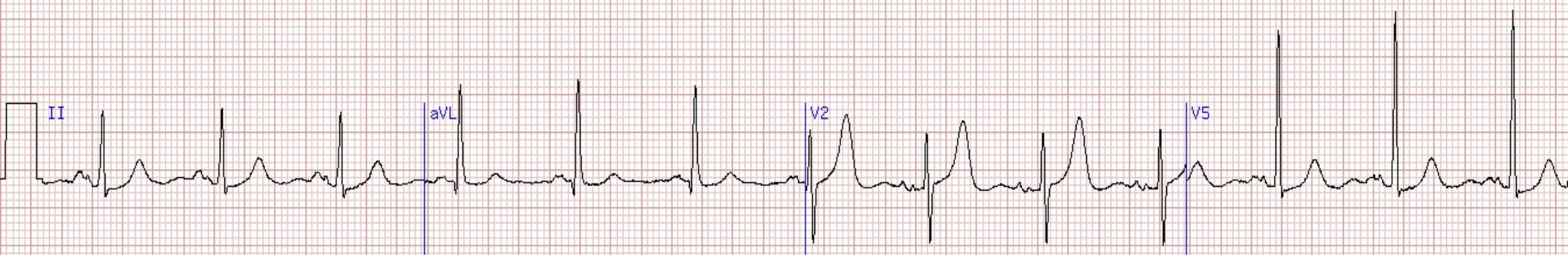
- Dilation or hypertrophy of the left atrium may increase the **DURATION** of the P wave ( $> 0.11$  msec). (Recall that right atrial enlargement causes an increase in the **HEIGHT** or amplitude of the P wave.)



# P-MITRALE PATTERN

P mitrale in II, III, aVF	P mitrale in V1
	

- Diagnosed by finding an *m*-shaped (notched) and widened P wave ( $\geq 0.12$  second) in a "*m*itral" leads (I, II, aVL) and/or a deep negative component to the P in lead V1.
- Caused by conditions that increase either pressure or volume loading on the atria leading to enlargement and/or hypertrophy.
  - Longstanding hypertension
  - Obstructive cardiomyopathy
  - Aortic stenosis
  - Aortic regurgitation



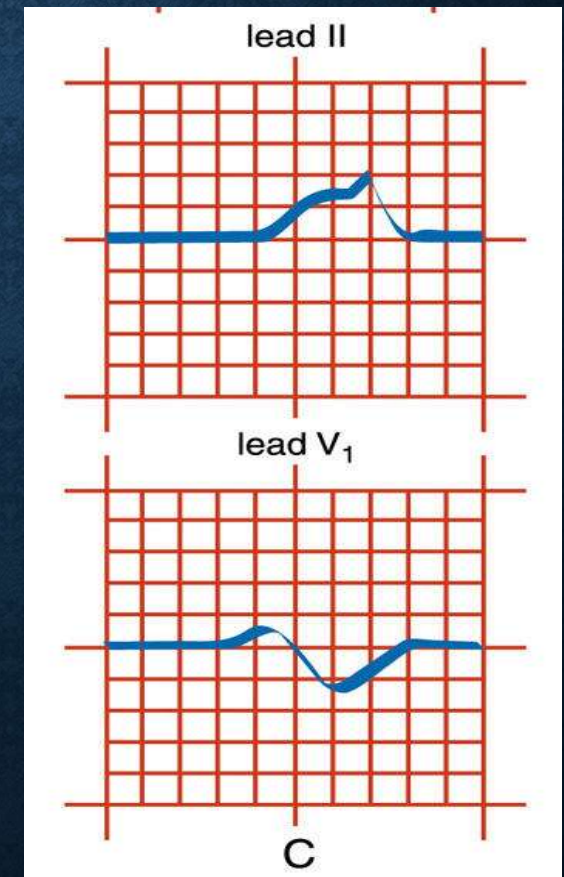
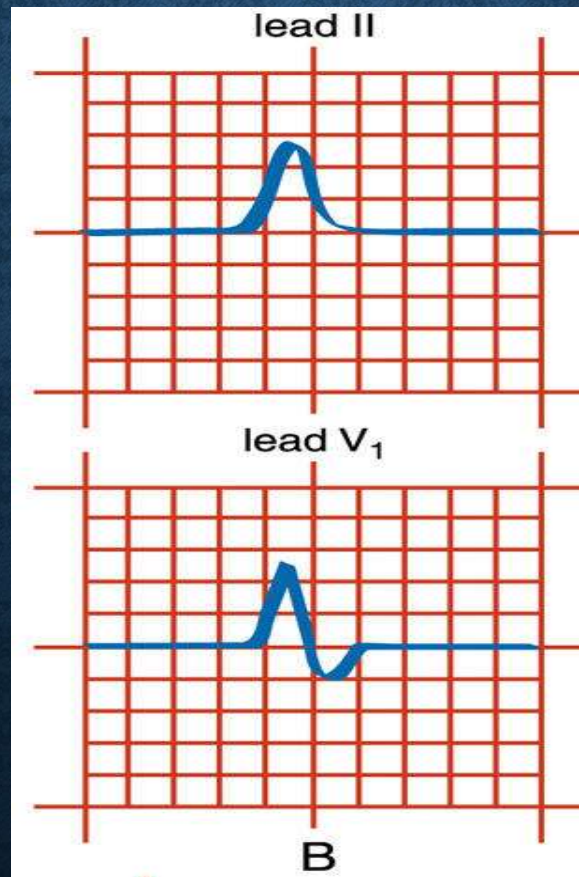
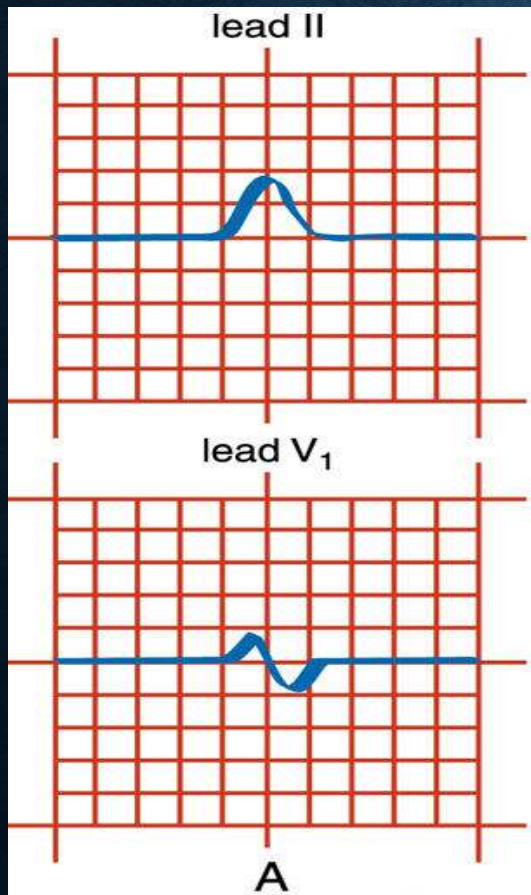
# SUMMARY

- Atrial Enlargement Criteria

P > 2.5mm height = RAE

P > 0.11 sec or P notch > 1 box width

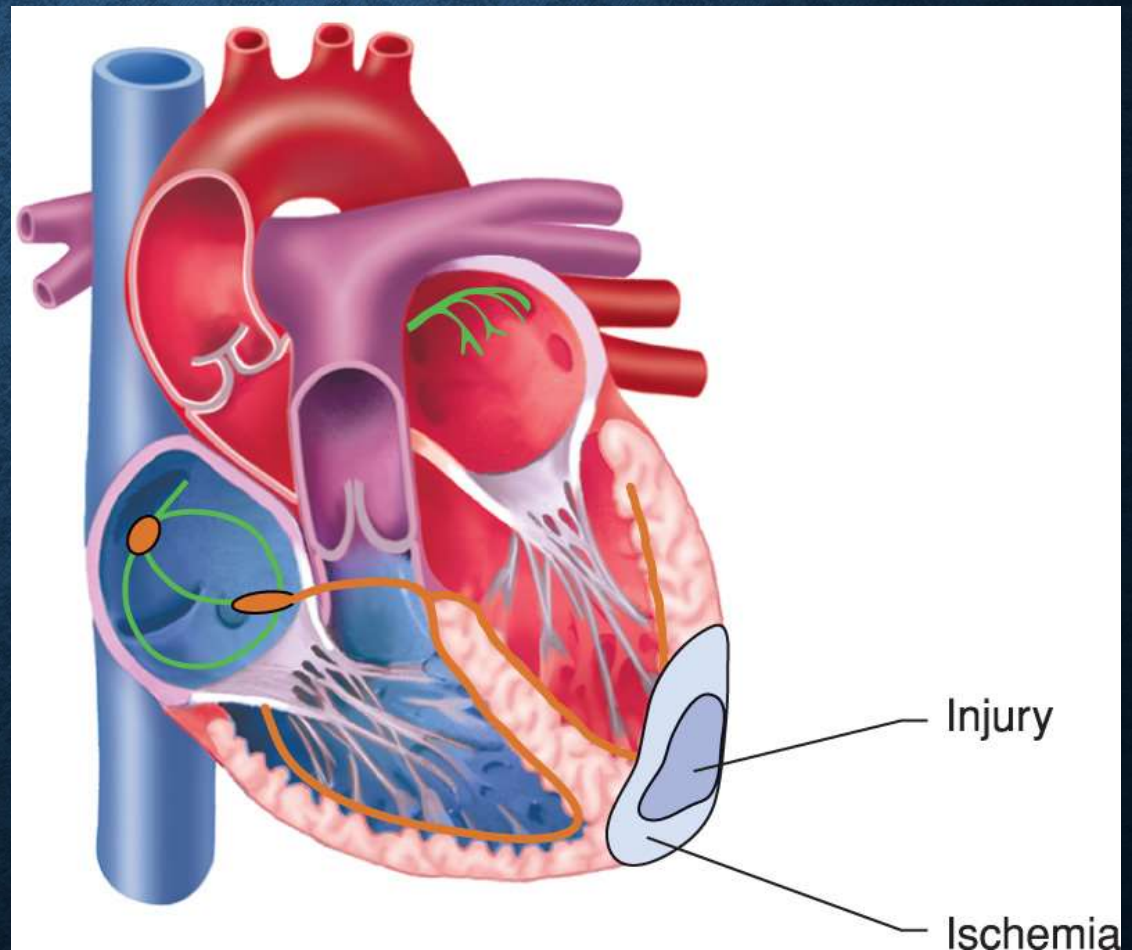
or P biphasic > 1 box square = LAE



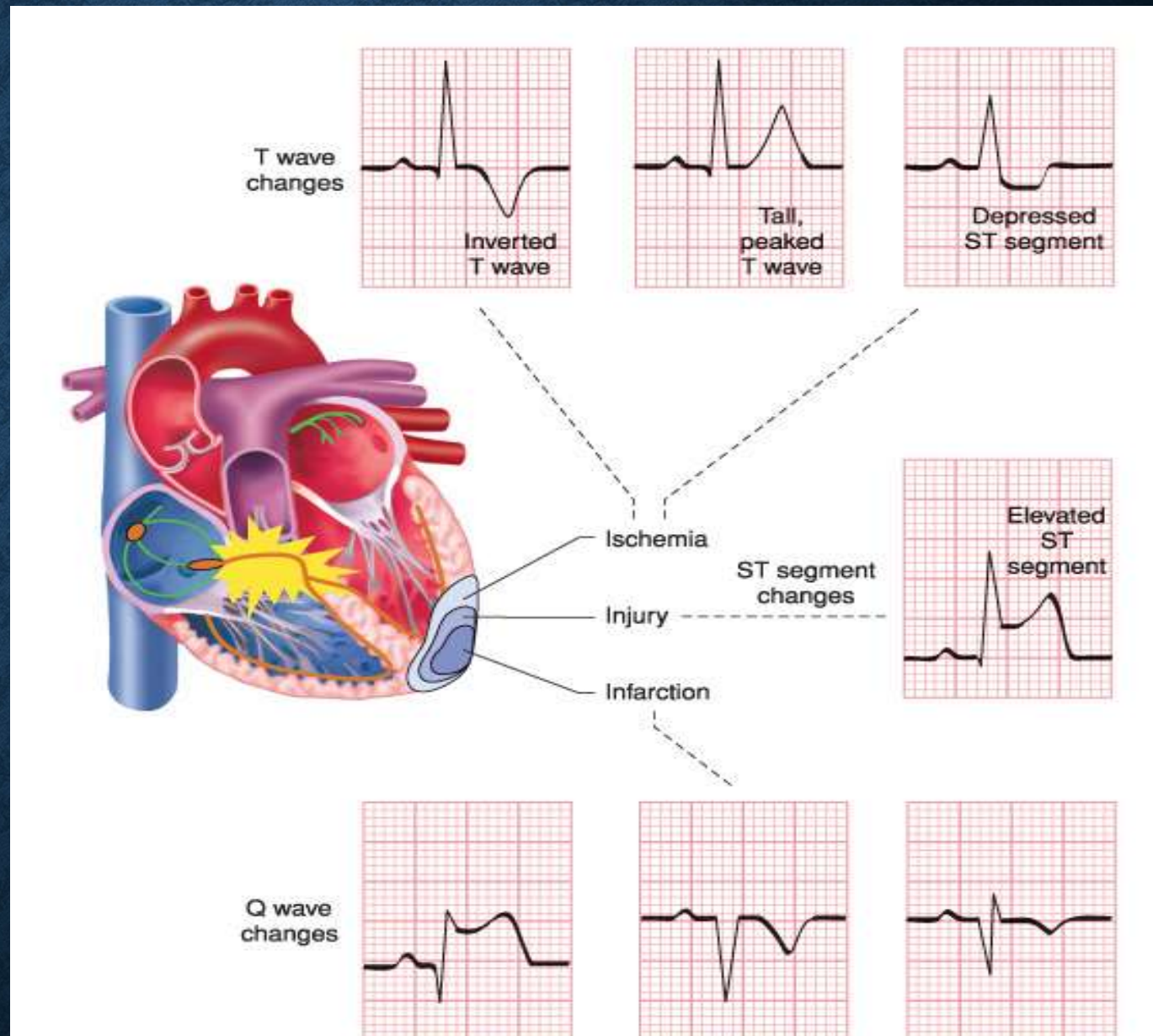


# MYOCARDIAL INJURY

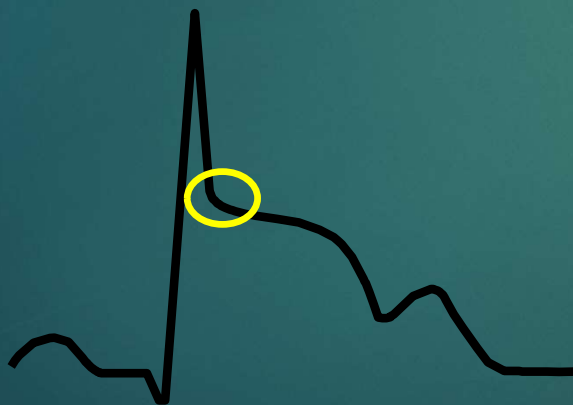
- Results if ischemia progresses unresolved or untreated



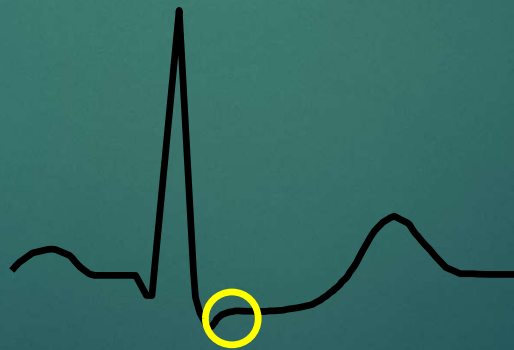
# EKG INDICATORS



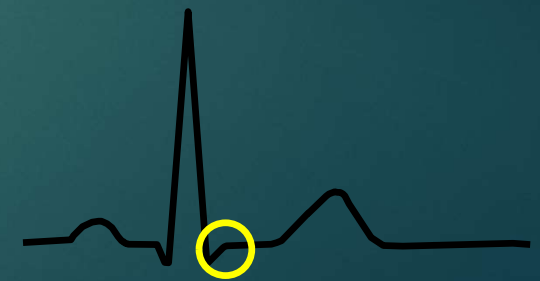
# J-Point



ST Elevation

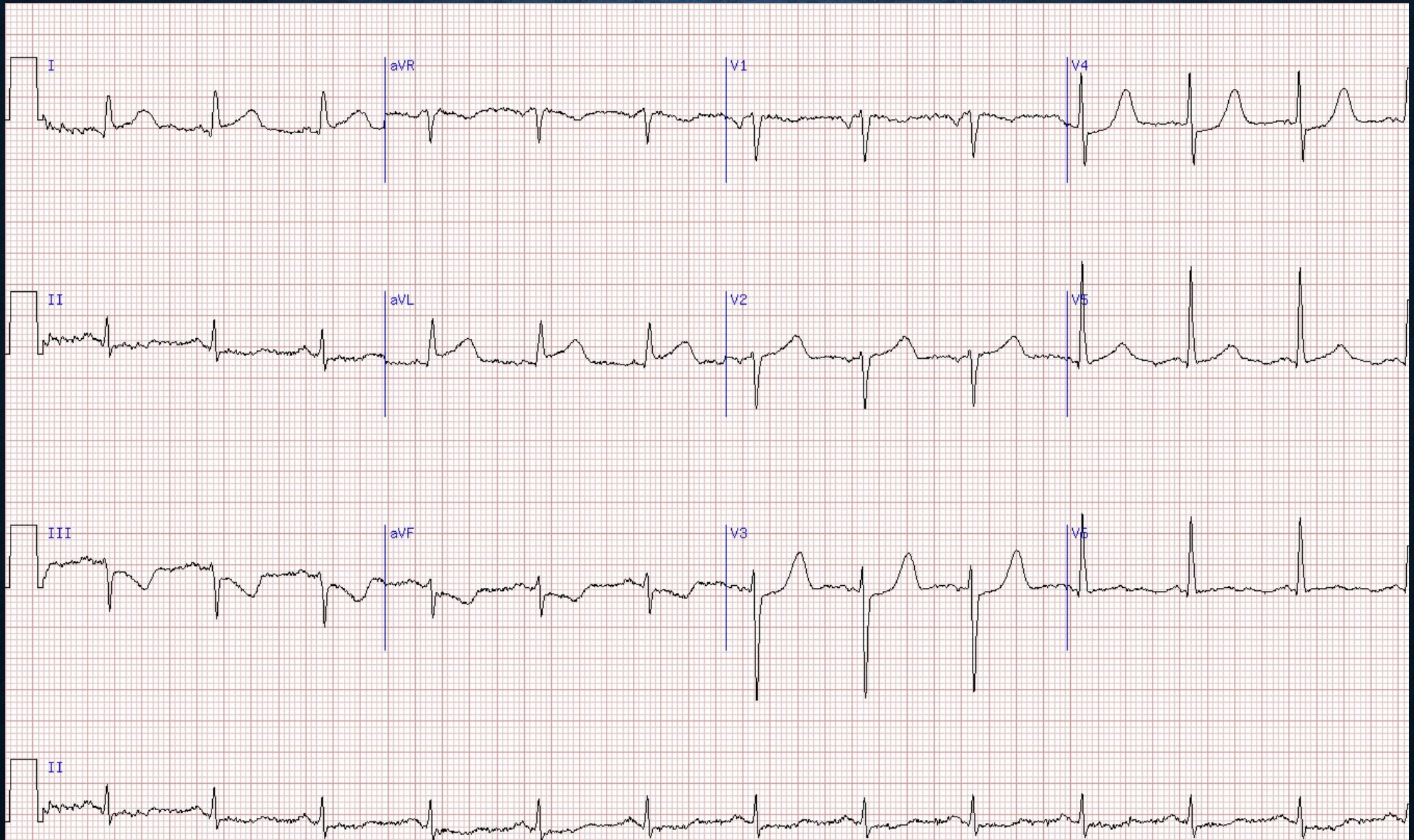


ST Depression

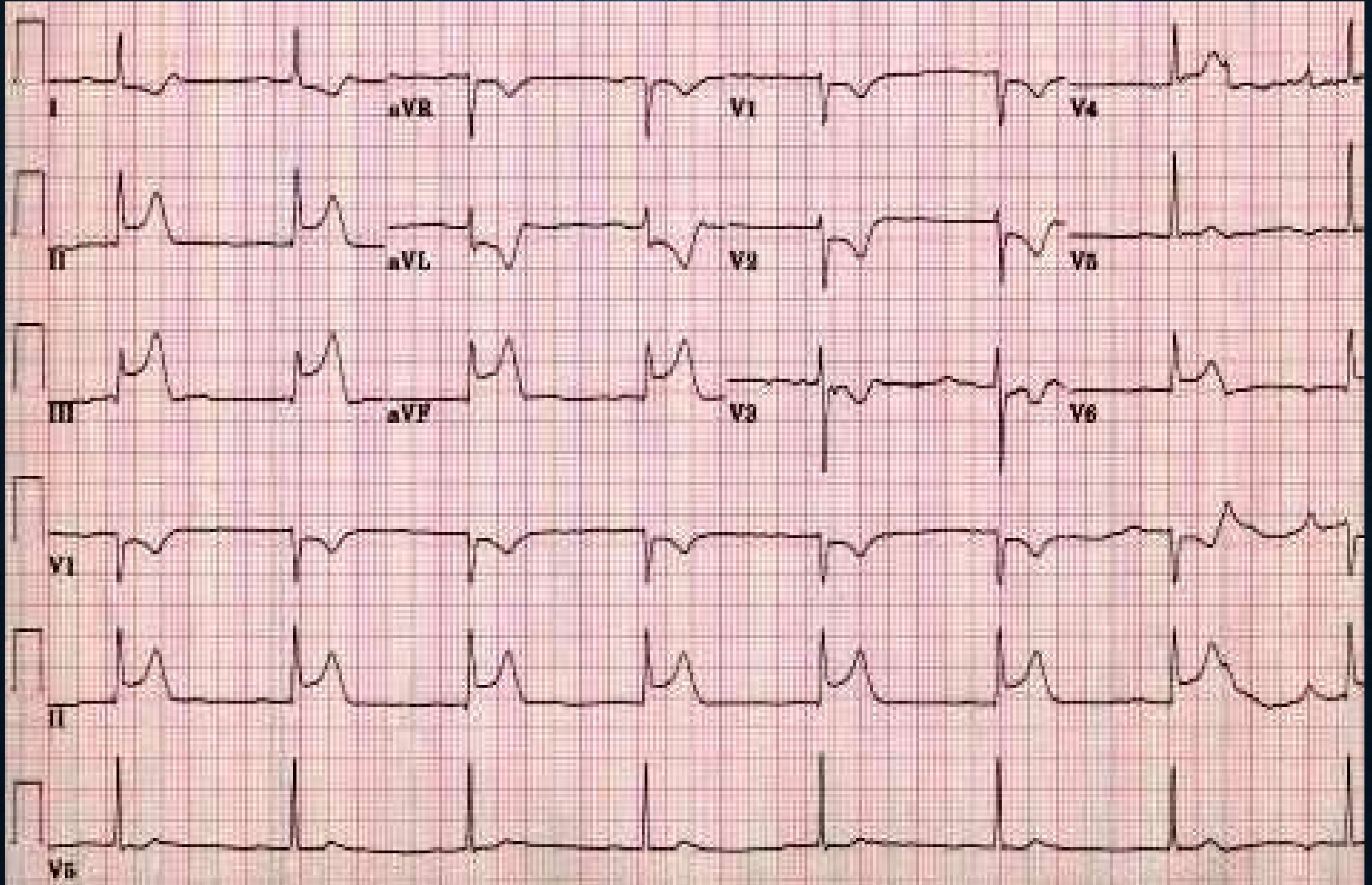


Normal

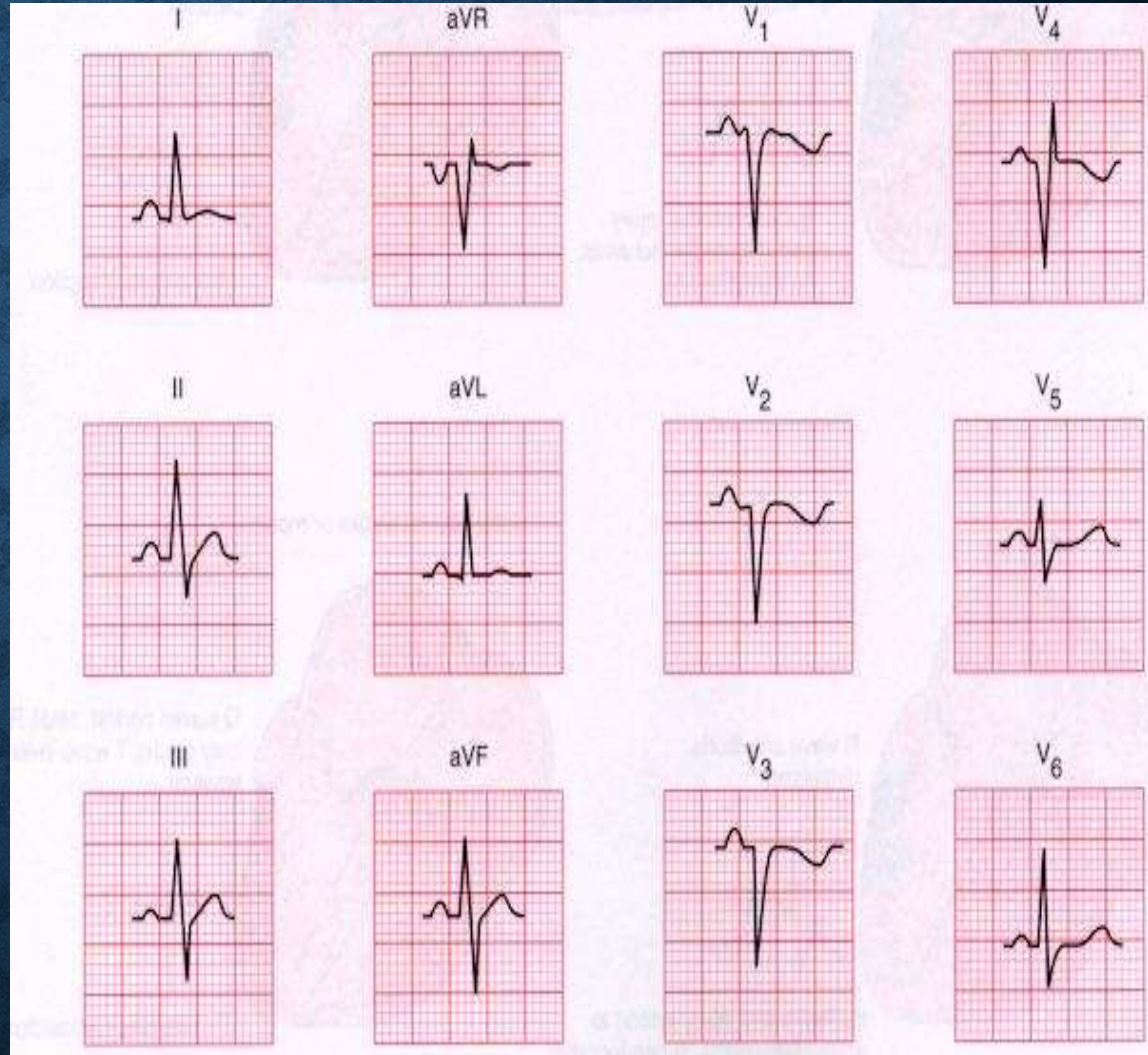
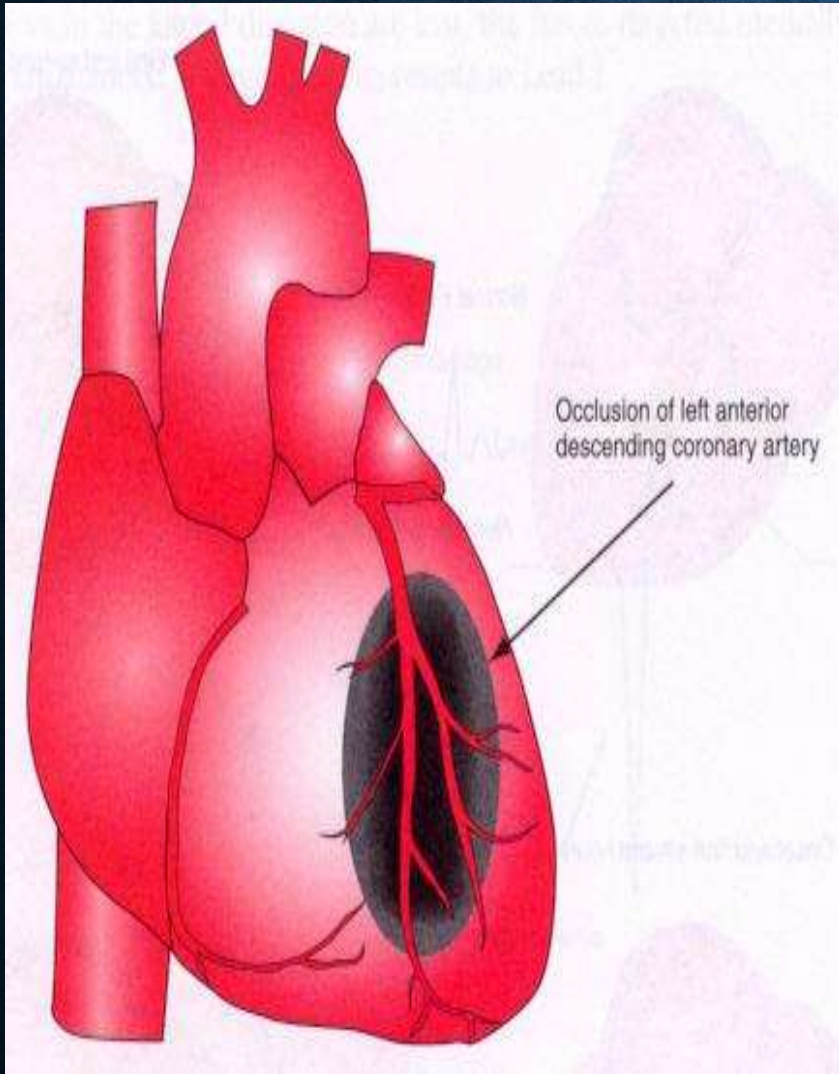
# LATERAL MI, INFERIOR RECIPROCITY



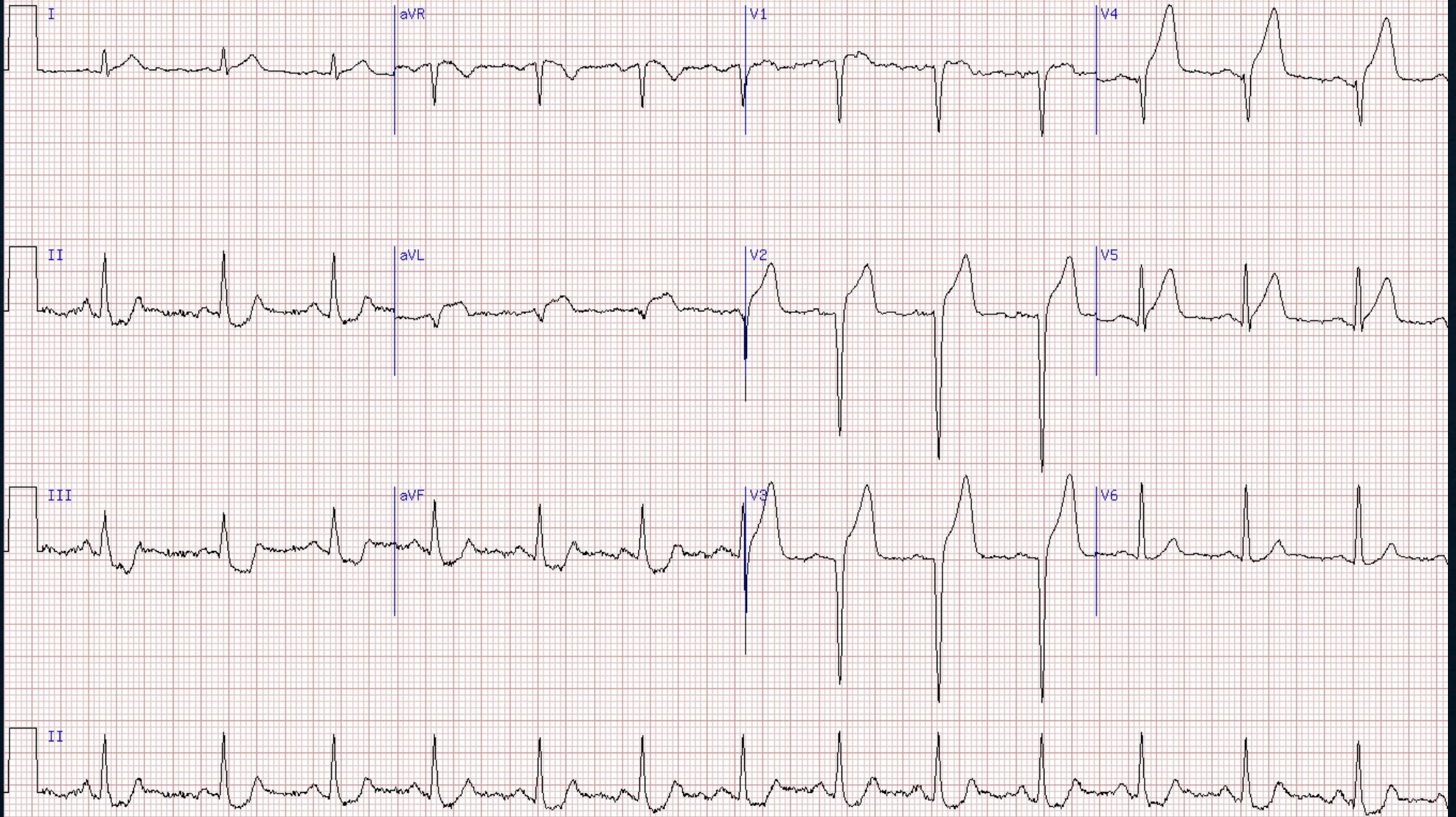
# INFERIOR MI, LATERAL RECIPROCITY



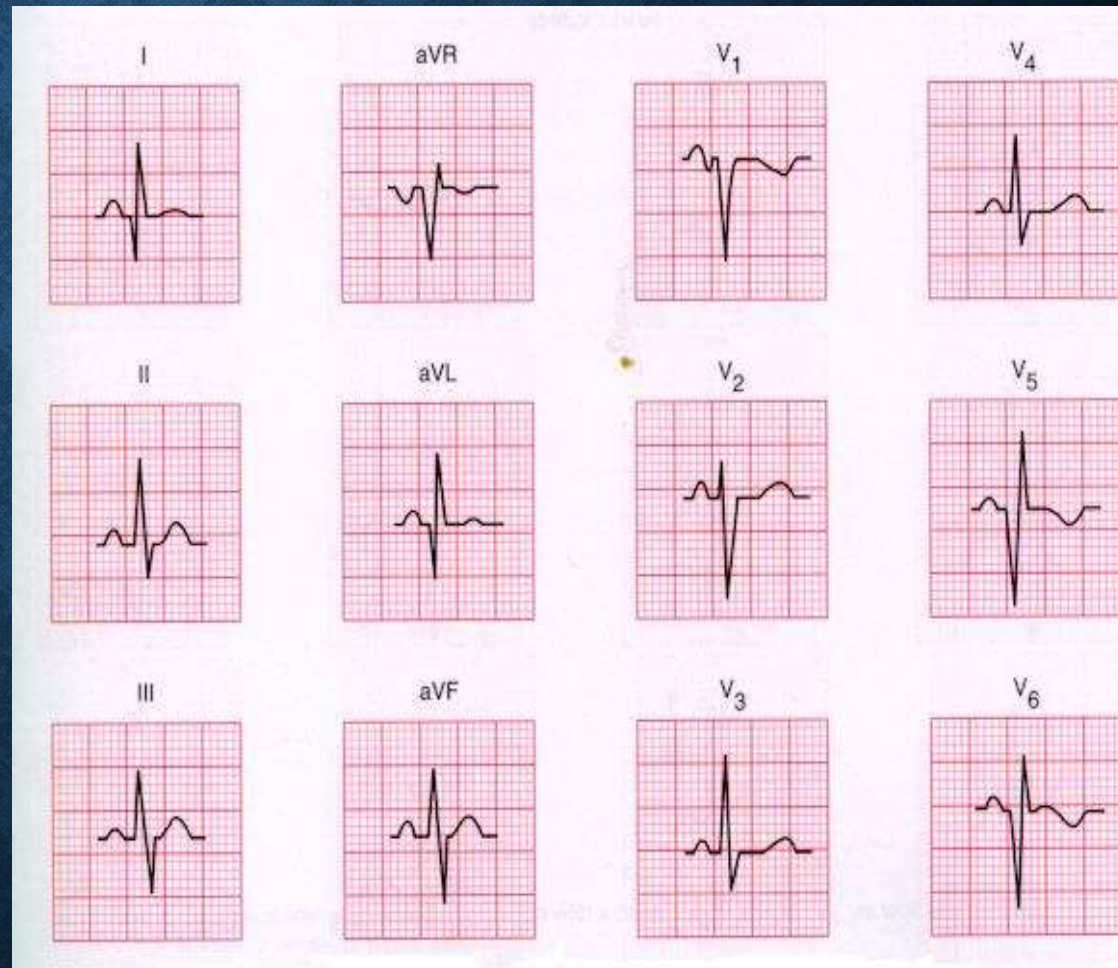
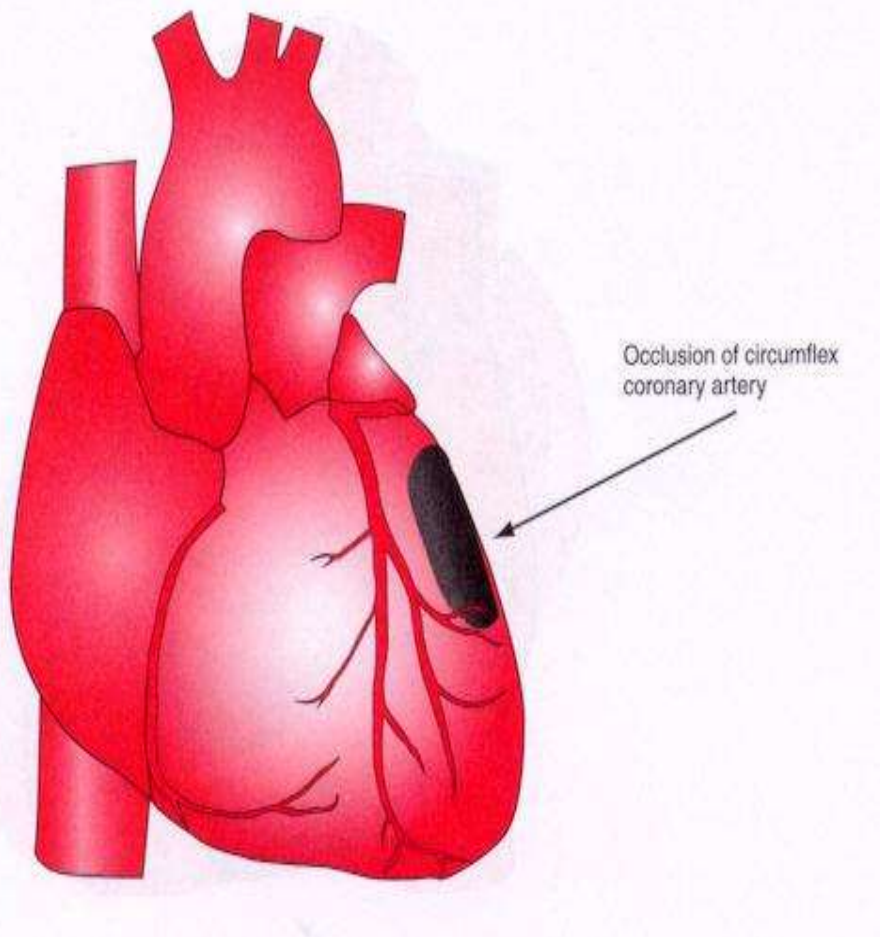
# ANTERIOR MI



# ANTERIOR WALL MI

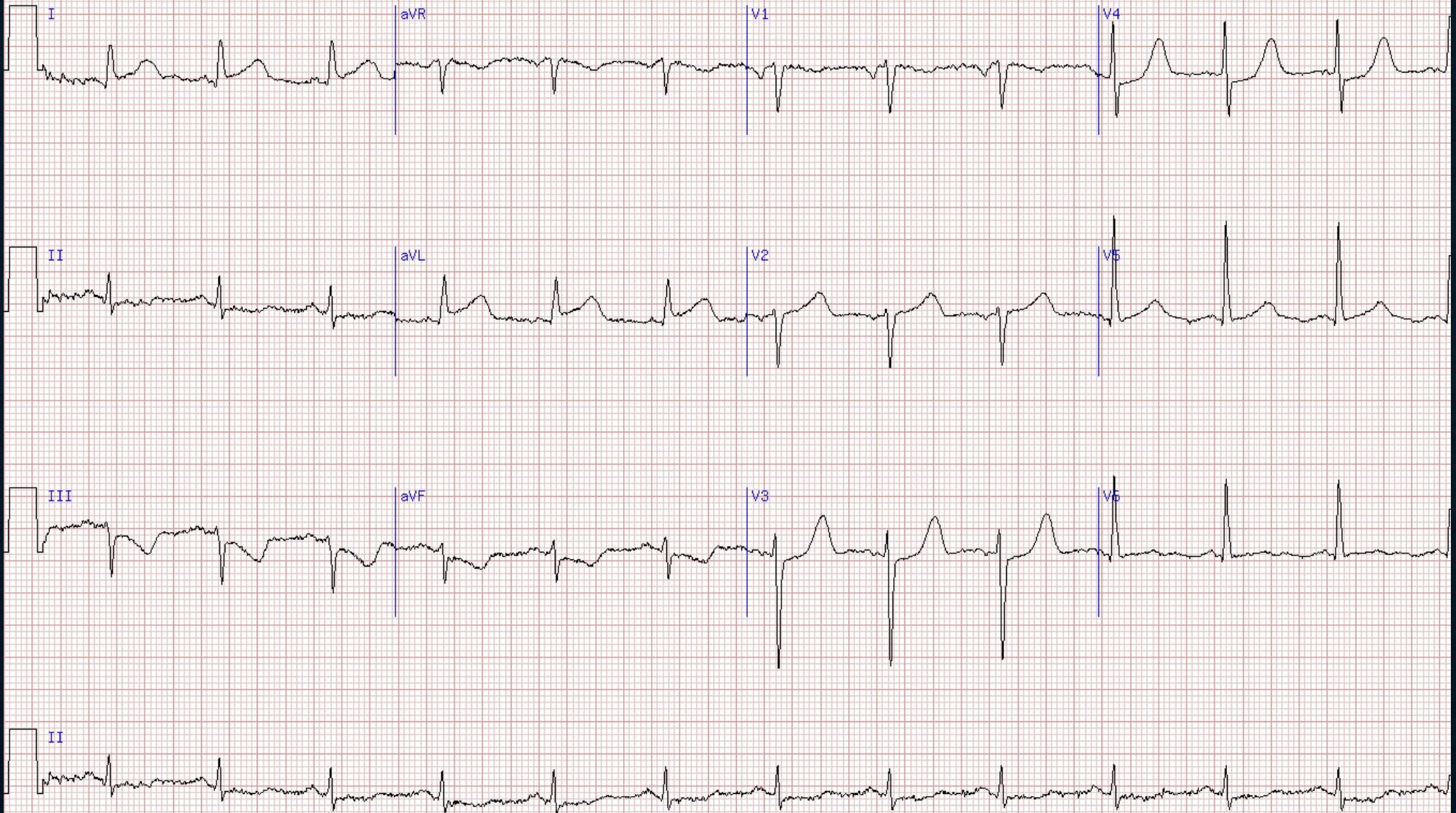


# LATERAL MI

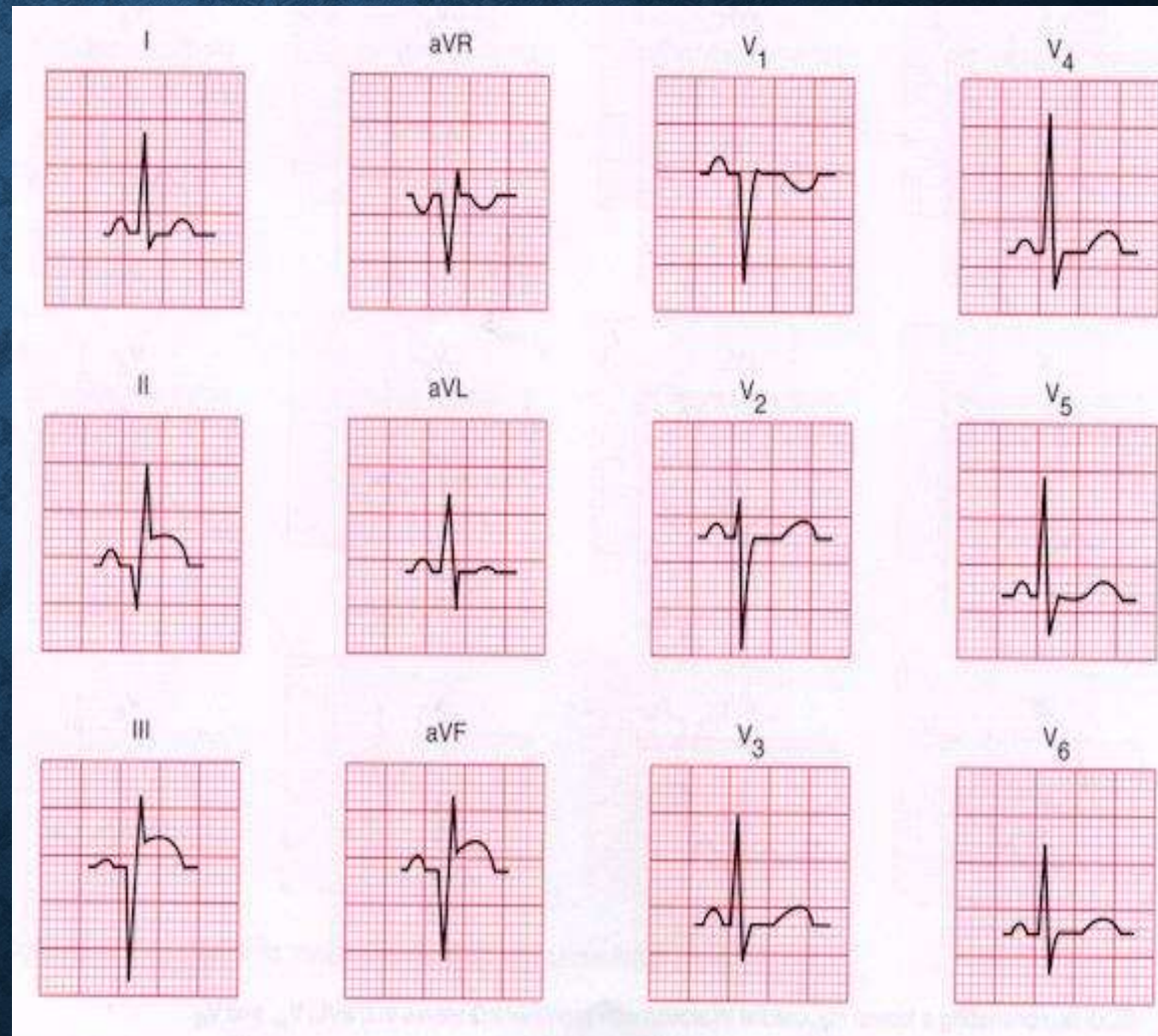
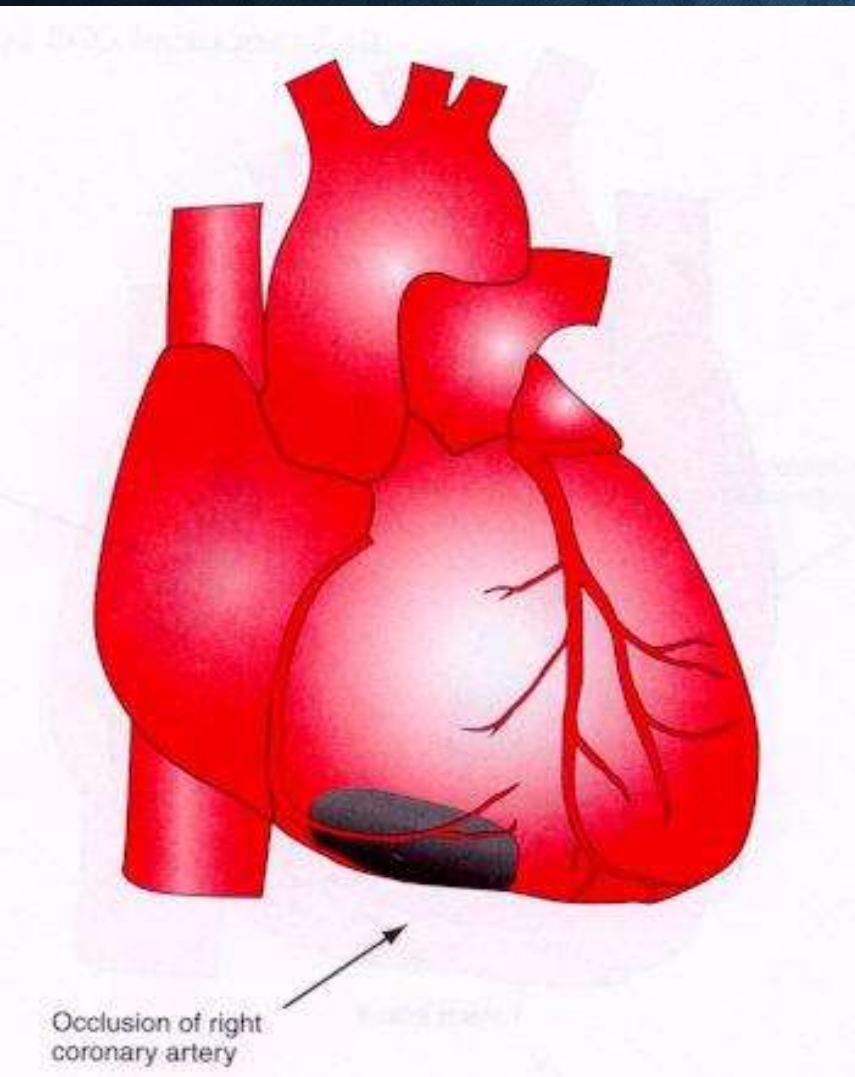




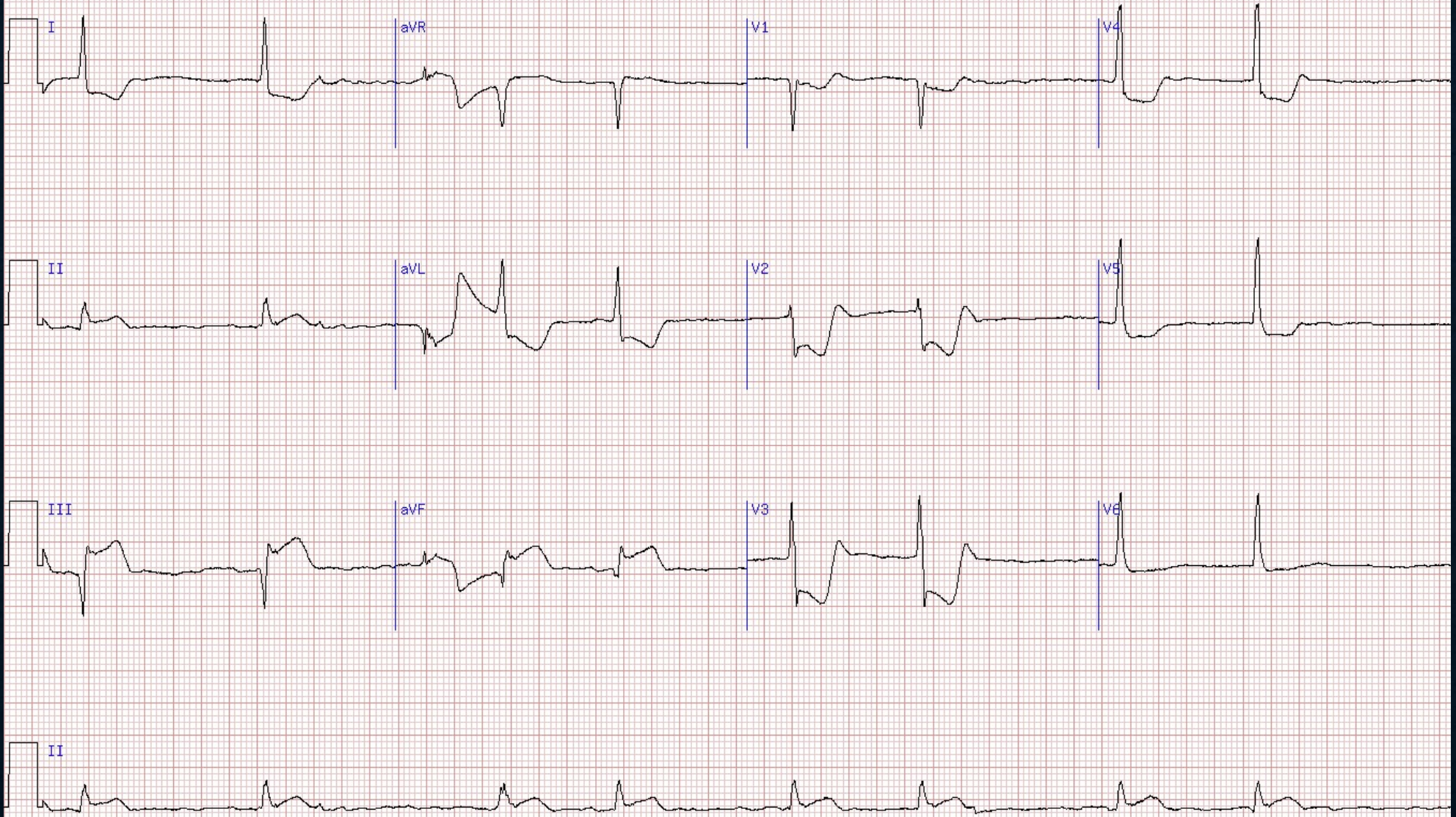
# LATERAL WALL MI



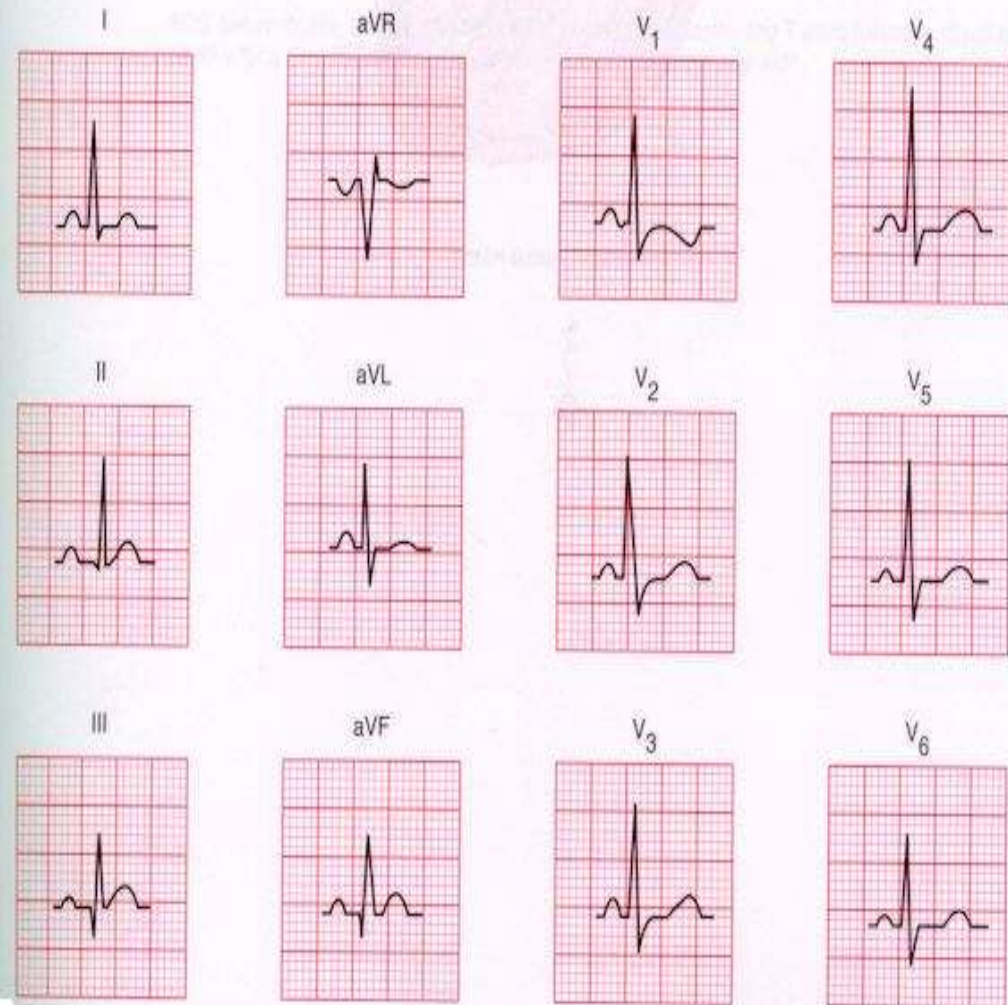
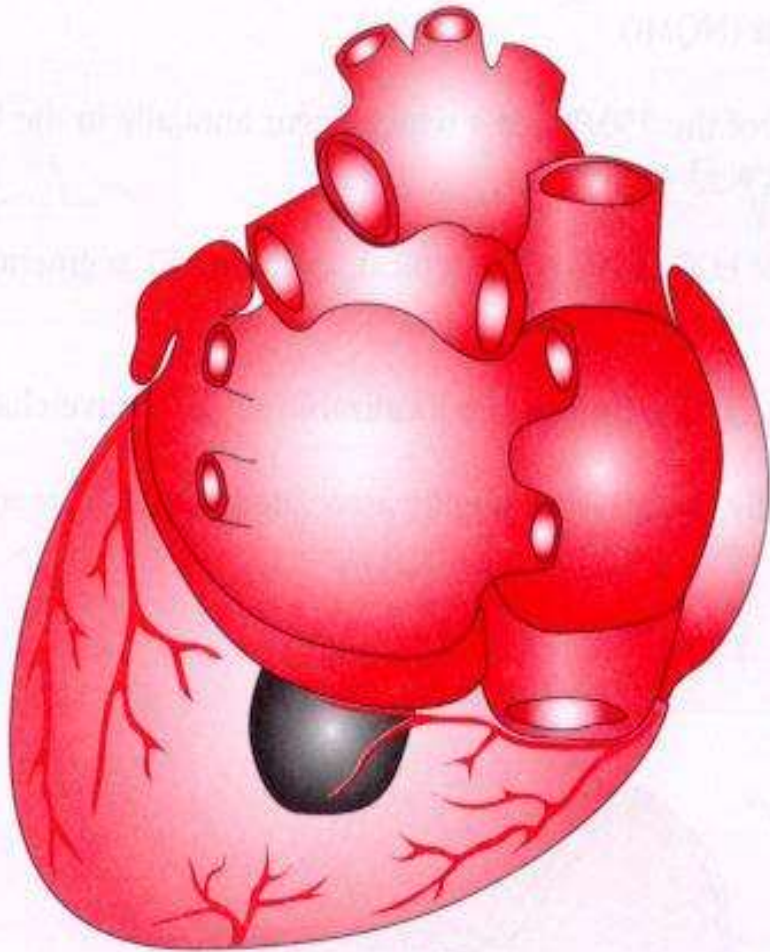
# INFERIOR INFARCT



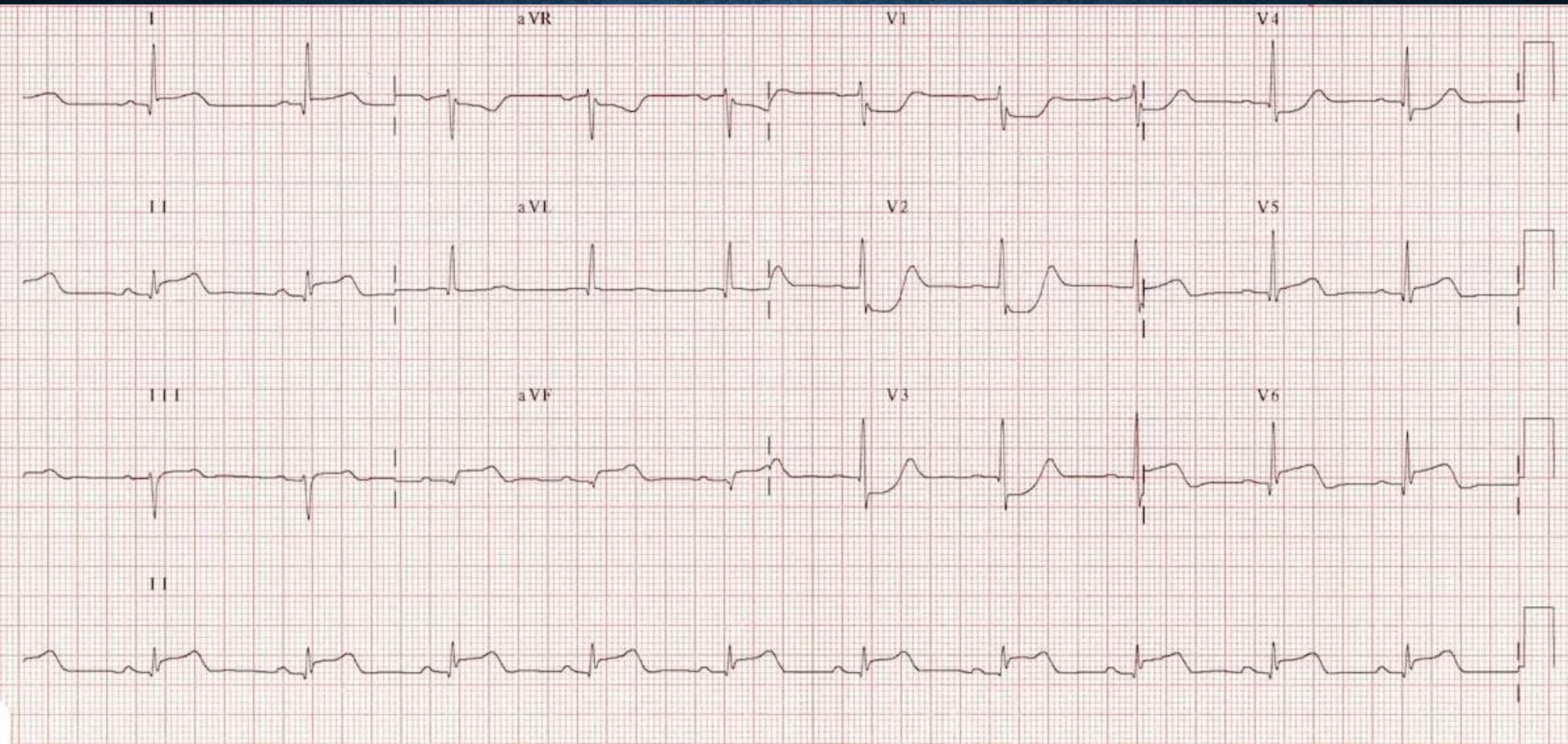
# INFERIOR WALL MI



# POSTERIOR INFARCT

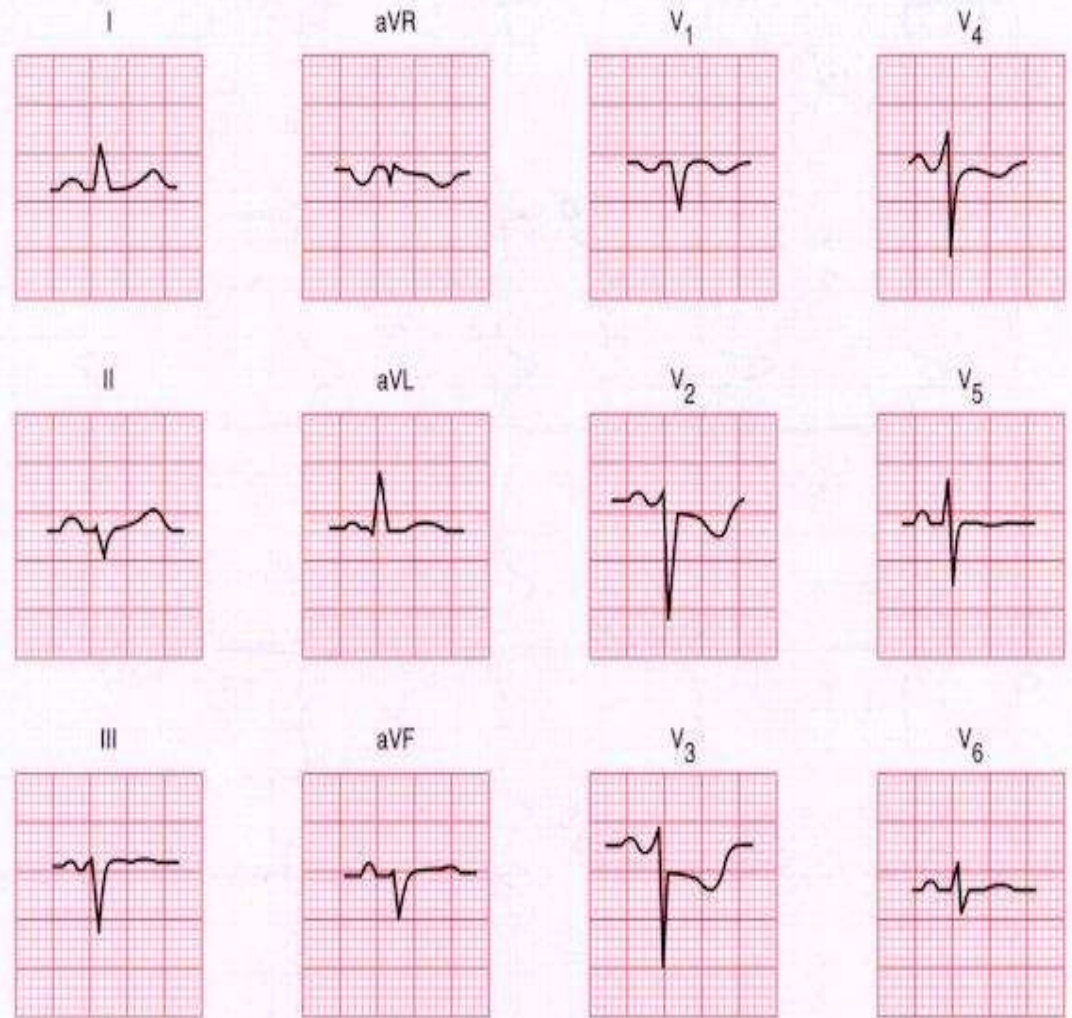
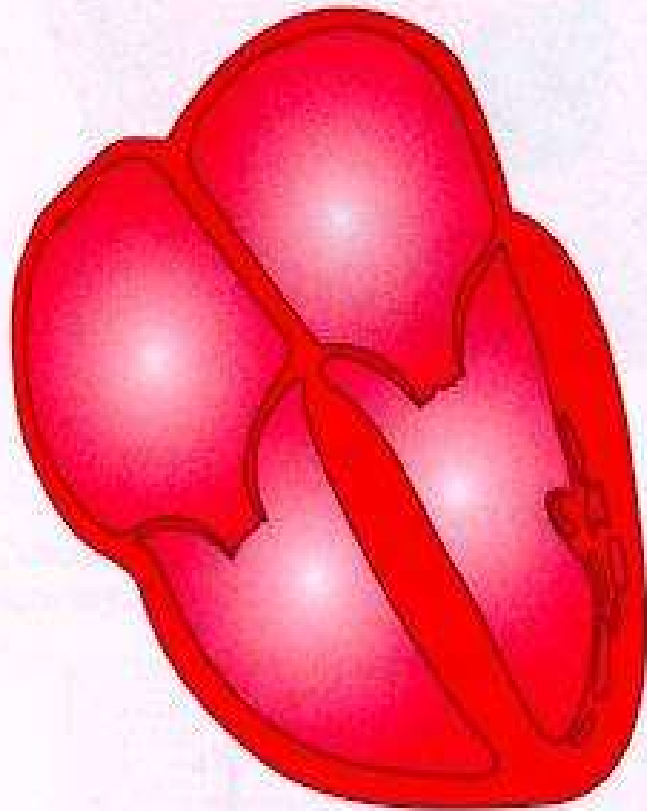


# POSTERIOR WALL MI

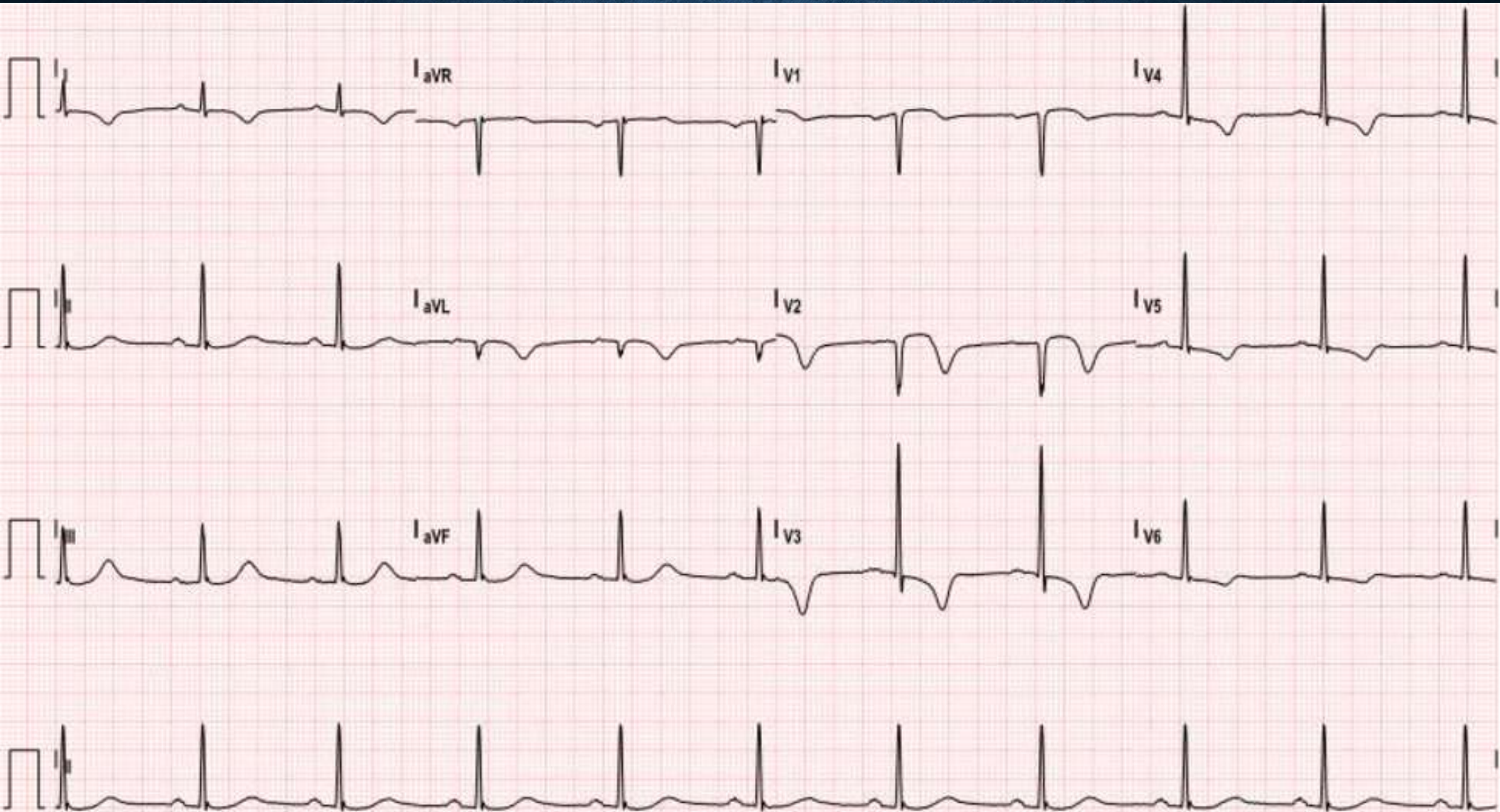


Notice tall R wave in V2. Posterior wall infarcts are often associated tall anterior R waves (especially new, and not secondary to RBBB/WPW/RVH), ST depression isolated to the anterior leads, especially horizontal, and often associated with upright T waves, and associated inferior or lateral hyperacute T waves or subtle elevation.

# NON Q-WAVE INFARCT



# Non Q-Wave MI

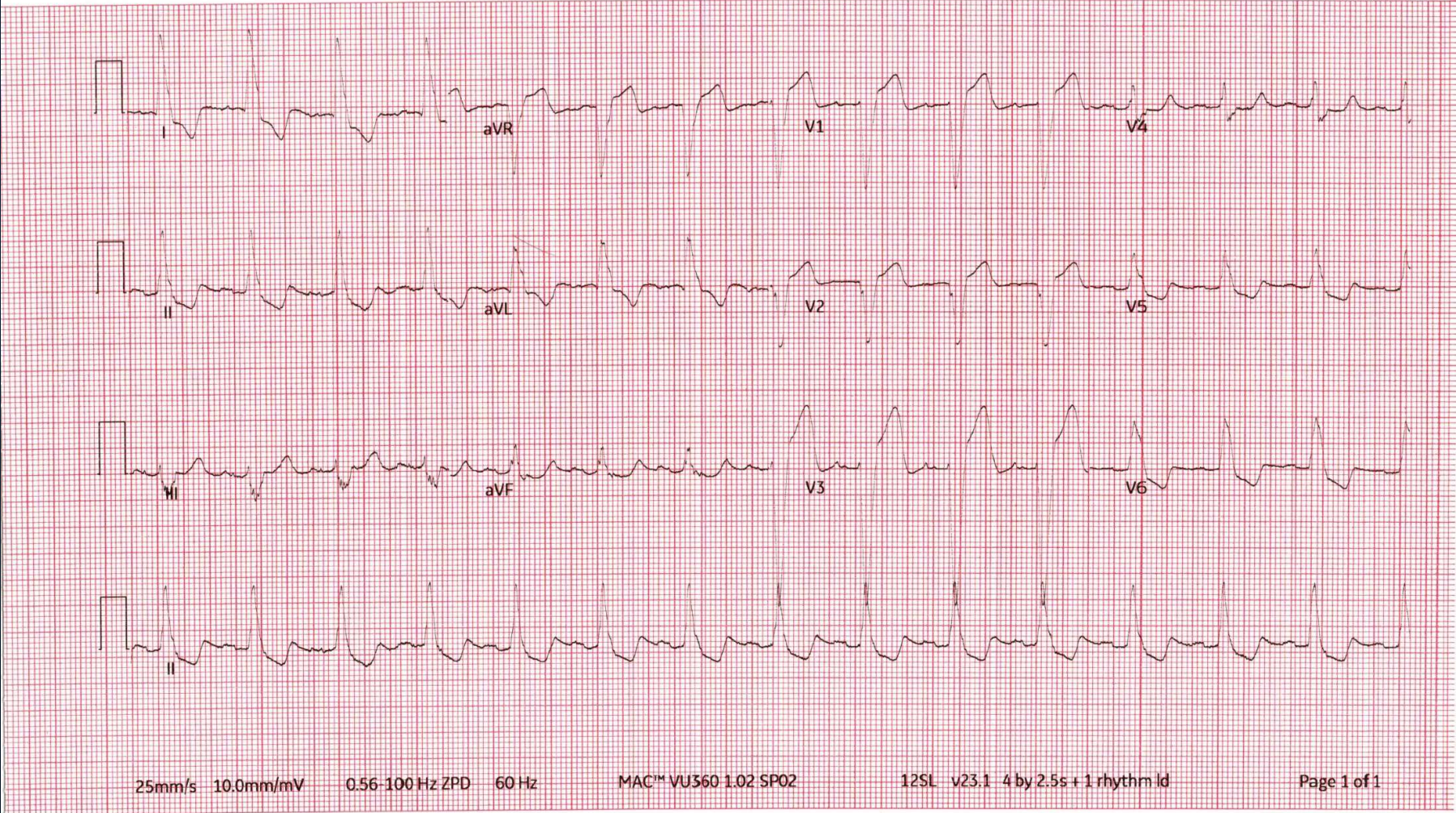


Vent. rate 87 BPM  
PR interval 192 ms  
QRS duration 156 ms  
QT/QTc-Baz 416/500 ms  
P-R-T axes 86 20 164



Visit: 500000568883

Unconfirmed



25mm/s 10.0mm/mV

0.56-100 Hz ZPD 60 Hz

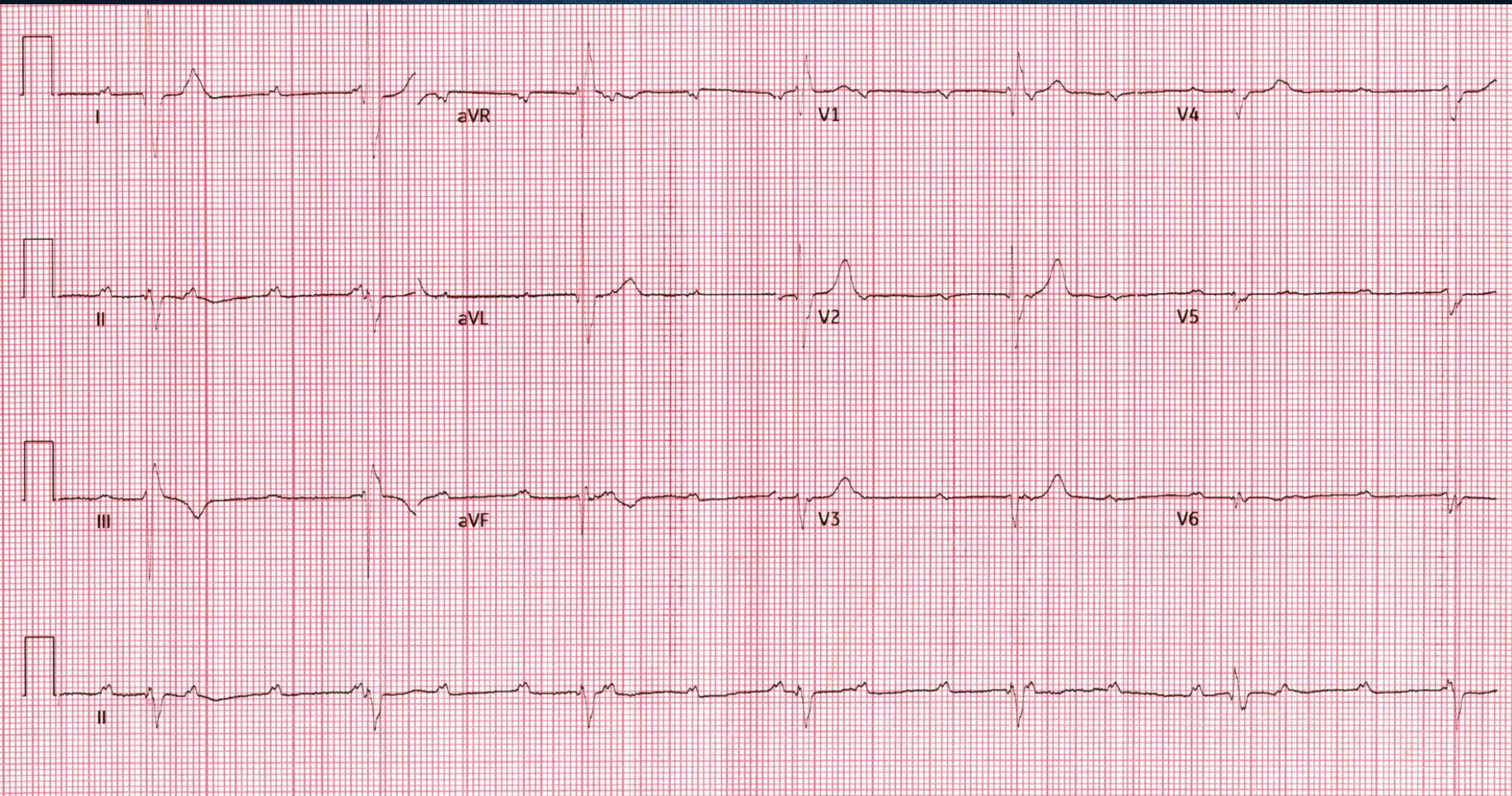
MAC™ VU360 1.02 SP02

12SL v23.1 4 by 2.5s + 1 rhythm ld

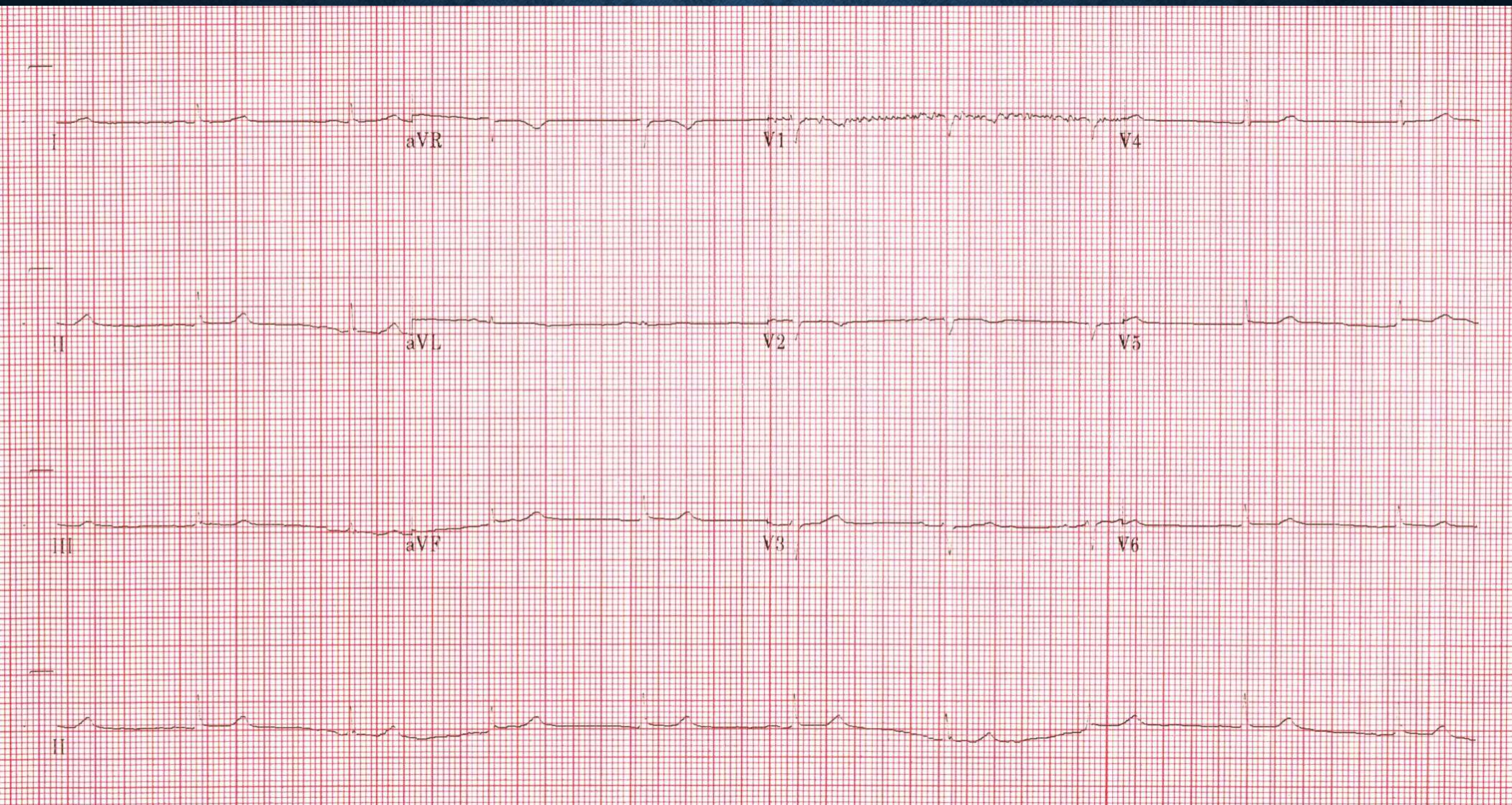
Page 1 of 1



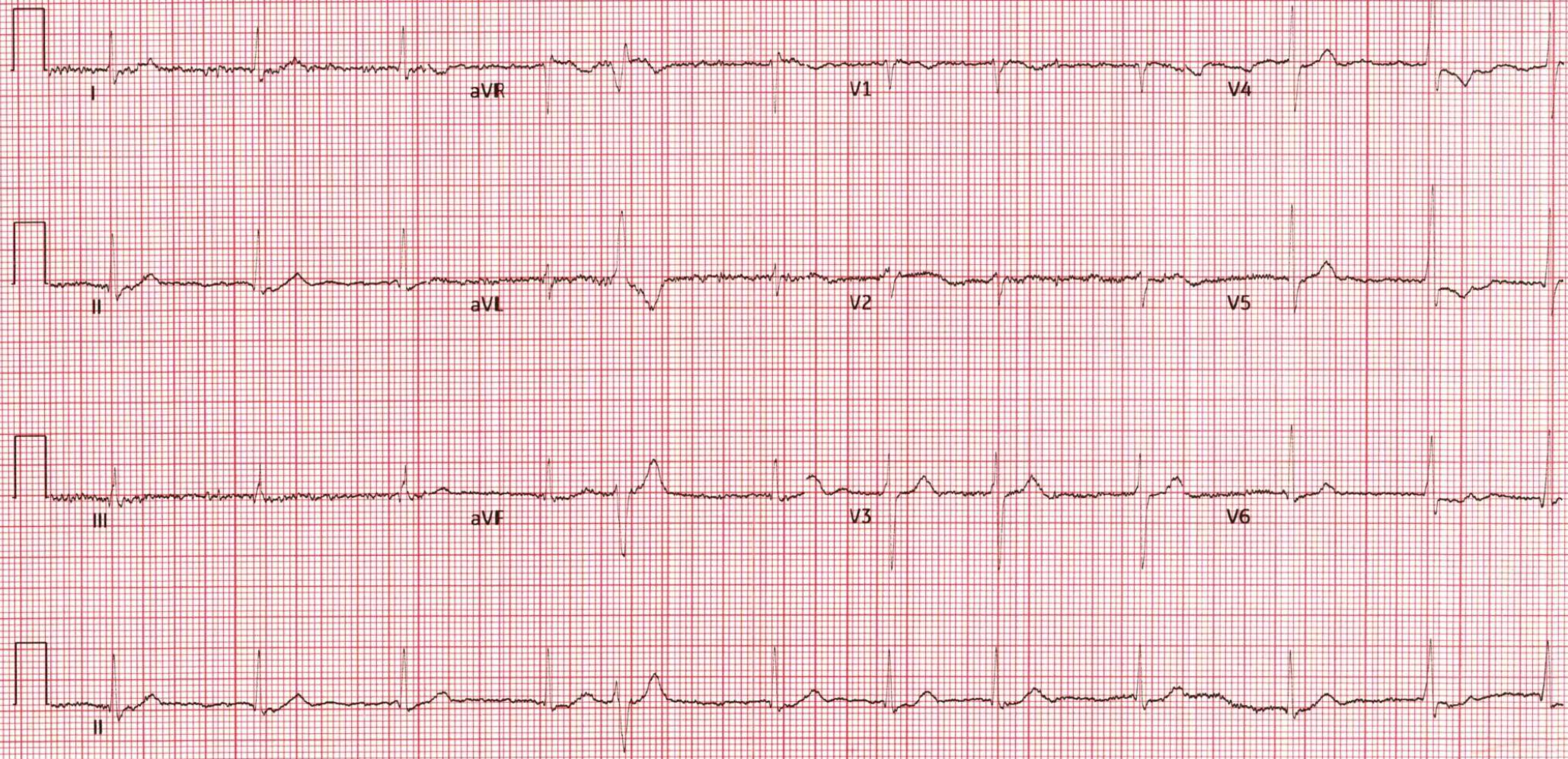




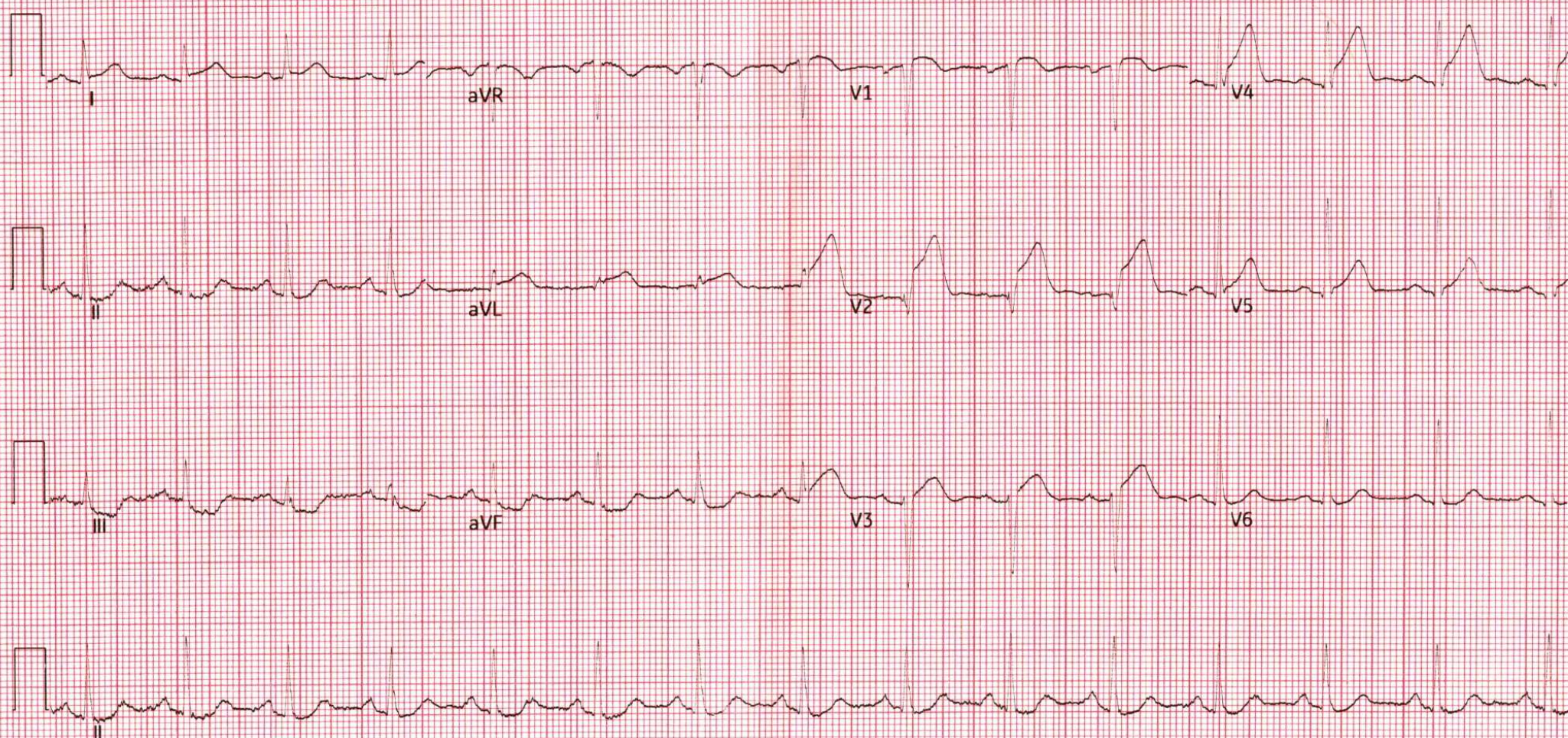
3rd AVB, LAD, RBBB, Marked S Brady-40bpm



Junctional Rhythm with low voltage complexes



A-Fib with multifocal PVCs



Anterior wall STEMI with Inferior ST depression

A red heart is positioned on the left side of the slide, with a red EKG line extending from it across the top. The background is dark with a faint grid pattern.

# Take Home Pointers

1. Use a Systematic Approach
  - a. Approach your analysis to the 12 lead EKG the same way every time.
2. Identify Lethal Rhythms first
3. Cover up the computer interpretation
4. Determine if the rhythm regular or irregular
5. Don't take forever trying to read the EKG
6. Look at every EKG you can to get more comfortable reading them

# REFERENCES

- <https://litfl.com/ecg-library/ecg-references/>
- <https://www.uptodate.com/contents/ecg-tutorial-basic-principles-of-ecg-analysis>
- <https://www.healio.com/cardiology/learn-the-heart/ecg-review/ecg-interpretation-tutorial/stemi-mi-ecg-pattern>



**Questions?**