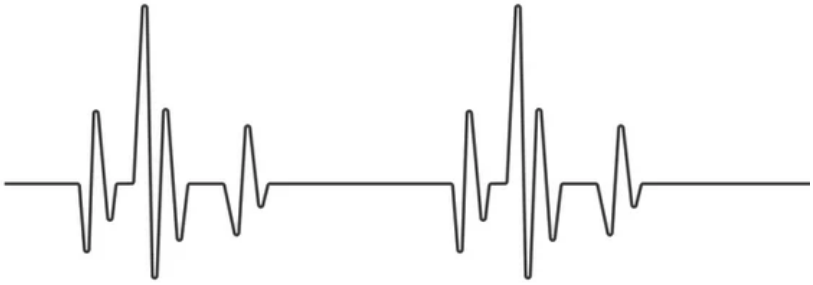
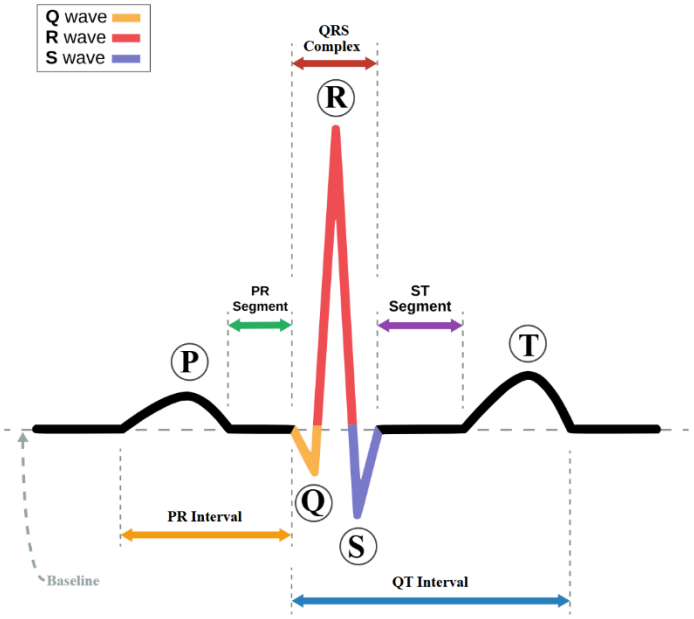
ECG

Made Easy



USMLE PULSE

1. What are the waves, intervals, and segments found in an ECG?



1. P- wave = Atrial depolarization
2. QRS complex = Ventricular depolarization (normal ≤ 100 msec)
3. T wave = Ventricular repolarization
4. U wave = Can be seen in hypokalemia as a wave after T wave
5. PR interval = Starts from the Atrial depolarization to the start of Ventricular depolarization
6. QT interval = Ventricular depolarization, contraction, and repolarization.
7. PR segment = the delay of the electrical impulse at the atrioventricular (AV) node
8. ST segment = Ventricle depolarized

If you are interested in understanding how every wave is measured and the electric current, you can refer to your textbook.

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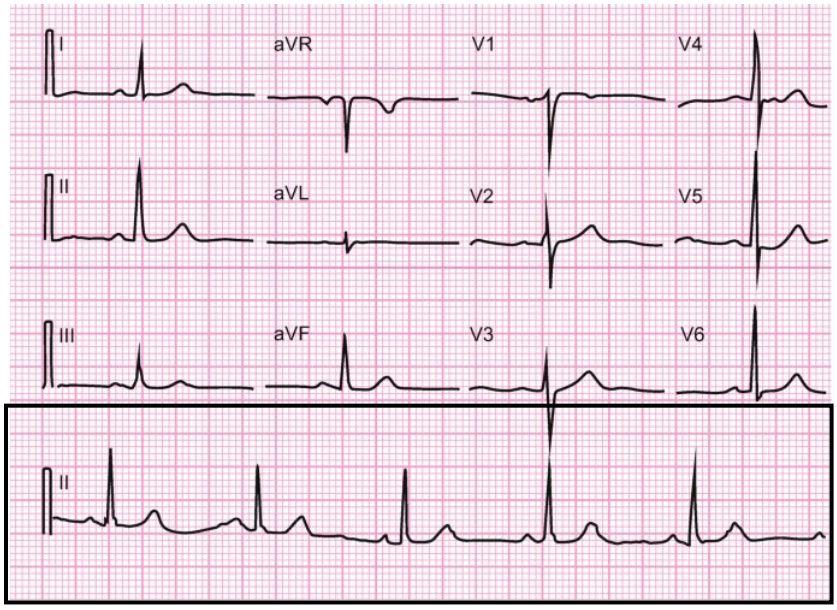
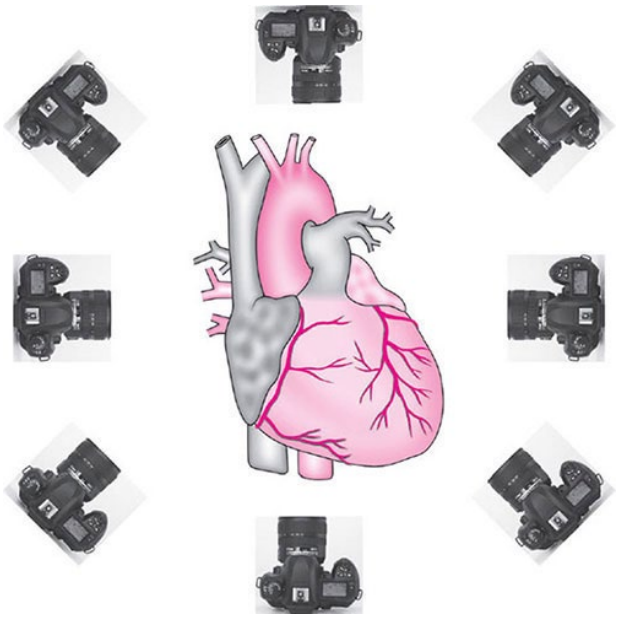
2- What are the 12 leads in the ECG report?



The black box indicated the rhythm strip made in most cases by lead 2 (More details later)

Imagine watching a soccer match. To capture every angle in the field, you must add many cameras, not just one. The same applies to the ECG, where multiple leads act as cameras that record every angle of the heart.



The ECG report contains

1-Bipolar leads (I, II, III)

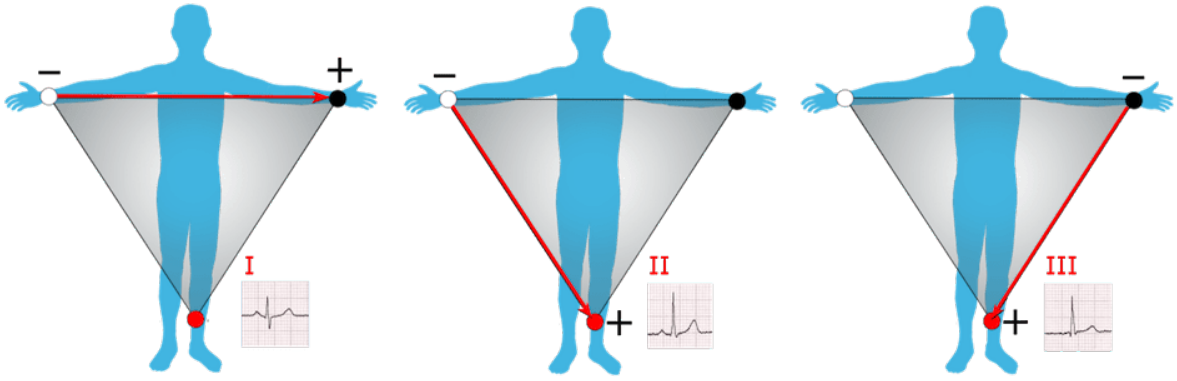
2-Augmented Leads (aVR, aVL, aVF)

3- Precordial Leads (V1-V6)

3-What is the importance of multiple ECG leads?

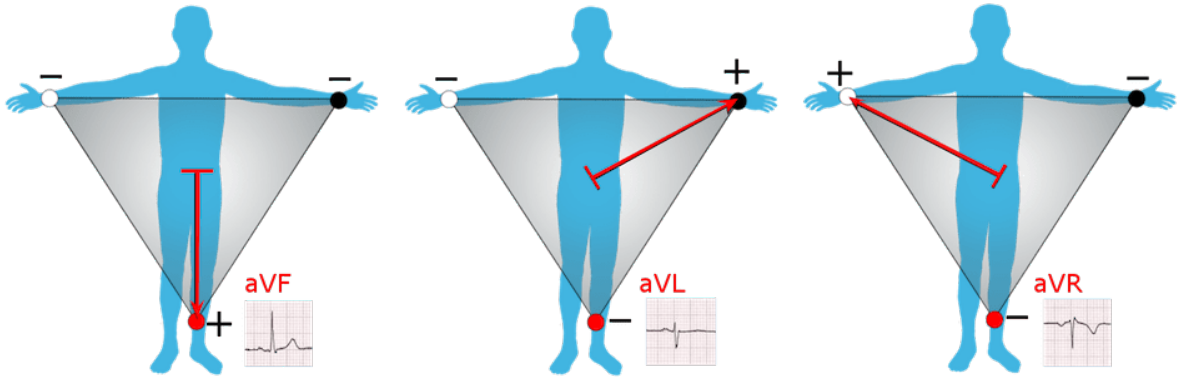
They help localize MI and serve other functions (mentioned in detail later).

1. **Bipolar leads (I, II, III)**



- Lead I localize lateral MI (LCX)
- leads II and III localize the inferior MI (RCA)

B. Augmented Leads (aVR, aVL, aVF)

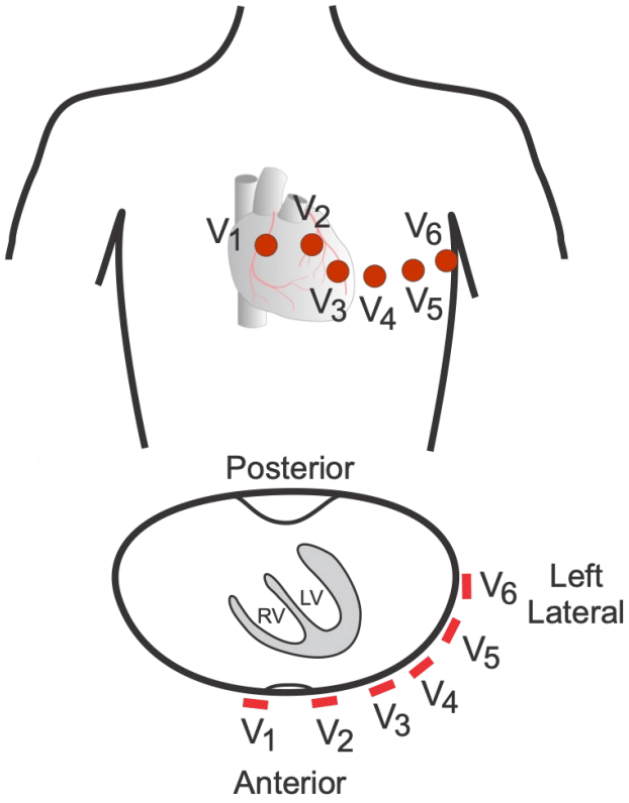


- Lead **aVL** localize **L**ateral MI (LCX)
- Lead **aVF** localize the Inferior MI (RCA)
- Lead aVR (details later)

C. Precordial Leads (V1-V6)

Percordial leads record the anterior part of heart:

- V1-4= Anterior (LAD)
- V5-6= Lateral (LCX)
- V7-9= Posterior (PDA) (Details later)



To Sum up:

Infarction location	Leads
Anterior (LAD)	V1-4
lateral (LCX)	I, aVL ,V5-6
Posterior (PDA)	V7-9
Inferior (RCA)	II,III, aVF

4. After learning the basics, how to approach any ECG report?

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7 Steps

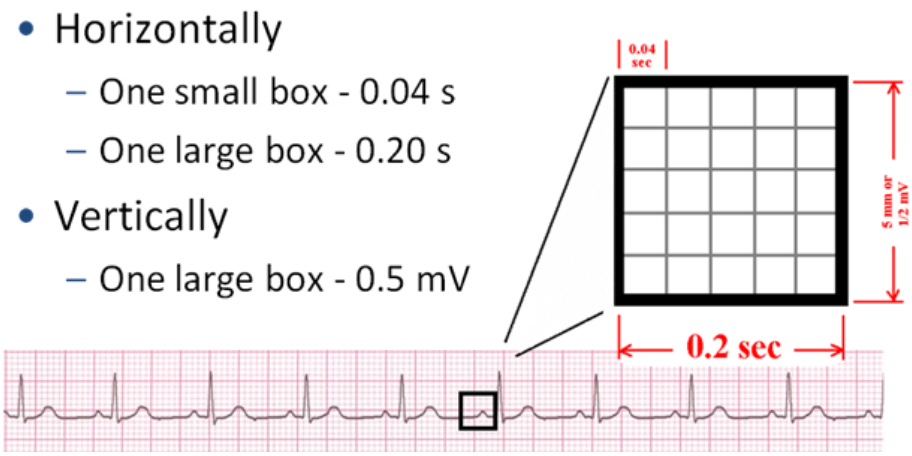
1. Rate
2. Rhythm
3. Axis
4. Intervals
5. P-wave
6. QRS
7. ST segment and T wave

Step 1: Rate

HR = 300/number of large boxes between two R waves

Or

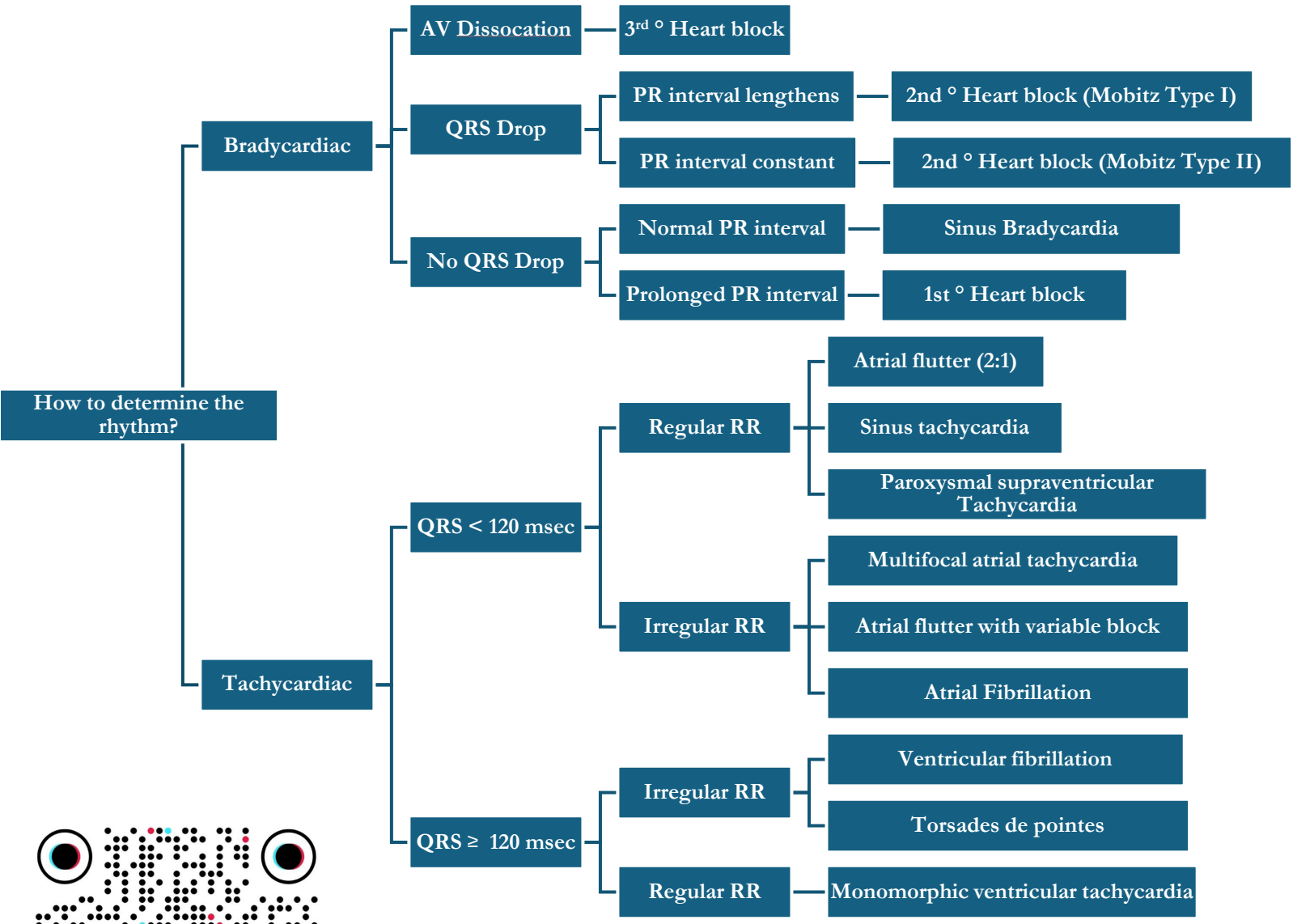
1500/number of small boxes between two R waves



For irregular rhythms: count QRS complexes over a 6-second strip and multiply by 10 for average rate.

Step 2: Rhythm

Look at the rhythm strip **only** to avoid confusion, then use the diagram below.



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I. Tachycardiac arrhythmias

A. Narrow QRS with Regular RR

1- Sinus tachycardia

Sinus Tachycardia

Rhythm: Regular
Rate: 130 bpm (normal range= 60-100 bpm)
P Waves: Upright and regular
P-R Interval: 0.16 sec (normal range= 0.12-0.20), one P wave for each QRS
QRS: 0.04 sec (normal range= 0.04-0.12)

2- Atrial Flutter (2 flutter waves to one QRS)

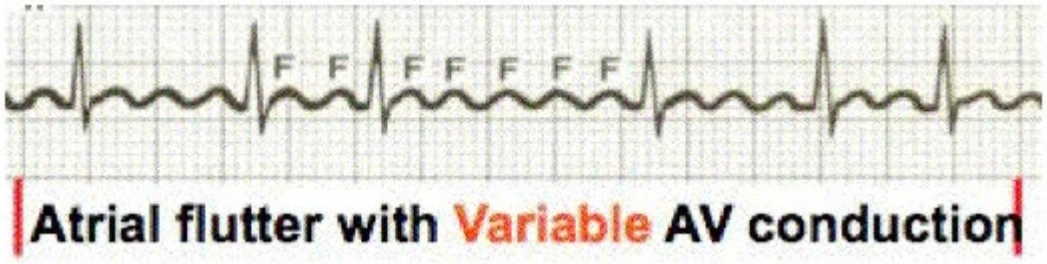
Atrial Flutter with 2:1 AV Conduction

3- PSVT

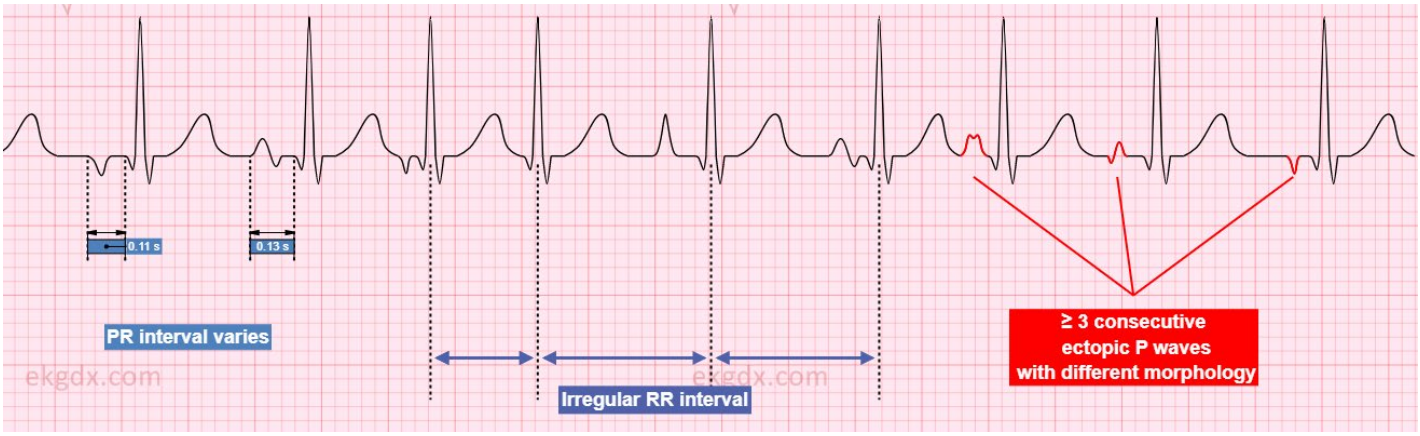
B. **Narrow QRS with irregular RR interval**

1. **Atrial fibrillation (No discrete P waves)**

2. **Atrial flutter with a variable block** (Number of flutter waves are different from beat to beat: one time it is 3 flutter waves, the next is 4 or 3 for example)

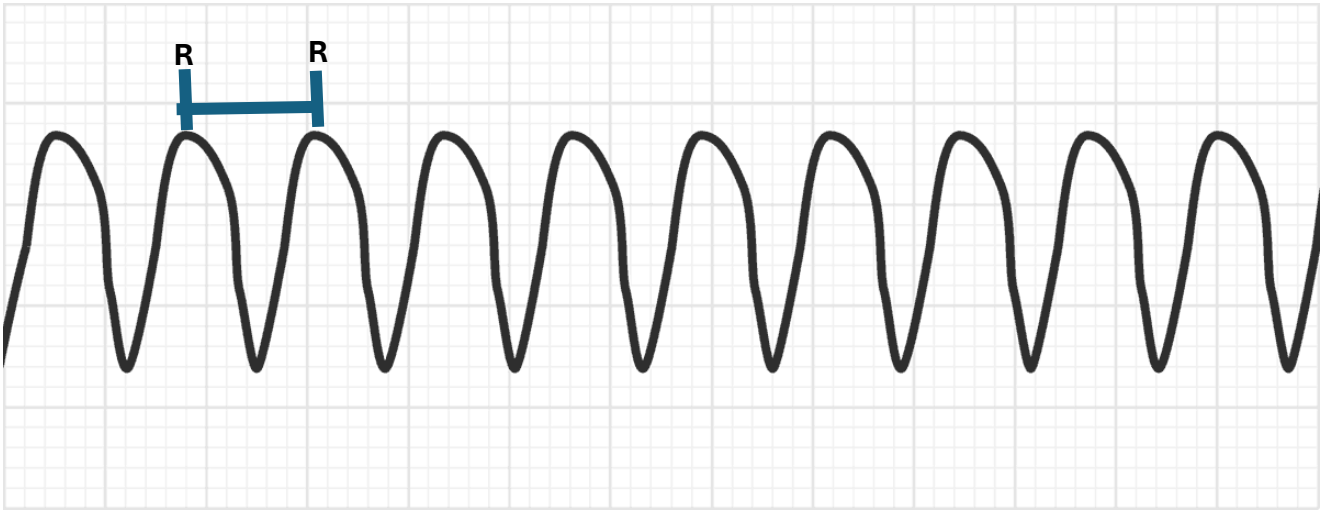


3. **Multifocal atrial tachycardia**



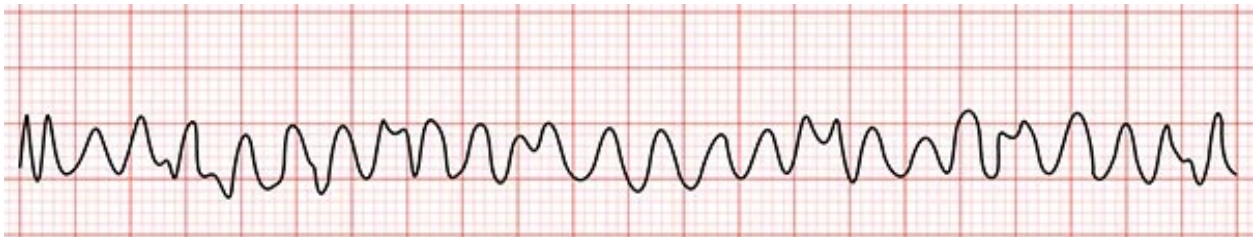
C. Wide QRS with Regular RR interval

Monomorphic ventricular tachycardia

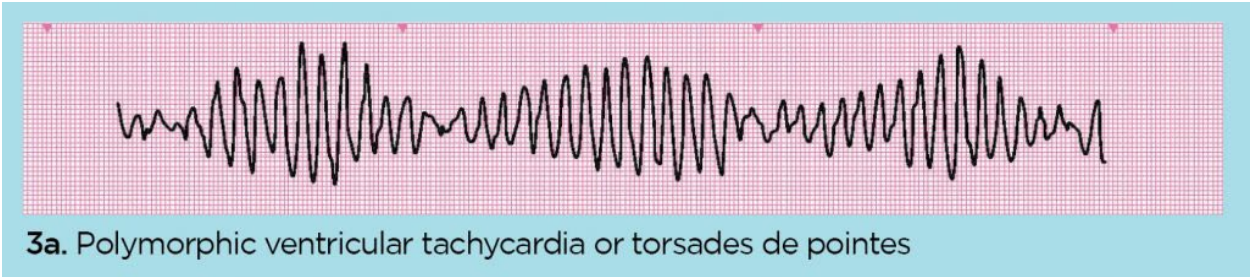


D. Wide QRS with irregular RR interval

1. Ventricular fibrillation



2. Torsades de pointes

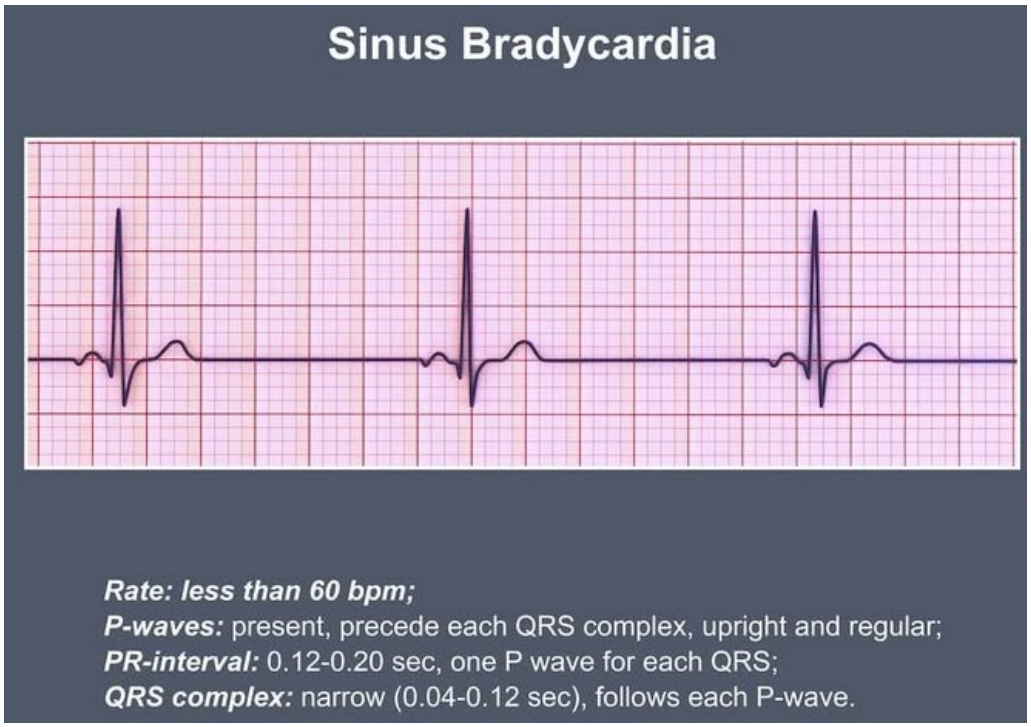


3a. Polymorphic ventricular tachycardia or torsades de pointes

II. Bradycardic arrhythmias

A. No QRS Drop

- **Normal PR interval: Sinus Bradycardia**



- **Prolonged PR interval: 1st ° Heart block**

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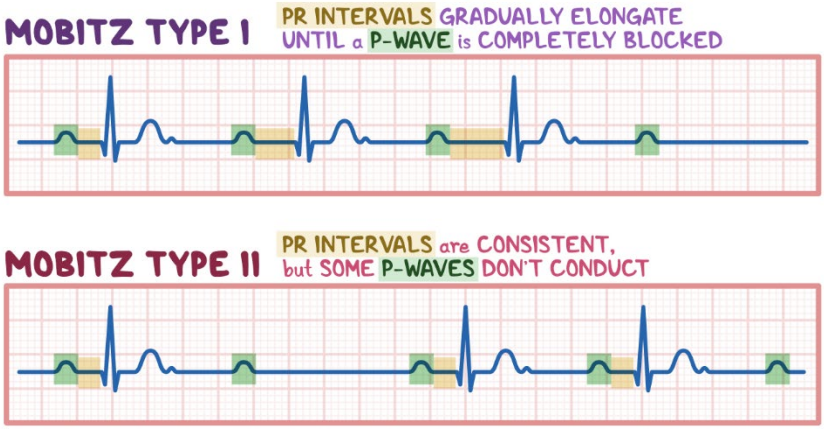
B. QRS Drop

- **PR interval lengthens: 2nd ° Heart block (Mobitz Type I)**
- **PR interval constant: 2nd ° Heart block (Mobitz Type II)**



C. AV Dissociation

- **3rd ° Heart block (Atria and ventricle beat independently: P wave without QRS and QRS with no P wave)**

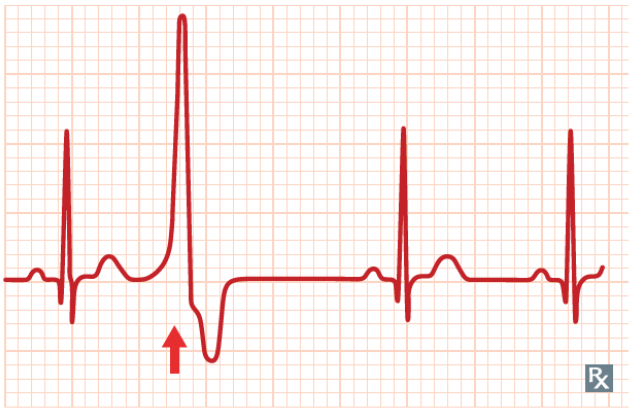
III. Others

1. **Premature atrial contraction:**

   Narrow QRS with a preceding P wave

2. **Premature ventricular contraction:**

   Wide QRS with no preceding P wave

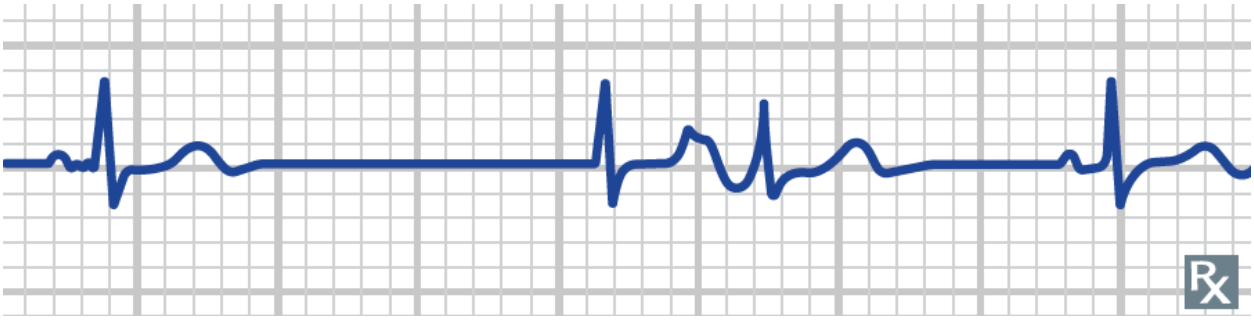


3. **Sick sinus syndrome:**

   Bradycardia

   Sinus pause

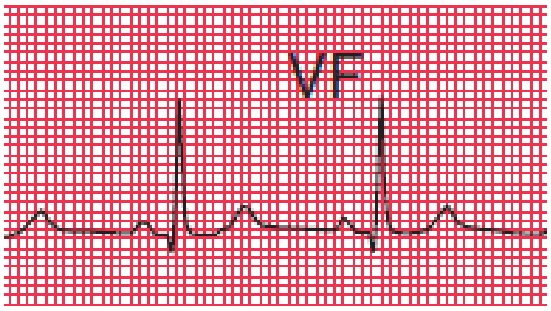
   Sinus arrest



Step 3: Axis

Look at lead I and aVF Only.

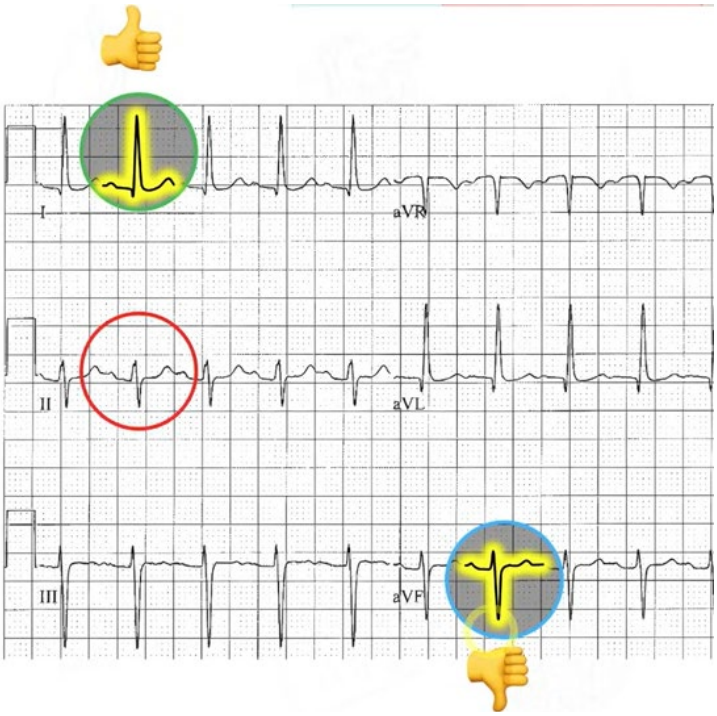
1. **Normally The QRS in both is predominantly positive.**



2. **Left axis deviation (LBBB and LVH)**

Lead I is positive and aVF is negative

N.P: Always confirm by lead II: it must also be negative



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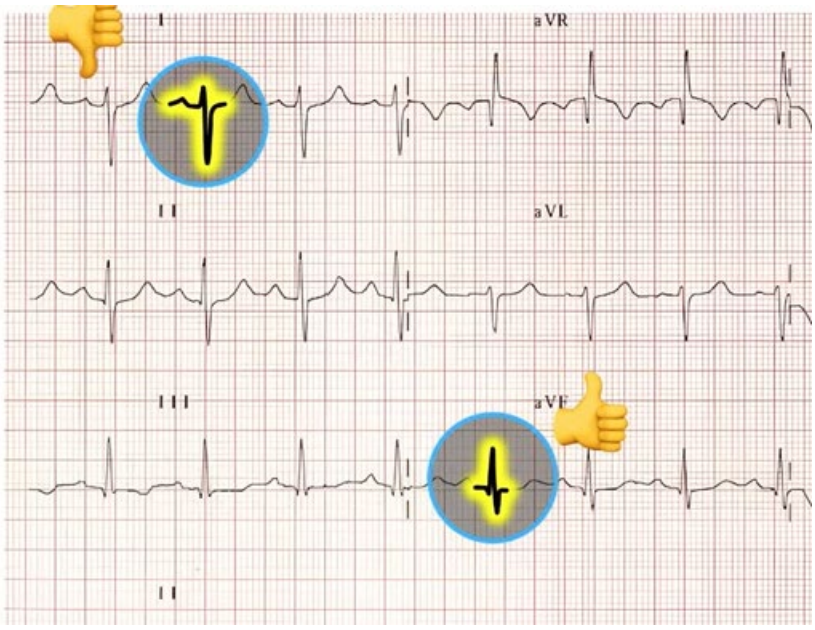
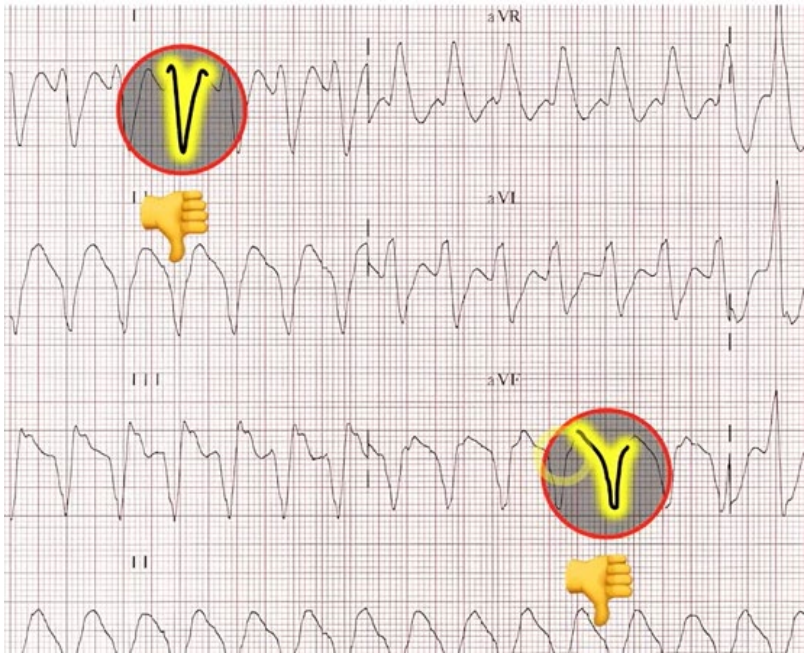
3. Right axis deviation (RBBB and RVH)

Lead I is negative and aVF is positive.



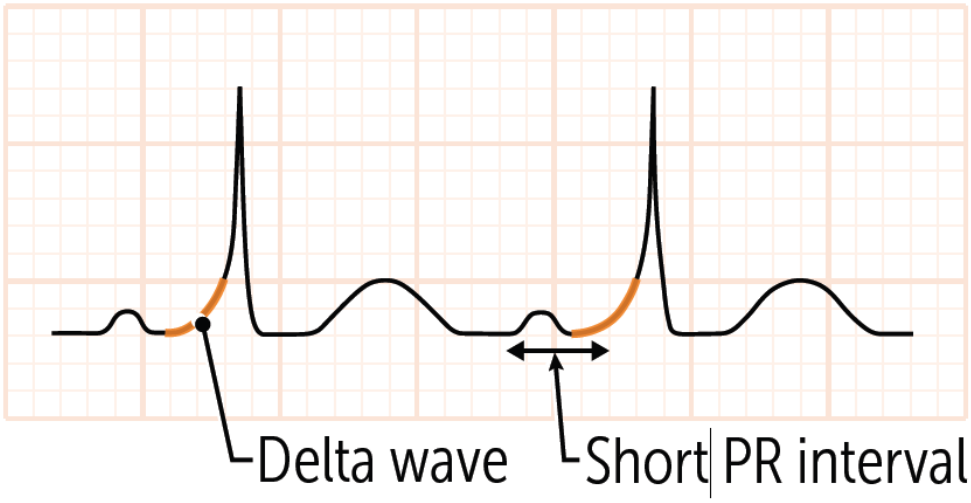
4. Extremely right axis deviation (Ventricular tachyarrhythmia)



Step 4: Intervals (PR and QT)

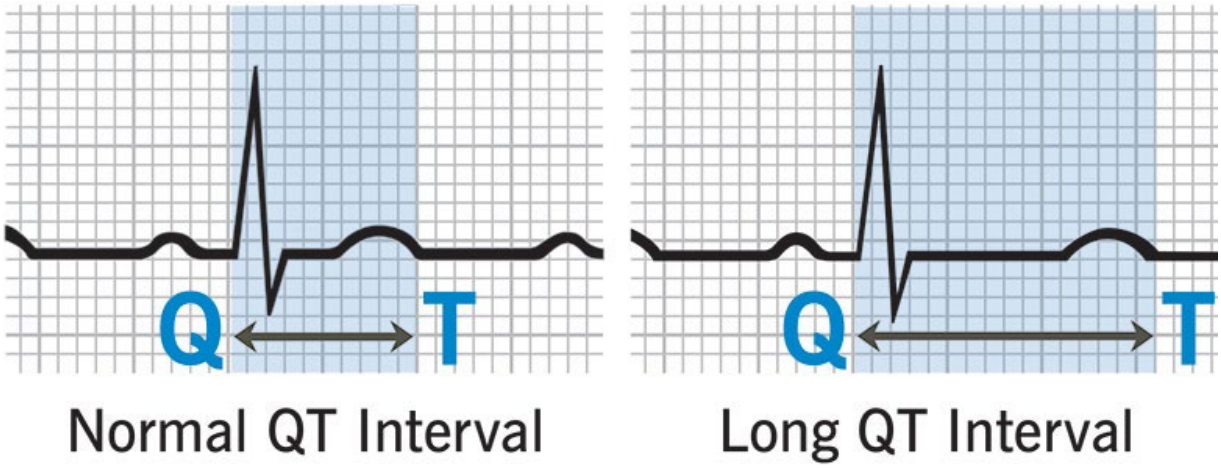
A. PR interval

- **Prolongation:** AV Block (SEE BEFORE)
- **Short:** Wolf Parkinson white syndrome



B. QT

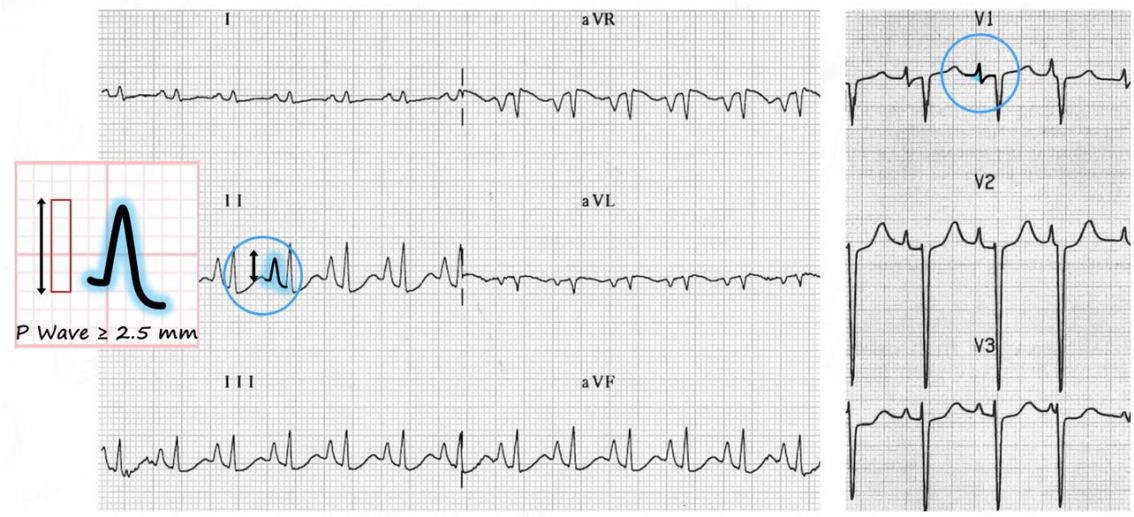
- **Prolongation:** Drugs or congenital
- **Short:** (Hypercalcemia and hyperkalemia)



Step 5: P-wave: Right or left atrial enlargement (Lead II and V1)

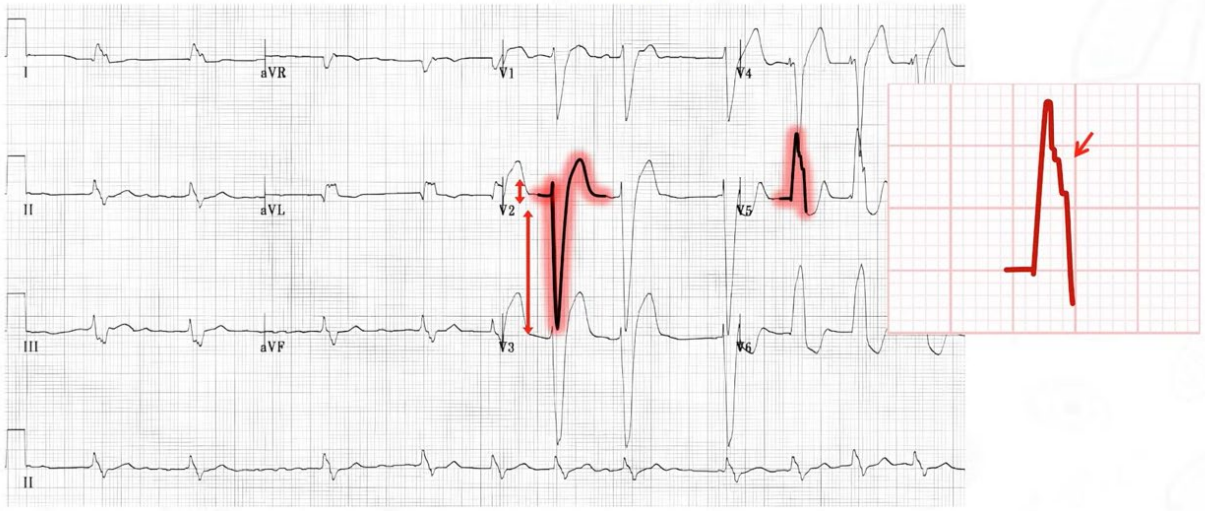
1. **Left Atrial Enlargement:**
   Lead II: Bifid P Wave
   Lead V1: Biphasic P wave with Large terminal component

2. **Right Atrial Enlargement:**
   Lead II: P wave ≥ 2.5 mm
   Lead V1: Biphasic P wave with a large initial component



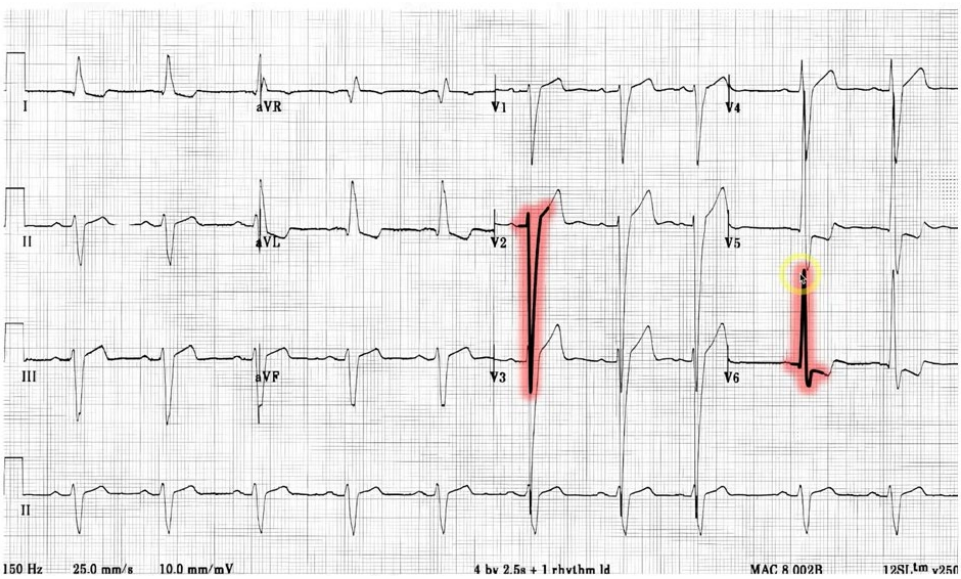
Step 6: QRS-wave (LBBB, RBBB, LVH, and RVH) (Lead V1, V2, V5, V6)

1. **LBBB**
    - **V1/V2:** rS Wave (Very deep S wave)
    - **V5/V6:** Notched R wave



2. **RBBB**
    - **V1/V2:** rSR' Wave (M shaped QRS)
    - **V5/V6:** Wide slurred S wave

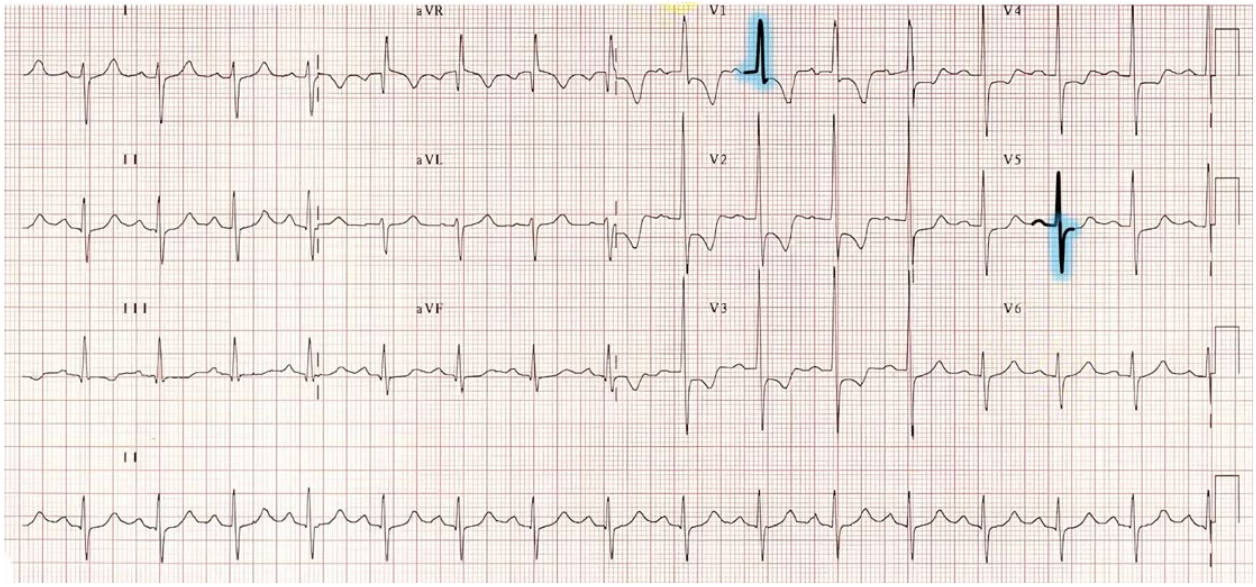
3. **LVH**
    - **V1/V2:** Deep S waves
    - **V5/V6:** Tall R waves



4. **RVH**

    V1/V2: Tall R waves

    V5/V6: Deep S waves



Step 7: ST segment

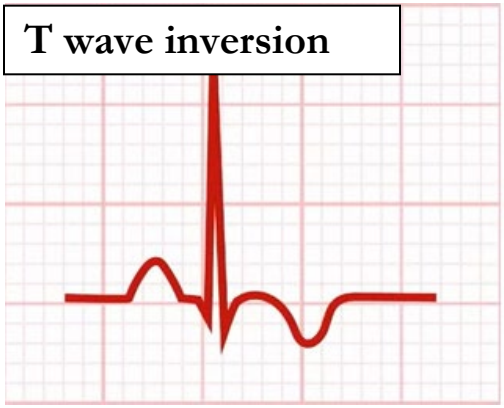
1. **ST-segment depression (NSTEMI or Unstable angina)**

- **>0.5 mm in V2/V3**
- **>1 mm in any other lead**

Can be accompanied by T wave inversion. (Highly indicative for ischemia)

If two contiguous leads showed ST depression this is highly indicative of cardiac ischemia

T wave inversion



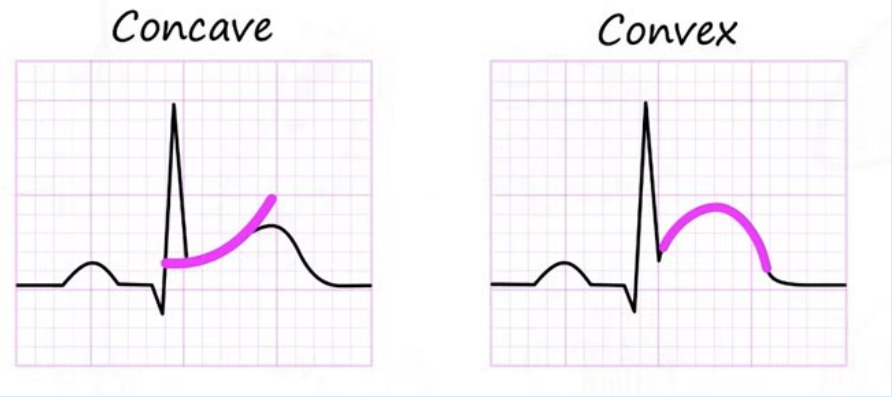
Up-sloping is less indicative for ischemia than Horizontal or down sloping

2. **ST-segment elevation (STEMI)**

- **>1 mm in limb leads**
- **>2 mm in precordial leads**
- **If two contiguous leads showed ST elevation, this is highly indicative of cardiac ischemia**
- **Can be accompanied by hyperacute T wave (can occur before ST-segment elevation)**

hyperacute T wave

Covex (Sad face) is more indicative of ischemia than concave (Happy face).

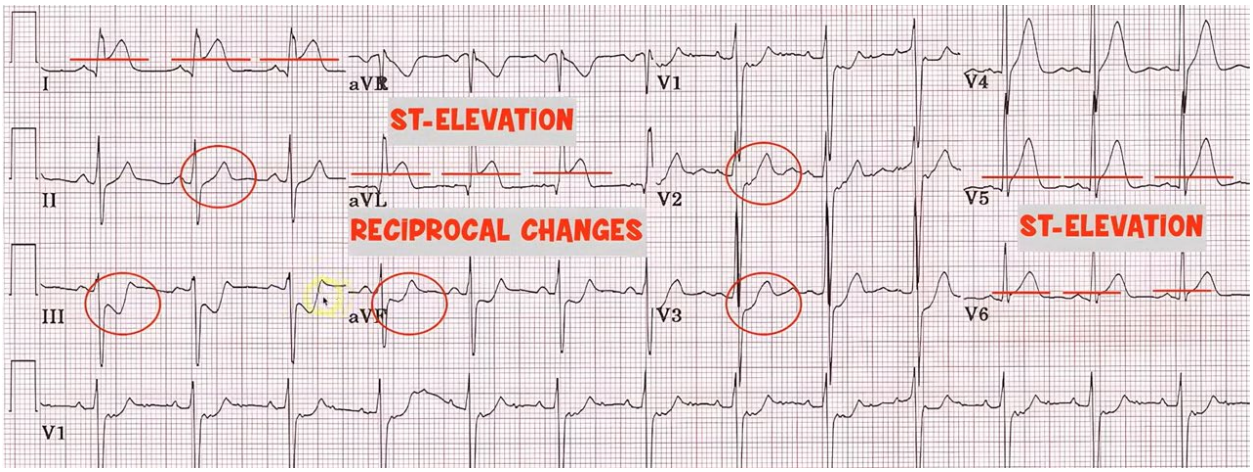


5. How to Localize a STEMI?

Infarction location	Leads	Reciprocal changes
Anterior (LAD)	V1-4	II,III,aVF
lateral (LCX)	I, aVL ,V5-6	
Posterior (PDA)	V7-9	V1,V2,V3
Inferior (RCA)	II,III, aVF	I, aVL

Leads changes will show an ST-segment elevation and may show a hyperacute T wave, while reciprocal changes will show ST depression and T wave inversion.

Example for lateral infarction



6. How to localize a posterior infarction?

Detect reciprocal changes in V1-3, then remove those leads from the anterior chest wall and put them on the back to detect the ST elevation.