PRIMARY CARE
MED437

ECG Interpretation

Objectives:

- Calculate Heart rate.
- Determine the axis deviation.
- Determine type of the rhythm.
- Diagnose all degrees of heart block (1st, 2nd type 1, 2nd type2, and third degree heart block).
- Diagnose bundle branch block (Rt and Lt).
- Diagnose main types of arrhythmia: Atrial fibrillation, Atrial flutter, Ventricular tachycardia, Ventricular Fibrillation, WBW, SVT, sinus tachycardia, prolong QT-interval, sinus arrhythmia and bradycardia.
- Diagnose ischemic changes with determining heart anatomy involved.
- Diagnose pericarditis and LVH.

Done by:

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References

- Doctor's slides and notes

Important *Notes* *Extra* *Golden*

Editing file link

An approach made by the team

First look at the rhythm

Rhythm.

- irregular → **Think about**
  1. Atrial Fibrillation with absent P wave
  2. Atrial flutter (saw tooth pattern)
  3. Second degree heart block Type 1 (mobitz l) (progressive PR prolongation + sudden beat drop)
  4. Second degree heart block T 2 (mobitz ll)(fixed normal PR/ fixed prolonged PR + sudden beat drop)
  5. Sinus arrhythmia
- regular → **Rate**
  - If regular rhythm: → Calculate the big squares between R-R
    if > 5 big square (bradycardia)
    if < 3 big square (tachycardia)
    if between 3 and 5 big squares (normal HR)
  - Another method working for regular and irregular rhythm → calculate the number of QRS complexes in 30 large squares & multiply by 10

Axis

P wave

- Absent → **Think about**
  1. Atrial Fibrillation: if absent P wave + irregular rhythm
  2. SVT (supraventricular tachycardia): regular **narrow** complex tachycardia
  3. VT (V tach) (Ventricular tachycardia): any **wide** QRS complex “>3 small sq” tachycardia is considered VT until proven otherwise.
  4. VF (V fib) (ventricular Fibrillation): An ECG finding of a rapid grossly irregular ventricular rhythm with marked variability in QRS cycle length, morphology, and amplitude.doesn’t have a specific pattern and usually occurs in a comatose pt
- present → **P R interval**
  - Look at more than one interval
    - Prolong PR interval >0.2 sec (> 200 ms) (>5 small boxes) → ***AVB (1st , 2nd type1, 2nd type 2 or 3rd degree heart block) or hyperkalemia.
    - Short PR interval <0.120 sec (120 ms) (< 3 small squares) → most important cause is WPW which is associated with delta wave. Remember 3rd degree heart block causing Variable P-R interval length, So it will cause short and prolonged P-R interval.

Q wave, QT interval, QRS complex, ST segment, T wave.

*** AV Block(Heart block):
Electrical block at the level of AV node causing delayed conduction. P wave reflects the signal from the SA node but doesn’t mean that a contraction happened, while the P-R interval (which is the beginning of P wave to the beginning of Q)reflects the duration of the electrical conduction from SA to AV node.So,any blockage usually will cause delay and therefore prolongation in the P-R interval on the ECG.
•Normal P-R interval = 0.2 sec (one big square).
First degree: The electrical impulses **pass**, but in a lower conduction velocity.So, we will have fixed prolonged P-R interval(**regular rhythm**).
Second degree:Not every impulse will pass.It contains 2 types:
1)Type 1:Progressive prolongation of P-R wave with sudden dropped beat (Dropped beat: P wave is not followed by QRS complex), irregular rhythm.
2)Type 2:Fixed P-R interval (could be prolonged or normal in duration), but sudden beat drop, and this type is riskier and have higher chance to become complete heart block (3rd degree heart block).
Third degree (complete heart block/AV dissociation):
Most of the impulses doesn’t get through. In such case, AV node can generate its own independent impulses (QRS waves) which will be in slower rate in comparison to the P waves. So,the two waves will be separated and not related to each other. Keep in mind that although the rate is different between the P waves and QRS complex but the duration between each two QRS complexes is the same as well as for the P waves on the same lead. Here the rhythm will be regular (as we said the rhythm is decided upon the duration between the R-R interval no matter what’s its relation to the P wave), but the P-R interval is variable.

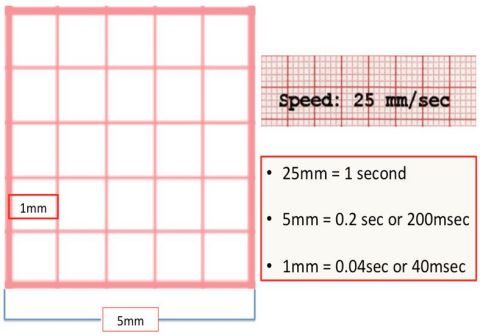
NOTE: This ECG interpretation approach to help to diagnose some common disorders. It is important to note that there are many other helpful approaches to interpret ECG and there are Many disorders not covered in this approach.

Approach:

ECG is a quick, cheap, non-invasive diagnostic tool.
•If you suspect any acute diseases from the ECG, repeat the test again and compare.

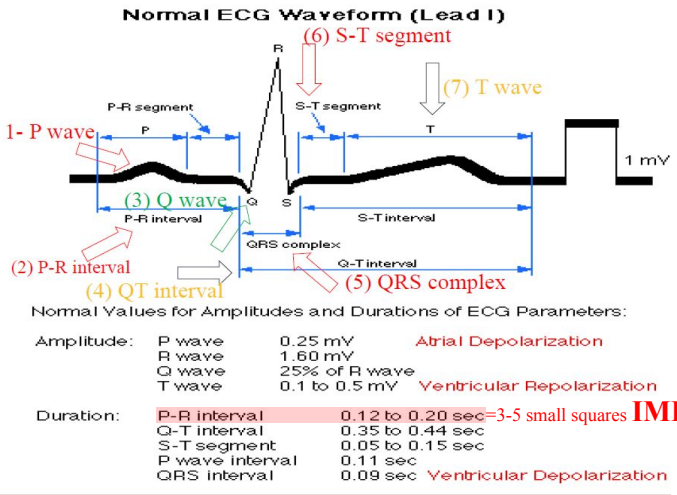
After checking the name and ID of the patient,Look at:
1)Rhythm.
Regular or irregular? Look at the R-R interval and see whether it is constant or changing.
2)Rate.
3)Axis.
4)P wave, P-R interval, Q wave, QT interval, QRS complex, ST segment, T-wave.

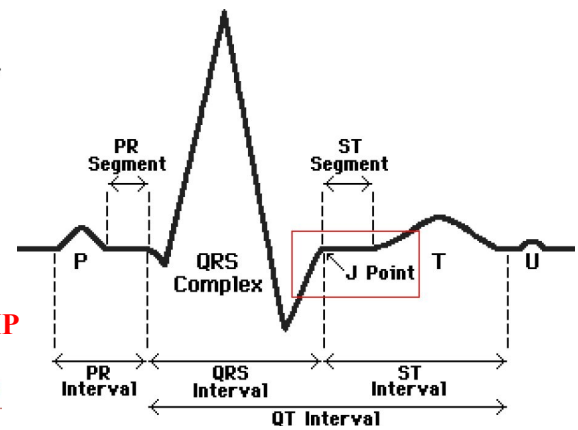
Absent P wave + irregular rhythm = A fib
Absent P wave + Wide QRS complex= V tach
Absent P wave + Narrow QRS complex = SVT



•One big square on the ECG paper = 0.2 sec.It contains 5 small squares.

•The best lead to assess the sawtooth appearance (if you are suspicious) is V1 and lead II for P wave





Irregular rhythm:

There are many causes but the most important and common are:

1)Atrial fibrillation(absent P wave).
2)Atrial flutter(sawtooth shape).
3)Second degree heart block type 1 (Mobitz 1).
4)Second degree heart block type 2 (Mobitz 11).

5)Sinus arrhythmia(It is a diagnosis of exclusion of all the previous DDx: no sawtooth appearance, no dropped beat) common in pediatric.

Rate:

If **regular** rhythm:

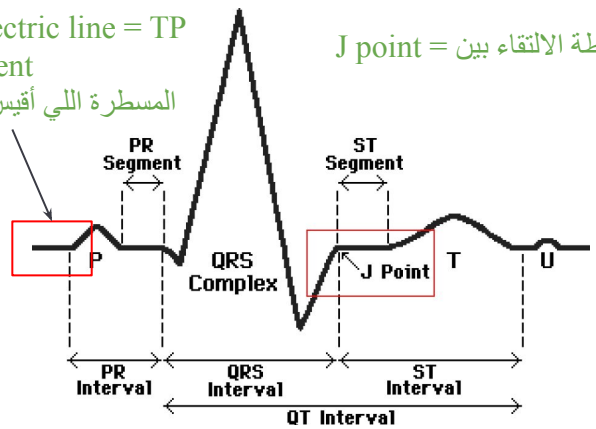
1) calculate big square between R-R:
   - if > 5 big square (bradycardia)
   - if < 3 big square (tachycardia)
   - if between 3 and 5 big squares (normal heart rate).

2) In standard ECG: calculate the number of QRS complex(on the strip lead, usually from lead 2)in ECG and multiply by 6 (because the ECG lasts 10 seconds and we want the heart rate in one minute)= HR.

3) calculate the number of QRS complexes in 30 large squares and multiply it by 10

Isoelectric line = TP segment
المسطرة اللي أقيس عليها

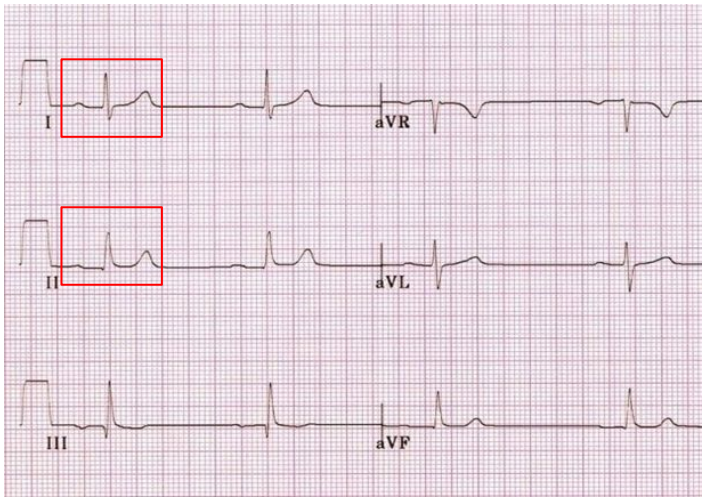
J point = نقطة الالتقاء بين S+T



How to know if ST segment is elevated or depressed?
Compare J point with the isoelectric line

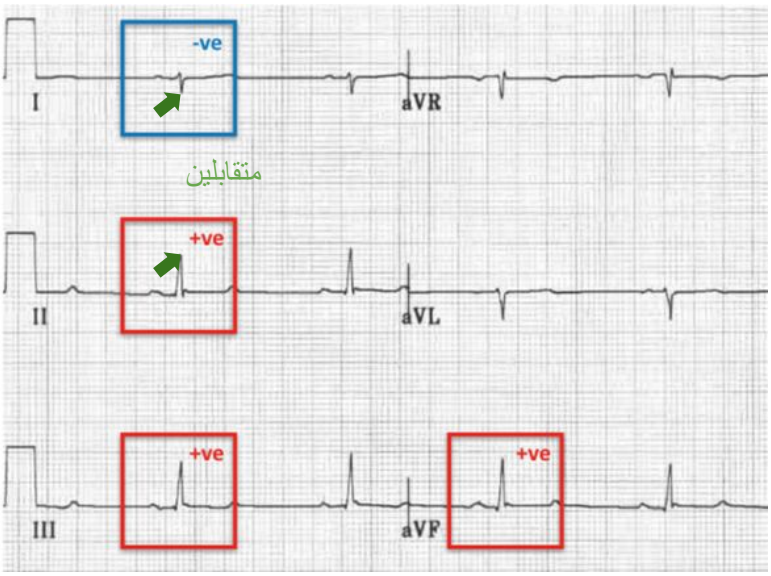
Normal axis:

Look at lead 1 & 2 and decide.



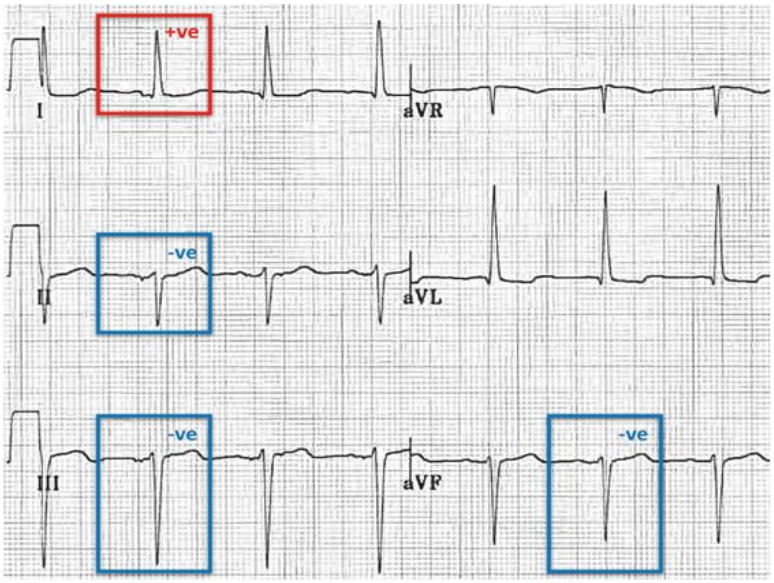
Positive in I and II = normal
Everything is going up

Right Axis Deviation: Mnemonic: أصحاب اليمين على سرر متقابلين



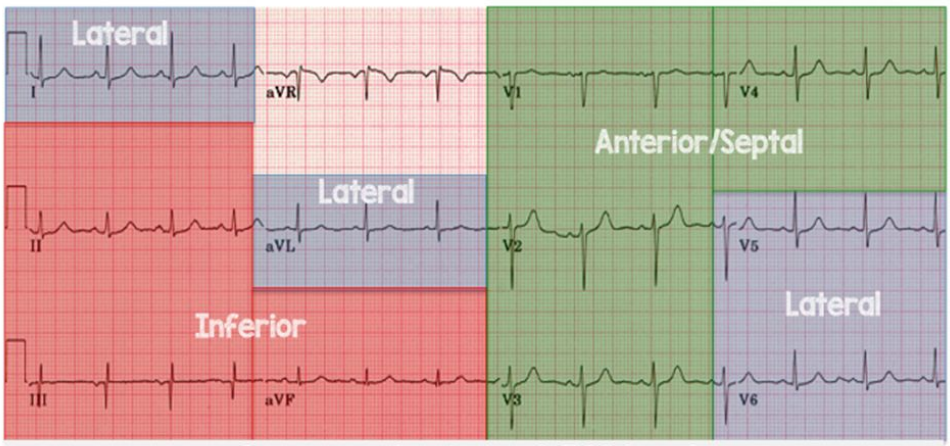
Negative in I and Positive in II = RAD

Left Axis Deviation:



Positive in I and Negative in II = LAD
The waves are opposite to each other

Memorize it for the 2nd part of the lecture



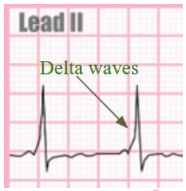
Coronary Anatomy & ECG Leads		
Lateral Leads	I, aVL, V5 - V6	LCx or Diagonal of LAD
Inferior Leads	II, III, aVF	RCA and/or LCx
Anterior/Septal Leads	V1 - V4	LAD

Interpretation:

Important finding:

- Irregular rhythm.
- The HR can't be determined in this pic
- Absent P-wave.
- **Diagnosis: Atrial Fibrillation.**

PR=109 ms



Important finding:

- Regular rhythm.
- Normal HR
- P-wave is present.
- Short PR interval.
- Delta waves.
- **Diagnosis: WPW.**

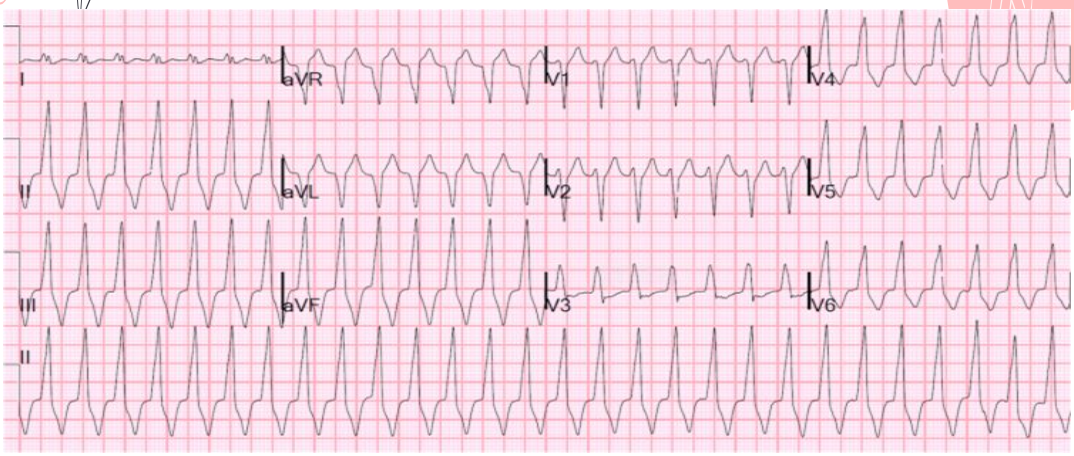
QRS drop
mnemonic:P-P sign

Important finding:
Irregular rhythm.
Fixed PR interval followed by a drop in QRS complex.
Diagnosis: 2nd degree AV block type 2

PR = 223 ms

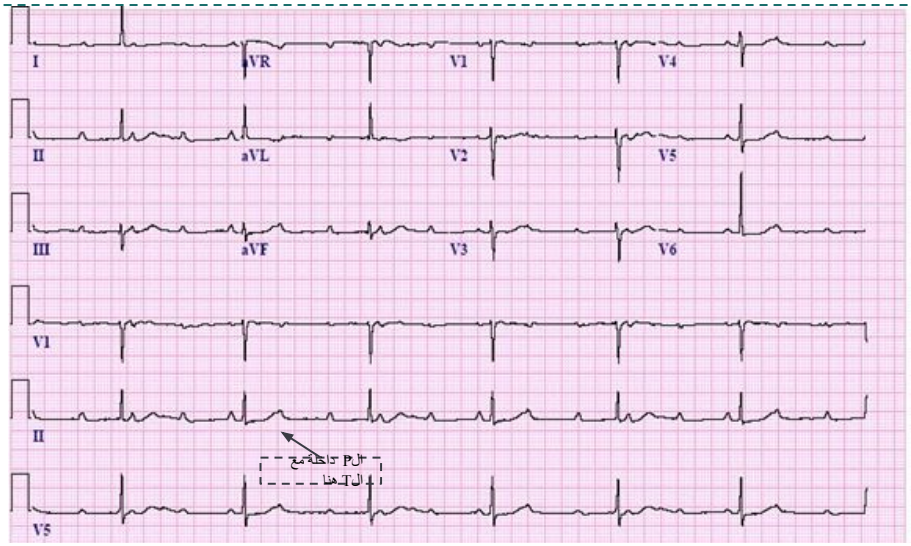
Important finding:

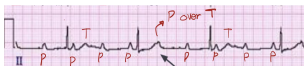
- Regular rhythm, Normal rate, P wave is present.Fixed prolonged PR interval without QRS complex drop.
- **Diagnosis:1st degree heart block.**



Here consider QRS complex is more than 3 small sq

- Regular , tachycardiac , absent P wave
- **Diagnosis: <u>Wide</u> complex tachycardia, most likely ventricular tachycardia**





Important finding:

- Regular rhythm , Bradycardia , P wave is present
- The P wave with a regular P-to-P interval*. The PR interval is variable.
- **Diagnosis: 3rd degree heart block (complete heart block)** Sometimes it shows wide QRS

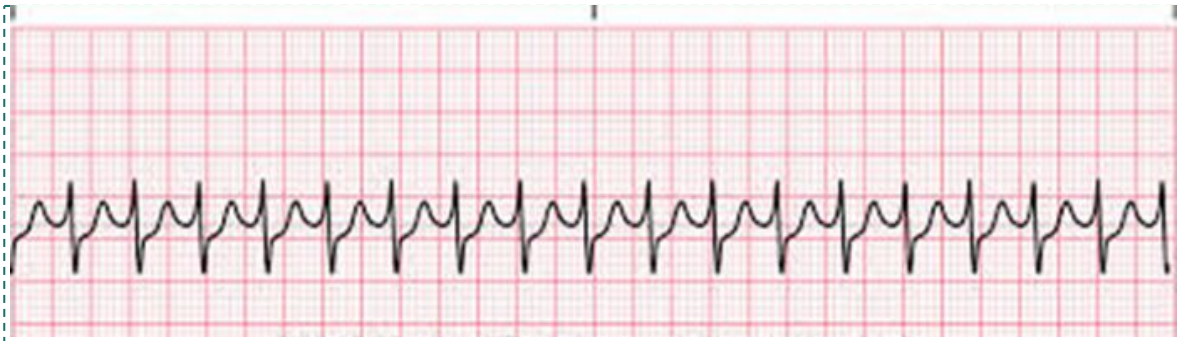
There is complete dissociation between P wave and QRS complex

*because SA node is working and as you can see it's not related at all to the QRS

Findings:

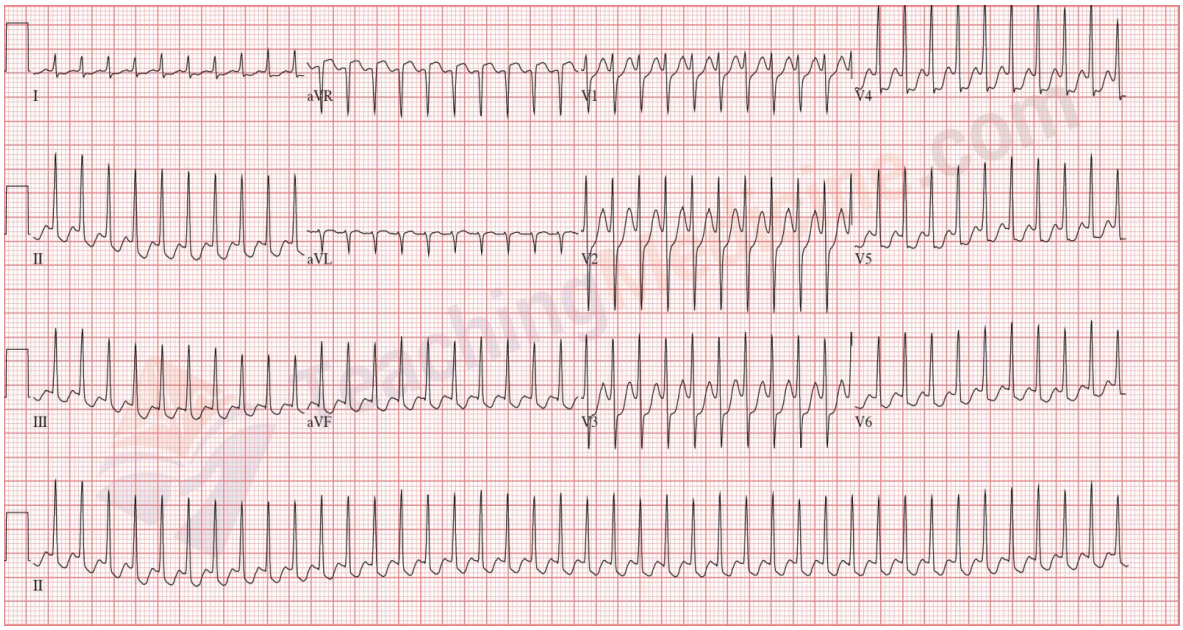
- Irregular rhythm with Progressive prolongation of PR interval* with a sudden drop in QRS complex.
- **Diagnosis: second degree AV block type 1**

*you might see a little variability but it's not a variable PR interval because it has a pattern "look at the previou pic to distinguish between them "



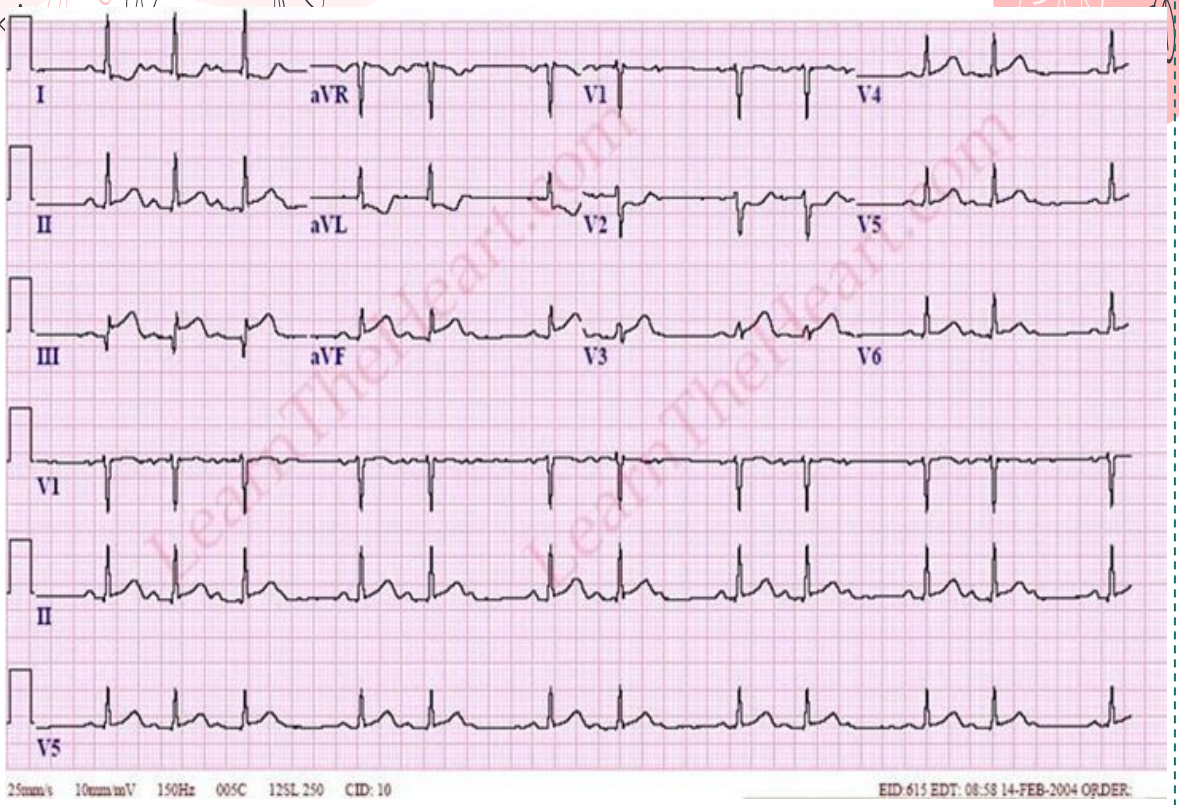
- Regular rhythm , tachycardia , absent P wave* with narrow complex
- ST segment depression
- **Diagnosis: SVT**

* this a bit confusing but in general if you the wave more towards the previous pulse→ T wave, also T wave usually can't be absent in all the leads but P wave can be



Important finding:

- Regular rhythm, tachycardia, absent P wave.
- ST segment depression
- **diagnosis: SVT**



To say we have ST elevation we need 2 things:

1. Elevation of 1 small square (maybe 2 small squares for V2,V3)
2. Two leads or more in the same anatomy

Findings:
ST elevation in lead III
ST elevation in lead aVF

→ Inferior MI

Findings:
ST depression in lead I
ST depression in lead aVL

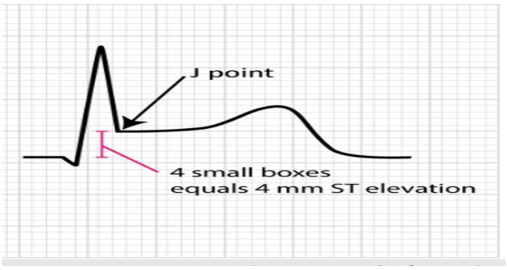
→ Reciprocal change in lateral leads

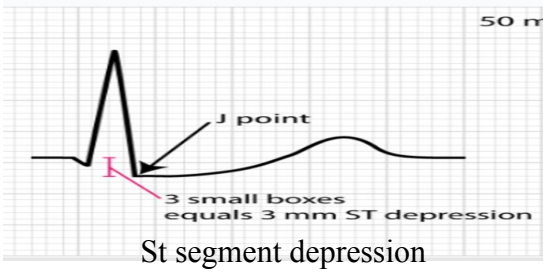
Check second part of the lecture for more explanations

Inferior MI and 2nd degree heart block type 1

Part II

S-T segment:

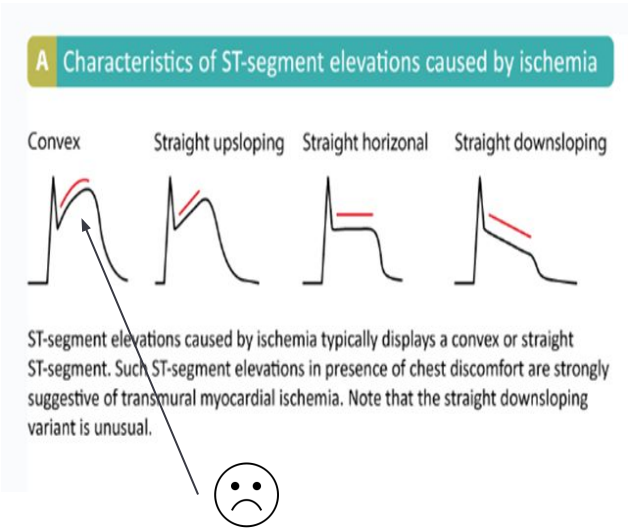




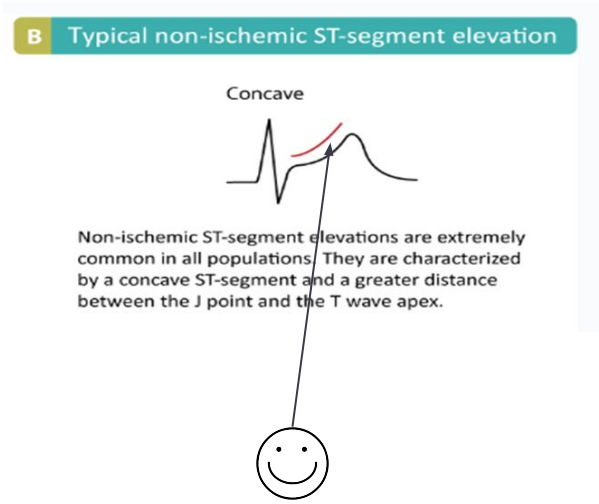
St segment depression

S-T segment:

- Either elevated or depressed. Significant → the changes must be 1.at least one box. 2.tow elevation or depression in different leads at the same anatomy
- Better determined by J point (The meeting point between the QRS wave and ST segment).
- The best isoelectric line to measure the ST segment elevation or depression is TP segment, so we compare it with the J point.



Convexity looks like a sad face (ما تطمن بالعربي)
ischemic

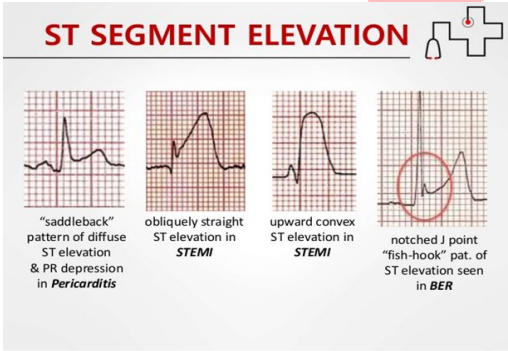


Concavity looks like a happy face (تريحك)
Non ischemic

This is just gives us a hint, we should depend on the medical history; age, risk factors, pain character

What are the Most Important causes of ST elevation in ECG?

- MI
- Acute pericarditis
- LBBB (wide QRS + ST Elevation)
- Benign early repolarization (common and not that serious)



Reciprocal changes:
Each lead looks at the heart from a different view.
II, III, aVF looks at the heart from below (inferiorly).
I, aVL, V5, V6 looks at the heart laterally
V1, V2, V3, V4 looks at the heart anteriorly

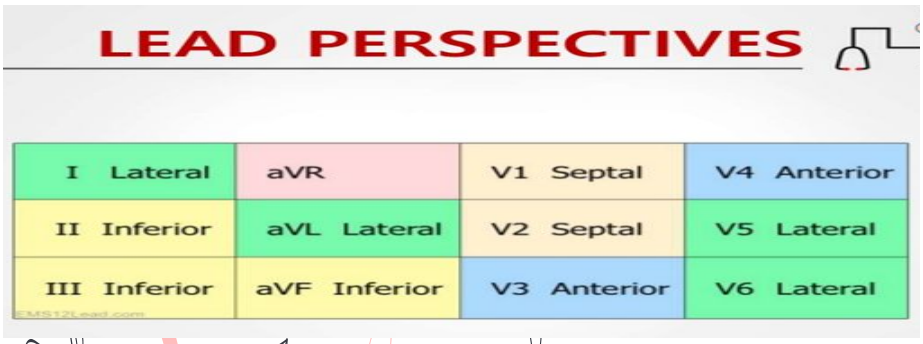
now let's say someone has MI. you'll have **ST elevation** on the leads looking at the **affected** part and **ST depression** on the **opposite leads** (think of it as if the ST **elevation** is dragging the electricity from the opposite leads and causing ST **depression)**
So which lead is opposite to which?

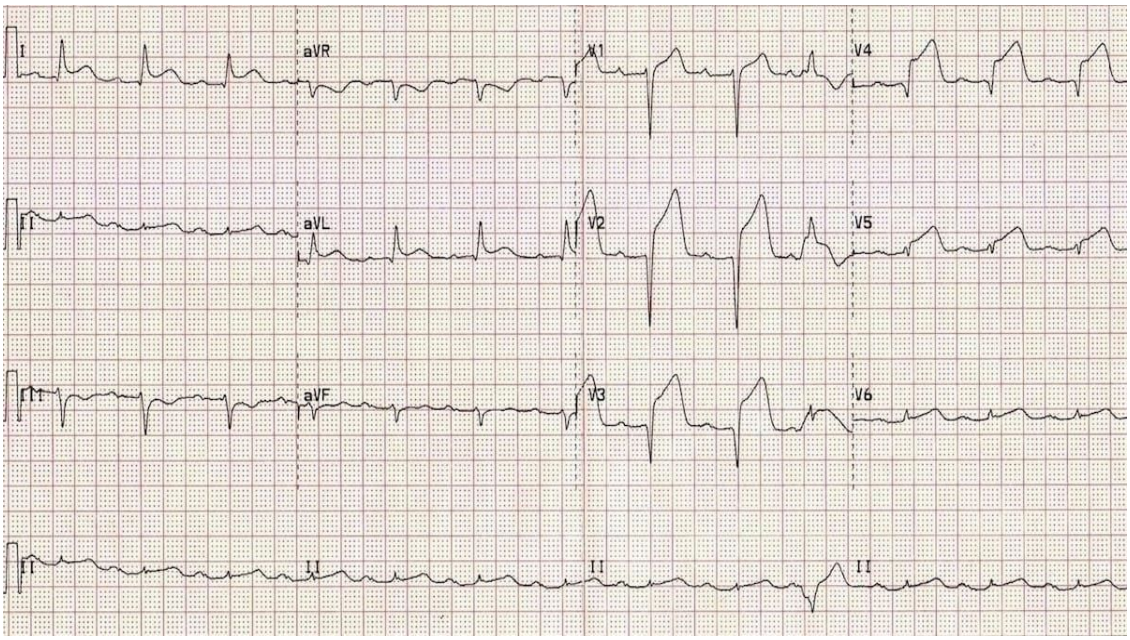
- lateral leads are opposite to inferior leads and vice versa.
- Anterior leads are opposite to posterior leads and vice versa but you need 15-ECG leads to look at the heart posteriorly rather than the regular 12-ECG leads

Please note

1. Reciprocal changes doesn't always occur
2. there are other causes for ST depression such as NSTEMI and LVH with repolarization abnormality

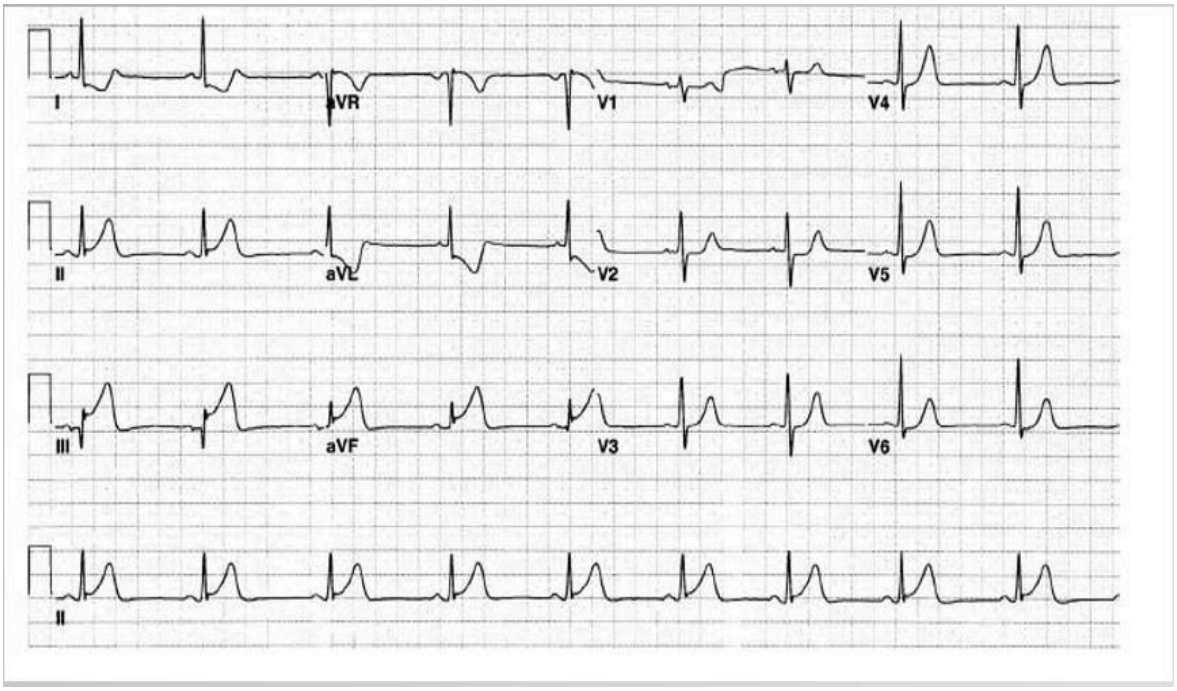
So basically once you see ST depression its either reciprocal change "check the opposite lead for ST elevation" and this is a STEMI (ischemia in the opposite lead; the one with elevation) or its NSTEMI (ischemia in the lead with ST depression)





Findings:

- Regular rhythm, Normal HR, P wave is present, left axis deviation ..Fixed prolonged PR interval without QRS complex drop >>**1st degree heart block.**
- ST elevation in lead I, aVL, V5, >> Lateral MI
  ST elevation in lead V1, V2, V3, V4>> Anterior MI
- **Diagnosis: Anterolateral STEMI** with reciprocal changes

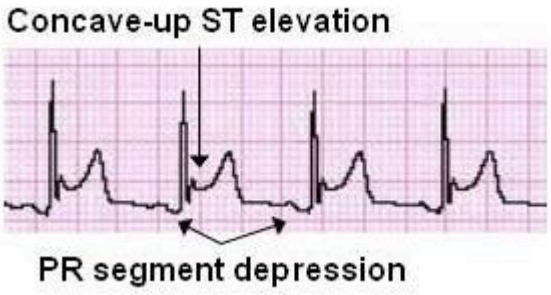


Findings:
Normal rhythm , bradycardia .
ST elevation in lead II, III, aVF >> inferior MI
ST depression in lead I, aVL, V5, V6 (reciprocal changes)
Diagnosis:Inferior STEMI with reciprocal changes

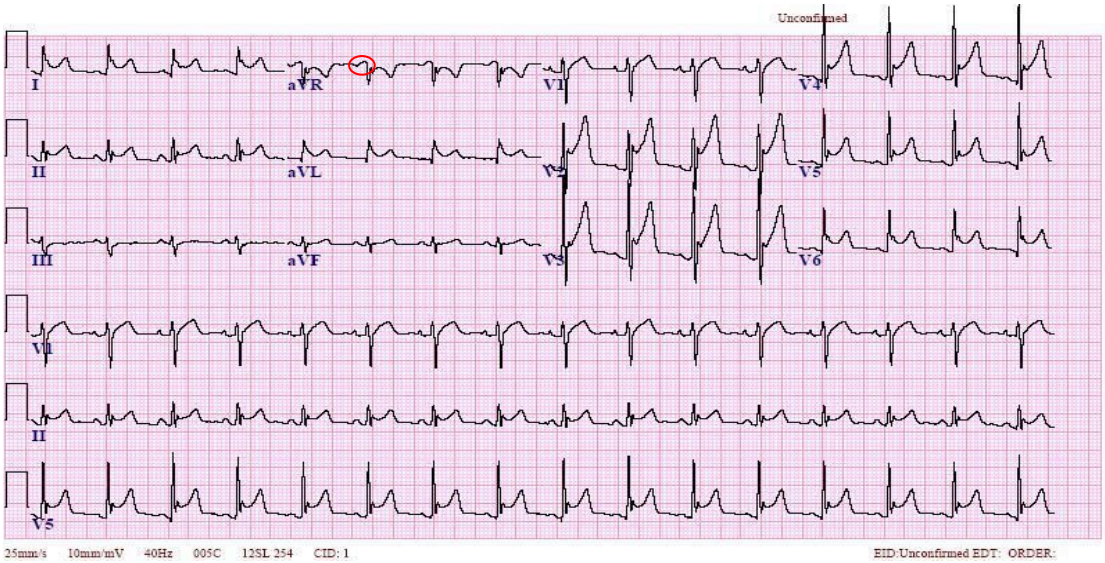
When you read the ECG If you start with any lead move to the next lead according to the anatomy i.e if you looked to lead I

Acute Pericarditis

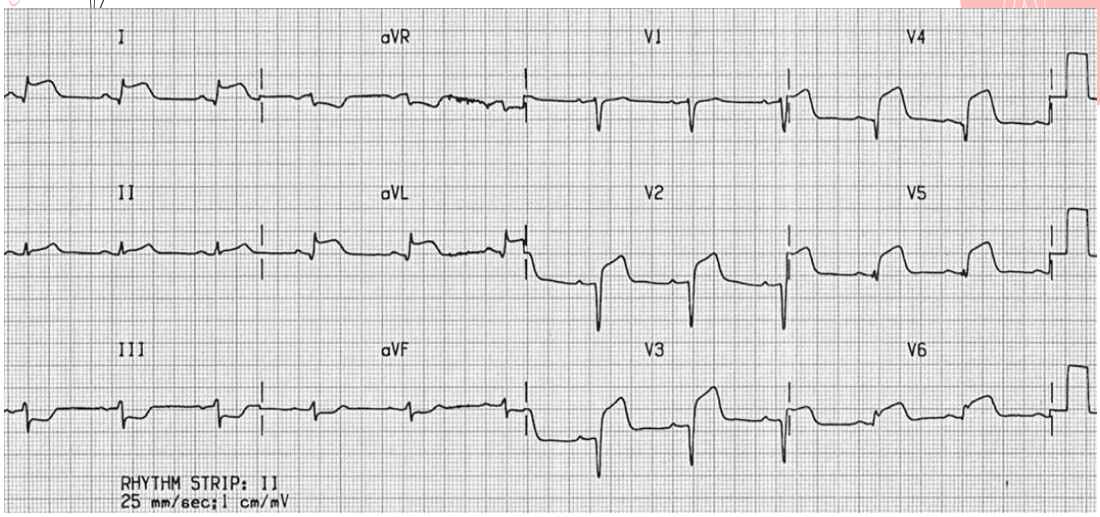
- Usually diffuse ST elevation (“diffuse” as in found in different anatomies)
- Can be associated with PR segment depression (except in aVR it will be elevated)
- No reciprocal changes
- The morphology of the ST segment (closer to smiling)



Notice that this is the first time we’re talking about P-R segment which is the flat line between the end of the P-wave and the start of the QRS complex



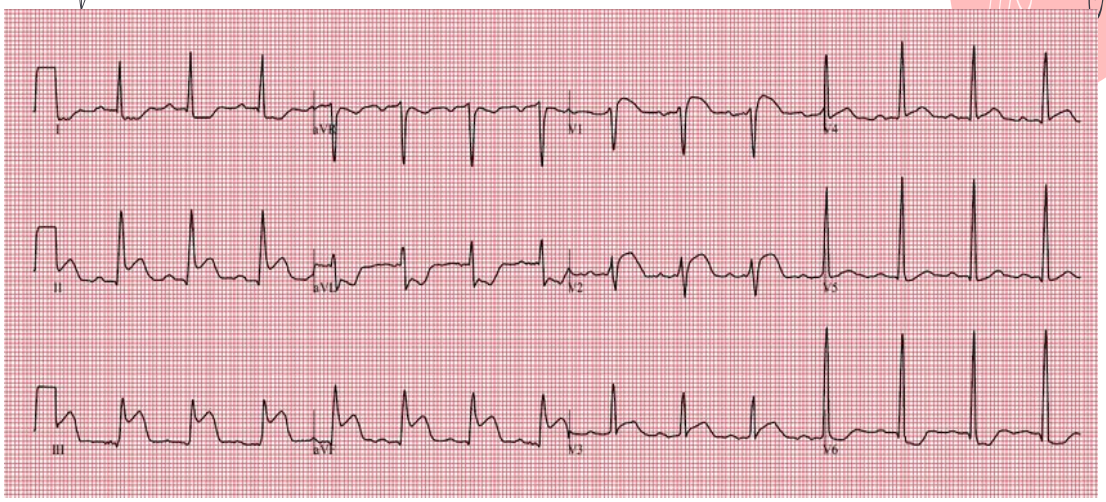
Findings:
ST elevation in V2, V3, V4
ST elevation in V5, V6
You might be thinking anterolateral MI but there is:
P-R segment depression that is elevated in aVR lead (look at the red circle) + the shape of ST seg is smiley face + diffuse ST seg elevation
Diagnosis: acute pericarditis



Findings:
Normal rate , rhythm .
ST elevation in V2, V3, V4
ST elevation in I, aVL,V5, V6
ST depression in lead III, aVF
It can't be acute pericarditis because there is reciprocal change + no PR seg depression + the shape of ST seg is very bad "not smiley face"

AnteroLateral STEMI

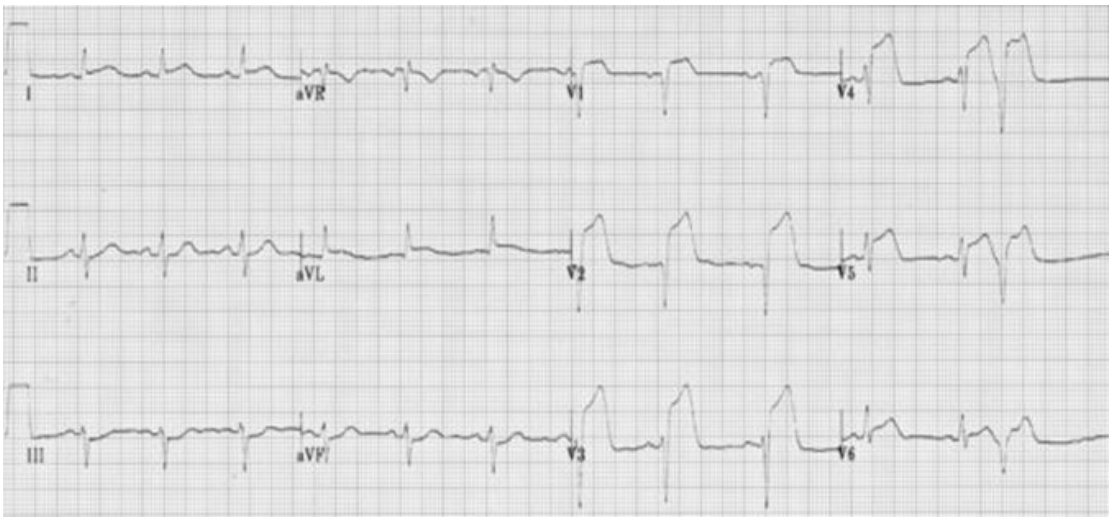
Anterolateral STEMI



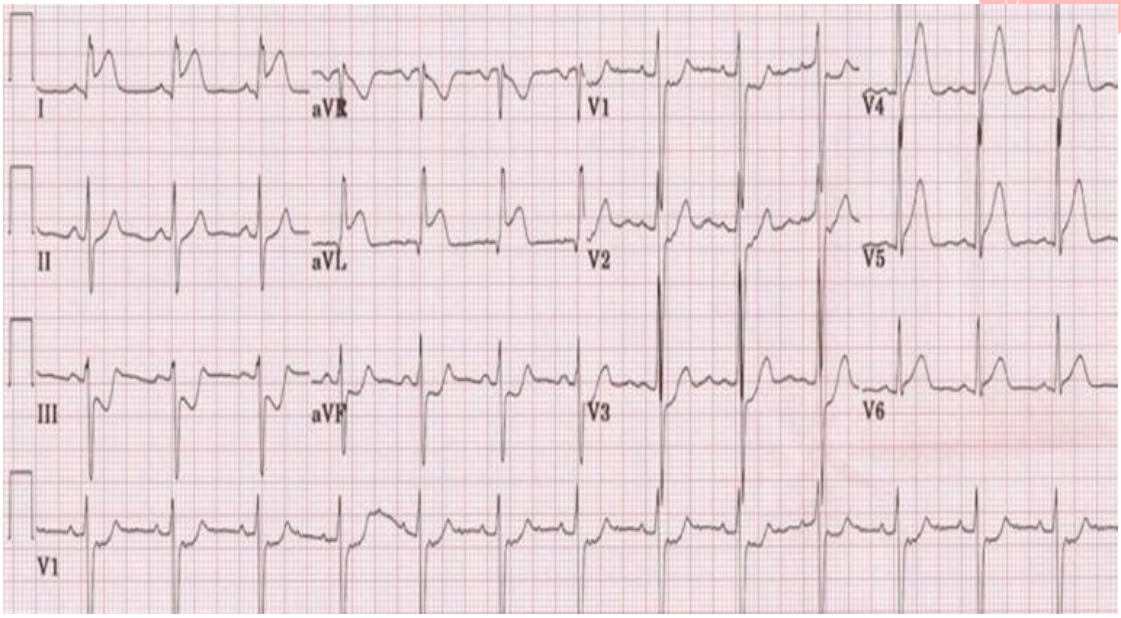
Findings:
ST elevation in lead II, III, aVF
ST depression in lead I, aVL

Not in our slides

Inferior STEMI

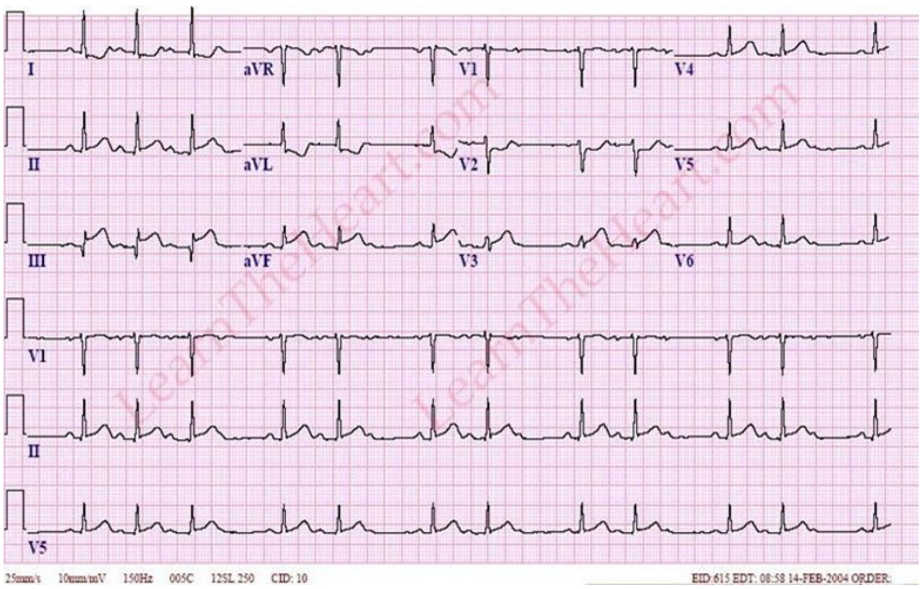


Anterolateral STEMI



Not in our slides

Anterolateral STEMI



Inferior STEMI with reciprocal changes and 2nd degree HB type 1

Extra

Q-T interval:

It is the time between the start of the Q wave and the end of the T wave
normal value for the QTc in men is ≤0.44 sec (440 ms) and in women is ≤0.45 (450 ms)
if QT interval > half (50%) the RR interval; then consider prolonged QT interval. Q-T interval is a marker for the potential of ventricular tachyarrhythmias like Torsades De Pointes and a risk factor for sudden death.

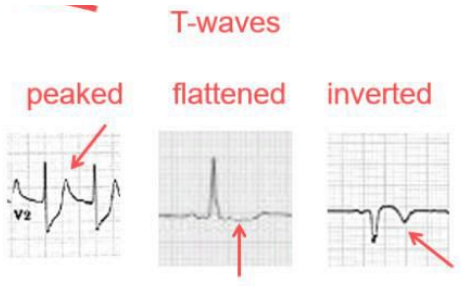
QRS complex:

Wide QRS if more than 0.12 sec (120 ms) (more than 3 small squares),
Most important causes of wide QRS complex:

1. Ventricular tachycardia.
2. Hyperkalemia.
3. Bundle branch block (Rt or Lt).
4. Some drug toxicity like TCA.
5. WPW wolff-parkinson-white syndrome (not always wide QRS complex).
6. 3rd degree heart block (not always wide QRS complex).

T-wave abnormality:

Peaked, Inverted, biphasic or flattened.
May be ischemia / injury but NONSPECIFIC.



Bundle Branch Block:

LBBB: terminal deflection in lead I (+); bunny ears in V5-V6 (WiLLiaM).LL = Left bundle.
RBBB: terminal deflection in lead I (-); bunny ears in V1-V2 (MaRRoW).RR= Right bundle.i.e., with LBBB, there is a W in lead V1 and an M in lead V6, whereas, with RBBB, there is an M in V1 and a W in V6.

Left Ventricular Hypertrophy:

Hypertrophy (more muscle -> more voltage).
LVH = SV1 or SV2 (The longest) + RV5 or RV6(The longest) >35 small squares (>7 big boxes).