

Basic ECG interpretation

Color Index

IMPORTANT

NOTES

GOLD

EXTRA

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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Sources	Drs file

Recall the approach

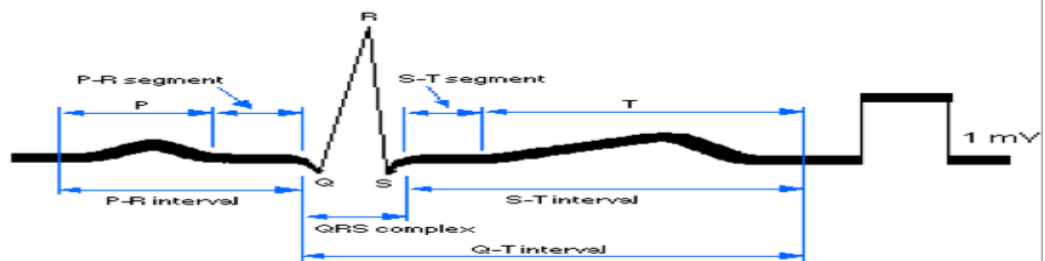
- 1) Take a deep breath.
- 2) Analyze rate.
- 3) Analyze rhythm.
- 4) Look at axis.
- 5) Look for injury/strain/ischemic patterns.
- 6) Look for conduction deficits (RBBB, LBBB).
- 7) Hypertrophy, meds, toxic effects.
- 8) Make your measurements (PR, QT/QTc, QRS).

Another approach

❖ Look at:

- 1) Rhythm.
- 2) Rate.
- 3) Axis.
- 4) P wave, P-R interval, Q wave, QT interval, QRS complex, ST segment, T-wave.

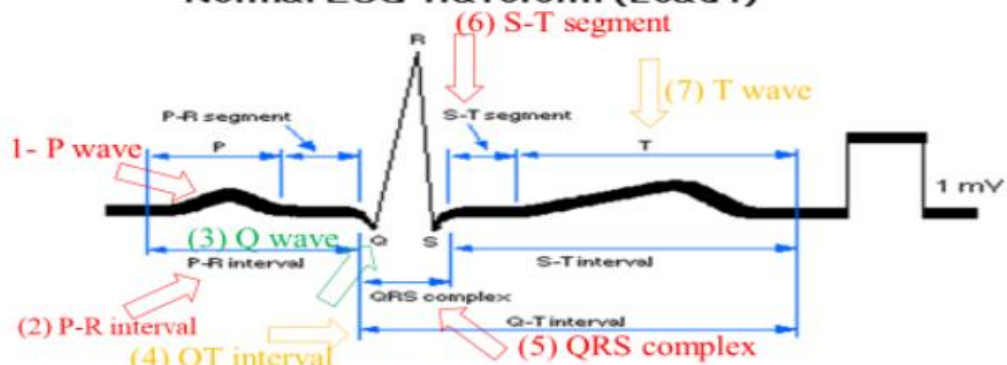
Normal ECG Waveform (Lead I)



Normal Values for Amplitudes and Durations of ECG Parameters:

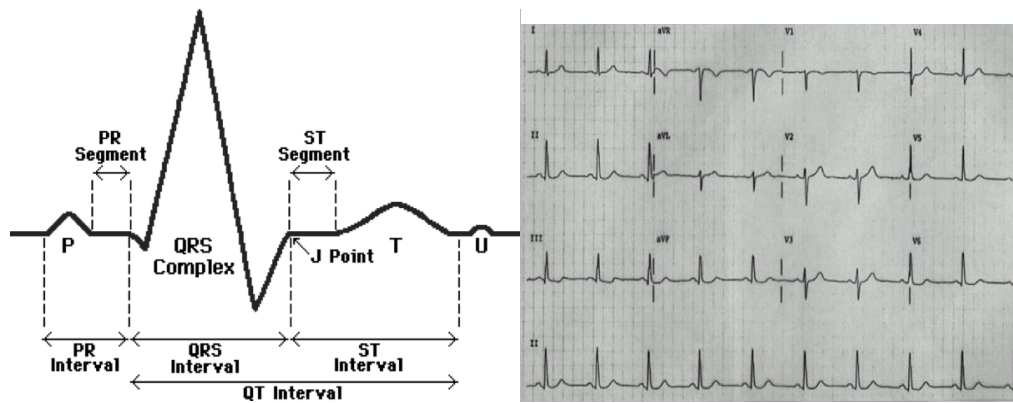
Amplitude:	P wave	0.25 mV	Atrial Depolarization
	R wave	1.60 mV	
	Q wave	25% of R wave	
	T wave	0.1 to 0.5 mV	Ventricular Repolarization
Duration:	P-R interval	0.12 to 0.20 sec	
	Q-T interval	0.35 to 0.44 sec	
	S-T segment	0.05 to 0.15 sec	
	P wave interval	0.11 sec	
	QRS interval	0.09 sec	Ventricular Depolarization

Normal ECG Waveform (Lead I)



Normal Values for Amplitudes and Durations of ECG Parameters:

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	Q-T interval	0.35 to 0.44 sec	
	S-T segment	0.05 to 0.15 sec	
	P wave interval	0.11 sec	
	QRS interval	0.09 sec	Ventricular Depolarization



Irregular rhythm

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

- 1) Atrial fibrillation.
- 2) Atrial flutter.
- 3) Second degree heart block type 1 (Mobitz 1).
- 4) Second degree heart block type 2 (Mobitz 11).
- 5) Sinus arrhythmia.

Rate

❖ If regular rhythm:

1) calculate big square between R-R:

if > 5 big square (bradycardia)

if < 3 big square (tachycardia)

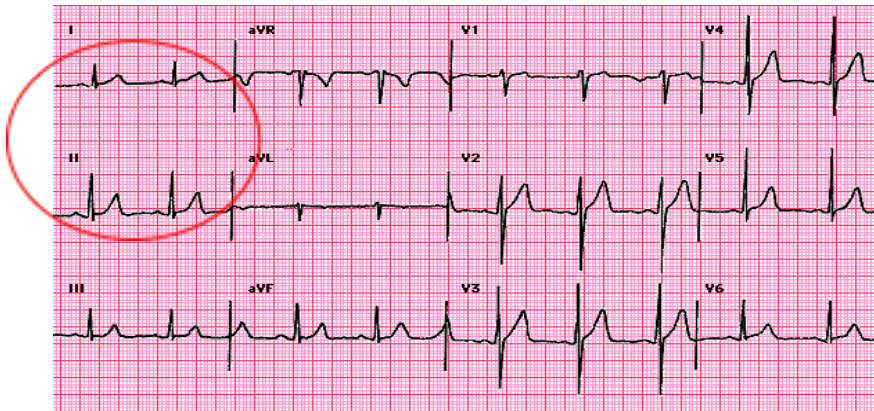
if between 3 and 5 big squares (normal heart rate)

Number of squares	1 square	2 squares	3 squares	4 squares	5 squares	6 squares
Heart rate	300	150	100	75	60	40

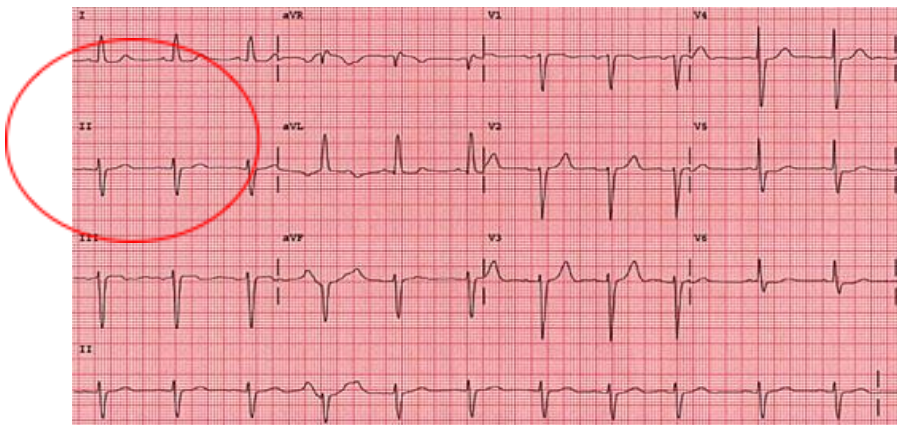
3) In standard ECG: calculate the number of QRS complex in ECG and multiply by 6 = HR

4) **Method working for regular and irregular rhythm:** measure 30 big square on ECG strip, then calculate how many QRS complex within this 30 big square, then multiply the number of QRS complex by 10 then you will get the heart rate.

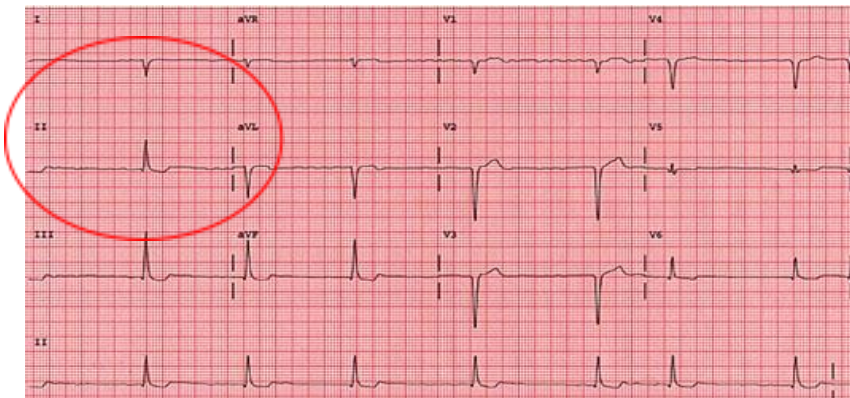
Axis trick



Positive in I and II = normal



Positive in I and Negative in II = LAD



Negative in I Positive in II = RAD

P-Wave

- **P wave:** better seen in lead II.
- ❖ absent P wave can be seen in many disorders, the most important and common causes are:
 1. **Atrial Fibrillation:** (if absent P wave + irregular rhythm = consider it as Atrial Fibrillation).
 2. **SVT (supraventricular tachycardia):** regular narrow complex tachycardia with absent P wave.
 3. **VT (V tach) (Ventricular tachycardia):** any wide QRS complex 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.

P-R interval

- Prolong PR interval >0.2 sec (> 200 ms) (>5 small boxes) = AVB (1st, 2nd type1, 2nd type2 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 prolong P-R interval.

Q-Wave

- Q waves: >1 small square in width and $>25\%$ height of R wave in >2 contiguous leads suggest old MI.

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 the RR interval; then consider prolonged QT interval.
- Q-T interval is a marker for the potential of ventricular tachyarrhythmias like Torsadesdepointes 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 (Right or Left) \longrightarrow
 4. Some drug toxicity like TCA
 5. WPW (not always wide QRS complex)
 6. 3rd degree heart block (not always wide QRS complex)

Won't come in exam

S-T segment

- Either elevated or depressed.
- Better determined by J point.
- The best isoelectric line to measure the ST segment elevation or depression is TP.
- ❖ Most important and common causes of ST-elevation:
 - 1) Acute STEMI
 - 2) Acute pericarditis (Widespread ST elevation and PR depression in most leads, expect lead AVR will be ST depression and PR elevation)
 - 3) LBBB
 - 4) Benign early repolarization
- If you find a notch in ST-segment, then very less likely to be ischemia



- ❖ Most important cause of ST segment depression:
 1. Ischemia (either as part of non-STEMI or as a reciprocal changes)
 2. LVH with repolarization abnormality

T-Wave abnormality

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

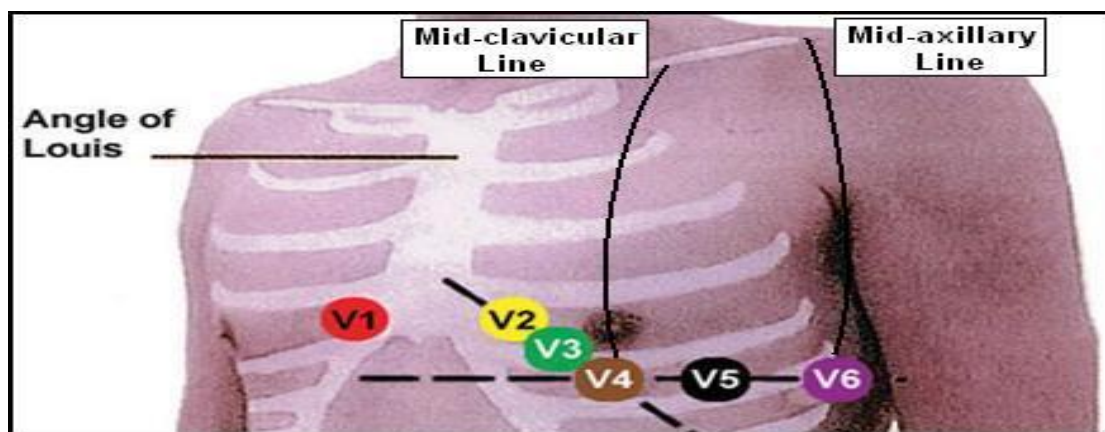
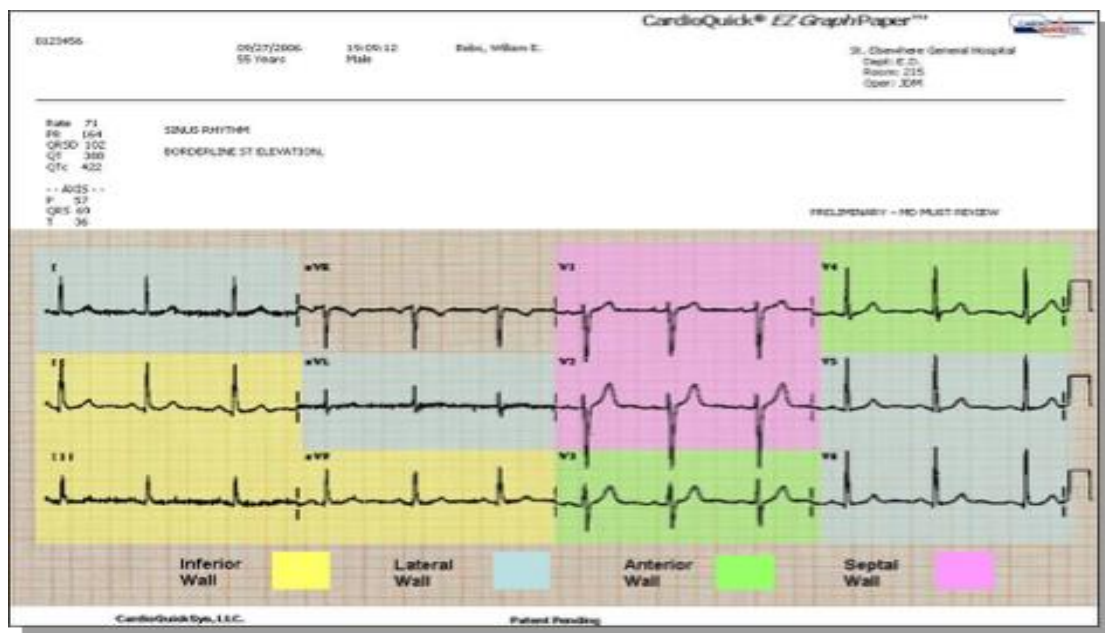
Bundle Branch Block

- LBBB: terminal deflection in lead I (+); bunny ears in V5-V6 (WiLLiaM)
- RBBB: terminal deflection in lead I (-); bunny ears in V1-V2 (MaRRoW)
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 = $SV1 + (RV5 \text{ or } RV6) > 35$ small squares (> 7 big boxes)

Precordial leads

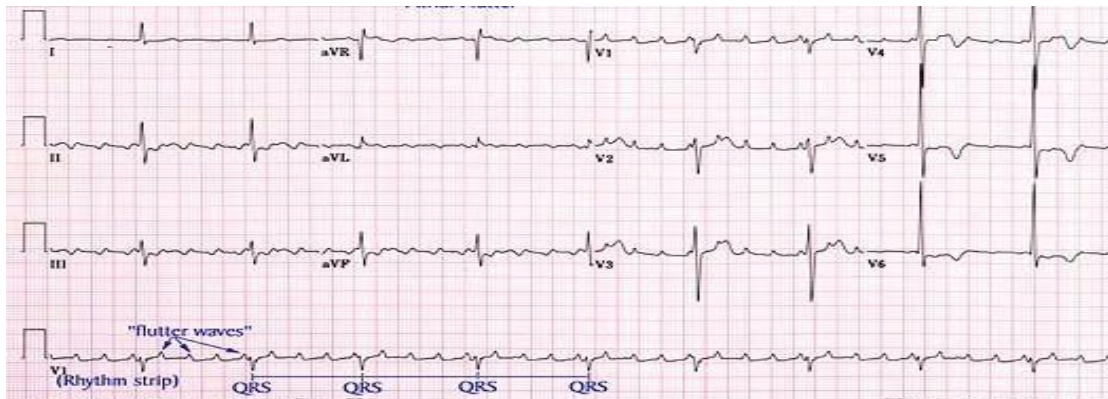


I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Limb leads

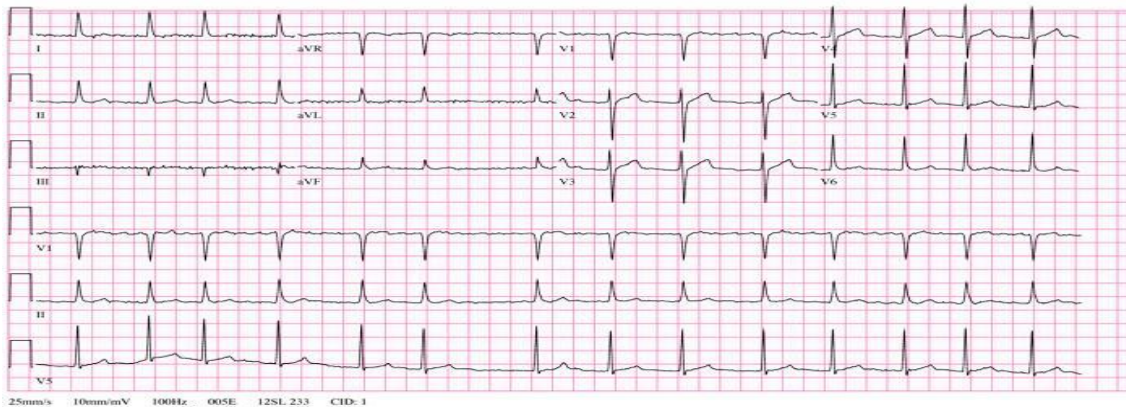
Chest leads

Let's interpret the following ECG:



Interpretation:

- Important finding:
Flutter waves ("saw-tooth" pattern).
- Diagnosis:
Atrial flutter.



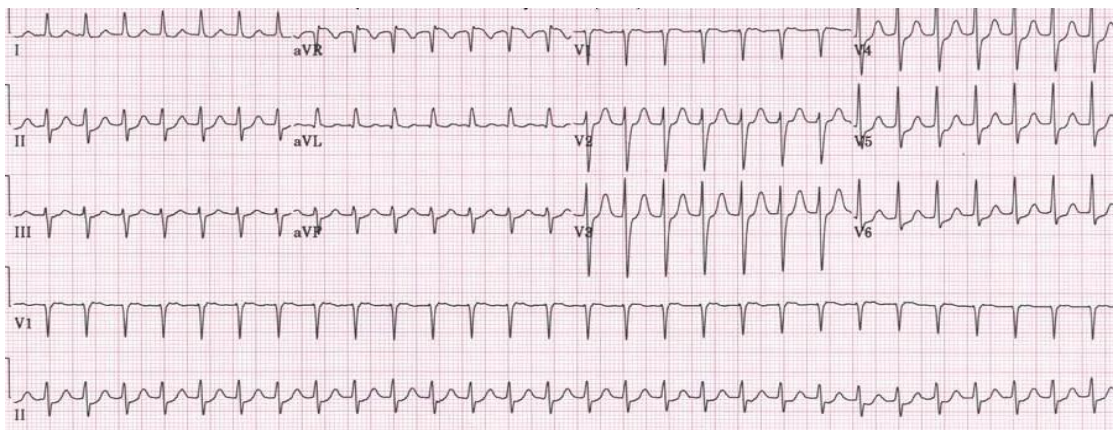
Interpretation:

- Important finding:
Irregular rhythm.
Absent P-wave.
- Diagnosis:
Atrial Fibrillation.



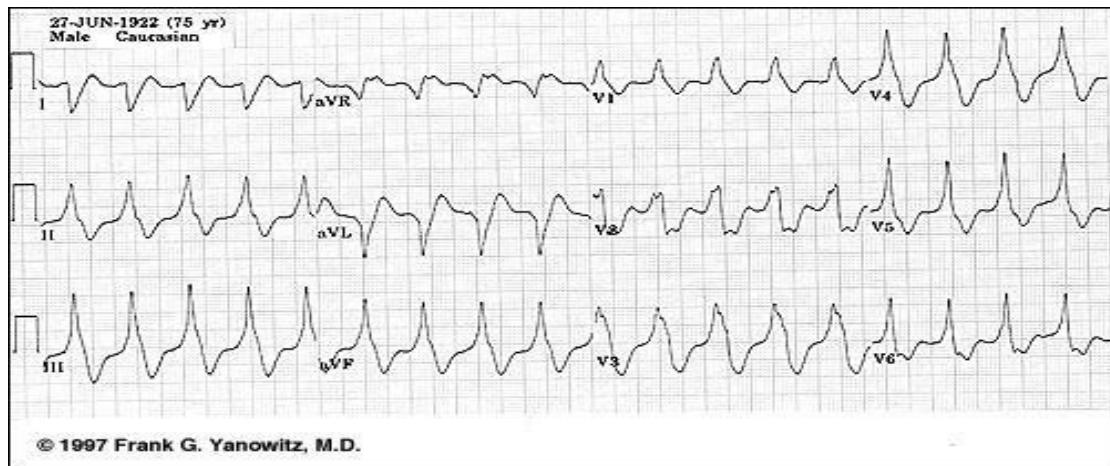
Interpretation:

- Important finding:
Irregular rhythm.
Present P-wave with normal PR interval.
- Diagnosis:
Sinus arrhythmia.



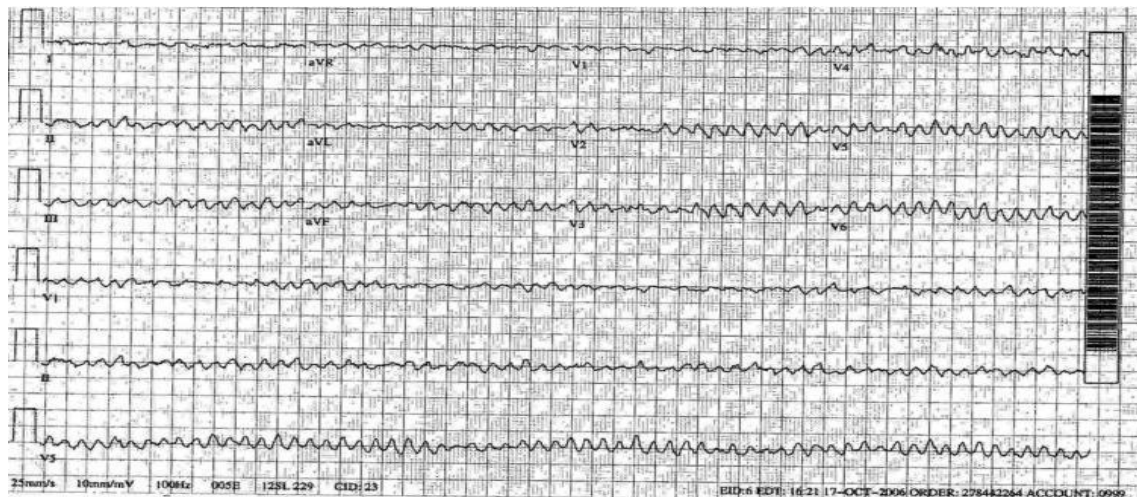
Interpretation:

- Important finding:
Regular tachycardia.
Absent P wave.
Normal QRS complex.
- Diagnosis:
SVT.



Interpretation:

- Important finding:
Regular tachycardia.
Absent P wave.
Wide QRS complex.
- Diagnosis:
Wide QRS complex tachycardia most likely: Ventricular Tachycardia



Interpretation:

- Diagnosis:
Ventricular Fibrillation.



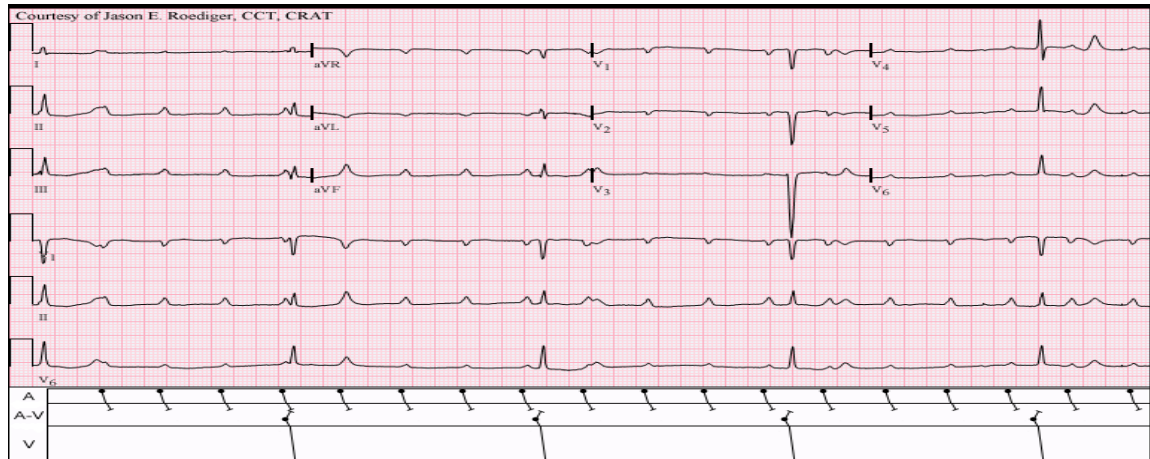
Interpretation:

- Important finding:
Regular rhythm.
Fixed prolonged PR interval without QRS complex drop.
- Diagnosis:
1st degree heart block.



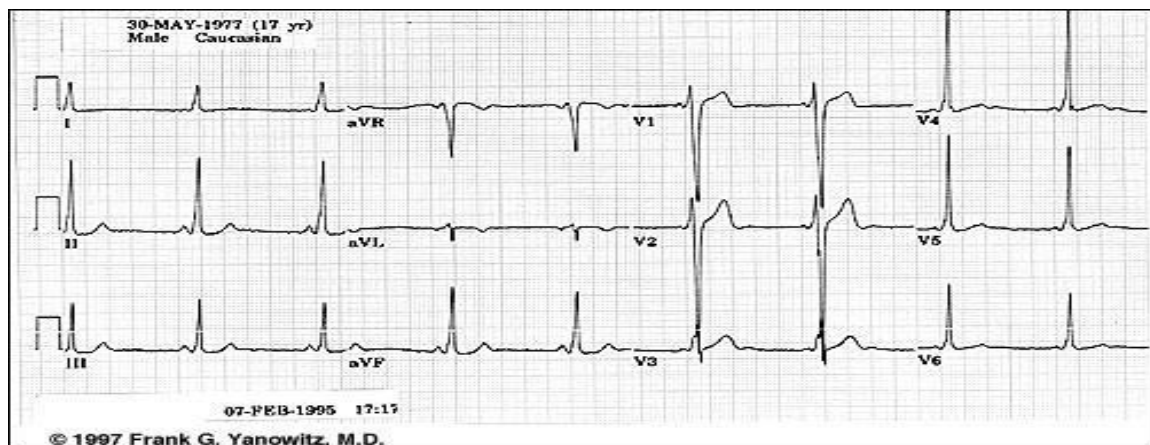
Interpretation:

- Important finding:
Irregular.
Progressive prolongation of PR interval followed by a drop in QRS complex.
- Diagnosis:
2nd degree heart block type 1 (Mobitz 1)



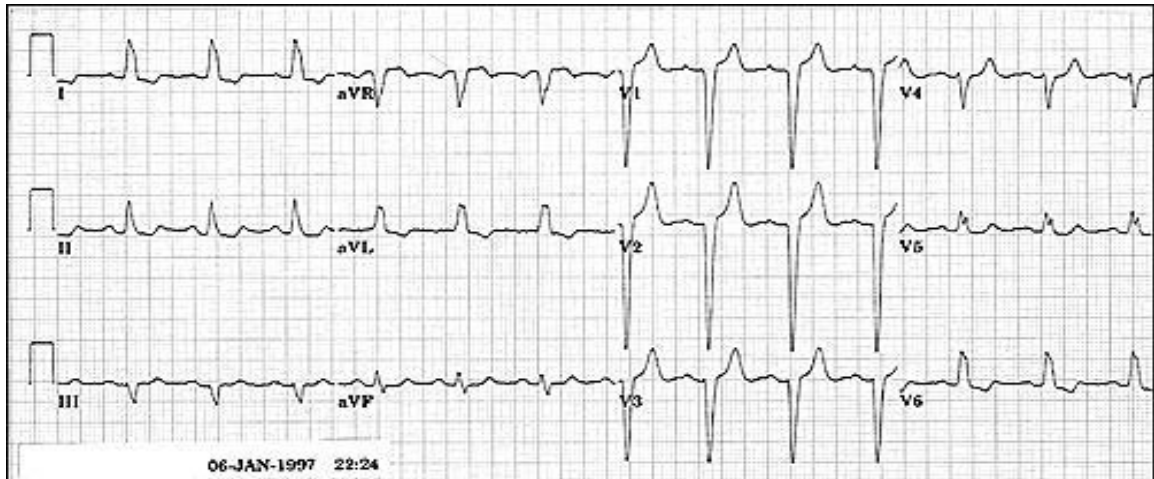
Interpretation:

- Important finding:
Regular rhythm.
Bradycardia.
The P wave with a regular P-to-P interval.
The QRS complex with a regular R-to-R interval.
The PR interval will be variable.
As the hallmark of complete heart block is lack of any apparent relationship
- Diagnosis:
3rd degree heart block (complete heart block).



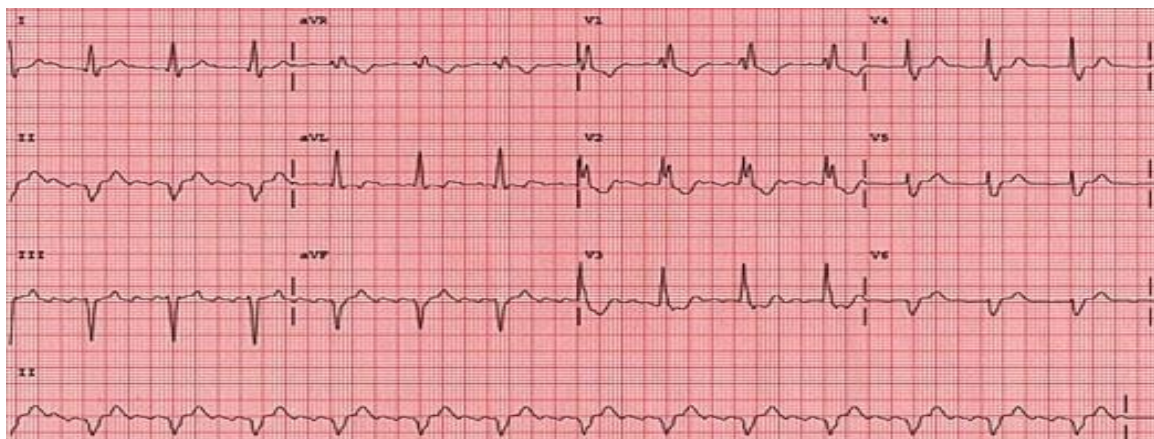
Interpretation:

- Important finding:
Short PR interval.
Delta Wave.
- Diagnosis:
WPW.



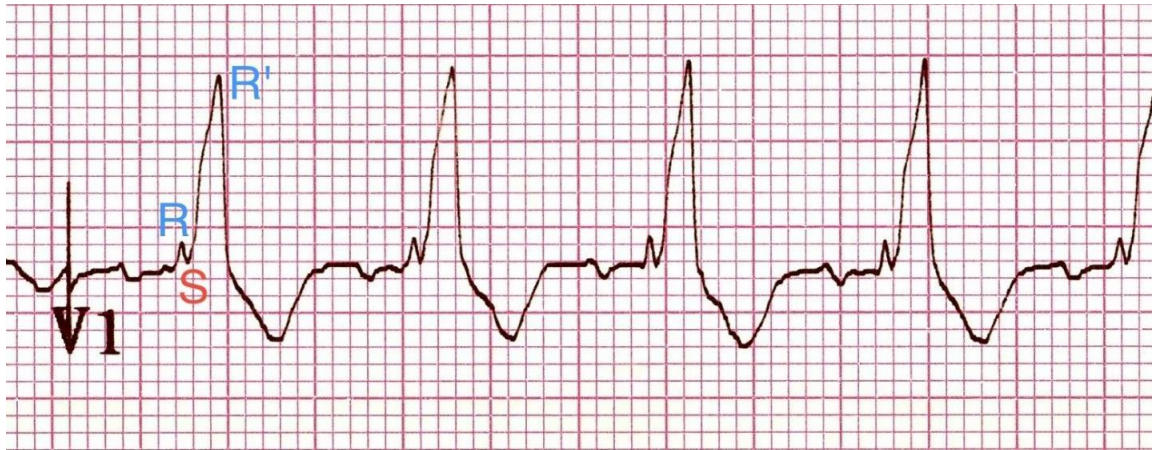
Interpretation:

- Important finding:
Wide QRS complex
ST elevation V1-V2
Notched ('M'-shaped) R wave in lead V6.
- Diagnosis:
Left Bundle Branch Block.



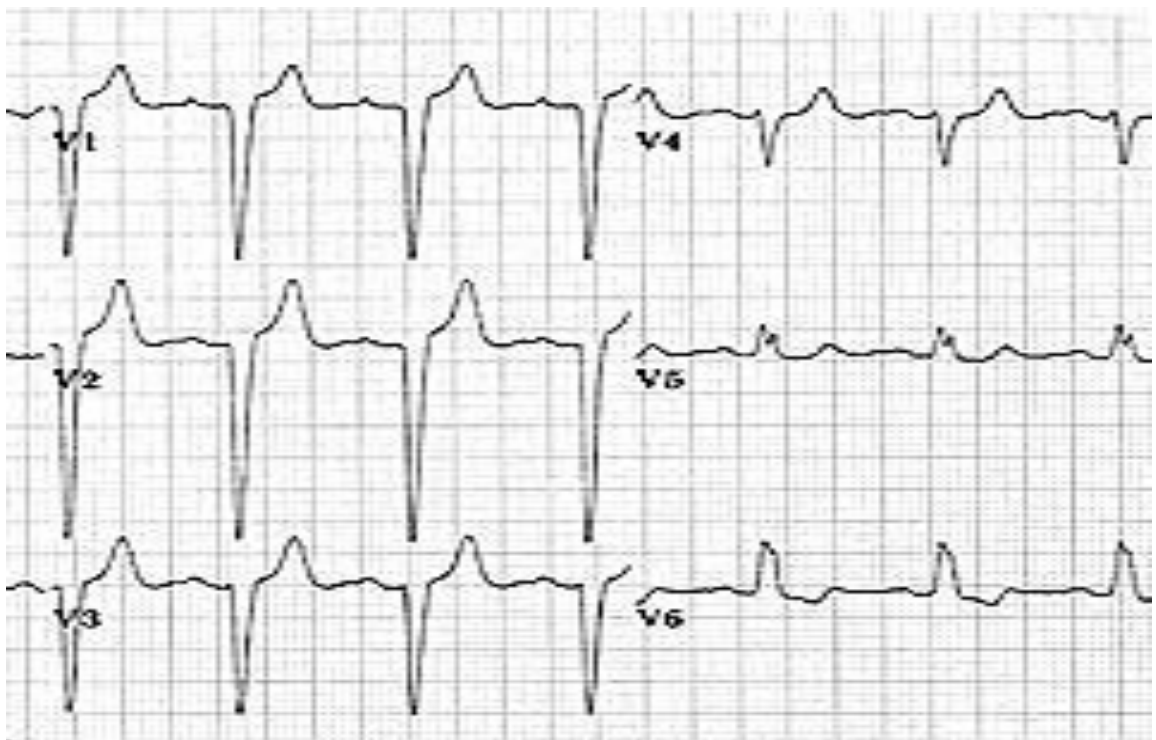
Interpretation:

- Important finding:
Wide QRS complex
Notched ('M'-shaped) RSR wave in lead V1.
- Diagnosis:
Right Bundle Branch Block.



Interpretation:

- Important finding:
RSR pattern.



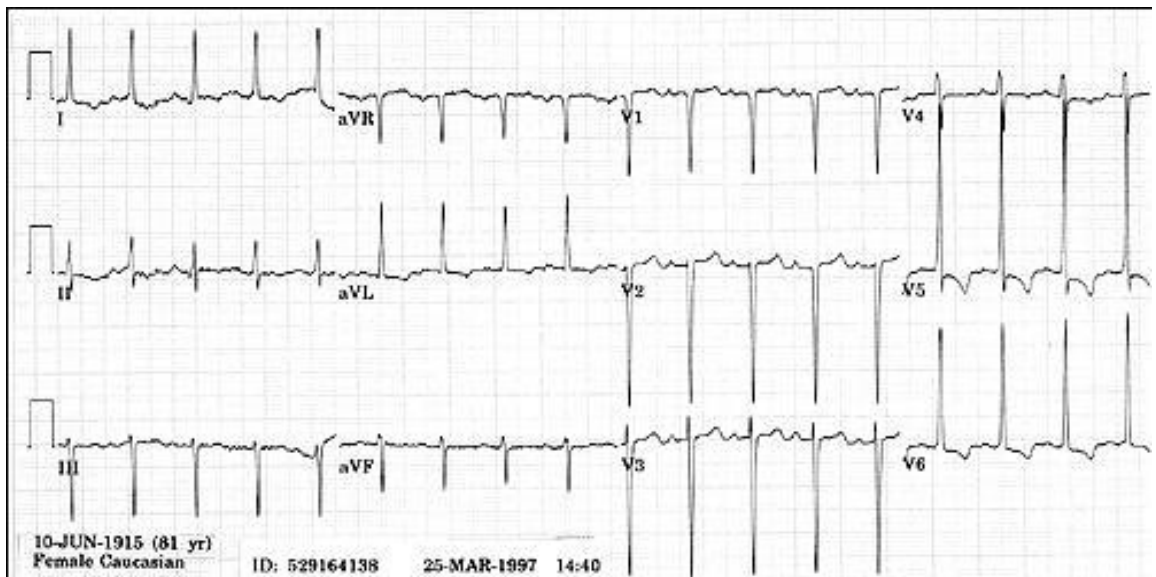
Interpretation:

- Diagnosis:
Left Bundle Branch Block.



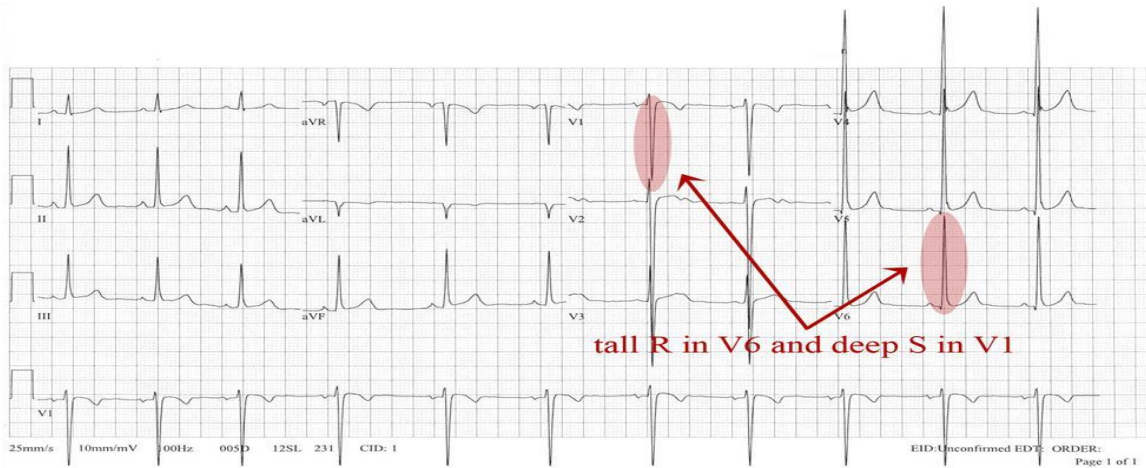
Interpretation:

- Diagnosis:
Right Bundle Branch Block.



Interpretation:

- Important finding:
SV1 + RV5 or 6 >35 small squares (>7 big squares).
ST segment depression with T wave inversion in V5-V6 (not always present).
- Diagnosis:
Left Ventricular Hypertrophy (LVH).

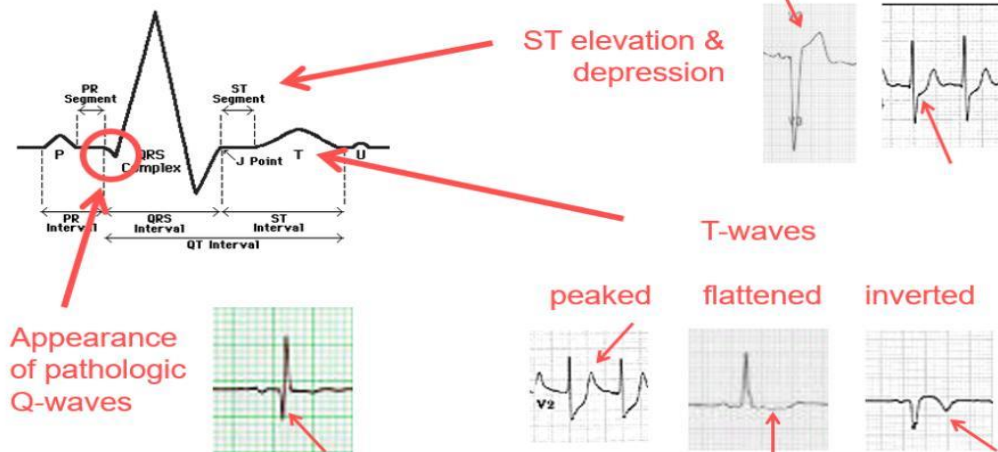


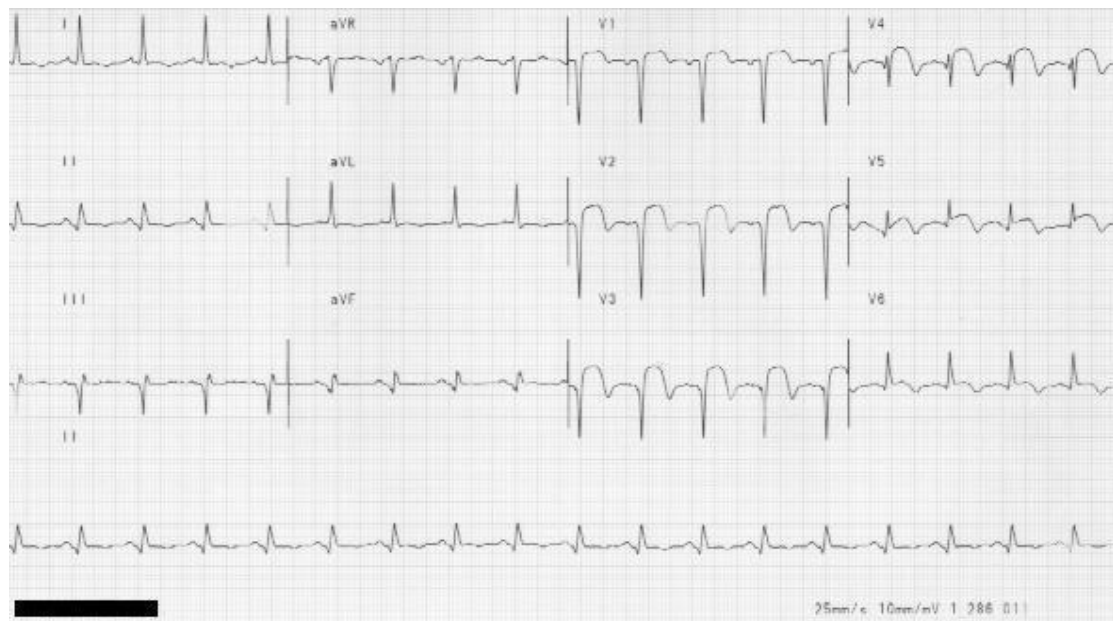
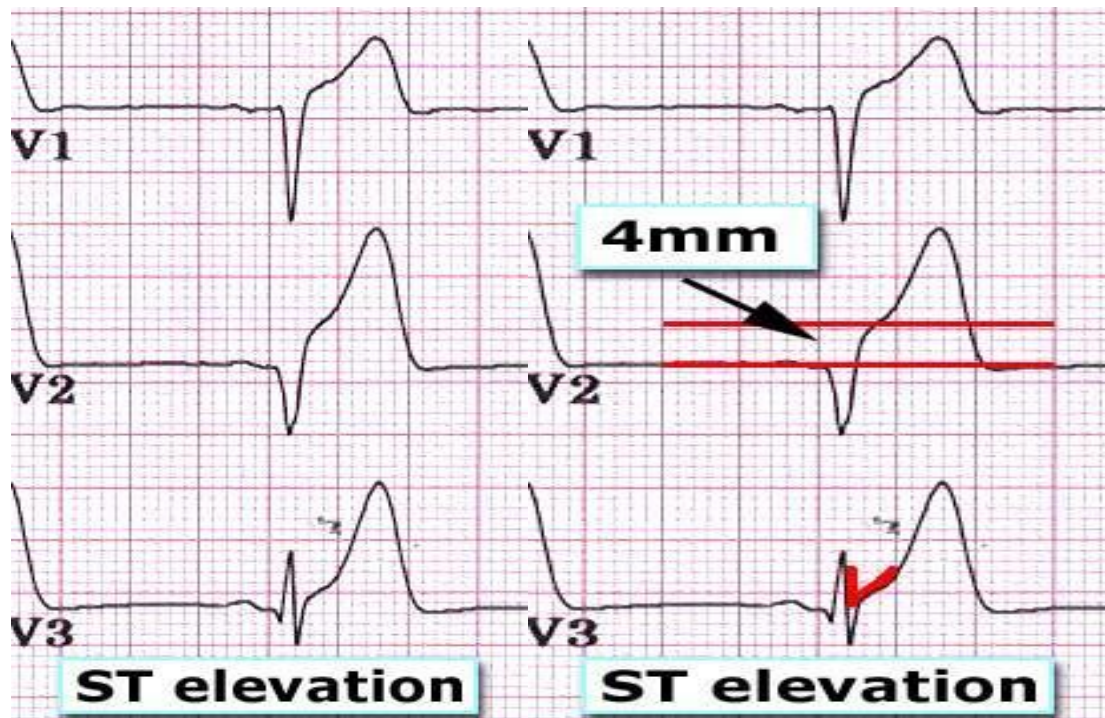
Interpretation:

- Diagnosis:
Left Ventricular Hypertrophy (LVH).

Ischemic ECG Changes

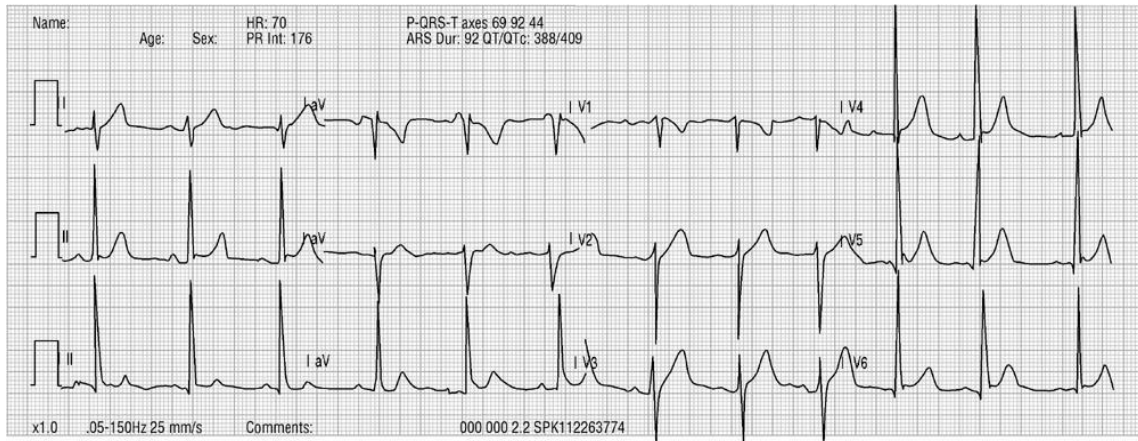
Ways the ECG can change include:





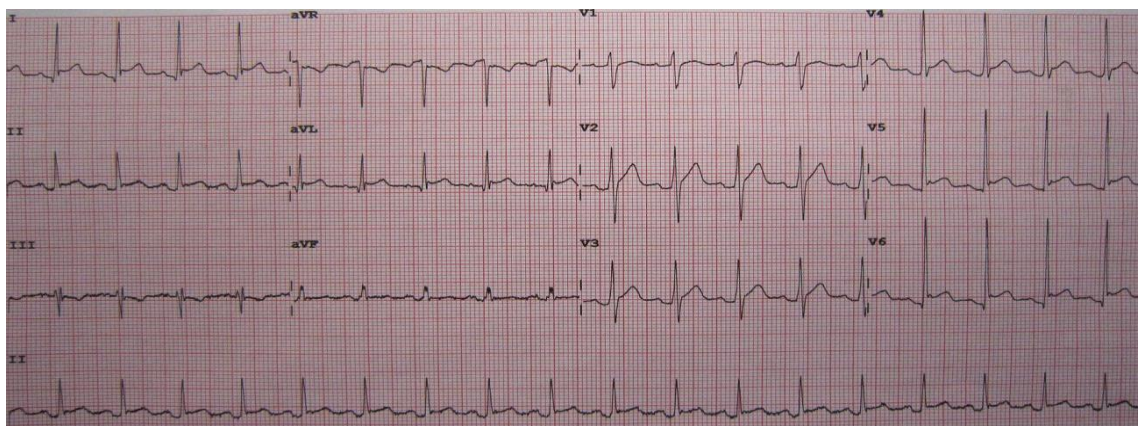
Interpretation:

- Important finding:
ST segment elevation in V1-V6
Flattened T wave in inferior lead.
- Diagnosis:
Most likely anterior MI (based on the Hx and complete picture).



Interpretation:

- Important finding:
Wide spread ST elevation.
There is a notch in ST segment which it less likely to be ischemia.
- Diagnosis:
Benign early repolarization.



Interpretation:

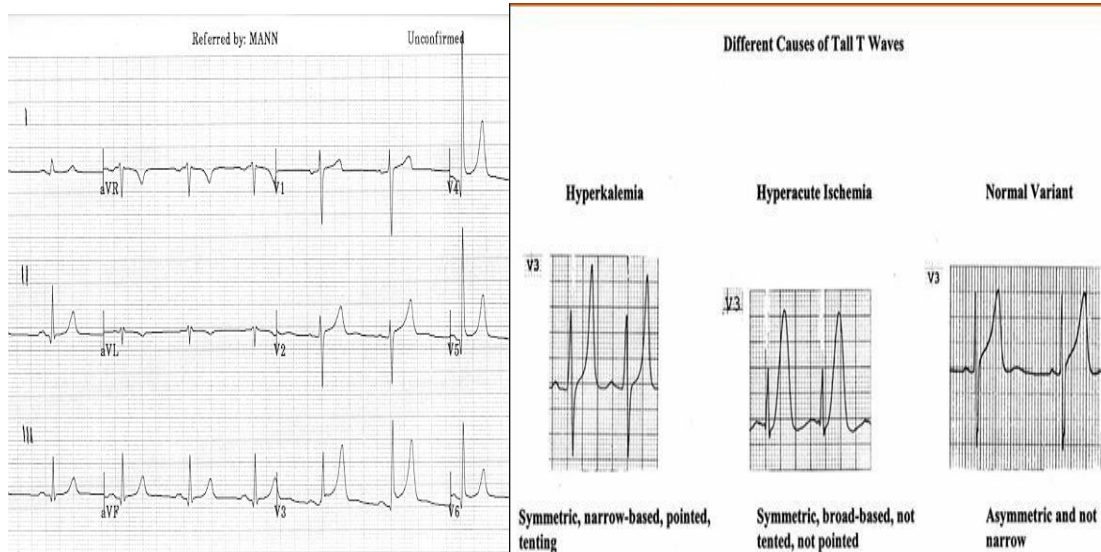
- Important finding:
Widespread ST elevation.
In AVR lead there is reciprocal changes (ST depression+ PR segment elevation)
- Diagnosis:
Acute pericarditis.

Figure 23



Interpretation:

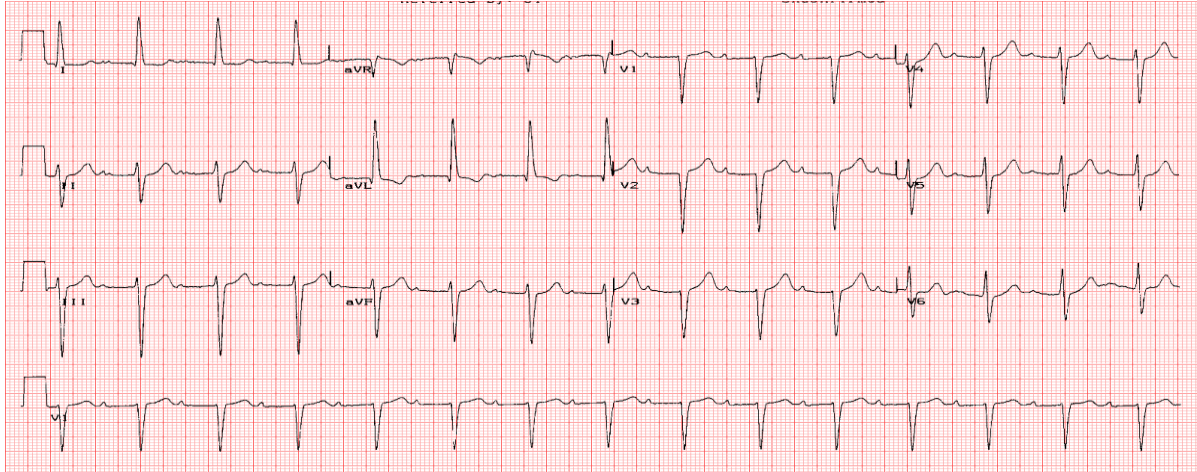
- Important finding:
ST depression.



Interpretation:

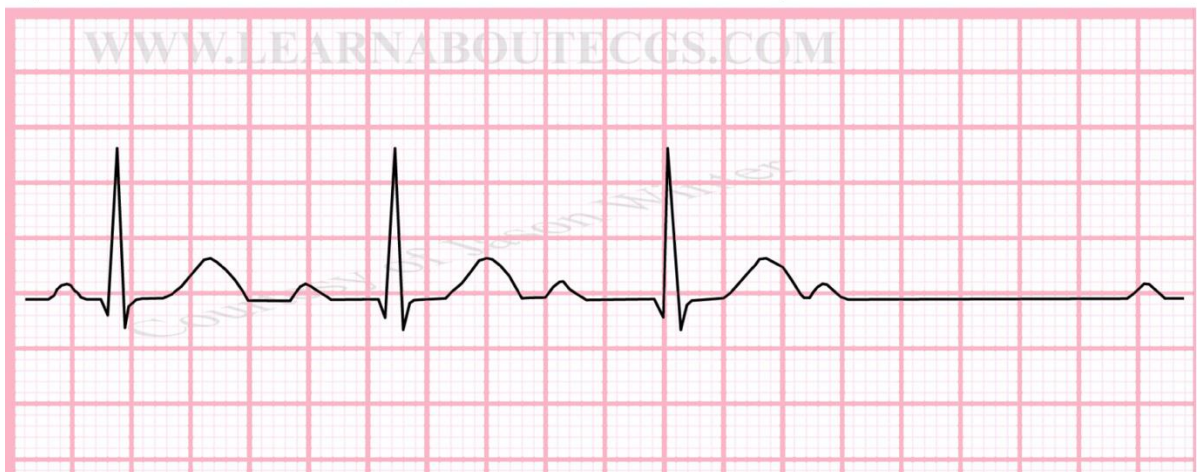
- Important finding:
Hyper acute T waves.

ECG interpretation test



Interpretation:

- Important finding:
Regular rhythm.
Fixed prolonged PR interval without QRS complex drop.
- Diagnosis:
1st degree heart block.



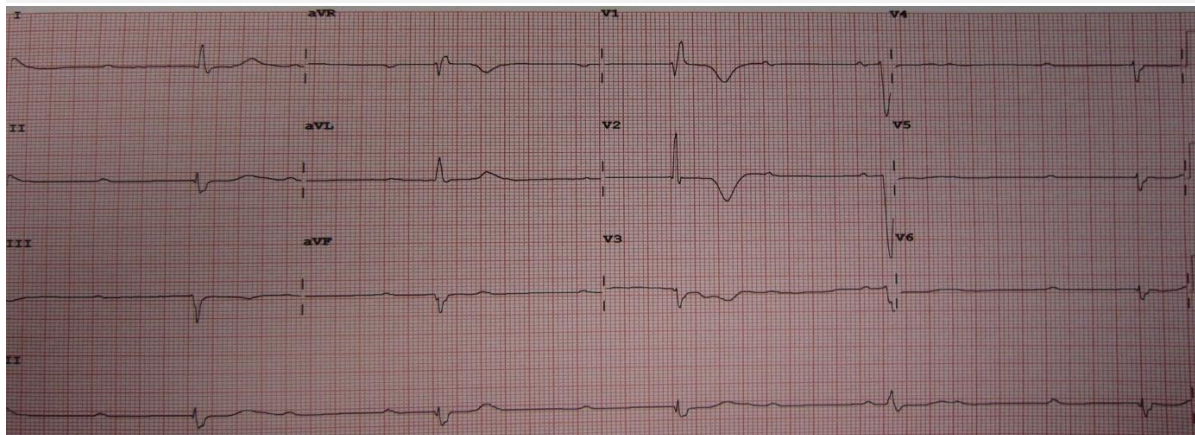
Interpretation:

- Important finding:
Irregular rhythm.
Progressive prolongation of PR interval followed by a drop in QRS complex.
- Diagnosis:
2nd degree heart block type 1 (Mobitz I)



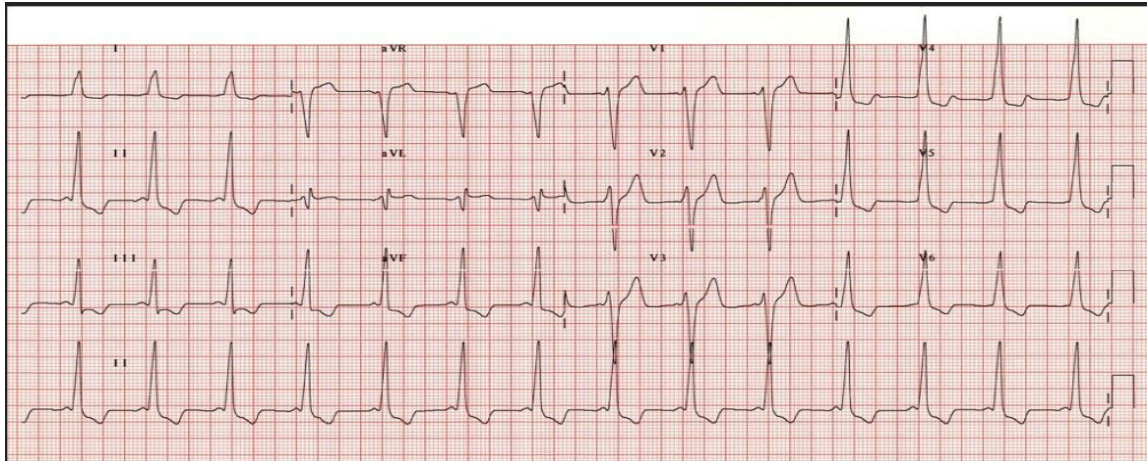
Interpretation:

- Important finding:
Irregular rhythm.
Fixed prolonged PR interval followed by a drop in QRS complex.
- Diagnosis:
2nd degree heart block type 2 (Mobitz II)



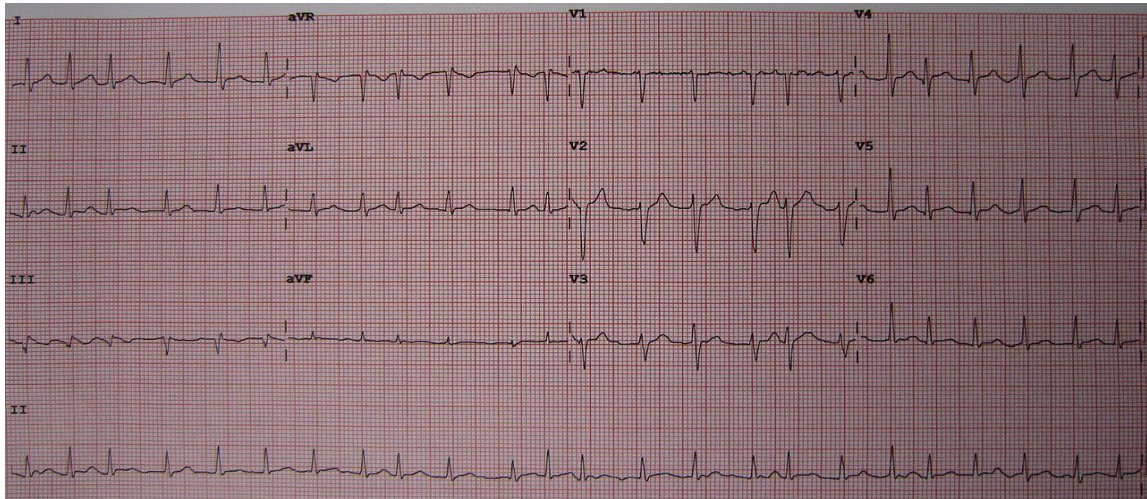
Interpretation:

- Important finding:
Regular rhythm.
Bradycardia.
Wide QRS complex.
The P wave with a regular P-to-P interval.
The QRS complex with a regular R-to-R interval.
The PR interval will be variable.
As the hallmark of complete heart block is lack of any apparent relationship between P waves and QRS complex.
- Diagnosis:
3rd degree heart block (complete heart block).



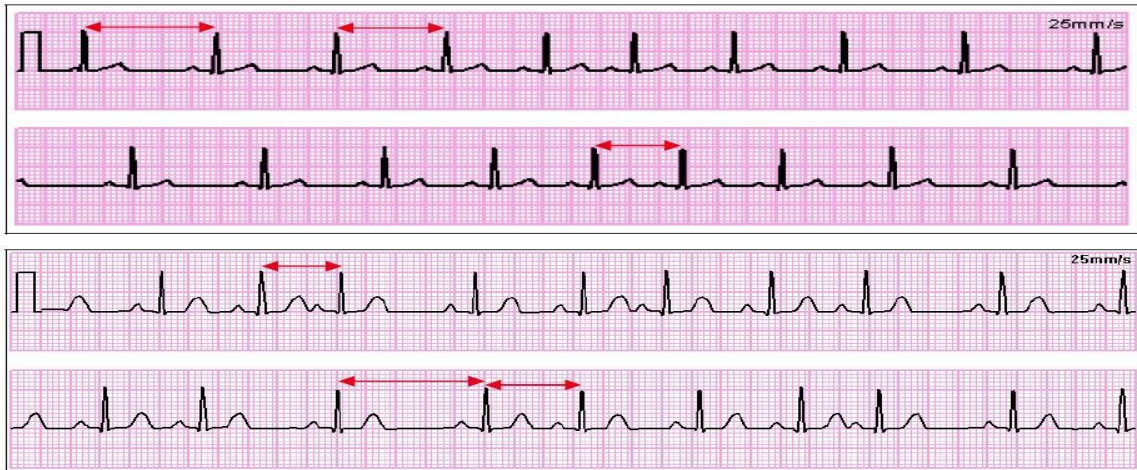
Interpretation:

- Important finding:
Short PR interval.
Delta wave.
- Diagnosis:
WPW



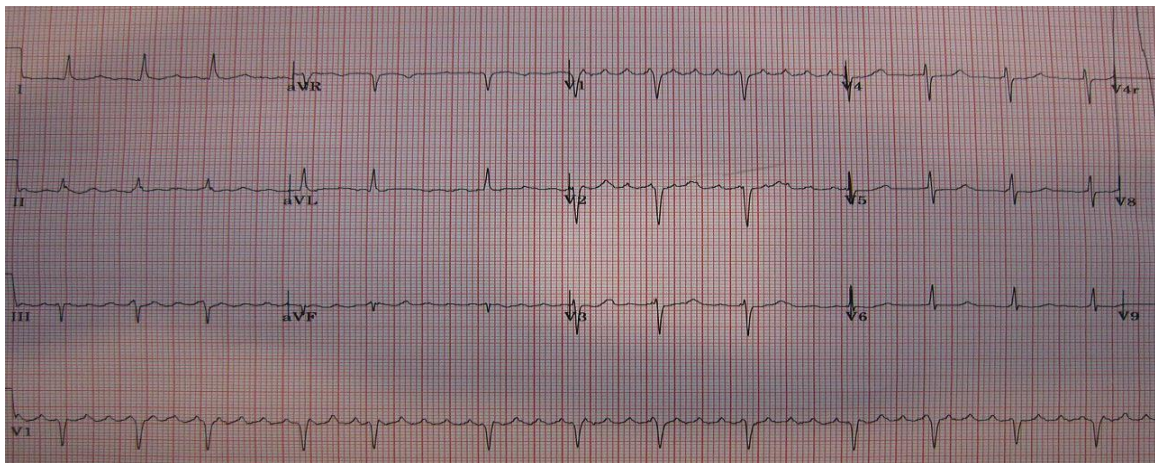
Interpretation:

- Important finding:
Irregular rhythm.
Absent P-wave.
- Diagnosis:
Atrial fibrillation.



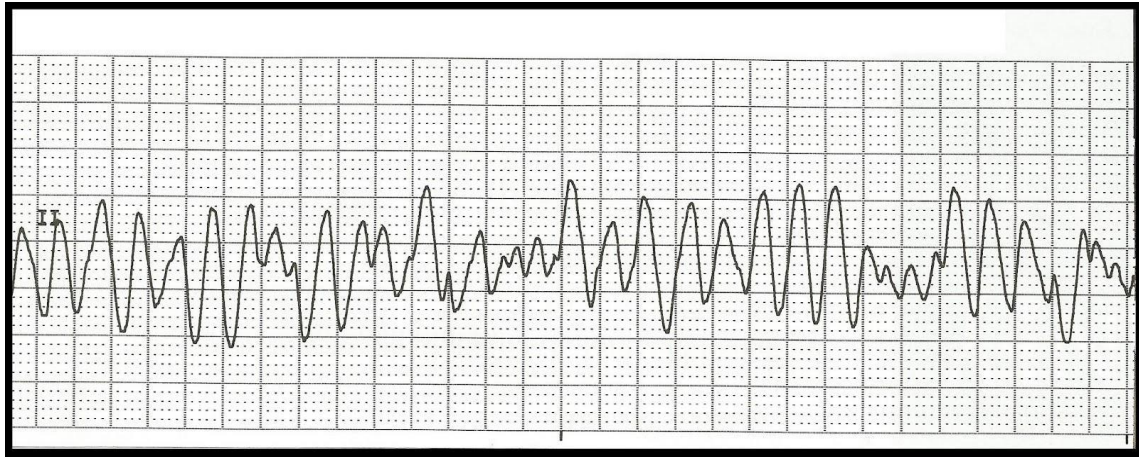
Interpretation:

- Important finding:
Irregular rhythm.
Present P-wave with normal PR interval.
- Diagnosis:
Sinus arrhythmia.



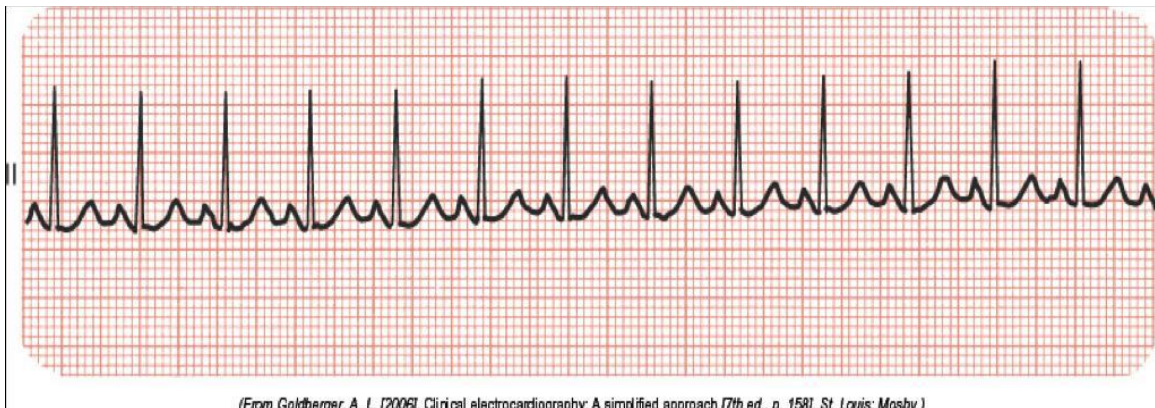
Interpretation:

- Important finding:
Flutter wave "saw tooth appearance".
- Diagnosis:
Atrial flutter.



Interpretation:

- Diagnosis:
Ventricular fibrillation.



(From Goldberger, A. L. [2006]. Clinical electrocardiography: A simplified approach [7th ed., p. 158]. St. Louis: Mosby.)

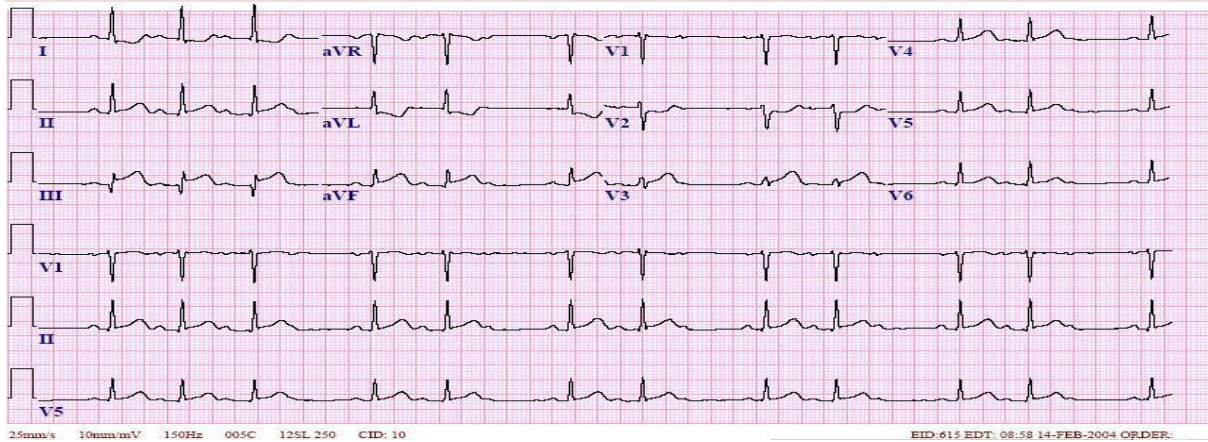
Interpretation:

- Important finding:
Regular rhythm.
Sinus rhythm (present P-wave).
Tachycardia.
Normal QRS complex.
- Diagnosis:
Sinus tachycardia.

❖ if there is no P wave in this ECG the diagnosis will be SVT

Case Scenarios

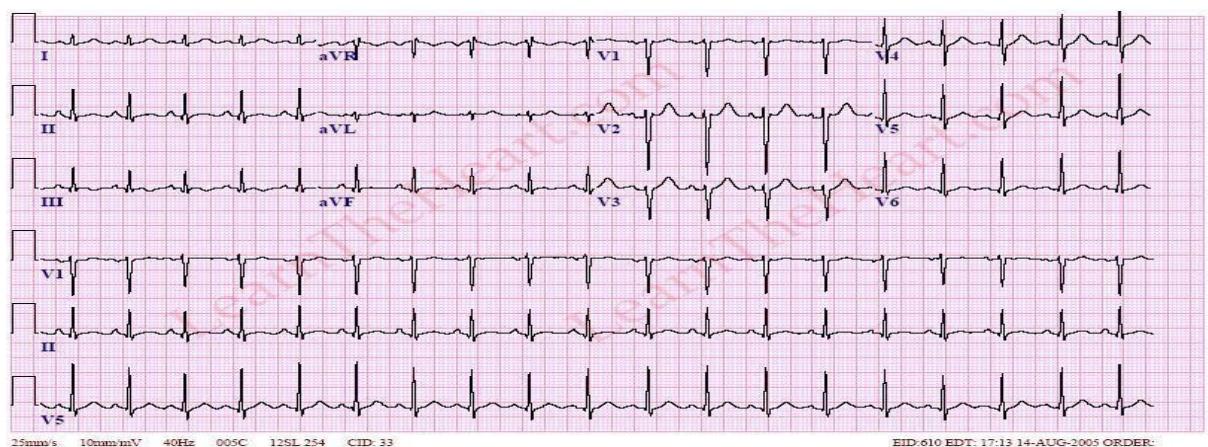
55 Years old with heavy retrosternal chest pain for 3 hours.



Interpretation:

- Findings:
 - progressive prolongation of PR interval with a drop of QRS complex.
 - Inferior ST segment elevation MI (leads II, III, and aVF) with reciprocal ST depression (leads I and aVL)
- Diagnosis:
 - Acute inferior STEMI with 2nd degree type 1 heart block.

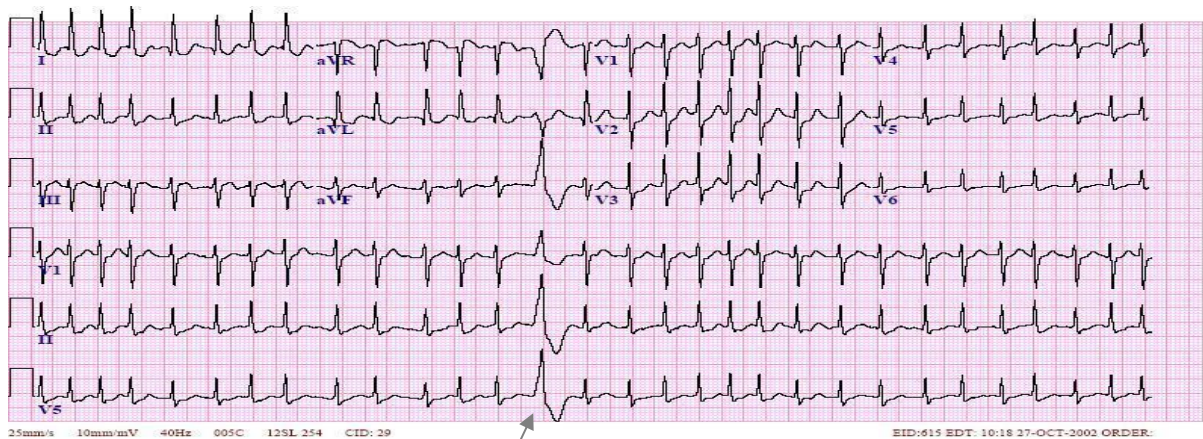
63 years old lady with Hx of SOB for 2 days



Interpretation:

- Diagnosis:
 - Sinus tachycardia.

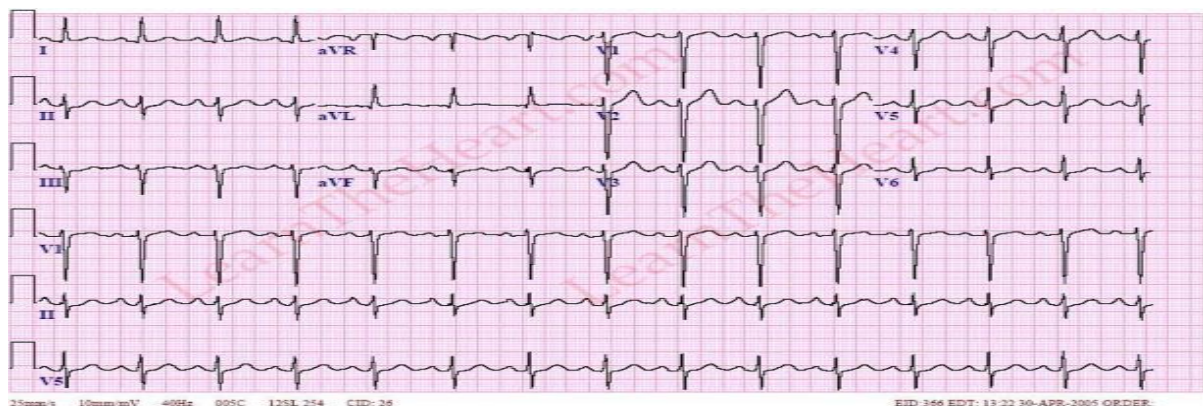
48-year-old with Hx of palpitation and SOB for 3 hours



Interpretation:

- Findings:
Irregular rhythm.
Absent P wave.
There is PVC.
- Diagnosis:
Atrial fibrillation.
PVC.

52 y old male pre-op ECG.



Interpretation:

- Findings:
Normal sinus rhythm with a first-degree AV block

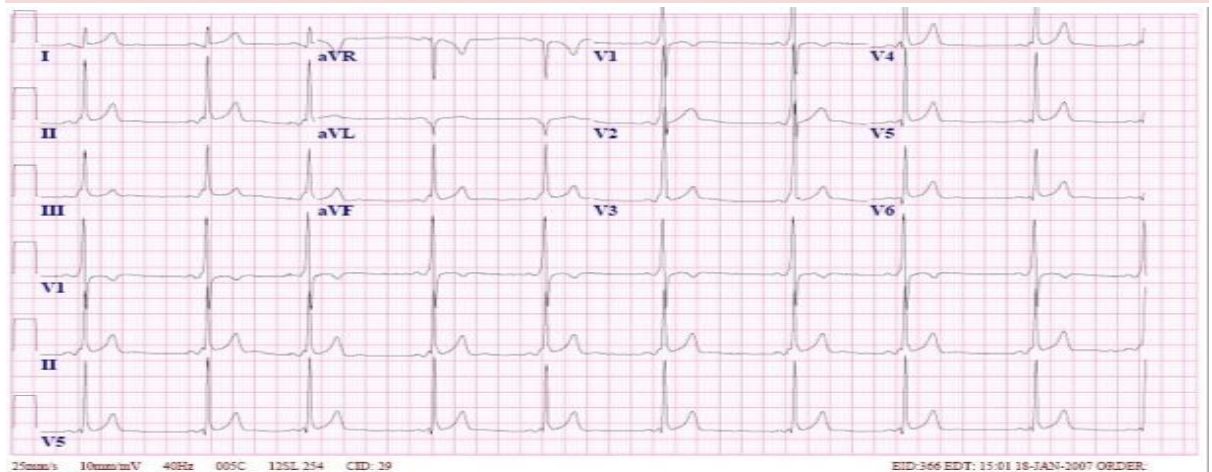
49 y old lady newly diagnosed HTN.



Interpretation:

- Diagnosis:
Left Ventricular Hypertrophy (LVH).

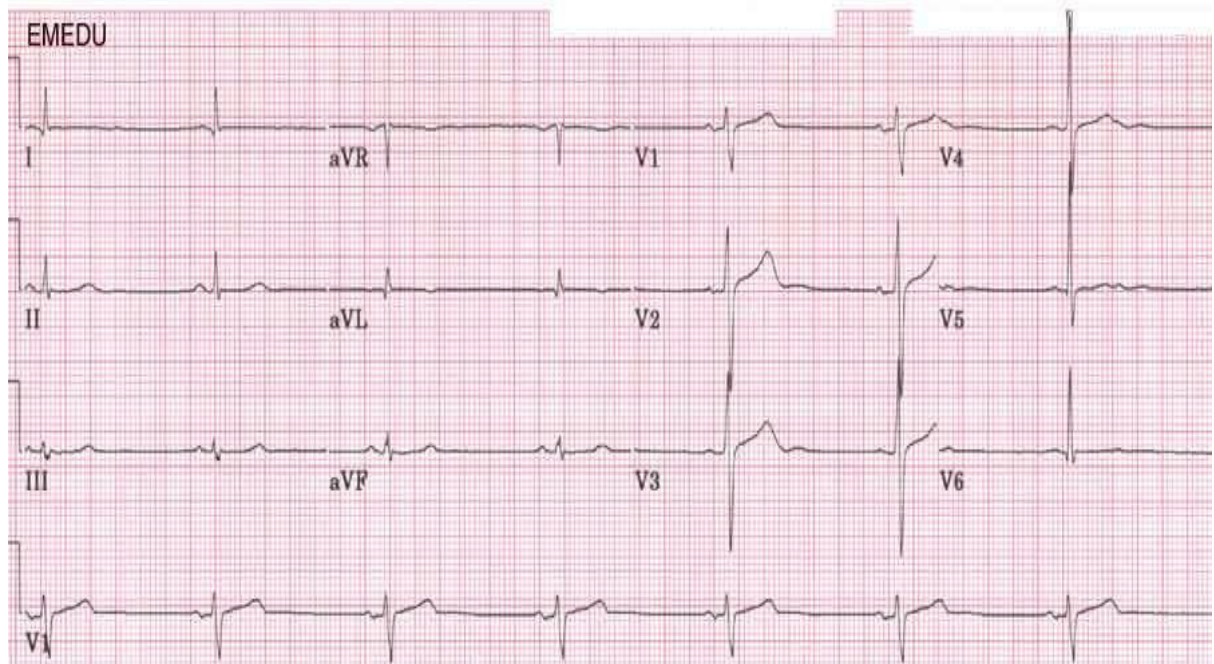
24 y old lady presented with Hx of syncope



Interpretation:

- Diagnosis:
Short PR interval and delta waves consistent with Wolff-Parkinson-White (WPW) syndrome.

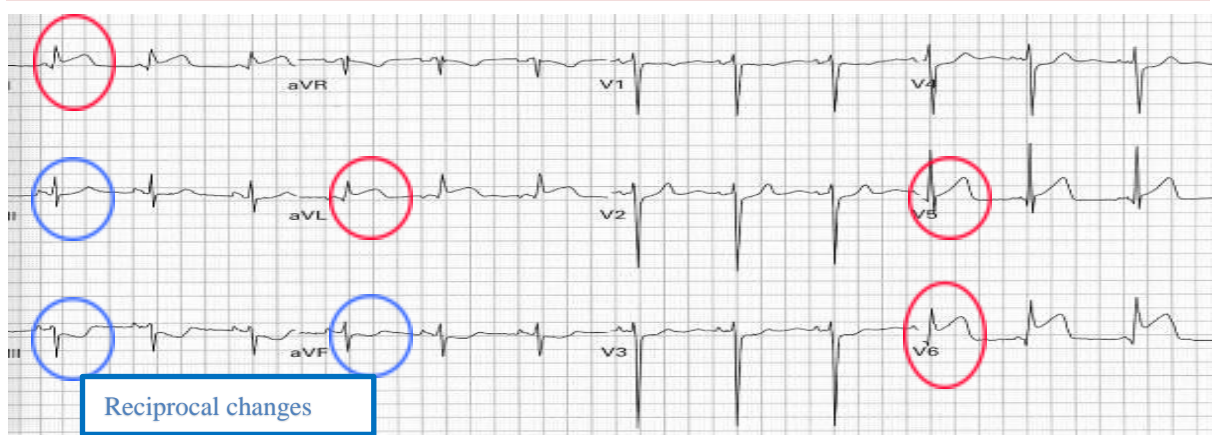
57 y old lady healthy with reproducible chest pain for 5 days.



Interpretation:

- Diagnosis:
Sinus bradycardia.

63 y old male with chest pain for 8 h.

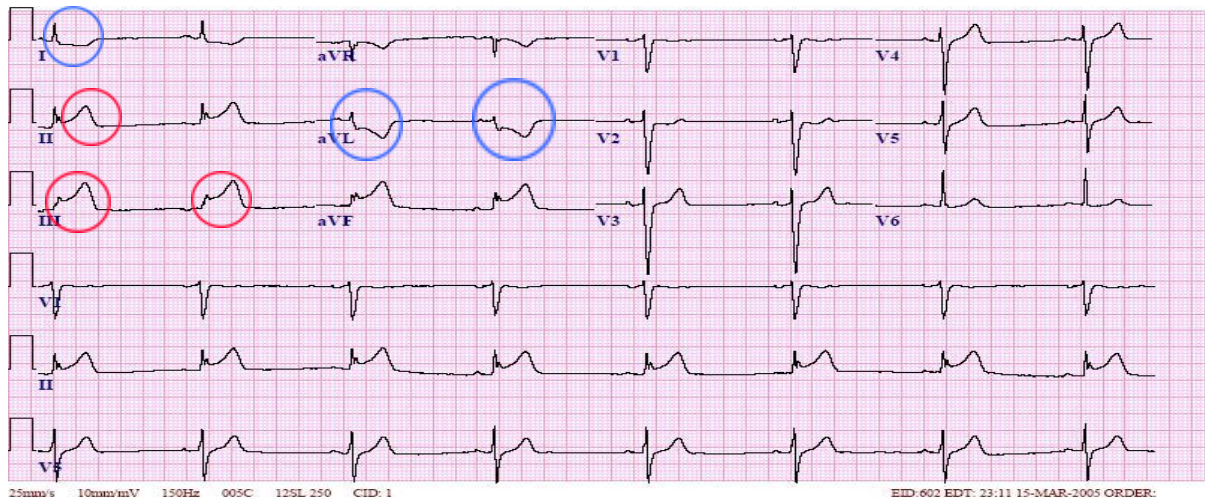


10. 43 year old man reports eight hours of left chest and arm pain

Interpretation:

- Diagnosis:
Lateral MI.

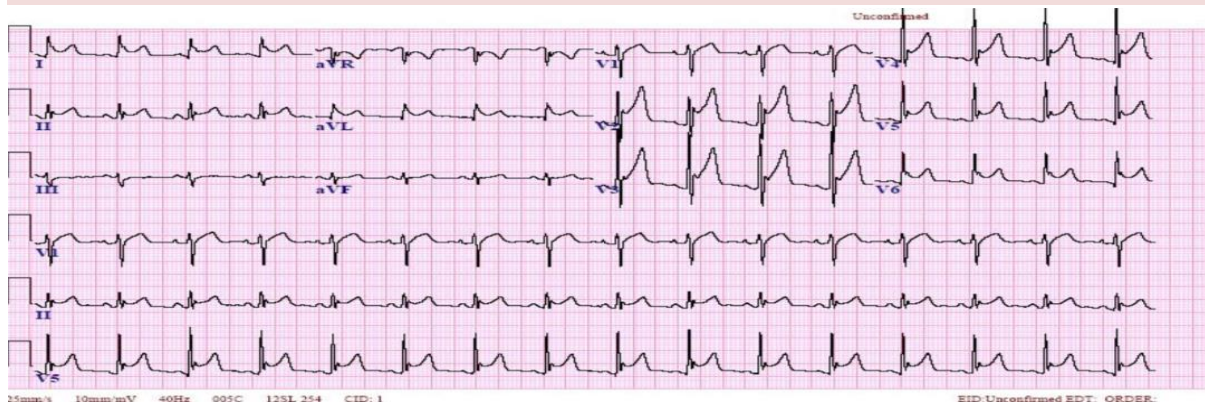
- 66 y old lady, diabetic presented with Hx of SOB for 3 h.
- HR 57, BP 90/60, other VS are stable



Interpretation:

- Diagnosis:
Inferior MI with reciprocal changes

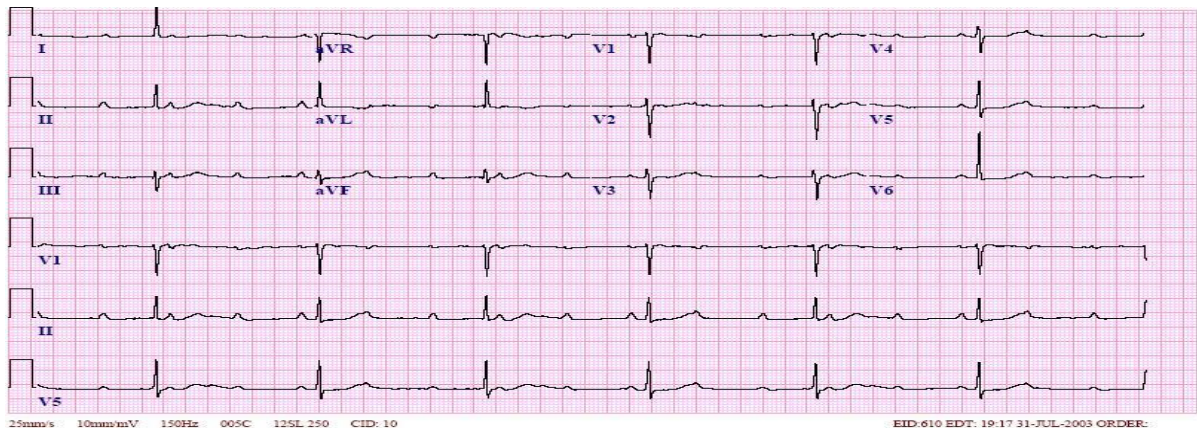
54-year-old male with no significant past medical history presents to his Family physician with 2 days of chest pain.



Interpretation:

- Important finding:
Widespread ST elevation with PR segment depression.
In AVR lead there is reciprocal changes (ST depression+ PR segment elevation)
- Diagnosis:
Acute pericarditis.

7-year-old with Hx of syncope



Interpretation:

- Important finding:
 - Regular rhythm.
 - Bradycardia.
 - The P wave with a regular P-to-P interval.
 - The QRS complex with a regular R-to-R interval.
 - The PR interval will be variable.
 - As the hallmark of complete heart block is lack of any apparent relationship between P waves and QRS complex.
- Diagnosis:
 - 3rd degree heart block (complete heart block).

29 y old male with Hx of syncope 4 days ago



Interpretation:

- Findings:
 - Long QT interval.

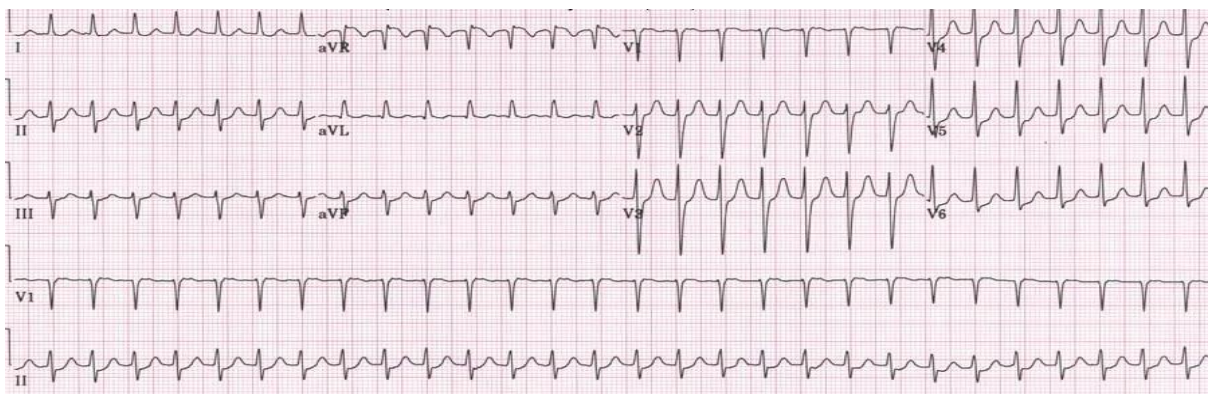
22-year-old pre-op ECG



Interpretation:

- Important finding:
Irregular rhythm.
Present P wave before each QRS complex and there is QRS complex after every P wave.
Normal PR interval.
- Diagnosis:
Sinus arrhythmia.

32-year-old male with Hx of SOB and palpitation for 1 hour



Interpretation:

- Important finding:
Regular tachycardia.
Absent P wave.
Normal QRS complex.
- Diagnosis:
SVT.