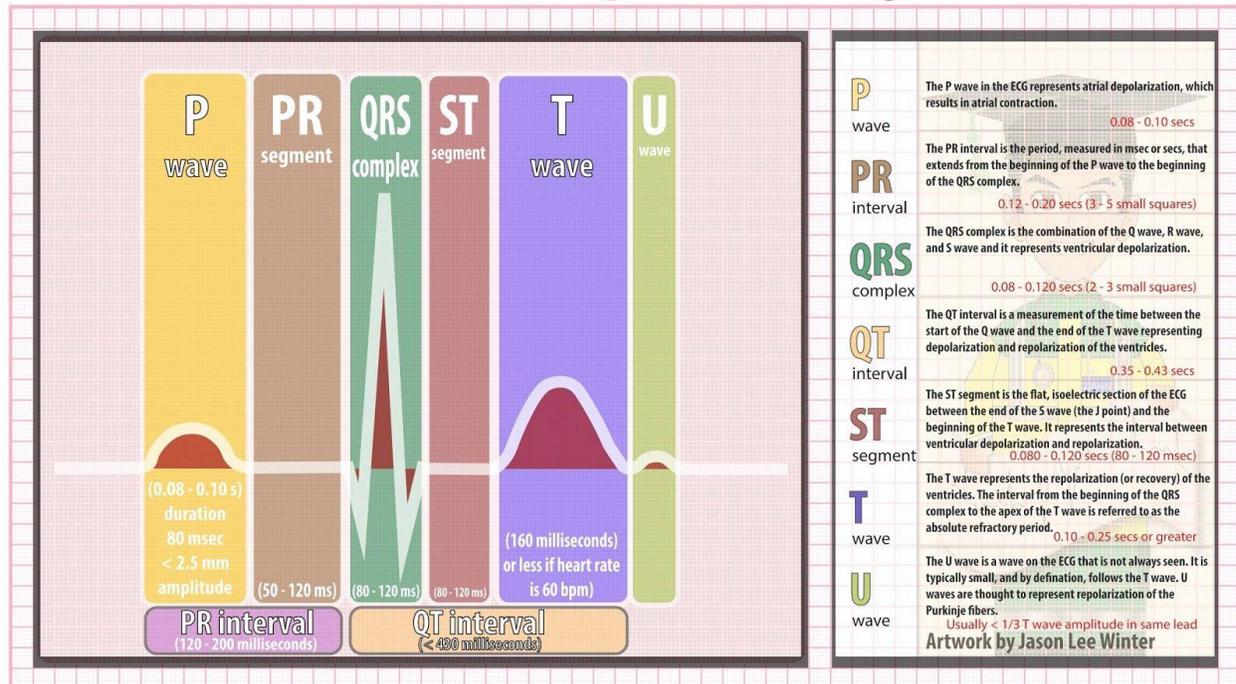


ECG

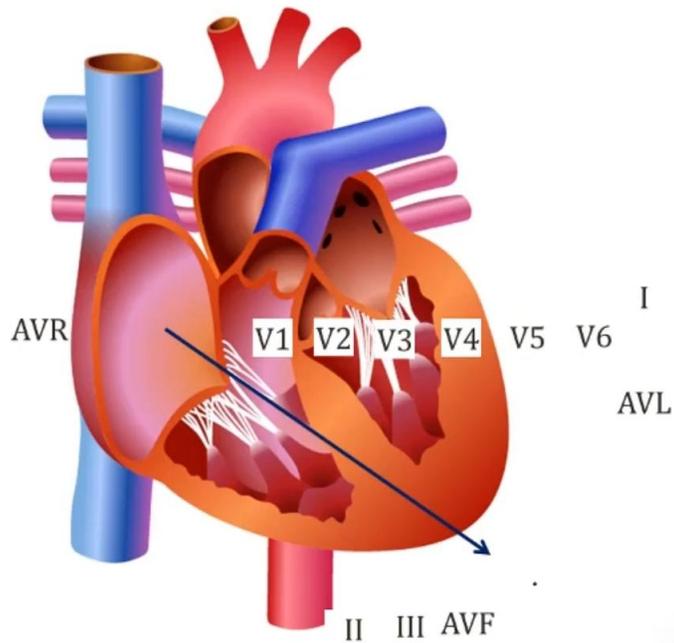
FA, Lectures, MedStudy

Normal ECG Complexes and Segments



© Jason Winter 2016 - The ECG Educator Page

P wave represents depolarization of atria, QRS wave represents depolarization of ventricle, T wave represents repolarization of ventricle. Repolarization of atria occurs at the same time of ventricular depolarization, at the same time of QRS wave.



How to start with ECG?

1. Axis
2. Assess P wave
3. Regular or Irregular?
 - a. Assess distance between R-R INTERVALS.
4. Assess QRS complexes, Narrow or Wide?
5. Check the intervals [PR, QT]
6. Assess ST segment & T wave.

Axis

Look for lead I & aVF

- Both (+) = normal
- I(+) and aVF (-)=check for LAD
- I(-) and aVF (+)=check for RAD
- Both (-) = extreme right or left axis

Causes of LAD	Causes of RAD
---------------	---------------

<ul style="list-style-type: none"> ● Acute inferior wall MI ● LBBB ● LVH ● WPW ● Left anterior fascicular block 	<ul style="list-style-type: none"> ● Acute anterior wall MI ● RBBB ● RVH ● PE, PHTN ● Left posterior fascicular block
--	--

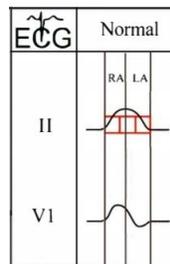
Rates & intervals

- HEART RATE
 - Divide 300 by the number of "big squares" in the RR interval.
 - Normal heart rate is between 3-5 big squares.
 - In irregular RR INTERVALS, count the number of QRS complexes (in 10 seconds) and multiplying by six.
- PR INTERVAL
 - The PR interval indicates the time between atrial and ventricular depolarization. Normal duration is 3- 5 small squares (120-200 ms).
 - Longer than 200 ms (1 big square) is the definition of I° AV block.
 - Shorter than 120 ms (3 small squares) may indicate WPW, junctional rhythm, or left atrial overload.
- QRS INTERVAL
 - QRS duration is normally < 120 ms. QRS > 120 ms may be caused by bundle-branch block.
- QT INTERVAL
 - The QT interval corrected for rate is normally 340-470 ms depending on gender and age. $QTc = QT/(RR)^{0.5}$
 - With prolonged QT there is a tendency to develop torsades de pointes.
 - Prolonged QTc has many causes:
 - $HypoCa^{+2}$, $hypoMg^{+2}$, $hypoK$

- Drugs: TCA, Type I,III antiarrhythmic drugs, antibiotics (Fluoroquinolones), antipsychotics.
- CNS insult
- Hypothermia
- Congenital Long QT Syndromes
- Short QTc can be caused by hyperCa⁺² and digitalis.

Waves & segments

- P wave
 - The P wave results from the depolarization of the atrium. The normal P wave is < 2 mm in height and < 120 ms (3 small squares) in duration.
 - Normal P wave is positive in lead II and negative in aVR.
 - Because atrial depolarization traverses from the patient's right to left, the left side of the P wave represents the right atrium, while the right side of the P wave represents the left atrium

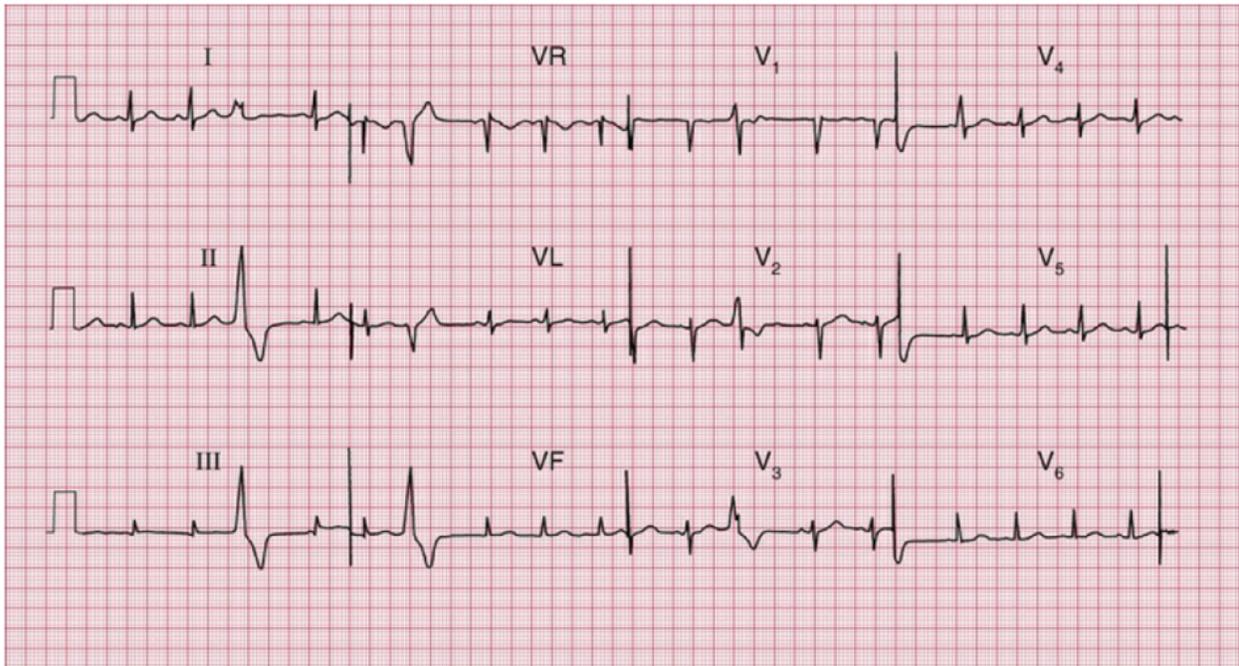


- Decreased P wave amplitude is seen in severe hyperkalemia.
 - In left atrial overload, wide P wave with a shortened or absent PR interval.
 - In right atrial enlargement, The P wave width stays normal, but look for an increased P wave amplitude in II and in V1.
- T WAVE

-
- The T wave is ordinarily in the same direction as the QRS, indicating that repolarization is actually occurring in the opposite direction of depolarization.
 - Peaked T waves are seen in: Hyperkalemia, Hyperacute MI
Intracerebral hemorrhage.
 - Focal-flipped T waves are seen in:
 - Ischemia
 - V1-2 with RBBB, RVH, and RV HTN
 - V1-2 with LVH
 - Lateral leads (I, aVL, V6) with LBBB
 - The precordial leads with LVH with "strain"
 - U WAVE
 - The U wave occurs just after the T wave. It is commonly small and is best seen in V2-3.
 - Prominent U waves are present with hypokalemia, bradycardia, digitalis, and amiodarone.
 - Negative U waves are considered significant even if the rest of the ECG is normal! Causes are ischemia, HTN, AV valve disease, and RVH.
 - ST SEGMENT
 - There are 3 main causes of ST-segment elevation: acute MI, Prinzmetal angina, and pericarditis. It may also be present in normal variants, intracerebral hemorrhage, HOCM, LVH, LBBB , cocaine abuse, myocarditis, and hypothermia.
 - ST-segment depression occurs in ischemia, LVH with LV strain, Isolated RV infarction, RVH, Digitalis toxicity & Hypokalemia.
 - QRS complex
 - Represents ventricular depolarization.
 - The normal duration of the QRS is < 100 ms. QRS changes seen with ventricular hypertrophy and conduction disturbances.
-

Case 1

This ECG was recorded from a 20-year-old student who complained of an irregular heartbeat, Apart from an irregular pulse, her heart was clinically normal.



P waves are seen, Sinus rhythm

Axis is normal

Normal QRS complexes and T waves

In ventricular ectopic beats, wide bizarre QRS complex, No P wave, R wave is opposite to T wave.

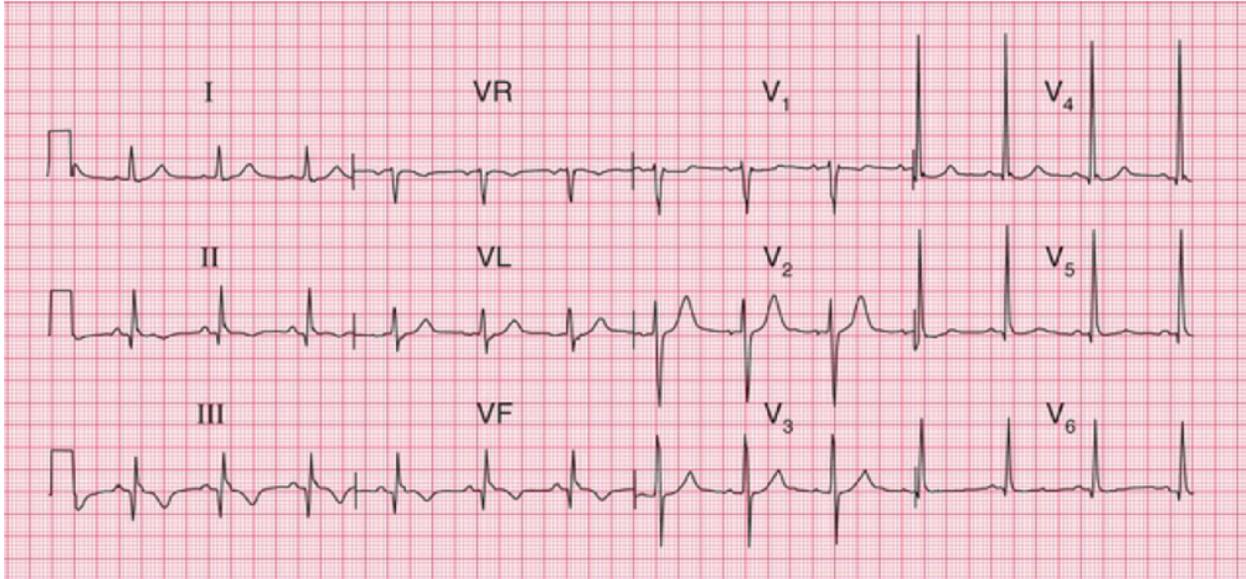
Dx: Ventricular extrasystoles

Occasional extrasystoles are benign. More than 100 per hour is considered serious, so Echocardiography is done to RO structural abnormalities (if frequent)

Specific treatment is not usually required beyond avoidance of alcohol and caffeine. Exercise!

Case 2

A 60-year-old man was seen as an outpatient, complaining of rather vague central chest pain on exertion. He had never had pain at rest.



Sinus rhythm

Normal axis

ST segments normal

Inverted T waves in leads II, III and VF

Prominent and deep Q waves in leads II, III and aVF.

To consider Q Waves as pathologic, not in V1 or aVR, in several leads, width more than 40ms, depth more than 2mm or more than $\frac{1}{4}$ R wave

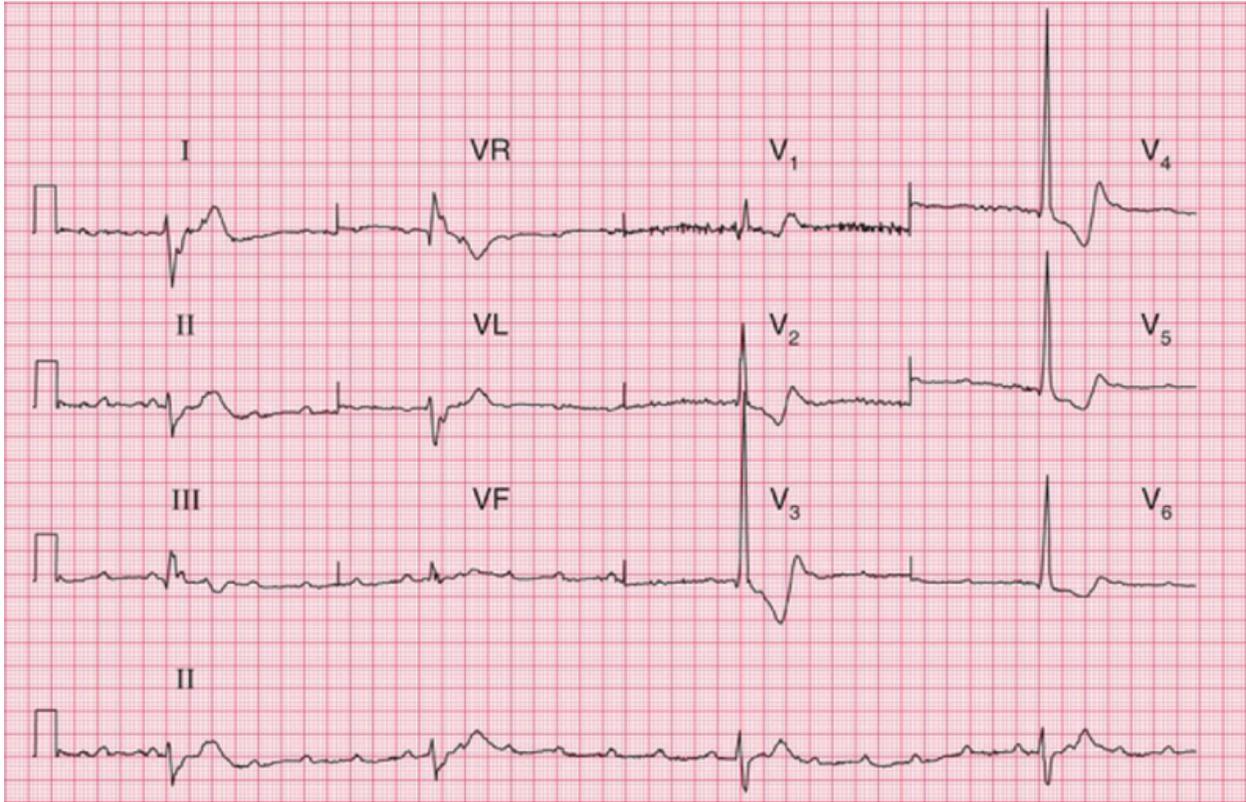
To diagnose LVH

- According to Sokolow-Lyon Criteria: S wave in V1 plus R wave in V5 or V6. If the sum is greater than 35 mm, LVH is present.
- Strain pattern (ST depression, T wave inversion)
- Axis deviation

Dx: old inferior myocardial infarction

Case 3

An 80-year-old woman, who had previously had a few attacks of dizziness, fell and broke her hip. She was found to have a slow pulse, and this is her ECG. The surgeons want to operate as soon as possible, but the anaesthetist is unhappy.



P wave rate = 130, Ventricular rate = 23

The ventricular 'escape' rhythm has wide QRS complexes and abnormal T waves.

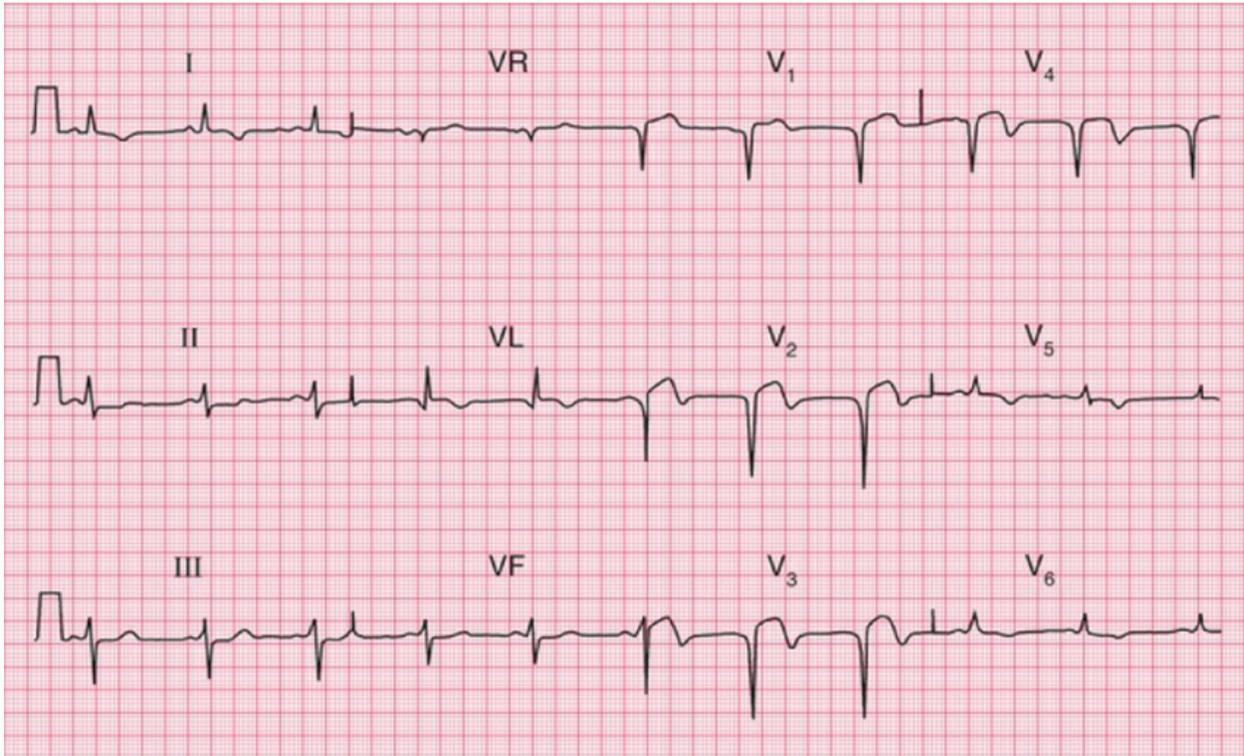
Adams-Stokes attacks is a periodic fainting spell in which there is intermittent complete heart block or other high-grade arrhythmia that results in loss of spontaneous circulation and inadequate blood flow to the brain. Mostly noticed during exertion.

Dx: Complete (third degree) heart block

Managed with pacemaker

Case 4

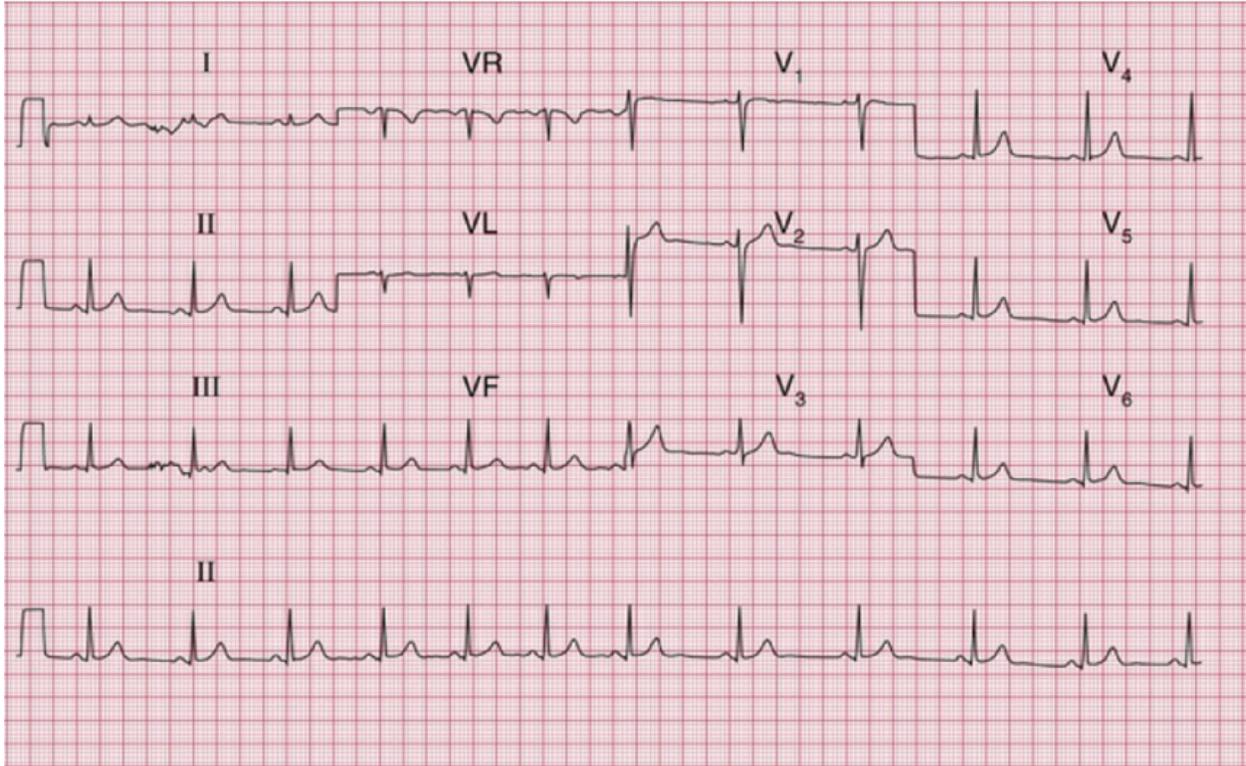
A 50-year-old man is seen in the ER department with severe central chest pain which has been present for 18 hours.



Sinus rhythm, rate 64 bpm, Normal axis
Q waves in leads V2-V4
Raised ST segments in leads V2-V4
Inverted T waves in leads I, aVL, V2-V6
Dx: Acute anterior STEMI

Case 5

This ECG was recorded from a medical student during a practical class.



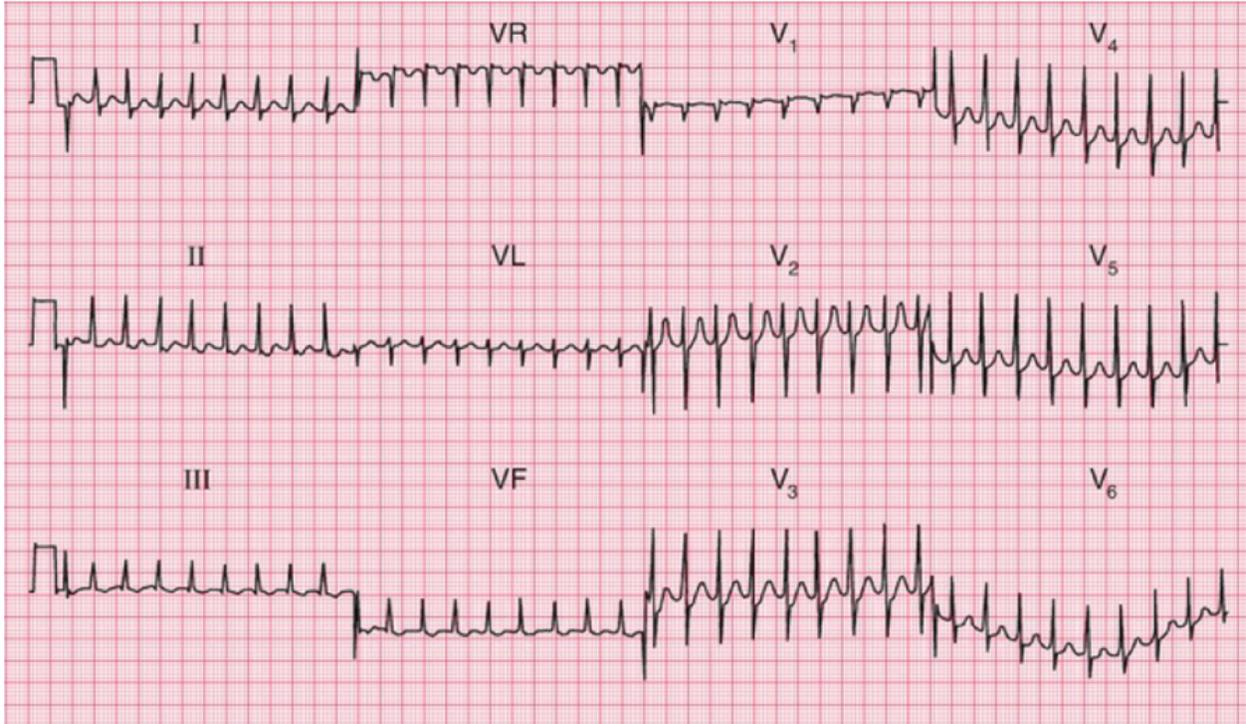
Sinus rhythm, rate 70 bpm.

Normal axis + QRS complexes + ST segments + T waves

Dx: Sinus arrhythmia

Case 6

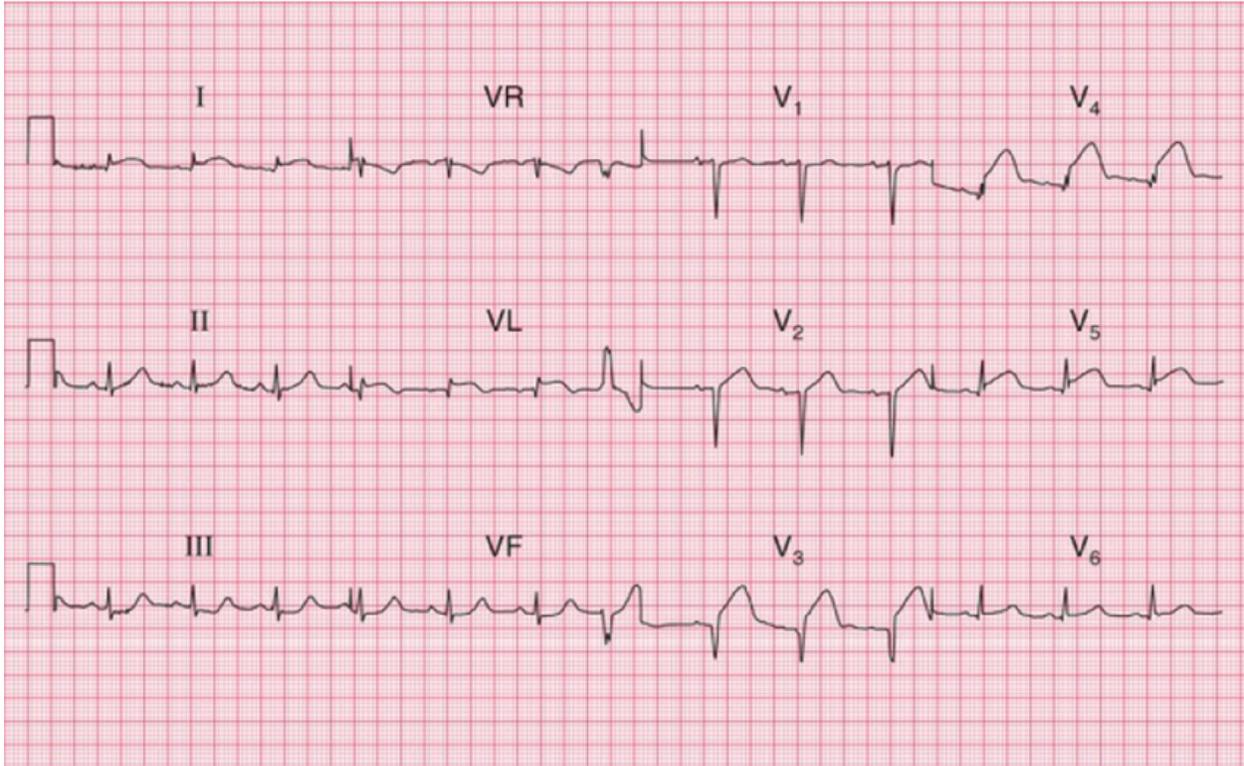
A 26-year-old woman, who has complained of palpitations in the past, is admitted to hospital via the ER department with palpitations.



Narrow complex tachycardia, rate about 200 bpm
No P waves visible / Regular QRS complexes
DX: supraventricular tachycardia

Case 7

This ECG was recorded in the ER department from a 60-year-old man who had had severe central chest pain for 1 hour.



Sinus rhythm, rate 82 bpm

Q waves in leads V2-V3; small Q waves in leads VL, V4.

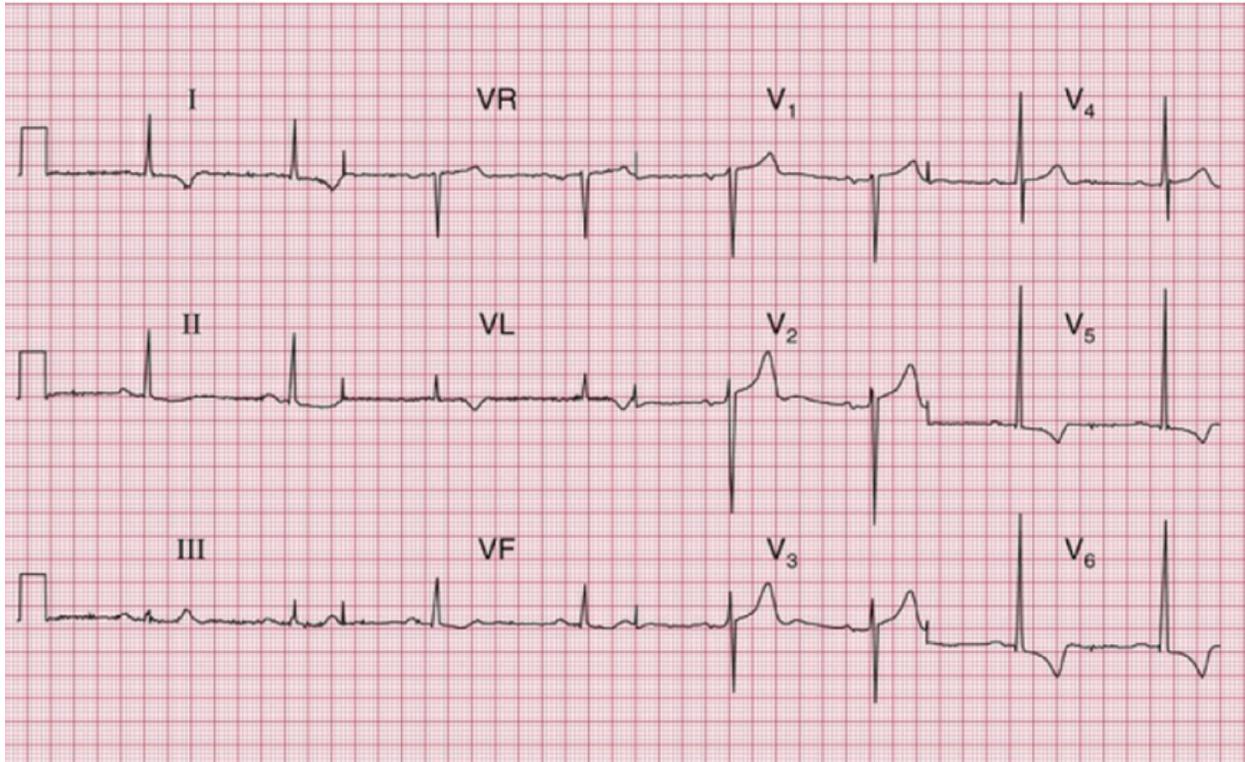
Raised ST segments in leads I, VL, V3-V6

Remember the PAILS mnemonic when assessing for reciprocal changes. PAILS stands for P-posterior A-anterior I-inferior L-lateral S-septal. ST elevations in these leads most commonly create reciprocal ST depressions in the corresponding leads of the next letter in the mnemonic.

DX: Acute anterolateral STEMI

Case 8

A 70-year-old retired orthopaedic surgeon telephones to say that he always gets dizzy playing golf. You find that he has a systolic heart murmur.



Sinus rhythm, rate 50 bpm, Normal axis

LVH criteria

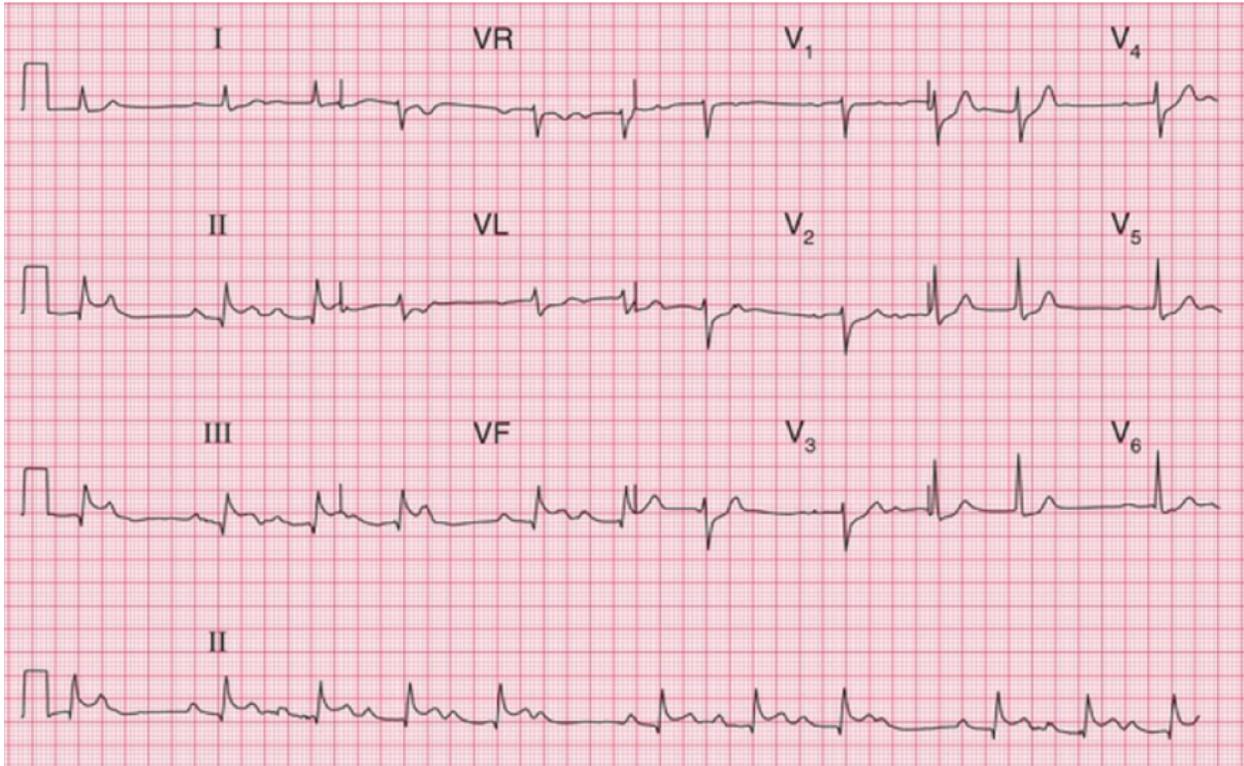
- R wave height in lead V5 is 30 mm, and the S wave depth in lead V2 is 25 mm.
- Inverted T waves in leads I, VL, V5-V6. (Strain pattern in lateral leads)

DX: Left ventricular hypertrophy due to aortic stenosis

Note: remember that ECG is not diagnostic for LVH, ECHO should be done to confirm LVH.

Case 9

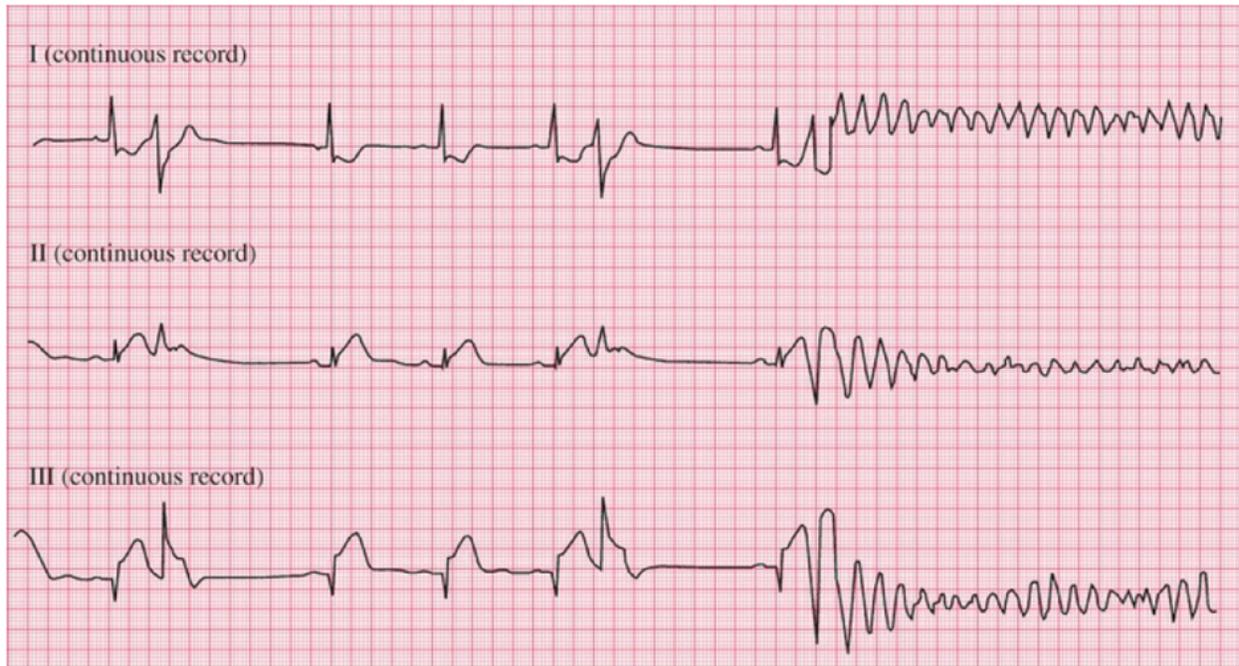
A 70-year-old man is admitted to hospital following the onset of severe central chest pain.



Sinus rhythm, rate of sinus beats 75 bpm
Second degree heart block (most obvious in the rhythm strip, recorded from lead II)
Small Q waves in leads II, III, VF
Raised ST segments in leads II, III, VF
Depressed ST segments in leads V5-V6
Note Most common rhythm in inferior mi is bradycardia .
Complete heart block in inferior mi is considered benign when compared to
complete heart block after anterior mi
DX: Second degree AV block with acute inferior STEMI

Case 10

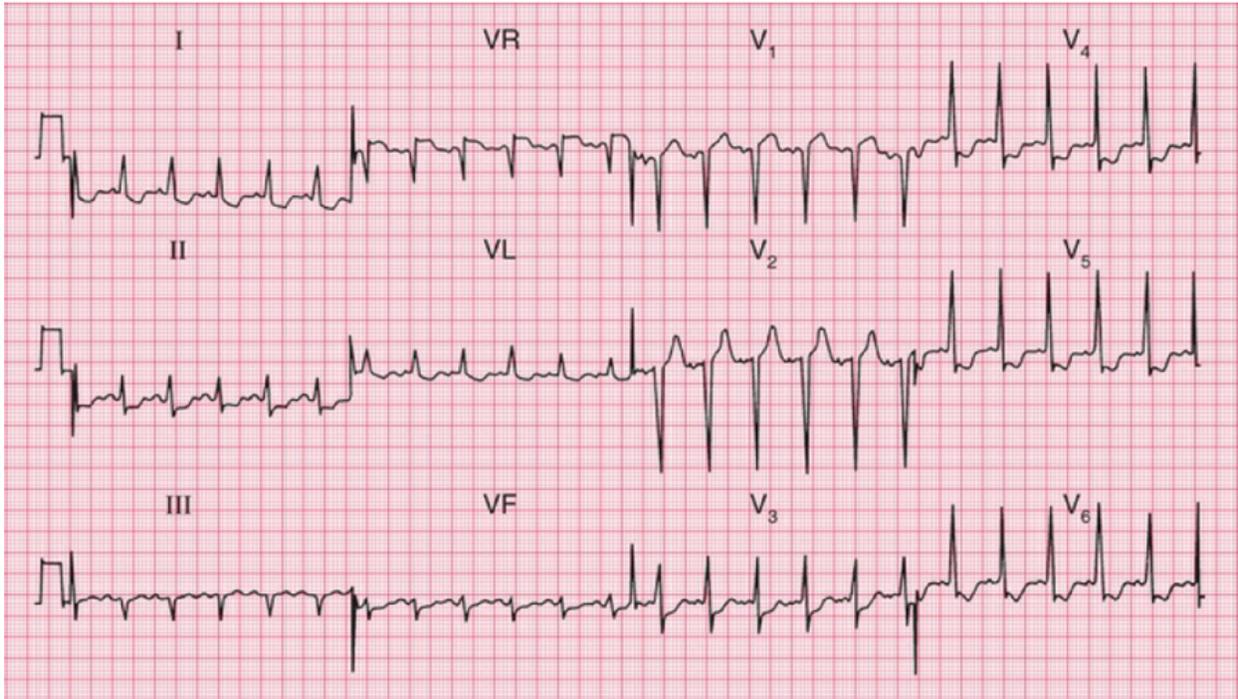
A 50-year-old man, who had come to the ER department with chest pain, collapsed while his ECG was being recorded.



Sinus rhythm initially 55 bpm, with ventricular Extrasystoles.
The third extrasystole occurs on the peak of the T wave of the preceding sinus beat.
After three or four beats of ventricular tachycardia, ventricular fibrillation develops.
Q wave in lead III; and there are raised ST segments in leads II and III, and ST segment depression and T wave inversion in lead I.
Dx = Probable inferior myocardial infarction
R on T ventricular extrasystole, causing ventricular fibrillation.
This is the mechanism of synchronised defibrillation, Not to have R wave from the defibrillator on the T wave of the patient.

Case 11

This ECG was recorded in the ER from a 55-year-old man who had had chest pain at rest for 6 Hours . There were no abnormal physical findings, and his plasma troponin level was normal.



Sinus rhythm, rate 130 bpm.

Normal axis / QRS.

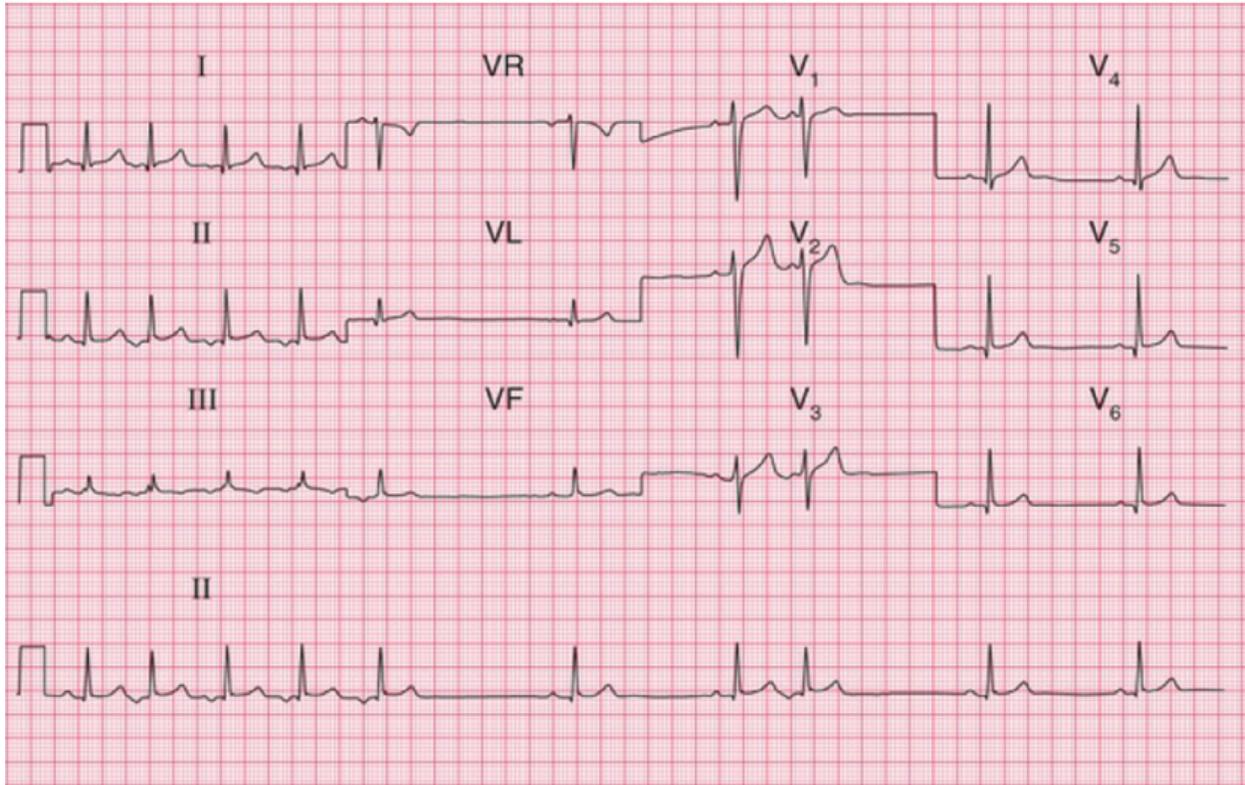
ST segment depression: slightly upward-sloping in lead V3, downward-sloping in leads I, II, VL, V4-V6.

من الصعب تمييز ال ST Depression في حال ال Sinus Tachycardia

DX: Anterolateral ischaemia.

Case 12

This ECG came from a 40-year-old woman who complained of palpitations, which were present when the recording was made.



The first beat has a normal P wave and is normal

The next four beats, at about 100 bpm, have abnormal (inverted) P waves, and this is an atrial tachycardia.

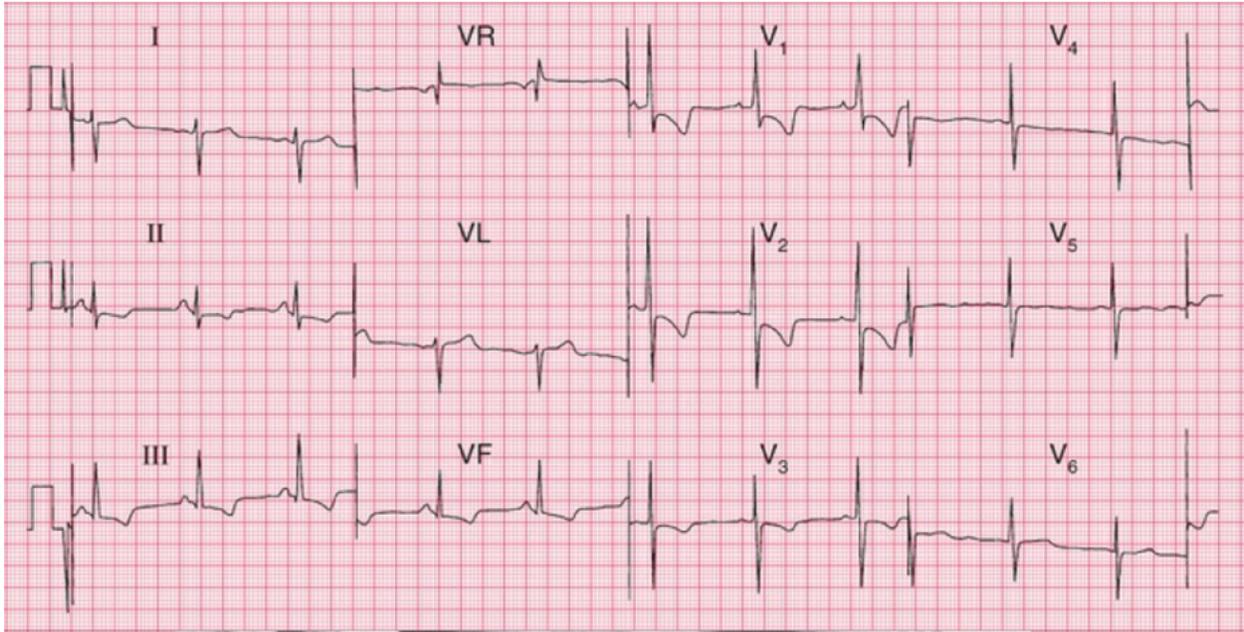
After a pause, the next two beats have normal P waves and are in sinus rhythm at about 60/min.

After two sinus beats, there is an extrasystole with an inverted P wave; this is an atrial extrasystole.

DX: Sinus rhythm with atrial tachycardia and one atrial extrasystole.

Case 13

A 40-year-old woman is referred to the outpatient department because of increasing breathlessness.



Sinus rhythm, rate 65 bpm

Right axis deviation

Peaked P waves, best seen in lead II (P Pulmonale)

Dominant R waves in lead V1, Deep S waves in lead V6

Inverted T waves in leads II, III, VF, V1-V3 (Strain Pattern)

DX = severe right ventricular hypertrophy

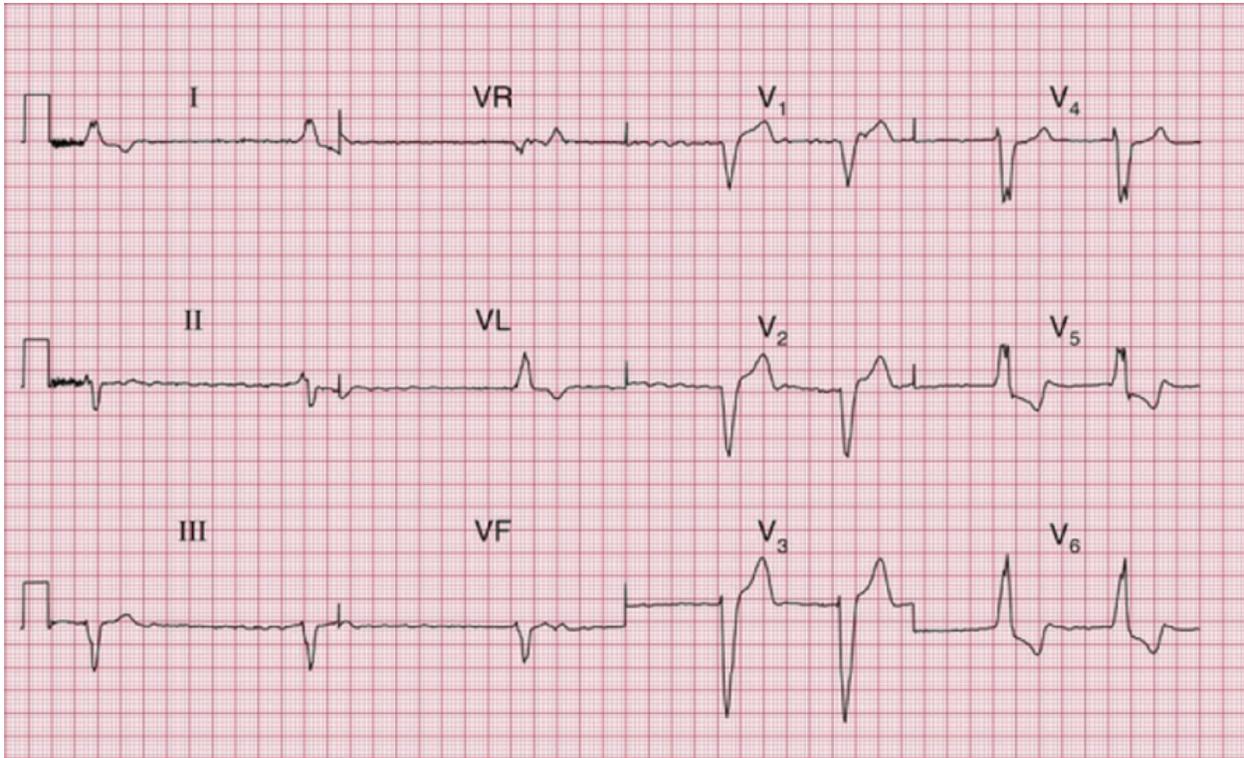
Causes of R in V1 are: WPW Syndrome, RVH, Dextrocardia, Posterior wall MI, Normal in children.

For differentiating RVH from other causes of R in V1, Use RSS

$R V1 > 5\text{mm}$, $R:S \text{ ratio in } V1 > 1$, $\text{Deep } S \text{ in } V5 > 5\text{mm}$

Case 14:

This ECG was recorded from an 80-year-old man who complained of breathlessness and ankle swelling which had become slowly worse over the preceding few months. He had had no chest pain and was on no treatment. He had a slow pulse and signs of heart failure.



Absent P wave

Atrial fibrillation with a ventricular rate of about 40 bpm

Wide QRS Complexes > 120 ms.

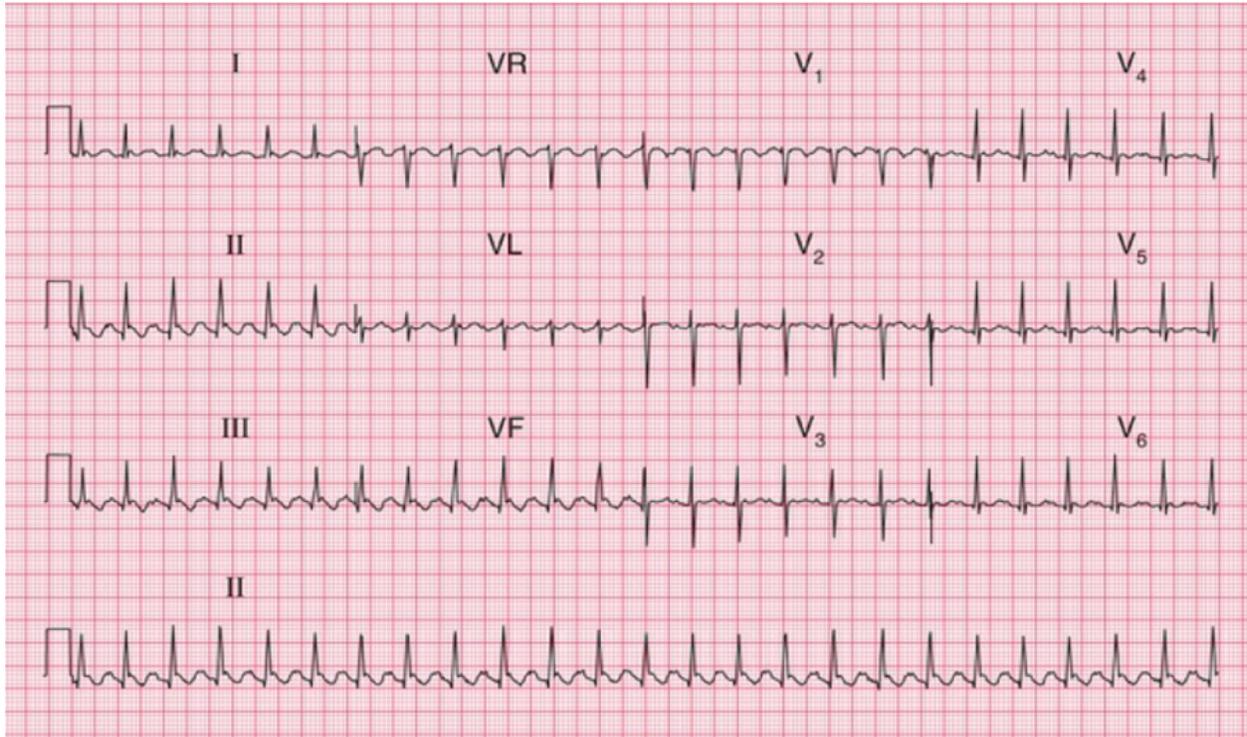
Left axis deviation

To differentiate between left and right BBB, Look at V1, if there is tall R wave, it is RBBB and if NOT, it is LBBB.

Left bundle branch block (LBBB).

Case 15

This ECG was recorded from a 40-year-old man who was admitted to hospital as an emergency, with the sudden onset of the symptoms and signs of severe left ventricular failure.



To see P wave, always look at V1.

Atrial flutter with 2 : 1 block (best seen in leads II, III, VF)

Normal axis

Normal QRS complexes

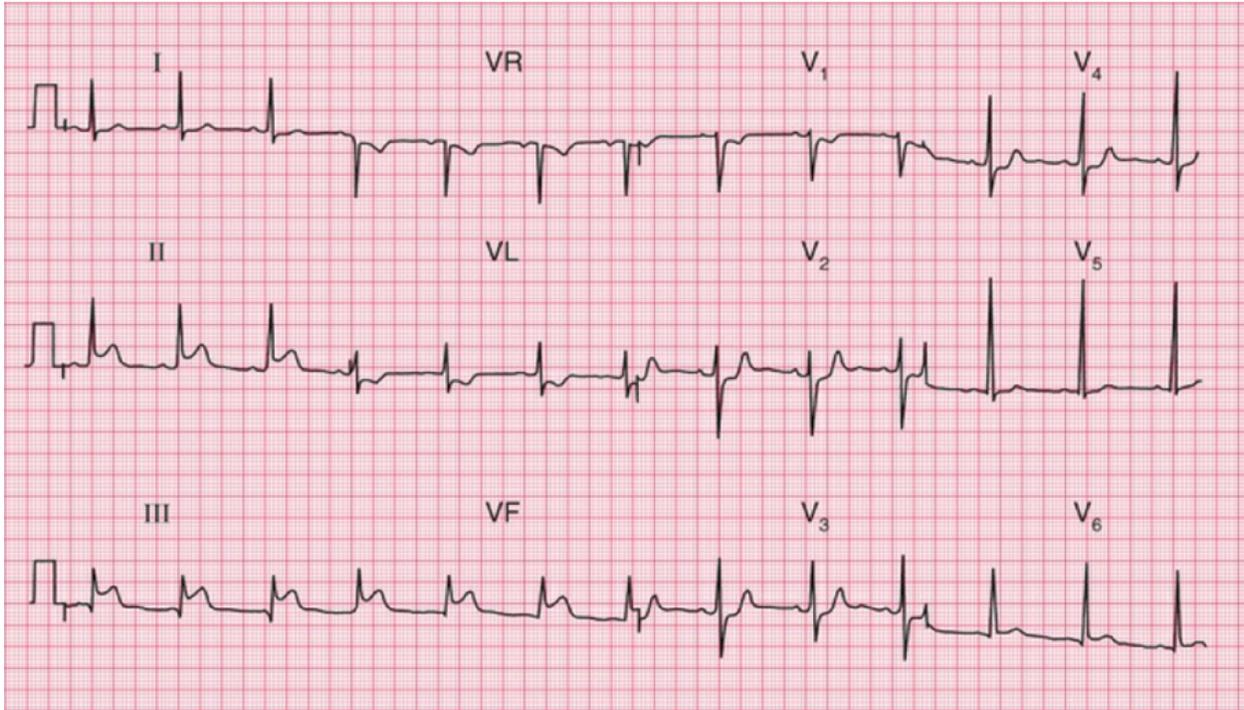
The T waves are difficult to identify because of the flutter waves.

This type of flutter is hard to identify اصعب اشكالها

Might be misdiagnosed with SVT. When adenosine is given, flutter waves will be obvious.

Case 16

A 50-year-old man is admitted to hospital as an emergency, having chest pain characteristic of a myocardial infarction for 4 hours.

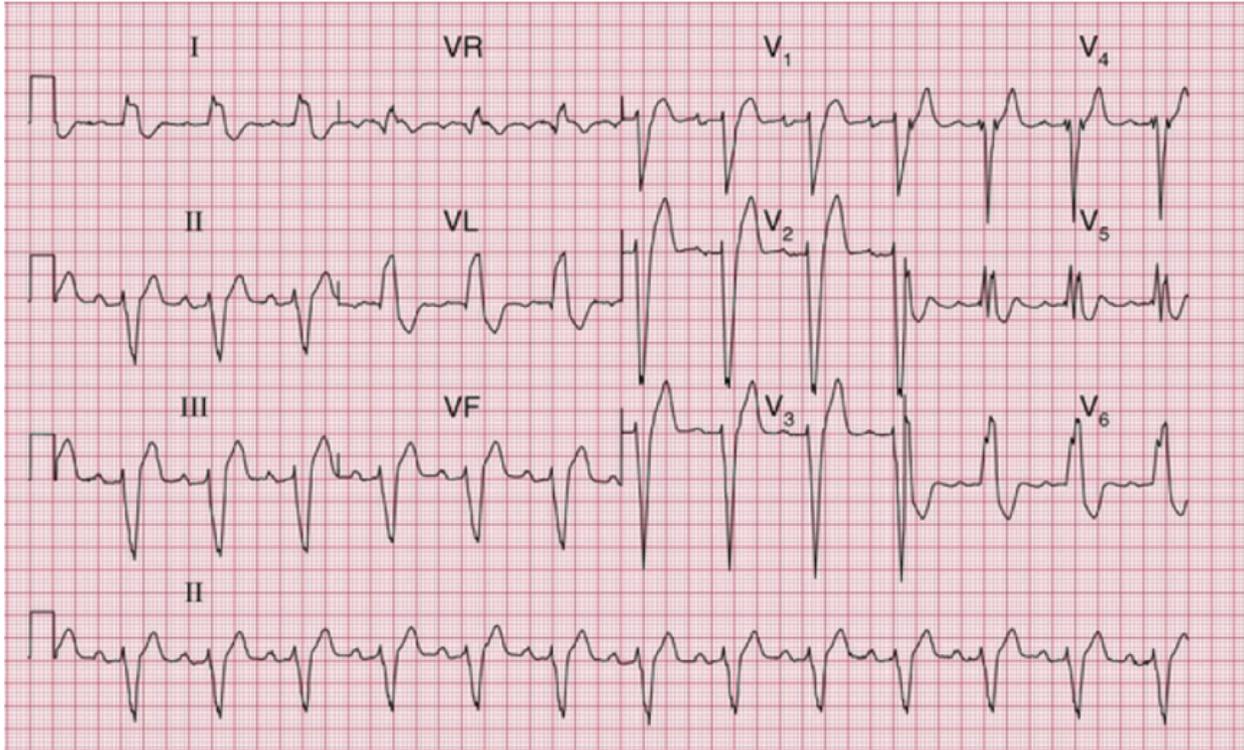


- Sinus rhythm, rate 72 bpm
- Normal axis
- Small Q waves in lead III
- Elevated ST segments in leads II, III, VF, with upright T waves
- Suggestion of ST segment depression in leads V2-V3
- T wave inversion in lead VL.

DX: Acute inferior STEMI.

Case 17

A 75-year-old woman complained of central chest discomfort on climbing hills, together with dizziness; on one occasion she had 'fainted' while climbing stairs.



- Sinus rhythm, rate 80 bpm
- Left axis deviation
- Broad QRS complexes (192 ms)
- 'M' pattern in lead V6, No RV1
- Inverted T waves in leads I, VL, V6.

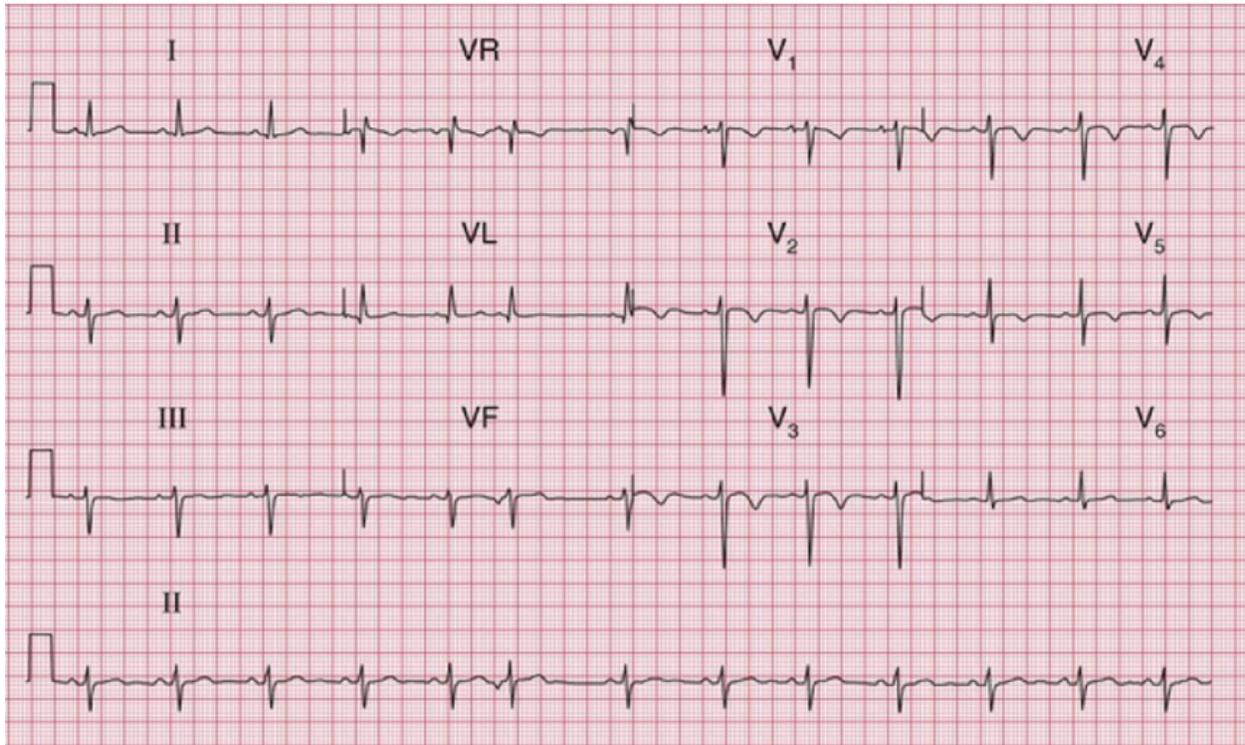
In LBBB, You can't assess ST segments or T waves for signs of ischemia.

If new LBBB, Manage as STEMI, if Old, Assess patient Clinically!

DX: LBBB

Case 18

This ECG was recorded from a 48-year-old man who had had severe central chest pain for 1 hour.



Sinus rhythm, rate 75 bpm

- Left axis deviation (left anterior hemiblock)
- Normal QRS complexes, with a small Q wave (probably septal) in lead VL.
- Inverted T waves in leads V1–V5, T wave are sharp like 'V'

In digoxin toxicity, T wave are flattened.

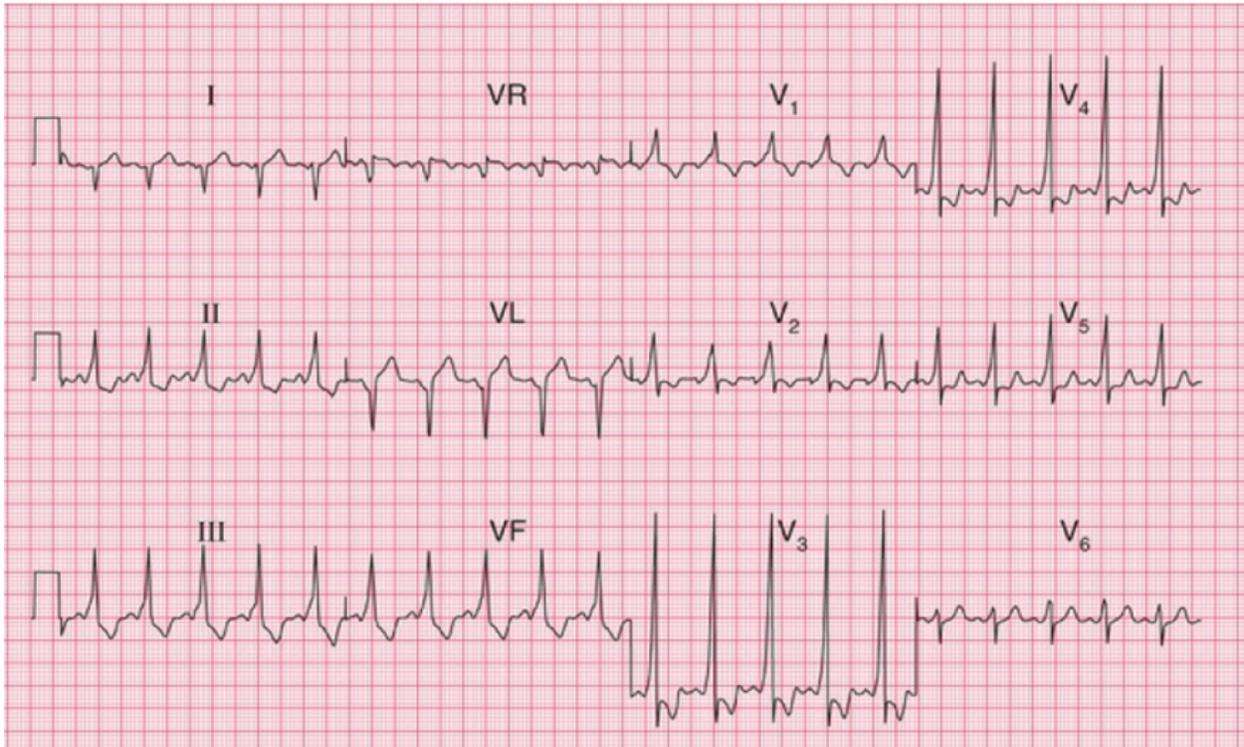
Poor R wave progression.

Recent studies have shown that poor R-wave progression has the following four distinct major causes: AMI, left ventricular hypertrophy, right ventricular hypertrophy, and a variant of normal with diminished anterior forces.

- DX = Acute anterior NSTEMI.

Case 19

A 20-year-old student complains of palpitations. Attacks occur about once per year. They start suddenly, his heart feels very fast and regular, and he quickly feels breathless and faint. The attacks stop suddenly after a few minutes. There are no abnormalities on examination.



Sinus rhythm, rate 125 bpm

- Short PR interval, most obvious in the chest leads
- Normal axis
- Wide QRS complexes (136 ms)
- Slurred upstroke of the QRS complex (delta wave)
- Dominant R wave in lead V1.

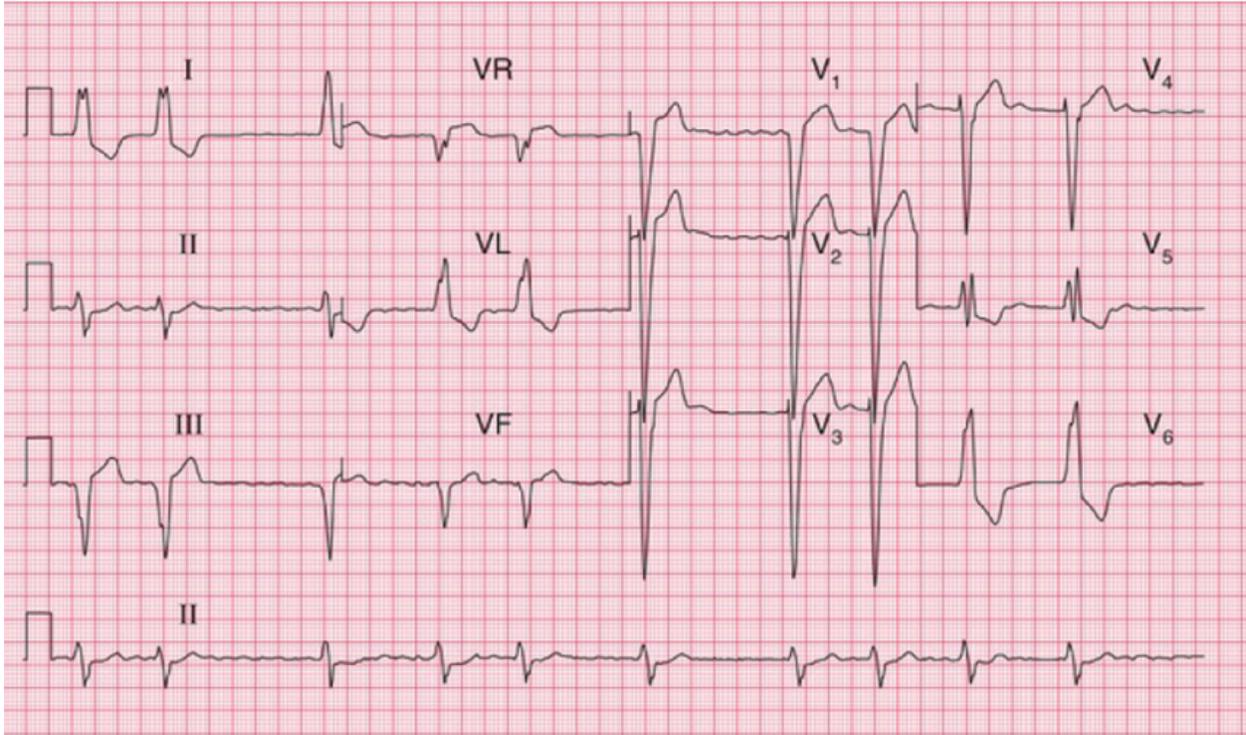
Type A (Tall R in V1)

Type A is described as having an upright positive delta wave in all precordial leads with a resultant R greater than S amplitude in lead V1. Type B has a predominantly negative delta wave and QRS complex in V1 and V2 and becomes positive in transition to the lateral leads, much as in left bundle-branch block (LBBB).

DX: Wolff-Parkinson-White (WPW) syndrome

Case 20

A 70-year-old man who had had angina for some time and was being treated with a beta-blocker. He came to the ER department complaining of pain similar to his angina, but much more severe and persistent for 4 hours. He had a heart murmur.



Atrial fibrillation; ventricular rate 62 bpm

- Left axis deviation (left anterior hemiblock)
- Broad QRS complexes (160 ms)
- 'M' pattern of QRS complexes in leads V5-V6, no R wave in V1.
- Inverted T waves in leads I, VL, V5-V6.

DX: Atrial fibrillation and LBBB

Case 21

A 50-year-old man is admitted to hospital as an emergency, having had chest pain for 4 hours.

Normal axis

ST elevation in II, III, aVF

Reciprocal changes in I, aVL, V1- V4

Dx: Acute inferior wall MI

Case 22

40-year-old man who complained of breathlessness on climbing stairs. He was not aware of a fast heart rate and had had no chest pain. Apart from a rapid rate there were no cardiovascular abnormalities, but he looked a little jaundiced and had an enlarged spleen.

Normal axis
rate around 150 bpm, abnormal P waves
Saw-tooth appearance
Dx: 2:1 block atrial flutter

Case 23

A 60-year-old man was referred to the outpatient department because of exercise-induced chest pain. The upper ECG is his record at rest, and the lower one was taken during exercise.

Upper ECG
Sinus rhythm, rate 75 bpm
T wave inversion in III

Lower ecg
ST Depression in II, III, aVF
Also ST DEPRESSION in V3-V6

Positive stress test

Case 24

A 70-year-old woman, from whom this ECG was recorded, was admitted to hospital with increasing congestive cardiac failure.

Irregular irregular pattern
Absent P wave
Sawtooth appearance
Dx: Atrial fibrillation (flutter fib)

Case 25

A 70-year-old man was seen as an outpatient with symptoms and signs of heart failure. His problem had begun quite suddenly a few weeks previously, when he had had a few hours of dull central chest discomfort.

Normal axis
Sinus rhythm
Rate around 100 bpm
ST elevation in I, V2-V5

Deep pathologic Q Waves in I, aVL, V1-V5
ST Elevations will disappear within 6 weeks of MI. If persist, think about ventricular aneurysm.
Dx: Ventricular aneurysm.

Case 26

Normal axis
Absent P wave, irregular RR INTERVALS
Rate 80 bpm
Down-sloping ST Depression in leads V4-V6
U wave in leads V2-v3 (sus. HypoK)

Dx: Atrial fibrillation, Digoxin toxicity.

Case 27

ST elevation in I, aVL V2-V6
Reciprocal changes in II, III, aVF
Deep pathologic Q Waves in lead v2-v3
Massive Anterolateral MI

Case 28

Axis Normal, rate 250 bpm
When you have ECG with tachycardia, focus on it
It is hard to determine ST segments, either with elevation or depression.

Case 29

Sinus rhythm
Atrial Extrasystole
RSR pattern in V1
Broad Slurred S in V6
T wave inversion V1-V3

Dx: RBBB with extrasystole
From the Hx & Examination, RBBB in young adults with heart murmur is commonly Associated with ASD.
Murmur also could be from high flow from pregnancy.
Echocardiography is advised!
Look at all leads!

Case 30

Regular rhythm, rate 60bpm
Left axis deviation
Some P waves are not related to QRS complexes. Lead I.
Peacemaker

Case 31
Rate 170, Axis NIL
Wide QRS Complexes
Ventricular Tachycardia
Treated with cardioversion or DC Shock

Case 32
Axis Normal, sinus rhythm
ST Elevations in v1- v5
Q wave in v1-v4
Acute Anterolateral STEMI

Case 33
Sinus rhythm, bradycardia
Axis Normal
PR Prolongation, progressive, without drop beats

First degree heart block

Case 34
Rate 55, axis Normal
PR prolongation, no drop beats
No coordination between P wave and QRS Complexes
Complete heart block

Case 35
Sinus rhythm, axis Normal
T wave inversion v1-v5
Non-ST-elevation MI