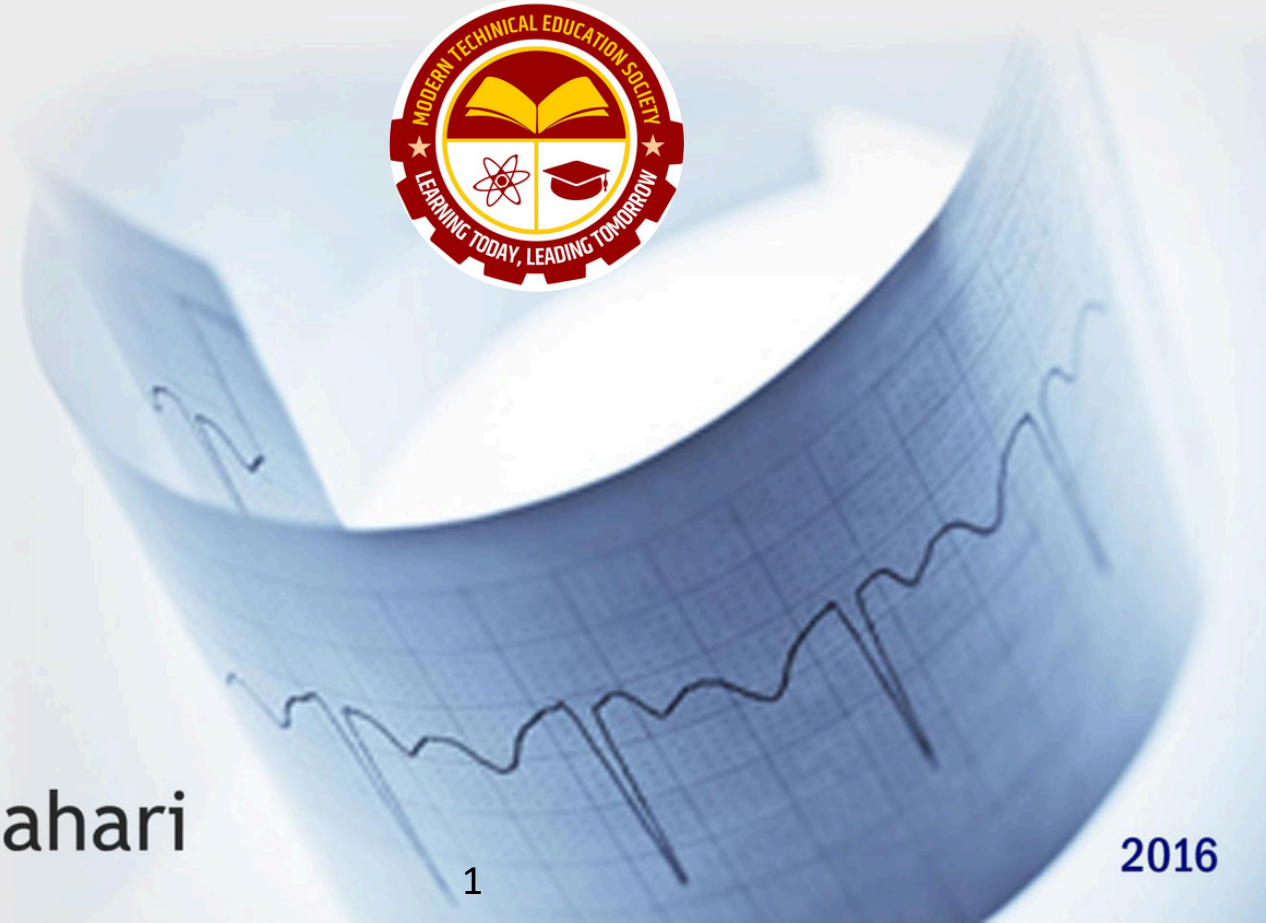
MODERN TECHNICAL EDUCATION SOCIETY

Concise guide for medical student

11 steps for systematic reading of

ECG



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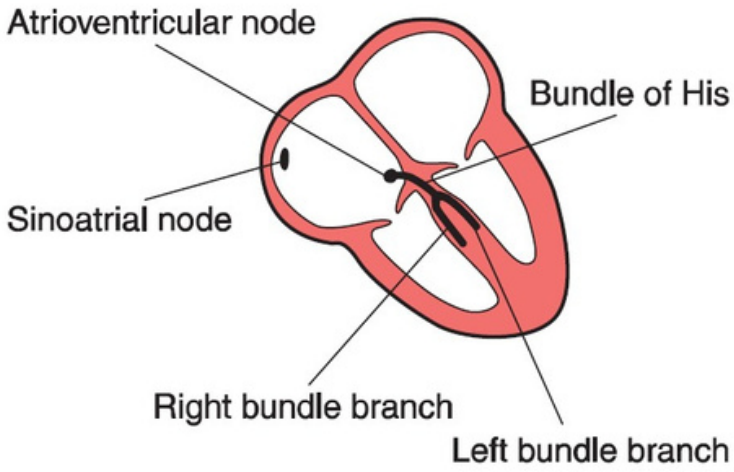
2016

General principles

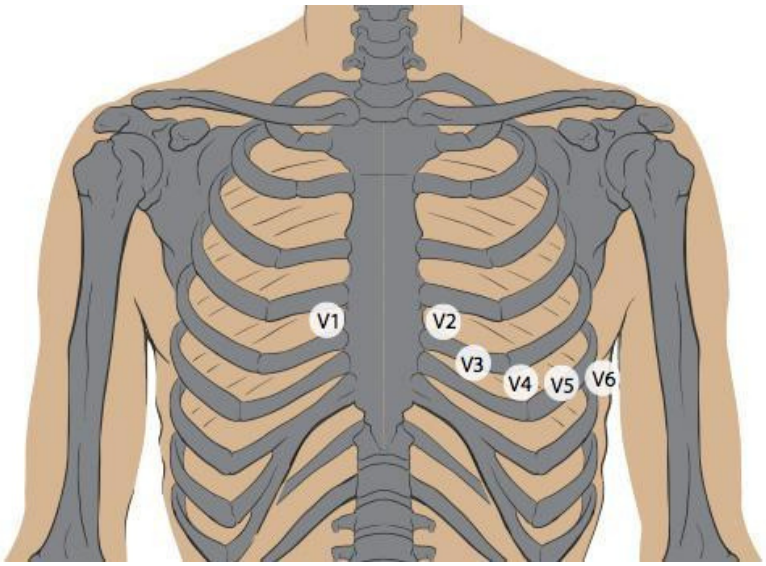
ECG is a recording of the electrical activity of the heart.

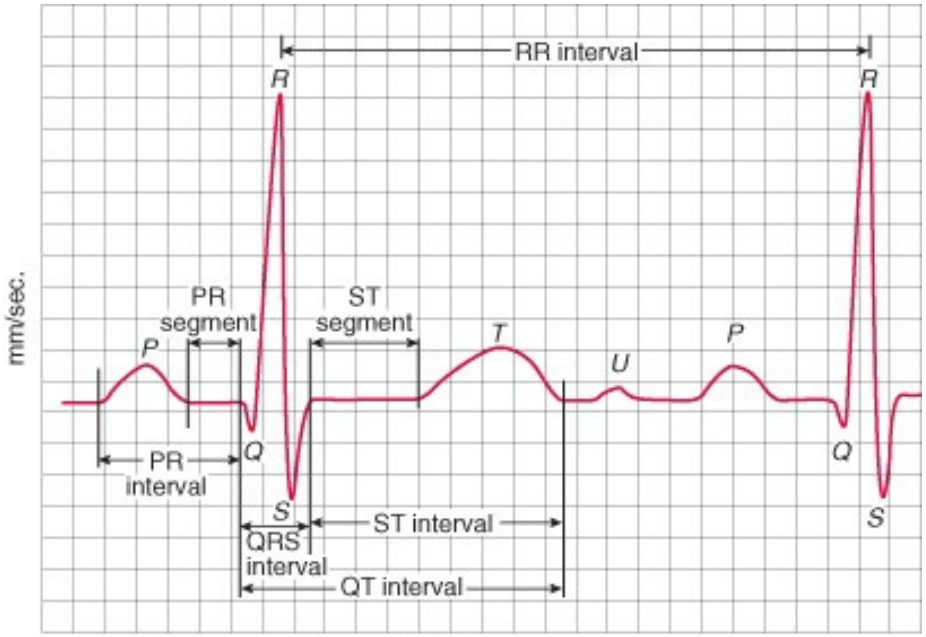
Electrical pathway of the heart :



- 12-lead ECG is composed of 12 leads as follow:
  - 3 unipolar leads AVL, AVR, AVF
  - 3 bipolar leads I , II , III
  - 6 chest leads V1, V2, V3, V4, V5, V6

- Terminology :
  - Wave : any deflection up or down (positive or negative)
  - Segment : isoelectric line
  - Complex : 2 waves or more
  - Interval : 1 wave or more + isoelectric line





P wave represents atrial depolarization (contraction)

QRS complex represents ventricular depolarization (contraction)

T wave represents ventricular repolarization (relaxation)

1- Check the patient name !

Make sure the ECG paper that you are reading is not for another patient !

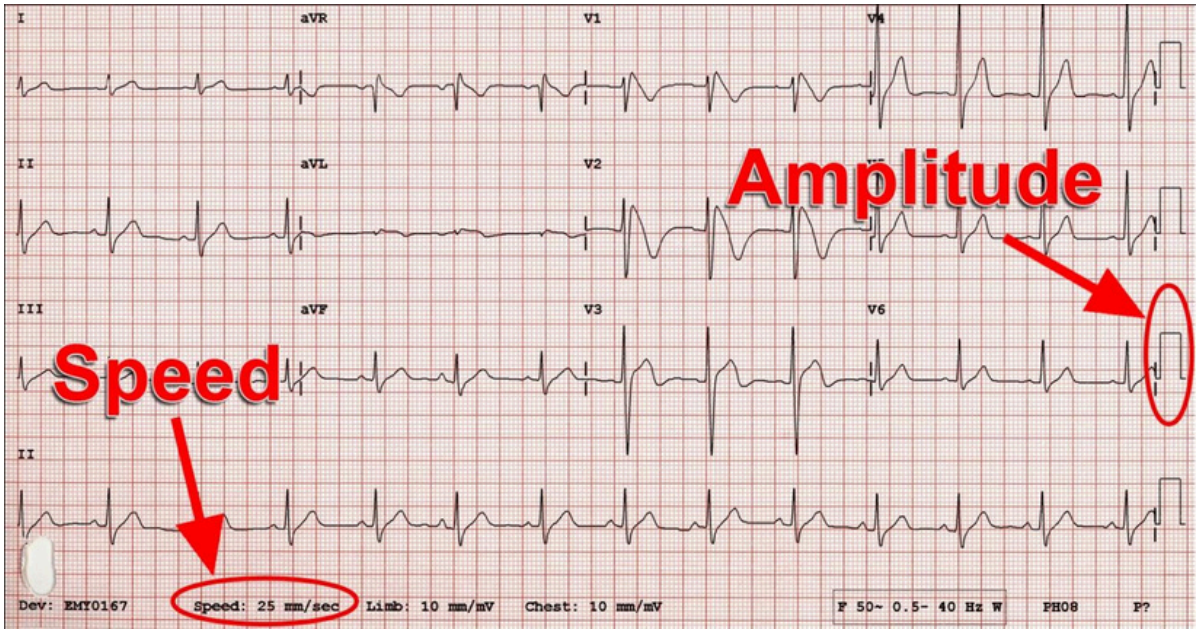
2- Check ECG machine calibration

Carefully look at the calibrations (settings) of the ECG machine , because the interpretations will be affected according to the calibration changes. In the usual ECG paper , two measures should be seen :

Amplitude (standard amplitude is 10 mm – 10 small squares)

Speed of ECG paper (standard ECG speed is 25 mm/second)

Remember : high speed ECG paper produce false bradycardia and low speed produce false tachycardia !



3- Rhythm

- The best lead to assess the rhythm is lead II.

Is the rhythm regular or irregular ? Measure the distance between R-R interval and compare it with other R-R intervals.

Three possibilities in the rhythm :

Regular rhythm : e.g. sinus rhythm.
Regularly irregular rhythm : e.g. some types of AV block.
Irregularly irregular rhythm : e.g. Atrial fibrillation.

An important part of rhythm assessment is deciding whether the rhythm is SINUS or not (sinus rhythm means the electrical impulses are running through the normal sinus pathway : SA node – AV node .. etc) , and to name the rhythm SINUS, it should have :

a) Regular rhythm + Single P wave before each QRS complex

b) P wave axis should be :

- Upright (positive) in the leads I, II, AVL , AVF
- Inverted (negative) in the lead AVR
- Biphasic in the leads V1, V2

Examples of Non-sinus rhythms :

- Absent P wave e.g. Atrial fibrillation.
- Multiple P waves e.g. Atrial flutter.

4- Rate

To count the rate , the rhythm must be identified because the rate counting is rhythm-dependant :

If rhythm is regular :

Rate = 1500 / number of small squares between R-R

Or = 300 / number of intermediate squares between R-R

If rhythm is irregular :

Rate = number of QRS complexes in 6 seconds then X 10

Or = number of QRS complexes in 5 seconds then X 12

5- QRS axis

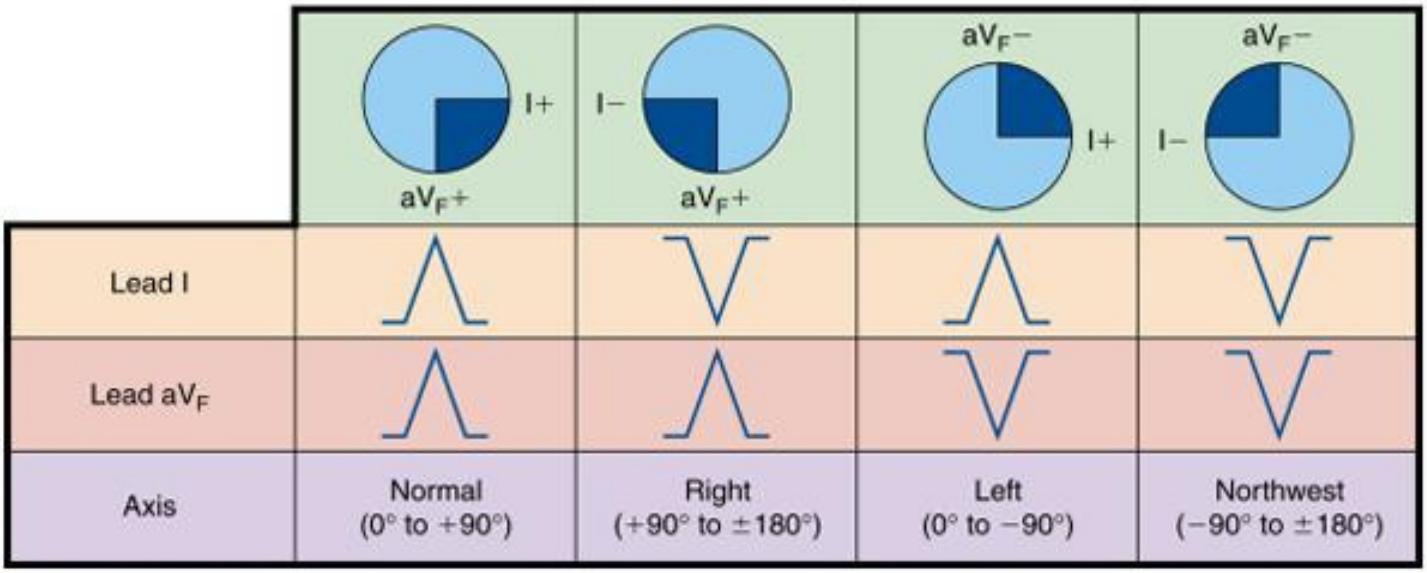
Why do we need the QRS axis ?

Actually, the QRS axis alone doesn`t help to establish any diagnosis, but it supports some other diagnostic criteria.

How to assess the QRS axis ?

Simply, Toassess the QRS axis youhave tolookatlead I andleadAVF :

- Normal axis If both are upright (positive).
- Left axis deviation If lead I is upright and lead AVF is inverted.
- Right axis deviation If lead I is inverted and lead AVF id upright.
- No man's land (unknown) If both are inverted.



6- P wave

- The P wave is the first positive deflection on the ECG.
- It represents atrial depolarization.
- The best leads to look at P wave are leads II, V1.
- Normal duration and amplitude is 2.5 x 2.5 small squares.

P waveinterpretation :

Absent P wave + irregular rhythm Atrial fibrillation.

Long duration with M-shape (M-Mitrale) Left atrium enlargement.

Tall P wave (P-Pulmonale) Right atrium enlargement.

At least 3 morphologically distinct P waves, irregular P-P intervals, and an isoelectric baseline between the P waves Multifocal Atrial Tachycardia (MAT) and it is commonly associated with chronic lung disease e.g. COPD.

P wave in unrelated to QRS complex AV dissociation (complete heart block)

Saw teeth appearance Atrial flutter.

Atrial flutter

7- PR interval

- The PR interval is the time from the onset of the P wave to the start of the QRS complex.

- PR interval normal duration : (0.12 - 0.21) seconds or 3-5 small squares.

If PR interval < 0.12 seconds pre-excitation e.g. WPW

If PR interval > 0.21 seconds heart blocke.g. 1st degree AV block.

8- QRS complex

- Normal duration of QRS complex is (0.06 sec. to 0.1 sec.)

Shape of QRS : Is it normal shaped or bizarre ?

Amplitude of QRS : HIGH in left ventricle hypertrophy.

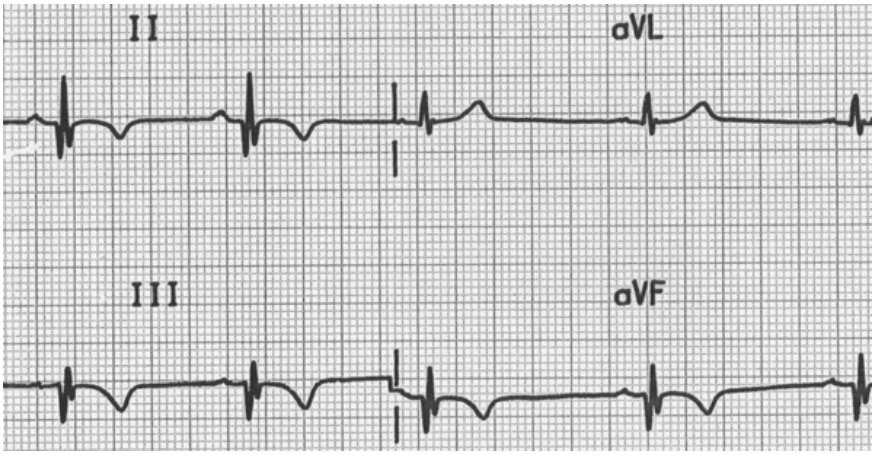
Q wave :

Is it there ? It is negative initial part of QRS.

Which leads ?

Is it significant ? There are 2 ways to determine significance of Q wave :

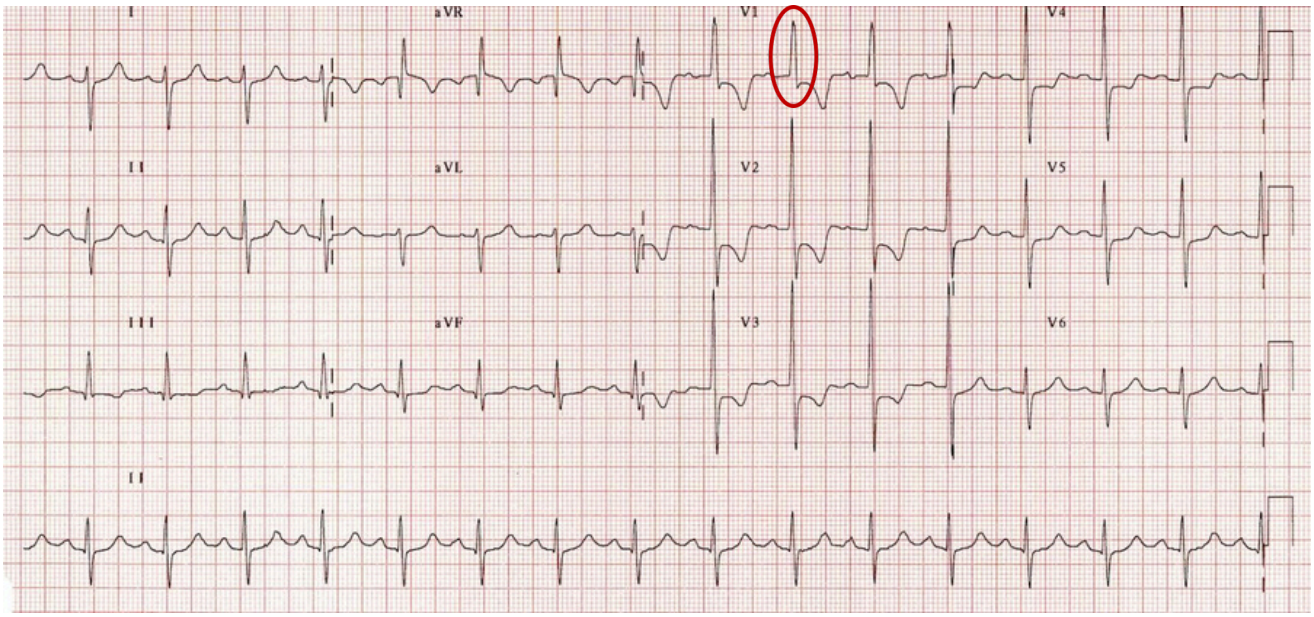
- Duration of Q wave is 1 mm or more.
- Amplitude of Q wave is more than 1/4 of R wave amplitude.



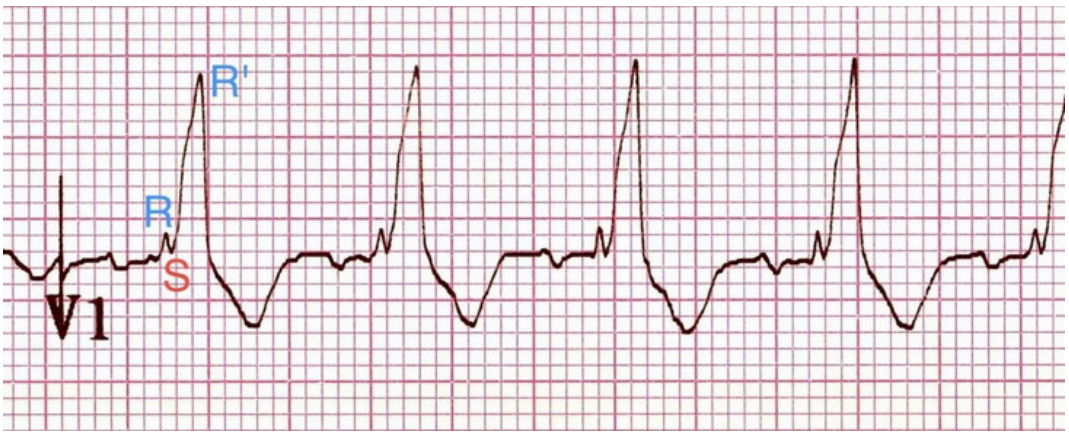
Significant Q wave Previous MI which occurs more than 6 hours ago or earlier.

Rwave in lead V1 : should be negative. However, If it is prominently positive, it may be cause by oneofthe following entities :

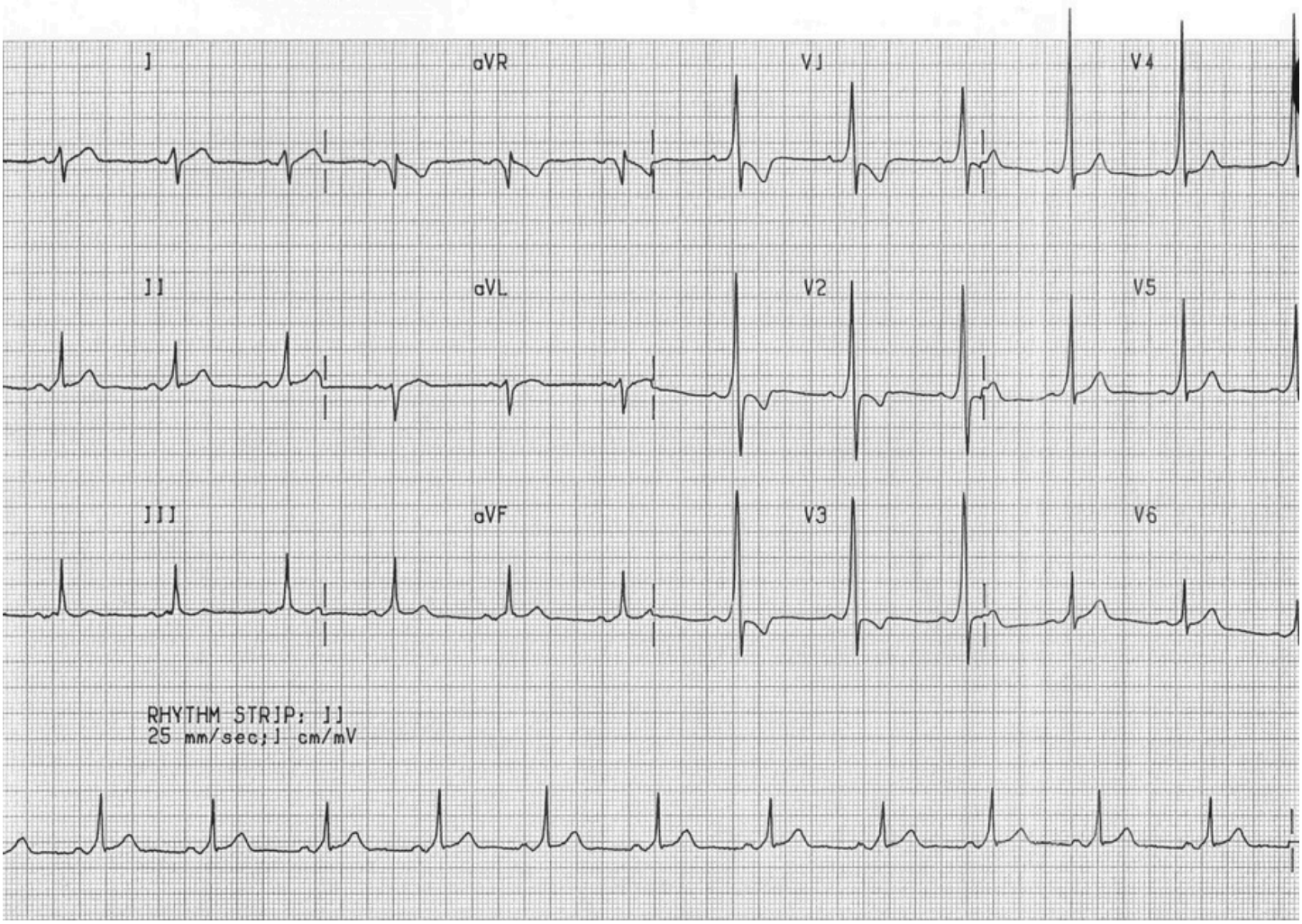
a) Right ventricle enlargement associated with right axis deviation and P-Pulmonale.



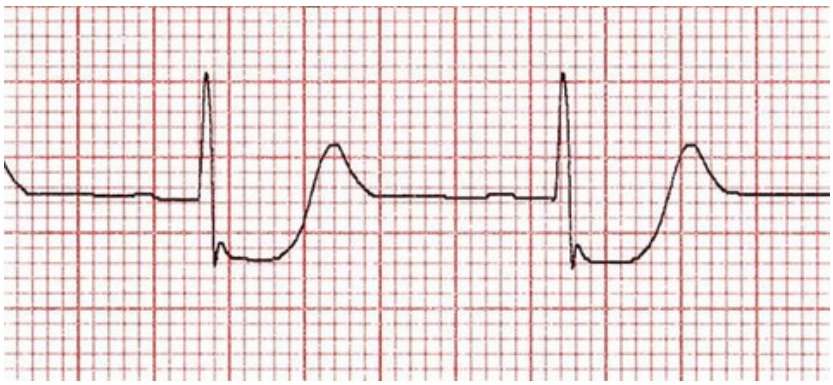
b) Right Bundle Branch Block (RBBB) associated with RSR' pattern.



c) Wolff-Parkinson-White Syndrome (WPW) – type A associated with very short PR interval + delta wave.



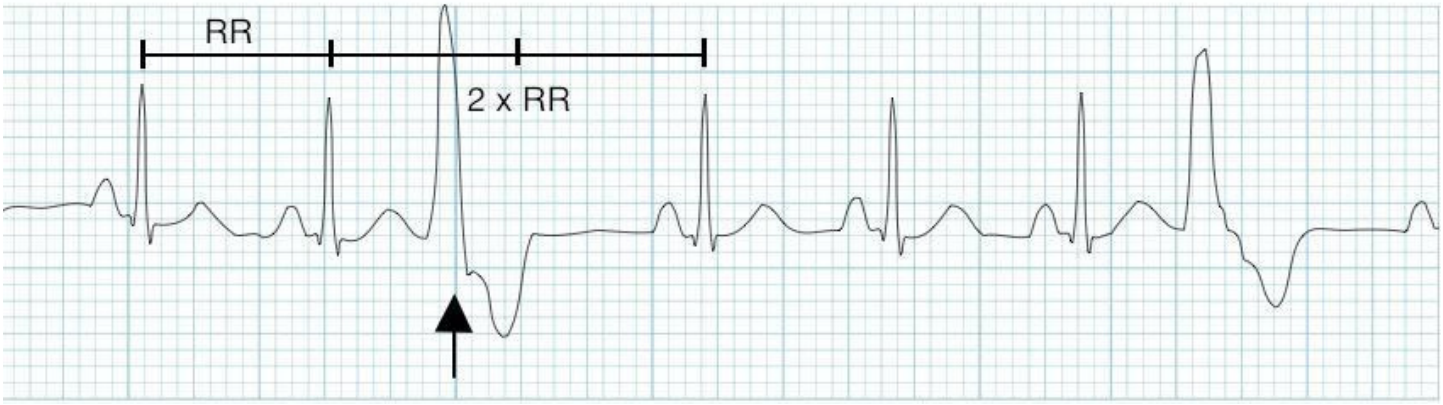
d) Posterior wall myocardial infarction (MI) associated with ST depression.



Some examples of QRS abnormalities :

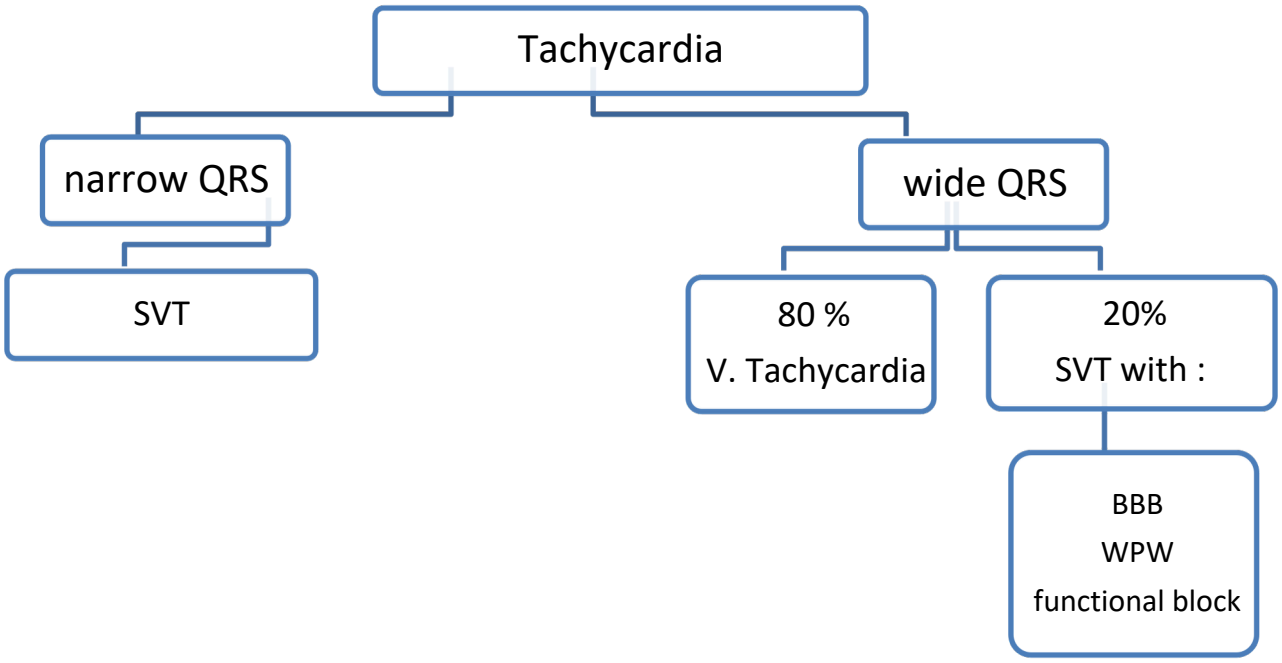
Premature VentricularComplex (PVC)characterizedby:

- Bizarre, wide QRS.
- Usually followed by a full compensatory pause.
- often occur in repeating patterns:
  - Ventricular Bigeminy — every other beat is a PVC.
  - Ventricular Trigeminy — every third beat is a PVC.
  - Ventricular Quadrigeminy — every fourth beat is a PVC.



AVnodalre-entrytachycardia(AVNRT)characterized by :

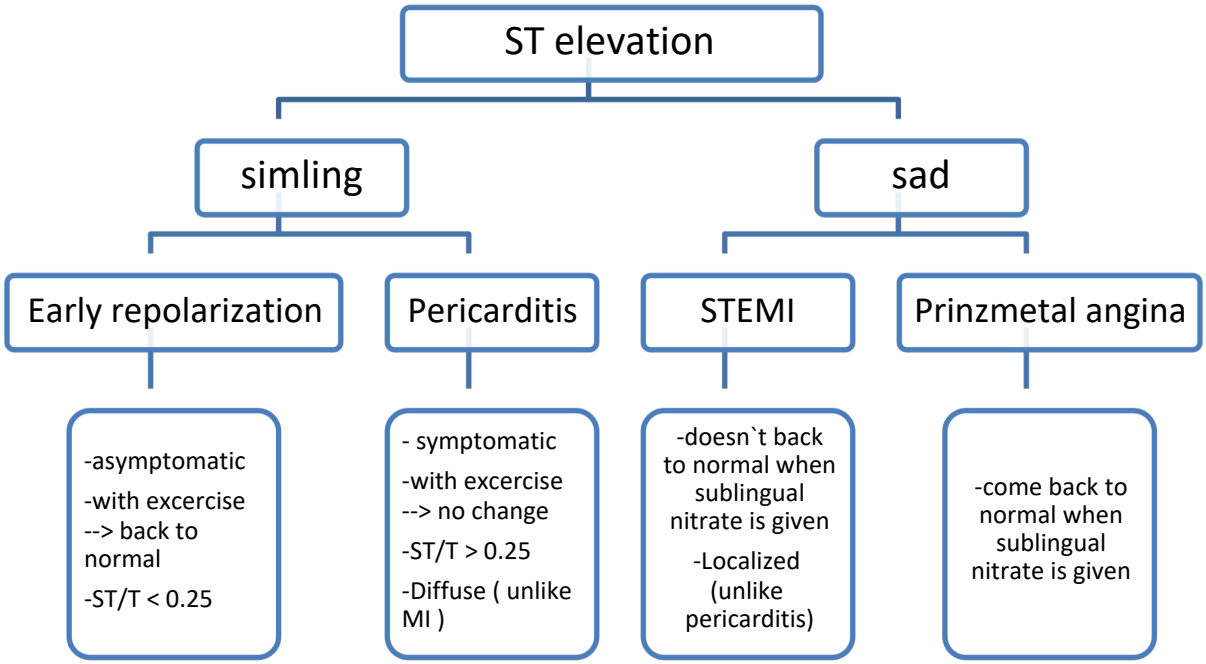
- Regular tachycardia (140-280) bpm
- QRS complexes usually narrow (< 120 ms).

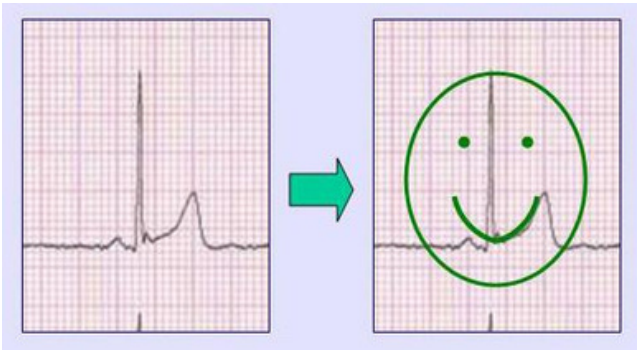


9- ST segment

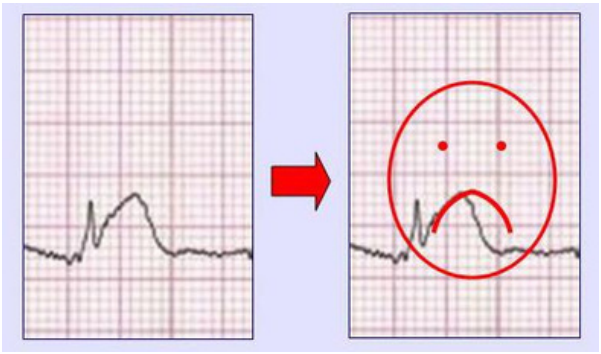
-It represents the interval between ventricular depolarization and repolarization.

The most important cause of ST segment abnormality (elevation or depression) is myocardial ischemia or infarction.





Smiling ST segment



Sad ST segment

Heart representation on the ECG leads :

Inferior wall		II, III, AVF
Lateral (high lateral)		I , AVL
Base		AVR
Anterior	anteroseptal	V1 , V2
	Anteroinferior	V3 , V4
	anterolateral	V5 , V6

- If there is inferior wall MI PLEASE exclude Right ventricle infarction.

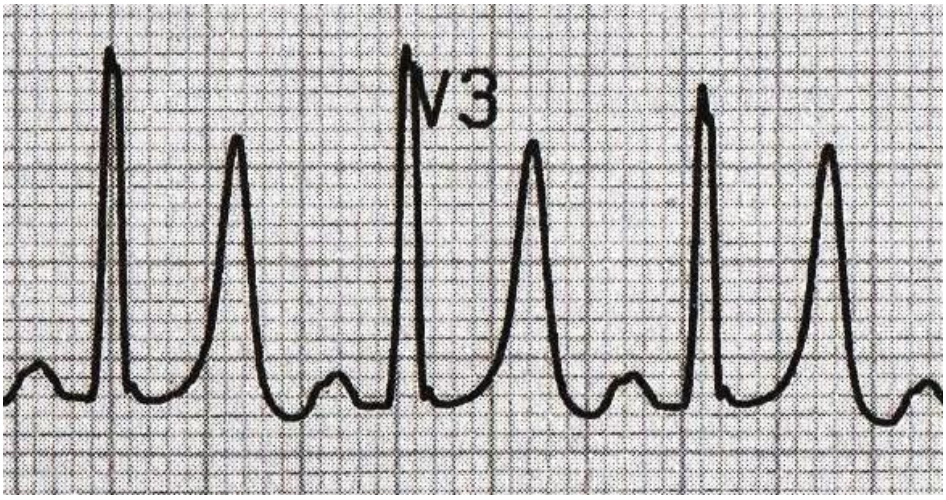
- Right ventricle infarction :
  - Clinically raised JVP + clear lung.
  - To confirm Right ventricle leads , you will find ST elevation in VR4.
  - Treatment FLUIDS , Don`t give ACEI, B-Blockers, Nitrate !

10- T wave

- It represents ventricular repolarization.

Causesof tall(peaked)Twave :

- Early STEMI (wide base).
- Hyperkalemia (narrow base).



CausesofflattenedTwave:

- Hypokalemia (associated with U wave which comes after T wave)
- Part of another criteria.

11- QT interval

- Commonly missed part of ECG.

- It represents the time taken for ventricular depolarization and repolarization.

How to measure QT ?

- Should be measured in either lead II or V5-6 .
- Measure several beats, then take the largest number.
- QT interval is affected by Gender and Heart rate.

o Corrected QT interval $QTc = \frac{QT}{\sqrt{RR}}$ (RR in seconds 60/heartrate)

o QTc is prolonged if (> 440ms in men or > 460ms in women)

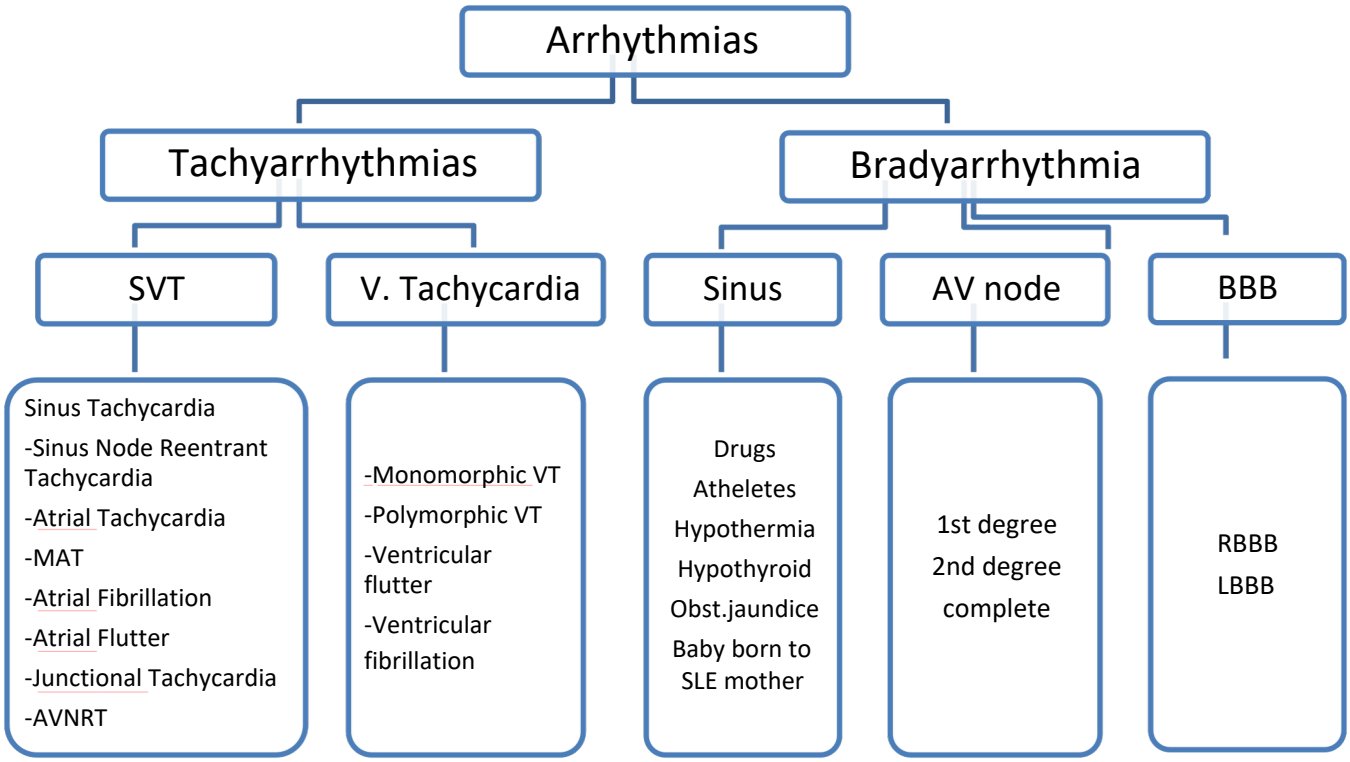
-If QTc > 500, it is associated with increased risk of torsades de pointes.

Causes of Prolonged QT interval:

- Hypocalcemia, Hypokalemia, Hypomagnesemia.
- Hypothermia.
- Drugs (e.g azithromycin)
- Ischemia.
- Brain insult (raised intracranial pressure)
- Congenital (Long QT syndrome).

Causes of Short QT interval :

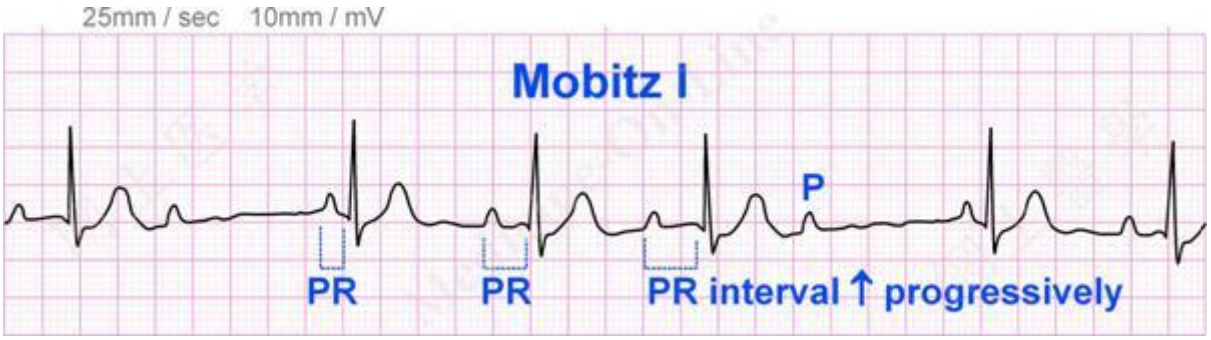
- Hypercalcemia.
- Congenital short QT syndrome.



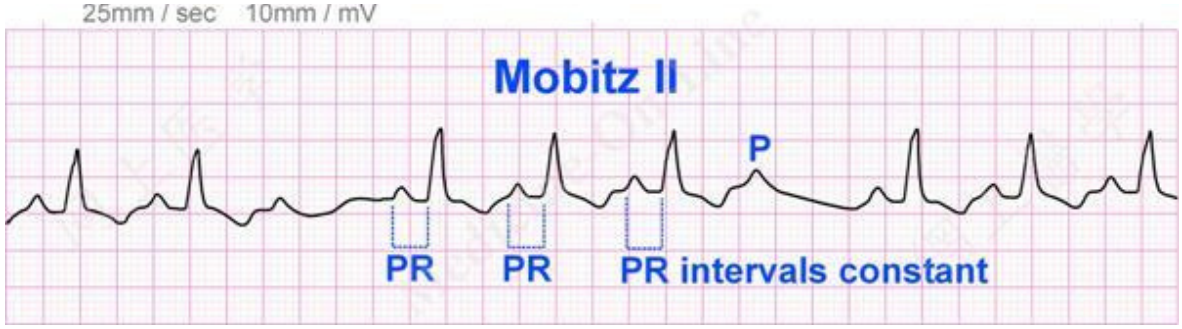
AV BLOCKS

- 1st degree AV block :
  - Fixed prolongation of PR.
  - Caused by : B-blockers, Calcium channel blocker, digoxin

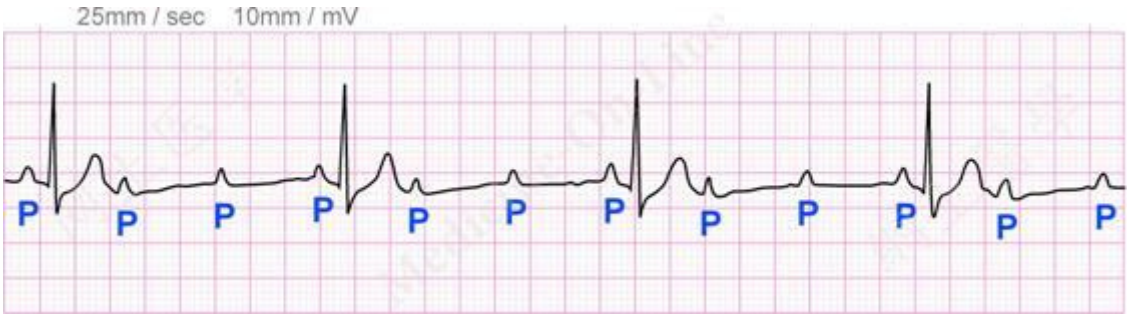
- 2nd degree AV block : (2 types):
  - Type-1 (mobitz I, Wenckebach) progressive prolongation of PR then followed by unconducted beat (P wave without QRS).



  - Type-2 (mobitz II) fixed PR, with:
    - conduct 1 QRS and block 1 or conduct 2 QRS and block 1 or conduct 3 QRS and block 1



- 3rd degree (complete) AV block
- AV dissociation
  - Clinically
  - Bradychardia + cannon a wave + variable intensity of S1



THE END

For any inquires or comments please don`t hesitate to e-mail me

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