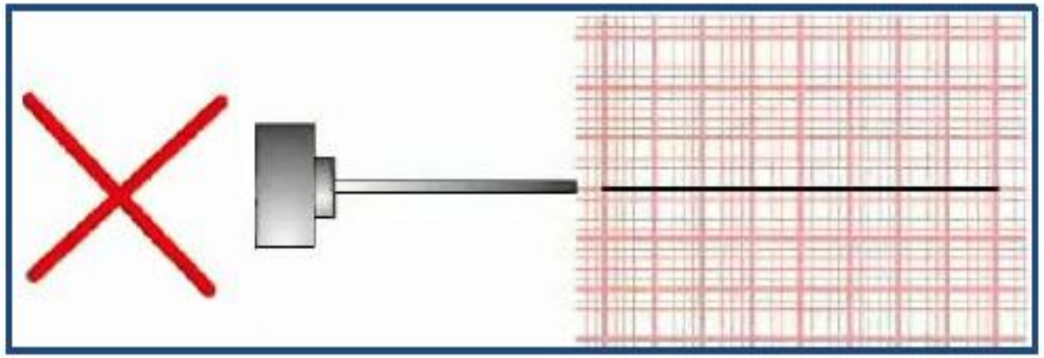
Sixth Year Clinical Teaching

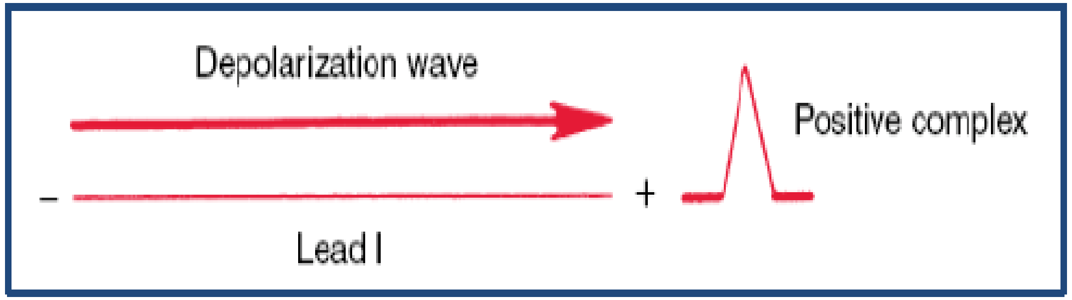
Dr. Mohammed Ismael Dawood
Assistant Professor of Medicine
University of Fallujah

Normal ECG

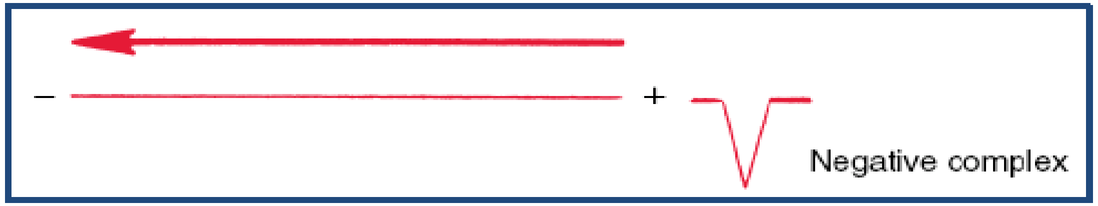
- In any ECG lead, a flat line is recorded when no current is flowing >> iso-electric line.



- The depolarizing current moving towards the lead produces a deflection on the ECG paper above the iso-electric line (a positive deflection).

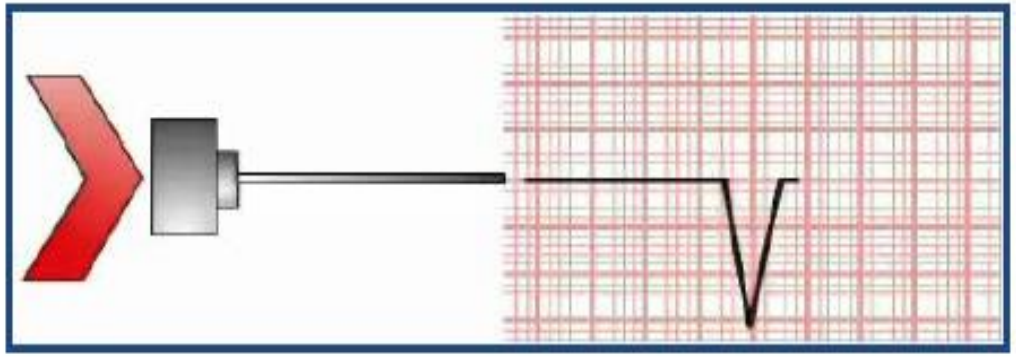


- The depolarizing current moving away from the lead produces a deflection but below the iso-electric line (a negative deflection)

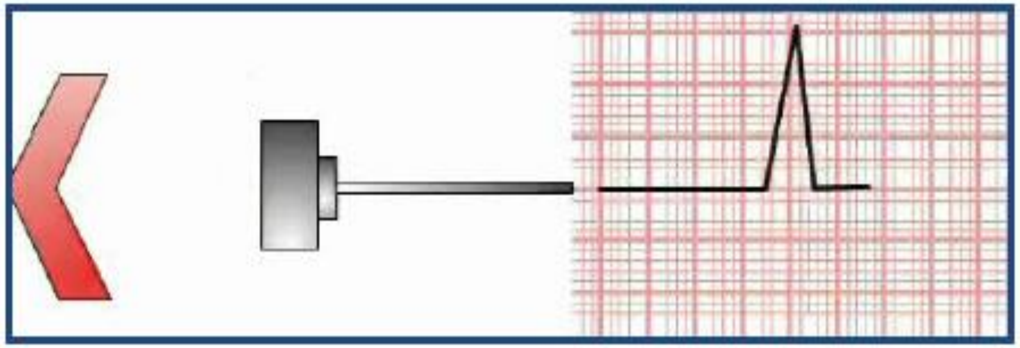


In contrast, repolarizing current has the opposite polarity to depolarizing current, Therefore :

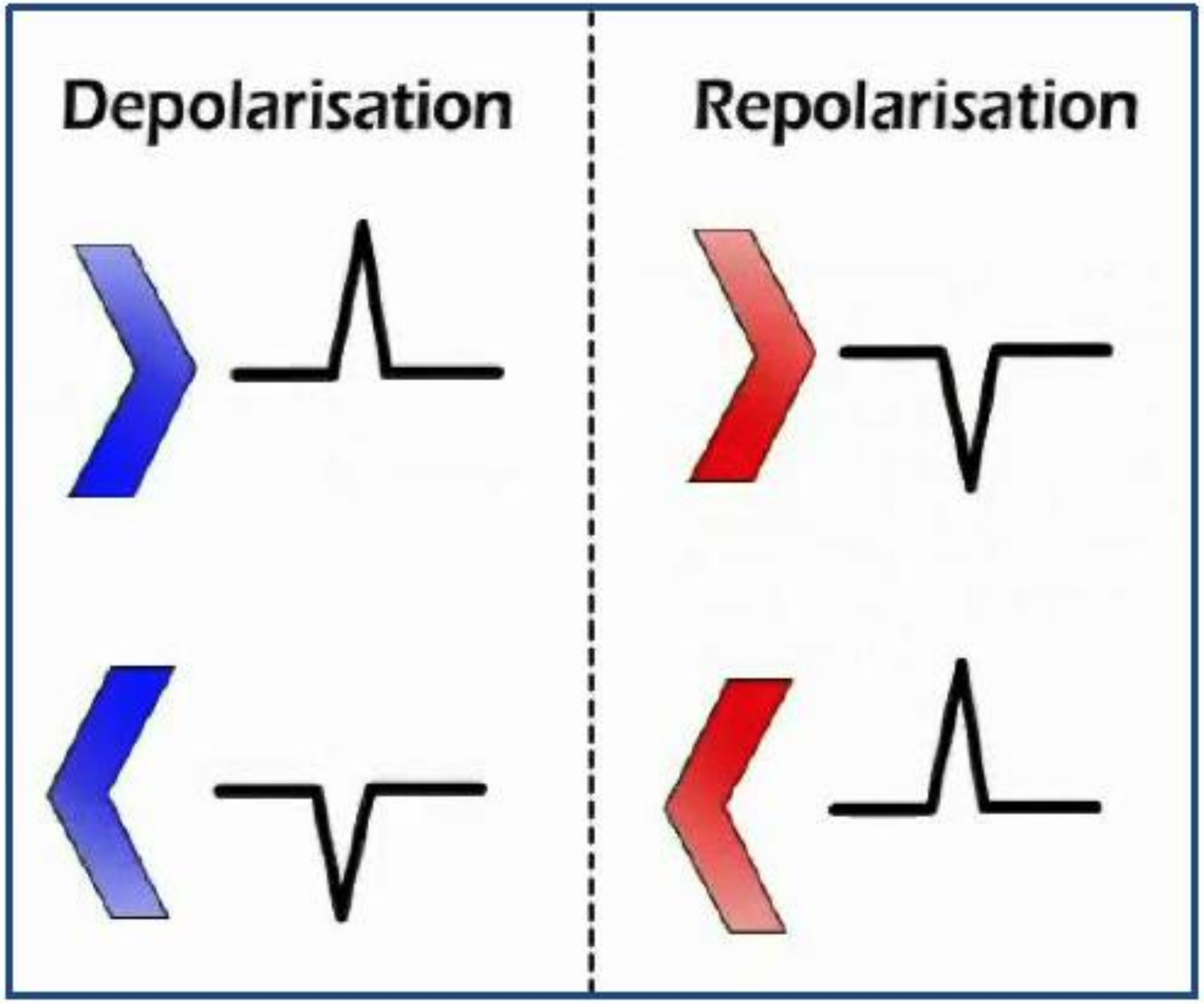
- Repolarizing current moving toward the lead produces a negative deflection on the paper.



- While, repolarizing current moving away from the lead produces a positive defelection.

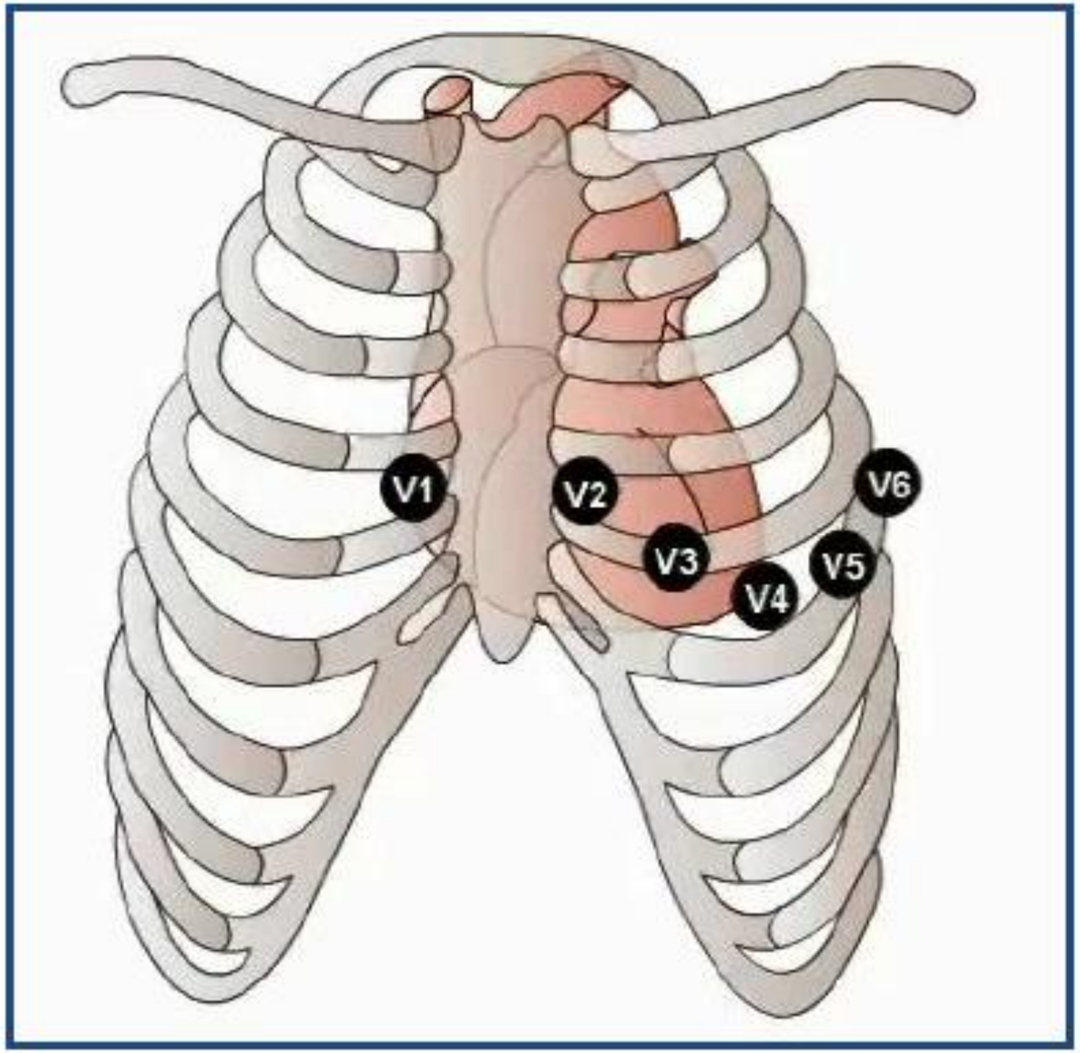


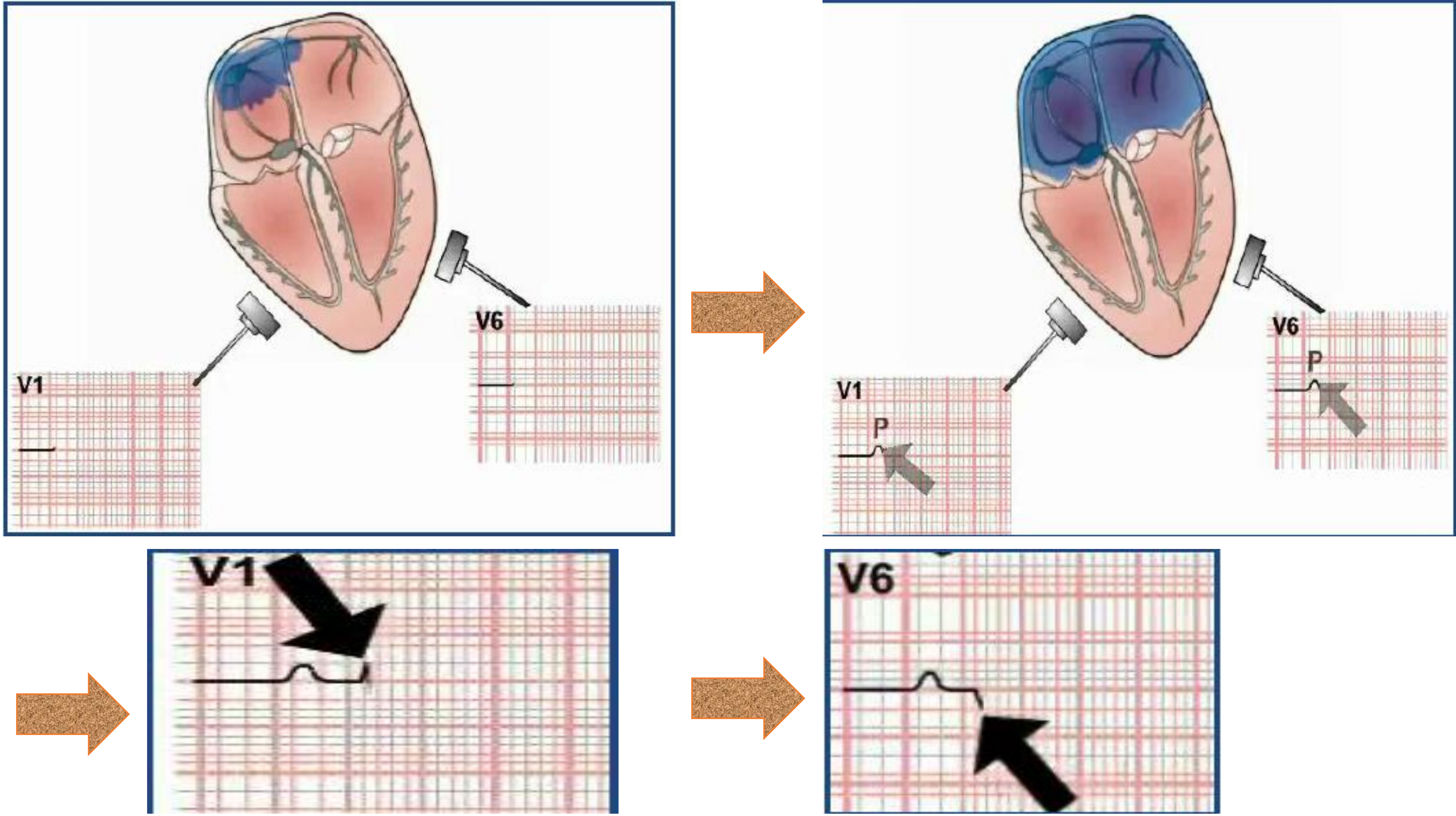
As the depolarization and repolarization waves spread over the normal heart in a well defined pattern. This means that, if we know the position of the ECG lead relatively to the heart, we can predict the form of the readers if recorded.



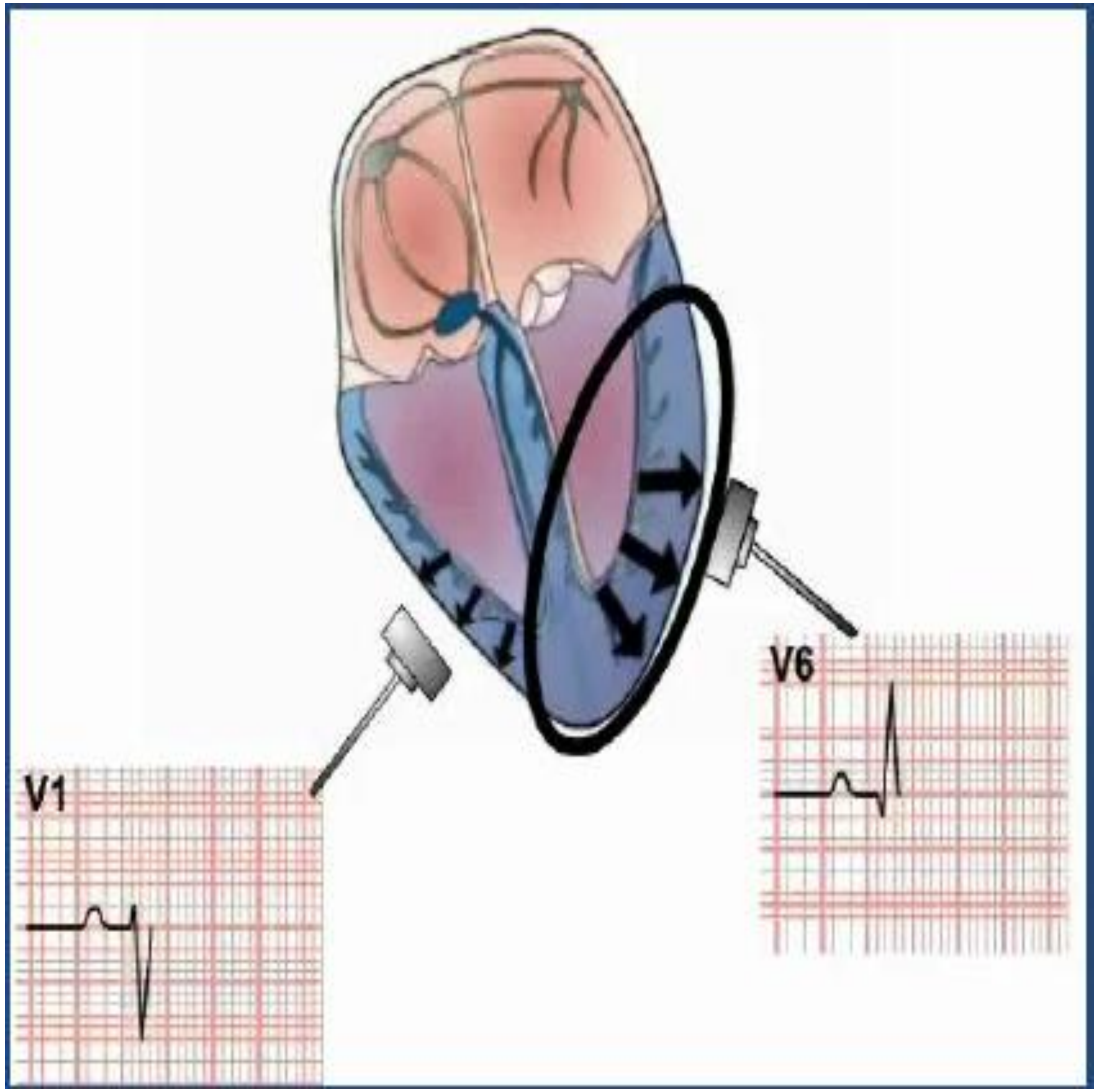
Lead V_1 is placed on the anterior surface of the patient's chest in the 4^{th} right intercostals space to the right of the sternum, and therefore to the right of the bulk of the ventricles.

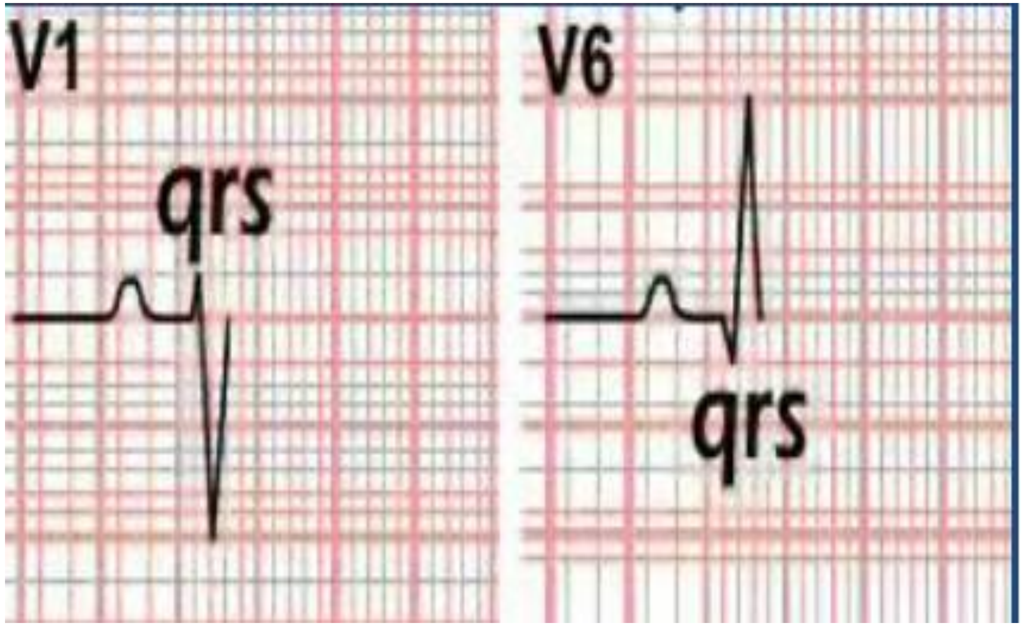
- In contrast, lead V_6 is placed on the patient's chest in the 5^{th} intercostals space mid-axillary line, and looks at the heart from the left of the ventricles.

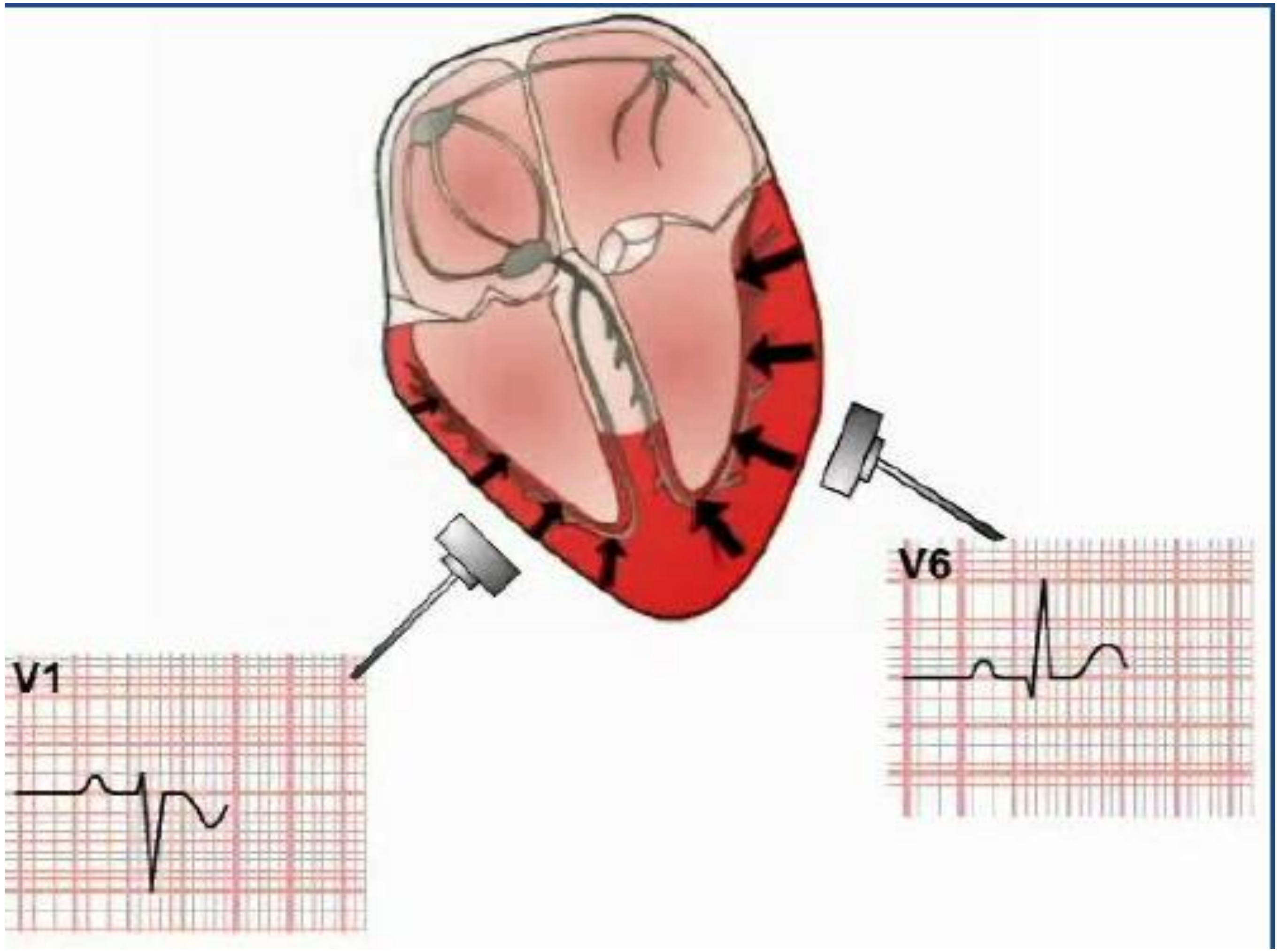




V1
V6
V1
P
V6
P
V1
V6


V6
V1


V1
qrs
V6
qrs



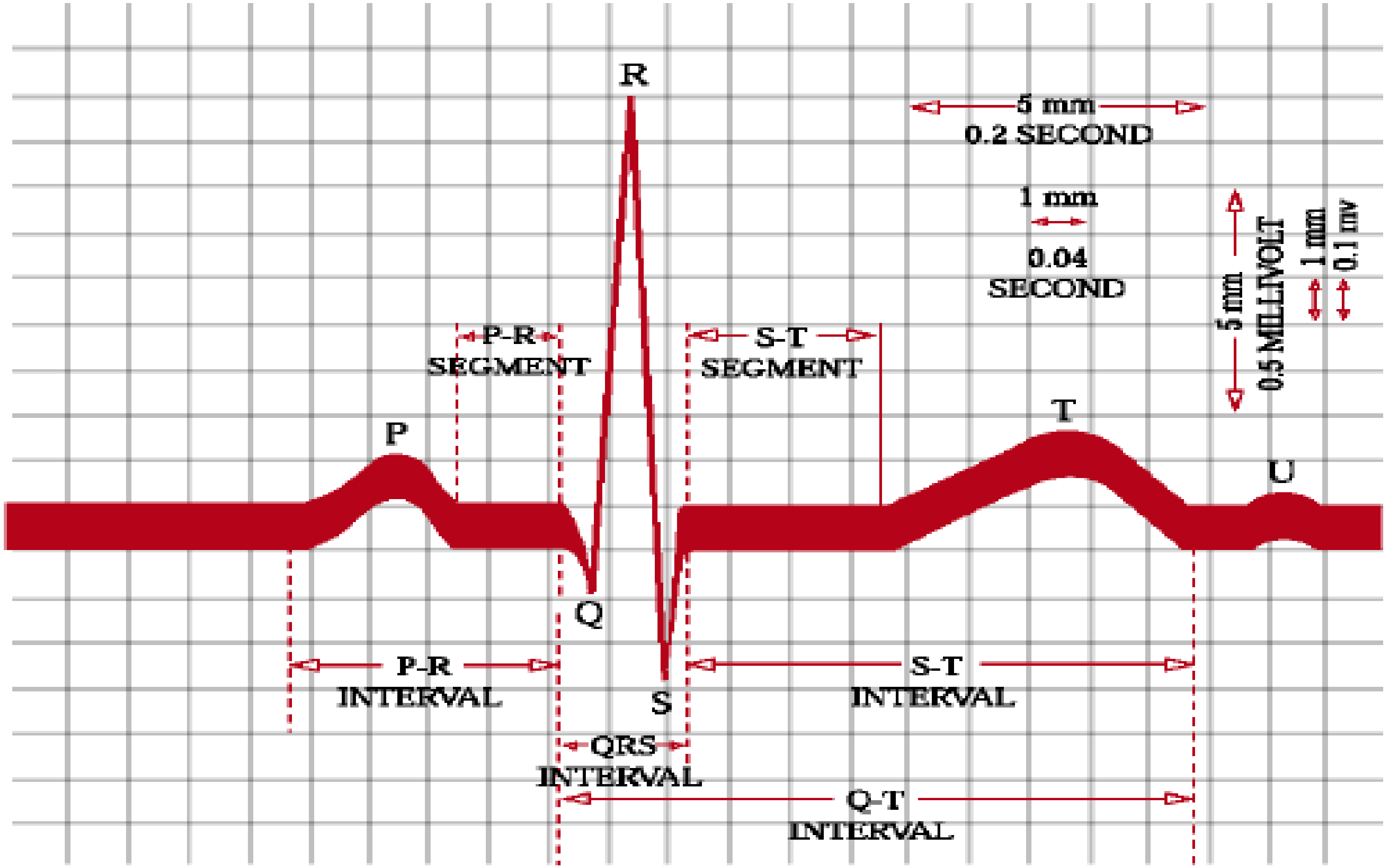
Remember repolarizing current has the opposite polarity to the depolarization wave, and therefore, when it is moving towards the lead it produces a negative deflection on ECG paper and positive deflection when moving away from a lead.

the deflection produced on an ECG by ventricular repolarization is dominated by the signals from the left ventricles

as this repolarizing current is moving towards V_1 >> the deflection produced >> is negative in this lead.

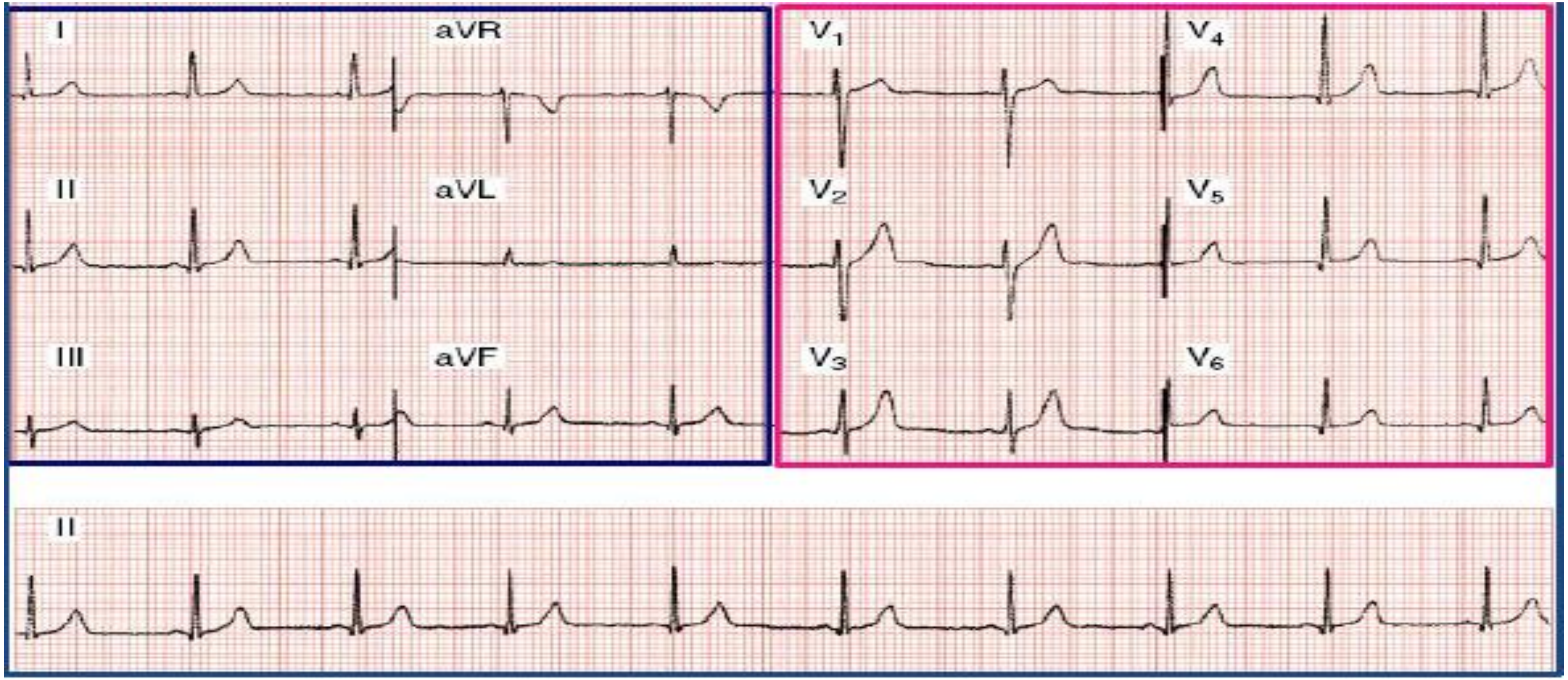
In contrast, this repolarizing signals is moving away from V_6 , producing a positive deflection

The deflection produced by a ventricular repolarization is termed a T wave



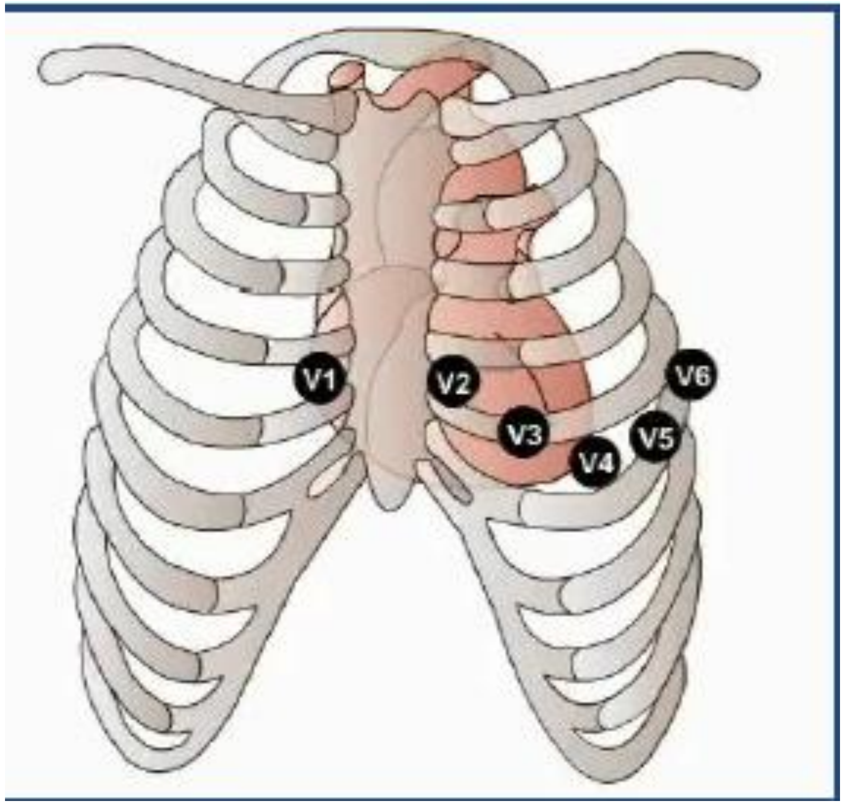
Recording Conventions, Waveform Nomenclature, and Normal Values for the Electrocardiogram.

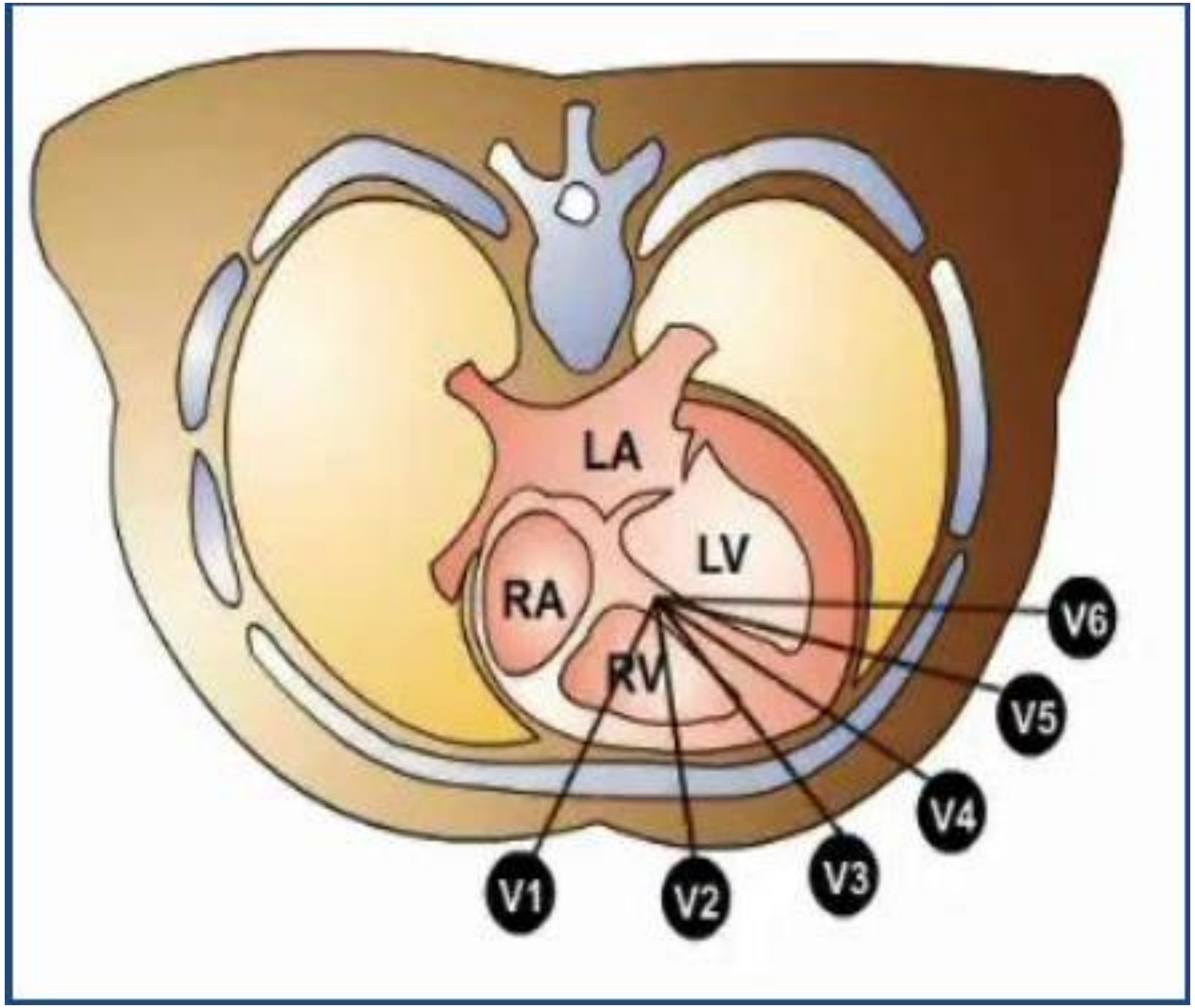
ECG Lead Perspectives



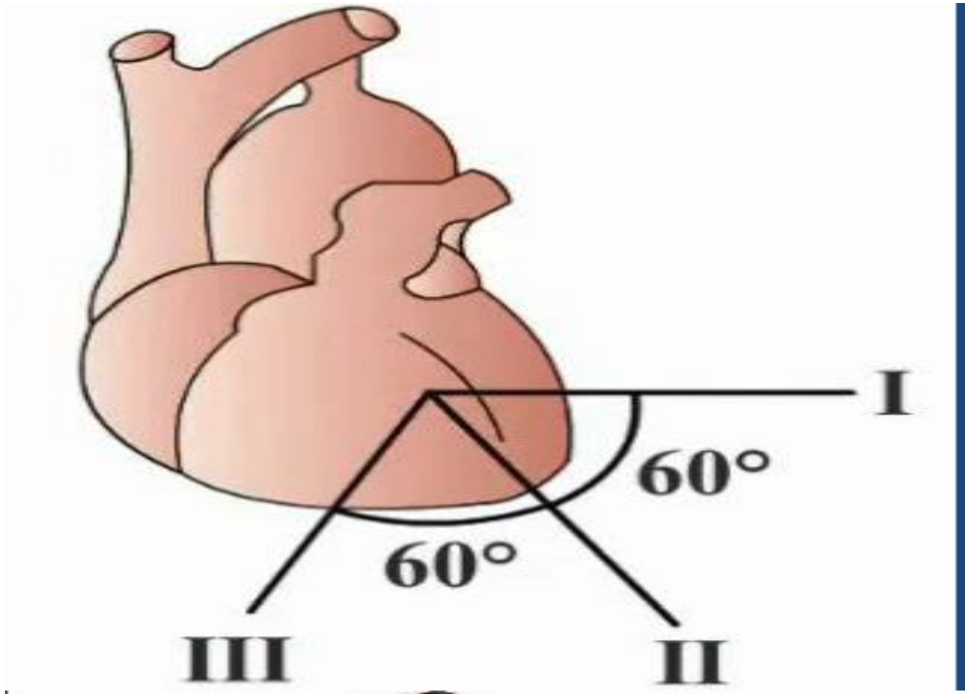
- V_1 in the 4th right intercostals space to the right of the sternum .
- V_2 in the 4th left intercostals space to the left of the sternum.
- V_3 between V_2 and V_4.

- V_4 in the 5th left intercostals space in the mid clavicular line.
- V_5 at the same horizontal level of V_4 but at anterior axillary line in the left.
- V_6 at the same horizontal lelvel of V_4 but at mid axillary line in the left.

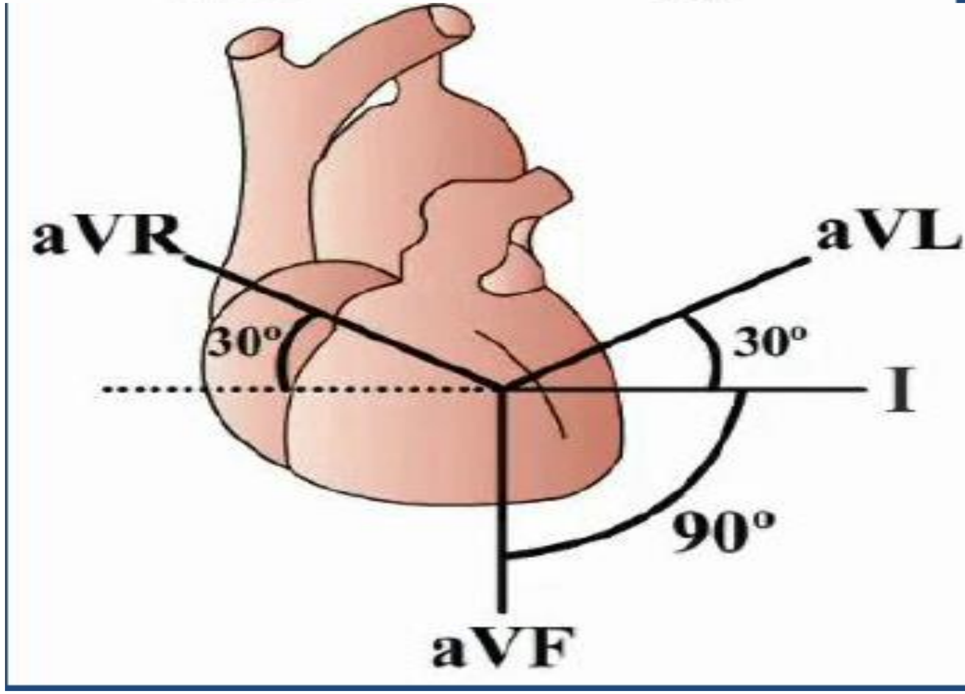



LA
LV
RA
RV
V1
V2
V3
V4
V5
V6

- ✓ Lead one: looks directly at the heart from the patient left hand side and define zero degrees in all for the discussion of the frontal leads.
- ✓ Lead two: looks the heart at an angle 60^{o} clock wise.
- ✓ Lead three: is positioned 60^{o} clock wise from lead two.



- ✓ aVL: looks at the heart from the left 30^{o} anti-clock wise from lead one.
- ✓ aVR: looks at the right side of the heart and just like aVL 30^{o} above the horizontal, relative to lead one.
- aVF: looks straight at the inferior surface of the heart and therefore at 90^{o} clock wise from lead one.

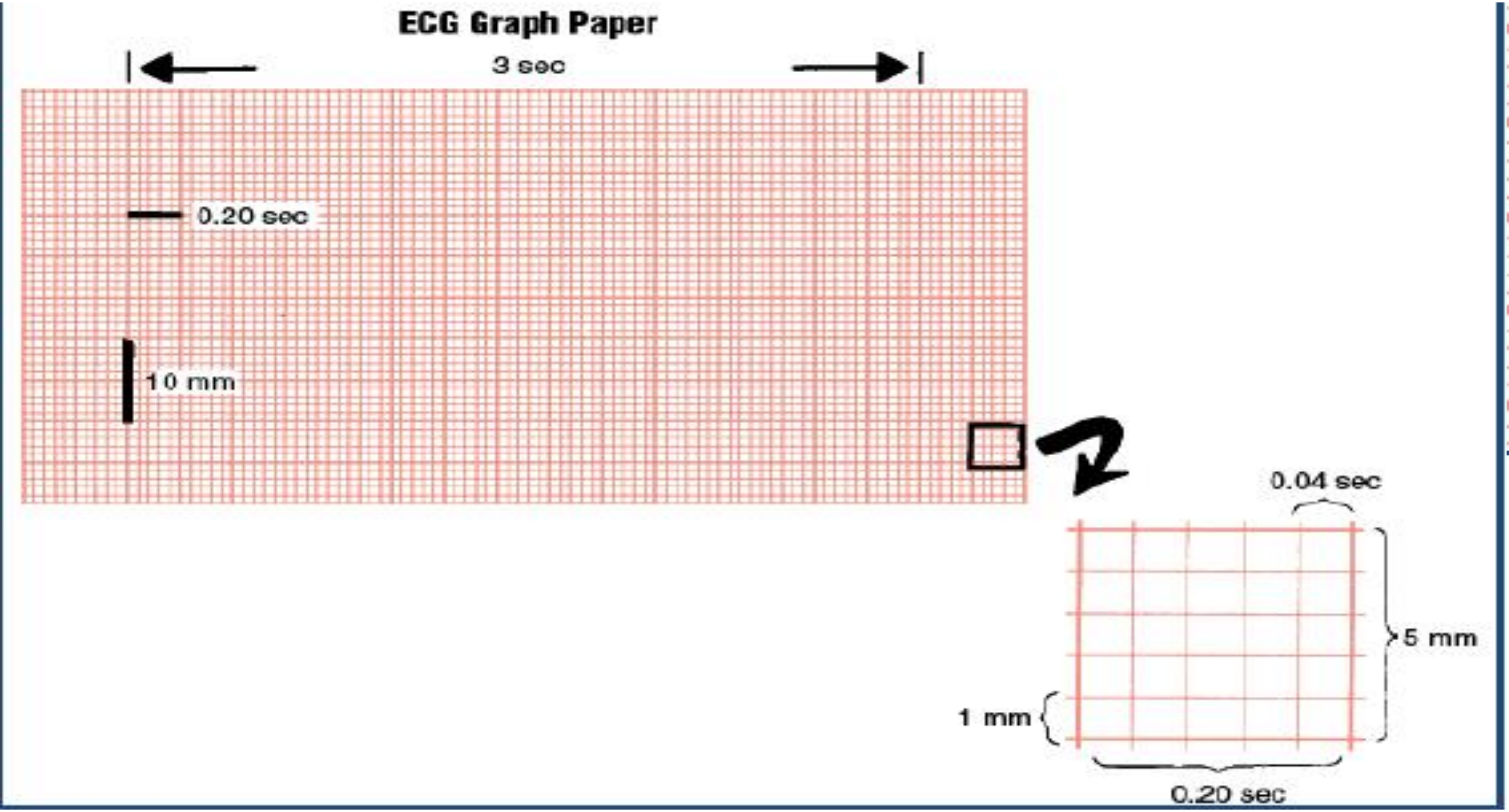


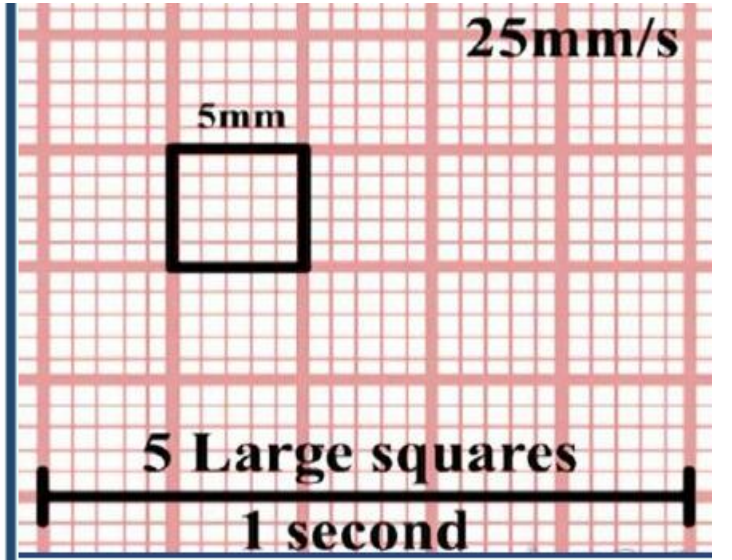
The relation between the ECG leads and the walls of the heart

Leads	Wall
II - III - aVF	Inferior
I - aVL	High lateral wall
V_1 - V_2	Septal (antro-septal)
V_3 - V_4	Strict anterior
V_5 - V_6	Low lateral
V_1 - V_3R V_6R	RV free wall
Louis Leads	Atrial Activity

N.B. posterior wall potentials are recorded in the anterior leads as a mirror image for waves provided to be drawn in the posterior leads because posterior leads are technically difficult to be made.

Time and the ECG paper

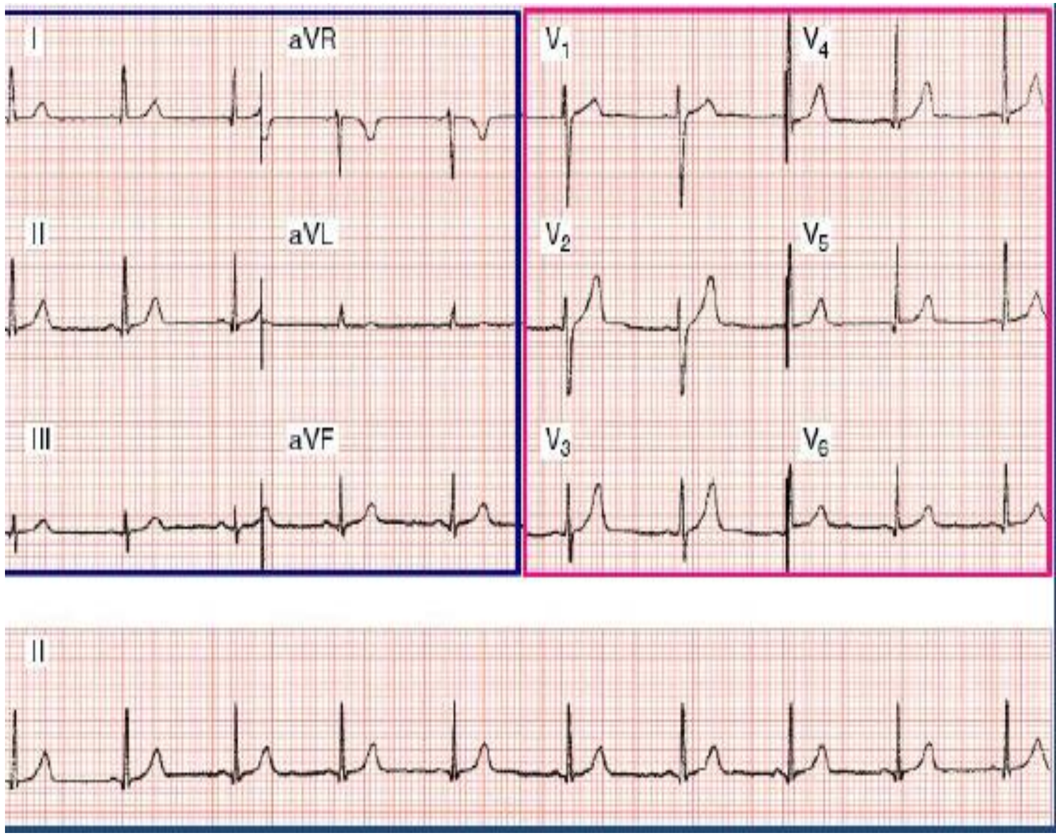




Comment on ECG

1. Rhythm
2. Rate
3. Axis
4. P wave
5. P-R interval
6. QRS complex
7. S-T segment
8. T wave
9. Q-T interval
10. U wave

1. Rhythm



What is meant by sinus ??

Every P wave is followed by QRS complex

What is meant by regular ??

Numbers of big squares between each RR interval are equal

What is meant by irregular ??

Numbers of big squares between each RR interval are not equal.

This irregular rhythm may be :

- ✓ Marked irregularity (e.g., atrial fibrillation)
- ✓ Occasional irregularity (e.g., extra systole)

2. Rate

How to calculate the heart rate ??

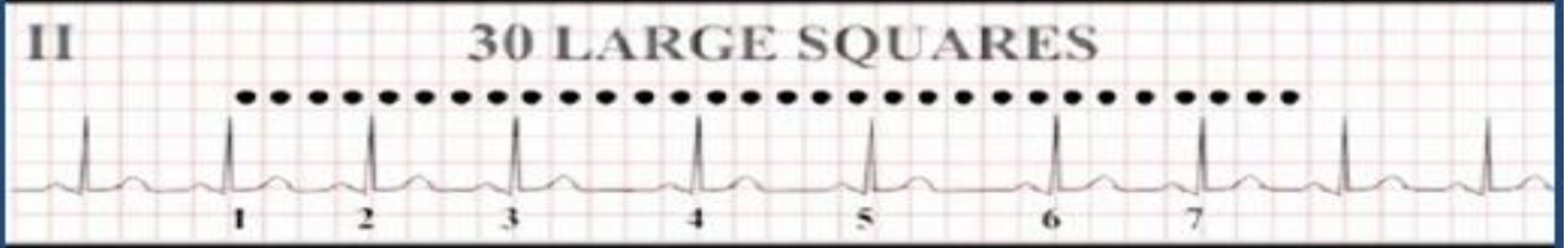
First look at the rhythm :

- *If regular rhythm* >> the heart rate equates 300 / n (which n the number of big squares between RR interval).
  Or 1500 /n (which n the number of small squares between RR interval), more accurate.

- *If irregular rhythm* >> count the number of R waves in 30 big squares and multiply the result by 10.
  Or, 300 / n (which n the average number of RR interval)

7 in 6 secs

7 x 10 = 70 bpm

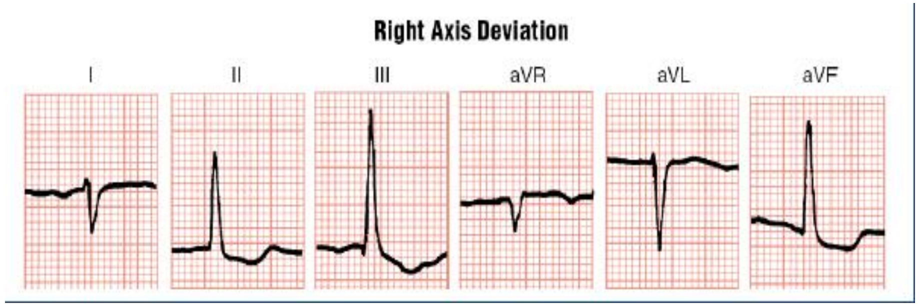


30 LS = 6 Seconds

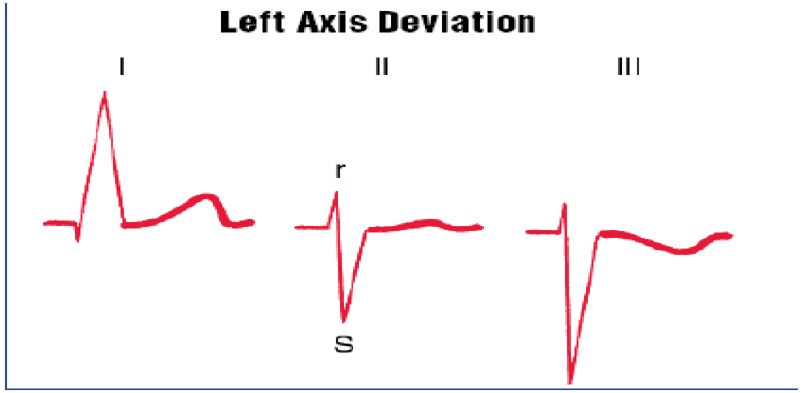
3. Axis

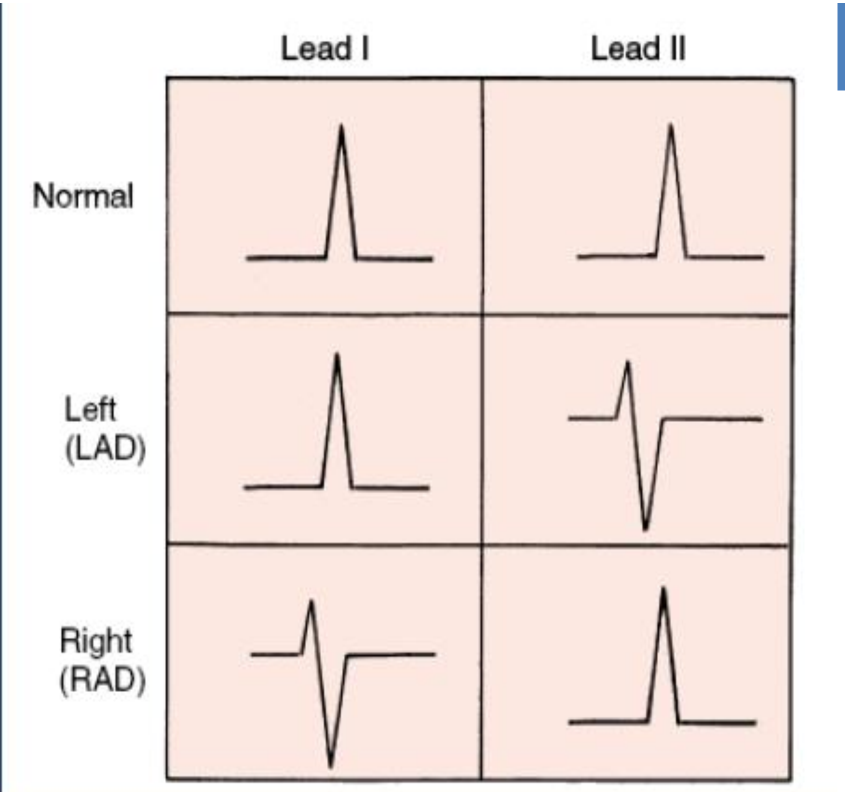
Look at QRS complex in lead one and aVF (or lead two).
Normally QRS complex is positive in lead one and aVF .

If you found the QRS complex is negative in lead one and positive in aVF this means right axis deivation.



If you found the QRS complex is positive in lead one and negative in aVF (lead II) this means left axis deviation.

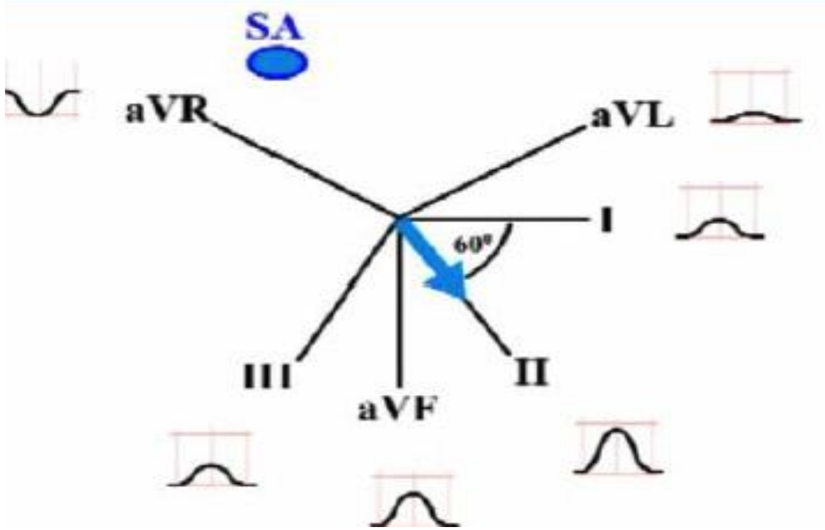




Causes of right axis deviation	Causes of left axis deviation
• Children	• Q waves of inferior MI
• Tall thin adults	• Artificial cardiac pacing
• Right ventricular hypertrophy	• Left ventricular hypertrophy
• Chronic lung disease	• Hyperkalemia
• Anterolateral myocardial infarction	• Ostium primum ASD
• Pulmonary embolus	• Injection of contrast into left coronary artery
• Atrial septal defect	*Note : pt. of left ventricular hypertrophy not usually has LAD*
• Ventricular septal defect	

4. P wave

Axis



- Width (duration) : = < 2.5 small square (< 0.12 sec.).
- Height (amplitude) : = < 2.5 small square (< 2.5 mm).

The P wave has two possibilities :

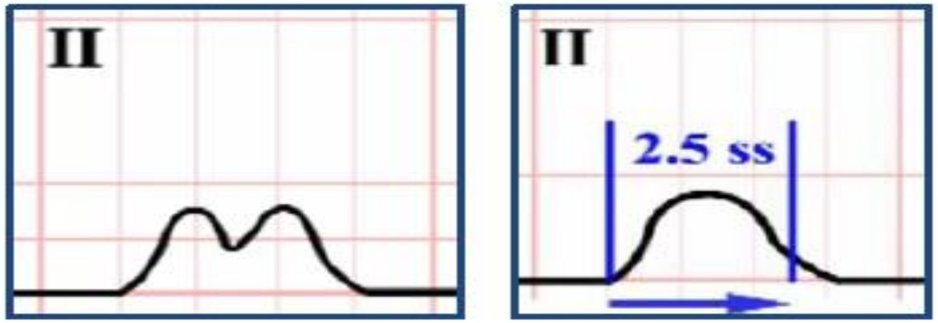
- Present
- Absent

If the P wave is present, it has two possibilities :

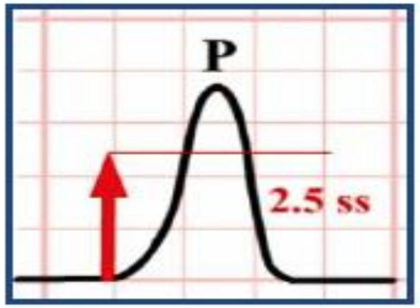
- Normal (less than 2.5 X 2.5 small squares)
- Abnormal

What is the possibilities of abnormal P wave ??

1. Broad P wave (M shaped- P mitrale)
   where the P wave becomes broad (> 2.5 small squares)
   denotes left atrial strain.



2. Peaked and high voltage P (P pulmonale)
   where the P wave becomes tall and peaked (> 2.5 small squares) denotes right atrial strain.



3. Pulmonale Mitral
   where the P wave is tall and broad (> 2.5 X 2.5 small squares)

4. Biphasic
   where part of the P wave is positive and the other is negative

The P wave in V_1 is biphasic (the first part represent the right atrium and second part represent the left atrium)

If the P wave is absent

Look at the rhythm ☺ :

- Irregular (A.F.)
- Regular

Absent P wave with regular rhythm look at QRS complex

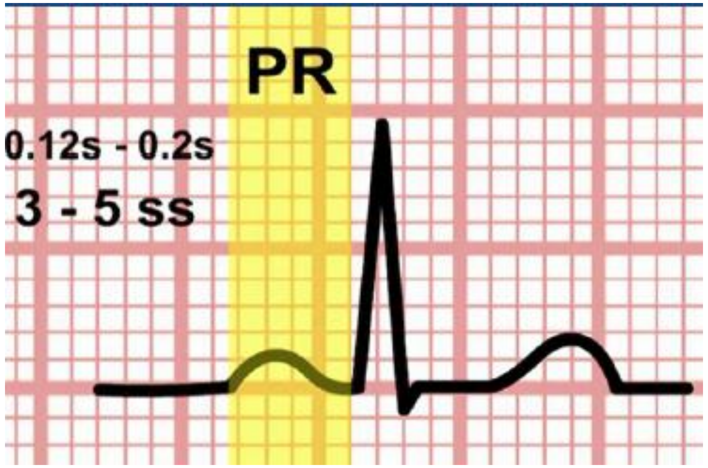
- ✓ Wide QRS complex (> 3 small squares) :
  - Ventricular tachycardia
  - Ventricular fibrillation
- ✓ Narrow QRS complex :
  - Supra ventricular tachycardia
  - Nodal rhythm

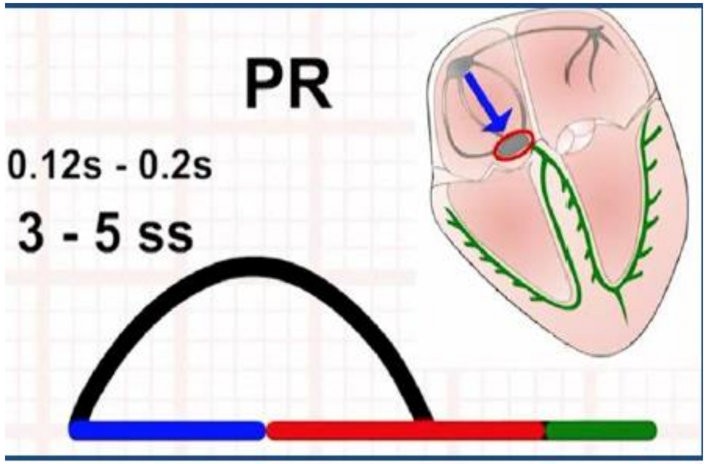
How to differentiate between them ??

By rate :

- Supra ventricular tachycardia >> tachycardia.
- Nodal rhythm >> slow

5. P-R interval



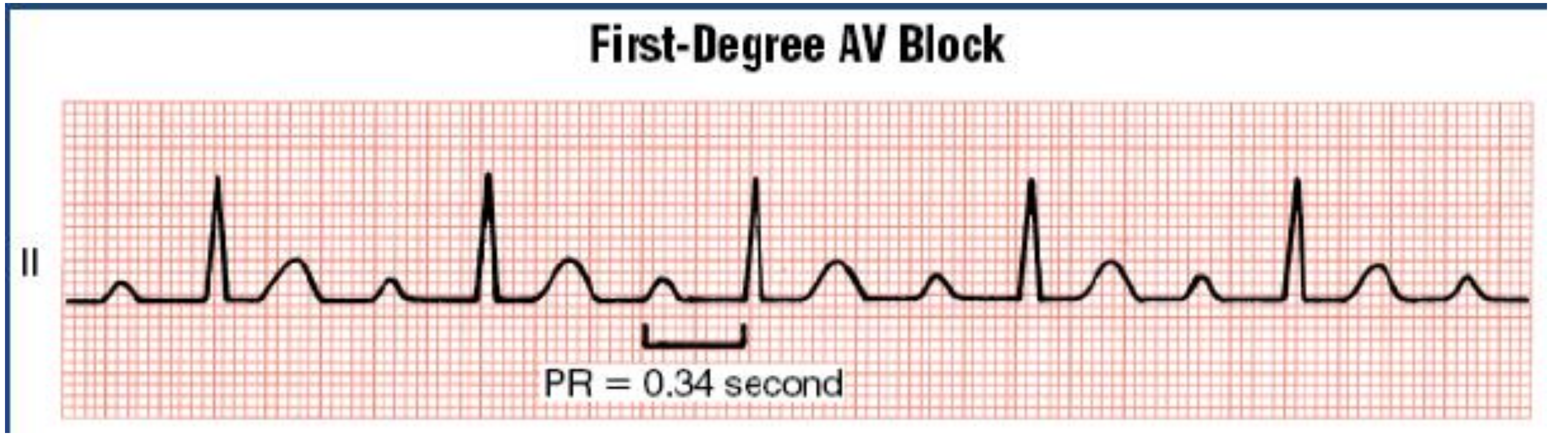


What is the possibilities of PR interval ??

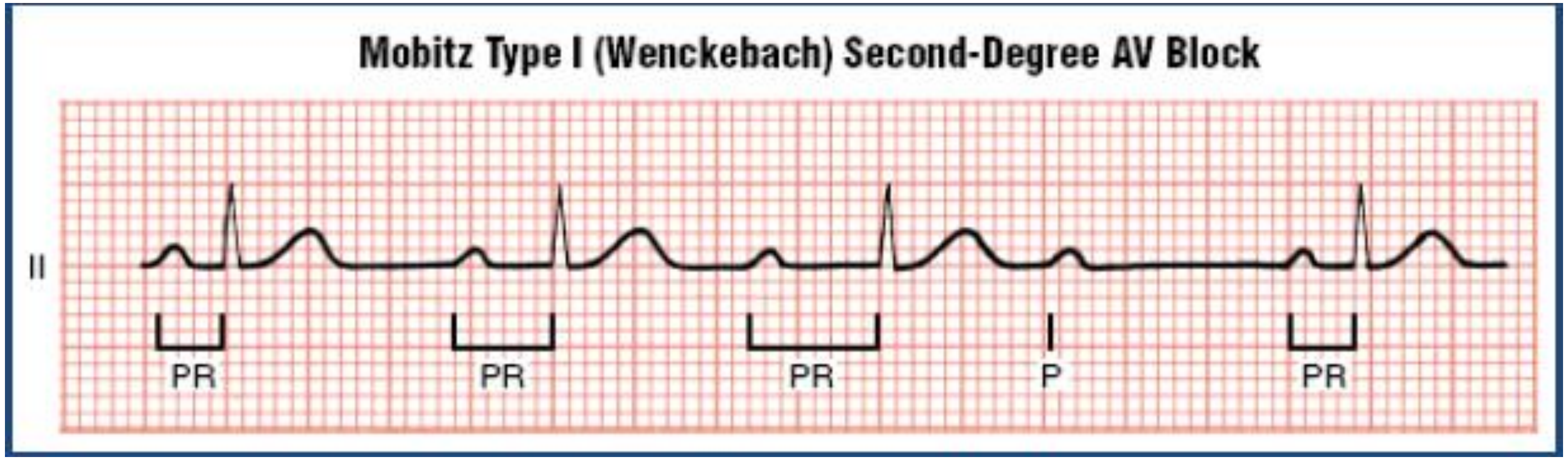
- Normal (between 3 and 5 small squares)
- Prolonged (> 5 small squares)
- Shortened (< 3 small squares)

Prolonged PR interval

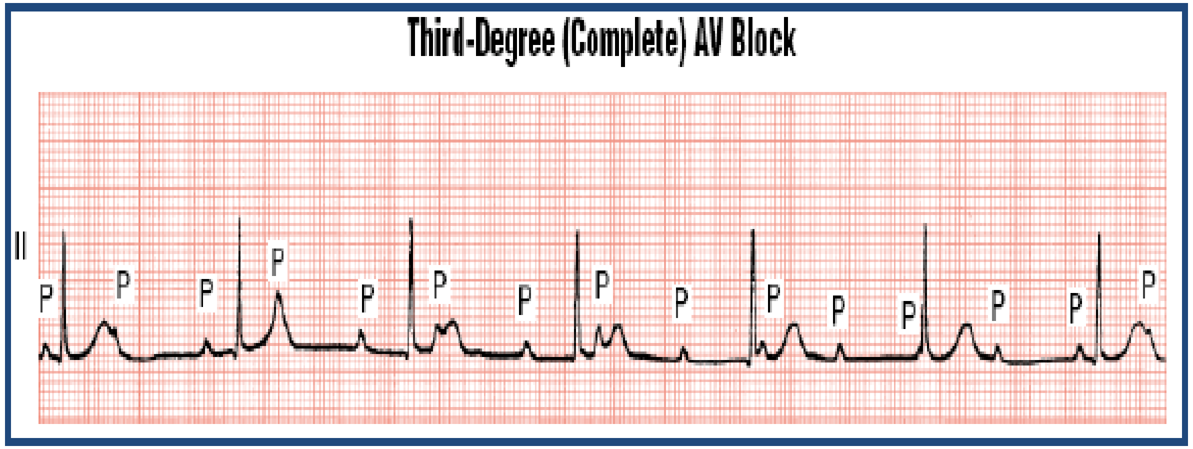
1. PR interval (long and fixed)
   just prolonged PR interval
   First degree heart block



2. PR interval (long with fixed change)
progressive prolongation of PR interval until dropped beat
Wenckebach phenomena
urgent case ☹



3. PR interval (not fixed)(variable)
   there is no relation between the atria and ventricle
   Atrio-ventricular dissociation
   Complete heart block

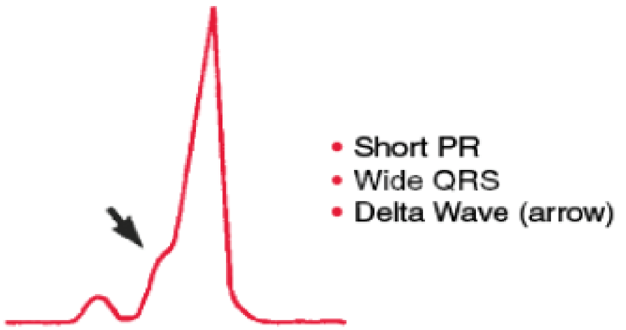


here,
if the P wave is present before the complex, it happens by chance.

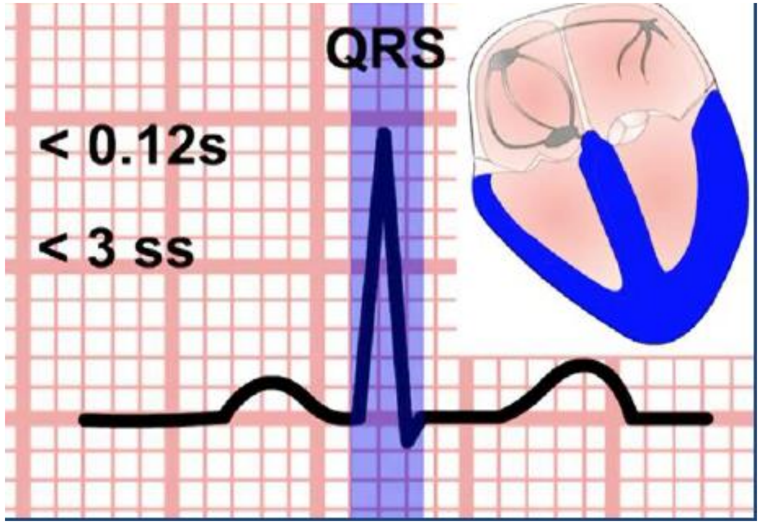
Shortened PR interval

Preexcitation of the ventricles with the classic WPW pattern produces the following characteristic triad of findings on the ECG :

1. Short P-R interval
2. Wide QRS complex
3. Delta wave



6. QRS complex



Better to be seen in :

- Right ventricle ($V_{1,2}$)
- Left ventricle ($V_{5,6}$)

- Q wave >> first negative wave in the complex
- R wave >> first positive wave in the complex
- S wave >> the negative wave following R

Q wave

is the first negative wave in the complex

- Width : less than one small square
- Height : less than ¼ the following R wave

If you found pathological Q, you should search for topographism :

- If in $V_{1,2}$ >> anterior infarction
- If in $V_{3,4}$ >> septal infarction
- If in $V_{5,6}$ >> Lateral infarction
- If in $V_{1,2,3,4}$ >> antro-septal infarction
- If in $V_{1,2,3,4,5}$ >> Extensive anterior infarction

R wave

The first positive wave in the complex (you may say the only positive wave in the complex)

Used as voltage criteria

- Width : between two and three small squares
- Height : between one and five big squares

Wide R wave (> 3 small squares “wide complex” in cases of LBBB, RBBB, Ventricular tachycardia)

S wave

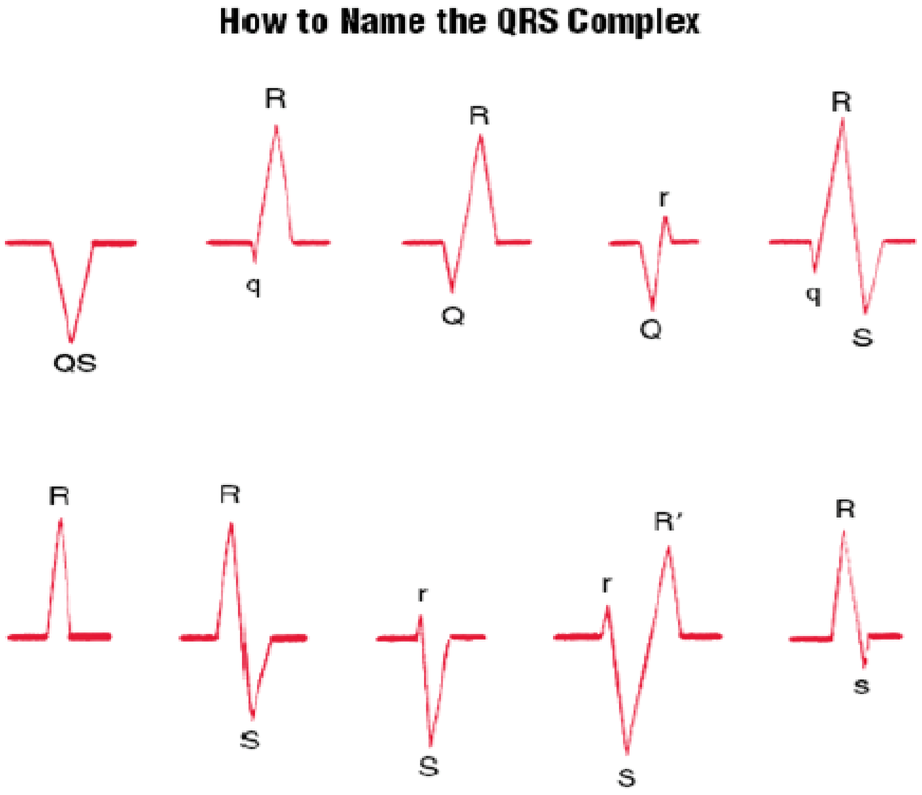
It is the first negative wave following R

There is a relation between S and R waves in chest leads :

- S wave starts big in V_1 and gradually decreases till V_5
- On the contrary R wave starts small in V_1 and gradually increases till V_6

- ***S*** in V_2 is > ***S*** in V_1
- ***S*** progress from V_2 to V_5
- ***S*** usually absent in V_6

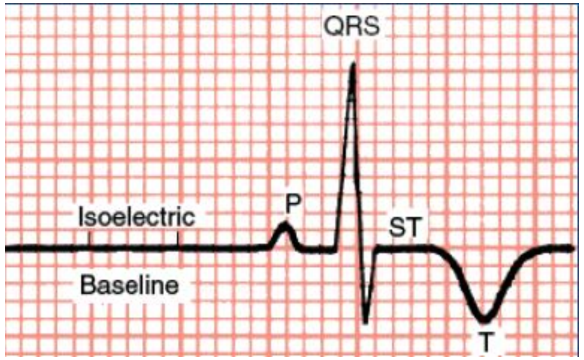
- If the amplitude of the wave less than 5 mm (< 5 small squares) >> written in small letter.



- If the amplitude of the wave more than 5 mm (> 5 small squares) >> written in capital letter.

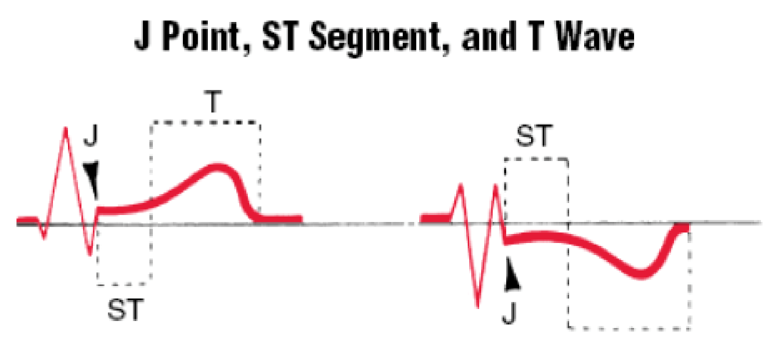
7. S-T segment

It represents the beginning of ventricular repolarization. The normal ST segment is usually isoelectric (i.e., flat on the baseline, neither positive nor negative), but it may be slightly elevated or depressed normally (usually by less than 1 mm).



J point

- Point where QRS complex returns to iso-electric line.
- Beginning of S-T segment.
- Critical in measuring S-T elevation.



S-T elevation

What is the causes of the ST elevation (above the iso-electric line) ??

- Pericarditis
- Myocardial infarction
- Prinzmetal's angina

How to differentiate between them ??

- ✓ In precarditis ST segment elevation >> in all leads
- ✓ Angina & Myocardial infarction >> in some leads

How to differentiate between angina and myocardial infarction ??

- ✓ Cardiac enzymes >> elevated in myocardial infarction
- ✓ Timing >> ST elevation more than half an hour >> myocardial infarction

S-T depression

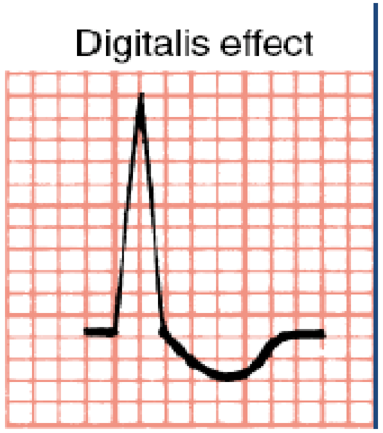
What is the causes of ST depression ??

- Digitalis
- Hypokalemia
- Angina (better to say ischemia as angina is a clinical diagnosis)
- Myocardial infarction
- Pericarditis
- Cardiac hypertrophy
- Bundle branch block

How to differentiate between them ??

- Digitalis
- Hypokalemia
- Pericarditis

With diffuse ST segment depression in all leads



Digitalis : the ST segment depression with J point at iso-electric line (called sagging)

Hypokalemia : measuring the serum potassium

Pericarditis : clinically by stitch pain

If ST segment depression in some leads :

- Angina (better to say ischemia as angina is a clinical diagnosis)
- Myocardial infarction
- Cardiac hypertrophy
- Bundle branch block

As Known V_1, V_2 and V_3 >> the leads of the right ventricle,
So ,
the ST segment depression in V_1, V_2 and V_3 >> with right ventricular hypertrophy >> strain pattern (or secondary changes)

Left ventricular enlargement >>
ST segment depression in V_4, V_5 and V_6

Right bundle branch block >>
ST segment depression in V_1, V_2 and V_3

Left bundle branch block >>
ST segment depression in V_4, V_5 and V_6

8. T wave (Never absent)

The asymmetry of the normal T wave contrasts with the symmetry of T waves in certain abnormal conditions, such as MI and a high serum potassium level.

- Width : less than 6 small squares
- Height : less than 1/3 the preceding R wave

What is the possibilities ??

- Upright (positive)
- Inverted (negative)

Positive T wave

- ✓ Normal
- ✓ Hyperacute >> called Himalaya T in cases of hyperkalemia

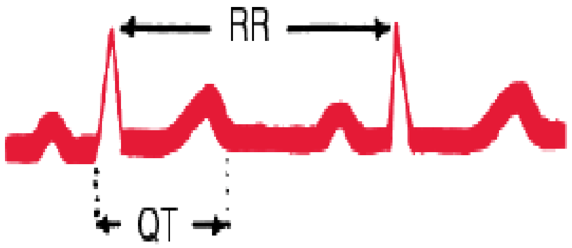
Inverted T wave

- ✓ May be normal in some individuals

9. Q-T interval

The QT interval is measured from the beginning of the QRS complex to the end of the T wave.

It primarily represents the return of stimulated ventricles to their resting state (ventricular repolarization).



Normally >> 11 small squares (0.44 seconds)

10. U wave

The U wave is a small, rounded deflection sometimes seen after the T wave. Its exact significance is not known.