Electrocardiogram

Department of Physiology

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Electrocardiogram

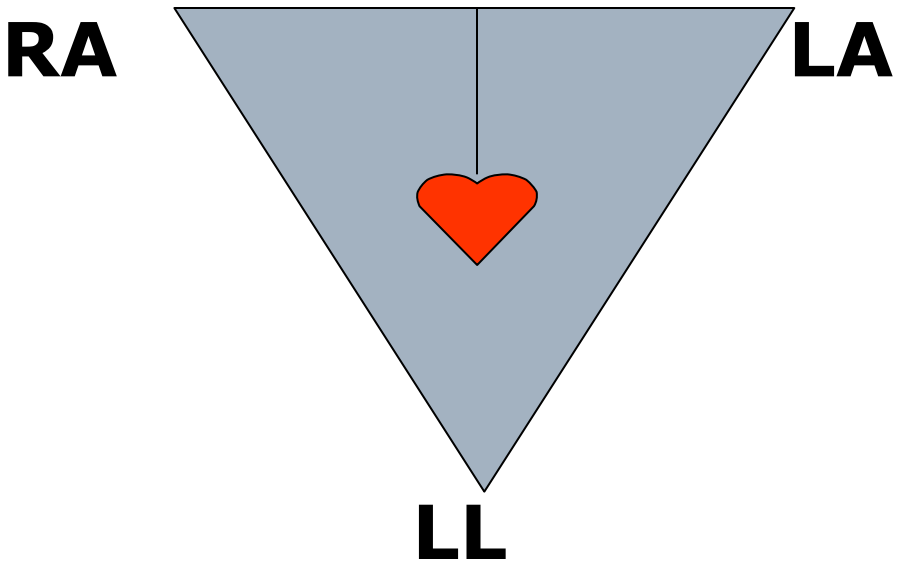
- The electrical activity of the heart can be recorded from the body surface
  - The body fluid contains ions
  - Therefore it is a volume conductor
- The surface electrodes
  - Records algebraic sum of the electrical fluctuations of the heart muscle fibers
- The record of these potential fluctuations during a cardiac cycle is the ECG

Electrocardiogram

- The surface electrodes are known as ECG leads
- Bipolar lead
  - Both the electrodes are actively recording
- Unipolar lead
  - Active electrode is connected to an indifferent electrode at zero point

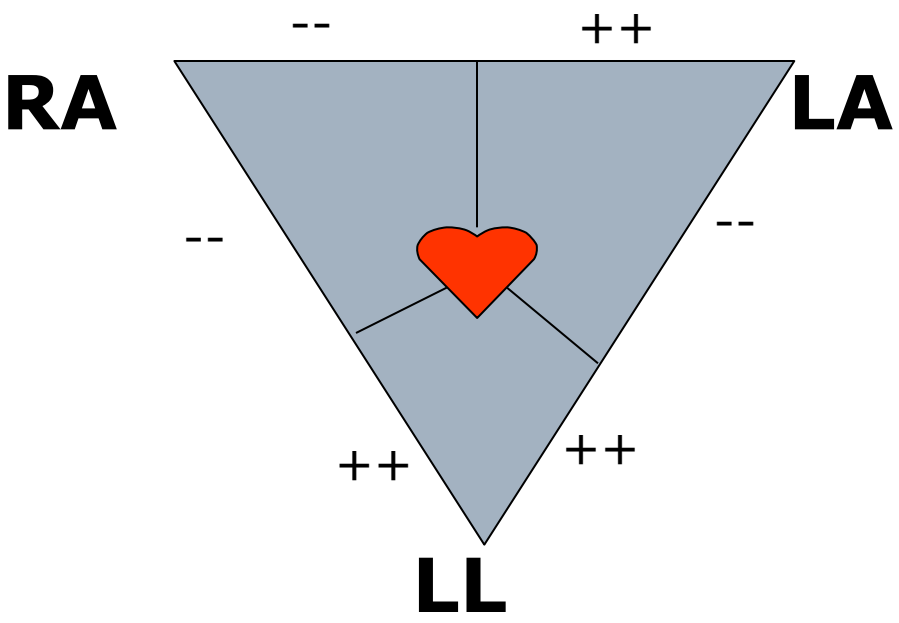
Electrocardiogram

- Einthoven's triangle
  - A triangle with a heart at its centre
- Can be simulated by
  - Placing electrodes on the both arms and the left leg



Electrocardiogram

- Einthoven's triangle
  - The sum of the potential at the points of this equilateral triangle is zero



- Depolarization moving towards an active electrode records a positive deflection

- Depolarization moving away from an active electrode records a negative deflection

Electrocardiogram

- ECG leads
- There are bipolar leads
  - Both leads are actively recording the potential
- Unipolar leads
  - One active lead recording the potential while it is connected to an indifferent electrode at zero potential

Electrocardiogram

- Bipolar leads
  - Standard limb leads – records potential difference between two arms
  - Lead I- L I
  - Lead II- L II
  - Lead III- L III

Electrocardiogram

- Unipolar leads (V leads)

1. Three Unipolar limb leads
2. Six Unipolar chest leads

- Augmented Unipolar limb leads designated by ‘a’
  - The three Unipolar limb leads
  - Records between one limb and two other limbs
  - Increases the size of potential by 50% without changing the configuration of the non-augmented lead

Electrocardiogram

- Augmented Unipolar limb leads
  1. aVR
  2. aVL
  3. aVF
- Unipolar chest leads
  - V_1 to V_6

Electrocardiogram

- Fixing of ECG leads
- Standard limbs leads (Bipolar limb leads) I, II and III
  - Lead I [left arm(+ve)- right arm(-ve)].
  - Lead II [right arm(-ve)- left leg(+ve)].
  - Lead III [left leg (+ve)- left arm (-ve)].

Electrocardiogram

- Fixing of ECG leads
- Unipolar limb leads
  - aVR [right arm(+ve)]
  - aVL [left arm(+ve)]
  - aVF [left leg(+ve)]

Electrocardiogram

- Fixing of ECG leads
- Unipolar chest leads
  - V_1 - 4th intercostal space just to the right of sternum
  - V_2 - 4th intercostal space just to the left of sternum
  - V_3 - halfway between V_2 and V_4
  - V_4 - left 5th intercostal space in the mid-claviclular line
  - V_5 - on same horizontal line as V_4 in anterior axillary line
  - V_6 - on same horizontal line as V_4 in the mid-axillary line

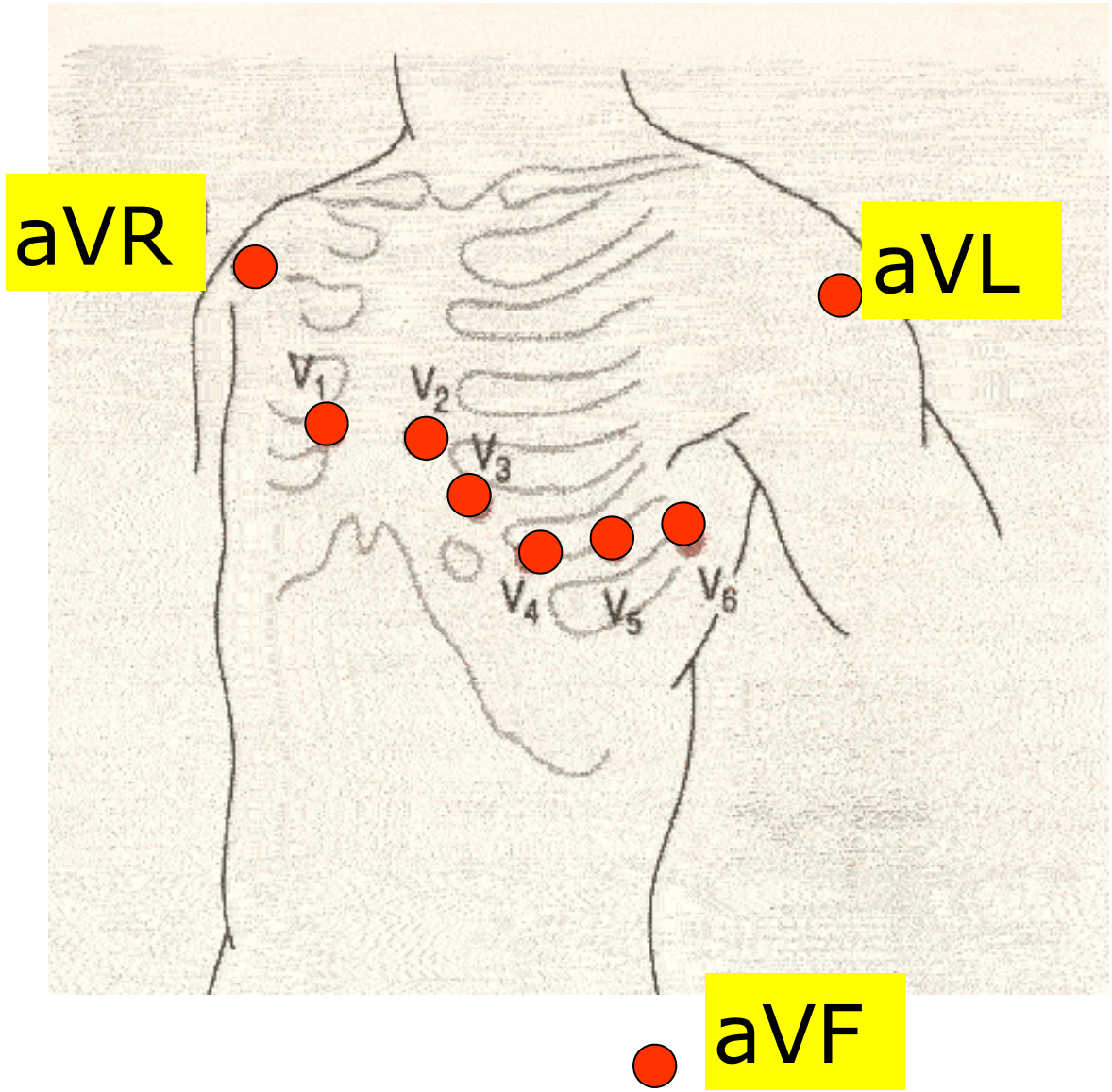
Electrocardiogram

- ECG paper
  - A paper with a grid
  - Has small and large squares
  - Small square is of 1mm X 1mm size
  - Five small squares make a one large square
  - Horizontal axis records the time scale
  - Vertical axis records the voltage

Electrocardiogram

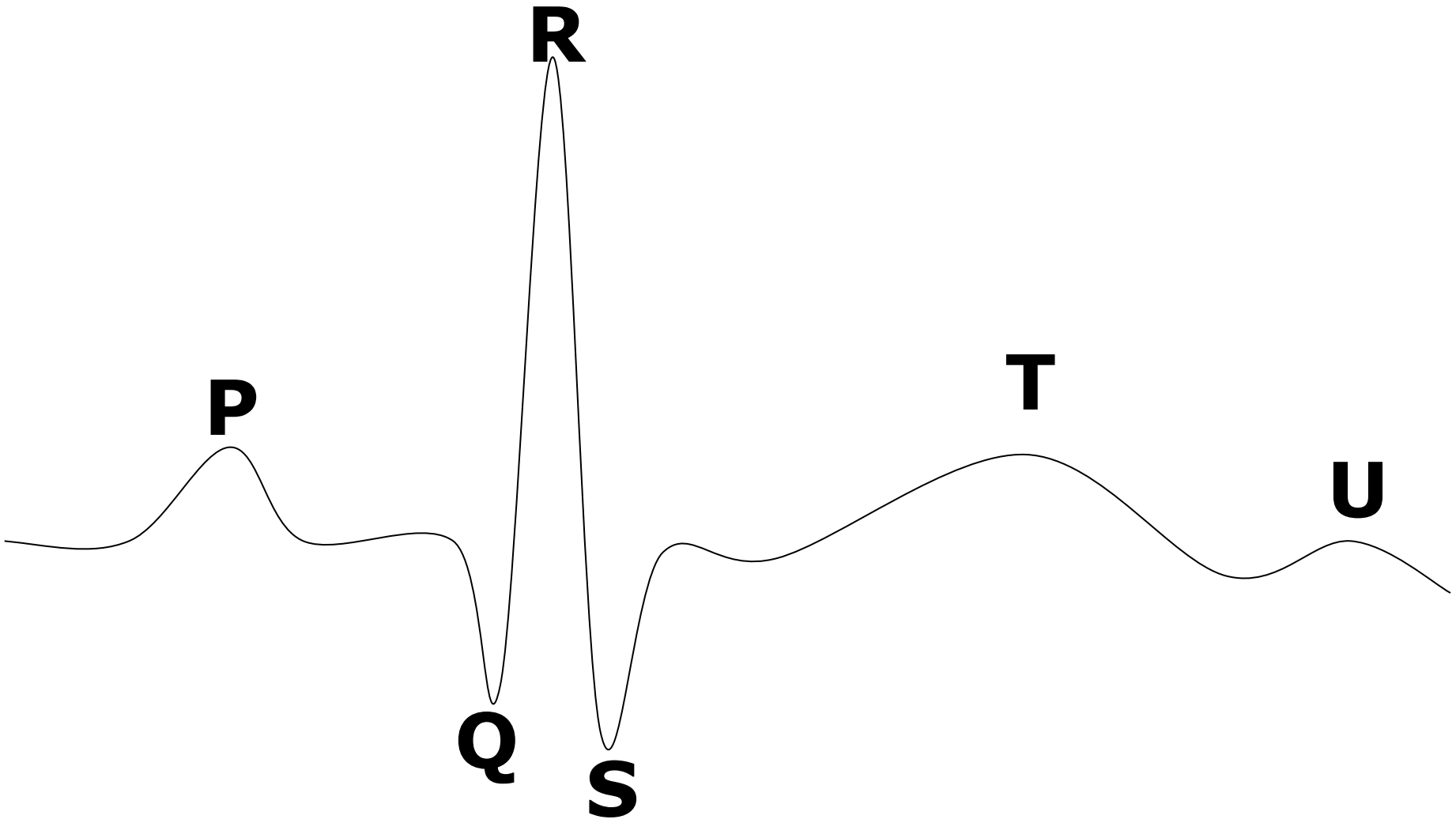
- Paper Speed of the machine
  - Standard speed is 25mm/s (5 large squares)
  - One large square =1/5=0.2s
  - One small square = 0.2/5=0.04s
- *Calculate the number of large and small squares for a minute*
- Voltage
  - Recorded on the vertical axis
  - Standard ECG 1mv is shown by 10mm (two large squares.)

Electrocardiogram



Electrocardiogram

- ECG wave forms named from letters PQRST



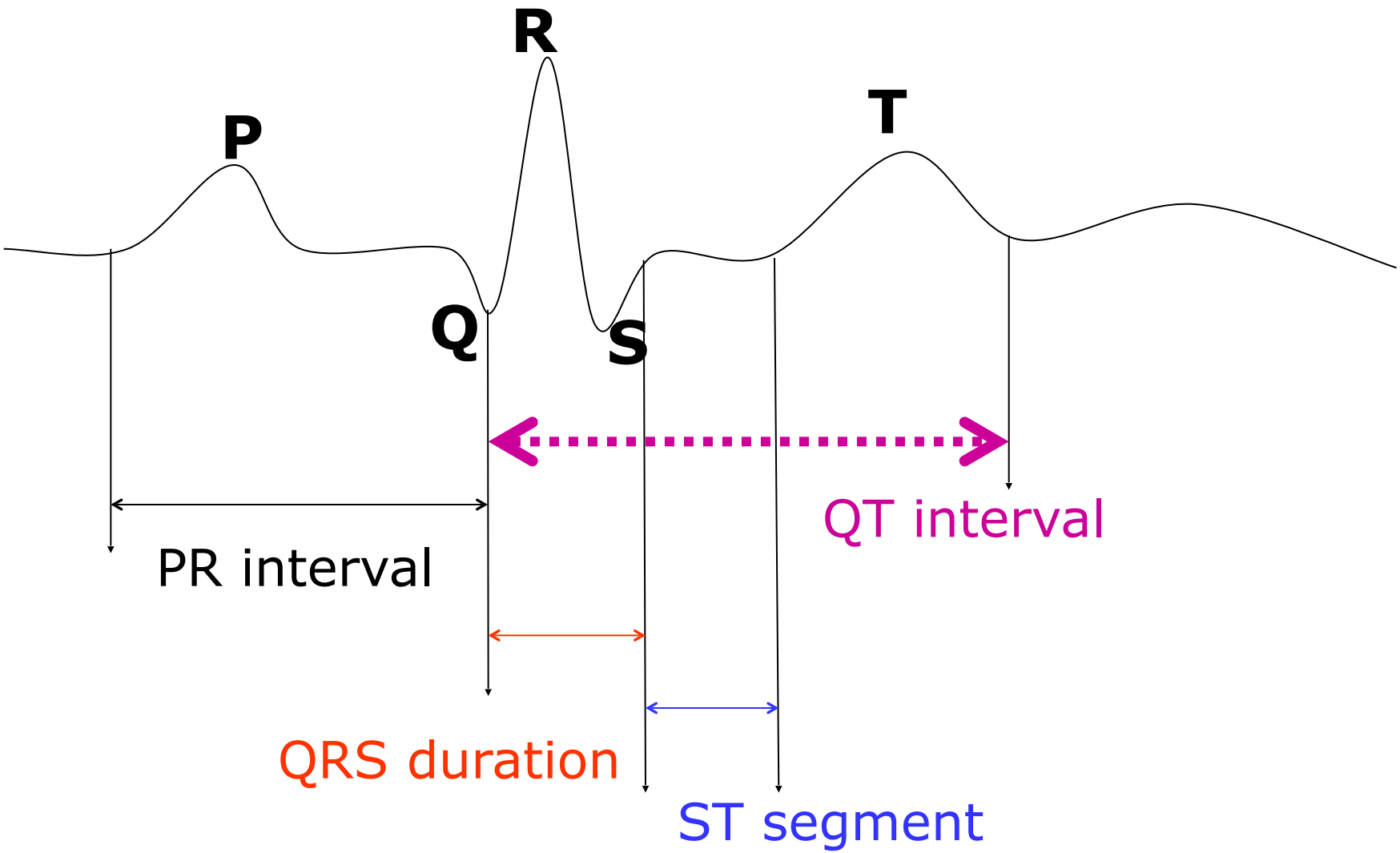
Electrocardiogram

- ECG wave forms named from letters PQRST
- P wave
  - is the first wave in an ECG
  - Produced by atrial depolarization
- Q wave first negative deflection after P
  - Produced by septal depolarization

Electrocardiogram

- R wave
  - First positive wave after P
  - Produced by rest of the ventricular depolarization
- S wave
  - Negative wave after R
- T wave
  - Produced by part of the ventricular repolarization
- U wave
  - Inconstant finding
  - Due to slow repolarization of papillary muscles

Durations and intervals



Electrocardiogram

- Durations and intervals
- PR interval-0.12-0.22s
  - Beginning of the P to beginning of QRS
  - atrial depolarization and Av node conduction occurs during this time
- QRS duration- 0.08-0.10s
  - Ventricular depolarization
- ST segment and T wave
  - Whole of ventricular repolarization
- Where is the atrial repolarization?

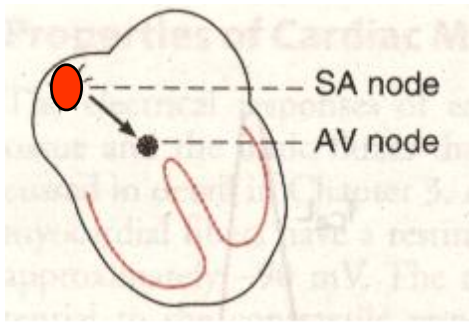
Electrocardiogram

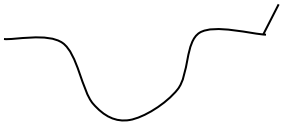
- The configuration of the ECG wave pattern depends on
  - Sequential electrical activity
  - Position of the electrodes relative to the heart

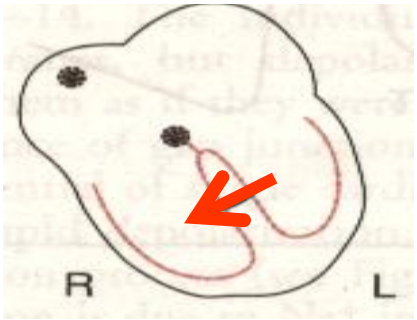
Electrocardiogram

- aVR lead ‘looks at’ the cavities of the heart
  - All the electrical activities are moving away from the lead except septal depolarization
  - Therefore all the wave forms are negative deflections except septum
  - Results small R

aVR

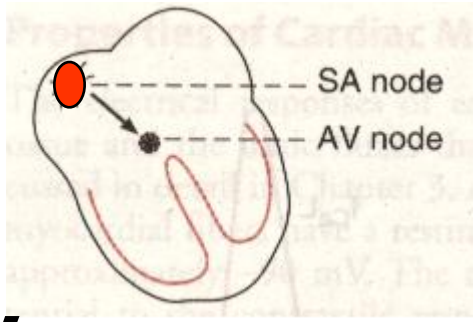


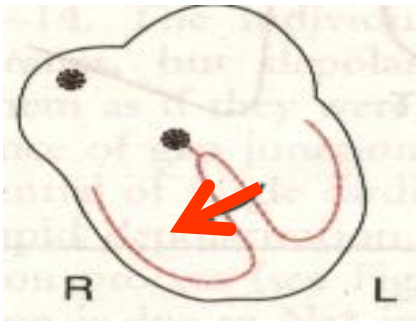


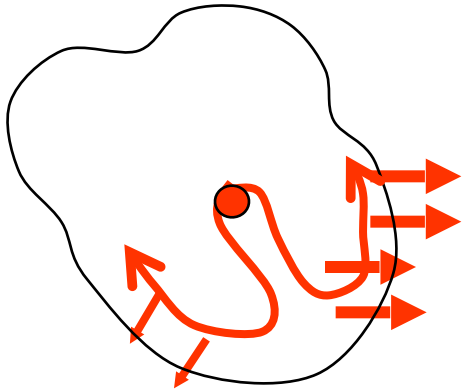


Electrocardiogram

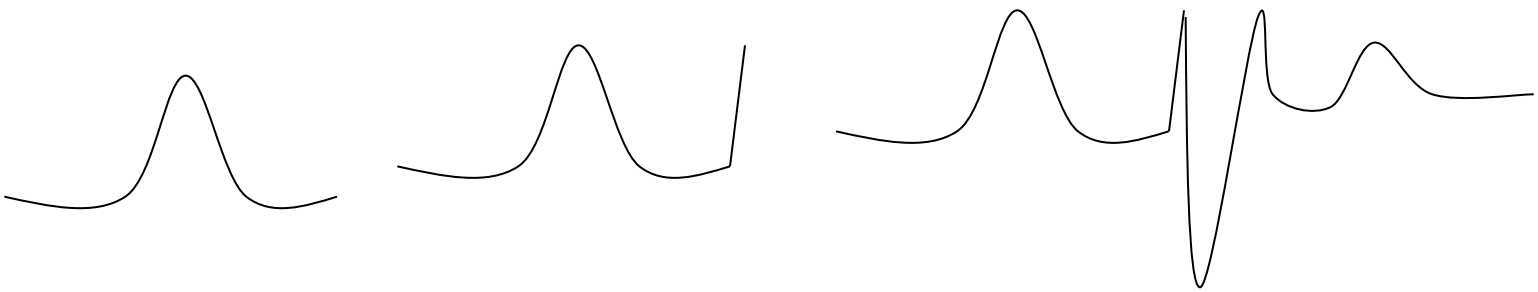
- In right sided Lead V_1 and V_2 there is no Q wave
  - As Septum depolarises from left to right





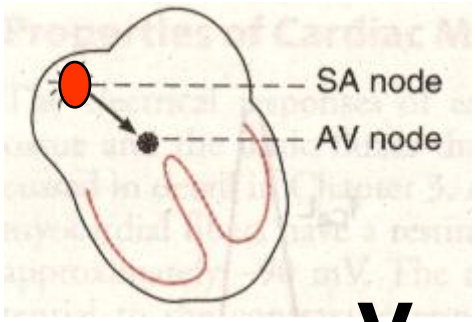


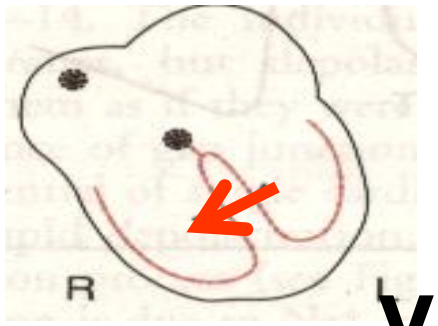
V_1

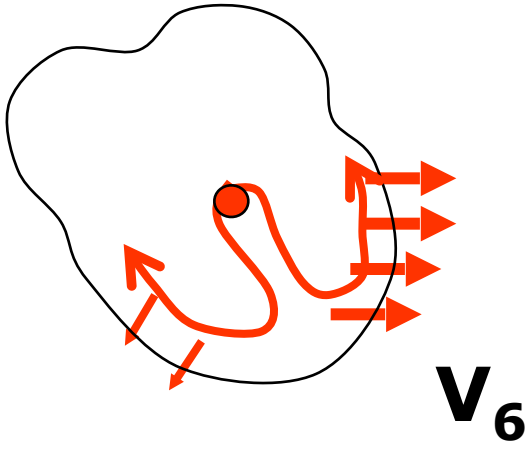


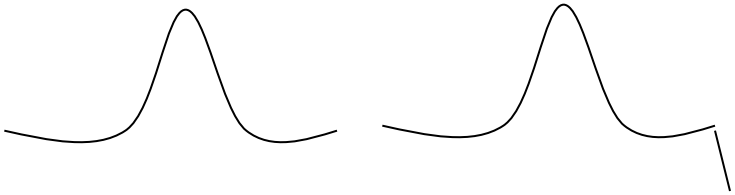
Electrocardiogram

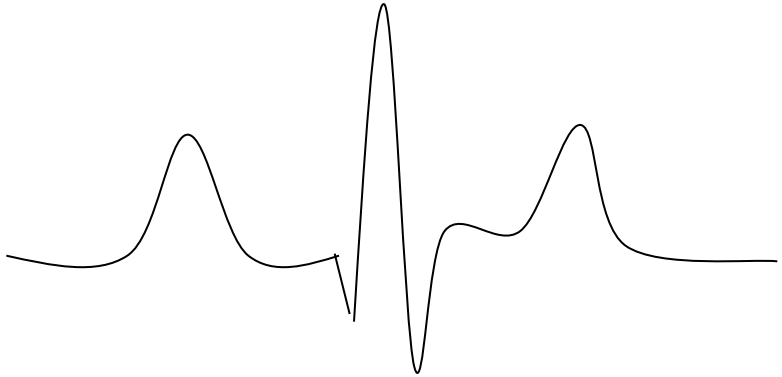
- In left sided leads $V_{4,}V_5$ and AVL has a small Q wave due to septal depolarization











Electrocardiogram

- Calculation of the hear rate from the ECG
  - In the ECG paper 1second = 5 large squares
  - One minute = 300 large squares= 1500 small squares
  - Hear rate = number of QRS complexes for 1 minute

- Heart rate= 300/ number of large squares between consecutive R waves (R-R interval in large squares)
- Or 1500/ R-R interval in small squares

Cardiac arrhythmias

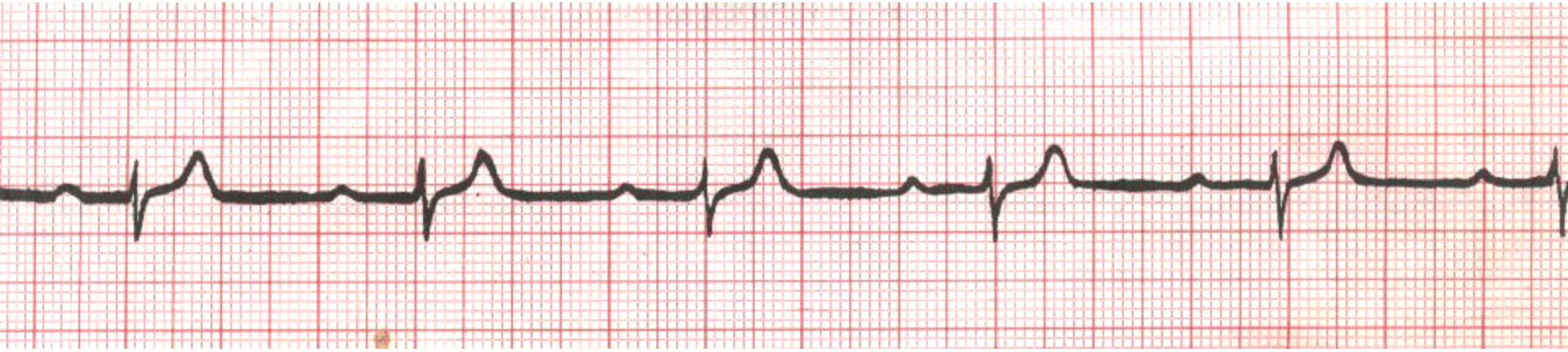
- Normal cardiac rhythm originates in SA node
- Known as normal sinus rhythm (NSR)
- Rate about =70/minute
- Normal Range =60-100/minute
- Sinus arrhythmia
  - Variation of heart rate during phases of respiration
  - Normal phenomenon -Commonly seen in young
- Heart rate increases in inspiration decreases in expiration

Cardiac arrhythmias

- Sinus bradycardia
  - Heart rate less than 60/minute
- Sinus tachycardia
  - Heart rate more than 100/minute
- List causes for sinus bradycardia and sinus tachycardia

Heart blocks (atrioventricular blocks)

- First degree heart block-I^0 block
  - The PR interval is longer than 0.22s
  - But all the atrial impulses reach the ventricles



Heart blocks (atrioventricular blocks)

- Second degree heart block- 2^0 block
  - Some P waves are conducted to the ventricles
  - Some are not conducted
  - Depending on the atrial rate every second (2:1) or every third (3:1) P waves are conducted to the ventricles

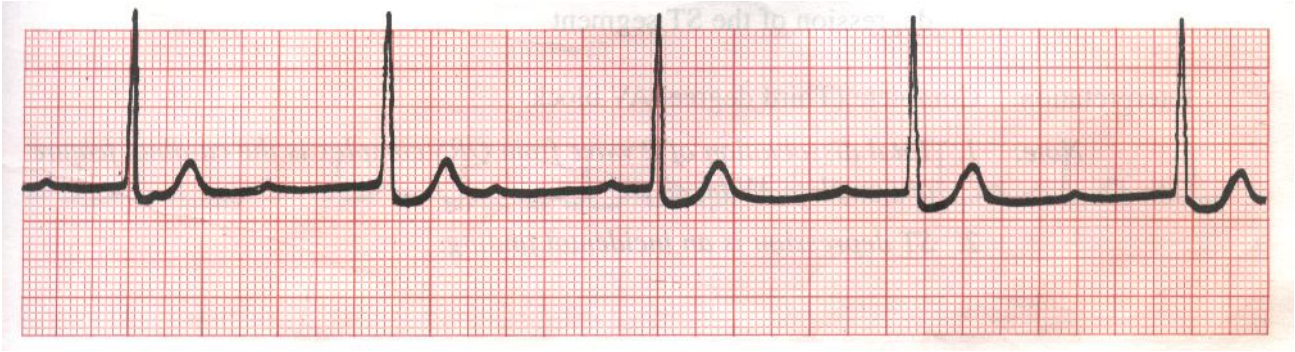
2:1 second degree block

Heart blocks (atrioventricular blocks)

- Third degree heart block -3^0 or Complete heart block
  - Conduction from atria to ventricles is completely interrupted
  - Due to damage to His bundle
  - Ventricles beat at a low rate on their own
  - Ventricles beat independently of the atria- the idioventricular rate

Heart blocks (atrioventricular blocks

- Third degree heart block -3^0 or Complete heart block
  - Latent ventricular pacemaker has a average rate 0f 35/ minute
  - Resulting cerebral ischaemia causes fainting attacks (syncope) –Strokes-Adams syndrome



Atrial arrhythmias

- Atrial flutter
  - The atria discharges rapidly
  - The atrial rate is 200-350/minute
  - AV node cannot conduct more than 300/minute
  - Therefore associated with 2:1 or greater AV block

Atrial arrhythmias

- Atrial flutter
- ECG findings
  - Rapid atrial rate
  - P waves produces a characteristic saw-tooth pattern of flutter waves
  - R waves occur at regular intervals
- The pulse is regular

Atrial arrhythmias

- Atrial flutter

Atrial arrhythmias

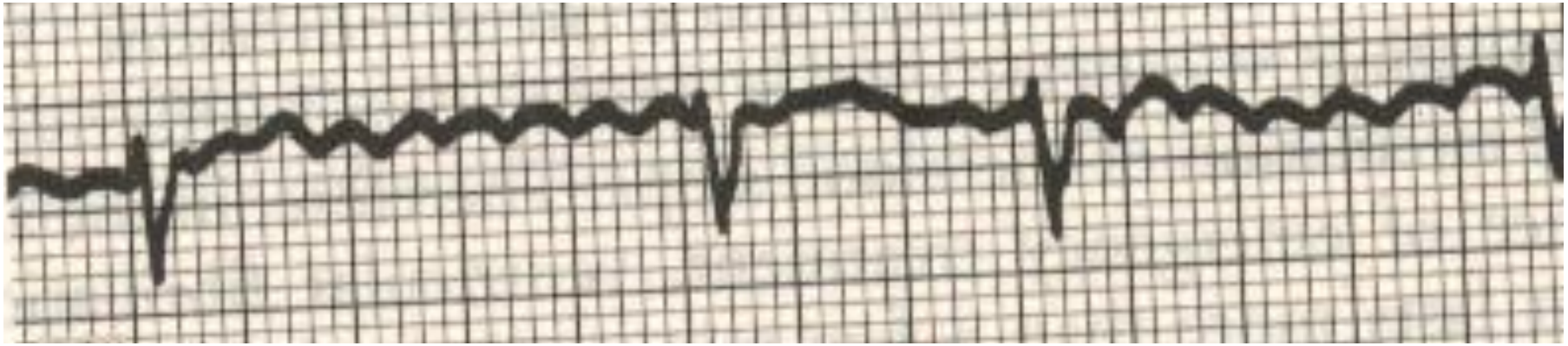
- Atrial fibrillation
  - Atria depolarization occurs at very rapid rate
  - In completely irregular and disorganised fashion
  - Rate 300-500/minute
  - AV node discharges at irregular intervals
  - Ventricles depolarize at completely irregulars rate
  - Ventricular contractions become irregular

Atrial arrhythmias

- Atrial fibrillation
- ECG findings
  - P waves are not seen-replaced by fine irregular fibrilatory waves
  - R waves occur completely irregularly
- Pulse is irregularly irregular

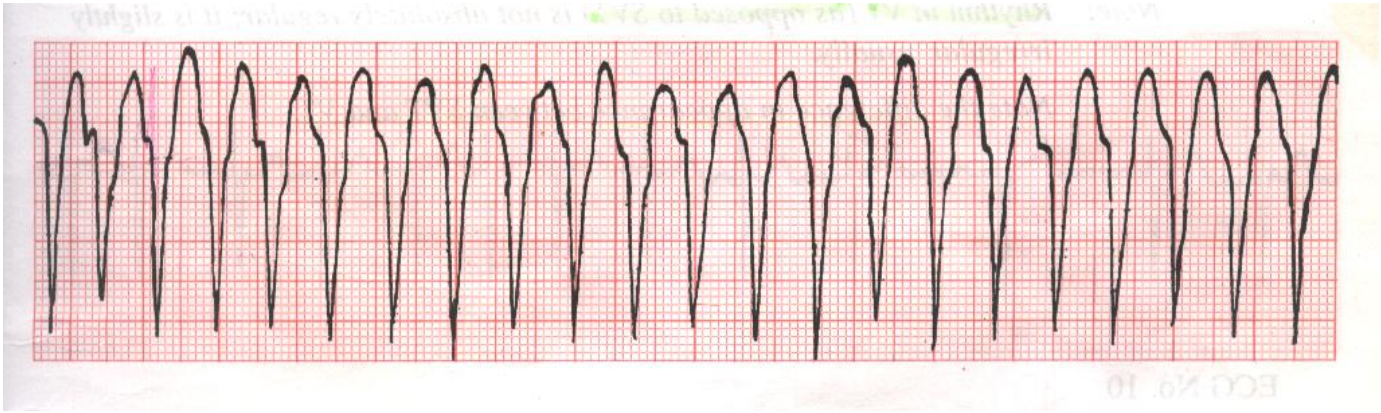
Atrial arrhythmias

- Atrial fibrillation



Ventricular arrhythmias

- Ventricular tachycardia
  - Series of rapid ventricular depolarizations
  - Ventricular rate is regular
  - Results reduction of cardiac out put



Ventricular arrhythmias

- Ventricular fibrillation
  - A life threatening condition
  - Ventricles depolarise and contract in a totally irregular, disorganised and ineffective way
  - Contracts like a ‘Bag of worms’
  - Cardiac output drop to zero
  - Pulse is not palpable
- ECG completely irregular complexes

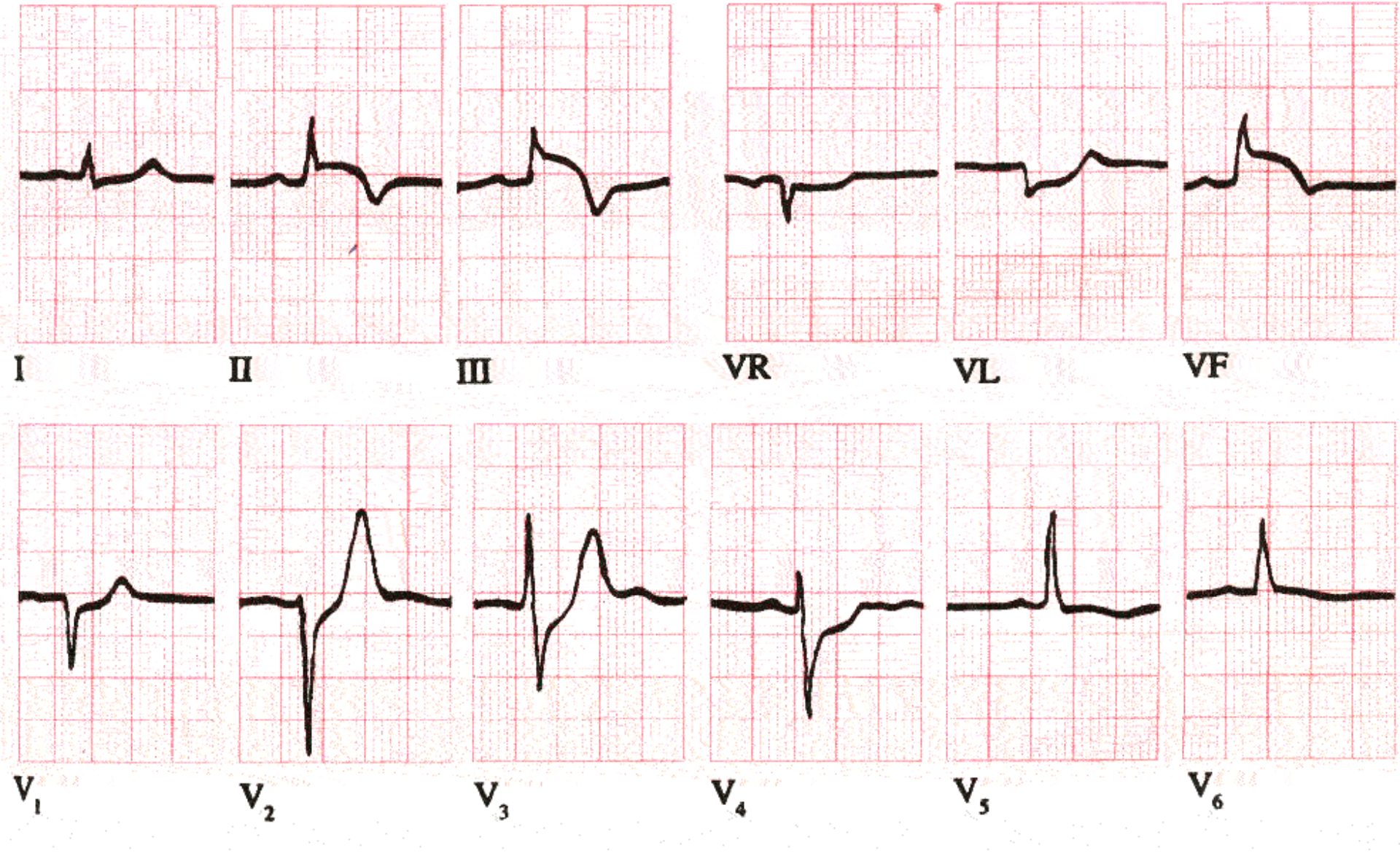
Ventricular arrhythmias

- Ventricular fibrillation

Myocardial infarction

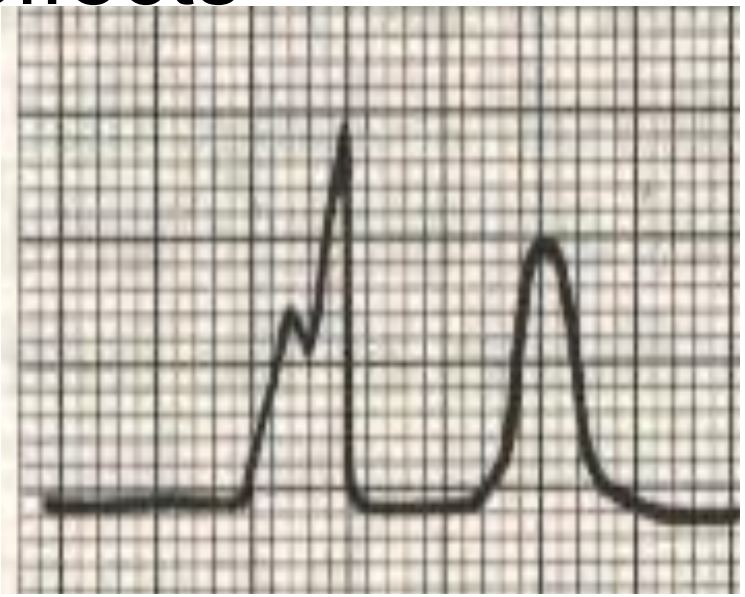
- Acute myocardial infarction
  - Changes are seen in ST segment
  - Results ST elevation
- After some days
  - ST Segment changes subsides and T wave inversion occurs
  - Development of Q wave persists

Myocardial infarction



Metabolic effects

- Hyperkalaemia- Rise in K^+ results tall peaked T waves



- Hypokalaemia – Low K^+ results inverted or flat T waves with Prominent U waves