

Cardiac Electrophysiology

DEFINITIONS

Membrane Potential

It represents the voltage difference between the inside of the cell and the surrounding extracellular environment of the cell, i.e. interstitial tissue.

Resting Membrane Potential

The cell membrane is polarised at rest. There is a steady potential difference between the interior and the exterior of the cell at rest, which is known as *resting membrane potential*. This steady state continues till it is supervened by action potential.

Depolarisation

With activity, the polarity reverses and the inside of the cell becomes more positive.

Repolarisation

Following depolarisation inside of the cell becomes negative, i.e. restoration of normal resting potential occurs and “Status quo” continues.

Hyperpolarisation

Inside of the cell becomes more negative, i.e. the polarisation of the membrane increases.

Properties of the Heart

1. *Automaticity*: It is the ability of a tissue to originate or initiate its own impulse or beat, e.g. pacemaker activity of SA node.
2. *Rhythmicity*: The regular/rhythmic nature of pacemaker activity.
3. *Excitability*: The ability of the heart to respond to a given stimulus.
4. *Conductivity*: Ability to conduct the impulse from the site of its origin, i.e. from SA node, through specialised conductive system of the heart to the atria and ventricles is known as conductivity.
5. *Contractility*: Ability of the tissue to shorten in length (contract), in response to a stimulus is called contractility.
6. *All or none law*: When a stimulus of either threshold intensity or above threshold intensity is applied, the heart muscle responds to the maximum. If the stimulus is of below threshold intensity, it does not respond at all.
7. *Refractory period*: It is the interval of time during which a normal cardiac impulse cannot re-excite an already excited area of cardiac muscle. The heart muscle cannot be tetanised due to this property.

Self excitation forms the basis of automaticity and rhythmicity and is the special property of the junctional and conductive systems of the heart.

1. *SA node or sinoatrial node*: The normal rhythmical impulse is originated here.



potential is 110 mV. The QRS wave, i.e. from the top of R wave to bottom of S wave is 1.0–1.5 mV normally. Voltage of P wave is 0.1 to 0.3 mV. The T wave is 0.2 to 0.3 mV.

PR Interval

It is the time interval between the beginning of P wave to the beginning of QRS complex. It also denotes time interval between the beginning of contraction of atria to the beginning of contraction of ventricles and the time taken for conduction of impulse from atria to ventricles. Normal PQ or PR interval is 0.12 to 0.2 seconds (0.16 sec).

QRS Complex

It is the duration denoting ventricular depolarisation and atrial repolarisation. It is 0.08 to 0.1 seconds.

QT Interval

It is the time interval between the beginning of the Q wave to the end of T wave. The contraction of ventricles occurs during this time. It is 0.35–0.43 seconds.

ST Interval

It is QT minus QRS. It is about 0.32 seconds. It denotes ventricular repolarisation.

Heart Rate

Heart rate is the reciprocal of the time interval between two heart beats, i.e. the R-R interval. Therefore, if R-R interval is 0.83 seconds, heart rate is $1/0.83 \times 60$ which is equal to 72 beats per minute.

ELECTROCARDIOGRAPHIC LEADS

A lead consists of two wires and their electrodes, connecting the body with the electrocardiograph, making a complete circuit.

ECG is recorded by using an active or exploring electrode, connected to an indifferent electrode at zero potential (unipolar recording) or by using two active electrodes (bipolar recording).



impulse from SA node. Hence, there is long compensatory pause.

5. It is not strong enough to produce pulse at the wrist.

Cause

An irritable ectopic focus in the ventricles discharges before the next impulse from the SA node.

Paroxysmal Ventricular Tachycardia

It can be supraventricular such as *paroxysmal nodal tachycardia* or *paroxysmal ventricular tachycardia*.

Characteristic

- *Torsade de pointes*: A form of ventricular tachycardia in which QRS morphology varies. It is seen as a number of ventricular premature beats, in quick succession to each other.

Cause

- Rapid ventricular depolarisation due to circus movement. The aberrant rhythm/irritable foci occur due to ischaemic damage of the ventricles.

This is a serious condition as ventricular fibrillation often follows.

Ventricular Fibrillation

Abnormal focus of impulse generation in the ventricles leads to ineffective disorganized contractions of the ventricles.

Characteristic

- Electrical activity of the heart is completely disorganized. Series of ineffective ventricular contractions look like *bag of worms*. Results in death within a few minutes.

Causes

Ventricular muscle fibres contract in irregular and ineffective way, due to multiple ectopic foci discharging at the same time