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Lecture title: ECG

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Summary: Heart sounds and ECG reflect mechanical and electrical heart activity, aiding diagnosis of valve disorders, conduction abnormalities, and cardiac muscle function.

Heart sounds:

Heart sounds are the sounds produced by mechanical activities of heart during each cardiac cycle.
Heart sounds are produced by:

1. Flow of blood through cardiac chambers.
2. Contraction of cardiac muscle.
3. Closure of valves of the heart.

Heart sounds are heard by placing the ear over the chest or by using a stethoscope or microphone. These sounds are also recorded graphically.

- ✓ First heart sound: It is the sound of closure of mitral and tricuspid valves at start of ventricular systole "lub".
- ✓ Second heart sound: It is the sound of closure of aortic and pulmonary valves after the end of ventricular systole "dup".
- ✓ Third heart sound: It is a soft, low-pitched sound of rapid ventricular filling which is due to blood rush. (During rapid filling phase)
- ✓ Fourth heart sound: It is very soft, a low-pitched sound coincident with late diastolic filling of the ventricle due to atrial contraction. in rare cases can be heard immediately before the first sound.

Importance of heart sounds

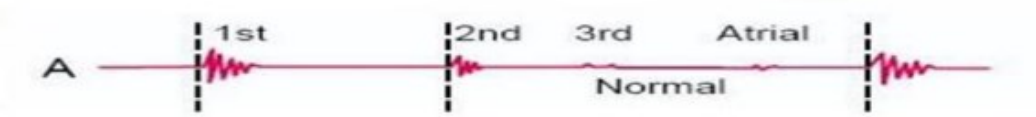
Study of heart sounds has important diagnostic value in clinical practice because alteration in the heart sounds indicates cardiac diseases involving valves of the heart. ***Methods of study of heart sounds***
Heart sounds are studied by three methods

1. By using stethoscope.
2. By using microphone.
3. By using phonocardiogram.

Phonocardiography:

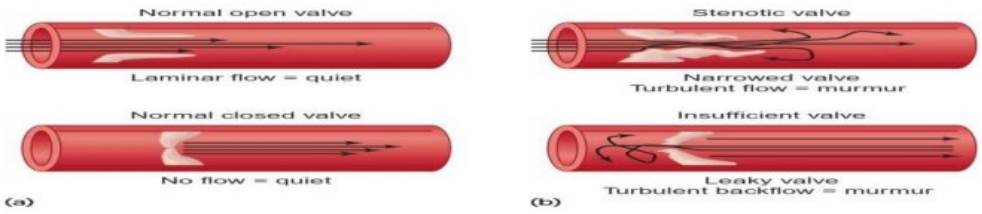
It is the recording of all the sounds made by the heart during cardiac cycle.

Phonocardiogram; it is the graphic records of the sounds and murmurs produced by contracting heart.



Murmurs: Any abnormal noisy heart sound produced due to turbulent blood flow valves

Causes: valvular diseases (major cause) stenosis or incompetence.



The normal electrocardiogram (ECG OR EKG)

✓ The **electrocardiogram** (ECG or EKG) is *a recording of changes in action potentials (the depolarization and repolarization of the heart) during each cardiac cycle Which are conducted to body surface through the body fluid (good conductors).*

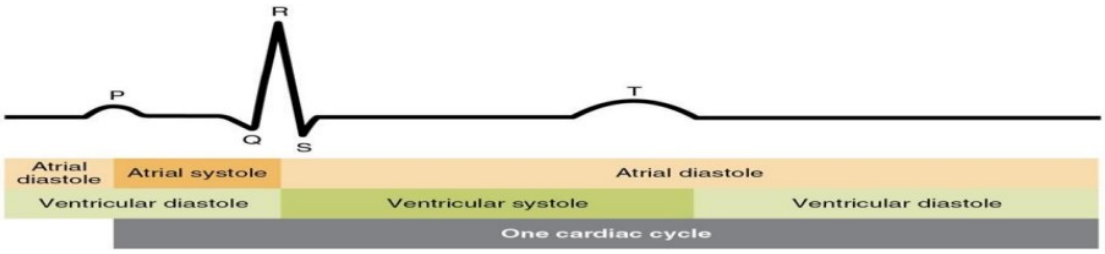
Uses of ECG;

Electrocardiogram is useful in determining and diagnosing the following;

1. Heart rate.
2. Heart rhythm.
3. Abnormal electrical conduction

4. Poor blood flow to heart muscle (ischemia). Heart attack.
5. coronary artery disease.
6. Hypertrophy of heart chambers.

✓ A normal ECG contains waves, intervals, segments and one complex, as in figure below.



Wave: *A positive or negative deflection from baseline that indicates a specific electrical event (depolarization and repolarization of the myocardium).* The waves on an ECG include the P wave, Q wave, R wave, S wave, T wave and U wave.

Interval: *The time between two specific ECG events.* The intervals commonly measured on an ECG include the PR interval, QRS interval (also called QRS duration), QT interval and RR interval.

Segment: *The length between two specific points on an ECG that are supposed to be at the baseline amplitude (not negative or positive).* The segments on an ECG include the PR segment, ST segment and TP segment.

Complex**:** *The combination of multiple waves grouped together.* The only main complex on an ECG is the QRS complex.

ECG WAVES:

These deflections are: P, Q, R, S, and T waves.

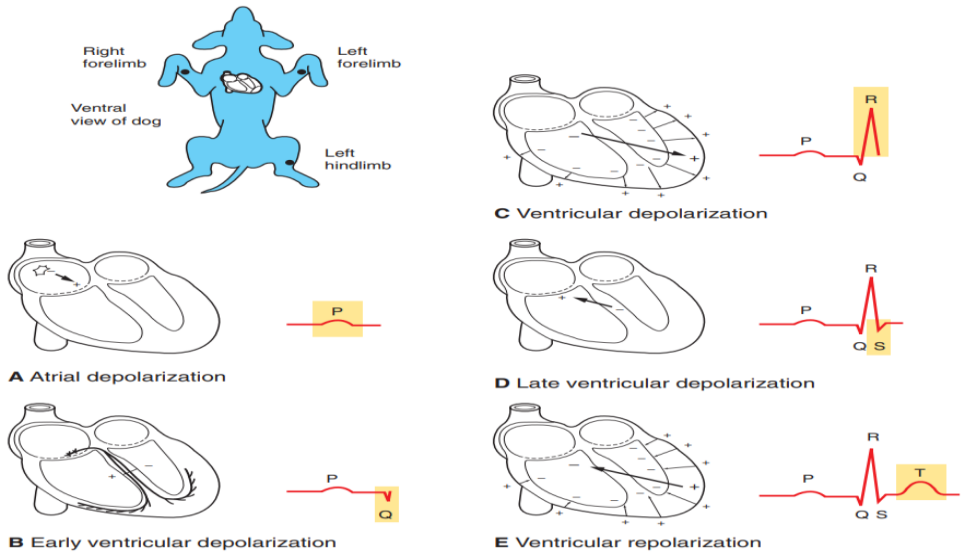
P- wave: The P wave represents *depolarization of the atria*.

Note:(Atrial repolarization is not seen on a normal ECG because it is "buried" in the QRS complex).

QRS: The QRS complex consists of three waves: Q, R, and S. Collectively, these waves represent *depolarization of the ventricles.*

T-wave: The T wave represents *repolarization of the ventricles.*

U- wave: rarely seen, it is due to slow repolarization of papillary muscles.



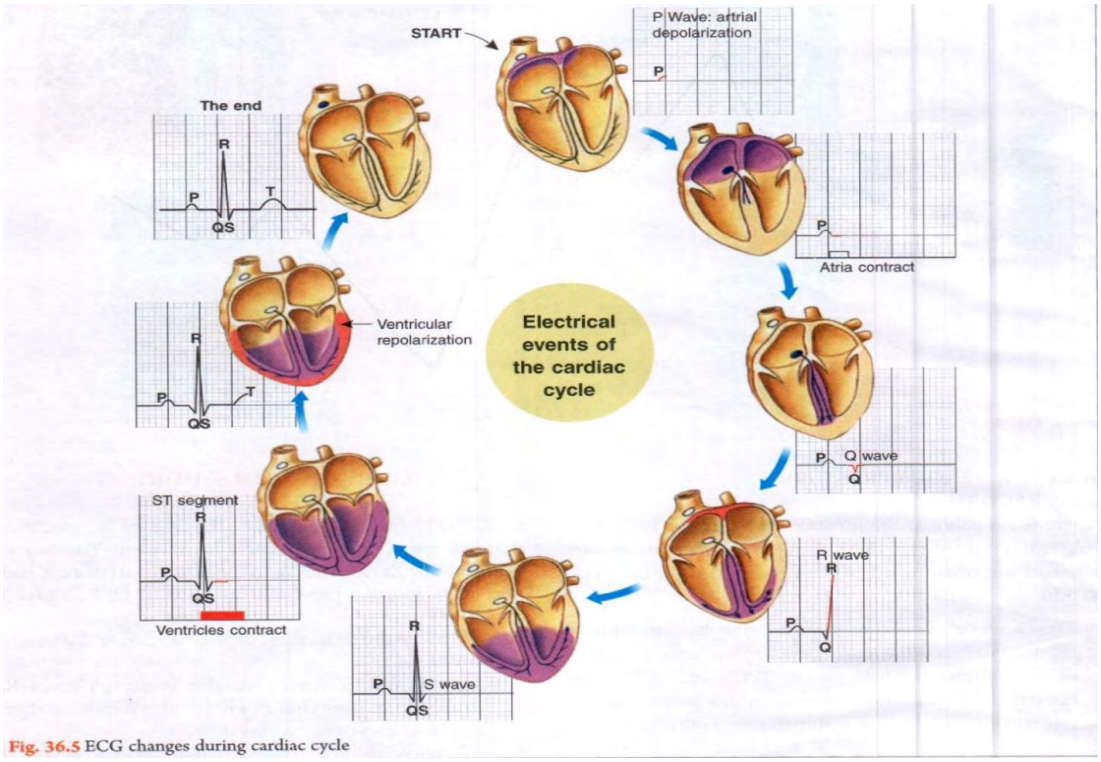


Fig. 36.5 ECG changes during cardiac cycle

ECG intervals:

PR- interval: the time between the start of atrial depolarization and the start of ventricular depolarization elapsed for 0.1 second, measurements from the beginning P to beginning of QRS complex and represents by conduction through atria and AV node.

QT-intervals: is the time from the beginning of ventricular depolarization to the end ventricular repolarization and elapsed for 0.2 second, measurements from the begging of QRS complex to the end of T wave and represented by ventricular depolarization and repolarization.

PP interval: is the time between atrial depolarization.it can be used to calculate the number of atrial contractions per minute (the atrial rate).

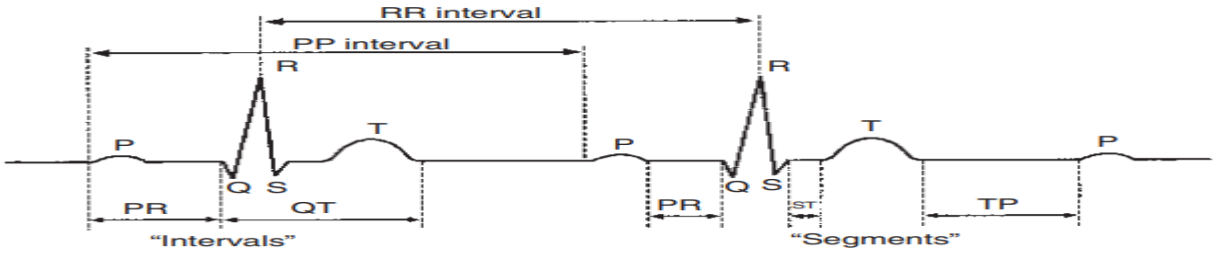
RR- interval: is the time between ventricular depolarization, and can be used to calculate the ventricular rate.

ECG segments:

PR- segment: starts at the end of the p-wave to the beginning of the QRS complex.

ST- segment: starts at the end of the QRS wave (end of S) to the start of the T-wave.

TP- segment: is found between the end of the T- wave and the beginning of the next p wave.



$$\text{Atrial rate (per minute)} = \frac{60{,}000 \text{ ms/min}}{\text{P-P Interval (in ms)}}$$

$$\text{Ventricular rate (per minute)} = \frac{60{,}000 \text{ ms/min}}{\text{R-R Interval (in ms)}}$$

- ECG can be recorded with the help of ECG machine i.e. **Electrocardiograph** (a galvanometer with a voltage amplifier recorder system). It gives a permanent record of ECG on a 'mm' graph paper recorded usually at a speed of 25 mm/sec.

Types of ECG leads:

Two methods are commonly employed for recording ECG are:

1. unipolar method in which ECG is recorded using one 'active (exploring) electrode.
2. bipolar method in which ECG is recorded using two 'active (exploring) electrodes.

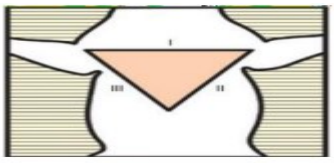
1. **The bipolar standard limb leads;** are used to display a graph of the potential difference recorded between two limbs at a time, they are bipolar. In these leads, one limb carries a positive electrode and the other limb, a negative one and forming a triangle called Einthoven's Triangle.

- **I "**Lead I is obtained by connecting right arm and left arm. Right arm is connected to the negative terminal of the instrument and the left arm is connected to the positive terminal".

-**II "**Lead II is obtained by connecting right arm and left leg. Right arm is connected to the negative terminal of the instrument and the left leg is connected to the positive terminal".
(Important Note Standard (or classical) limb lead II is often used for cardiac monitoring as positioning of the electrodes most commonly resemble the pathway of current flow in normal atrial and ventricular depolarization).

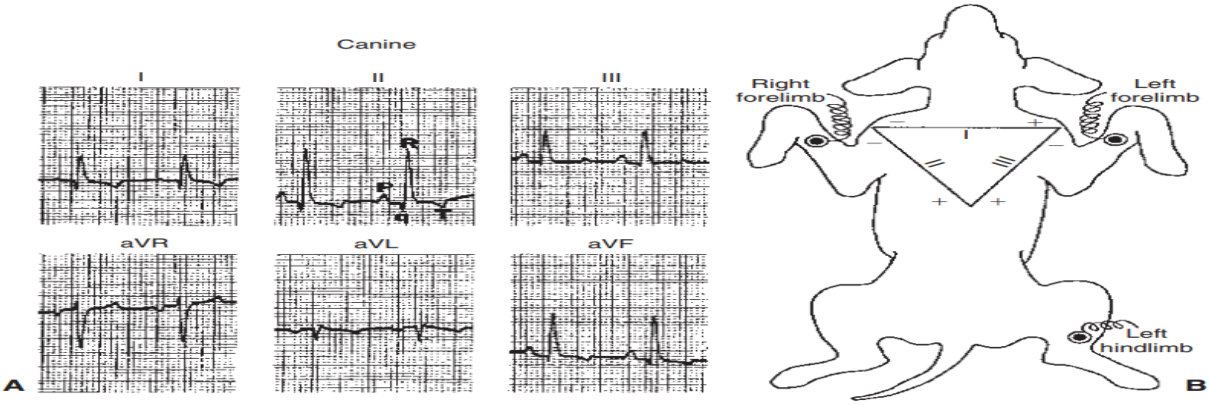
-**III "**Lead III is obtained by connecting left arm and left leg. Left arm is connected to the negative terminal of the instrument and the left leg is connected to the positive terminal".

-**Einthoven's Triangle;** is the drawn triangle around the area of the heart of two arms and the left leg, at which the two arms connect electrically with the fluids around the heart, and the lower apex is the point at which the left leg connects with the fluids.



2. Unipolar leads

Here, one electrode is active electrode and the other one is an indifferent electrode. Active electrode is positive and the indifferent electrode is serving as a composite negative electrode. Unipolar leads are of two types;



a) Unipolar limb leads. (Are also called augmented limb leads or augmented voltage leads. Active electrode is connected to one of the limbs. Indifferent electrode is obtained by connecting the other two limbs through a resistance).

Unipolar limb leads are of three types: *aVR lead (Active electrode is from right arm. Indifferent electrode is obtained by connecting left arm and left leg), aVL lead (Active electrode is from left arm. Indifferent electrode is obtained by connecting right arm and left leg), and aVF lead (Active electrode is from left leg (foot). Indifferent electrode is obtained by connecting the two upper limbs).*

b) Unipolar chest leads. (Chest leads are also called 'V' leads or precordial chest leads. Active electrode is placed on six points over the chest. This electrode is known as the chest electrode and the six points over the chest are called V1, V2, V3, V4, V5 and V6. V indicates vector, which shows the direction of current flow.

Note: Why is it necessary to have a 12 lead E.C.G.?

- *The six limb leads (I, II, ill, a V R' a V Land a VF) reflect depolarization of the heart in a vertical (frontal) plane i.e., electrical activity moving up and down, and left and right across the heart.*

(i) lead 1 and aV_L are called Left Lateral Leads as they view the left lateral wall of the heart, predominantly formed by the left ventricle.

(ii) Lead II, Ill and aV_f are called Inferior Leads as they view the inferior surface of the heart, formed by the right and left ventricles. (Lead aV_R. is oriented to the cavities of the heart whatever may be the position of the heart).

2. *The precordial leads (V1 to V6 reflect electrical activation of the heart in the Horizontal plane i.e., view the electrical activity moving anteriorly and posteriorly*.

(i) Leads V1 through V4 are referred as the anterior leads, this may be formed by the right and left ventricles.

(ii) Leads V5 and V6 are referred as Left lateral leads.