What Is An Electrocardiogram (ECG)?

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Abstract

An electrocardiogram (ECG) is the representation of the electrical activity of the heart (cardiac) muscle as it is recorded from the body surface. This article describes in understandable terms the basics of an ECG.

INTRODUCTION

An electrocardiogram (ECG) is the representation of the electrical activity of the heart (cardiac) muscle as it is recorded from the body surface. The muscle cells of the heart are linked so closely to one another that electrical impulses can easily spread from one cell to the next. Certain groups of cardiac cells are designed to rapidly transmit electrical activity through the heart. These specialized cells include the atrial conduction tracks, the atrioventricular (AV) node, the bundle of His, the bundle branches, and the distal ventricular conduction system.

In the resting state, cardiac muscle cells are “polarized”, with the inside of cells being negatively charged with respect to the outside. This charge is created by having a greater concentration of certain charged particles (ions) on one side of the cell membrane as compared with the other side. For example, the concentration of potassium ions is much higher inside the cells while the concentration of sodium ions is much higher outside. In response to stimuli, movement of these ions occurs, particularly a rapid inward movement of sodium. This causes a rapid loss of internal negative potential and thus generates electricity. This process is known as “depolarization”.

The heart has some very specialized cells. The so-called automatic cells of the heart are capable of spontaneous depolarization. They are important in the generation of heart rhythm, and because of this they are also known as pacemaking cells. Under normal conditions, the pacemaking cells in a special area in the upper part of the heart called the sinoatrial (SA or sinus) node depolarize most rapidly and set the heart rate. Other pacemaking cells are situated in the atria (upper chambers of the heart), between the atria and the ventricles (called the AV node), and in the ventricles (lower chambers of the heart).

Figure 1

Image 1: A modern ECG machine

Figure 2

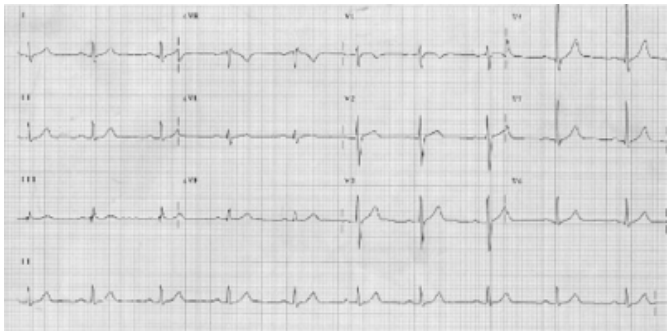
Image 2: Recording an ECG from a patient

READING A BASIC ECG

The first crude ECG was described in 1903 by Willem Einthoven. His procedure has been expanded, and now the probes used to measure electricity (called electrodes) are placed on the right and left arms, left leg, and across the chest wall. Currently there are 12 standardized “leads” for the standard ECG: bipolar leads I, II and III, described by Einthoven, augmented unipolar leads aVR, aVL and aVF and unipolar precordial leads V1-V6. How do these “leads” work and what do they mean?

Figure 3

Image 3: A normal ECG with all the different leads

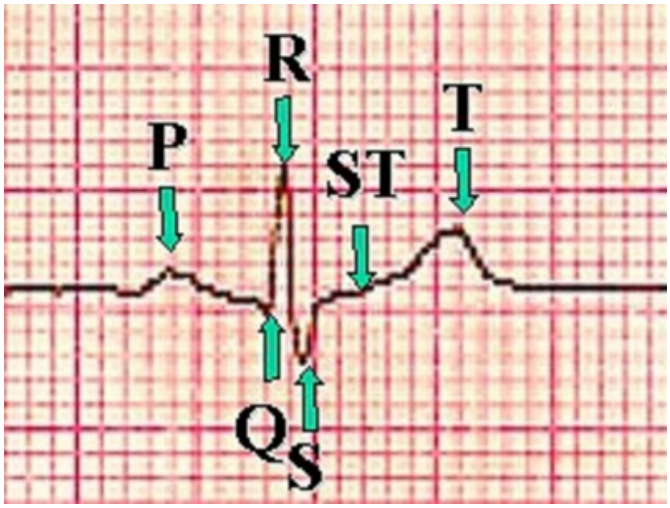


When current passes to the positive end of the bipolar (2-sided) electrode, it causes a positive deflection, which corresponds to an upward movement of the pen on the ECG paper. Passage of current away from the positive pole of the bipolar electrode causes a negative deflection and a downward movement of the pen on the ECG paper. Current flowing at an oblique angle to the electrode causes smaller deflection, and current flowing perpendicular to the electrode does not cause any deflection in the recorder. Thus each lead “sees” the heart in a different way. This information is recorded on paper as a series of deflections and waves.

The distances between the deflections on an ECG are called segments and the distance between waves are called intervals.

Figure 4

Image 4: The different ECG segments of a heart beat



- The P wave represents depolarization of the upper part of the heart, the atria. P wave duration is a measure of the time required for depolarization to spread through the atria to the atrioventricular node. Normal maximum P wave duration is 0.1 seconds.
- The P-R interval begins at the beginning of the P wave and ends at the peak of the R wave. It represents the time required for an electrical impulse to depolarize the atria and reach the electrical conduction system of lower part of the heart, the ventricular. Normal P-R interval is 0.12 to 0.2 seconds in adults in normal heart rhythm (which is also called sinus rhythm).
- The QRS complex represents ventricular depolarization.
- The ST segment is abnormal (elevated or depressed) if the heart lacks oxygen.
- The T wave is an ECG representation of ventricular repolarization. The Q-T interval represents the time when the heart is unable to be depolarized, also called electrical systole. Heart muscle contraction or mechanical systole usually

begins during the recording of the QRS complex.

Commonly encountered ECG abnormalities include:

- misplaced ECG leads
- rhythm problems called dysrhythmias or arrhythmias
- blockage of the electricity pathways in the heart, called intraventricular conduction defects
- enlargement of certain areas of the heart due to increased stress in these areas, called cardiac chamber enlargement
- heart “attack” also called an acute myocardial infarction
- lack of oxygen in certain areas of the heart, termed myocardial ischemia
- changes in the concentrations of ions (electrolytes)

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