

# **ECG**

## **Electro cardiogram / electro cardio graph**

### **TOPICS**

-ECG

-Types of ECG Leads

-Standard Speed of ECG

-WAVES IN ECG

- **Significance and Importance of V-leads in ECG**
  - **Properties of electro cardiograph paper**
- **Principles of ECG Recording, Paper Speed, Lead Positioning:**

An ECG, or electrocardiogram (also sometimes called an EKG), is a test that records the electrical activity of the heart, allowing doctors to assess heart rate, rhythm, and identify potential problems with the heart's electrical function.

Here's a more detailed explanation:

**What it measures:**

ECGs measure the electrical signals that control the heart's beat, which are transmitted through the body and can be picked up on the skin.

**How it works:**

During an ECG, small sticky patches called electrodes are placed on the chest, arms, and legs. These electrodes are connected to a machine that records the electrical activity as a graph.

**What it can show:**

An ECG can reveal information about:

- Heart rate:** How fast the heart is beating.

- Heart rhythm:** Whether the heartbeat is regular or irregular.

- Electrical activity:** Whether the electrical impulses are traveling through the heart normally.

- Potential problems:** ECGs can help detect conditions like irregular heartbeats (arrhythmias), heart attacks, and other heart conditions.

**Why it's used:**

ECGs are a common and relatively simple test used to evaluate heart health, diagnose heart conditions, and monitor the effectiveness of treatments.

**When it's recommended:**

A doctor may recommend an ECG if you are experiencing symptoms like chest pain, palpitations, dizziness, or shortness of breath, or if you have a family history of heart problem




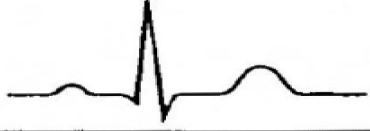



EKG Component	Graphic Depiction	Definition
PR Segment		From the end of the P wave to the beginning of the QRS complex
PRI		From the beginning of the P wave to the beginning of the QRS complex (normally .12 – .20 seconds)
Q Wave		First negative deflection of the QRS complex
R Wave		First positive deflection of the QRS complex
S Wave		First negative deflection following the R wave
QRS Complex		From the beginning of the Q wave to the end of the S wave (normally less than .12 seconds)
ST Segment		From the end of the S wave to the beginning of the T wave

Figure 1-6. EKG wave, segment, and interval definitions.

## **Types of ECG Leads:**

An ECG lead is a representation of the heart's electrical activity from a specific angle. They are created by the voltage difference between electrodes, offering a comprehensive view of the heart's electrical activity.

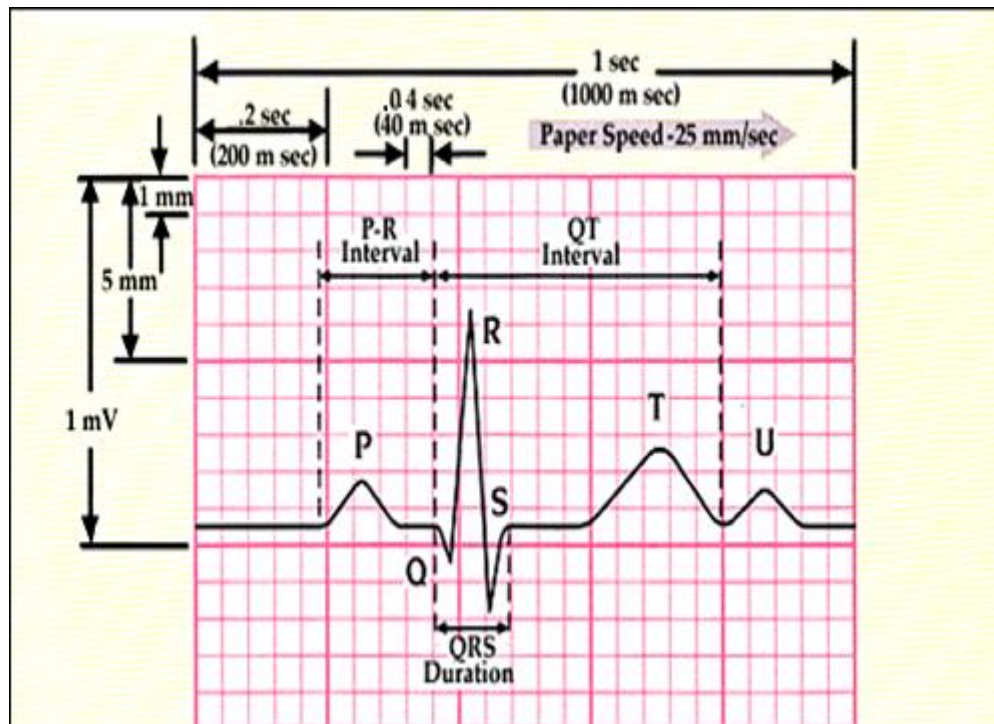
Types and Subtypes:

- Limb Leads: These view the heart's electrical activity in the frontal plane.
  - Bipolar Limb Leads: I, II, and III. These leads measure the potential difference between two specific limbs. Lead I measures the difference between the right and left arm, Lead II between the right arm and left leg, and Lead III between the left arm and left leg.
  - Augmented Unipolar Limb Leads: aVR, aVL, and aVF. These leads measure the absolute potential at one limb relative to a central point. aVR measures the right arm, aVL the left arm, and aVF the left foot.
  - Precordial (Chest) Leads: These view the heart's electrical activity in the horizontal plane
  - Unipolar Precordial Leads: V1, V2, V3, V4, V5, and V6. These leads are placed directly on the chest and provide a detailed view of the electrical activity originating from different areas of the ventricles.
- O
- Examples: Lead I records the potential difference between the right and left arm. A positive deflection in Lead I indicates that the electrical current is flowing from the right arm towards the left arm. Lead V1 is placed in the fourth intercostal space to the right of the sternum. It is particularly useful for examining the electrical activity of the interventricular septum

## Standard Speed of ECG:

The standard speed at which ECG paper runs is 25 mm/second. This allows for accurate measurement of the duration of heart events, ensuring that the various components of the cardiac cycle can be clearly distinguished and analyzed

At this speed, each small square (1mm) on the ECG paper represents 0.04 seconds (40 milliseconds), and each large square (5mm) represents 0.20 seconds. This precise measurement is crucial for calculating heart rate and the timing of electrical events.



## **WAVES IN ECG**

An ECG (electrocardiogram) displays the heart's electrical activity, showing waves representing different stages of the cardiac cycle. These waves are labeled P, Q, R, S, and T, with the QRS complex consisting of Q, R, and S waves, and the T wave representing ventricular repolarization.

Here's a breakdown of the ECG waves and what they represent:

**-P wave:**

Represents atrial depolarization (the electrical activity that causes the atria to contract).

**-QRS complex:**

Represents ventricular depolarization (the electrical activity that causes the ventricles to contract).

**-Q wave:** The first negative deflection of the QRS complex.

**-R wave:** The first positive deflection of the QRS complex.

**-S wave:** The second negative deflection of the QRS complex.

**-T wave:**

Represents ventricular repolarization (the electrical activity that causes the ventricles to return to a resting state).

**-U wave:**

A small, sometimes barely visible wave that follows the T wave, thought to represent repolarization of the Purkinje fibers.

In ECG analysis, intervals are durations of time that include one or more waveforms and/or segments, such as the PR, QRS, QT, and RR intervals, which are crucial for assessing heart function. Here's a breakdown of the key ECG intervals:

**PR Interval:**

This measures the time from the beginning of the P wave (atrial depolarization) to the beginning of the QRS complex (ventricular depolarization), reflecting the time it takes for the electrical impulse to travel through the atria and AV node.

**Normal Duration:** 0.12 to 0.20 seconds.

**Abnormalities:** A prolonged PR interval can indicate a first-degree AV block, while a shortened PR interval might suggest pre-excitation or a junctional rhythm.

**QRS Interval (or QRS Duration):**

This measures the duration of the QRS complex, representing ventricular depolarization.

**Normal Duration:** Less than 0.12 seconds.

**Abnormalities:** A prolonged QRS duration can indicate a bundle branch block or other conduction abnormalities.

**QT Interval:**

This measures the time from the beginning of the QRS complex to the end of the T wave, representing the total time of ventricular electrical activity (depolarization and repolarization).

**Normal Duration:** Varies with heart rate, but a normal corrected QT (QTc) is generally considered to be less than 0.44 seconds.

**Abnormalities:** A prolonged QT interval can increase the risk of certain arrhythmias, while a shortened QT interval is less common but can also be abnormal.

**RR Interval:**

This measures the time from the peak of one R wave to the peak of the next R wave, representing the duration of one cardiac cycle and used to calculate heart rate.

**Abnormalities:** Irregular RR intervals can indicate an arrhythmia

## **Significance and Importance of V-leads in ECG:**

V-leads (V1-V6), also known as precordial or chest leads, are crucial in ECGs because they provide a different perspective on the heart's electrical activity than limb leads, allowing for better localization of cardiac issues, particularly in the anterior and lateral regions of the heart.

Here's a more detailed explanation:

### **Anatomical Perspective:**

**Limb Leads:** View the heart in the vertical plane, focusing on the inferior, lateral, and anterior surfaces.

**V-Leads:** View the heart in the horizontal plane, providing a more direct view of the anterior and lateral walls of the heart, as well as the septum.

### **Specific Lead Significance:**

**V1-V2 ("Septal Leads"):** Primarily observe the ventricular septum, but may occasionally display ECG changes originating from the right ventricle.

**V3-V4 ("Anterior Leads"):** Observe the anterior wall of the left ventricle.

**V5-V6 ("Anterolateral Leads"):** Observe the lateral wall of the left ventricle.

### **Clinical Importance:**

**Myocardial Infarction (MI) Localization:** V-leads are essential for identifying the location and extent of a heart attack (MI).

**ST-Segment Elevation:** ST-segment elevation in specific V-leads (e.g., V3 and V4) strongly suggests an anterior MI.

**Arrhythmia Detection:** V-leads can help in identifying and characterizing certain arrhythmias, particularly those affecting the ventricles.

### **Proper Placement:**

V-leads are placed on the chest, following a specific pattern to ensure accurate recordings.

Accurate placement is crucial for obtaining meaningful ECG data.

### **Comparison to Limb Leads:**

Limb leads (I, II, III, aVR, aVL, aVF) provide a different perspective on the heart's electrical activity than the chest leads. Both limb and chest leads are essential for a comprehensive ECG interpretation.

--The six chest leads (V1 to V6) “view” the heart in the horizontal plane. The information from the limb electrodes is combined to produce the six limb leads (I, II, III, aVR, aVL, and aVF), which view the heart in the vertical plane. The information from these 12 leads is combined to form a standard electrocardiogram



Specific Lead Significance:

**V1 and V2:**

These leads are particularly sensitive to changes in the right ventricular electrical activity and can help detect right ventricular infarction or strain.

**V3 and V4:**

These leads are excellent for detecting anterior myocardial infarctions, especially those involving the left anterior descending artery.

**V5 and V6:**

These leads are important for detecting lateral myocardial infarctions and can help differentiate between high and low lateral infarcts.

**Right-Sided Precordial Leads (V3R and V4R):**

These leads are crucial for assessing the right ventricle, particularly in cases of inferior myocardial infarction, where right ventricular involvement is common.

**Posterior Leads (V7-V9):**

Although not part of the standard 12-lead ECG, posterior leads can be used to assess the posterior surface of the heart and help identify posterior myocardial infarction. Clinical Applications:

**Myocardial Infarction (MI):**

ST-elevation or depression in precordial leads can indicate an MI, allowing for localization of the infarction to a specific region of the heart.

**Right Ventricular Infarction:**

Right-sided precordial leads are essential for detecting right ventricular involvement in inferior MI.

**Bundle Branch Blocks:**

Precordial leads can help identify and assess the severity of bundle branch blocks, especially left bundle branch block (LBBB).

**Ischemia and Injury:**

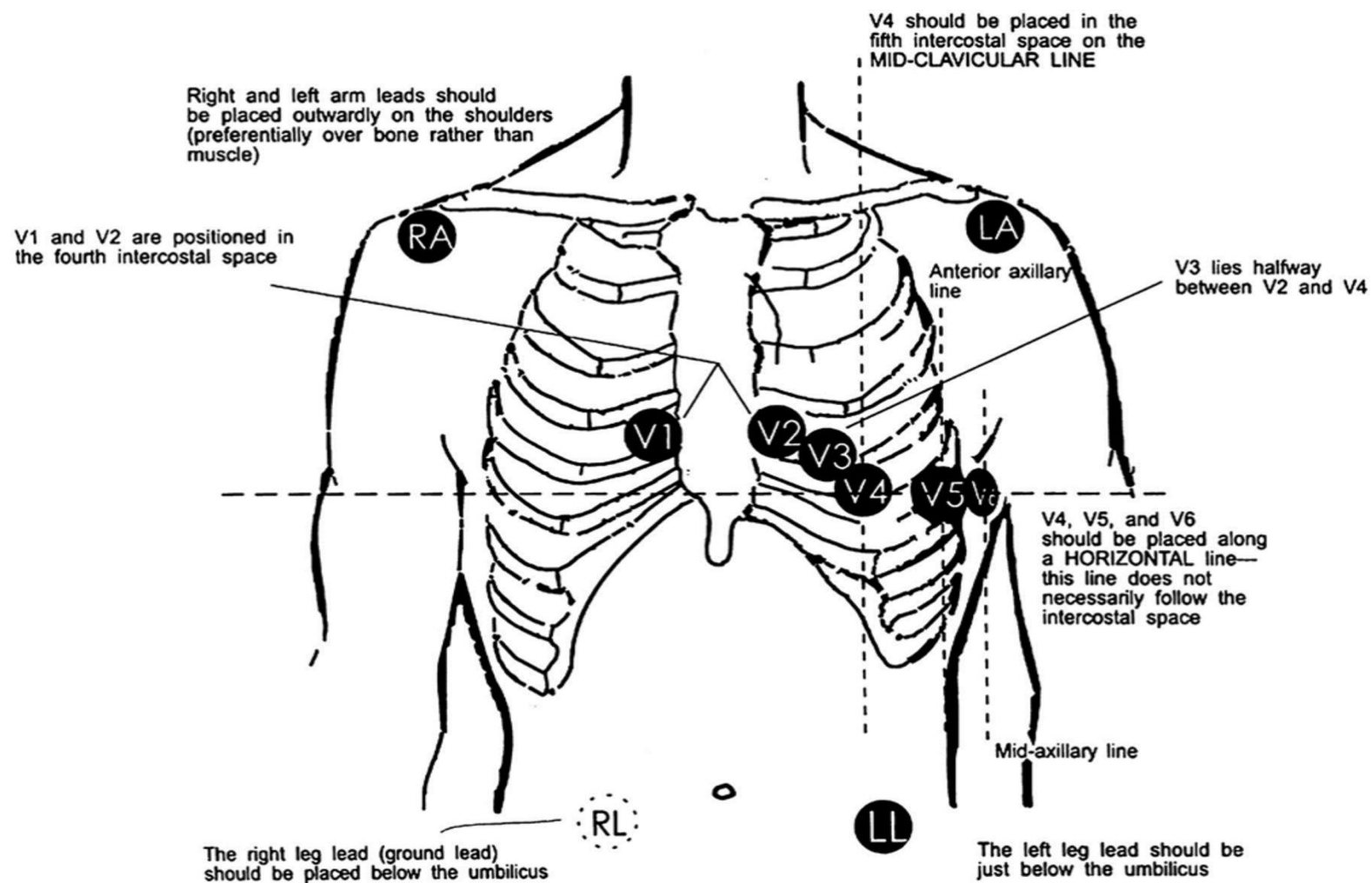
Changes in the ST segment and T-wave morphology in precordial leads can indicate myocardial ischemia or injury.

**Arrhythmias:**

Precordial leads can help in the diagnosis and assessment of certain arrhythmias, particularly those originating in the ventricles.

**Precordial Lead Misplacement:**

Misplacement of precordial leads can lead to significant ECG abnormalities and misdiagnosis.



## **Properties of electro cardiograph paper**

ECG paper is a grid of squares used to record heart activity, with each small square representing 0.04 seconds and each large square representing 0.2 seconds, allowing for easy measurement of heart rate and intervals.

Here's a more detailed breakdown of the properties of ECG paper:

Grid Structure:

### **Small Squares:**

Each small square on the paper represents 0.04 seconds (40 milliseconds).

### **Large Squares:**

Each large square (composed of 5 small squares) represents 0.2 seconds (200 milliseconds).

### **Standard Speed:**

ECG paper is typically set to a standard speed of 25 mm/s, meaning that 1 second of time is represented by 25 mm on the paper.

### **Voltage:**

The vertical axis represents voltage, with each large square usually representing 0.5 mV and each small square representing 0.1 mV.

Time and Voltage Axes:

### **Horizontal Axis (Time):**

The horizontal axis represents time, with the grid allowing for easy measurement of intervals and durations of ECG waves.

### **Vertical Axis (Voltage):**

The vertical axis represents the electrical potential (voltage) of the heart's electrical activity.

Standardization:

### **Standardization Square:**

At the beginning of an ECG, there's a standardization square, usually 10 mm high by 5 mm wide, to ensure proper calibration and voltage measurement.

### **Consistency:**

The grid and paper speed are standardized across most hospitals to ensure consistent interpretation of ECG tracings.

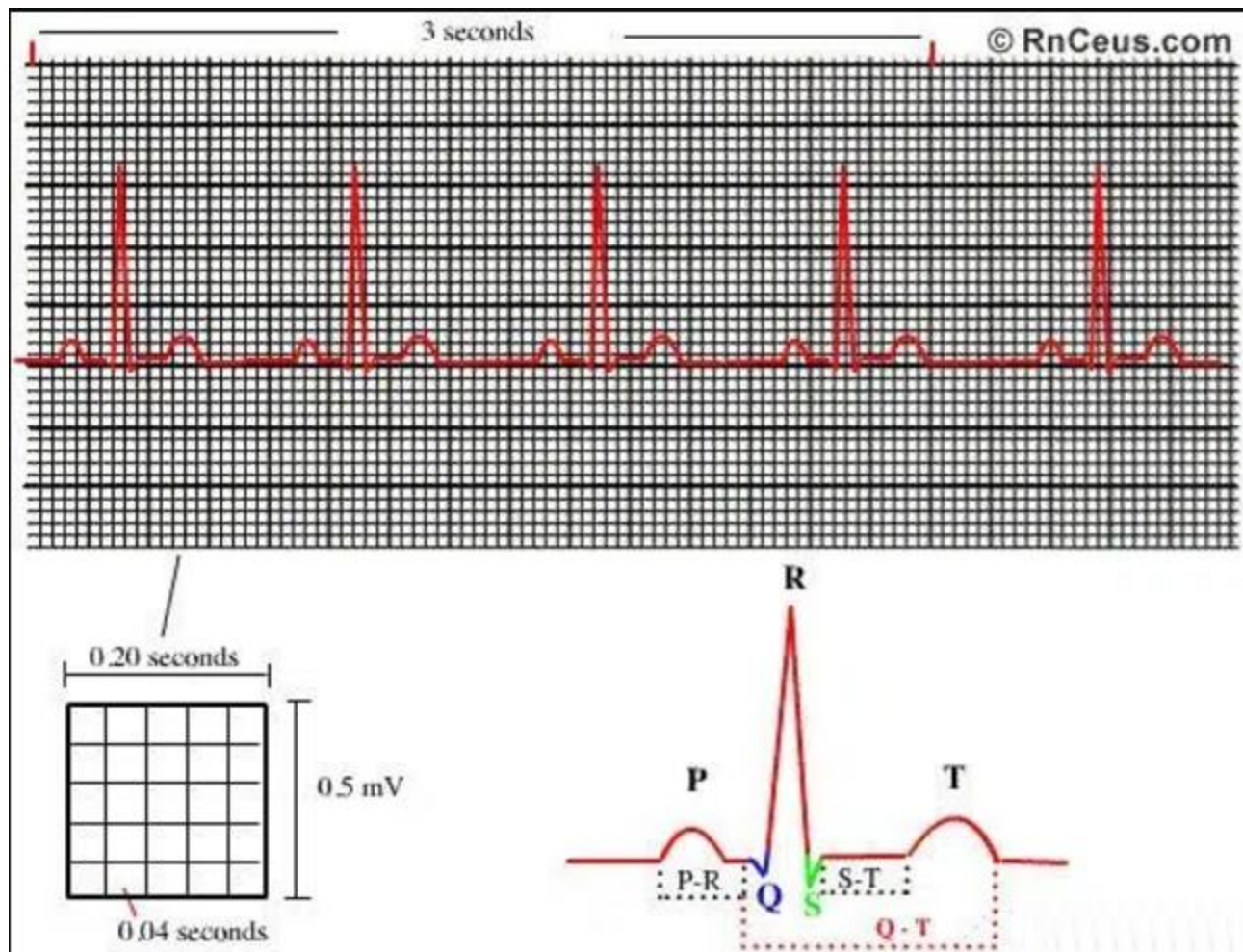
Purpose:

### **Heart Rate and Rhythm Analysis:**

The grid and standardized paper speed allow for accurate measurement of heart rate and rhythm, as well as the duration and amplitude of ECG waves.

### **Identifying Cardiac Abnormalities:**

ECG tracings can help identify various cardiac abnormalities, such as arrhythmias, heart block, and myocardial infarction.



## **Principles of ECG Recording, Paper Speed, Lead Positioning:**

**Principles of ECG Recording:** ECG recording involves placing electrodes on the patient's skin to detect the small electrical changes caused by the heart's depolarization and repolarization. These electrical signals are amplified and recorded as waveforms.

**Explanation:** The electrodes detect the ionic currents produced by cardiac muscle cells during depolarization (the activation of heart muscle cells) and repolarization (the return of heart muscle cells to their resting state). These currents are conducted through the body fluids and tissues to the skin surface, where they can be measured. The ECG machine amplifies these weak signals to make them visible and interpretable.

**Paper Speed:** The standard paper speed is 25 mm/second, allowing for accurate measurement of cardiac intervals.

**Explanation:** This speed ensures that waveforms are spread out enough to be analyzed for duration and timing, which is crucial for diagnosis. A slower speed might compress the waveforms, making it difficult to distinguish between closely spaced events, while a faster speed might spread them out too much, requiring more paper and making it harder to see the overall rhythm. While 25mm/second is standard, other speeds like 50mm/second may be used in specific clinical situations..

**Lead Positioning:** Accurate lead placement is essential for obtaining a reliable and interpretable ECG.

**Explanation:** Standardized positions for limb and chest leads ensure that the ECG records the heart's electrical activity from consistent angles, allowing for comparison and accurate diagnosis. Incorrect placement can lead to misinterpretation of the ECG, potentially resulting in missed diagnoses or incorrect treatment. For example, limb leads are typically placed on the wrists and ankles to minimize muscle artifact, while precordial leads are placed at specific intercostal spaces and lines on the ECG, potentially resulting in missed diagnoses or incorrect treatment.

The P wave on an electrocardiogram (ECG) represents atrial depolarization, the electrical signal that initiates atrial contraction, and is typically a small, positive deflection before the QRS complex.

Here's a more detailed explanation of the P wave:

**What it represents:**

The P wave reflects the electrical activity of the atria, specifically the depolarization (the electrical signal that causes the heart muscle to contract) of the right and left atria.

In electrocardiography (ECG), the R wave is the first positive deflection in the QRS complex, representing the electrical activity during the early phase of ventricular depolarization.

Here's a more detailed explanation of the R wave:

Definition and Properties:

**What it represents:** The R wave signifies the electrical stimulus as it passes through the main portion of the ventricular walls.

**QRS Complex:** The R wave is part of the QRS complex, which represents the depolarization of the ventricles.

**Positive Deflection:** The R wave is a positive (upward) deflection on the ECG tracing.

**Normal Progression:** In the precordial leads (V1 to V6), the R wave amplitude typically increases from V1 to V6, with a corresponding decrease in the S wave depth.

**R-wave peak time:** The time from the onset of QRS complex to the peak of R wave.

**R-wave peak time for right ventricle:** Measured from leads V1 or V2, with an upper range of normal of 35 ms.

**R-wave peak time for left ventricle:** Measured from lead V5 or V6, with 45 ms as the upper range of normal.

**Poor R-wave progression:** Defined by R wave height  $\leq 3$  mm in V3.

The QRS complex on an ECG represents ventricular depolarization, a sequence of electrical activity that occurs as the ventricles contract, and is characterized by a Q wave (initial negative deflection), an R wave (positive deflection), and an S wave (negative deflection).

Here's a more detailed breakdown:

Definition:

**QRS Complex:**

The QRS complex is a group of three waves (Q, R, and S) on an electrocardiogram (ECG) that represent the electrical activity of the ventricles during depolarization (the process of the heart muscle cells getting ready to contract).

**Depolarization:**

Depolarization is the process by which the heart muscle cells become electrically charged, which triggers a contraction.

**Q, R, and S Waves:**

**Q Wave:** The initial downward deflection (negative) of the QRS complex.

**R Wave:** The first upward deflection (positive) of the QRS complex.

**S Wave:** The downward deflection (negative) that follows the R wave.

**Duration:**

The QRS complex normally lasts 80 to 100 milliseconds (0.08 to 0.10 seconds).

**Normal QRS Axis:**

The normal QRS axis should be between -30 and +90 degrees.

Properties:

**Ventricular Depolarization:**

The QRS complex reflects the electrical activity that occurs as the ventricles depolarize, which leads to ventricular contraction.

**R wave is the dominant peak:**

The R wave is the most prominent and tallest component of the QRS complex

## **The electric field of heart**

The heart generates a powerful electromagnetic field with each contraction, detectable throughout the body and even extending outwards, which is stronger than the brain's electromagnetic field.

Here's a more detailed explanation:

### **Electrical Activity:**

The heart's electrical activity, a coordinated depolarization of myocytes (heart muscle cells), produces a current flow that generates both an electric and a magnetic field.

### **Electromagnetic Field:**

This electrical activity can be detected through an electrocardiogram (ECG), which measures the electrical signals of the heart. The heart's magnetic field is also detectable, even outside the body, using sensitive instruments like SQUIDs (Superconducting Quantum Interference Devices).

### **Strength and Extent:**

The heart's electromagnetic field is significantly stronger than the brain's, with the magnetic field being more than 100 times stronger. The heart's electromagnetic field is not limited to the body, but extends out in all directions, and can be measured several feet away from the body.

### **Potential Implications:**

Some research suggests that the heart's electromagnetic field may be an important carrier of information and could potentially influence individuals around us.

### **Heart-Brain Connection:**

The heart's electrical activity can also influence brain activity, as the cardiac field can cause changes in surface potentials on the scalp, superimposed on brain electrical signals.





*ALWAYS KEEP SMILE*