

ECG Operating Procedure

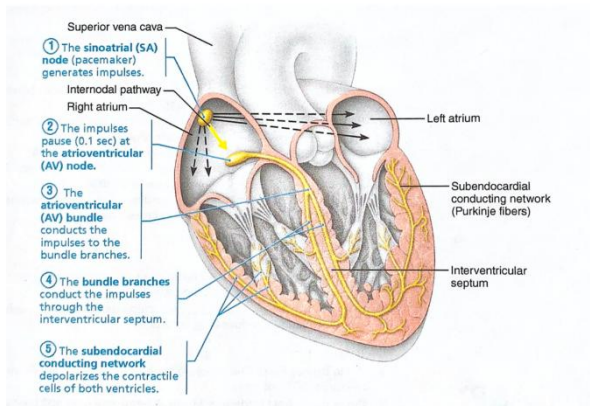
Table of Contents

| | |
|--|----|
| I. The Heart and Electrocardiography (ECG) | 2 |
| 1. The Heart | 2 |
| 2. Electrocardiography (ECG) | 2 |
| 3. ECG Lead and Lead Placement | 3 |
| A. Limb Lead | 4 |
| B. ECG chest | 4 |
| 4. ECG Wave form with Noise and Without Noise | 6 |
| 5. ECG Accessories and Consumables | 7 |
| II. ECG Set up and Performance | 7 |
| 1. Set up | 7 |
| 2. ECG Performance | 8 |
| a. Enter new patient information: | 8 |
| b. Check waveform quality:..... | 8 |
| 3. Printing the Result | 8 |
| 4. After Measurement | 8 |
| III. Safety and Precaution | 9 |
| A. Preparation Before ECG | 9 |
| B. Precautions During and After ECG | 10 |

I. The Heart and Electrocardiography (ECG)

1. The Heart

When the heart contracts, it pumps blood through vessels to deliver oxygen and nutrients while removing waste. Its contractions are triggered by rhythmic electrical depolarization waves generated by specialized pacemaker cells. The sinoatrial (SA) node, located in the right atrium, initiates these impulses, which then spread through the atria, causing atrial contraction. The signal then passes through the atrioventricular (AV) node, bundle of His, bundle branches, and Purkinje fibers to depolarize the ventricles, causing them to contract. This electrical system allows the heart to beat automatically, without direct dependence on the nervous system.

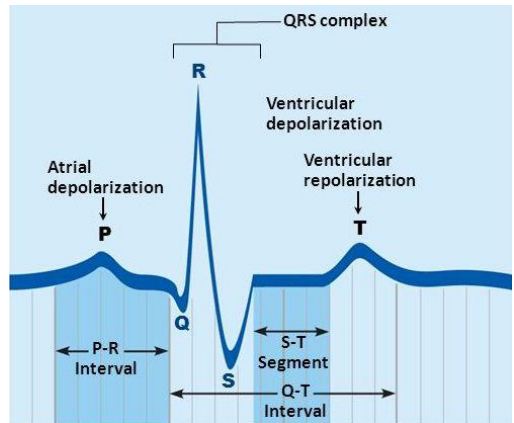


2. Electrocardiography (ECG)

The electrocardiograph is an instrument that detects and records the electrical currents on the body's surface, generated by the

impulses of the heart. This electricity is due to depolarization of cardiac cells, which moves from the atria SA to AV node and from AV node to ventricles.

- The P wave represents atrial depolarization.
- The PR interval is the time between the first deflection of the P wave and the first deflection of the QRS complex.
- The ST segment reflects the period of zero potential between ventricular depolarization and repolarization.
- T waves represent ventricular repolarization.
- The QRS complex represents ventricular depolarization, which is when the ventricles contract to pump blood.



3. ECG Lead and Lead Placement

The heart's electrical activity occurs in three dimensions. However, an ECG can only record voltage differences along a single axis at a time. To see the heart from different angles, we use multiple leads, each representing a different viewpoint of the heart's electrical field. And there several ECG leads such as 12 leads, 3 leads and 5 leads.

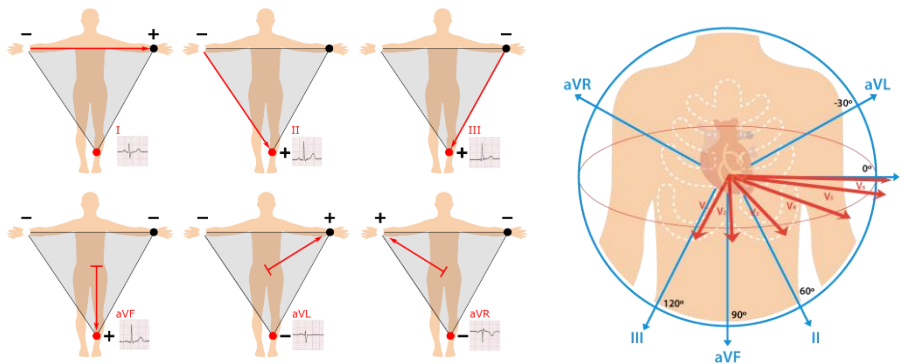
A. Limb Lead

There are 3 bipolar leads and 3 unipolar leads are obtained from 3 electrodes attached to the left arm, the right arm, and the left leg, respectively. The bipolar limb leads reflect the potential difference between two of the 3 limb electrodes:

- lead I: right arm to left arm
- lead II: right arm to left leg
- lead III: left leg to left arm

Unipolar (augmented) leads measure the voltage at one limb electrode compared to an estimated zero potential from the other two electrodes. The augmented leads and their corresponding electrodes are:

- aVR lead: right arm
- aVL lead: left arm
- aVF lead: left leg



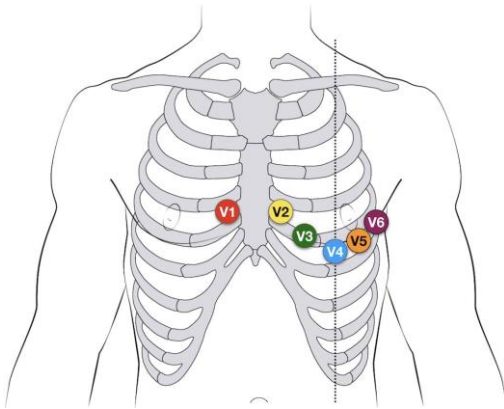
B. ECG chest

Another six electrodes, placed in standard positions on the chest wall, give rise to a further six unipolar leads the chest leads, V1-

V6. The potential difference of a chest lead is recorded between the relevant chest electrode and an estimate of zero potential derived from the average potential recorded from the three limb leads.

- ECG chest lead placement

- V1: 4th intercostal space (ICS), RIGHT margin of the Sternum
- V2: 4th ICS along the LEFT margin of the sternum
- V4: 5th ICS, mid-clavicular line
- V3: midway between V2 and V4
- V5: 5th ICS, anterior axillary line (same level as V4)
- V6: 5th ICS, mid-axillary line (same level as V4)



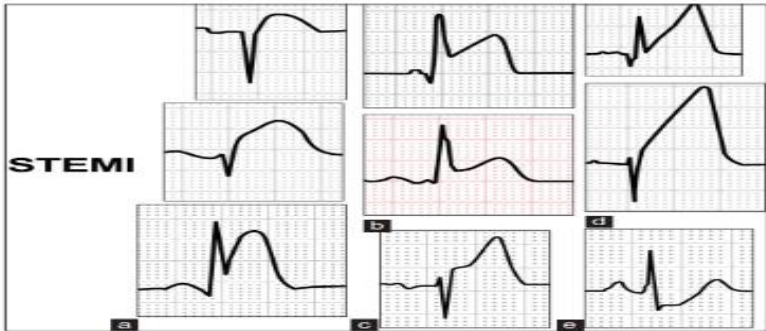
Noted

A 12-lead ECG is essential in detecting heart attacks because it records the electrical activity of the heart from twelve different viewpoints, giving a complete picture of how electrical impulses travel through the heart muscle. Each lead looks at a specific region.

Example,

- Leads II, III, and aVF view the inferior wall.

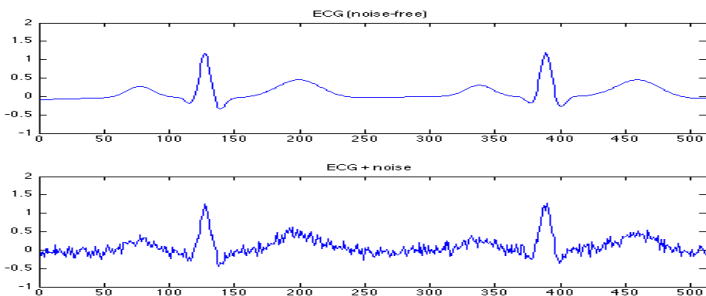
- Leads V1–V4 view the anterior wall.
- Leads I, aVL, V5–V6 view the lateral wall.
- Lead aVR view the upper right side of the heart.
- After a heart attack, the ECG shows changes such as ST-segment elevation or depression, T wave inversion, and sometimes pathological Q waves, indicating heart muscle injury or death in the affected area.



4. ECG Wave form with Noise and Without Noise

There are three filter to reduce or remove the Noise from the ECG wave form:

- Low-pass filter: removes high-frequency noise,
- EMG filter: reduces muscle movement interference.
- AC filter: remove electrical noise.



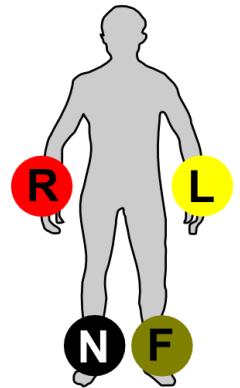
5. ECG Accessories and Consumables

- Patient Cable
- Electrode (Reuse, single use)
- Printing paper
- ECG lead
- ECG gel

II. ECG Set up and Performance

1. Set up

- Connect the ECG power supply cable to the isolation transformer.
- Turn ON the isolation transformer, then turn ON the ECG machine.
- Connect the clamp leads or suction electrodes to the patient cable.
- * For Clamp:
 - a. L: Left arm
 - b. R: Right arm
 - c. F: Left foot
 - d. N: Right foot (used to reduce noise)
- Apply ECG gel on each electrode to detect well signal.
- Connect the ECG leads to the patient (R, L, F, N).
- Ask the patient to remain still and relaxed during measurement.



2. ECG Performance

a. Enter new patient information:

- Press F1 to select a new patient.
- Enter the patient's name.
- Select the sex (Male, Female)
- Click OK, then press button ESC



b. Check waveform quality:

Check the waveform to see if there is any noise

- If noise appears, press button F5, then go to Setup → Filter to adjust the filter
- * Filters:
- Low-pass filter: 75 Hz / 100 Hz / 270 Hz / 300 Hz (choose based on signal quality)
 - EMG filter: must be Turn ON (set to 25 Hz, 35 Hz, or 45 Hz)
 - AC filter: Must be ON
 - After select the value of the filter Click OK, then press button ESC

3. Printing the Result

- Once the waveform is clear and free from noise, press Print/Stop to print the result.
- Press Print/Stop again to stop printing.

4. After Measurement

- Remove the electrodes from the patient.
- Clean the electrodes and patient cable with tissue or alcohol 70% wipes for disinfection.

- Turn OFF the ECG and isolation transformer.

III. Safety and Precaution

A. Preparation Before ECG

- Check the power supply:
 - Ensure the ECG is connected through an isolation transformer or medical-grade power outlet.
 - Avoid using damaged or ungrounded sockets.
- Inspect all cables and electrodes:
 - Make sure patient leads, electrodes, and power cords are not broken, cracked, or frayed.
 - Replace any damaged parts immediately.
- Clean and dry the equipment:
 - Ensure the machine, cables, and electrodes are clean and dry before connecting to the patient.
 - Avoid using ECG near water or wet surfaces.
- Check grounding:
 - Verify that the ECG device is properly grounded to prevent leakage current.
 - Never remove the grounding pin from the plug.
- Patient preparation:
 - Ensure the patient's skin is clean and dry where electrodes will be placed.
 - Remove excess hair or oil for better contact and less noise.

B. Precautions During and After ECG

- Never touch the patient and electrical outlet at the same time.
- Avoid using other electrical devices (like infusion pumps or chargers) on the same outlet unless properly isolated.
- Keep all connections secure.
- Do not open or repair the ECG machine while it is powered on.
- Regular electrical safety testing(During maintenance and calibration)
 - Test the ECG periodically using IEC 62353 or equivalent safety standards.
 - Check leakage current, insulation resistance, and earth continuity.
- Turn off and unplug the device after use.
- Store it in a dry, dust-free area.