

<< MENU >>

The Electrocardiogram (ECG)

<< MENU >>

The ECG

- The ECG is a voltmeter
 - Records electrical voltages (potentials) generated by depolarization of heart muscle
- Electrical activity within the heart can be observed by means of electrodes connected by cables to an ECG machine

<< MENU >>

The ECG

- Can provide information about:
 - The orientation of the heart in the chest
 - Conduction disturbances
 - The electrical effects of medications and electrolytes
 - The mass of cardiac muscle
 - The presence of ischemic damage

<< MENU >>

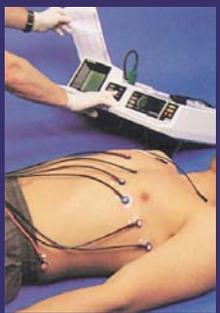
The ECG

- Does not provide information about the mechanical (contractile) condition of the myocardium
 - Evaluated by assessment of pulse and blood pressure

<< MENU >>

Electrodes

- Disposable disk electrodes contain conductive media
 - Conductive media conducts the skin surface voltage change through color-coded wires to a cardiac monitor
- Applied at specific locations on the patient's chest wall and extremities



<< MENU >>

Leads

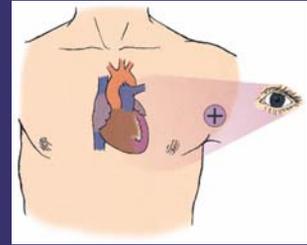
- A **lead** is a record of electrical activity between two electrodes
 - Allow viewing of the heart's electrical activity in two different planes: frontal (coronal) or horizontal (transverse)
- Each lead records the average current flow at a specific time in a portion of the heart

Types of Leads

- There are three types of leads:
 - Standard limb leads
 - Augmented leads
 - Precordial (chest) leads

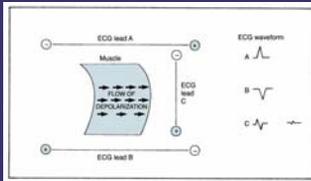
Leads

- Think of the positive electrode as an eye
 - The position of the positive electrode on the body determines the portion of the heart "seen" by each lead



Waveform Deflections

- If the wave of depolarization moves toward the positive electrode, the waveform recorded on the ECG graph paper will be upright
- If the wave of depolarization moves toward the negative electrode, the waveform produced will be inverted

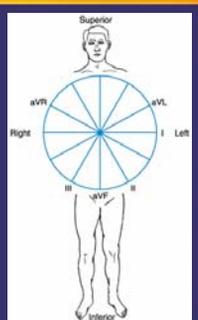


Waveform Deflections

- A biphasic (partly positive, partly negative) waveform is recorded when the wave of depolarization moves perpendicularly to the positive electrode
- When electrical activity is not detected, a straight line is recorded called the "baseline" or "isoelectric" line

Frontal Plane Leads

- Six leads view the heart in the frontal plane as if the body were flat: three bipolar leads and three unipolar leads
- Bipolar lead
 - A lead that consists of a positive and negative electrode
 - Leads I, II, and III



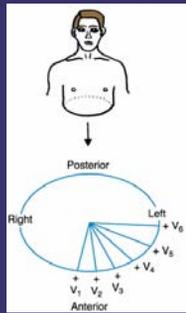
Frontal Plane Leads

- Unipolar lead
 - A lead that consists of a single positive electrode and a reference point
 - Augmented limb leads
 - Leads aVR, aVL, and aVF

<< MENU >>

Horizontal Plane Leads

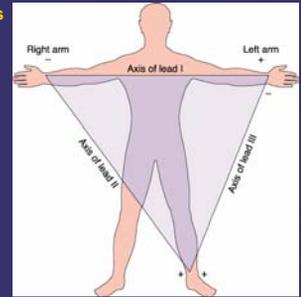
- Six precordial (chest or V) leads view the heart in the horizontal plane
- Precordial leads - V1, V2, V3, V4, V5, and V6



<< MENU >>

Standard Limb Leads

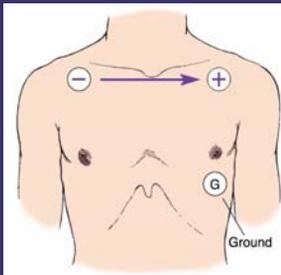
- Leads I, II, and III make up the standard limb leads
- In the bipolar leads:
 - Right arm electrode is always negative
 - Left leg electrode is always positive



<< MENU >>

Lead I

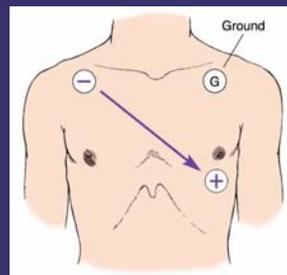
- Records the difference in electrical potential between the left arm (+) and right arm (-) electrodes
- Views the lateral wall of the left ventricle



<< MENU >>

Lead II

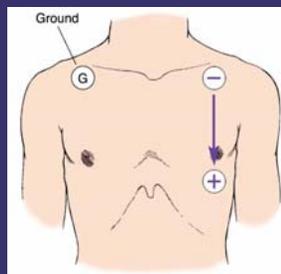
- Records the difference in electrical potential between the left leg (+) and right arm (-) electrodes
- Views the inferior surface of the left ventricle



<< MENU >>

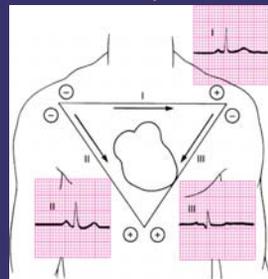
Lead III

- Records the difference in electrical potential between the left leg (+) and left arm (-) electrodes
- Views the inferior surface of the left ventricle



<< MENU >>

Limb Leads – Waveform Comparison



< MENU >

Summary of Standard Limb Leads

• Lead	• Positive Electrode	• Negative Electrode	• Heart Surface Viewed
• Lead I	• Left arm	• Right arm	• Lateral
• Lead II	• Left leg	• Right arm	• Inferior
• Lead III	• Left leg	• Left arm	• Inferior

< MENU >

Modified Chest Leads

- The modified chest leads (MCLs) are bipolar precordial (chest) leads that are variations of the unipolar precordial leads
 - Each MCL consists of a positive and negative electrode applied to a specific location on the thorax

< MENU >

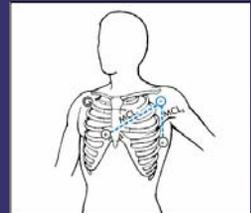
Modified Chest Leads

- MCLs are useful in:
 - Detecting bundle branch blocks
 - Differentiating SVT from VT

< MENU >

Lead MCL₁

- A variation of the precordial lead V₁
 - Negative electrode below left clavicle toward left shoulder
 - Positive electrode right of sternum in 4th intercostal space
- Views the ventricular septum



< MENU >

Lead MCL₁

- Because the primary wave of depolarization is directed toward the left ventricle, the QRS complex recorded in this lead will normally appear negative



< MENU >

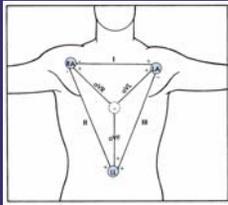
Lead MCL₆

- A variation of precordial lead V₆
 - Negative electrode below left clavicle toward left shoulder
 - Positive electrode 5th intercostal space, left midaxillary line
- Views the low lateral wall of the left ventricle



Augmented Limb Leads

- Leads aVR, aVL, and aVF make up the augmented limb leads
 - A = augmented
 - V = voltage
 - R = right arm
 - L = left arm
 - F = foot (usually the left leg)
- Unipolar leads
 - Consist of only one electrode on the body surface



Augmented Limb Leads

- Lead aVR
 - Views the heart from the right shoulder
 - Does not view any wall of the heart
- Lead aVL
 - Views the heart from the left shoulder
 - Oriented to the lateral wall of the left ventricle
- Lead aVF
 - Views the heart from the left foot (leg)
 - Views the inferior surface of the left ventricle

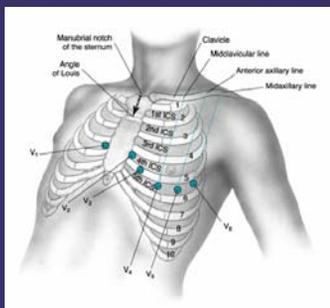
Summary of Augmented Leads

•Lead	•Positive Electrode	•Heart Surface Viewed
•Lead aVR	•Right arm	•None
•Lead aVL	•Left arm	•Lateral
•Lead aVF	•Left leg	•Inferior

Precordial (Chest) Leads

- The six precordial leads are unipolar leads
 - View the heart in the horizontal plane
 - Identified as V₁, V₂, V₃, V₄, V₅, and V₆
- Each electrode placed in a V position is a positive electrode
 - Leads V₁ and V₂ lie over the right ventricle
 - Leads V₃ and V₄ lie over the interventricular septum
 - Leads V₅ and V₆ lie over the left ventricle

Precordial (Chest) Leads



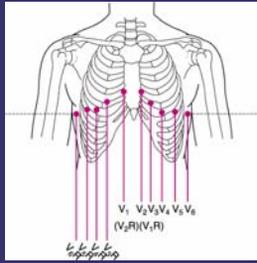
Summary of Precordial Leads

•Lead	•Positive Electrode Position	•Heart Surface Viewed
•Lead V ₁	•Right side of sternum, 4 th intercostal space	•Septum
•Lead V ₂	•Left side of sternum, 4 th intercostal space	•Septum
•Lead V ₃	•Midway between V ₂ and V ₄	•Anterior
•Lead V ₄	•Left midclavicular line, 5 th intercostal space	•Anterior
•Lead V ₅	•Left anterior axillary line at same level as V ₄	•Lateral
•Lead V ₆	•Left midaxillary line at same level as V ₄	•Lateral

<< MENU >>

Right Precordial Leads

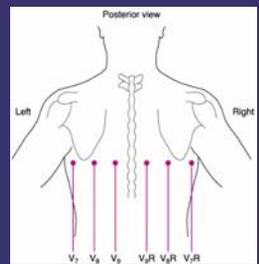
- Used to view the right ventricle
- Placement identical to standard precordial leads except on the right side of the chest
 - If time does not permit obtaining all of the right precordial leads, V_4R is the lead of choice



<< MENU >>

Posterior Precordial Leads

- Used to view the posterior surface of the heart
- Placed on the same horizontal line as V_4 to V_6
 - V_7 - posterior axillary line
 - V_8 - posterior scapular line
 - V_9 - left border of spine

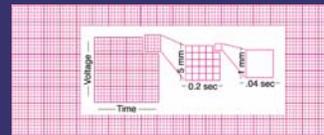


<< MENU >>

ECG Paper

ECG Paper

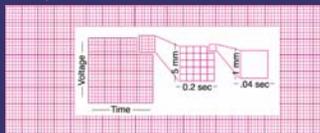
- ECG paper is graph paper made up of small and larger, heavy-lined squares
 - Smallest squares are 1 mm wide and 1 mm high
 - 5 small squares between the heavier black lines
 - 25 small squares within each large square



<< MENU >>

Horizontal Axis = Time

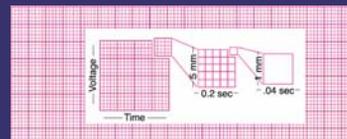
- Width of each small box = 0.04 second
- Width of each large box (5 small boxes) = 0.20 second
 - 5 large boxes (each consisting of 5 small boxes) = 1 second
 - 15 large boxes = 3 seconds
 - 30 large boxes = 6 seconds



<< MENU >>

Vertical Axis = Voltage/Amplitude

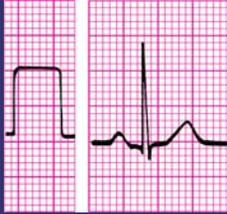
- Size or amplitude of a waveform is measured in millivolts (voltage) or millimeters (amplitude)



<< MENU >>

Calibration

- When the ECG machine is properly calibrated, a 1-millivolt electrical signal will produce a deflection that measures exactly 10 millimeters tall



<< MENU >>

Artifact

- Distortion of an ECG tracing by electrical activity that is noncardiac in origin
- Can mimic various cardiac dysrhythmias, including ventricular fibrillation
- Patient evaluation essential before initiating any medical intervention

<< MENU >>

Causes of Artifact

- Loose electrodes
- Broken ECG cables or broken wires
- Muscle tremor
- Patient movement
- External chest compressions
- 60-cycle interference

<< MENU >>

Artifact – Loose Electrodes



<< MENU >>

Artifact – Muscle Tremor



<< MENU >>

Artifact – 60-cycle Interference

