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Biopac Student Lab® Lesson 6
ELECTROCARDIOGRAPHY (ECG) II
Data Report
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ELECTROCARDIOGRAPHY II

- *Bipolar Leads (Leads I, II, III,) Einthoven's Law, and*
- *Mean Electrical Axis on the Frontal Plane*

DATA REPORT

Student's Name: Thisari Amarasekara
Lab Section: Electrocardiography (ECG) II
Date: 11/28/2022

Subject Profile

Name: D.K.D.Dewagiri________________ Height: 172cm________

Age: 22________ Gender: Male / ~~Female~~ Weight: 52kg________

I. Data and Plots

A. **Einthoven's Law—Simulated Confirmation: Lead I + Lead III = Lead II**

Table 6.1 Supine

Lead	*Same Single Cardiac Cycle*	mV*
Lead I	1 Delta	0.31494
Lead III	2 Delta	0.68725
Lead II	40 Delta	1.00219

*Include the polarity (+ or -) of the Delta result since R-waves may be inverted on some of the leads.

B. **Mean Electrical Axis of the Ventricles (QRS Axis) and Mean Ventricular Potential—Graphical Estimate**

Use Table 6.2 to record measurements from the Data Analysis section:

Table 6.2

CONDITION	QRS Lead I (1 Delta)	QRS Lead III (2 Delta)
Supine	0.31494	0.68725
Seated	0.29510	0.71289
Start of inhale	0.29022	0.70892
Start of exhale	0.33752	0.59417

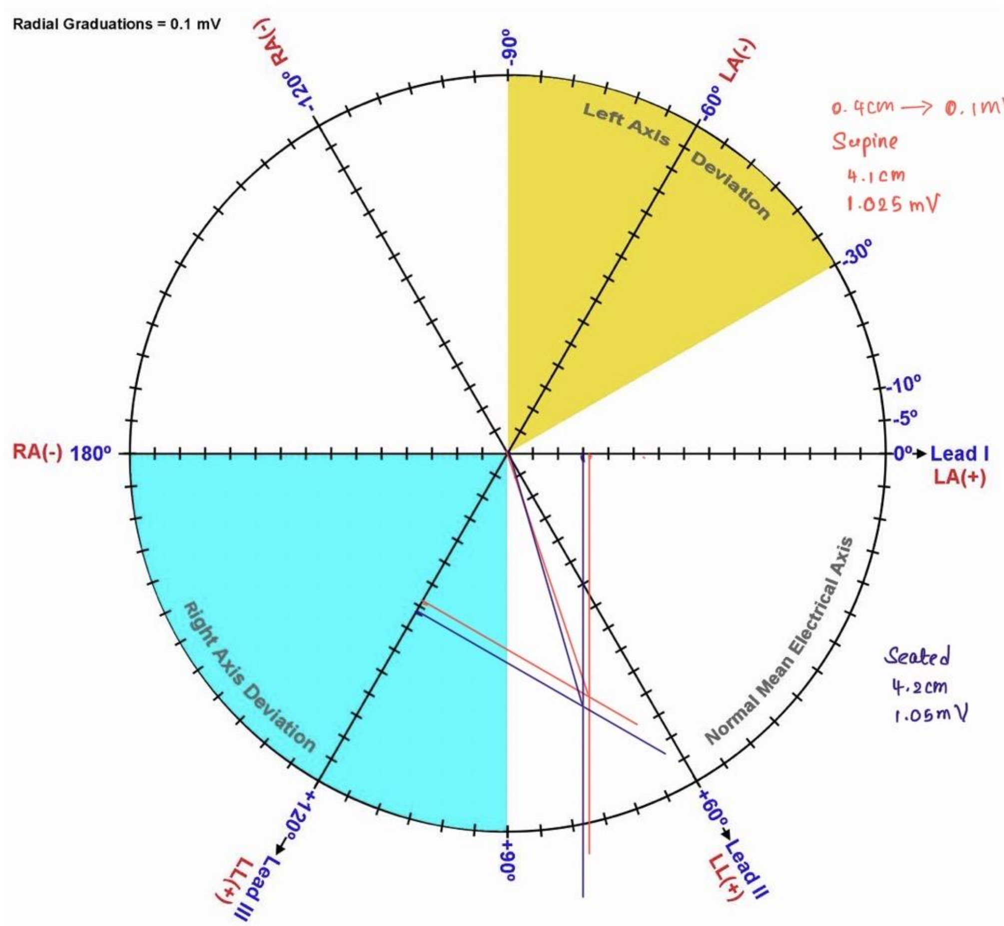
One way to approximate the mean electrical axis in the frontal plane is to plot the magnitude of the R wave from Lead I and Lead III, as shown in the Introduction (Fig. 6.4).

1. Draw a perpendicular line from the ends of the vectors (right angles to the axis of the Lead) using a protractor or right angle guide.
2. Determine the point of intersection of these two perpendicular lines.
3. Draw a new vector from point 0.0 to the point of intersection.

The direction of this resulting vector approximates the mean electrical axis (QRS Axis) of the ventricles. The length of this vector approximates the mean ventricular potential.

Create two plots on each of the following graphs, using data from Table 6.2. Use a different color pencil or pen for each plot.

Graph 1: *Supine and Seated*



From the above graph, find the following values:

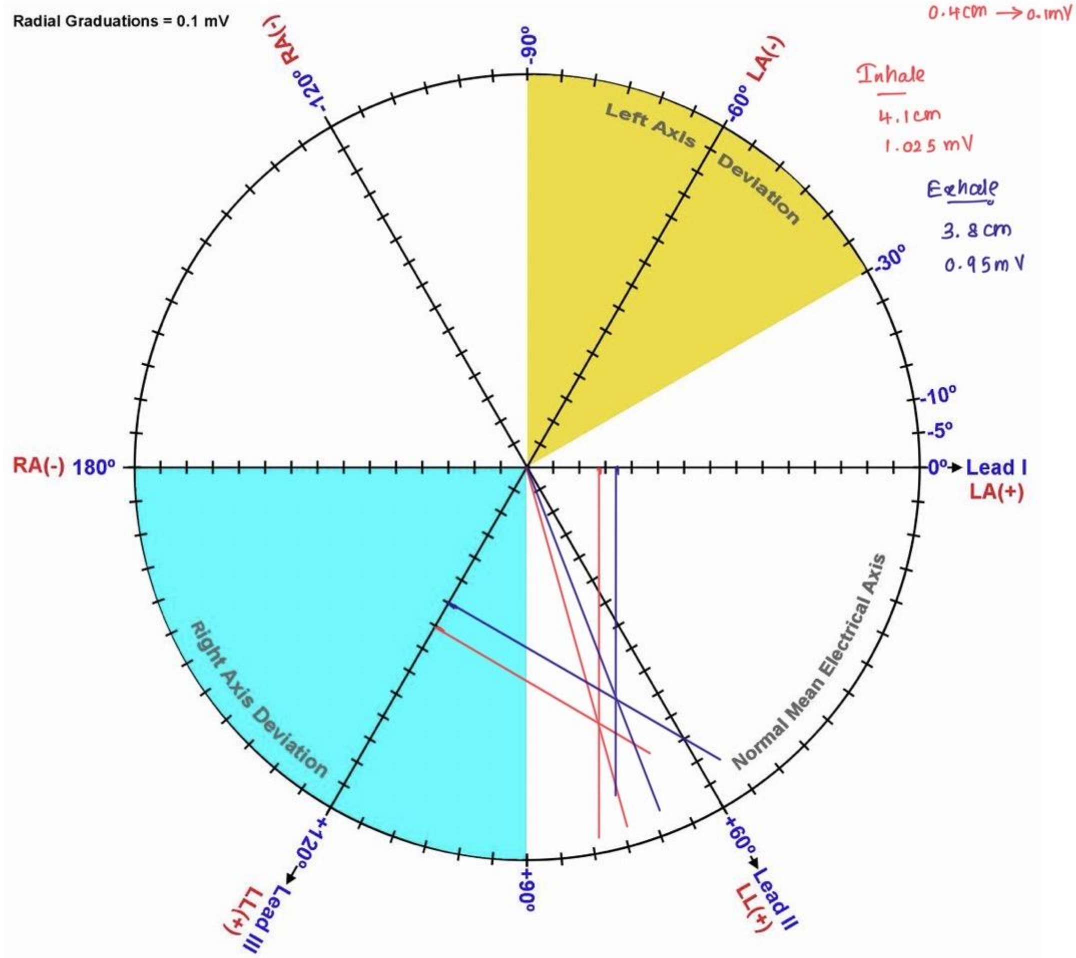
Condition	Mean Ventricular Potential	Mean Ventricular (QRS) Axis
Supine	1.025 mV	72º
Seated	1.05 mV	74º

Explain the difference (if any) in Mean Ventricular Potential and Axis under the two conditions:

The difference in Mean Ventricular Potentials in the tow conditions is almost negligible.

The position of the heart in the chest affects the Mean Ventricular Axis. When the person is in supine position, the heart is typically located towards the back of the chest cavity, closer to the spine due to gravity. This causes a slight shift in QRS axis to the left towards the axis LA(+). When the person is seated, the heart is more vertical causing a slight shift of QRS axis to the right compared to the supine state.

Graph 2: ***Inhale /Exhale***



From the above graph, find the following values:

Condition	Mean Ventricular Potential	Mean Ventricular (QRS) Axis
Start of inhale	1.025 mV	74°
Start of exhale	0.95 mV	69°

Explain the difference (if any) in Mean Ventricular Potential and Axis under the two conditions:
The Mean Ventricular Potentials show very small difference similar to the previous case.
However, the change of the Mean Ventricular Axis more significant comparatively. In start of inhale, the changes in the position of the diaphragm rotates the apex of the heart to the right causing the heart to be more vertical. Hence the QRS axis shifts away from the positive Lead I and towards the positive Lead III.
In start of exhale, the changes of the position of diaphragm causes changes in the apex of the heart. This causes the QRS axis to shift towards the positive Lead I away from the positive Lead III.

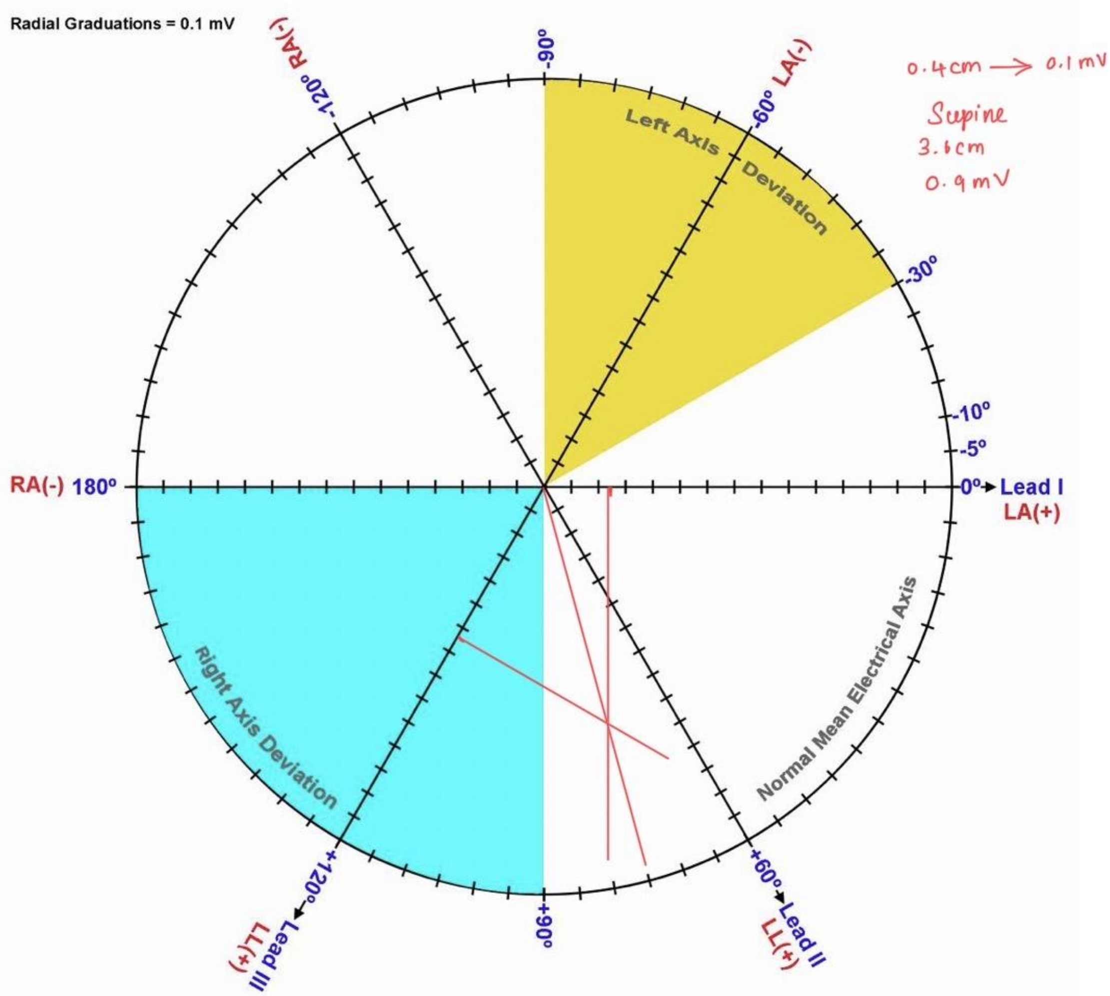
C. **Mean Electrical Axis of the Ventricles (QRS Axis) and Mean Ventricular Potential—More Accurate Approximation**

Use Table 6.3 to add the Q, R, and S potentials to obtain net potentials for Recording 1—Supine.

Table 6.3

POTENTIAL	QRS Lead I 1 Delta	QRS Lead III 2 Delta
Q	0.02990	-0.01464
R	0.30120	0.67932
S	-0.08117	-0.01831
QRS Net	0.24993	0.64637

Graph 3: *Supine*



From the above graph, find the following values:

Condition	Mean Ventricular Potential	Mean Ventricular (QRS) Axis
Supine	0.9 mV	75º

Explain the difference in Mean Ventricular Potential and Axis for the Supine data in this plot (Graph 3) and the first plot (Graph 1).

The difference of the values obtained for Mean Ventricular Potential and the Mean Ventricular Axis is due to including the amplitudes of Q wave and S wave resulting in a more accurate measurement.

II. Questions

D. Define **ECG**.

ECG (electrocardiogram) is a non-invasive test that measures and records the electrical activity of the heart. It graphically represents the electrical impulses that simulates the heart to contract and pump blood throughput the body. During the test, electrodes are attached to the chest, arms and legs which detects and amplify the electrical signal generated by the heart. A normal ECG consists of manly 3 components. Namely, P wave, QRS complex and T wave which represents the atrial depolarization, ventricular depolarization and ventricular repolarization respectively.

E. Define **Einthoven's Law**.

If the electrical potential of any 2 of the three bipolar limb leads are known at any given instance, the third can be calculated by summing the first two algebraically.

Lead I + Lead III = Lead II

F. Define **Einthoven's Triangle** and give an example of its application.

Einthoven's triangle is a formation of three limb leads in an inverted equilateral triangle with the heart as the center formed by the two shoulders and the pubis.

An example for the application of Einthoven's Triangle is in the diagnosis of cardiac arrhythmias. By analyzing the electrical activity of the heart from different angles represented by the leads in Einthoven's Triangle, physicians can determine the type and location of the arrhythmia. It provides a useful visual aid for understanding the spatial orientation of the heart's electrical activity.

G. What normal factors effect a change the orientation of the **Mean Ventricular (QRS) Axis**?

Age – As people age, the axis may shift towards the left due to changes in the heart's structure and function.

Body position – The axis can shift depending on the position of the body. For example, a person when lying down may have a different axis than when they are standing up.

Heart rate – Changes in the heart rate can affect this axis. For example, tachycardia can cause the axis to shift leftward while bradycardia can cause it to shift right.

H. Define **Left Axis Deviation (LAD)** and its causes.

LAD is a condition where Mean Ventricular axis of the heart is shifted towards left side (lies within the frontal plane direction between -30º to -90º. It indicates that the heart's electrical activity is primarily occurring in the left ventricle.

This shift can be caused by a variety of conditions including left ventricular hypertrophy (enlargement of the heart muscle), left bindle branch block, heart attack or abnormalities in conduction in the heart's electrical system.

I. Define **Right Axis Deviation (RAD)** and its causes.

RAD is a condition where Mean Ventricular axis of the heart is shifted towards right side (lies within the frontal plane direction between +90º to +180º. It indicates that the heart's electrical activity is primarily occurring in the right ventricle.

This shift can be caused by a variety of conditions including right ventricular hypertrophy (enlargement of the heart muscle), or conditions that cause right ventricular strain (pulmonary embolism - a blockage in the lung's blood vessels, pulmonary hypertension).

J. What factors affect the amplitude of the R wave recorded on the different leads?

The distance between the heart and the ECG electrode (or limb length) and the direction of the depolarization affects the amplitude of the R wave.

End of Lesson 6 Data Report