Lab Activity 24

EKG


Portland Community College
BI 232
1 second equals 25 little boxes or 5 big boxes.
EKG Waveform

- **P wave** (atria depolarize)
- **Q wave**
- **S wave**
- **T wave** (ventricles repolarize)
- **R wave**
- **P–R interval** (ventricles depolarize)
- **S–T interval**
- **QRS interval**
P Wave

- Indicates atrial depolarization, or contraction of the atrium.
- Normal duration is not longer than 0.11 seconds (less than 3 small squares)
- Amplitude (height) is no more than 3 mm
- Dysfunctions of the sinoatrial node result in the observance of abnormalities in the P-wave; (i.e., longer, wider or absent)
PR Segment

- Measured from the end of the P wave to the beginning of the QRS complex
- This pause is caused by the slow depolarization within the AV node.
PR Interval

• PR interval = P wave + PR segment
• Indicates AV conduction time (depolarization from the SA node through the AV node)
• Duration time is 0.12 to 0.20 seconds
QRS Complex

• Indicates ventricular depolarization, through the Bundle Branches and Purkinje fibers. (Starts the contraction of the ventricles)
• Normally not longer than .10 seconds in duration
ST Segment

- Indicates early ventricular repolarization; the plateau phase
- Represents the ventricles in an active contraction state but with no electrical activity occurring.
- The S-T segment is measured from the end of the QRS complex to the beginning of the T-wave
T Wave

- Indicates the rapid phase of ventricular repolarization
ST Interval

- ST interval = T wave + ST segment
- Represents the complete repolarization phase of the ventricle (plateau phase and rapid phase)
QT Interval

- Represents the duration of ventricular systole (depolarization and repolarization).
- General rule: duration is less than half the preceding R-R interval
Terminology

- **Normal Sinus Rhythm (NSR):** The SA node is pacing the heart (P wave is present) with a rate of 60-100 beats per minute.
- **Sinus Tachycardia:** The SA node is pacing the heart at a rate greater than 100 beats per minute.
- **Sinus Bradycardia:** The SA node is pacing the heart at a rate less than 60 beats per minute.
Rate

- When examining an EKG, you should determine the rate first.
- The time required to record 5 large boxes will be one full second \((0.20 \times 5 = 1.0\ \text{second})\).
- Thus, if a **QRS complex occurs with each large box**, then the R-R interval will be 0.20 second, and the rate of the rhythm is **300 beats/minute** (i.e., 5 beats occur each second \(\times 60\ \text{seconds/minute} = 300/\text{minute}\)).
Rate: 300-150-100-75-60-50

- R-R interval is 1 large boxes, rate = 300 \( (300 \div 1) \)
- R-R interval is 2 large boxes, rate = 150 \( (300 \div 2) \)
- R-R interval is 3 large boxes, rate = 100 \( (300 \div 3) \)
- R-R interval is 4 large boxes, rate = 75 \( (300 \div 4) \)
- R-R interval is 5 large boxes, rate = 60 \( (300 \div 5) \)
- R-R interval is 6 large boxes, rate = 50 \( (300 \div 6) \)

- If the R-R interval is between boxes, you just estimate or divide 1500 by the number of small boxes per R-R interval.
Rate: 300-150-100-75-60-50
Determining Rate

- Find an R wave on a thick line, then start counting

Start here: It is on a thick line

The next R wave is 2.5 large boxes away

2 boxes = 150 and 3 boxes = 100
So 2.5 boxes is about 120 beats/minute
Axis

- **Axis** refers to the average direction of the movement of depolarization, which spreads throughout the heart to stimulate the myocardium to contract.
Vectors

• We can demonstrate the general direction of the heart movement of depolarization by using a vector.

• The average vector (which equals the axis) in a normal heart travels to the left and downward
Vectors

• A vector is the average direction of all of the positive charges as they travel through the myocardium

• Since the left ventricle is thicker, its vectors are bigger (which contributes to the average being toward the left)
Influences on Vector Direction

- Anything that influences the overall amount of charge flowing through the myocardium will change the average direction the charge is flowing.
- Infarction would not have a vector associated with it so the average vector would point somewhat away from that area.
Influences on Vector Direction

- Hypertrophy would have a larger vector associated with it, so the average would point more toward that area (e.g. left side hypertrophy)
Vectors (Math stuff)

- Vectors are described in degrees
  - Remember a circle is 360°, and a line is 180°
- When we calculate the axis, it is expressed as degrees in the frontal plane.
- 0° is horizontal to the left
- +180° is horizontal to the right
- The body is then just divided accordingly (see next slide)
- Since a normal vector is down and to the left, it would be between 0° and +90°
Leads on an EKG
Limb Leads

- If leads I, II, and III are placed around the heart, instead of radiating from the heart, you get a triangle.
- Lead I = Red
- Lead II = Green
- Lead III = Blue
- Each lead has a positive and negative pole
Lead I

- Lead I is the leftward axis
- If the QRS is pointing up (a positive deflection), the wave of depolarization is going towards the left (toward the positive)
Axis and Vectors: Lead I

- Green lines indicate axes of the heart
- The corresponding black lines represent the average vector for that axis in relation to lead I (red line).
- Larger vector, larger the deflection on an EKG
- Vectors A and B = negative deflections on lead I
  - This means the vector is moving away from the positive pole
- Example EKG:

NOTE: Axis D would usually be the closest accurate axis for this picture
Axis and Vectors: Lead I

- Vectors D and E = positive deflections on lead I
  - This means the vector is moving towards the positive pole of lead I
- Example EKG:
  - Why is there no vector for Axis C?
  - What would be the expected deflection on Lead I for Axis C?

NOTE: Axis D would usually be the closest accurate axis for this picture
Example Vectors: Lead I
Lead II

- Lead II is a downward axis
- If the QRS has a positive deflection, the wave of depolarization is downward towards the left foot (towards the positive)
Example Vectors: Lead II
Lead III

• Lead III is a downward axis

• If the QRS has a positive deflection, the wave of depolarization is downward towards the right foot (towards the positive)
Example Vectors: Lead III
Axis:
Putting it Together

- If the QRS is upright in leads I, II, and III then the axis is normal.

The average of the 3 vectors is the axis (about +60°)

Pointing up 5 boxes  Pointing up 15 boxes  Pointing up 10 boxes
Atrial Fibrillation

- This is a result of many sites within the atria firing electrical impulses in an irregular fashion causing irregular heart rhythm.

Notice the absence of P waves and the irregular rate.
Erratic impulses

Sinoatrial (SA) node

Right atrium

Left atrium

Atrioventricular (AV) node
Premature Ventricular Complexes (PVC)

• The ventricles fire an early impulse which causes the heart to beat earlier causing irregularity in the heart rhythm.
3\textsuperscript{rd} Degree or Complete AV Block

- Complete heart block is complete failure of conduction through the AV node.
- The atria and the ventricles are depolarizing independently of each other.
Ventricular Tachycardia

Ventricular Tachycardia (3 or more consecutive beats)
Ventricular Fibrillation

Notice that the first 2 beats of this EKG are Ventricular tachycardia
Ventricular Fibrillation

- Abnormal electrical circuits
- Damaged heart muscle
ST Elevation

ST elevation indicates acute or recent infarction.
T Wave Inversion

T wave inversion is indicative of ischemic heart tissue.

[Graphs showing T wave inversion]
Negative Q-wave

A negative Q-wave is indicative of necrotic heart tissue.
The End