Electrocardiography – Normal

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Objectives

- Recognize the normal ECG tracing
- Calculate the heart rate
- Determine the rhythm
- Calculate the length of intervals and determine the segments deflections
- Draw the Hexagonal axis of the ECG
- Find the mean electrical axis of QRS (Ventricular depolarization)
Principles of Vectorial Analysis of EKG’s

- The current in the heart flows from the area of depolarization to the polarized areas, and the electrical potential generated can be represented by a vector, with the *arrowhead pointing in the positive direction*.
- The length of the vector is *proportional to the voltage of the potential*.
- The generated potential at any instance can be represented by an *instantaneous mean vector*.
- The normal mean QRS vector is $60^\circ$ ($-30^\circ$ - $110^\circ$).
Mean Vector Through the Partially Depolarized Heart
Einthoven’s triangle and law
Axes of the Three Bipolar and Augmented Leads

- aVF
- aVL
- aVR

+ I
- I
+ II
- II
+ III
- III

0° 60° 120° 210° 30°
Axes of the Unipolar Limb Leads
Principles of Vectorial Analysis of EKG’s (cont’d)

- The axis of lead I is zero degrees because the electrodes lie in the horizontal direction on each of the arms.
- The axis of lead II is +60 degrees because the right arm connects to the torso in the top right corner, and left leg connects to the torso in the bottom left corner.
- The axis of lead III is 120 degrees.
Principles of Vectorial Analysis of EKG’s (cont’d)
Principles of Vectorial Analysis of EKG’s (cont’d)

- In figure B, the depolarization vector is large because half of the ventricle is depolarized.
- Lead II should be largest voltage when compared to I and III when the mean vector is 60°.
- In figure C, left side is slower to depolarize.
- In figure D, the last part to depolarize is near the left base of the heart which gives a negative vector (S wave).
- Q wave is present if the left side of the septum depolarizes first.
The T Wave (Ventricular Repolarization)

- First area to repolarize is near the apex of the heart.
- Last areas, in general, to depolarize are the first to repolarize.
- Repolarized areas will have a + charge first; therefore, a + net vector occurs and a positive T wave.
Atrial Depolarization (P-Wave) and Atrial Repolarization (Atrial T Wave)

- Atrial depolarization begins at sinus node and spreads toward A-V node.
- This should give a + vector in leads I, II, and III.
- Atrial repolarization can’t be seen because it is masked by QRS complex.
- Atrial depolarization is slower than in ventricles, so first area to depolarize is also the first to repolarize. This gives a negative atrial repolarization wave in leads I, II, and III.
Vectorcardiogram

- This traces vectors throughout cardiac cycle.
- When half of the ventricle is depolarized, vector is largest.
- Note zero reference point, number 5, is point of full depolarization.
Determining Mean Electrical Axis

- Use 2 different leads
- Measure the sum of the height and the negative depth of the QRS complex
- Measure that value in mm onto the axis of the lead and draw perpendicular lines
- The intersection is at the angle of the mean axis.
Plot of the Mean Electrical Axis of the Heart from Two Electrocardiographic Leads
Lead I
Q = -0.5
R = +5
\[ \frac{+4.5}{+26} \]

Lead III
Q = -4
R = +26
\[ +22 \]
**NORMAL MEAN ELECTRICAL AXIS OF QRS**
From 0 to +90

**LEFT AXIS DEVIATION OF QRS**
From 180 to 360 (-90)

**SEVERE RIGHT OR LEFT AXIS DEVIATION OF QRS**
From 180 to 360 (-90)

**RIGHT AXIS DEVIATION OF QRS**
From +90 to +180

**LEAD I**
From +180 to 0
Heart Rate Calculation

- R-R interval = 0.83 sec
- Heart rate = \(\frac{60 \text{ sec}}{0.83 \text{ sec}}\) = 72 beats/min

min beat
ECG Calculations

- PR interval
- ST segment
- QRS interval
- QT interval

mm/mV 1 square = 0.04 sec/0.1mV
ECG Calculations

Diagram showing ECG waveforms and annotations:
- P Wave
- PR Interval
- QRS Complex
- ST Segment
- T Wave
- U Wave
- QT Interval
- RR Interval
Determine regularity

- Look at the R-R distances (using a caliper or markings on a pen or paper).
- Regular (are they equidistant apart)? Occasionally irregular? Regularly irregular? Irregularly irregular? Interpretation?

Regular
ECG Deflection Waves

(Pacemaker) Sinoatrial node

Atrial depolarization

Atrial repolarization

QRS complex

Ventricular depolarization

Ventricular repolarization

P-Q Interval

S-T Segment

Q-T Interval

Time (s)

0 0.2 0.4 0.6 0.8
ECG Deflection Waves

60 seconds ÷ 0.8 seconds = resting heart rate of 75 beats/minute

1st Degree Heart Block = P-Q interval longer than 0.2 seconds.
Enlarged QRS =

Hypertrophy of ventricles
ECG Deflection Wave Irregularities

Prolonged QT Interval = Repolarization abnormalities increase chances of ventricular arrhythmias.
Elevated T wave: Hyperkalemia
ECG Deflection Wave Irregularities

Flat T wave:

Hypokalemia or ischemia
Thank You