

Electrocardiogram [ECG]

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Learning Objectives

- **Definition of ECG**
- **ECG Paper**
- **Calculation of heart rate from ECG**
- **Leads of ECG & recordings from leads**
- **Einthoven's triangle**
- **Wave of excitation**

Electrocardiogram

- **Summated effect of**
- **Action potentials from cardiac muscle**
- **Can be recorded from the surface**

Electrocardiogram

- **If electrodes are placed**
- **On the skin**
- **On opposite sides of the heart**

Electrocardiogram [ECG]

- **Electrical potentials**
- **Generated by the current can be recorded**
- **The recording is**
- **Known as an *Electrocardiogram (ECG)***

Electrocardiogram [ECG]

- **Record of**
- **Potential fluctuations**
- **During a cardiac cycle**

Electrocardiograph

- **Recording device**
- **Recording Machine**

ECG Paper

- **Recorded on → Heat sensitive paper**
- **Time (Duration) measured on → X-axis**
- **Voltage measured → Y-Axis**

ECG Paper

- **ECG paper has →**
- **Small boxes of → 1 mm²**
- **Five (5) small squares demarcated by →**
- **Thick line**

Horizontal Calibration Line

- **Voltage calibration lines**
- **10 of the small line divisions**
- **Each one → 0.1 mV**
- **Upward or Downward**
- **In the standard ECG represent → 1 millivolt**

Horizontal Calibration Line → Voltage

- **Positivity** → **Upward direction**
- **Negativity** → **Downward direction**

Y – Axis → Each small square

- Each of small square
- On Y- Axis corresponds to → 0.1 mV

Vertical Calibration Line

- **Time calibration lines**

Speed of Typical ECG

- **25 mm per Second**

Each 25 mm → Horizontal direction

- 25 mm → Horizontal direction → 1 second
- 1 mm → 0.04 sec

Each 5 mm Segment →

- Indicated by the → Dark vertical lines
- Represents → 0.20 second

0.20 second intervals broken → 5

- **Broken into 5 smaller intervals**
- **$0.20 / 5 \rightarrow$ Each 1 mm on X-axis $\rightarrow 0.04$ sec**
- **Speed of the ECG Paper $\rightarrow 25$ mm / sec**
- **So 1 mm = 0.04 sec**

X-Axis → Each small 1mm square

- Equal to **0.04 sec**
- When speed of the ECG paper is **25 mm / sec**

Y-Axis → Each small 1mm square

- **Equal to 0.1 mV**

Calibration → Before Recording

- **ECG machine**
- **Calibrated before each recording**
- **For normal recording**

Calibration → Before Recording

- **Instrument has to be Calibrated to show**
- *Displacement of → 10 mm for 1 mV*
- **Each 1mm (Y-Axis) correspond to 0.1mV**

Speed of ECG Paper

- **ECG paper can be moved at 2 Speeds**
- **Depending on type of recording**
- **Normally a speed of → 25mm/sec**

Speed → 25 mm / sec

- **Paper moves a distance of**
- **1500 mm in 1 minute**
- **$25 \text{ mm} \times 60 \text{ sec} = 1500 \text{ mm} / \text{minute}$**

Speed → 50 mm / sec

- **Used when Heart rate (60 to 100 bpm)**
- **Heart rate → High → Tachycardia**
- **Better view of different waves is required**

Rate of Heartbeat from ECG

- **Can be determined**
- **As the heart rate is the**
- **Reciprocal of the time interval**
- **Between two successive heartbeats**

Calculation of Heart rate from ECG

- **1500 / RR interval**
- *1500 / Small squares*
- **Between 2 RR interval**

Calculation of Heart rate from ECG

- **1500 / Small squares between RR Interval**
- **$1500 / 23 = 65$ beats per minute**

Calculation of Heart rate from ECG

- **1500 / Small squares between RR Interval**
- **$1500 / 23 = 65$ beats per minute**

Calculation of Heart rate from ECG

- **Heart rate can be calculated**
- **When heart beats → Regular**
- **Cannot be used → Irregular beats**
- **RR or PR interval will vary**

ECG → Recorded

- **From the surface of the body**
- **Using different electrodes**

Types of Leads

- 1. Bipolar leads**
- 2. Unipolar leads**

ECG → Recorded in Unipolar recording

- Using an
- 1 → Active or Exploring electrode
- 1 → Indifferent electrode at Zero potential

ECG → Recorded in Bipolar recording

- Using an
- 2 → Active or Exploring electrode

Bipolar / Standard Limb Leads

- **Electrical connections between**
- **The Patient's limbs and**
- **The Electrocardiograph for recording ECGs**

3 Bipolar / Standard Limb Leads

- **Leads record**
- **Potential difference**
- **Between → 2 limbs**

“Bipolar” means...

- **The electrocardiogram is recorded**
- **From → Two (2) electrodes**
- **Located → On different sides of the heart**

Bipolar / Standard Limb Leads

- **Two (2) electrodes**
- **Located at → The Limbs**

“Lead” → Not Single wire

- **Is**
- **Not a single wire**
- **Connecting from the body**

“Lead” → Combination of

- **2 wires and their Electrodes**
- **To make a complete circuit**
- **Between the body and Electrocardiograph**

3 Bipolar / Standard Limb Leads

1. Lead I
2. Lead II
3. Lead III

Limb Lead I

- **Negative terminal of the electrocardiograph**
- **Connected to the Right arm →**
- **Positive terminal is connected to the Left arm**

Limb Lead I

- When the point where
- Right arm connects →
- To the chest is electronegative
- With respect to the point where
- The Left arm connects

Limb Lead I → Recoding

- **The electrocardiograph records**
- **Positively**
- **Above the zero voltage line in the ECG**

Limb Lead II

- **Negative terminal of the electrocardiograph**
- **Connected to the Right arm**
- **Positive terminal is connected to the Left leg**

Limb Lead II

- **Right arm →**
- **Electronegative**
- **With respect to**
- **The Left leg**

Limb Lead II → Recoding

- **The electrocardiograph records**
- **Positively**
- **Above the zero voltage line in the ECG**

Limb Lead III

- **Negative terminal of the electrocardiograph**
- **Connected to the Left arm**
- **Positive terminal is connected to the Left leg**

Limb Lead III

- **Left arm →**
- **Electronegative**
- **With respect to**
- **The Left leg**

Limb Lead III → Recoding

- **The electrocardiograph records**
- **Positively**
- **Above the zero voltage line in the ECG**

Einthoven's Triangle

- **The triangle, Called**
- *Einthoven's triangle*
- *Is drawn around the area of the heart*

Einthoven's Triangle → Illustrates

- **The Two arms (Right & Left Arms)**
- **The Left leg**
- **Form → Apices of a triangle**
- **Surrounding the heart**

2 Apices at Upper part of Triangle

- **Represent the points At which**
- **The Two arms → Connect**
- **Electrically with the fluids around the heart**

Lower Apex of Triangle

- **Is the point**
- **At which**
- **The Left leg → Connects with the fluids**

Einthoven's Law

- **If the ECGs are recorded simultaneously**
- **With the three (3) limb leads (I , II, III)**
- **Bipolar or Standard limb leads (I, II, III)**

Einthoven's Law

- **The Summation (+) of the potentials recorded**
- **In Leads I and Lead III**
- **Will equal the potential in Lead II**

Einthoven's Law

- Lead I potential + (Plus)
- Lead III potential
- Equal to → Lead II potential

Einthoven's Law → *Importance*

- **If the electrical potentials of**
- **Any 2 of the 3 bipolar limb electrocardiographic leads**
- **Are Known**
- **At any given instant**

Einthoven's Law → *Importance*

- **The potential of 3rd one**
- **Can be determined**
- *By simply summing the first two*

Einthoven's Law

- Lead I potential + (Plus)
- Lead III potential
- Equal to → Lead II potential

Note → + / - Signs Must

- **That the Positive and Negative signs**
- **Of the different leads**
- *Must be observed*
- **When → Making this summation**

Potential in all 3 Bipolar Limb Leads

- **Lead I = +0.5mV**
- **Lead III = +0.7mV**
- **Lead II = +1.2mV**

Einthoven's Law

- Lead I potential + Lead III potential = Lead II potential
- $(+ 0.5 \text{ mV}) + (+0.7\text{mV}) = (+1.2\text{mV})$

Mathematically Einthoven's Law

- **Holds true at any given instant**
- **While**
- **The three (3) “Standard”**
- **Bipolar ECGs are being recorded**

Recordings of Bipolar / Standard Limb Leads

- **All record**
- **Positive P waves**
- **Positive T waves and**
- **The major portion of the QRS complex**
- **Is also positive in each ECG**

Unipolar (V) Leads → 9

- **9 Unipolar leads**
- **Records → *Potential difference* → between**
- ***An exploring electrode & An indifferent electrode***

Unipolar (V) Leads → 9

- 6 → Standard Unipolar Chest Leads
- 3 → Augmented Unipolar Limb leads
- Total = 9

Chest Leads (Precordial leads)

- ECGs are recorded with
- One electrode placed
- On the → Anterior surface of the chest
- Directly over the heart at V_1, V_2, V_3, V_4, V_5 & V_6

Chest Leads (Precordial leads)

- $V_1 = 4^{\text{th}}$ ICS to the **Right** margin of the Sternum
- $V_2 = 4^{\text{th}}$ ICS at the **Left** margin of the Sternum

Chest Leads (Precordial leads)

- V_4 = 5th ICS Midclavicular line
- V_3 = In between V_2 & V_4
- V_5 = 5th ICS in the Anterior axillary line
- V_6 = 5th ICS in the Mid axillary line

Chest Leads (Precordial leads)

- One electrode placed at → V_1, V_2, V_3, V_4, V_5 & V_6
- This electrode is connected
- To the Positive terminal
- Of the Electrocardiograph [ECG machine]

Chest Leads (Precordial leads)

- **The Negative electrode** → *Indifferent electrode*
- **Is connected through equal electrical resistances**
- *To the Right arm, Left arm, and Left leg*
- *All at the same time*

6 standard Chest Leads are recorded

- **With the chest electrode being placed**
- **Sequentially**
- **At the 6 points shown in the diagram**

6 standard Chest Leads are recorded

- **One at a time**
- **From the → Anterior chest wall**

Different recordings of 6 Chest leads

- **Known as...**
- **Leads V1, V2, V3, V4, V5, and V6**

Chest leads Records Electrical Potential

- **Of the cardiac musculature**
- **Immediately beneath the electrode**
- **Because**
- **The heart surfaces are close to the chest wall**

Unipolar (V) Leads → 9

- 6 → Standard Unipolar Chest Leads
- 3 → Augmented Unipolar Limb leads
- Total = 9

3 **Augmented Unipolar Limb Leads**

- **Unipolar leads**
- **Records Potential difference between**
- **An *Exploring electrode* and *Indifferent electrode***

3 **Augmented Unipolar Limb Leads**

- **Augmented limb leads → Record →**
- **Potential difference between**
- **One Limb & the Other 2 Limbs**

3 **Augmented Unipolar Limb Leads**

- **Two (2) of the limbs are connected**
- **Through Electrical resistances**
- **To the Negative terminal of the ECG machine**

3 Augmented Unipolar Limb Leads

- **The Third (3rd) limb**
- **Is connected → To the Positive terminal**
- **of ECG Machine**

Positive Terminal is on → Right Arm

- **The lead is known as the →**
- **aVR lead**

Positive Terminal is on → Left Arm

- **The lead is known as the →**
- **aVL lead**

Positive Terminal is on → Left Leg

- **The lead is known as the →**
- **aVF lead**

3 **Augmented Unipolar Limb Leads**

1. aVR →

- **Exploring (+Ve) electrode connected to Right Arm**

2. aVL →

- **Exploring (+Ve) electrode connected to Left Arm**

3. aVF →

- **Exploring (+Ve) electrode connected to Left Leg**

Normal recording of Augmented Limb Leads

- **All similar to the standard limb leads**
- **Lead I, II, III recordings**

Normal recording of Augmented Limb Leads

- **Except recording from**
- **The aVR lead is → Inverted**

Normal ECG composed of

- 1. P wave**
- 2. QRS complex**
- 3. T wave**

Normal ECG composed of

- **QRS complex is often**
- **But not always**
- **Three 3 separate waves:**
- **The Q wave, The R wave, and the S wave**

Waves recorded in ECG → Depend

- **On → The Pattern of depolarization**
- **On → Position of the heart**
- **In → Relation to the recording electrodes**

Atria Located →

- **Posteriorly**

Ventricles form →

- **Base**
- **Anterior surface**
- **of the Heart**

Right Ventricle is →

- **Anterolateral →**
- **To the Left ventricle**

Recording from aVR → Inverted

- **aVR → “Looks at” the cavities of the ventricles**
- **Atrial depolarization**
- **Ventricular depolarization**
- **Ventricular repolarization**
- **Move away from the exploring (Positive) electrode**

Recording from aVR → Inverted

- P wave
- QRS complex
- T wave are
- **All negative (downward) deflections**

Recording from aVL, aVF → Positive

- **aVL and aVF look at the ventricles**
- **The deflections are**
- **Therefore**
- **Predominantly “Positive” or “Biphasic”**

Chest leads V_1 & V_2

- No \rightarrow Q-Wave

Chest leads V_1 & V_2 \rightarrow QRS complex

- **A small upward (Positive)deflection**
- **because**
- **Ventricular depolarization first moves across**
- **The mid portion of the septum**
- **From left to right toward exploring electrode**

Large S wave → Negative

- **The wave of excitation**
- **Then moves down the septum**
- **Into the left ventricle**
- **Away → From the exploring (Positive) electrode**
- **Producing a large S wave**

Wave of Excitation

- **Moves →**
- **Towards → Exploring (Positive) electrode**
- **Positive deflection**

Wave of Excitation

- **Moves →**
- **Away from → Exploring (Positive) electrode**
- **Negative deflection**

Return to the Isoelectric Line

- **Wave of excitation finally moves back**
- **Along the ventricular wall**
- **Toward → The electrode**
- **Producing the return to the isoelectric line**

ECG: Waves, Intervals, Segments & Uses

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ECG Waves

- **Composed of both**
- **Depolarization waves**
- **And**
- **Repolarization waves**

Repolarization wave

- **Halfway repolarization of the same muscle fiber,**
- **With**
- **Positivity returning to the outside of the fiber**

Repolarization wave

- **The left electrode is in an area of positivity**
- **The right electrode is in an area of negativity**
- **Consequently,**
- **The recording becomes negative**

P Wave → Atrial Depolarization

- **Occurs →**
- **Electrical potentials generated when**
- **The atria depolarize**
- **At the before**
- **Contraction of the atria**

P Wave → Normal duration

- **0.1 second**
- **Calculated from X-Axis →**
- **Vertical calibration line**

P Wave → Voltage (mV)

- **0.1 to 0.3 millivolts (mV)**
- **Calculated from Y-Axis →**
- **Horizontal calibration line**

P Wave → Upright Wave

- **In all the Leads**
- **Positive wave**

P Wave → Inverted Wave

- In → aVR

P Wave → Inverted Wave

- **In → Nodal rhythm**
- **Nodal rhythm →**
- **Impulses travel in opposite direction**
- **From AV node towards SA node**

P Wave → Absent → SA block

- **SA node (Sinoatrial node → Pacemaker)**
- **Does not generate the impulses**
- **As in → SA Block**

QRS complex → Beginning of Ventricular contraction

- **QRS complex → due to**
- **Potentials generated**
- **When the Ventricles depolarize**
- **Before contraction**

QRS complex → Due to

- **Ventricular depolarization**
- **Atrial repolarization**

QRS Complex → Normal duration

- **0.08 – 0.1 second**

Normal Voltage in ECG

- **On the manner in which the**
- **Electrodes are applied To the surface of the body**
- **How close the electrodes are to the heart**

QRS Complex Voltage → 3 to 4 mV

- **1st electrode is placed directly over the ventricles**
- **2nd electrode is placed**
- **Elsewhere on the body remote from the heart**

QRS Complex Voltage → 1.0 to 1.5 mV

- **When ECGs are recorded from electrodes**
- **On the two arms or (Augmented Limb Leads)**
- **On one arm and one leg (Augmented Limb Leads)**

QRS Complex Voltage → Calculation

- **From**
- **The top of the R wave**
- **To**
- **The bottom of the S wave**

QRS Complex → Importance

- **Helps to determine →**
- **Electrical axis of the heart**

Q R S T Waves → Ventricular complex

- **Average duration of Q R S T → 0.43 seconds**
- **Q R T → 0.08 sec**
- **Should not exceed → 0.1 seconds**

Q Wave → Cause

- **Contraction of**
- **Muscular part of the interventricular septum**

Q Wave → Characteristic

- **Small**
- **Negative wave**
- **Inconspicuous displacement**

Q Wave → Not found

- **Reptiles and Amphibians (e.g. Snakes & Frogs)**
- **Do NOT possess → Interventricular septum**

Q Wave → Congenital patency of septum

- **Q wave → Absent**
- **VSD → Ventricular septum defect**
- **Infants having →**
- **Congenital patency of interventricular septum**

Q Wave → Prominent

- **Old Myocardial Infarction (MI)**

R Wave → Tallest amplitude

- **Constant**
- **Conspicuous**
- **First positive deflection**
- **During ventricular depolarization**

S Wave → Downward deflection

- **Constant but**
- **Inconspicuous**

In Bipolar Limb Lead I →

- **R wave → Right ventricle**
- **S wave → Left ventricle**

In Bipolar Limb Lead III →

- **R wave → Left ventricle**
- **S wave → Right ventricle**

Bundle Branch Heart Block →

- **Duration of the R and S wave →**
- **Prolonged beyond 0.1 second**
- **Amplitude (mV) varies**

T wave → Cause

- **Caused by the action current**
- **Due to the contraction of**
- **The basal parts of the ventricles**

T Wave → Atrial Repolarization

- **Atria repolarize**
- **About 0.15 to 0.20 second**
- **After termination of the P wave**

T Wave → Atrial Repolarization

- **Which is also approximately**
- **When the QRS complex**
- **Is being recorded in the ECG**

T Wave → Atrial Repolarization

- *Atrial T wave*
- **Is usually *obscured* by the**
- **Much *larger QRS complex***

T Wave → Ventricular Repolarization

- **Ventricular Repolarization**
- **Process normally occurs ventricular muscles**
- **After 0.25 to 0.30 seconds after depolarization**

Ventricular Repolarization T wave → Duration

- **0.15 seconds**

T wave in normal ECG is Prolonged wave

- **Ventricular muscle begins to repolarize**
- **In some fibers about 0.20 second after**
- **The beginning of the depolarization wave (QRS)**

T wave in normal ECG is Prolonged wave

- **But in many other fibers it takes**
- **As long as 0.35 second**
- **The process of ventricular repolarization extends**
- **Over a long period → About 0.15 seconds**

Voltage of T wave < Voltage of QRS

- **Because of**
- **Prolonged length of the T wave**

T wave → Normally Positive

- **The apex of the heart repolarize**
- **More earlier than the base of the heart**

T wave → Inverted → III

- **In Lead III → Normal**
- **Without apparent reasons**

T wave → Significance

- **Young adults → Prominent**
- **Old age → Flattened**
- **Exercise → Increases the amplitude in health heart**

T wave → Altered

- **Stimulation of the Vagus (Xth - CN)**
- **By Digitalis & Poisons**
- **Anoxia → Constriction of coronary arteries**

T wave → Inverted → Other Leads

- **Abnormal → Seen in**
 - 1. Myocardial Ischaemia**
 - 2. Myocardial Infarction (MI)**
 - 3. Ventricular Hypertrophy**

T wave → Lead I & II

- **Abnormalities**
- **Size**
- **Shape**
- **Duration**
- **Direction**
- **Reaction to exercise**

**Prognostic
Significance**

**Myocardial damage
Cardiac hypoxia**

U wave → Seen after T wave

- **Inconstant finding**
- **May be due to Ventricular myocytes**
- **With long action potentials**

U wave → Repolarization of

1. Septum of ventricles (**Interventricular**)
2. Papillary muscle

U wave →

- **However,**
- **The contributions to this segment**
- **Are still undetermined**

Duration & Voltage of ECG Waves

ECG Waves	Duration (second)	Voltage (mV)
P wave	0.1	0.1 to 0.3
QRS Complex	0.08 – 0.1	3 to 4 mV 1.0 to 1.5 (Augmented leads)
Ventricular T wave	0.2 – 0.3	-

ECG Intervals

- 1. P – P Interval**
- 2. R – R Interval**
- 3. P – Q or P – R interval**
- 4. QRS duraion**
- 5. Q-T interval**
- 6. S-T interval**

R – R Interval → How to Measure

- **Interval between**
- **2 successive R Waves**

R – R Interval → Significance

- **If the R – R interval in next successive stage**
- **Same → Indicates →**
- **Ventricles depolarizing rhythmically**

P – P Interval → How to Measure

- **Interval between**
- **2 successive P Waves**

P – P Interval → Significance

- **If the P – P interval in next successive stage**
- **Equal →**
- **Rhythmical depolarization of the atrium**

Short notes: 4 Marks

- **Significance of P-R interval in ECG.**
- **Name where P-R interval prolonged**

P-Q or P-R Interval → How to Measure

- **Measured**
- **From → Beginning of P wave**
- **To → Beginning of QRS complex**

P-Q or P-R Interval →

- **Often this interval is called → PR interval**
- **The Q wave is likely to be absent**

P-Q or P-R Interval → Significance

- **Interval between**
- **Beginning of electrical excitation of the Atria &**
- **Beginning of excitation of the Ventricles**

P-Q or P-R Interval → Significance

- **Atrioventricular conduction (AV conduction)**
- **Indicates time for Atrial depolarization**
- **Conduction through the AV node**

P-Q or P-R Interval → Significance

- **Conduction time of the impulse**
- **From the SA node**
- **To the Ventricles**

P-Q or P-R Interval → Variable

- **Variable P – R interval →**
- **Successive stages of**
- **Atrioventricular Dissociation**

P-Q or P-R Interval → Duration

- @ Heart rate → 70 beats / minute
- Range : 0.12 – 0.20 Seconds (**Ganong**)
- Average: 0.18 seconds (**Ganong**)
- **Guyton** : 0.16 Seconds

P-Q or P-R Interval → Shortens

- **As Heart rate → Increases → Tachycardia**
- **From → average of 0.18 s at a rate of 70 beats/min**
- **To → 0.14 seconds at a rate of 130 beats/min**

P-Q or P-R Interval → Increases in

- **Wenckebach Phenomenon**
- **Form of → Incomplete heart block**
- **P – R interval gradually prolonged**
- **Until → Ventricular beat is missed**

P-Q/P-R Interval → Very Short → WPW

- **Wolff – Parkinson-White (WPW) syndrome**
- **Additional Muscular or Nodal tissue connection**
- **Between Atria & Ventricle → Bundle of Kent**

P – R Interval → WPW Syndrome

- **Bundle of Kent →**
- **Conducts excitation impulses**
- **Faster to one ventricles than**
- **Slow conducting AV- node (0.1 second delay)**

WPW Syndrome

- **Wolff – Parkinson-White (WPW) syndrome**
- **Shorter PR Interval**
- **Prolonged QRS complex**

Wolf -Parkinson-White Syndrome

- **Bundle of Kent**
- **Shorter PR or PQ Interval**
- **Prolonged QRS complex**

QRS Duration → Normal

- **Range : 0.08 – 0.1 Seconds**

QRS Duration → How to measure

- **Beginning of the Q wave**
- **To**
- **End of S wave**

QRS Duration → Significance

- **Measures →**
- **Total ventricular depolarization time**

Q – T Interval → How to Measure

- **Measured**
- **From → Beginning of Q wave or**
- **From → Beginning of R wave (If Q-wave Absent)**
- **To → End of T wave**

Q – T Interval → Significance

- **Ventricular Action potential**
- **Ventricular electrical events**
- **Depolarization & Repolarization**

Q – T Interval → Significance

- **Measures →**
- **The ventricular total systolic time**

Q – T Interval → Duration

- **Range : 0.40 – 0.43 Seconds (Ganong)**
- **Average: 0.40 seconds (Ganong)**
- **Guyton : 0.35 Seconds**

Q – T Interval → Reduced

- Can be lower → 0.35
- Depending on the heart rate

Q – T Interval → Altered

- Drug → Quinidine

S – T Interval → How to Measure

- **ST interval = QT Interval – QRS duration**
- **ST interval = 0.40 – 0.08**
- **ST Interval = 0.32 seconds**

S – T Interval → Significance

- **Plateau portion of the**
- **Ventricular Action potential**

T – P Interval → How to measure

- **End of T wave**
- **To**
- **Beginning of P wave**

T – P Interval → Significance

- **Alteration of this interval**
- **Indicates → Alteration of the heart rate**

T – P Interval → Measures

- **The diastolic period of the heart**

ECG Segments

1. S-T segment
2. P-Q segment

S – T Segment → How to Measure

- **Segment Between →**
- **End of S wave**
- **Beginning of T wave**

S – T Segment → Isoelectric line

- **Present on → Isoelectric line**
- **Ventricles completely depolarised**
- **No potential difference recorded in S-T segment**

S – T Segment → Duration

- **Average: 0.32 seconds**

S – T Segment → Depression

- **Ischaemia Ventricular muscle**
- **Causes → Depression of ST segment**

S – T Segment → Elevation

- **Acute Myocardial Infarction → Acute MI**

S – T Segment

- **Why ST segment elevation or depression occurs..?**

Myocardial Ischaemia & Infarction

- **Ventricular muscles**
- **Not → Completely depolarized →**
- **Partly depolarized**
- **Potential difference is recorded**

Myocardial Ischaemia & Infarction

- **Potential difference →**
- **Shift the ST segment**
- **From the Isoelectric line**
- **ST depression → Ischaemia**
- **ST elevation → Infarction**

S – T Depression → Myocardial Ischaemia

- **ST depression → Ischaemia**

S – T Elevation → Myocardial Infarction

- **ST elevation → Infarction**

ECG Intervals

ECG Interval	Duration (seconds)
P – Q or P – R	Guyton → 0.16 Ganong → 0.12 to 0.20
QRS Duration	0.08 – 0.1
Q – T	Guyton → 0.40 to 0.43 Ganong → 0.35