



Electrocardiogram

"ECG"

2nd edition



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First of all :

What's ECG ?

How record looks like ?

How could we record ?

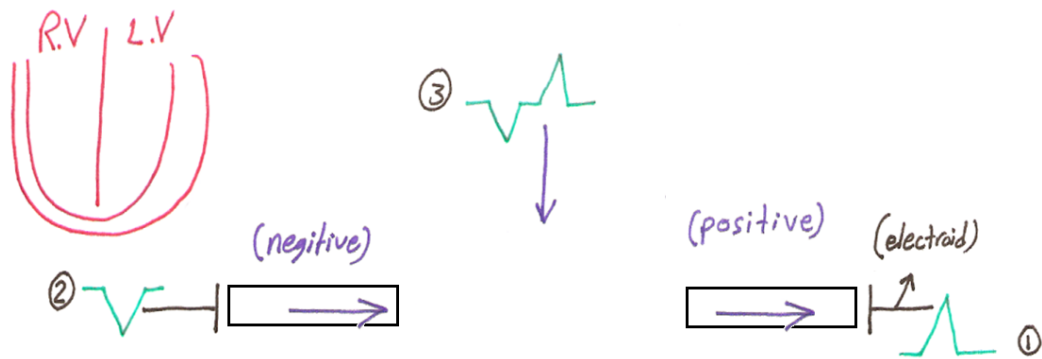
And what's the difference between the Action potential and the ECG ?

Action potential is a record from one single cell , BUT **ECG** is from all cardiac cell during a cardiac cycle.

ECG : is algebraic sum of all action potential.

Is : a record of fluctuating (change) action potential in one cardiac cycle

Electrode is placed away from the heart:



Electrode : it picks up the action potential

- ① : if the direction of impulse is going to the electrode , it cause positive wave (+)
- ② : if the direction of impulse is going away from the electrode , it cause negative wave (-)
- ③ : If the recorded from the middle , it will cause both positive and negative wave

Electrode is placed between the heart:

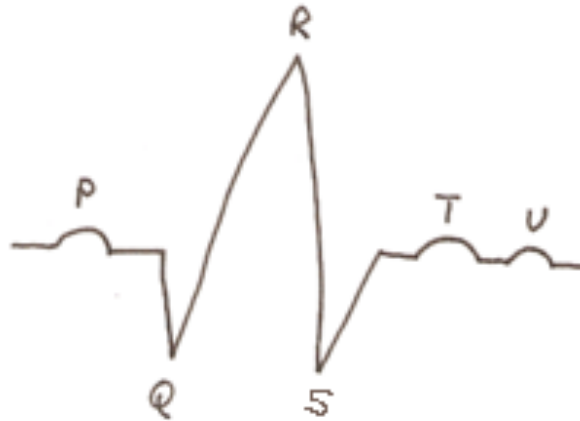
if we record from this electrode only ① ⇒
 small - Big =
 (negative)
 The arrow (→) is moving away of the electrode ①



if we record from this electrode ② only.
 Big - small -
 (positive)
 → The arrow is moving to the electrode ②

Rule : direction of impulse from inside (endocardium) to outside (epicardium)

ECG Diagram



P wave : because of the atrial depolarization

Q R S wave : ventricular depolarization

T wave : ventricular repolarization

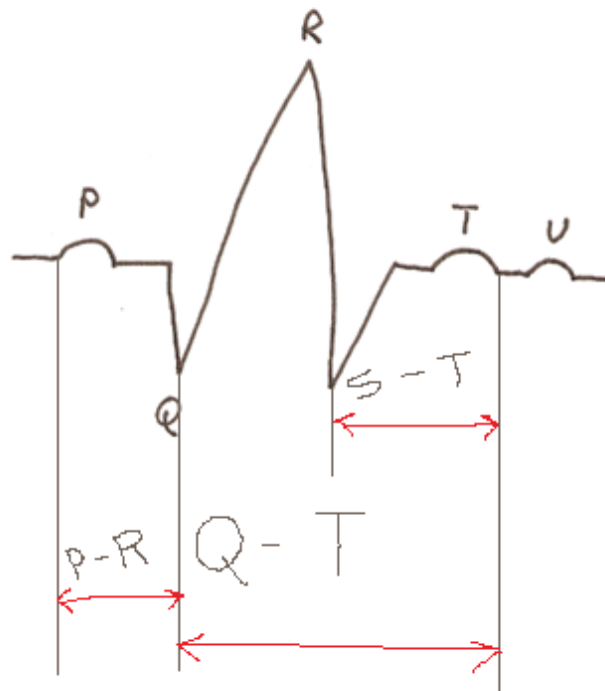
U wave : slow repolarization of papillary muscle

BY THE WAY !

U wave is not always present (inconstant wave)

You can't see atrial repolarization , it's "barred " in **Q R S** wave

.. continued



P-R Interval : (it's actually P-Q interval as we can noticed from the figure):

It's formed when the impulse starts from SA node → AV → node Bundle of His → Branches → Purkinje Fibers

So P-R interval is the time taken for impulse to move from SA node to Purkinje Fibers

Normal time : 0,12 to 0,21 second

Q-T interval : is the time between ventricular depolarization (contraction) and ventricular repolarization (relaxation) .

Q-T interval is indirectly ..

Normal time : 0.32 to 0.42

S-T segment : it's on the base line so we'll call it isoelectiric . it's telling us that total ventricular depolarization has finished already

ECG, how to record ?

There are 12 leads (places) to record the whole heart , **why ?**

Because it covers all heart , circulation the heart and record from each

Types of leads

Bi-polar

contains 3 leads

called standard leads

Written in roman numbers : **I , II and III**

Uni-polar

contains 9 leads

V means uni-polar recording

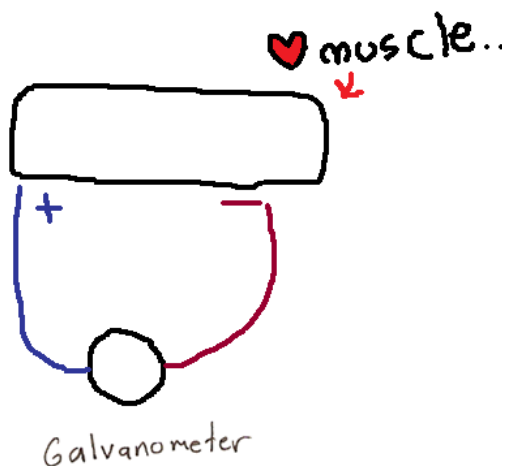
it's divided into :

① **Chest : has 6 leads V1- V6**

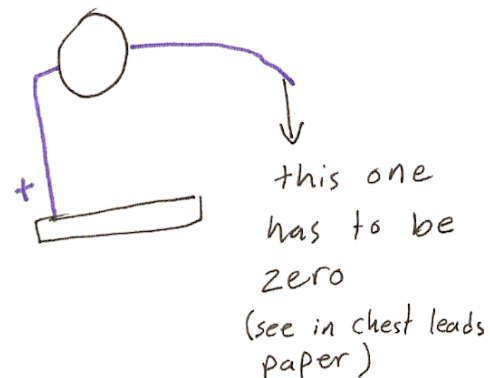
② **Augmented : has 3 leads**

Augmented means Increase up to 50 %

Bi-polar..

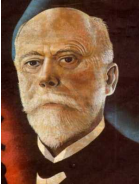


Uni-polar



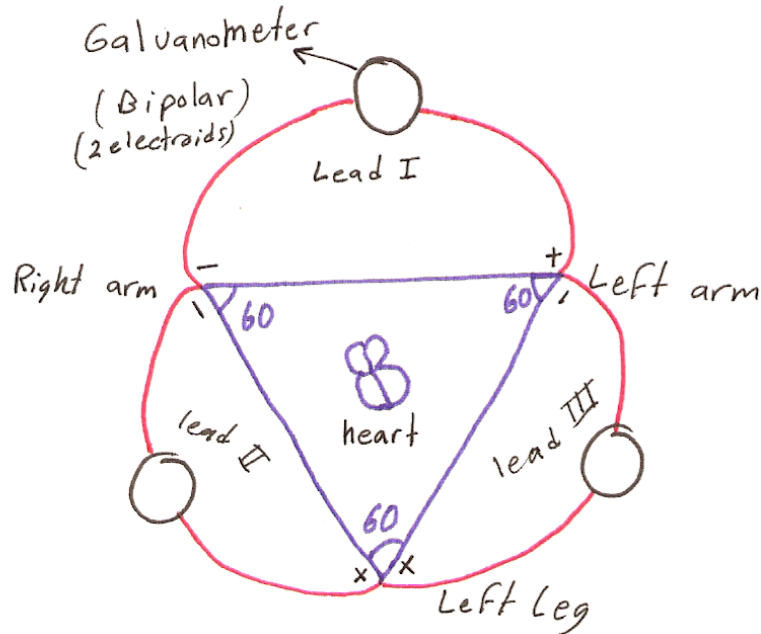
.. If you record from 2 recording electrodes (+ , -)

Galvanometer : machine that record potential in deferent places



In 1909, the ECG recorded first time by Willem Einthoven

Einthoven Triangle

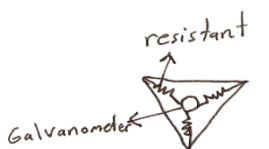


If you connect Right Arm (-) + Left Arm (+) = Lead I

If you connect Right Arm (-) - Left leg (+) = Lead II

If you connect Left Arm (-) + Left Leg (+) = Lead III

- Left leg always positive (+)
- Right arm always negative (-)
- The current ALWAYS move from (-) to (+)



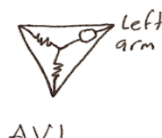
The record is zero

A: Augmented
V: unipolar

Willson said:



R : right arm



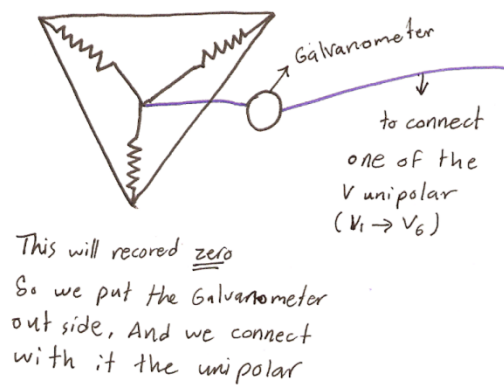
L: Left arm



F: foot

Wilson saw the record increased by 50 % so he called it augmentation (A)

Chest leads



V₁ : 4th intercostal space to the right near the margin of sternum

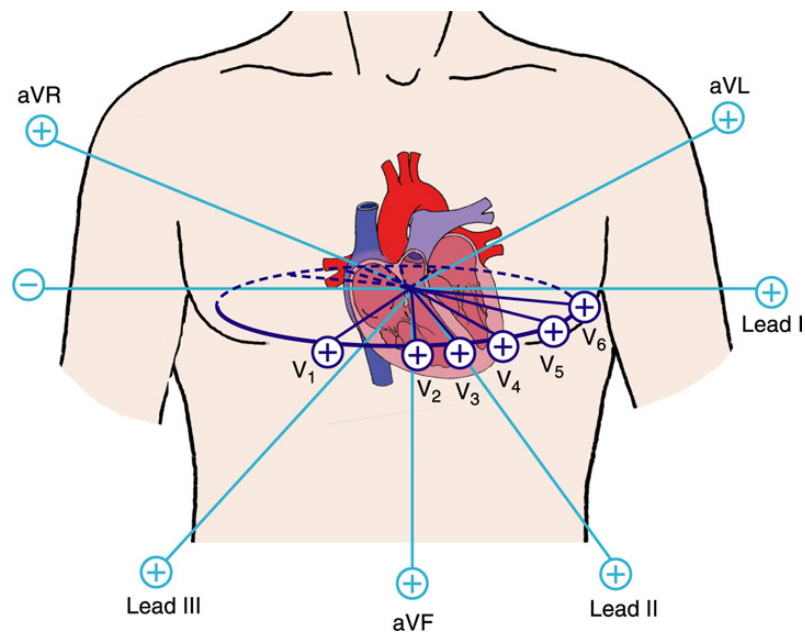
V₂ : opposite to V₁ (to the left side)

V₃ : between V₂ and V₄

V₄ : mid clavicle line $\frac{1}{2}$ inch inside the left 5th intercostal space (apex of heart)

V₅ : anterior axillary line to the left of 5th intercostal line

V₆ : in the left of 5th intercostal space in the middle of axillary line



This figure shows the Bio-polar and the uni-polar leads position on human's chest

ECG Paper

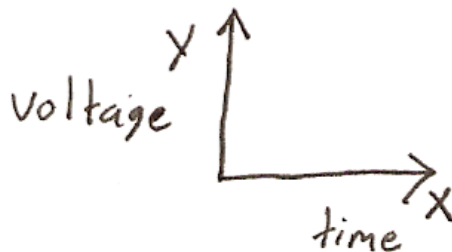
First :

- It's a wax treated paper
- Recorded by ink (or heated pointer) to write
- The machine speed is 25 mm in 1 sec.
- Each square in the paper is 1 mm long
- It takes $\frac{1}{25}$ sec for one square = 0.04 sec

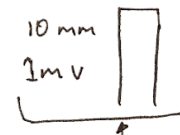
Calibration : the standard of measuring . e.g. when you take a student **X** from a class and make him standard , if someone is taller than **X** we'll tell him that he's tall . same thing to who become shorter than **X**
It's done to standardized the duration and amplitude of the wave .

X: measure the time

Y: measure the voltage



Before starting any record you should make a calibration →




If we say the **P-R** interval is 0.12 sec that means : It's 3 square (mm) long
That's how we calculate the timing ..

Normal ECG Wave

Lead I : 

Lead II : 

Recorded PQRS wave clearly and R wave is tall

Lead III : 

AVR : 

Every thing is reversed because we are recording from rightside .
If the AVR is not reversed , the heart is on the right side

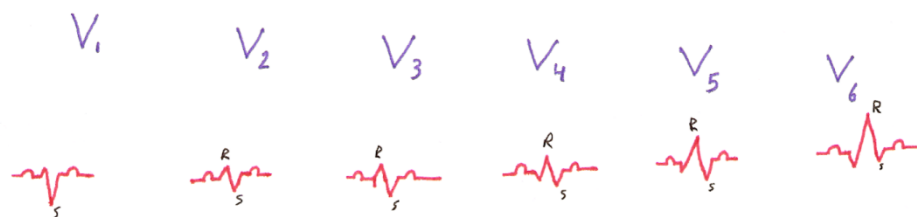
AVL : 

Like lead I

AVF : 

Like lead III

V Leads



There are 2 rules in V leads (1-6) :

❶ The **R** wave in lead V1 is missing or it's small, it increases when moving to V6 , so V6 has the highest **R** wave and V1 the lowest.

❷ The **S** wave in lead V1 is the clearest, it decreases when moving to V6, so V6 has the lowest **S** wave and V1 has the maximum depth .

What can we Read in ECG ?

❶ **Rhythm** : is relationship of the duration of 2 consecutive heart beats

1: if the distance between **R** and the other **R** is equal, we call it : regular Rhythm

2: if the distance between **R** and the other **R** is not the same, then we call it : **a**rrhythmia

Lead II is used for rhythm monitoring (it's the clearest Lead)

❷ **Heart Rate:**

❸ **Axis**

❹ **Print to the observed**

P-R interval

If there is **P** wave or not

How much is **S-T** interval

T wave , upright , unverted , tall or small

If **Q R S** wave is present or not

If you see **U** wave , it means :

❶ The person is normal

❷ Or he has Hypokalemia (decrease in K)

AXIS

It's the heart position or which side the heart is shifted inside the thoracic cavity .

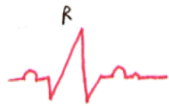
- ❶ if the heart on the left side , this will be : left Axis
- ❷ If the heart on the right side, this will be : right Axis

Rule of thumb

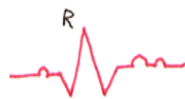


This rule depend on lead I and III :

❶ Lead I



Lead III

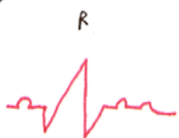


If both R waves are up , the heart is in normal position (-30°) – ($+90^\circ$)

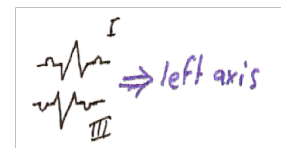
More positive : right axis

More negative : left axis

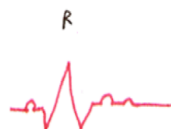
❷



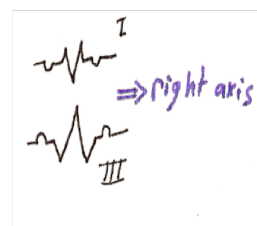
If R wave in lead I and S wave in lead III are in different direction heart will be in the left axis



❸



If S wave in lead I is meeting R wave in lead III then it's right axis



ECG

- 1st heart sound : during or at the end of **Q R S**
- 2nd heart sound : after T wave
- Diastolic Sound : the 3rd and 4th heart sound

When **R** is far , it means slow heart rate (during expiration)

When **R** is near , it means fast heart rate (during inspiration)

to remember :

increase = **in**spiration

This is known as **sinus arrhythmia** (normal condition)

Notes : If the impulse is from SA node we call it : Sinus

◆ In Hyperkalima condition you'll see :

- Tall **T** wave
- Wide **Q R S**
- No **P** wave

- Tachycardia : fast heart rate
- Bradycardia : slow heart rate

Atrial Fibrillation

Atrial isn't contracting, it's vibrating (no full contraction)

That would lead to : absence of 4th heart sound and **P** wave

That's all :)