12 Lead ECG & Axis Deviation

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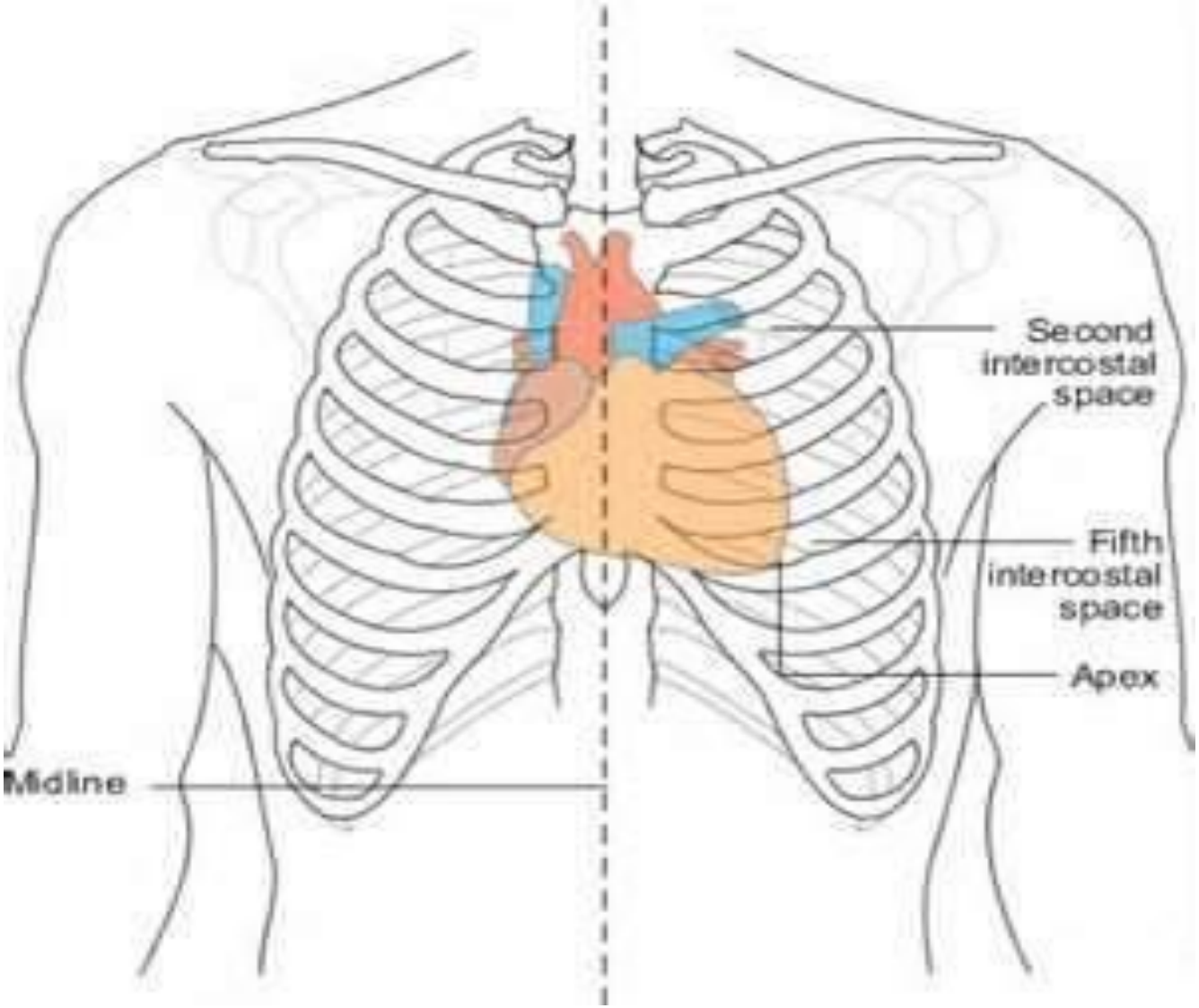
Objectives

- By the end of the session the learner should be able to describe;-
  - 12 lead ECG
  - bipolar leads
  - augmented leads
  - precordial (chest) leads
  - cardiac axis
  - Types of ECGs
- Perform an ECG (practical)

Review

- The heart lies in the mediastinum between the points of attachment of the 2nd through 6th rib
- 2/3 of the heart is located on the left side of the midline and 1/3 on the right.
- The heart is about the size of a clenched fist
- The heart has 2 anatomical positions:
  - Apex; (5ICS, MCL).
  - Base; 2 ICS

Location of the heart



Review

- **Electrocardiogram** (ECG) is a graphic recording of the electrical changes in the heart during electrical excitation (depolarization) and recovery (repolarization)

- The ECG records electrical changes in heart muscle caused by an action potential.

Origin of ECGs

- In the late 1800's and the early 1900's, Willem Einthoven pioneered the practice of electrocardiography.

- He developed a machine that was sensitive enough to reliably measure electrical differences between two different parts of the body.

Willem Einthoven

History of ECGs

- To obtain a recording of the heart's electrical activity, the patient would stick a limb into a large jar filled with salt water then put another limb into a separate jar.
- The machine that was connected to both jars would measure the electrical differences between the two limbs.
- Einthoven and his associates experimented with a variety of combinations of limbs and other regions of the body.

History of ECGs

- They found that putting the right hand in one jar and the left hand in the other would give a different result from a different combination (e.g. the right hand and the left leg).
- Each of these combinations represented a different "view" of the heart's electrical activity.
- They called each combination a **lead**, and noted that some leads gave a better view of the heart than others.

History of ECG

- The scientists experimented with the different combinations of limbs and body parts and, later Einthoven established the **three standard "limb leads." i.e. Limb I, II, III**

- **These leads formed the basis of the current ECGs**

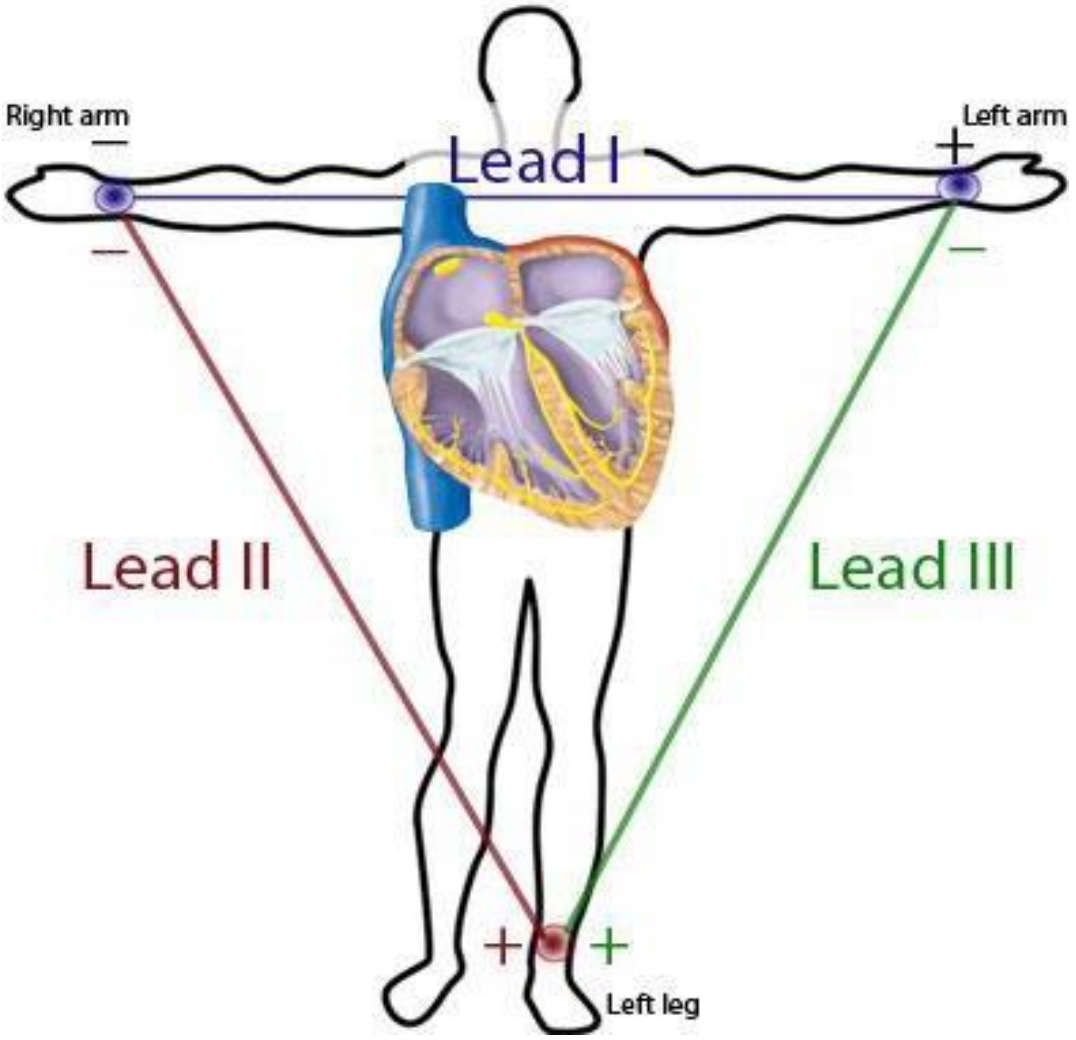
Lead Definition

- **Lead** is a recording or a tracing of electrical activity between two electrodes
- Leads allow viewing the heart's electrical activity in different planes
- Each lead has a –ve and +ve electrode
- **The position of the +ve electrode on the body determines the portion of the heart 'seen' by each lead.**

Einthoven Triangle

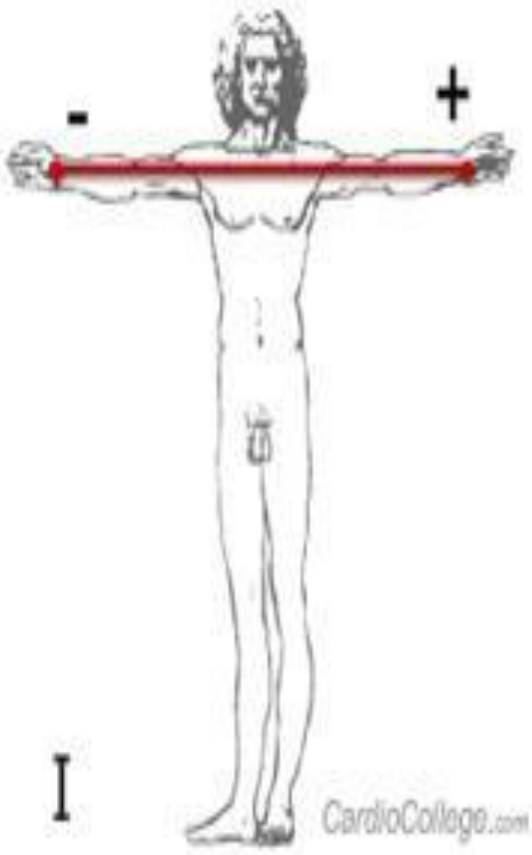
- Einthoven's triangle" refers to the imaginary inverted equilateral triangle having the heart at its center and formed by lines that represent the three standard limb leads of the electrocardiogram i.e. Lead I, II, III.
- The limb leads are placed on the:
  - Lead I (right arm)
  - lead II (left arm)
  - lead III (left leg)

Einthoven's triangle

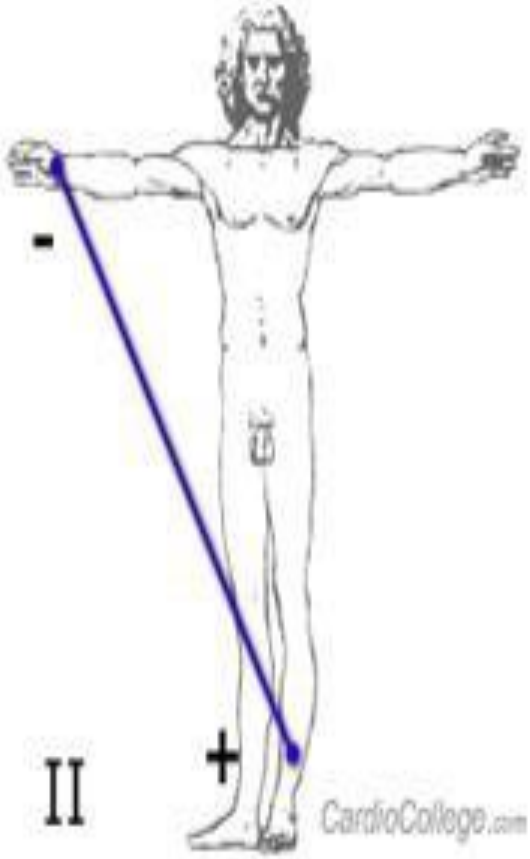


Standard Limb leads

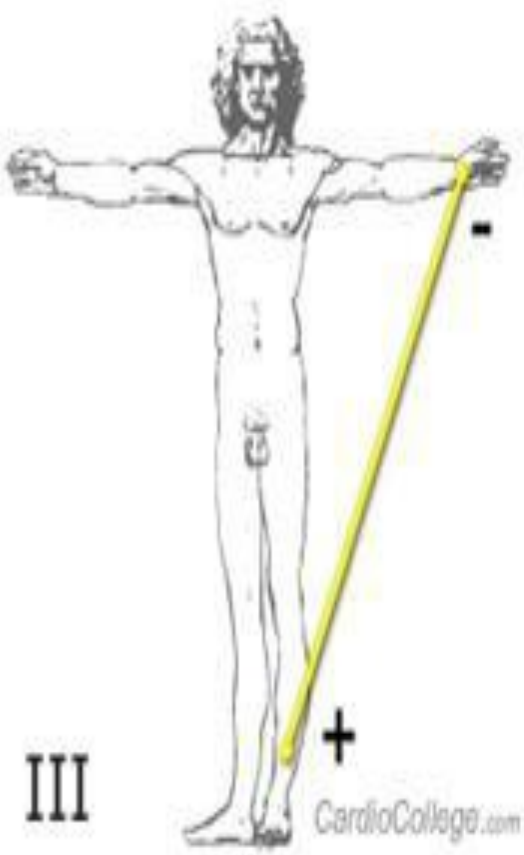
- **Lead I** is formed using the right arm electrode as the negative electrode and the left arm electrode as the positive electrode
- **Lead II** is formed using the right arm electrode as the negative electrode and the left leg electrode as the positive electrode
- **Lead III** is formed using the left arm electrode as the negative electrode and the left leg electrode as the positive



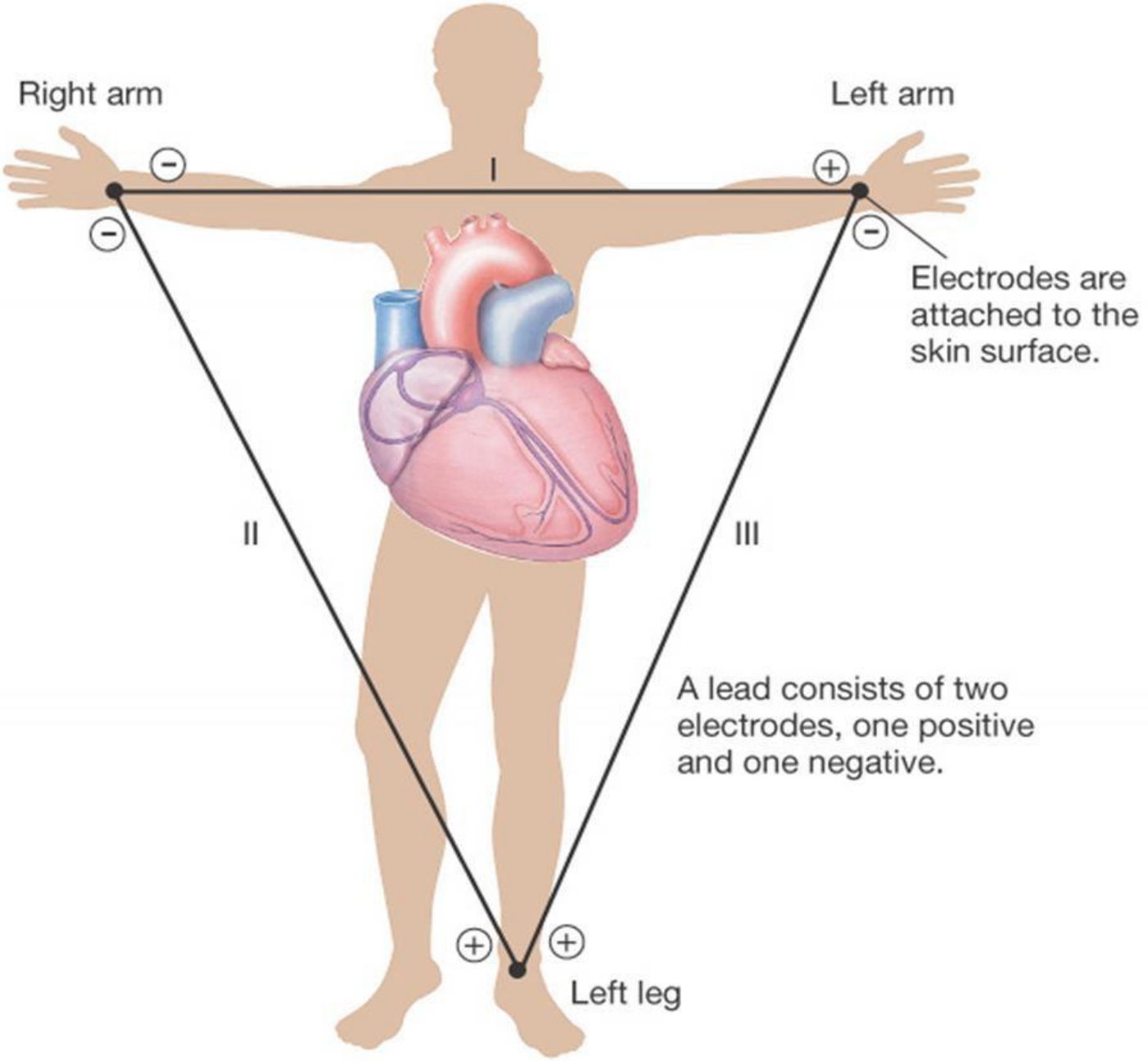
In lead I the left arm electrode is the positive pole and the right arm electrode is the negative pole.



In lead II the left foot electrode is the positive pole and the right arm electrode is the negative pole.



In lead III the left foot electrode is the positive pole and the left arm electrode is the negative pole.

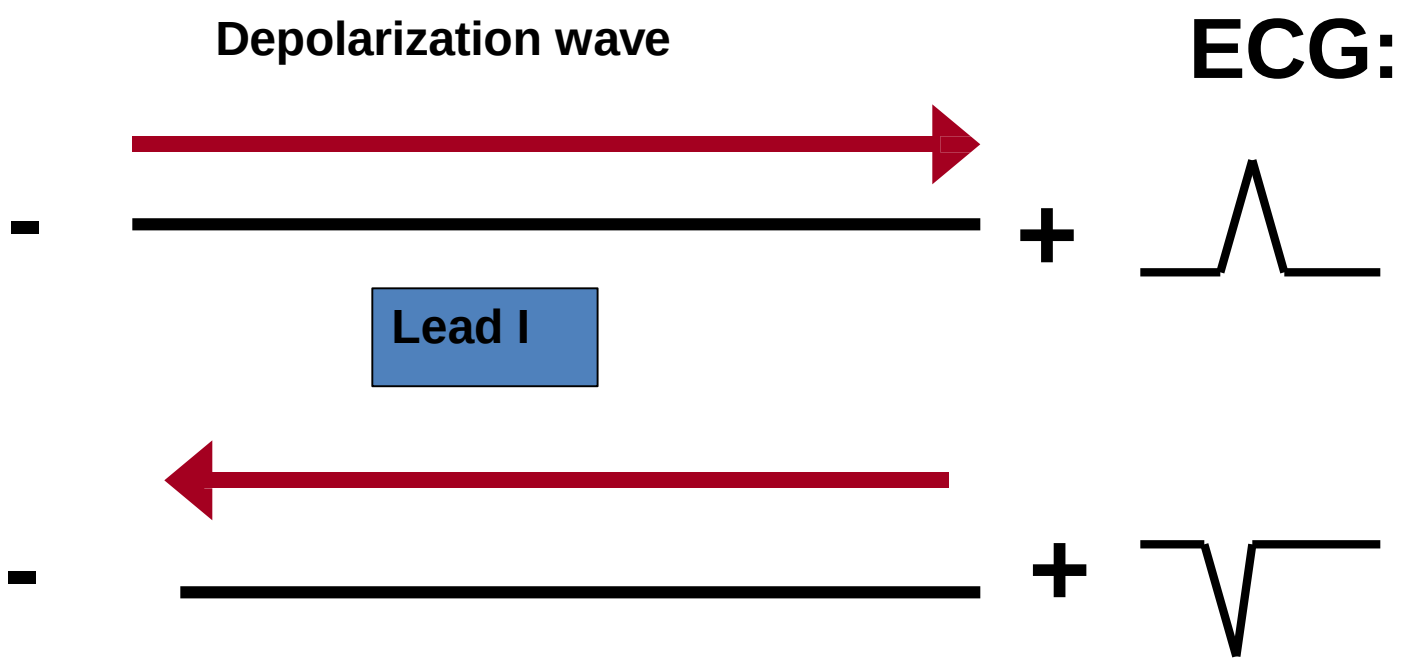

Right arm
Left arm
I
II
III
Electrodes are attached to the skin surface.
A lead consists of two electrodes, one positive and one negative.
Left leg

Standard Limb leads

- If the wave of depolarization moves toward the +ve electrode, the waveform recorded on the ECG graph paper will be upright (+ve deflection).

- If the wave moves away from the +ve electrode the waveform recorded will be a downward line (-ve deflection)

Like So:



12 Lead ECG

- The standard 12-lead electrocardiogram is a representation of the heart's electrical activity recorded from different electrodes on the body surface

- Each lead provides a tracing, which is characteristic of a different view of the same electrical activity i.e. 12 different angles (pictures) of the same activity.

12 Lead ECG

- The 12 lead ECG enables one to view the heart's electrical activity from different angles and planes.

- A 12-lead ECG records 12 of these "leads" producing 12 separate graphs on the ECG paper

- **However you only actually attach 10 physical electrodes to the patient**

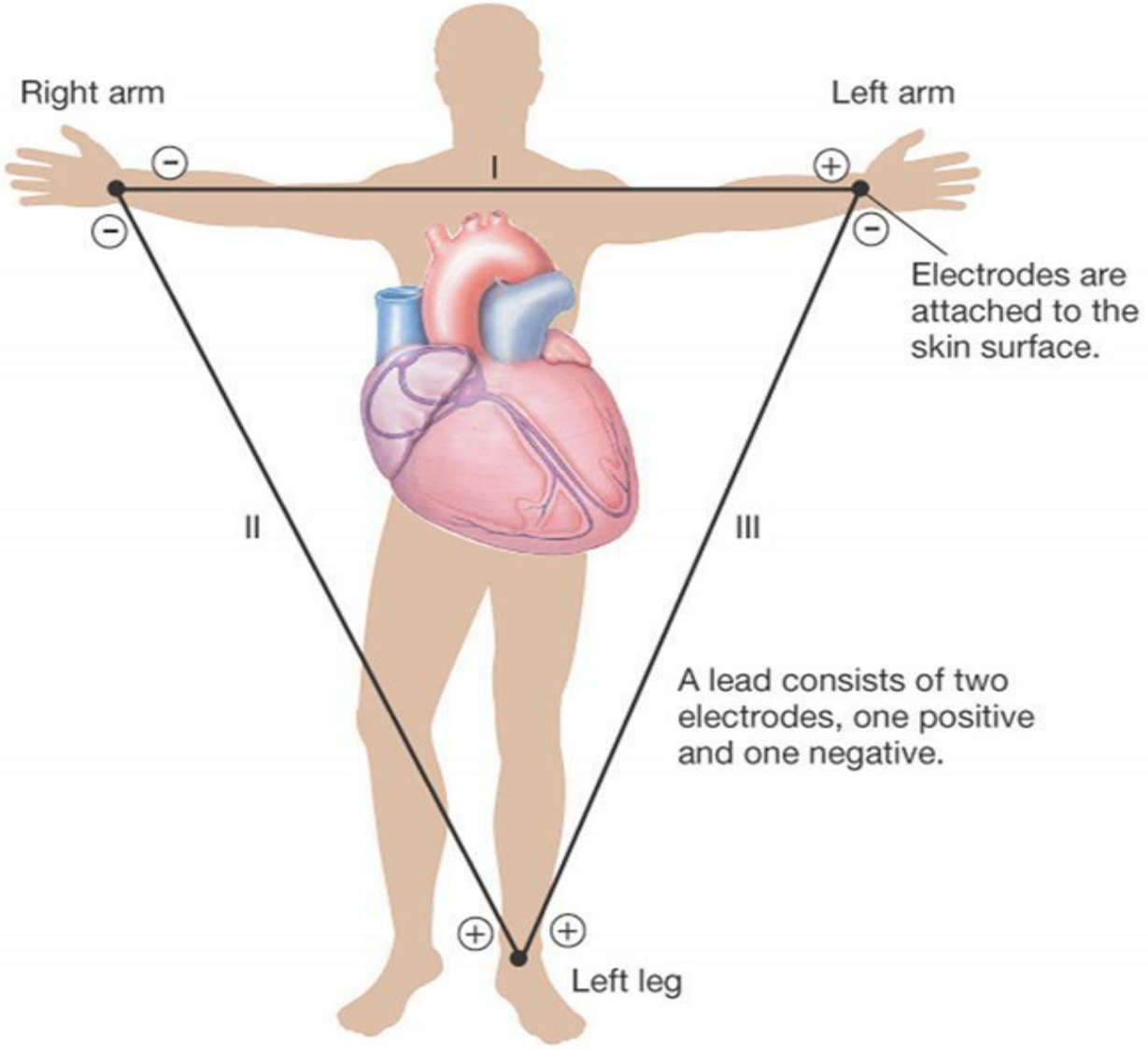
12 Lead ECG

- The standard 12 lead ECG consists of:
  - 3 Standard/ bipolar Limb Leads
  - 3 Augmented/ unipolar Limb Leads
  - 6 Precordial/ chest Leads

12 lead ECG

- **Standard/Bipolar leads:**
- Leads I, II and III make up the standard/ bipolar limb leads.
- The 3 standard limb leads are commonly referred to as **bipolar leads**
- Bipolar because each of the 3 leads has a distinct positive and negative pole

Standard Limb Leads



Placement of the electrodes (bipolar leads) on a patient

- The electrodes are color coded for easier identification and are indicated where to be placed.
- The color codes however may vary according to different ECG machines
- The electrodes are placed on the wrists and ankles of the limbs
- Both arms and the left leg are used as active electrodes

Placement of the electrodes (bipolar leads) on a patient

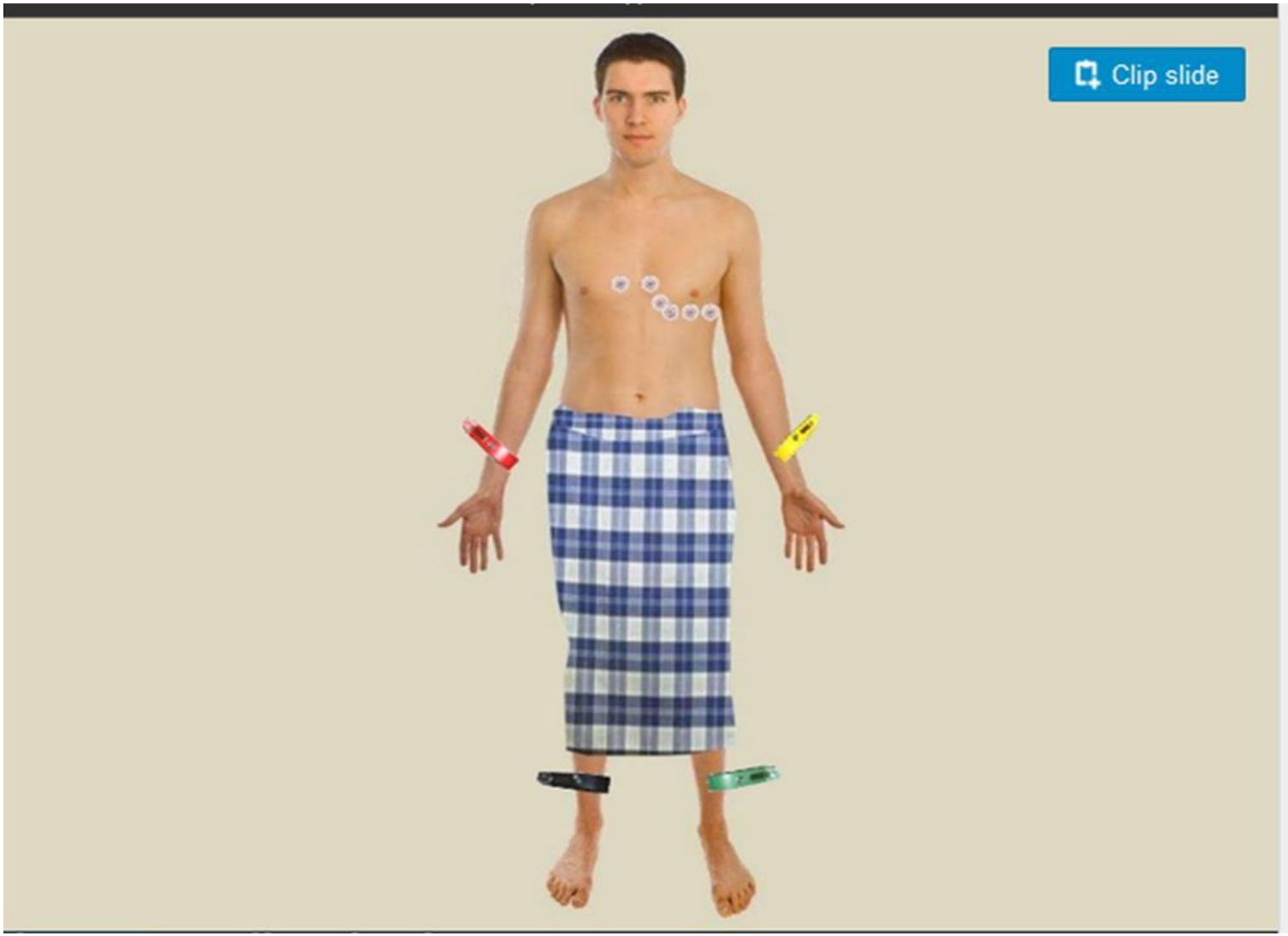
- During placement of the electrodes an extra electrode is placed on the right leg as an earthing or ground electrode

- The right leg however does not generate a signal on the ECG

Placement of the electrodes (bipolar leads) on a patient

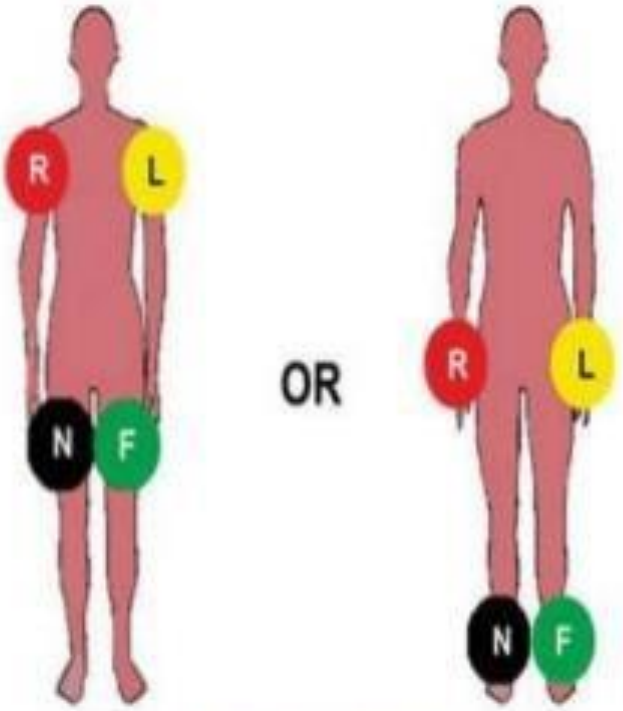
- The purpose of the earthing electrode is:
  - Used as a reference point from which other electrical potentials can be measured
  - Protect the patient in cases of a short circuit or a very high current flow

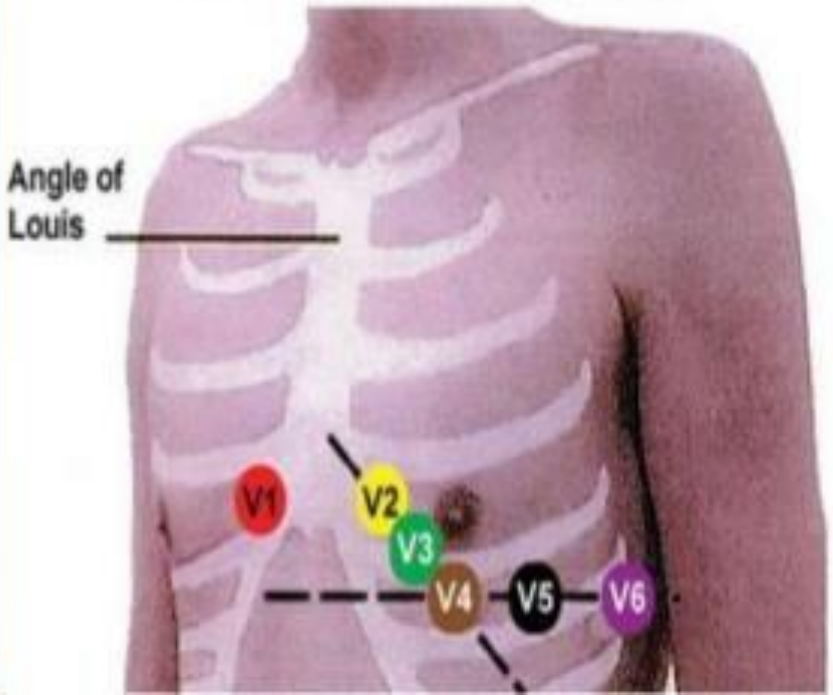
Bipolar leads placement



Limb Lead Placement

- Connect the lead wires to the electrodes. The tip of each lead wire is lettered and color-coded for easy identification.
- The red or RA lead wire goes to the right arm
- The yellow or LA lead wire goes to left arm
- The black or N/ RL lead wire goes to right leg
- The green or LL lead wire goes to left leg





12 lead ECG

- **Augmented leads:**
- The augmented unipolar leads were devised as a way of increasing the size of the signal (the heart's electrical activity) and giving us new views of that activity.
- The augmented unipolar leads use the same electrodes as the standard limb leads.
- The only thing that changes is how these electrodes are connected

12 lead ECG

- **Augmented leads:**
- For each of the augmented unipolar leads, two of the three electrodes are tied together and brought to ground/ earth.
- The remaining electrode becomes the exploring or active lead
- The ECG machine does the actual switching and rearranging of the electrode designations

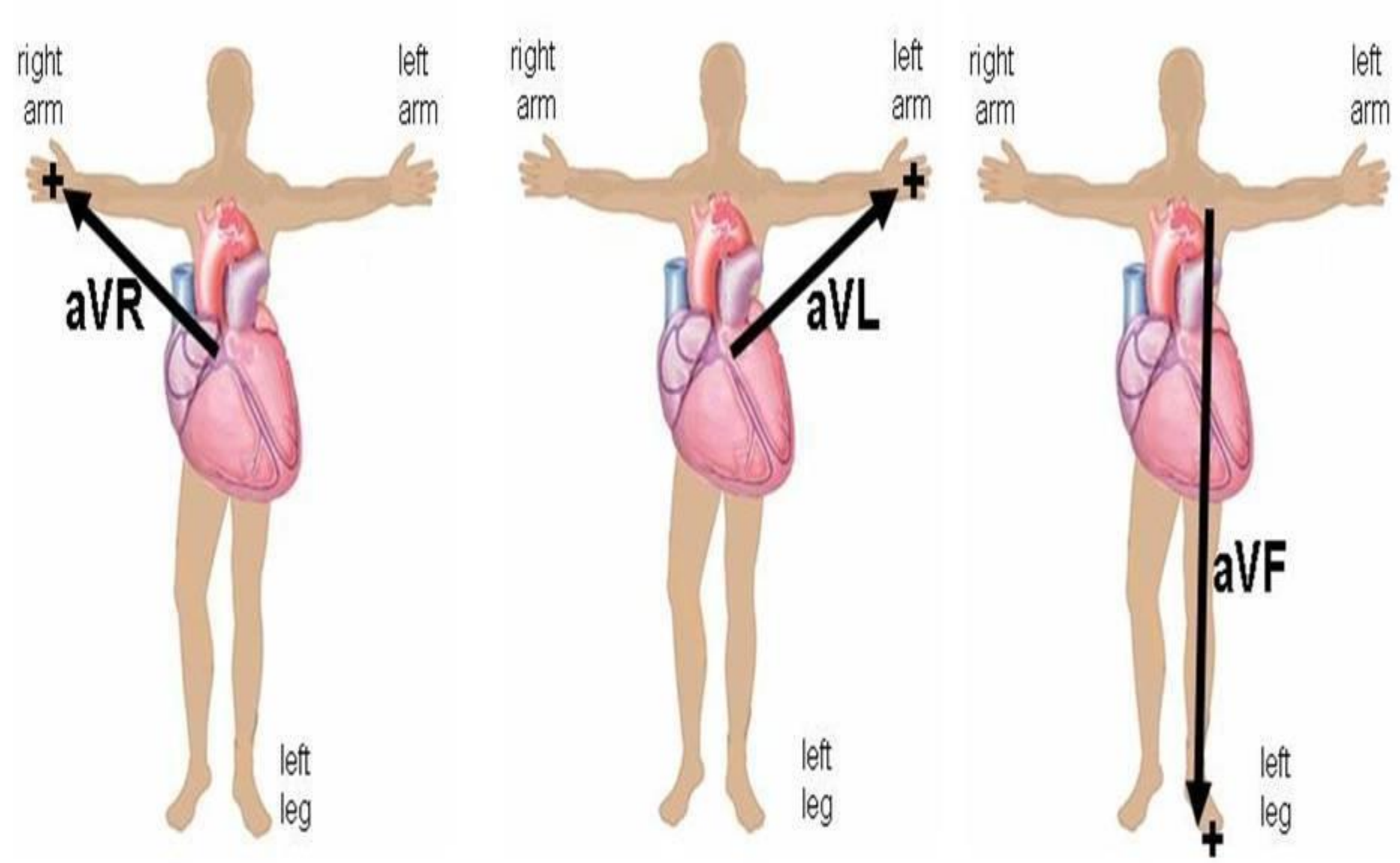
12 lead ECG

- **Augmented leads:**
- The augmented leads are represented by the prefix **aV**
- Augmented leads are also referred to as **unipolar leads** because there is only one remaining electrode which is positive
- The negative pole of the augmented leads is the heart
- E.g. avR- the current flows from the heart to the right arm

12 lead ECG

- Augmented leads include:
- aVR- Augmented Voltage at Right arm,
- aVL- Augmented Voltage at Left arm
- aVF- Augmented Voltage at Left foot

AUGMENTED LIMB LEADS (aVR, aVL, aVF)



12 lead ECG

- The augmented leads and the bipolar leads collectively are referred to as **“6 limb leads**” of the ECG.

- The limb leads record the electrical activity in the heart in the vertical/frontal plane

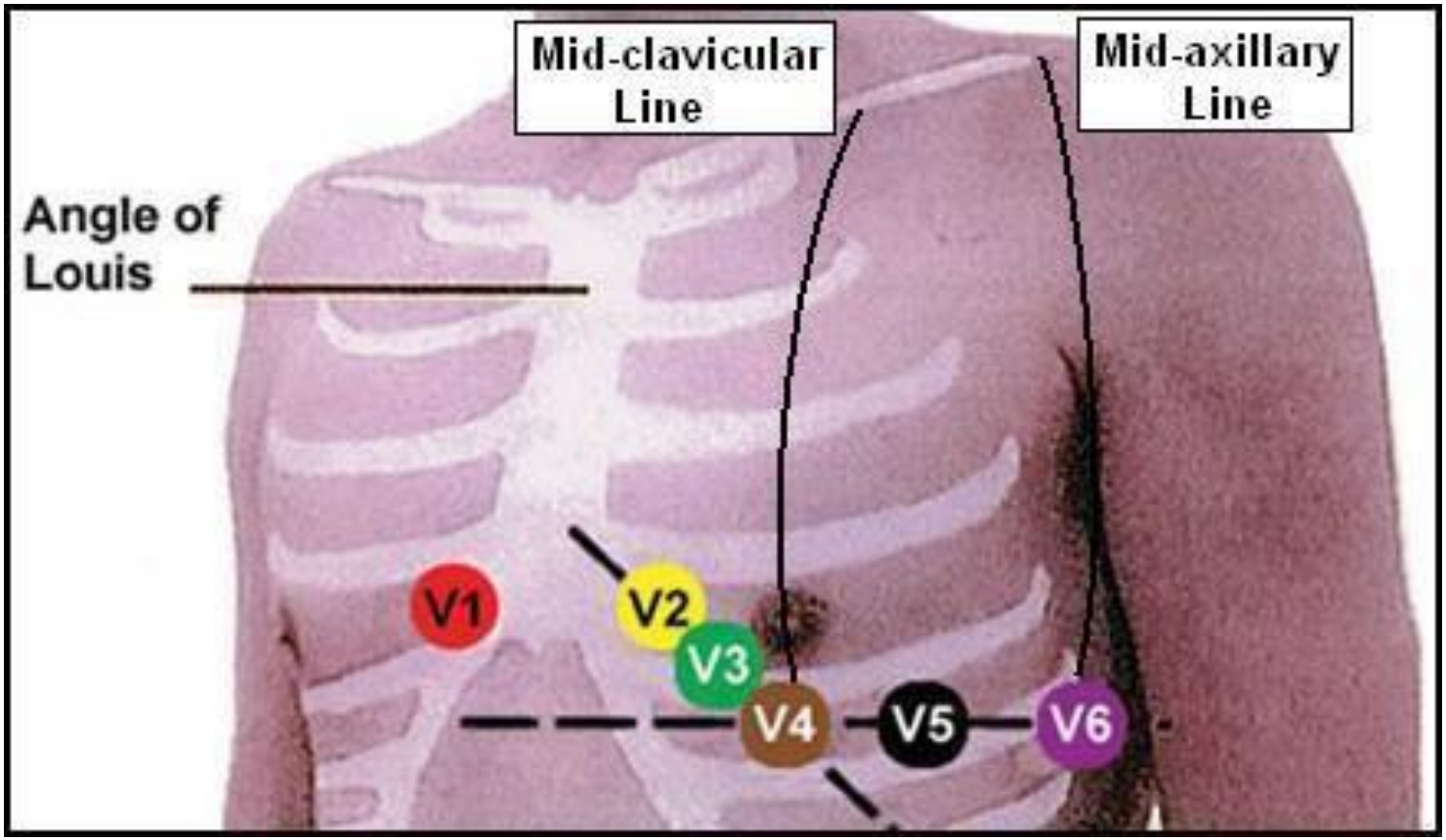
12 lead ECG

- **Precordial/ Chest leads:**
- The leads are labeled “V” and are numbered from 1 to 6.
- The precordial leads view the heart on a horizontal/ transverse plane
- They are placed anatomically on the chest as follows:

12 lead ECG

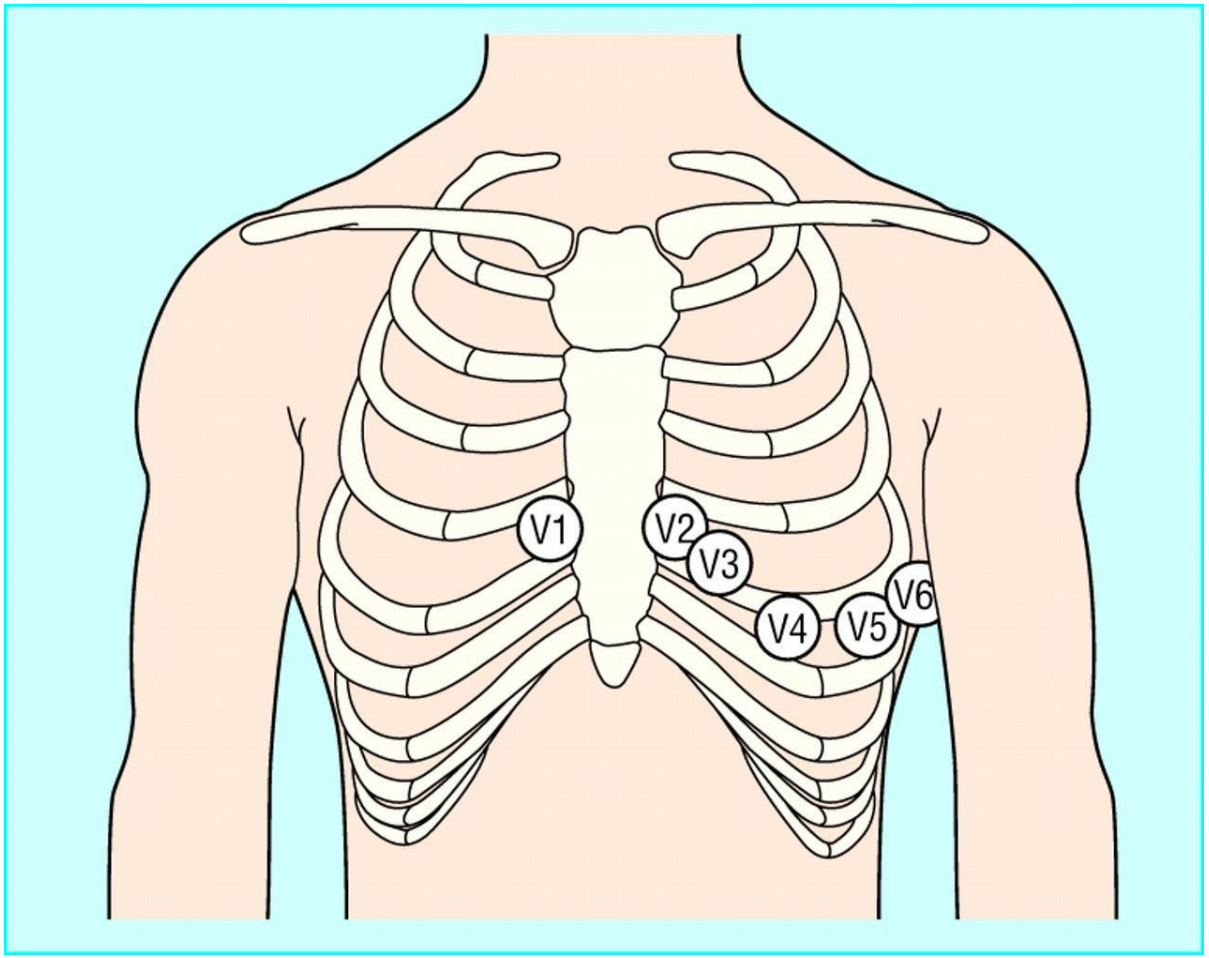
- **Precordial leads placement:**
- V1- 4 ICS right sternum
- V2- 4 ICS left sternum
- V3- between V2 and V4
- V4- 5 ICS MCL
- V5- 5 ICS anterior axilliary
- V6- 5ICS mid axilliary line

Precordial Leads



Adapted from: www.numed.co.uk/electrodepl.html

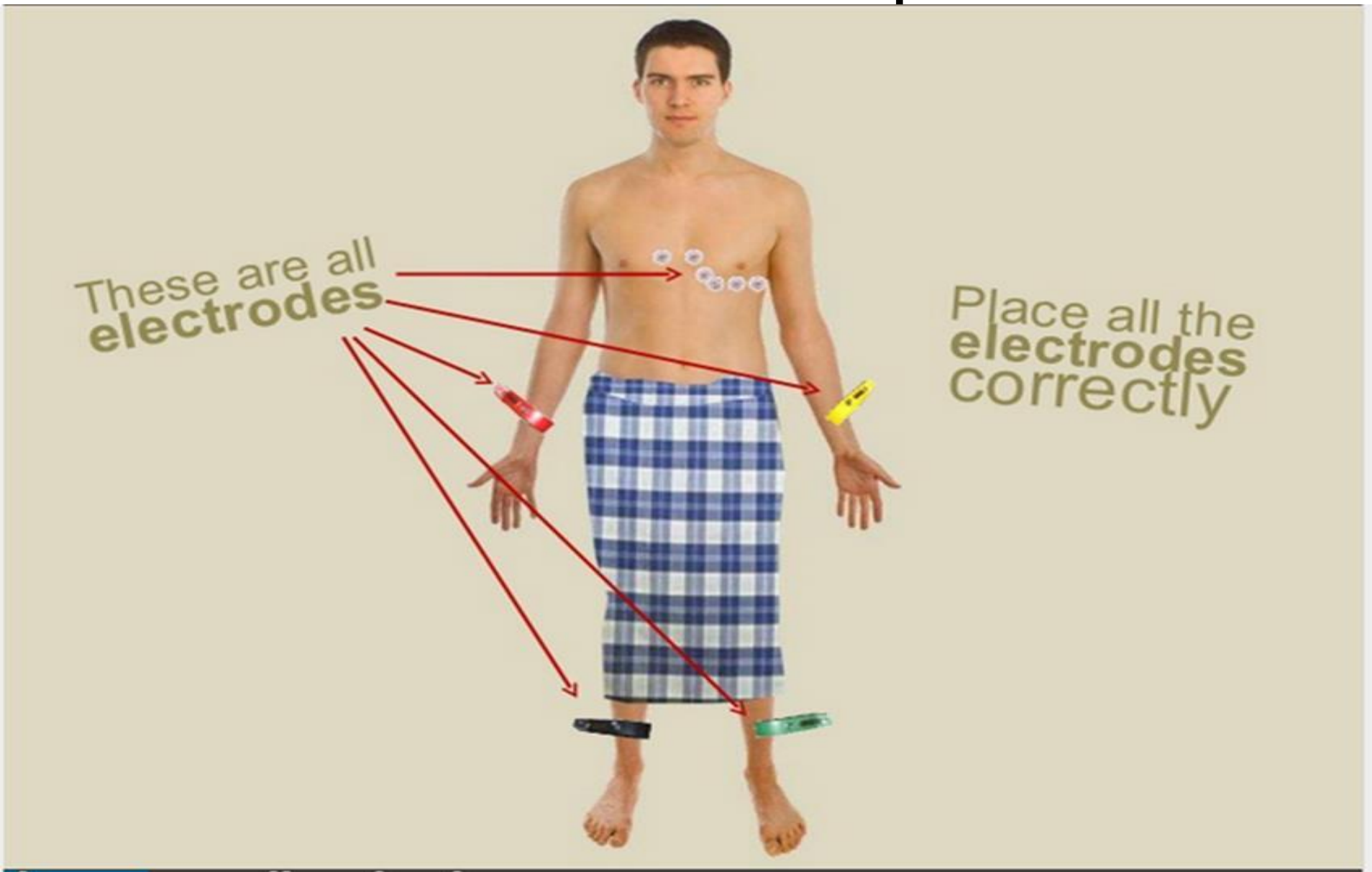
The Six Chest Leads Positions



12 lead ECG

- **Remember:**
- The standard 12 lead ECG consists of:
  - 3 Standard/ bipolar Limb Leads
  - 3 Augmented/ unipolar Limb Leads
  - 6 Precordial/ chest Leads
- However you only actually attach 10 physical electrodes to the patient

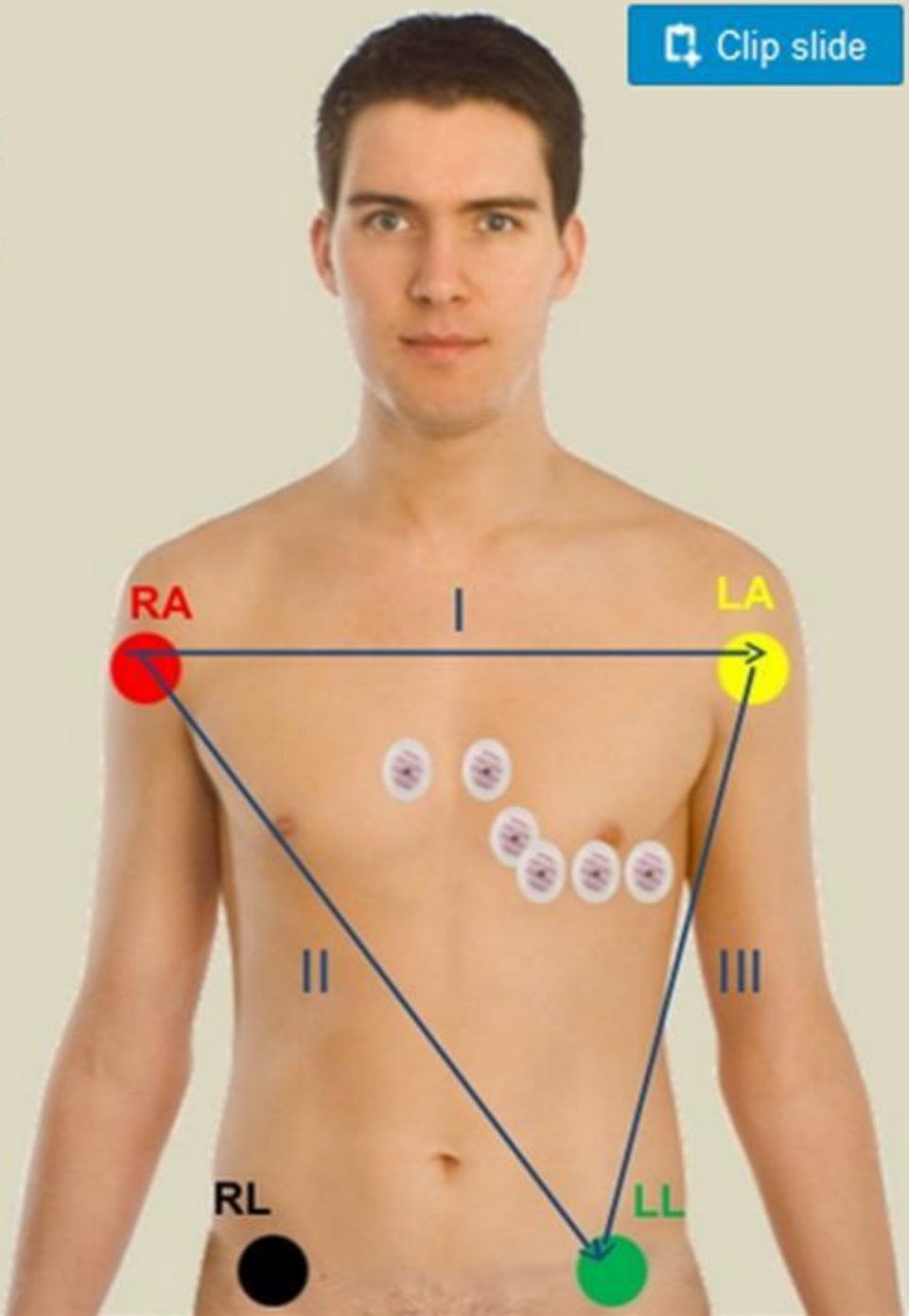
12 lead ECG electrode placement



LEADS I, II, III

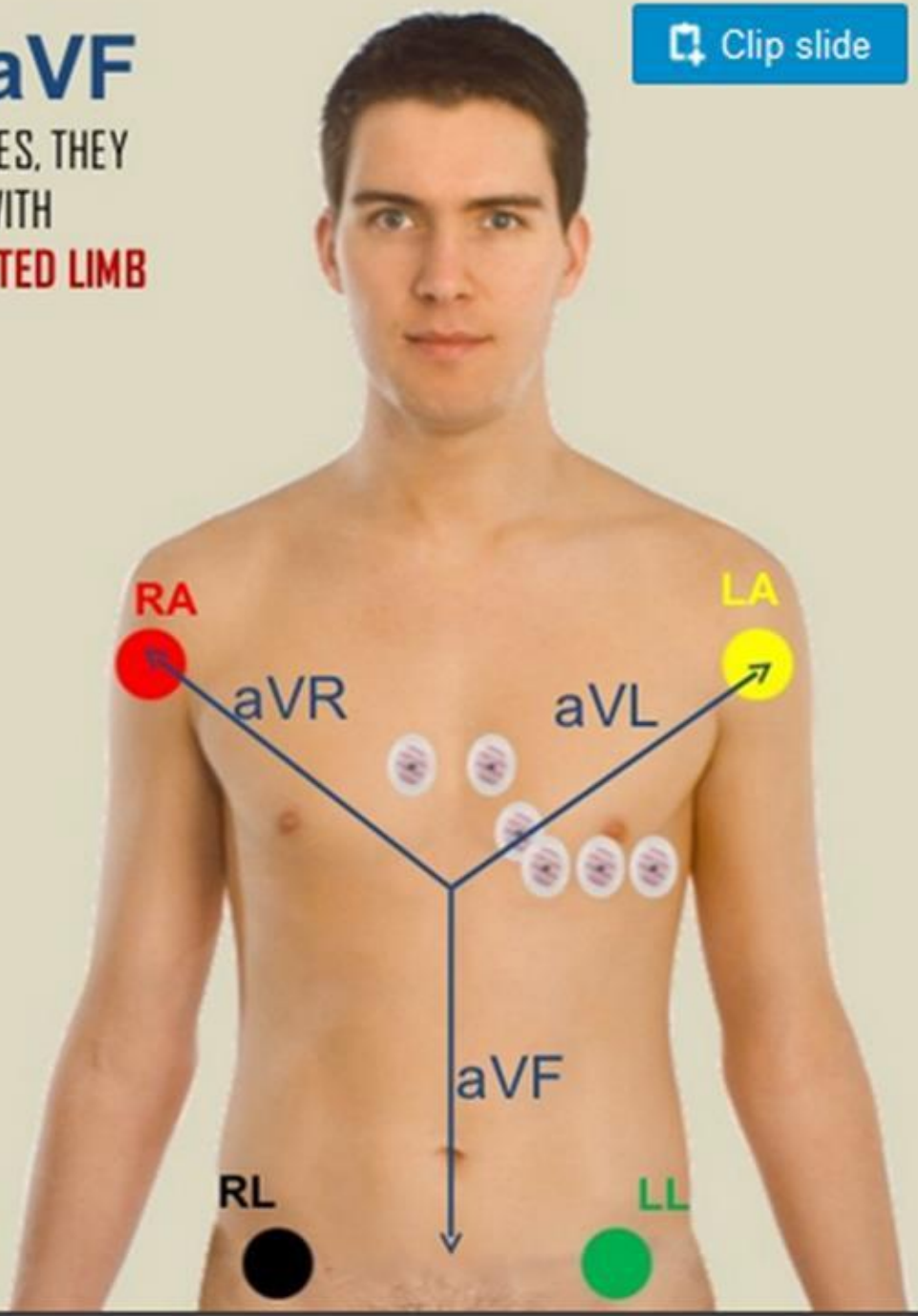
THEY ARE FORMED BY VOLTAGE TRACINGS BETWEEN THE LIMB ELECTRODES (RA, LA, RL AND LL). THESE ARE THE ONLY BIPOLAR LEADS. ALL TOGETHER THEY ARE CALLED THE **LIMB LEADS** OR

THE EINTHOVEN'S TRIANGLE



LEADS aVR, aVL, aVF

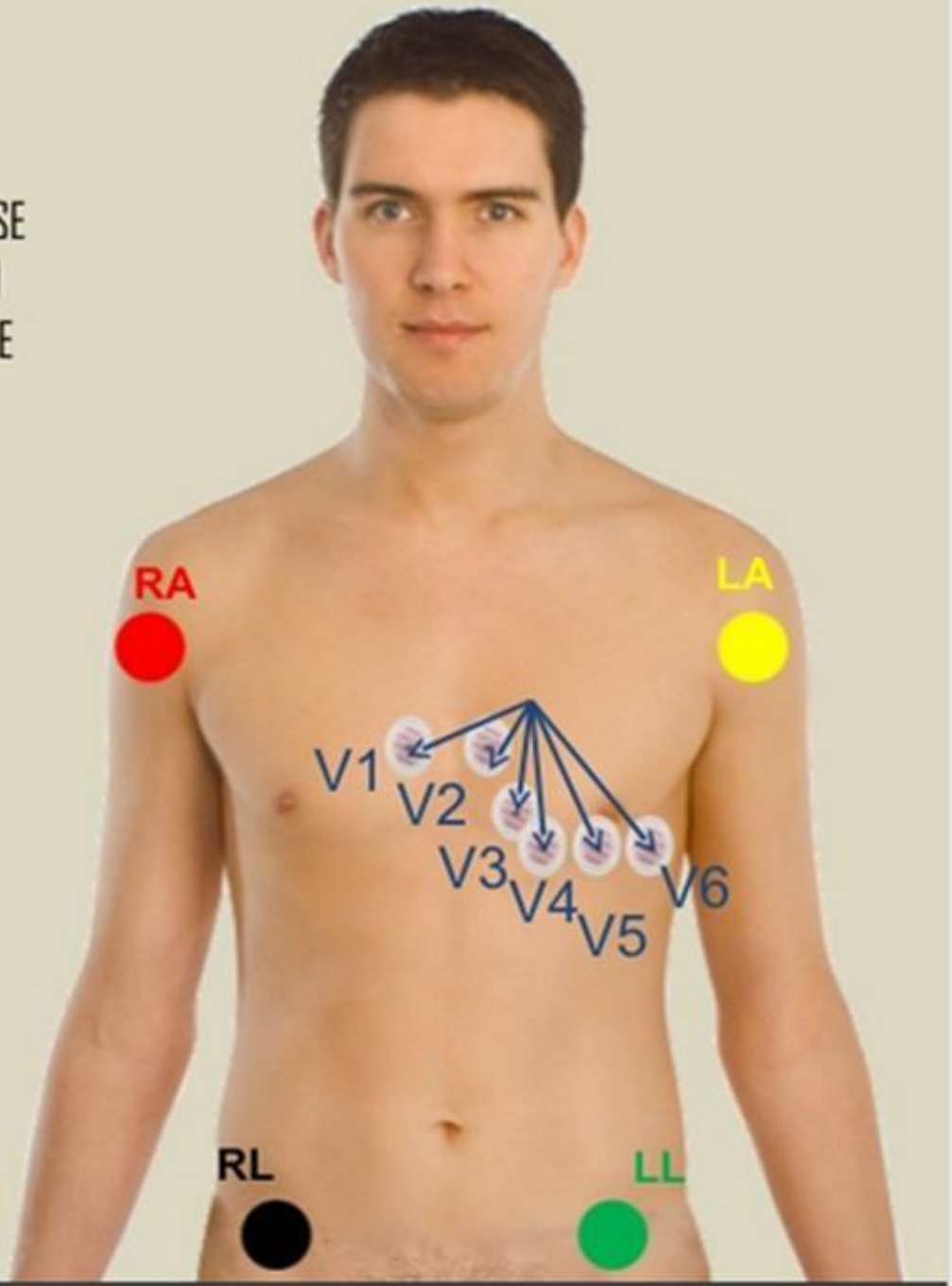
THEY ARE ALSO DERIVED FROM THE LIMB ELECTRODES. THEY MEASURE THE ELECTRIC POTENTIAL AT ONE POINT WITH RESPECT TO A NULL POINT. THEY ARE THE **AUGMENTED LIMB LEADS**



LEADS

V1,V2,V3,V4,V5,V6

THEY ARE PLACED DIRECTLY ON THE CHEST. BECAUSE OF THEIR CLOSE PROXIMITY OF THE HEART, THEY DO NOT REQUIRE AUGMENTATION. THEY ARE CALLED THE **PRECORDIAL LEADS**



12 lead ECG

- ECG machines tend to print 3 seconds of each lead in a standardized format with three rows of four columns.
- **Column one**: leads I, II, and III.
- **Column two**: aVR, aVL, and aVF.
- **Column three**:V1, V2, and V3.
- **Column four**: V4, V5, and V6.
- Typically, lead II flows along the base of the 12-lead ECG and is the main lead used for ECG interpretation

Arrangement of Leads on the ECG Paper

I	aVR	V_1	V_4
II	aVL	V_2	V_5
III	aVF	V_3	V_6

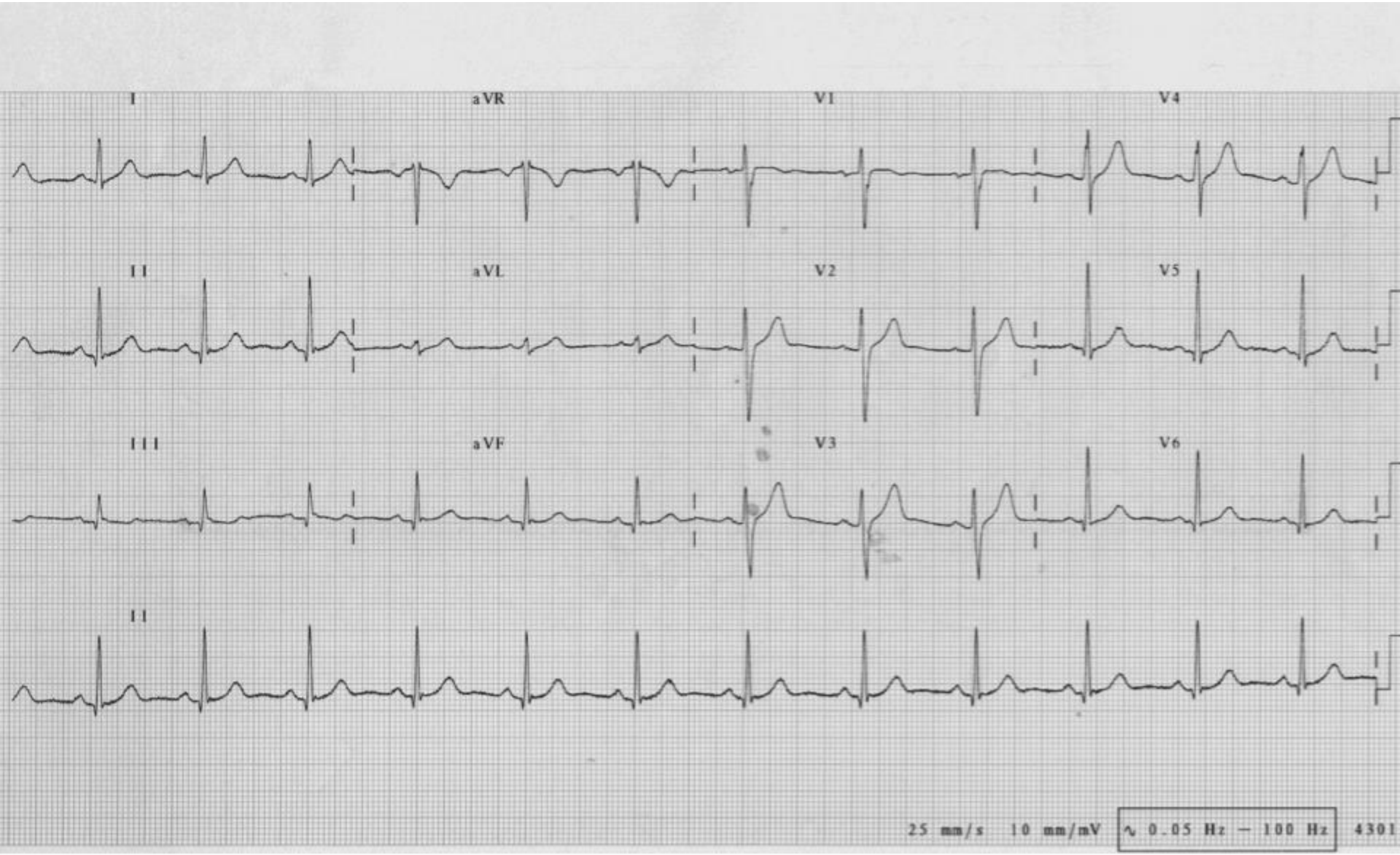
Arrangement of Leads on the ECG Paper

Types of Leads

I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Limb Leads **Chest Leads**

12 leads on ECG paper



Skin preparation for ECG

- Both re-usable and disposable electrodes rely on the electrolyte in the electrodes to make an effective connection between the machines electrode and the patient's electro-physiological signals.

- This is achieved by removing oil, grease and dirt from the skin sites of the patient

Skin preparation

- Dirty, moist or oily skin will not conduct clear signals.

- Alcohol wipes can interfere with transmission of impulses therefore ensure the alcohol/ spirit has dried from the patient’s skin surface

Skin preparation

- Avoid placing electrodes over the following so as to allow the electrolyte to pick up the signals beneath the skin:
  - Sites with excessive hair
  - Scar tissue
  - Skin folds
  - Bony protuberances
  - Areas of erythema
  - Lesions of any kind

How to produce an excellent ECG

- Proper skin preparation
- Correct electrode placement
- Check the electrodes to make sure the gel is still moist.
- Do not place the electrodes over bones.
- Do not place the electrodes over areas where there is a lot of muscle movement.
- Recognize and know how to correct problems
- Recognize basic critical values

Performing an ECG

1. Wheel the ECG machine and any other supplies you will need to the patient's bedside
2. Wash your hands upon entering the room and before touching the patient.
3. Identify yourself to the patient
4. Confirm the identity of the patient requiring an ECG
5. Explain the procedure to the patient

- Instruct the patient to lie still, breath normally and not talk when you are ready to run the report.

Performing an ECG

6. Ensure privacy for the patient and ask him/her to remove all clothing from the waist up
- You may offer them a gown that is open at the front to put on if uncomfortable
7. As the patient is undressing, prepare the ECG machine by putting in the patient's details
- If the ECG machine does not allow direct entry of patient details, these should be attached to the ECG as soon as the tracing is recorded

Performing an ECG

8. Position the patient in the supine position if possible.

- Patients with severe respiratory compromise will not be able to lie in this position and may need to have an ECG performed while sitting or semi-fowlers
- Ensure to document on the ECG as the change in patient's position- may alter the ECG
- Expose the arms and legs at the wrist and ankles respectively

Performing an ECG

9. Prepare the patient's skin for electrode placement

- Clean the skin around the areas of electrode placement with an alcohol pad.
- Allow the alcohol to dry for a few minutes then rub the skin with a dry cloth/ gauze
- For a patient who is diaphoretic or is soiled, first clean the skin with a cloth/ gauze then use the alcohol pad and complete with a dry cloth/ gauze

Performing an ECG

10. Place the electrodes on the patient as is required
- Begin by placing the precordial leads first then the limb leads

11. Advise the patient to relax and lie still.

Performing an ECG

12. Press the appropriate button on the machine to initiate recording i.e. the ‘start’ or ‘auto’ button

13. Review the printed ECG to confirm adequacy of the tracing and to identify immediate life-threatening abnormalities (ventricular fibrillations, pulseless ventricular tachycardia, asystole)

Performing an ECG

14. Disconnect the patient from the machine
15. Clean the skin on the areas of electrode placement
16. Thank the patient and allow them to get dressed
17. Remove the machine from the room.
18. Wash hands and document procedure

Trouble shooting/ What you need to look for:

- Is the skin well prepared?
- Is the patient well positioned?
- Is there proper electrode placement?
  - Are the limb electrodes hooked up correctly?
  - Are the chest electrodes hooked up correctly?
- Is the ECG free of artifact.
- Is the ECG a Critical Value

ARTIFACTS

- Distortion of an ECG tracing by electrical activity that is non- cardiac in origin is called **artifacts**.

- Because artifacts can mimic various cardiac dysrhythmias, **it is essential to evaluate the patient before initiating any medical intervention.**

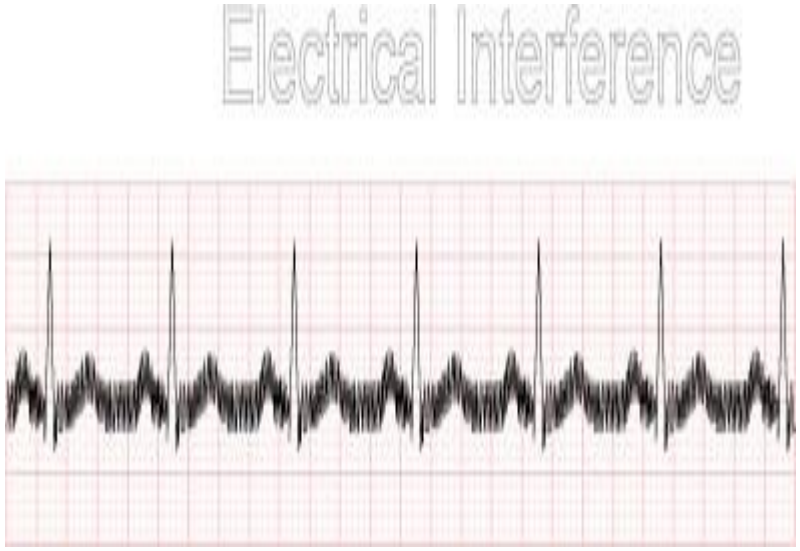
Causes of artifacts

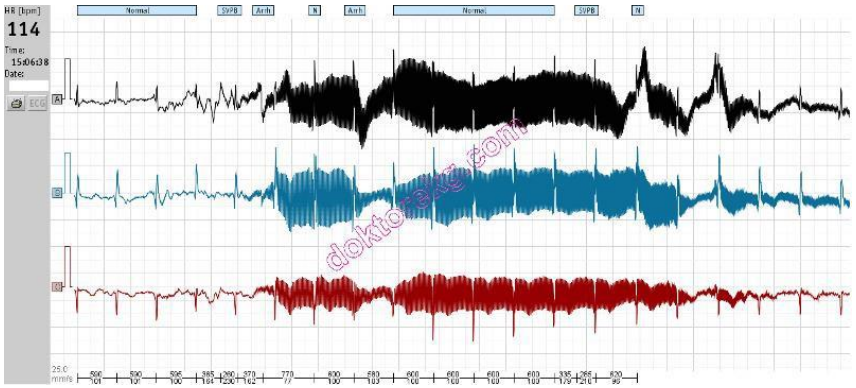
1. Loose electrodes
2. Broken ECG cables or broken wires
3. Muscle tremors/ twitching
4. Wandering pacemaker
5. Electrical interference
6. Patient movement
7. External chest compressions

Troubleshooting an ECG

- **Electrical interference:**
- This appears as a very jagged series of lines running close together.

Troubleshooting an ECG





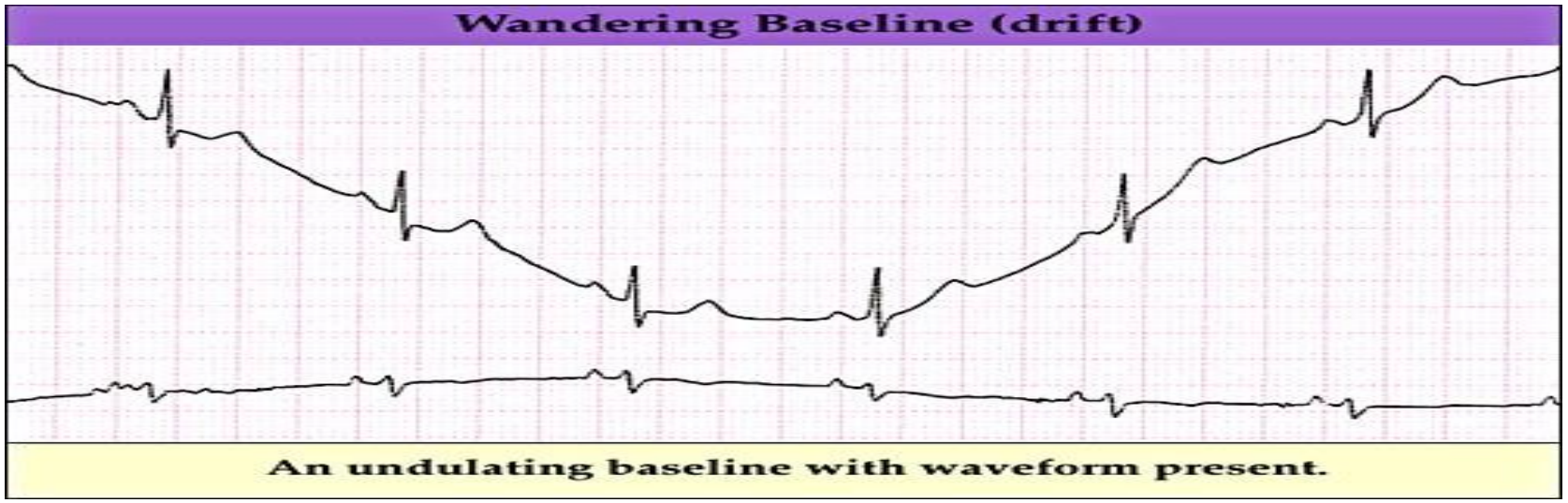
Troubleshooting an ECG

- **Causes of electrical interference:**
- Multiple pieces of electrical equipment in use
- Patient using electrical appliance e.g. cell phone

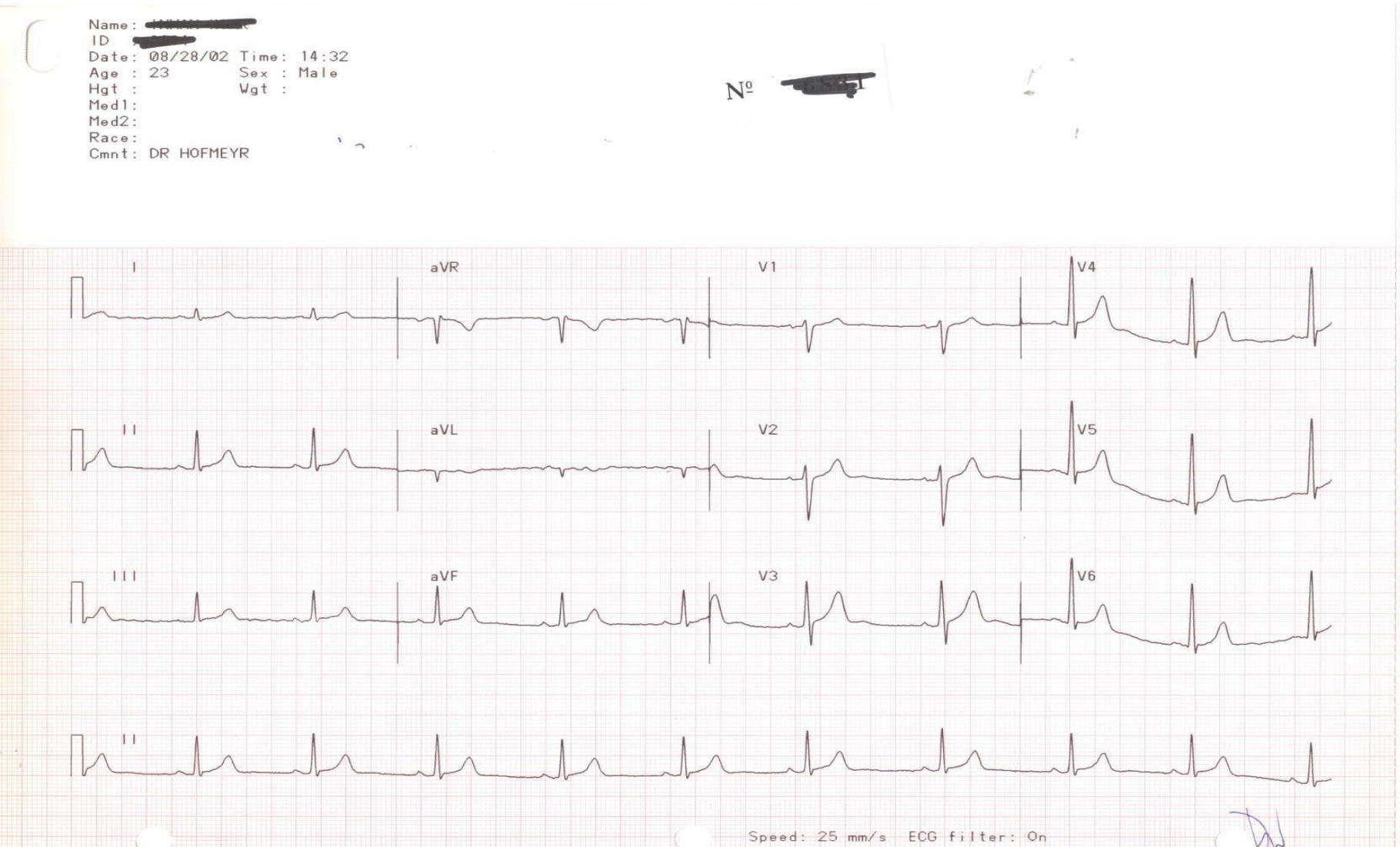
- **How to trouble shoot:**
- Unplug non-essential electrical devices
- Ensure cable is not lying on ECG machine
- Ensure the wires are not twisted
- Turn cell phone off

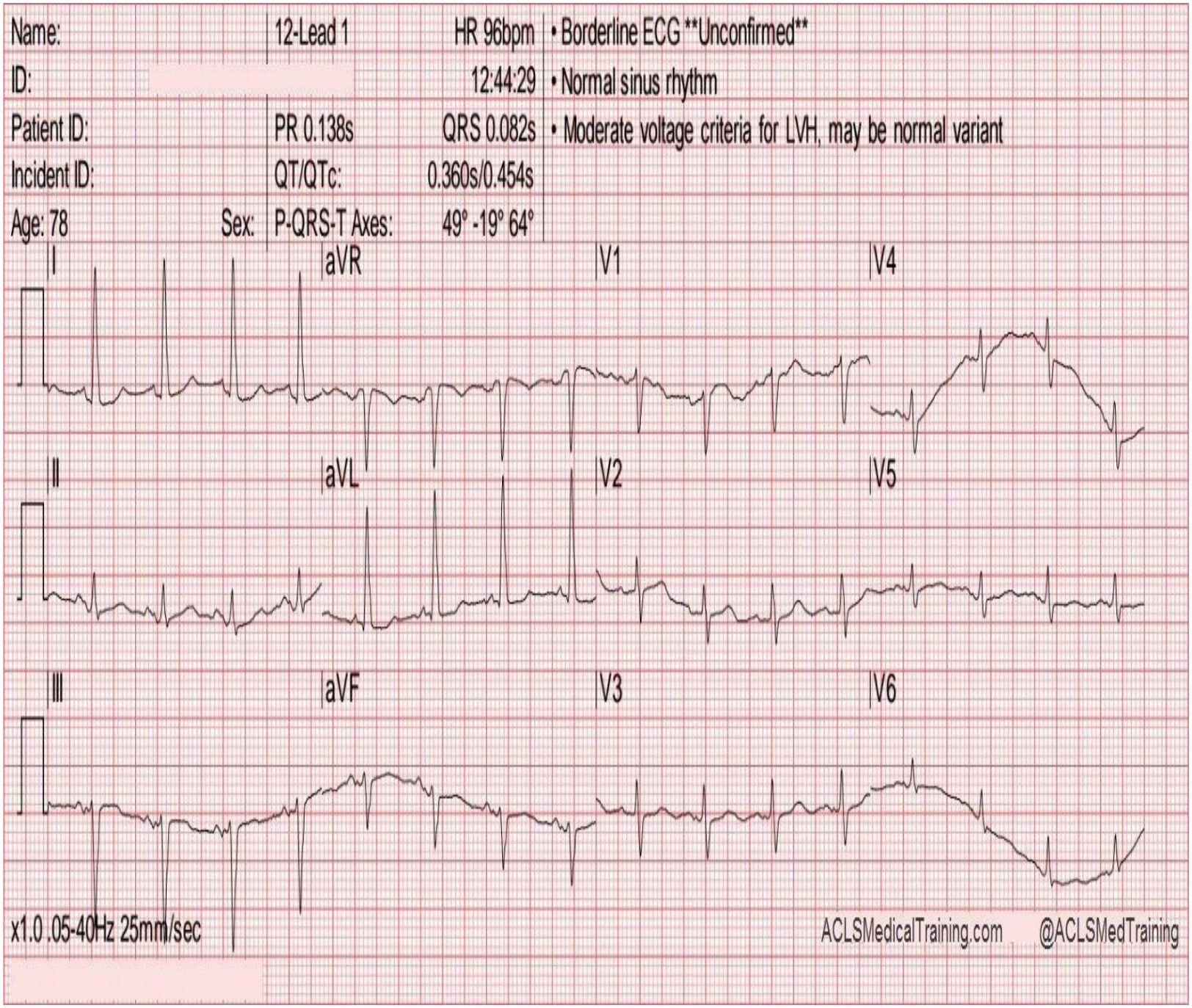
Troubleshooting an ECG

- **Wandering baseline:**
- The waveform moves up and down over the course of the tracing.



WANDERING BASELINE




Name:
12-Lead 1
HR 96bpm
• Borderline ECG **Unconfirmed**
ID:
12:44:29
• Normal sinus rhythm
Patient ID:
PR 0.138s
QRS 0.082s
• Moderate voltage criteria for LVH, may be normal variant
Incident ID:
QT/QTc:
0.360s/0.454s
Age: 78
Sex:
P-QRS-T Axes:
49° -19° 64°
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 .05-40Hz 25mm/sec
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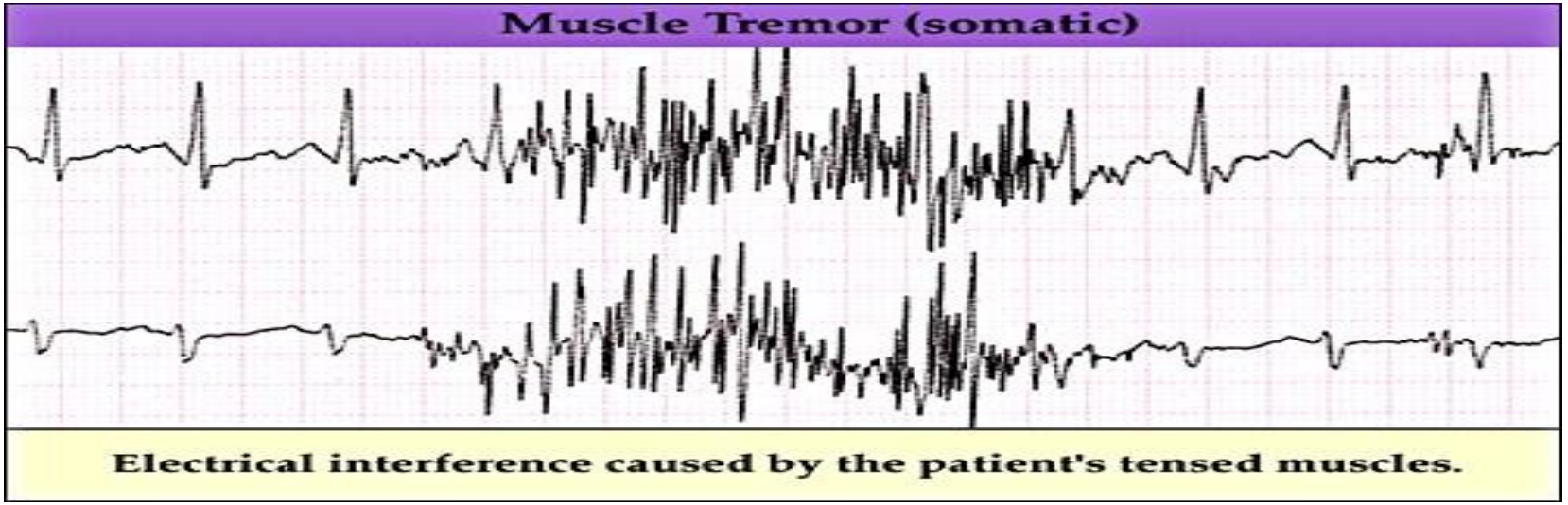
Troubleshooting an ECG

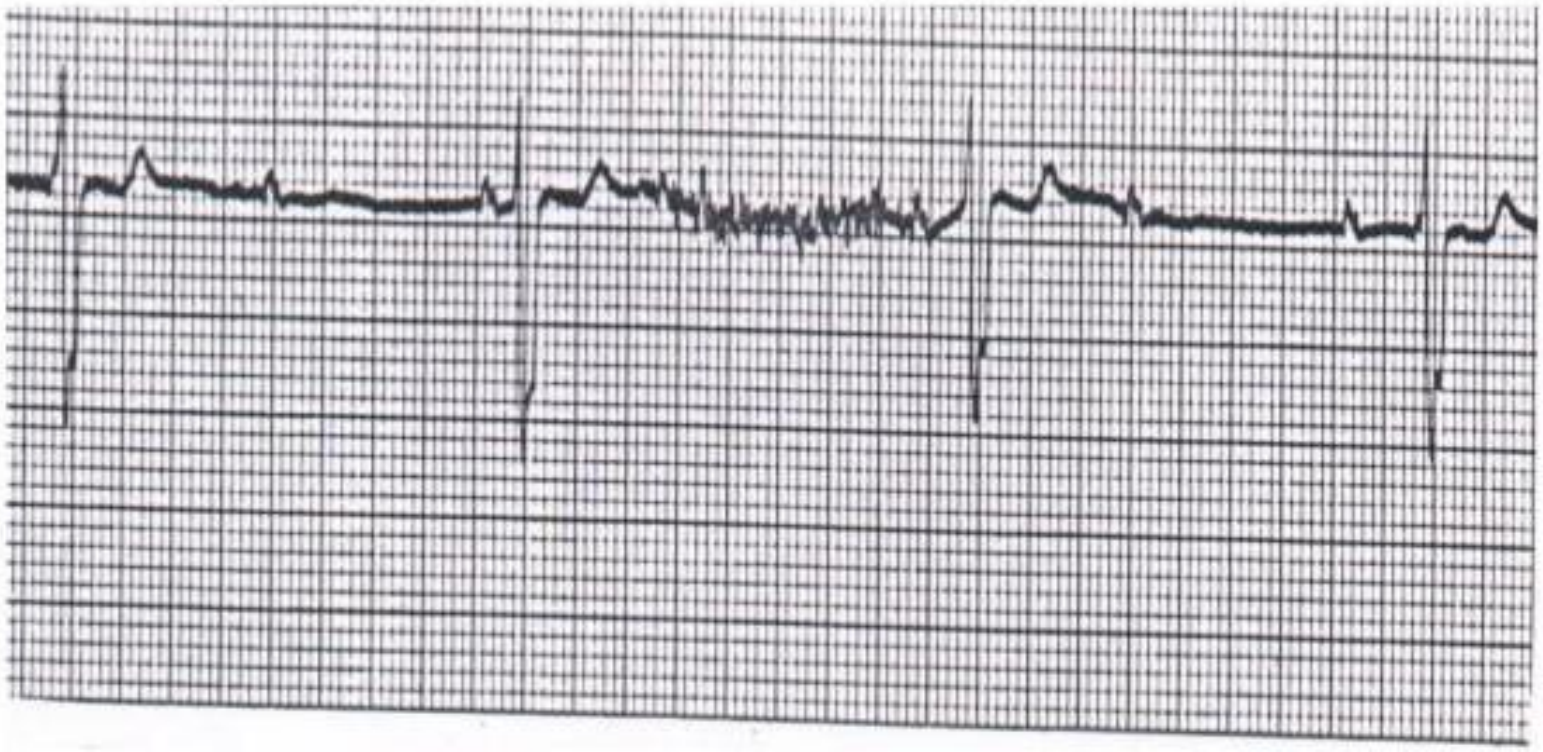
- **Causes of a wandering baseline:**
- Poor connection between the lead and the skin
- Wrong electrode connection
- Exaggerated respiratory movements
- Patient movement
- **How to trouble shoot:**
- Check all electrodes for correct positioning
- Ensure there is full contact of electrode to the skin
- Ask the patient to breath in and out and relax

Troubleshooting an ECG

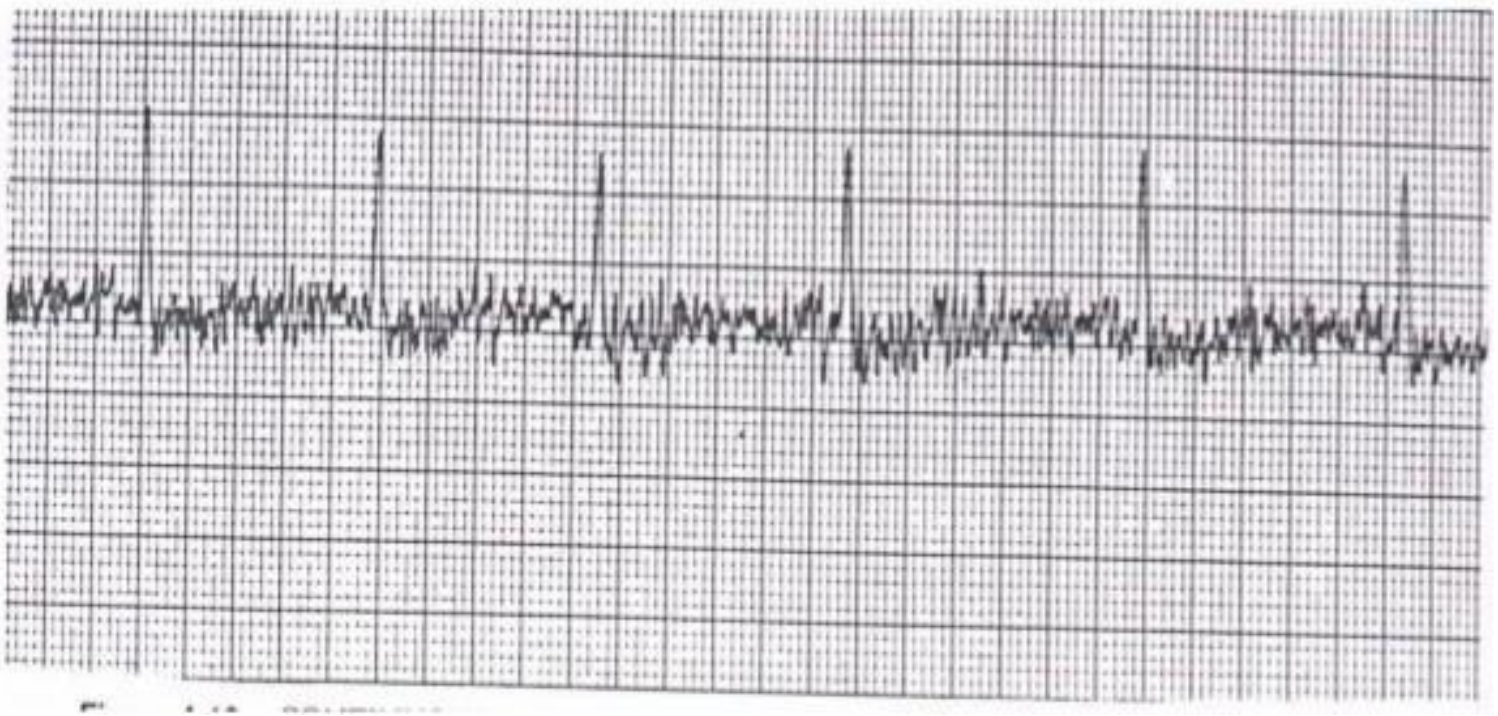
- **Muscle tremor:**
- The waveform shows movement in the form of lines spiking and running close together.



INTERMITTENT MUSCLE TREMOR



CONTINUOUS MUSCLE TREMOR



Troubleshooting an ECG

- **Causes of muscle tremors:**
- Skeletal muscle movement (e.g. chills, nervousness, restlessness, or disease such as Parkinson's)

- **How to trouble shoot:**
- Cover patient if chilled
- Position patient's hands under hips to reduce movement

Lets review

- What is an ECG
- What are the limb leads?
- What are the chest leads?

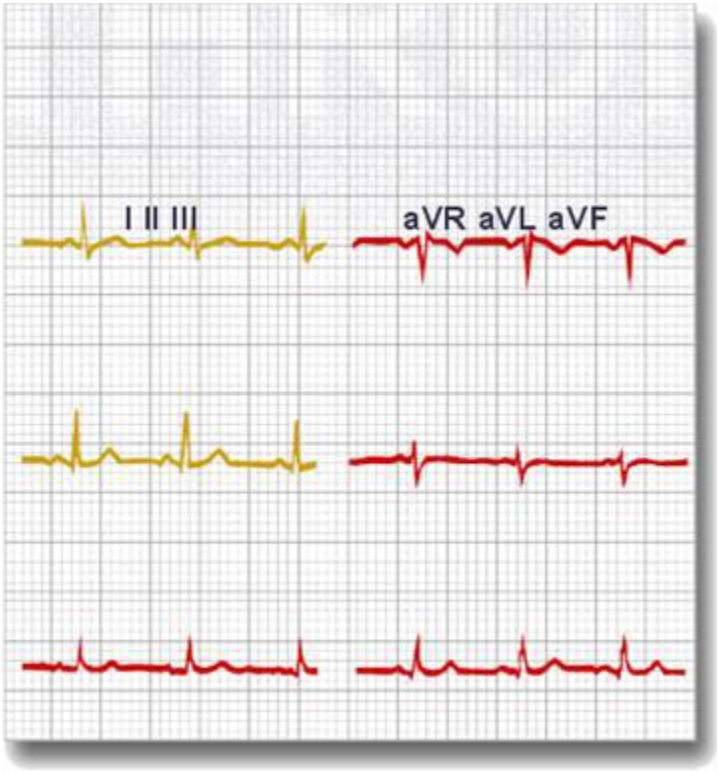
10 points of reading a 12 lead ECG

- **Rule 1:**
- PR interval should be 0.12 to 0.2 sec i.e. 3 to 5 small boxes

- **Rule 2:**
- The width of the QRS complex should be less than 3 small boxes

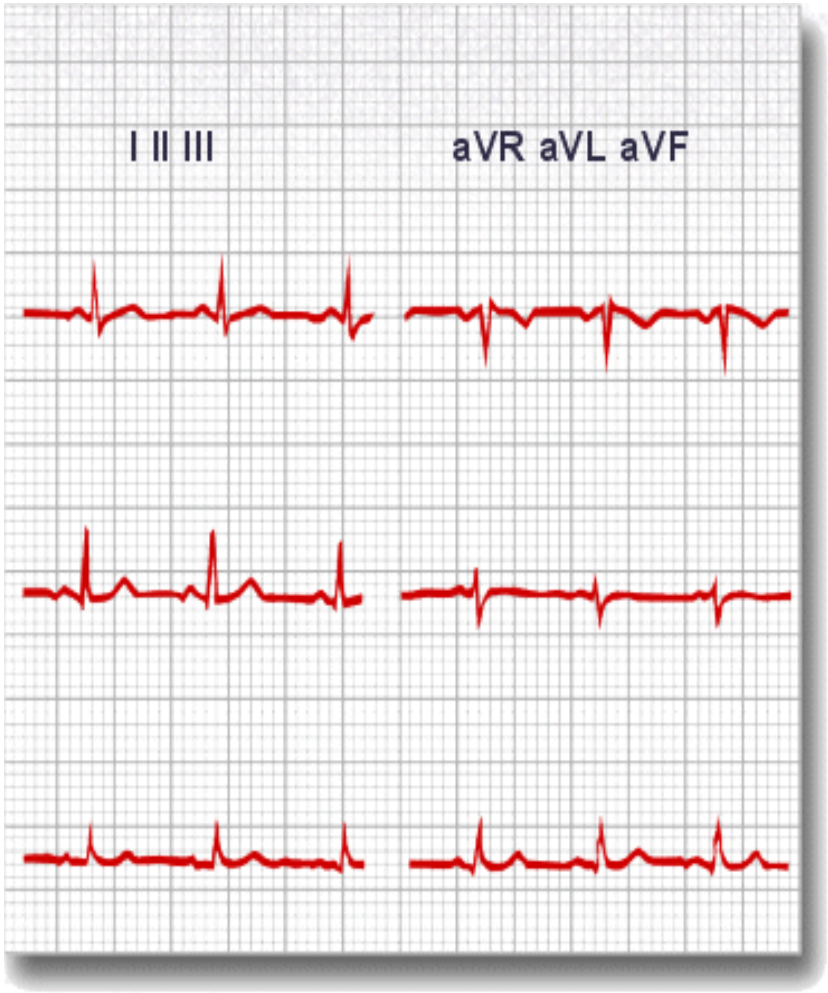
10 points of reading a 12 lead ECG

- **Rule 3:**
- The QRS complex should be dominantly upright in leads I and II



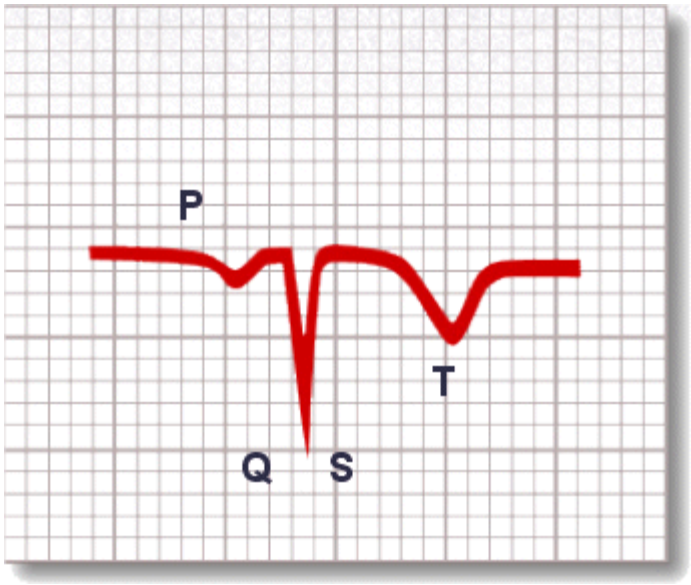
10 points of reading a 12 lead ECG

- **Rule 4:**
- QRS and T waves tend to have the same general direction in the limb leads



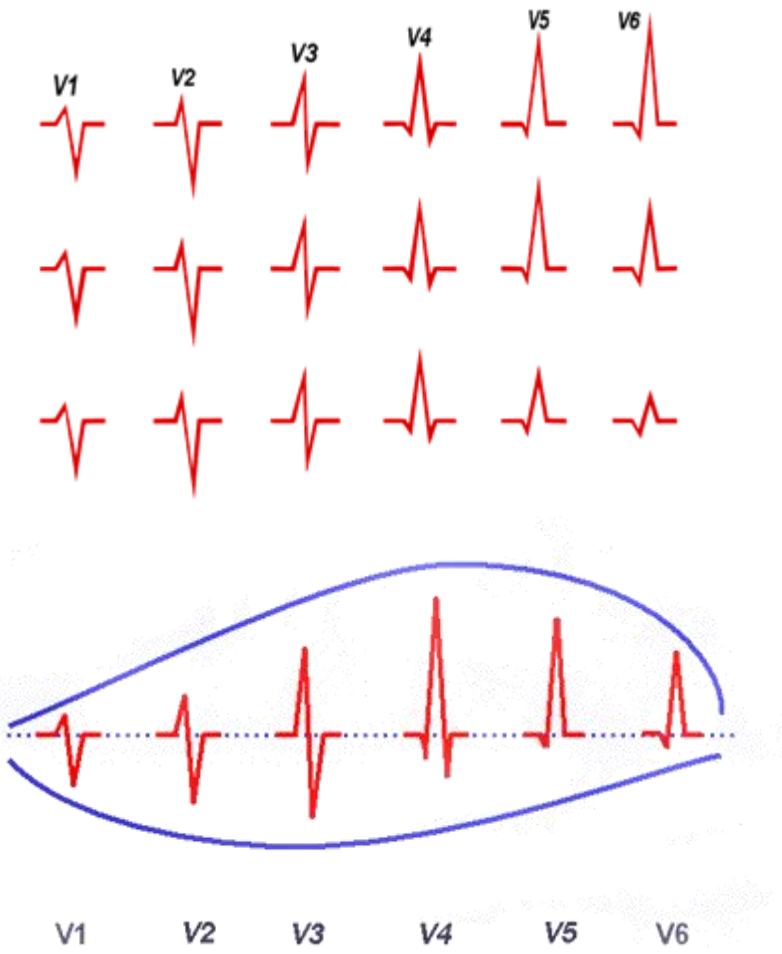
10 points of reading a 12 lead ECG

- **Rule 5:**
- All waves are negative in lead aVR



10 points of reading a 12 lead ECG

- **Rule 6:**
- The R wave in the precordial leads must grow from V1 to at least V4
- The S wave in the precordial leads must grow from V1 to at least V3 and disappear in V6

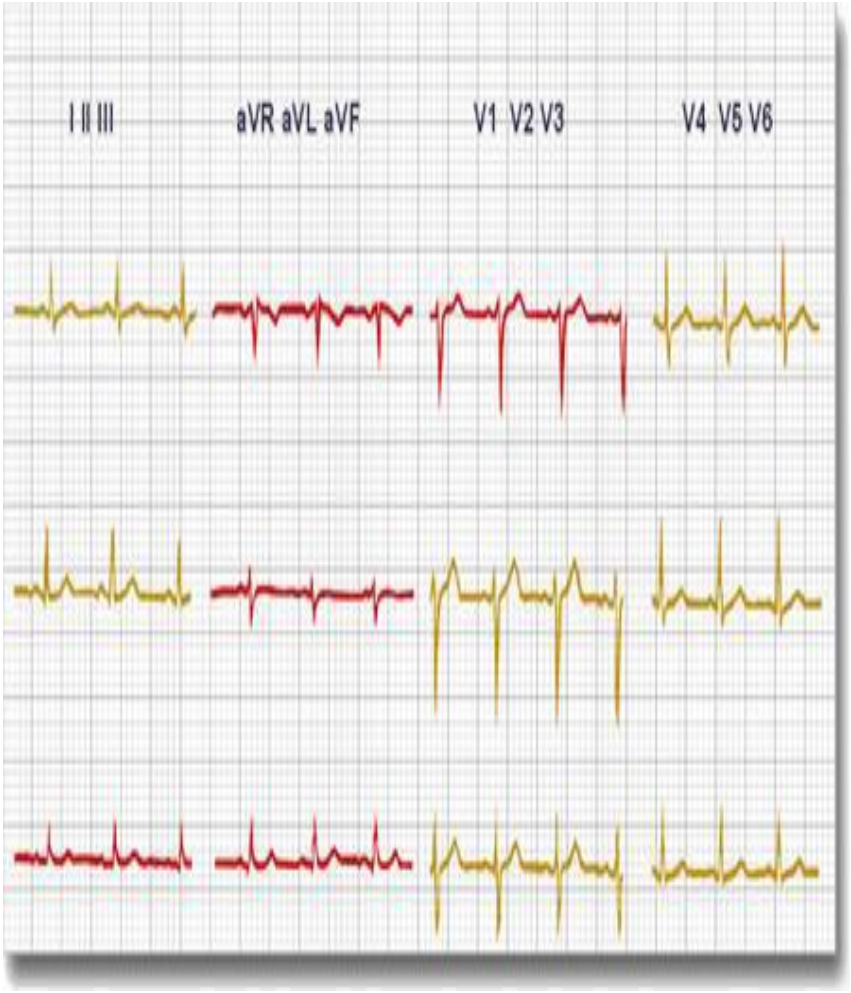


10 points of reading a 12 lead ECG

- **Rule 7:**
- The ST segment should start at the isoelectric except in V1 and V2 where it may be elevated

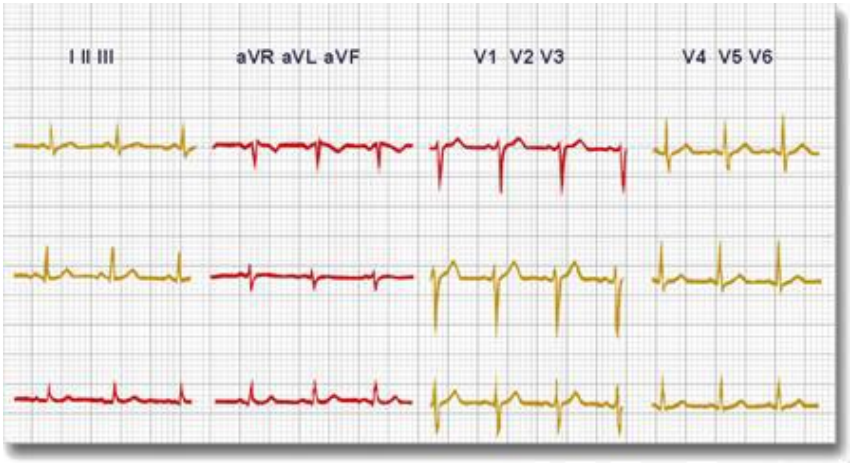
10 points of reading a 12 lead ECG

- **Rule 8:**
- The P waves should be upright in I, II, and V2 to V6



10 points of reading a 12 lead ECG

- **Rule 9:**
- There should be no Q wave or only a small q less than 0.04 seconds in width in I, II, V2 to V6



10 points of reading a 12 lead ECG

- **Rule 10:**
- The T wave must be upright in I, II, V2 to V6

12 Lead ECG Basics
Bipolar Limb Leads

Lead	P wave	QRS	T wave
I	upright	upright	upright
II	upright	upright	upright
III	upright	upright	upright

12 Lead ECG Basics

Augmented Limb Leads

Lead	P wave	QRS	T wave
aVR	negative	negative	negative
aVL	upright	upright	upright
aVF	upright	upright	upright

12 Lead ECG Basics
Chest Leads

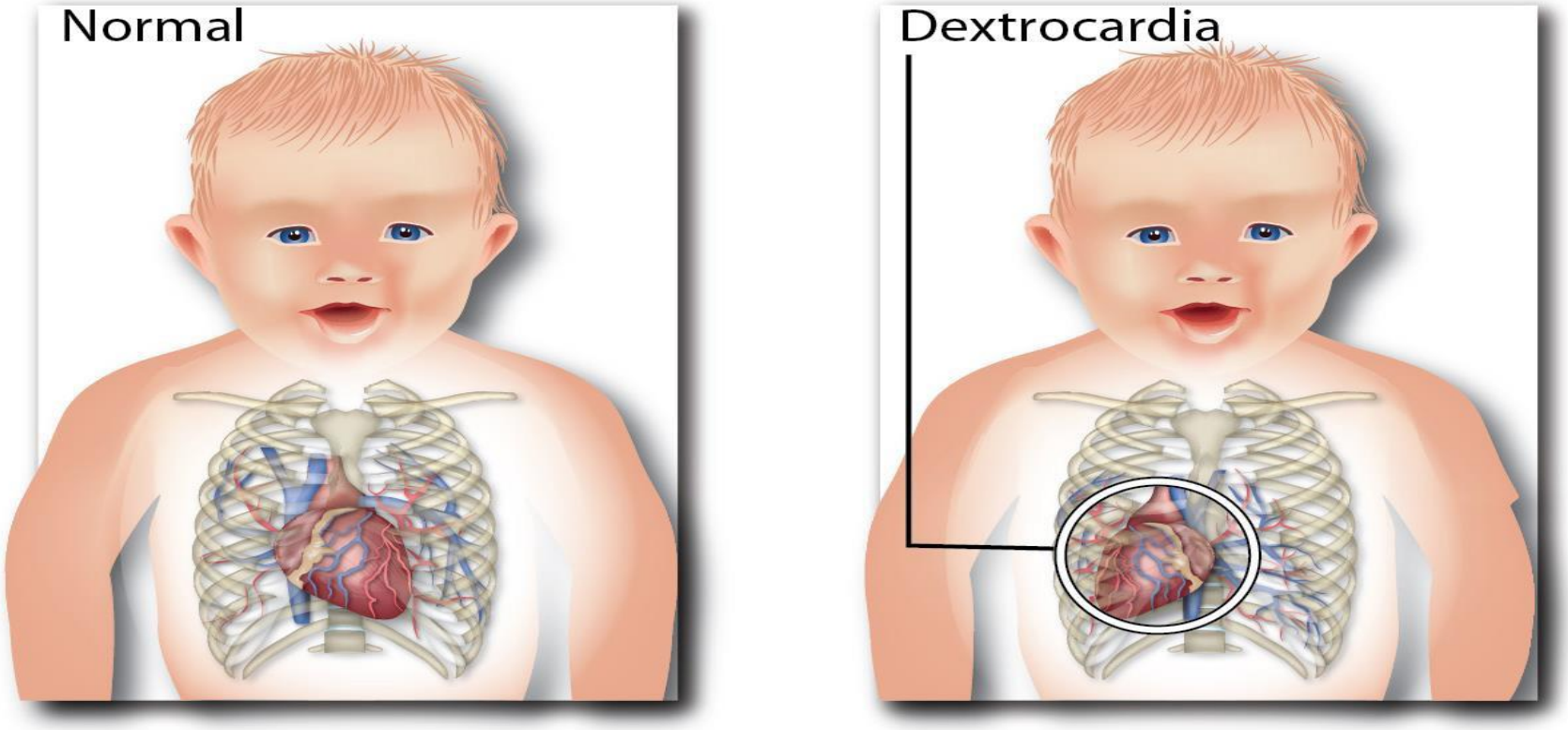
Lead	P wave	QRS	T wave
V1	upright/ biphasic	small R wave / QS	upright
V2	upright	small R wave / QS	upright
V3	upright	equipahsic QRS - upright	upright

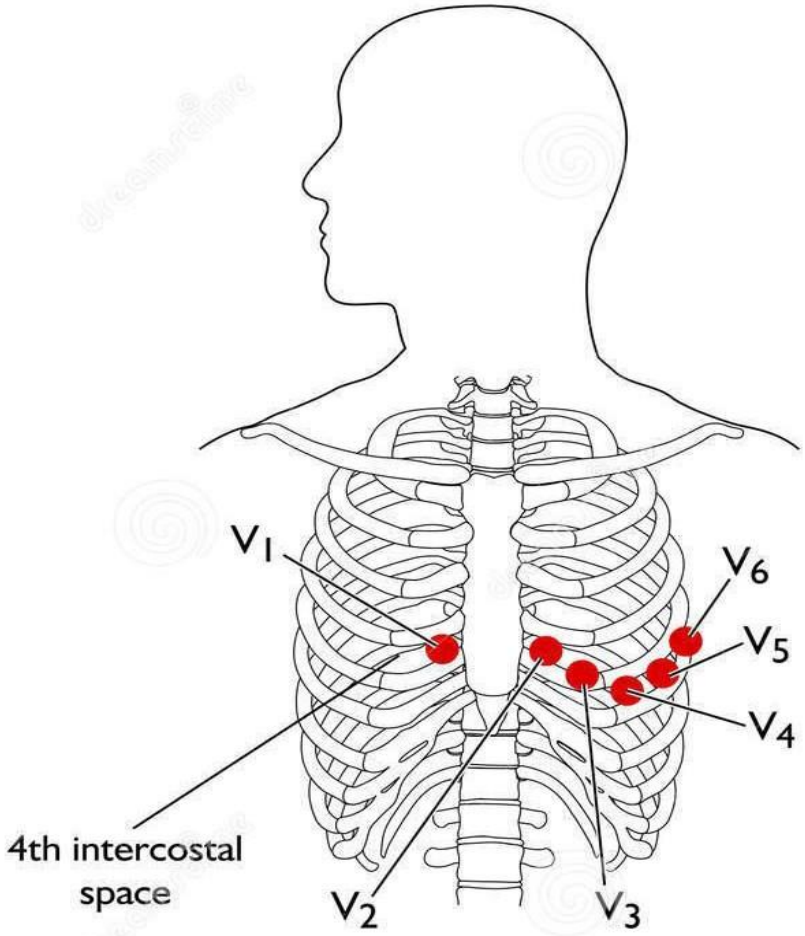
12 Lead ECG Basics
Chest Leads

Lead	P wave	QRS	T wave
V4	upright	upright	upright
V5	upright	upright	upright
V6	upright	upright	upright

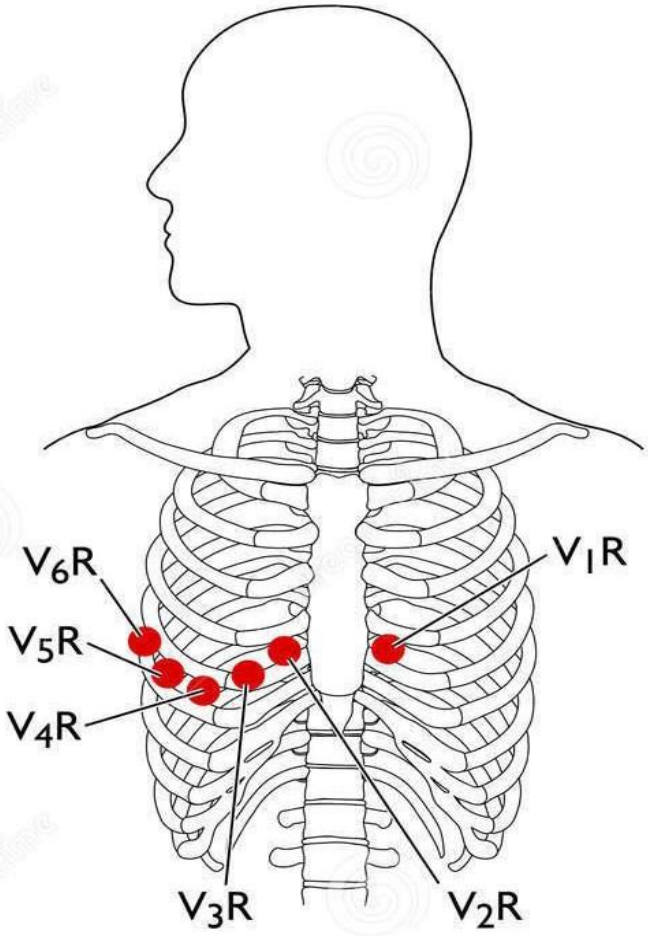
Dextrocardia

Heart location in the right side of the chest



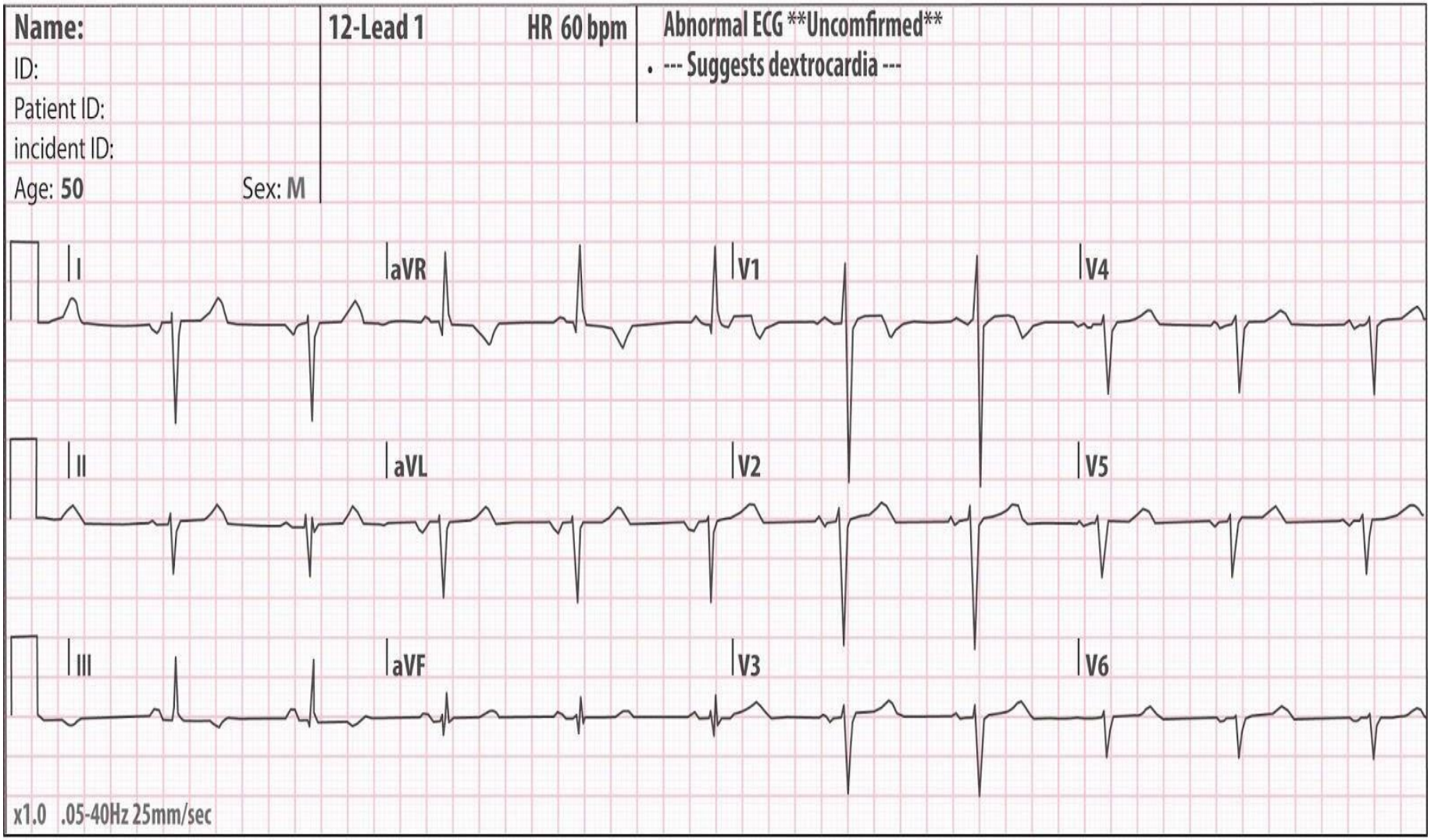


A. Standard chest lead placement



B. Right sided chest lead placement

Dextrocardia



Coronary circulation

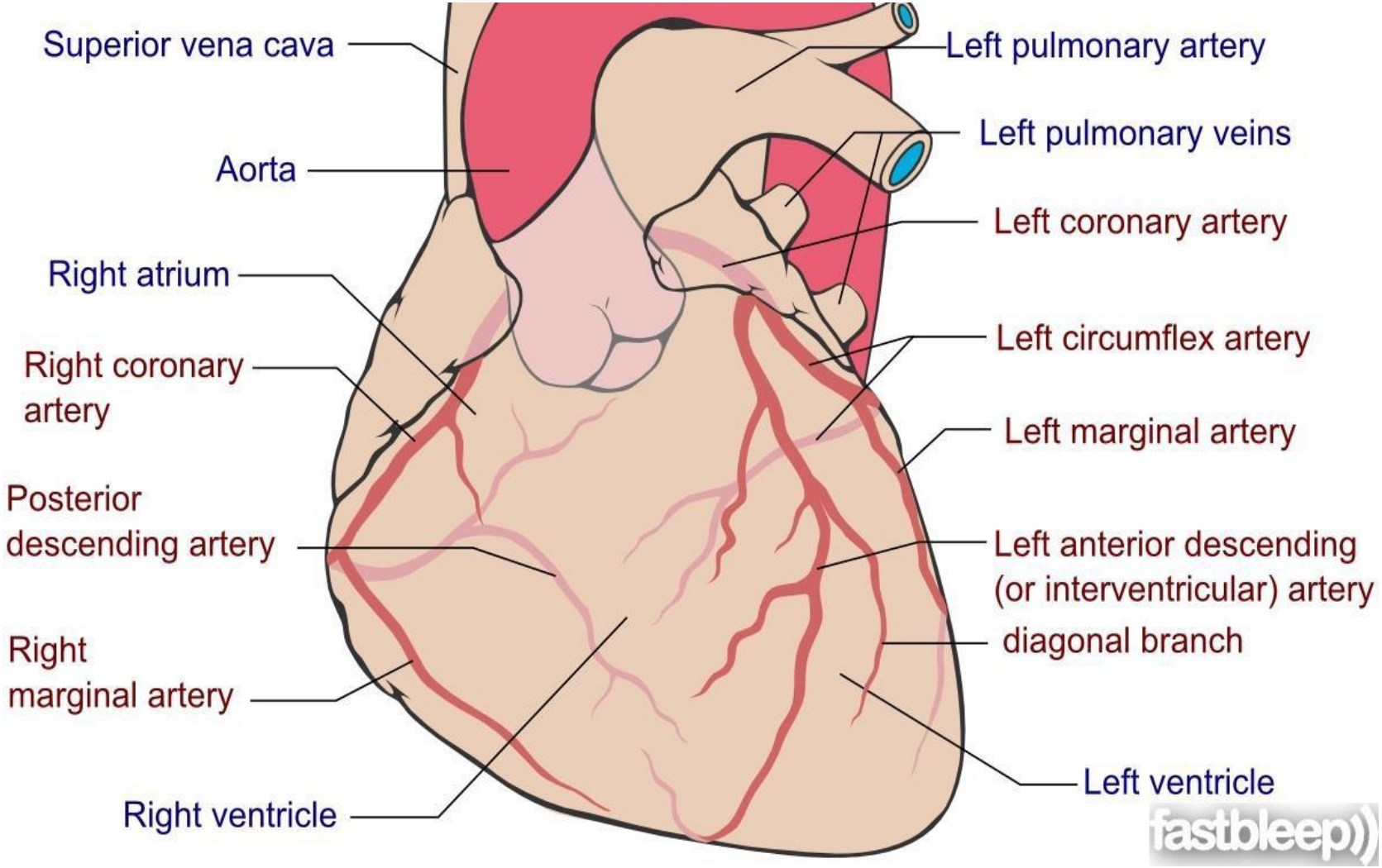
- Blood supply to the heart is through the coronary circulation, which encircles the entire surface of the heart to supply its different regions.

- Coronary circulation consists of coronary arteries and veins that carry oxygenated blood and deoxygenated blood respectively

Coronary arteries

- The two main coronary arteries that branch from the ascending aorta are the:
  - Left coronary artery
  - Right coronary artery

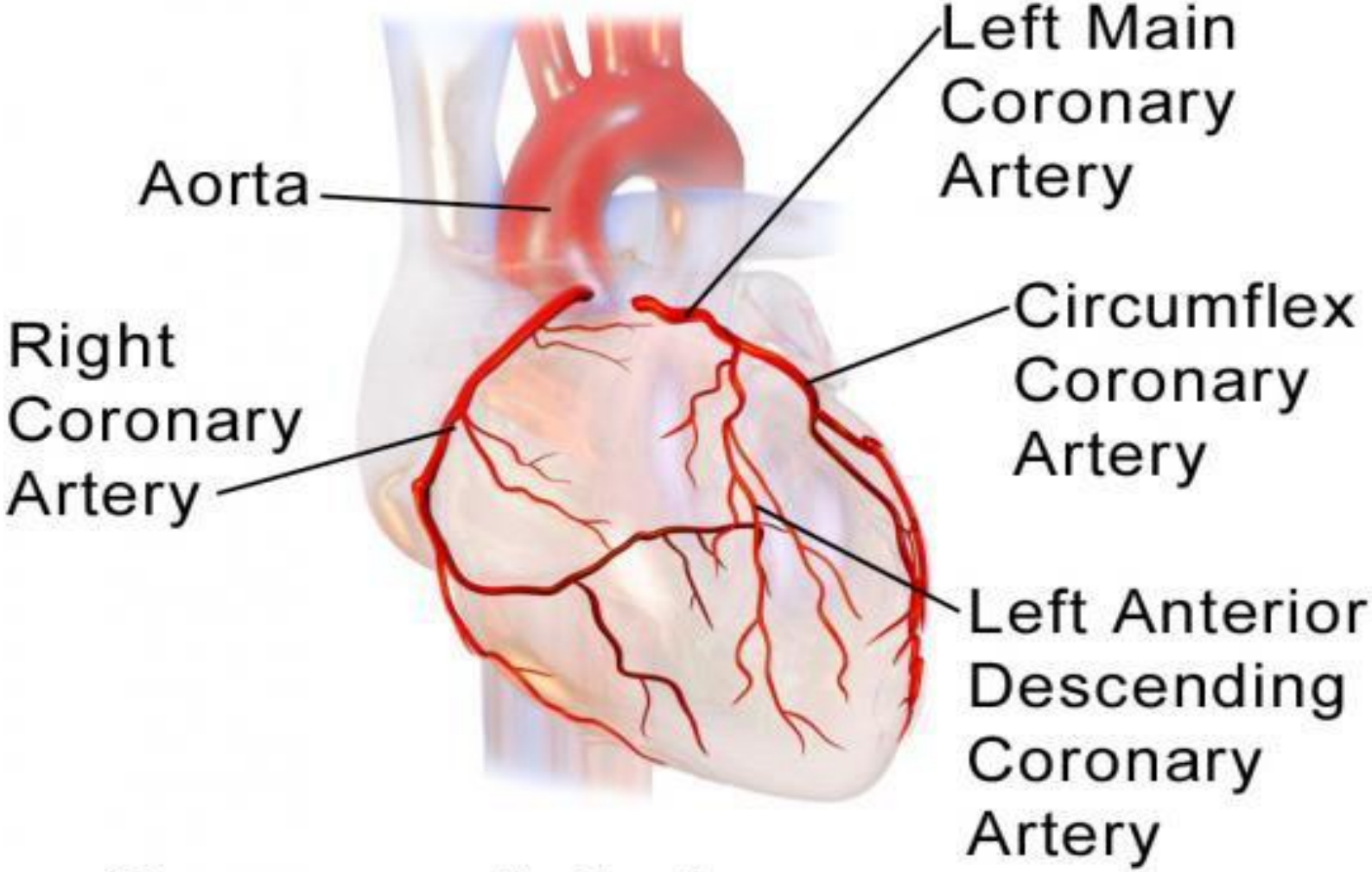
Coronary arteries



Left coronary artery (LCA)

- LCA originates from the left side of aorta
- The LCA supplies the **left atrium, inter-ventricular septum, left ventricle and the anterior wall of the right ventricle.**

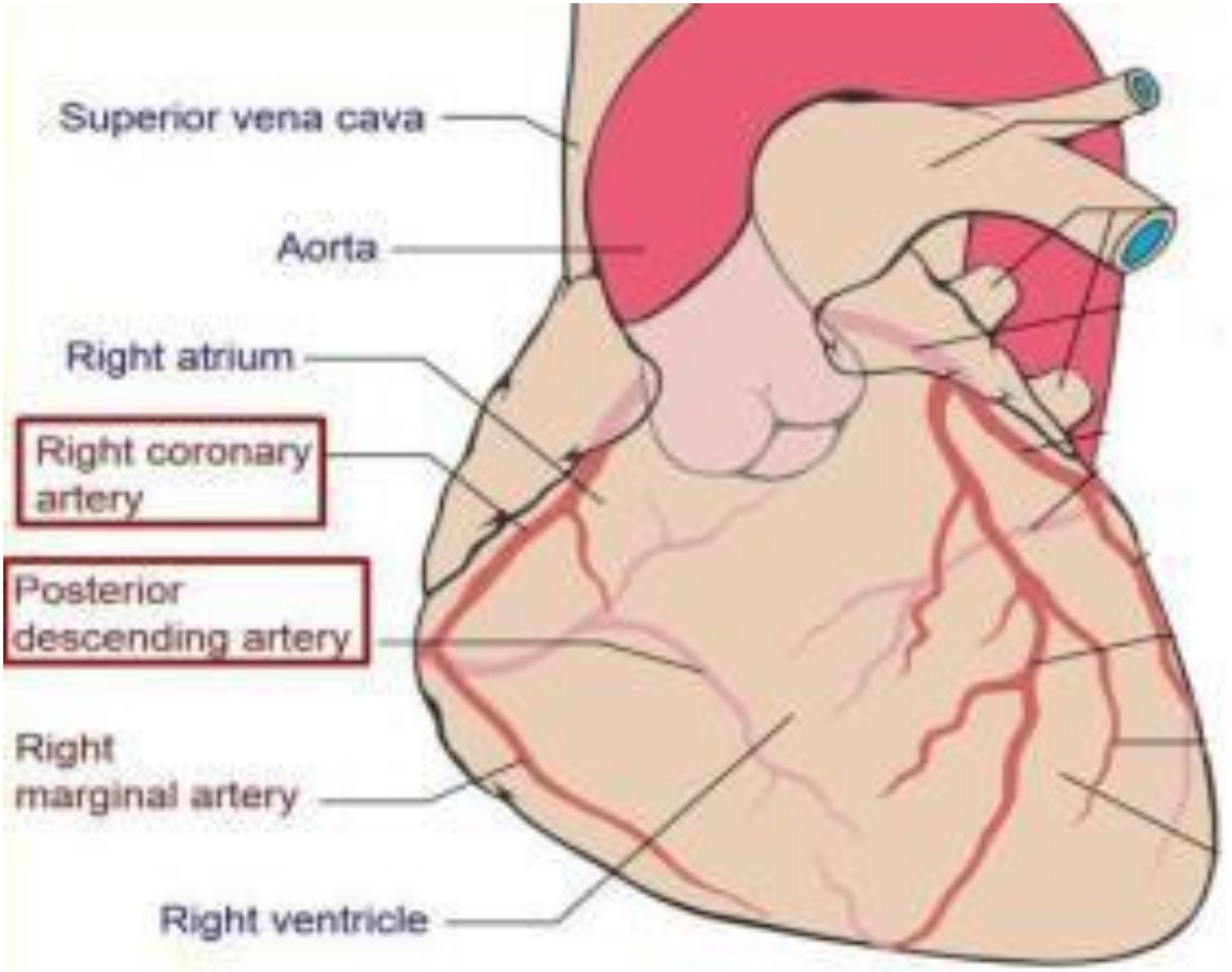
- **LCA divides into two primary branches:**
- The left anterior descending (LAD)
- Left circumflex (LCX)
- The two primary branches of the LCA further divide into other branches



Coronary Arteries

Right coronary artery (RCA)

- RCA originates from the right side of aorta
- RCA supplies the **right atrium, the right ventricle, atrio-ventricular node as well as the sino-atrial node.**
- The Av node in 90% of the population is supplied by the RCA
- **RCA divides into two primary branches:**
- The posterior descending artery (PDA) which supplies the walls of both ventricles.
- The right marginal branch which supplies the right atrium and Right ventricle.

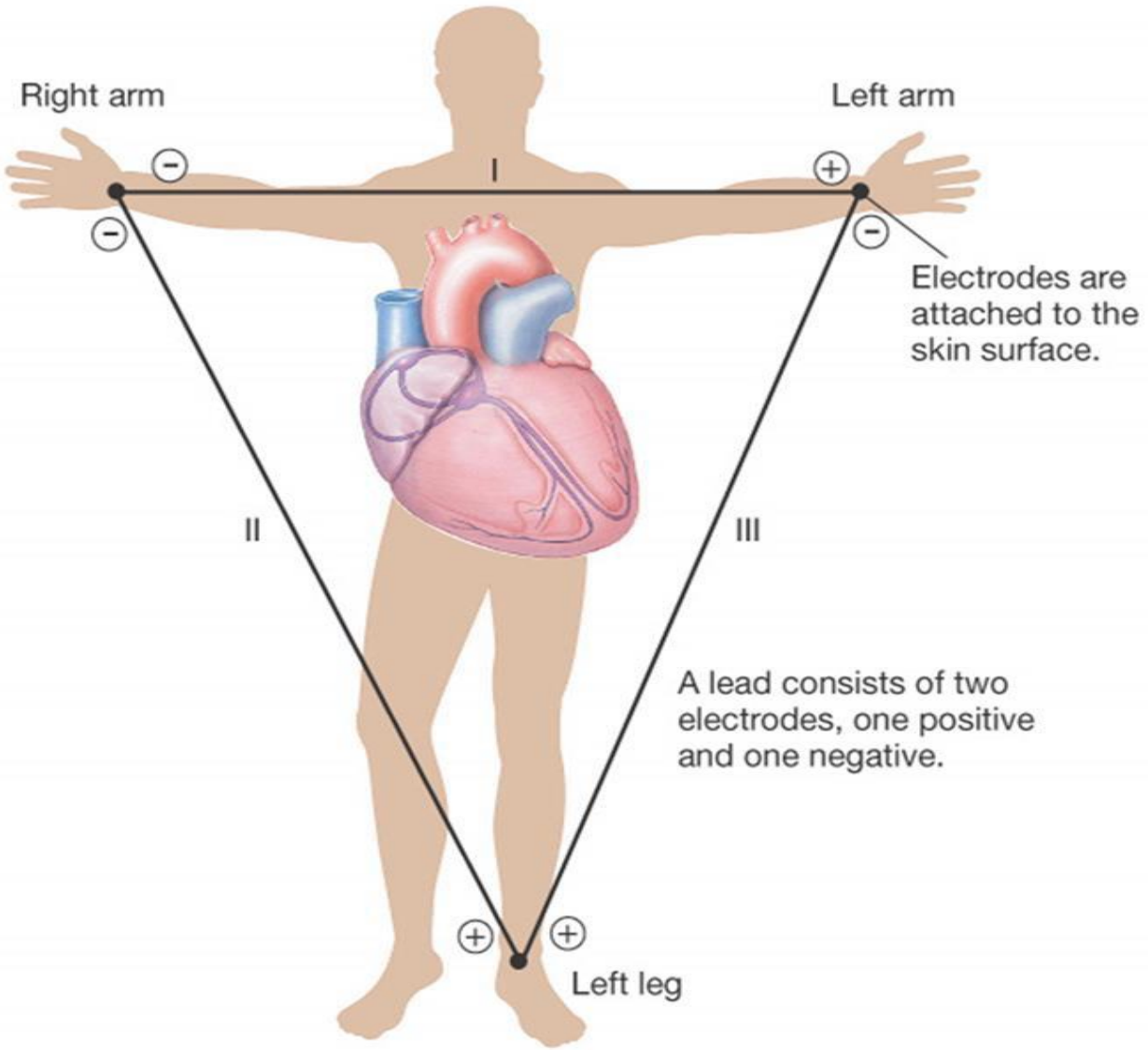

Superior vena cava
Aorta
Right atrium
Right coronary artery
Posterior descending artery
Right marginal artery
Right ventricle

12 lead ECG Views

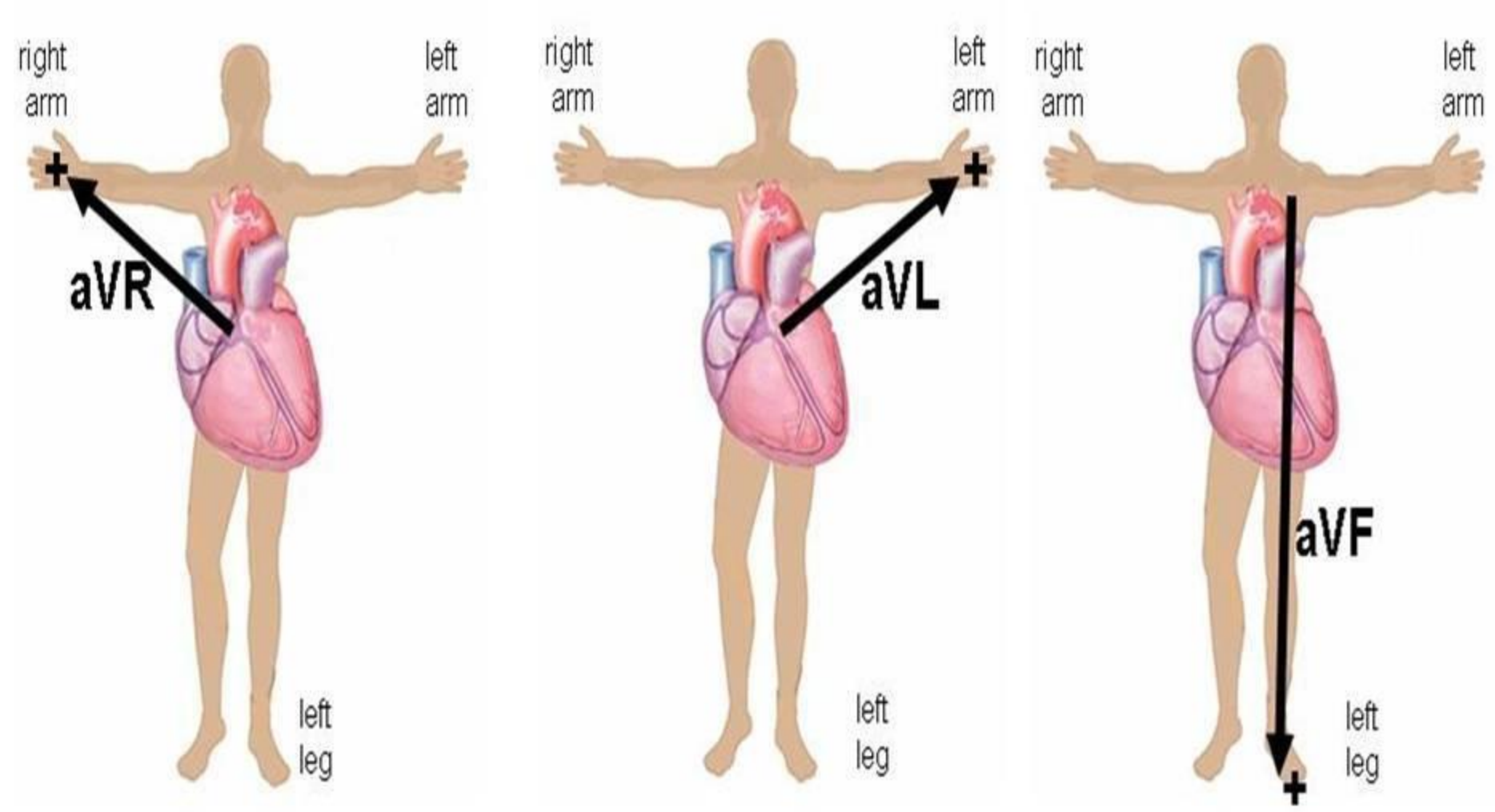
- **Remember:**
- The limb leads record the electrical activity in the heart in the vertical plane/ frontal plane

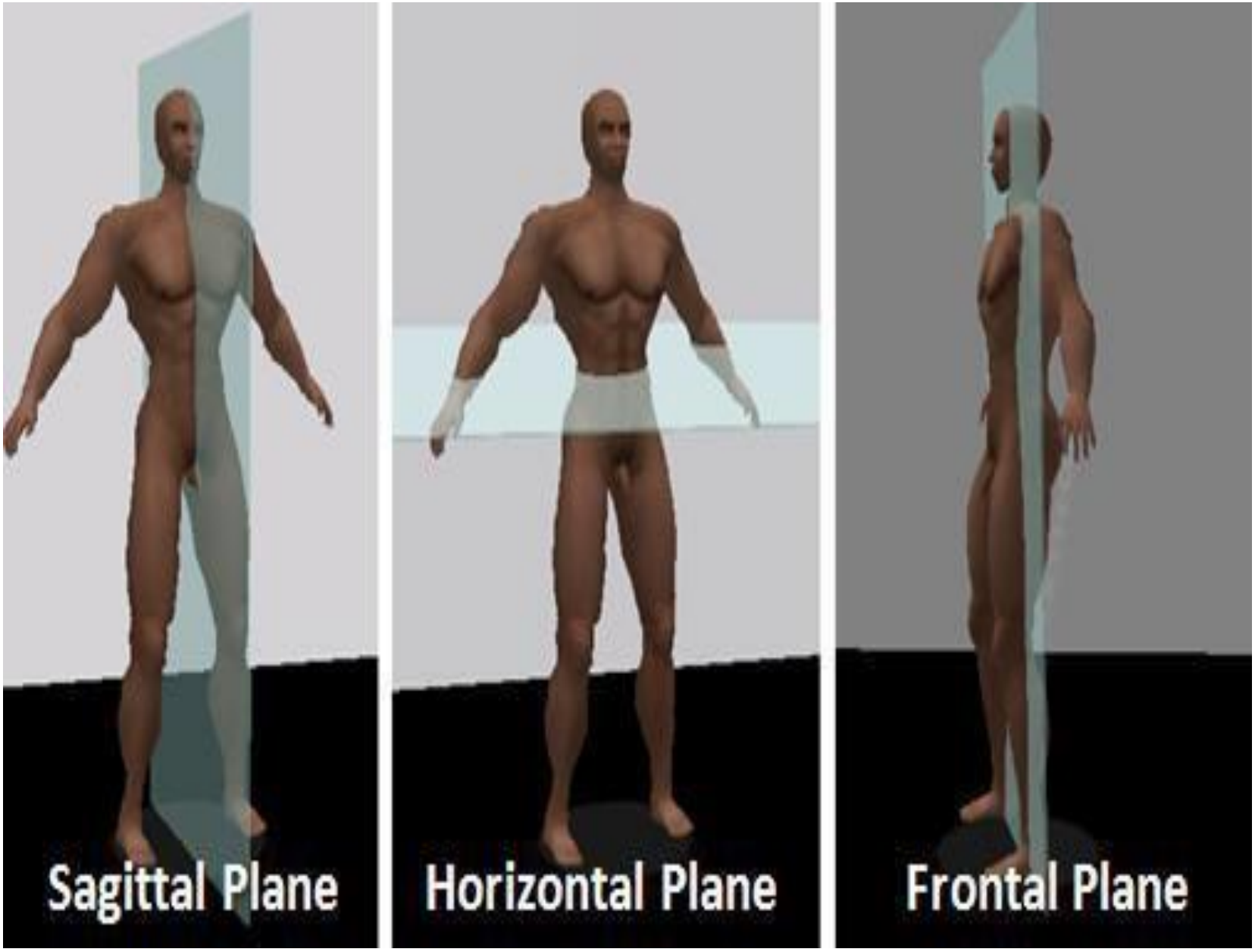
- The chest leads/ precordial leads record the electrical activity in the transverse/ horizontal plane

Standard Limb Leads

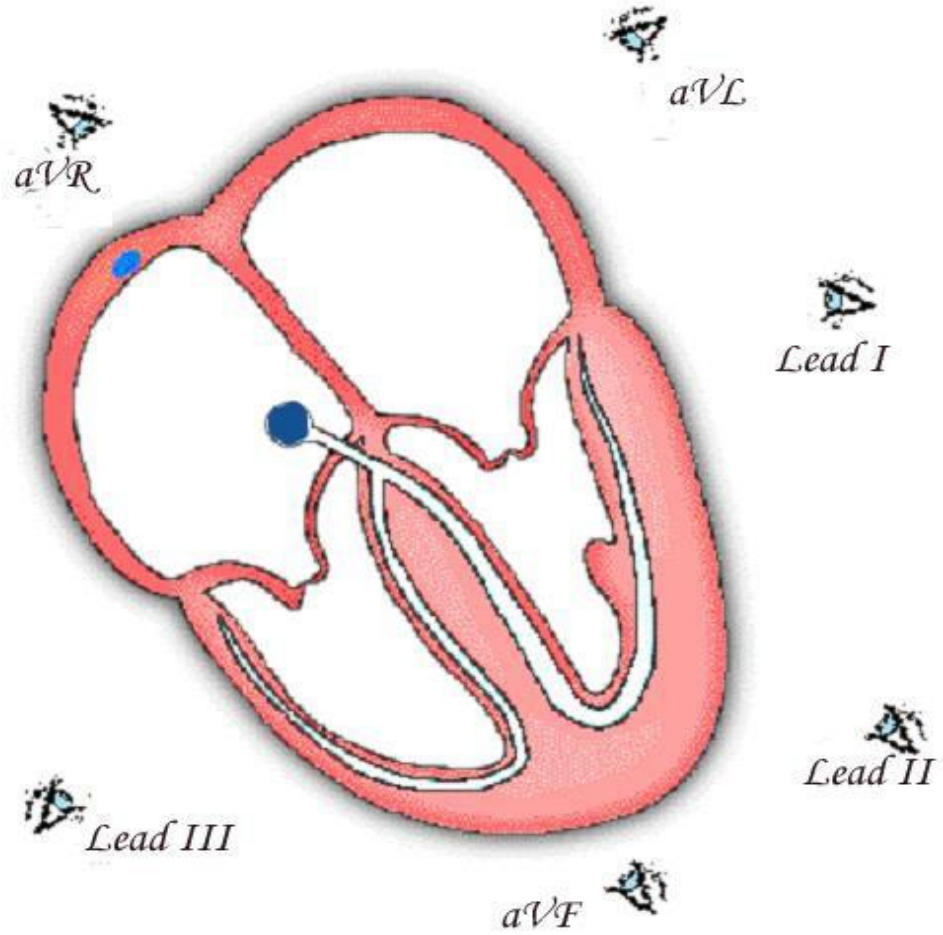


AUGMENTED LIMB LEADS (aVR, aVL, aVF)

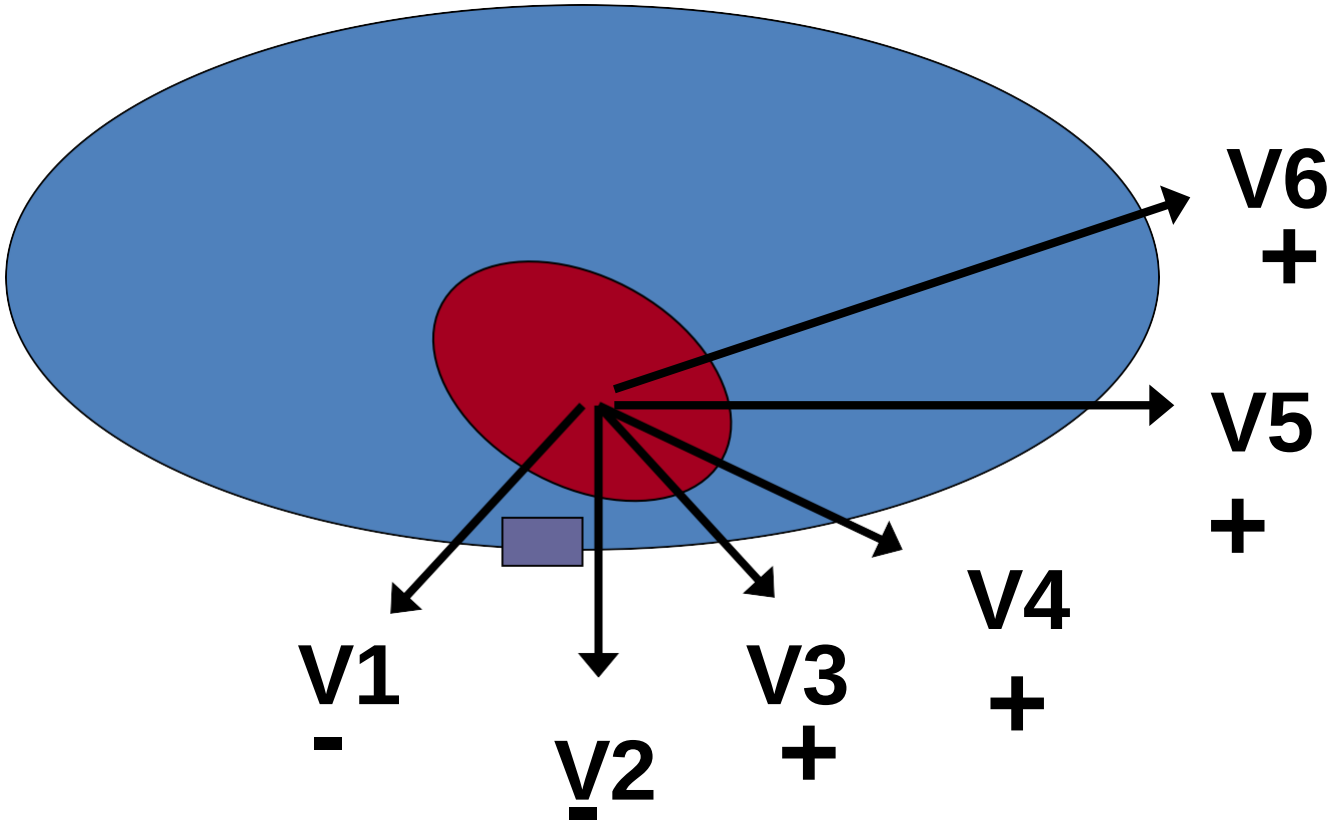


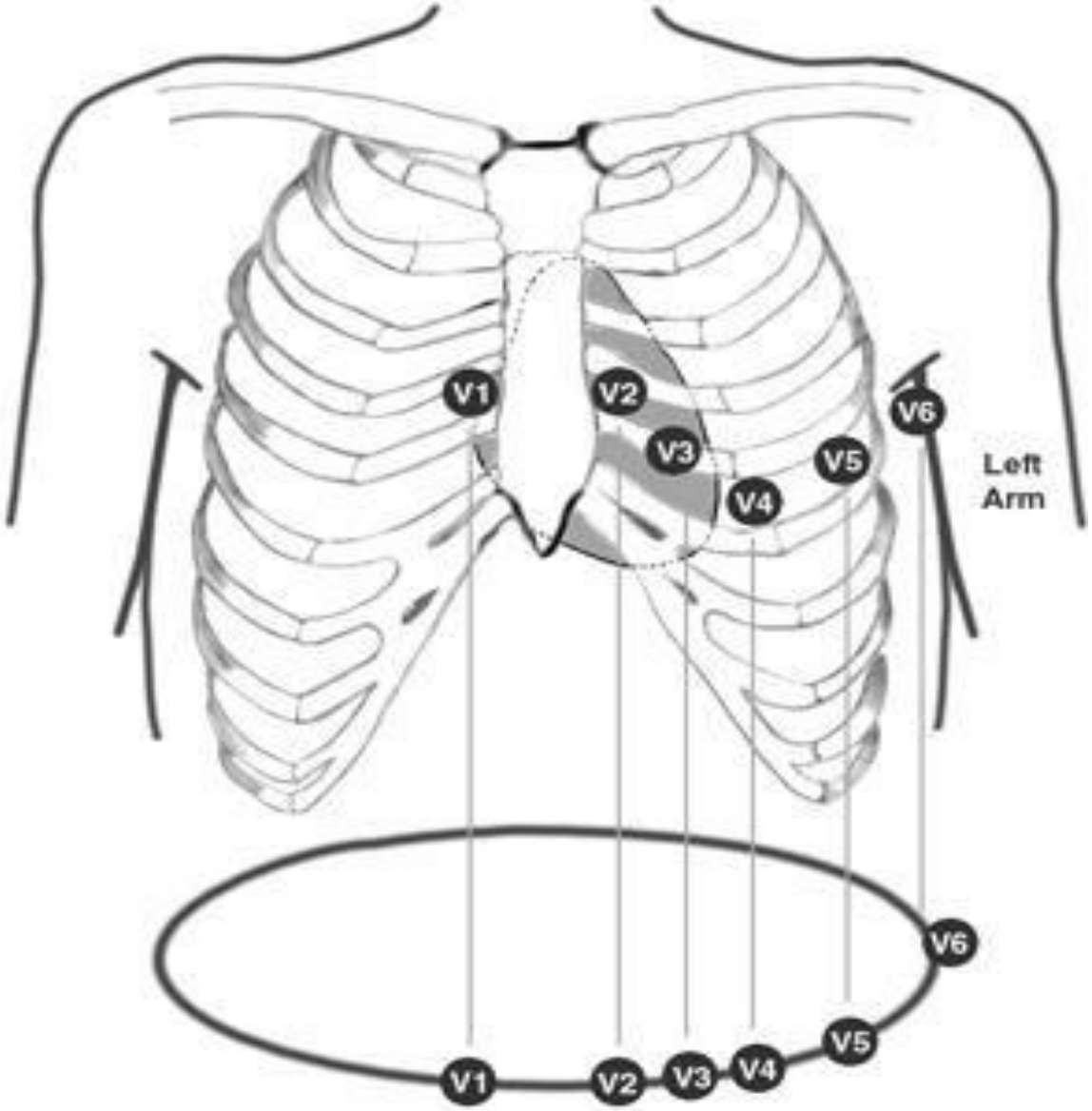

Sagittal Plane
Horizontal Plane
Frontal Plane

Views from Augmented and Limb Leads- Frontal

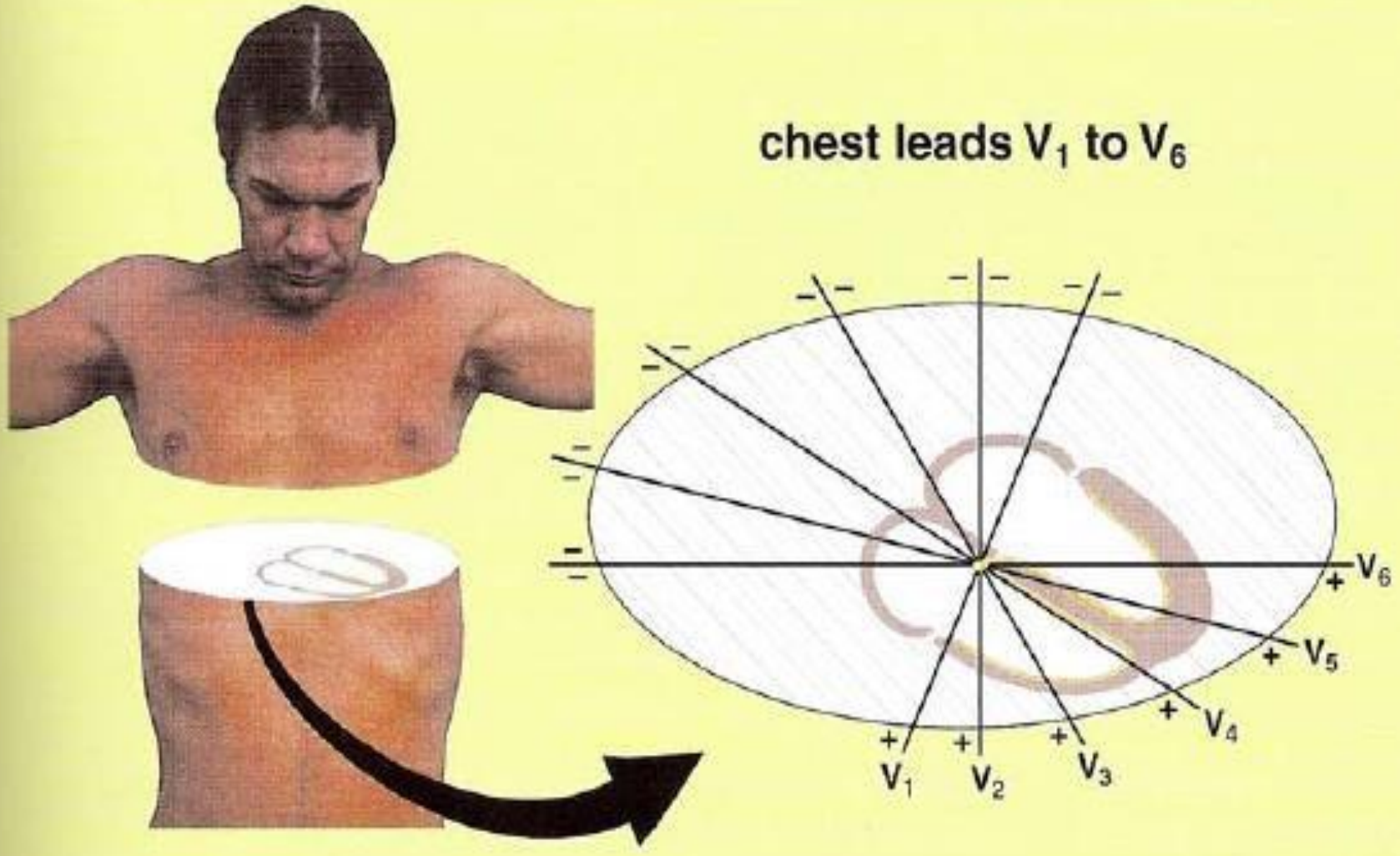


“Seeing” the heart in the Transverse plane: The Chest Leads




V1
V2
V3
V4
V5
V6
Left
Arm
V6
V5
V4
V3
V2
V1

Chest Leads in the Horizontal Plane

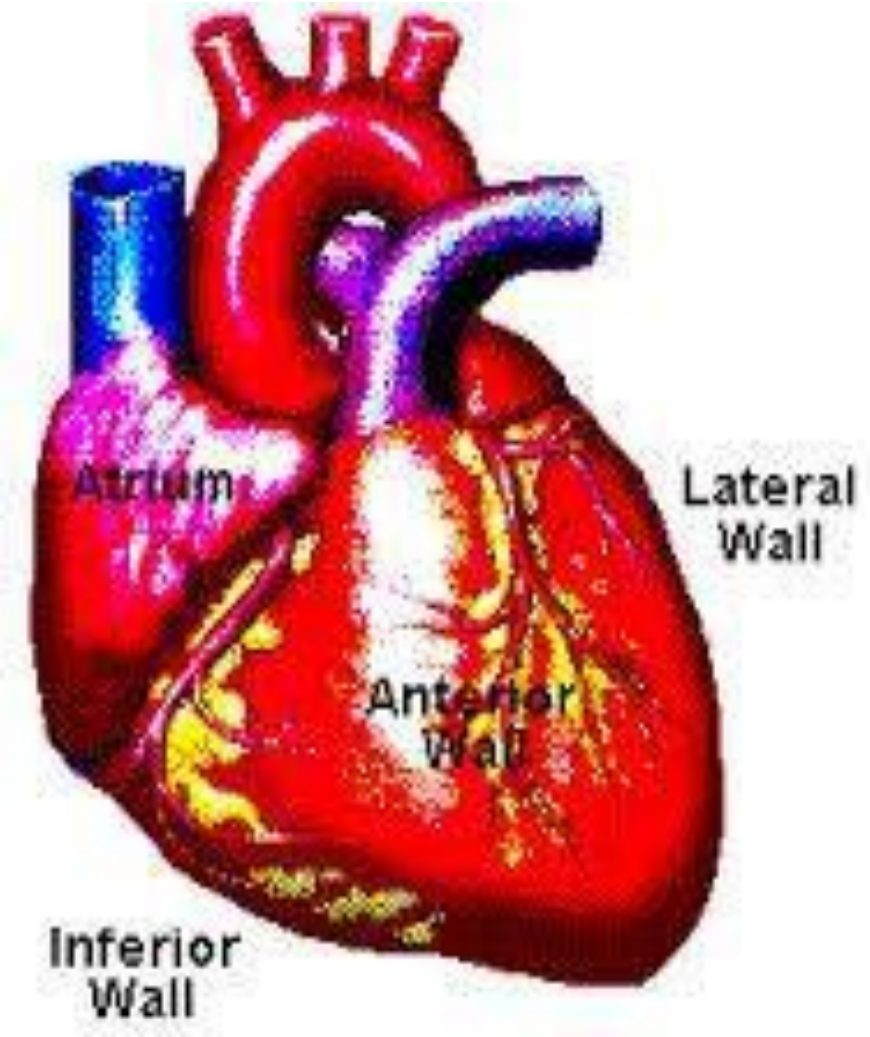


Views of the Heart

Some leads get a good view of the:

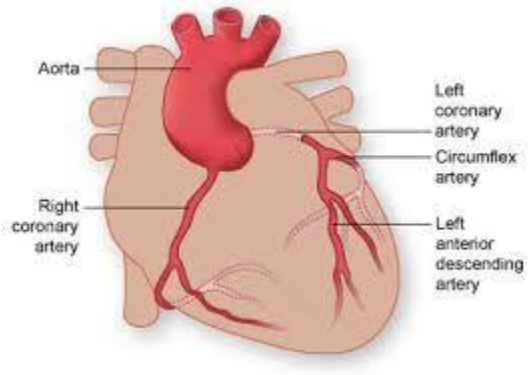
Surfaces of the heart

- Inferior wall - underneath
- Anterior wall- front
- Lateral wall- left side
- Posterior wall - back



Inferior surface of the heart

- **Inferior Surface:**
- Its viewed by leads II, III and avF
- They look **UP** from below to the inferior surface of the left ventricle
- The inferior surface is mostly perfused by the Right Coronary Artery



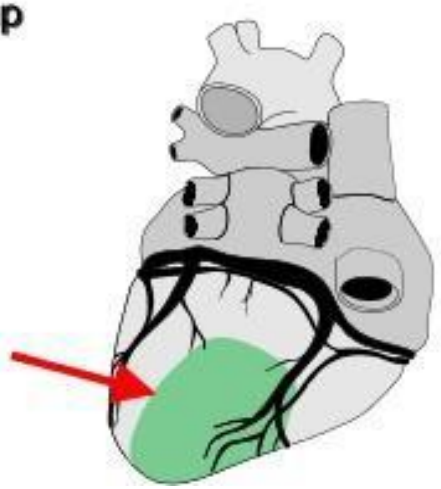
Inferior leads

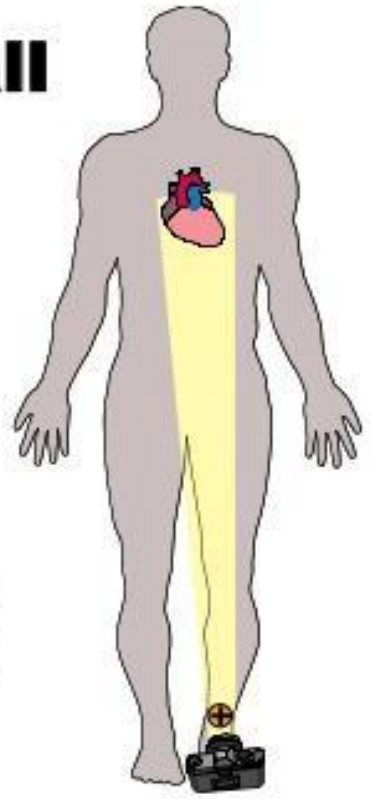
Anatomy of a 12-Lead EKG (cont.)

View of Inferior Heart Wall

- **Leads II, III, aVF**
  - Looks at inferior heart wall

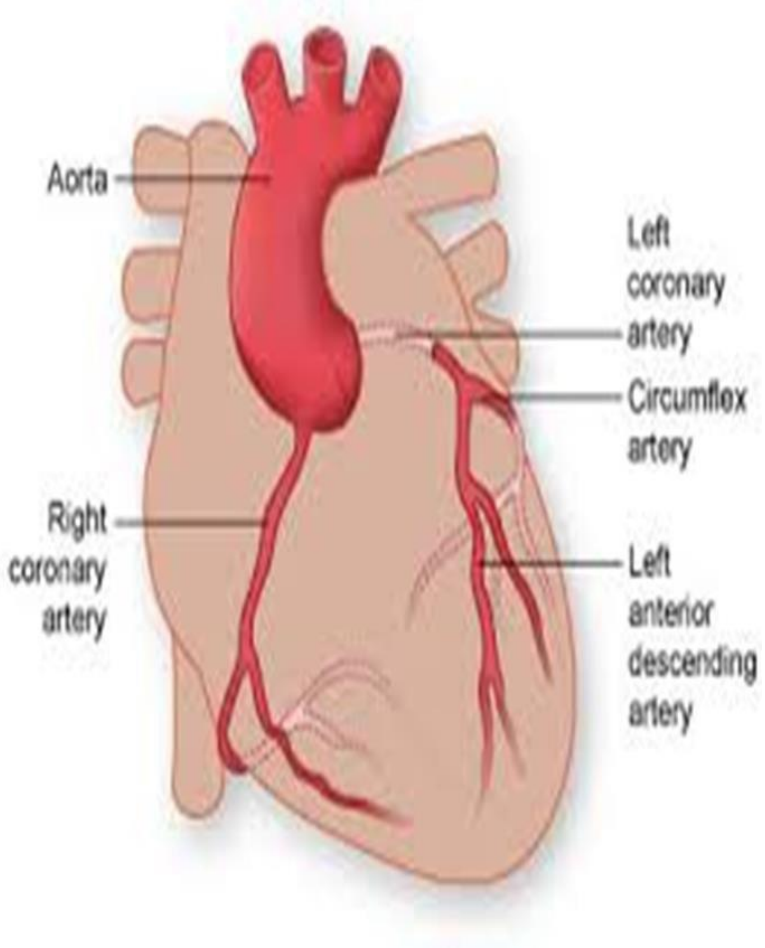
-Looks from the left leg up



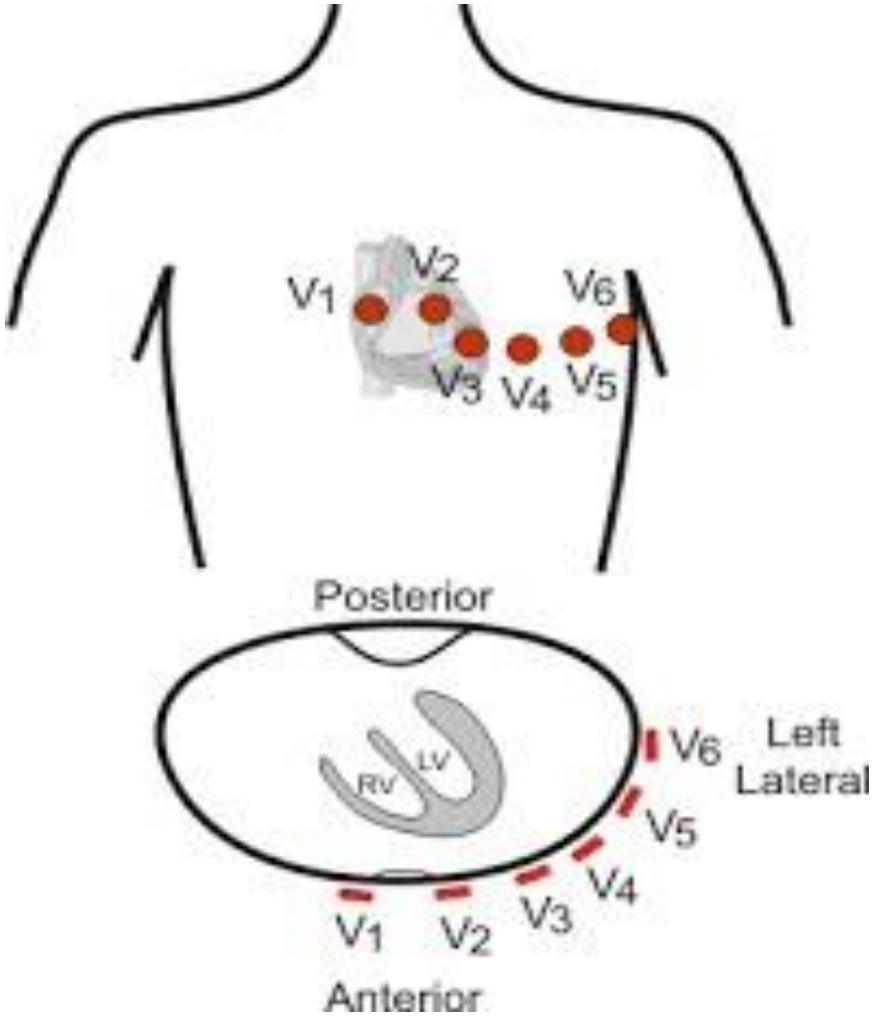


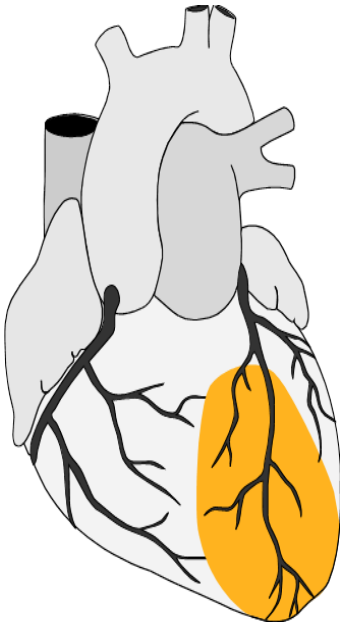
Surfaces of the left ventricle

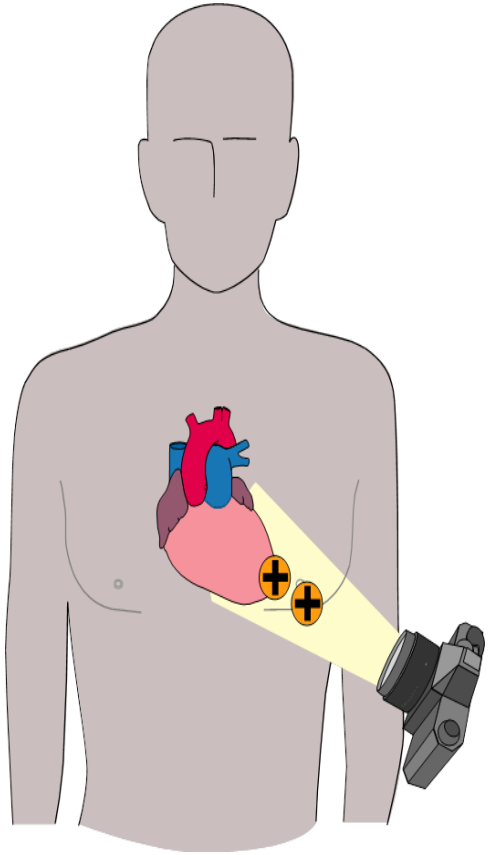
- **Anterior Surface:**
- This allows frontal viewing of the left ventricle and the Septum
- **Leads V1, V2, (septal) V3, V4 (anterior)** look towards this surface
- This area is perfused by the left Anterior Descending branch of the Left coronary artery



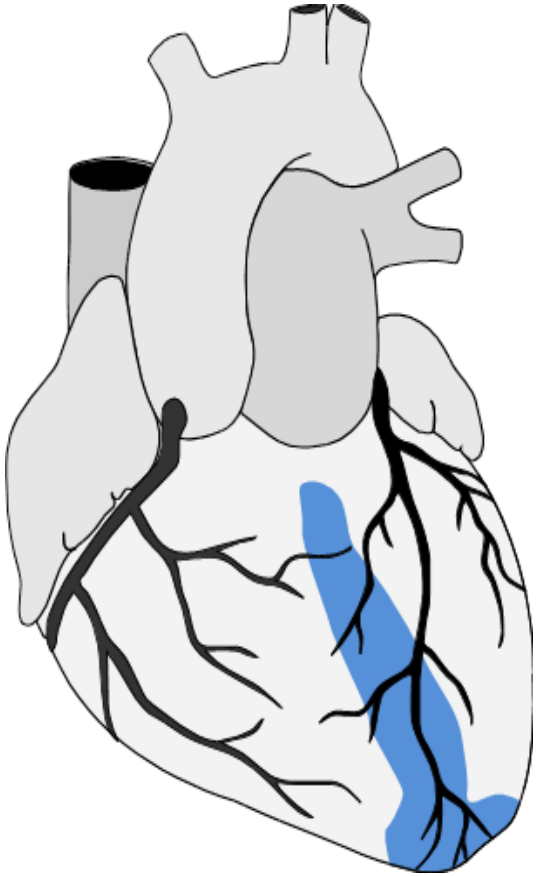
Anterior leads (V3, V4)

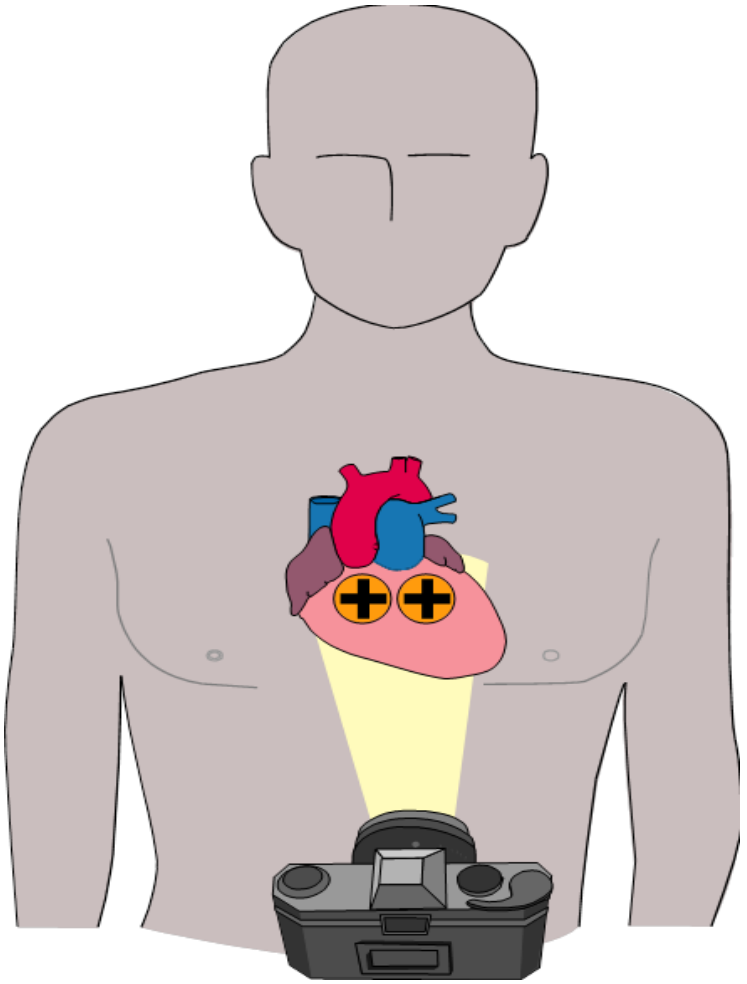






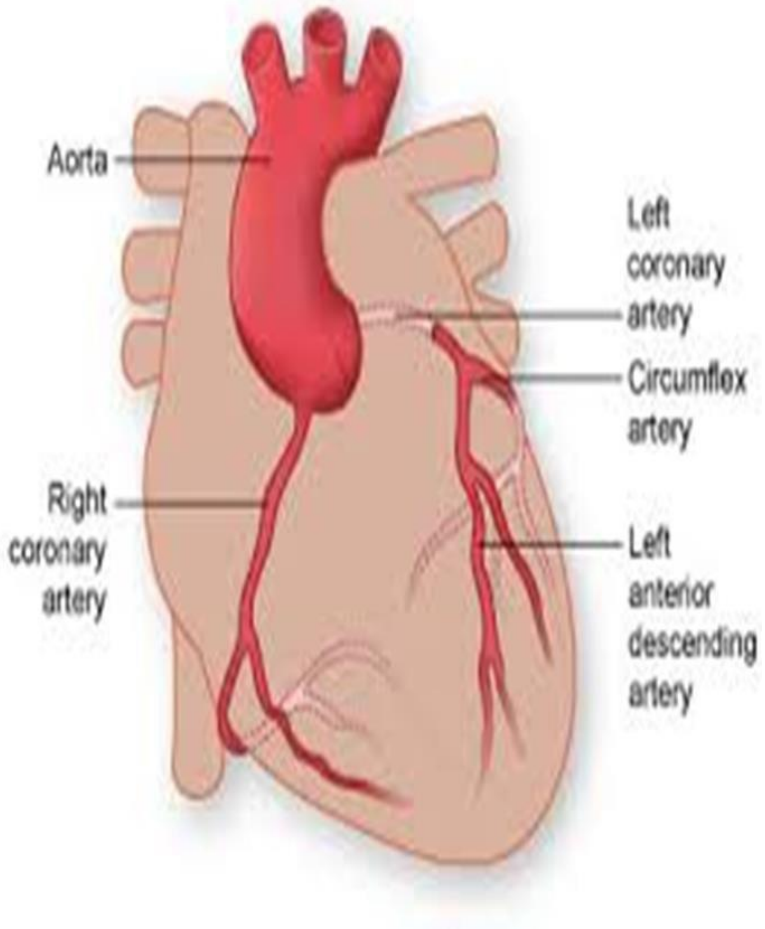
Septal leads (V1, V2)



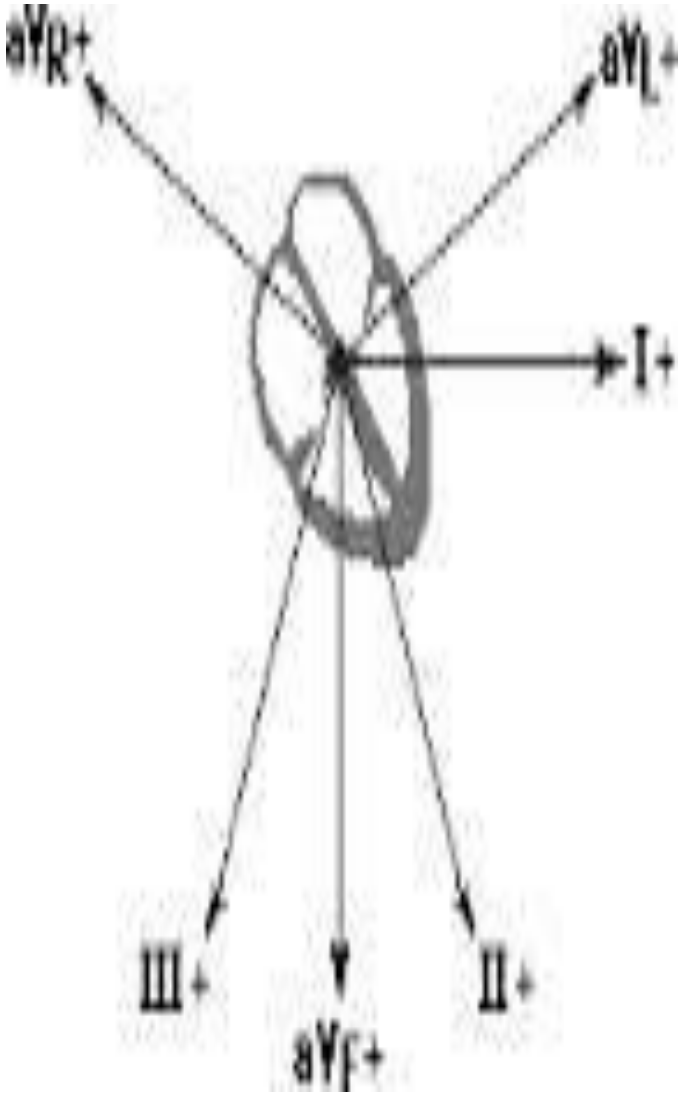


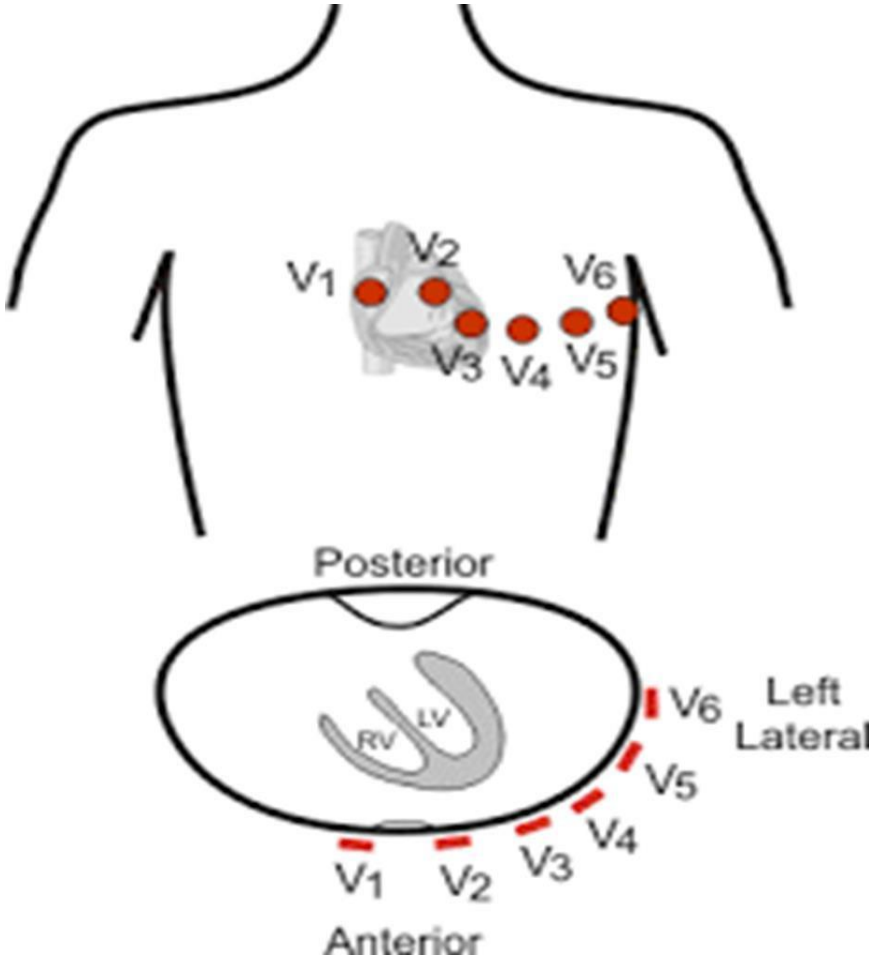
Surfaces of the left ventricle

- **lateral Surface:**
- This views the left side wall of the left ventricle
- **Leads V5 and V6, I and avL** look at this surface
- Mostly fed by the Circumflex branch of the left artery

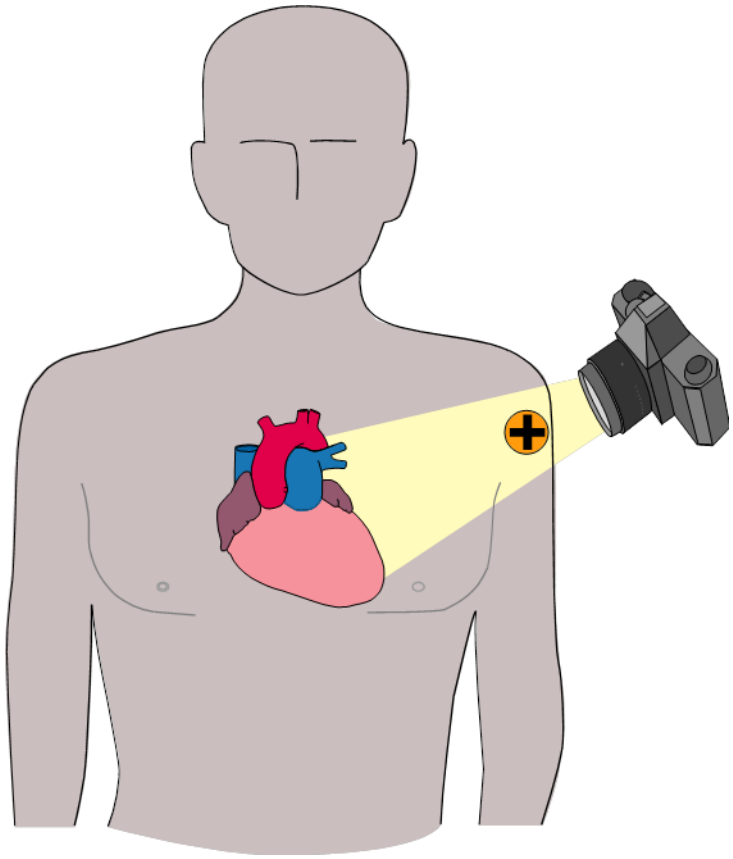


Lateral leads

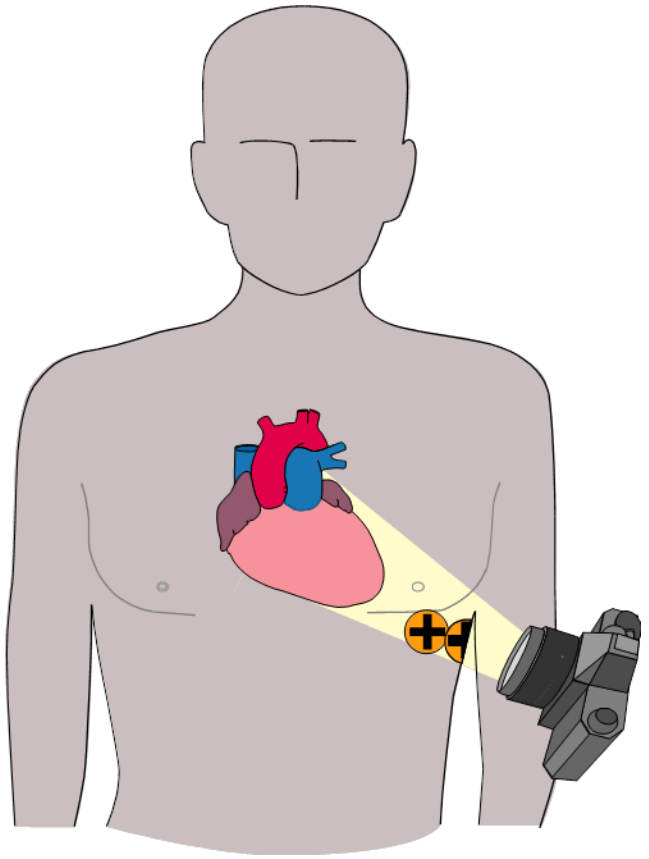




Lateral leads



Leads I and aVL



Leads V5 and V6

Surfaces of the heart

- **Posterior wall:**
- Infarcts on these area are rare
- Normally there are inferior ischemic changes
- Blood supply is predominantly from the Right Coronary

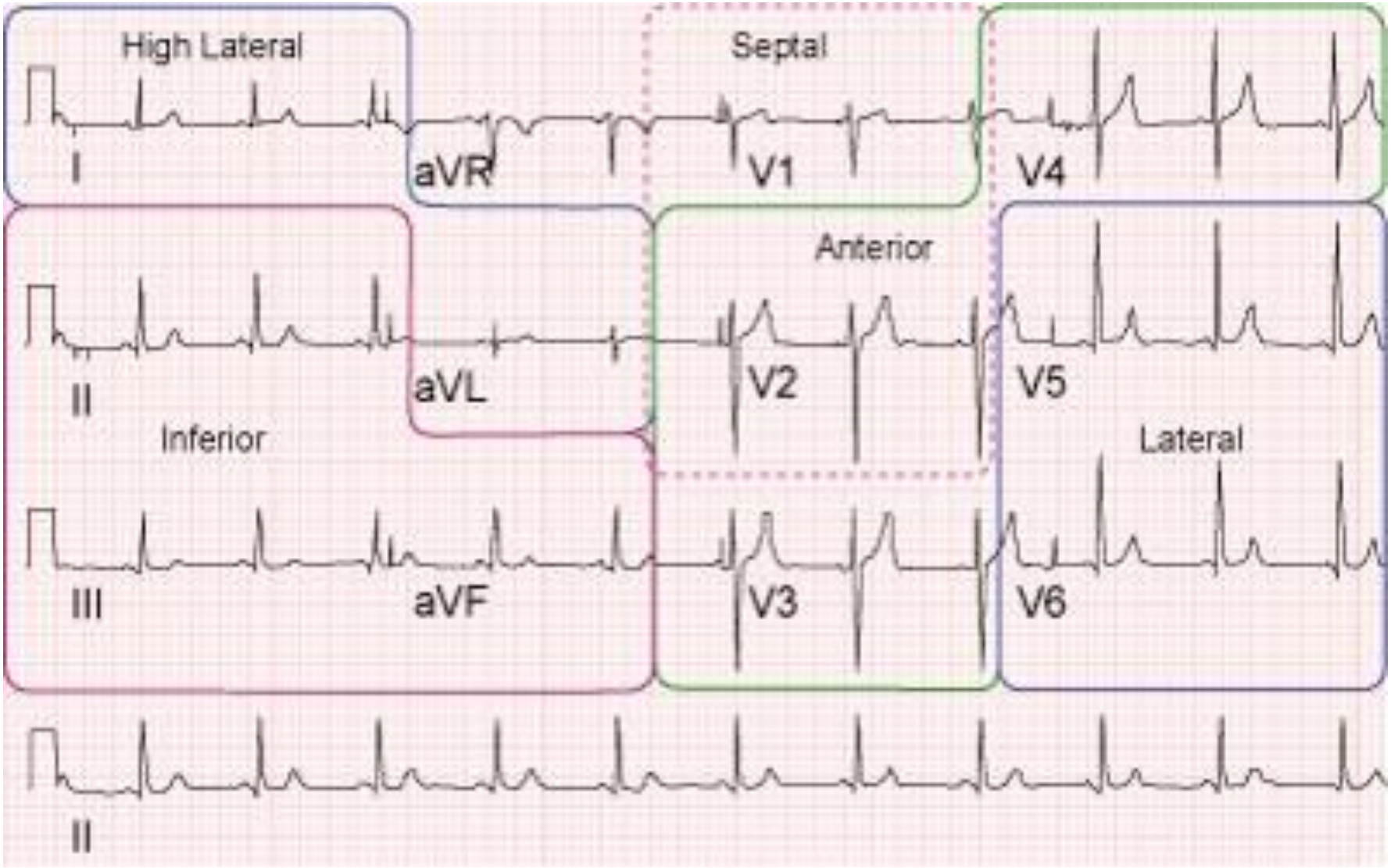
The 3 groups of leads (bipolar, unipolar, precordial) on the 12 lead ECG view the heart from different angles

LEADS	VIEWS	CORONARY ARTERY
Inferior	II, III, aVF	Right coronary artery
Anterior	V3, V4	Left anterior descending artery
Septal	V1, V2	Left anterior descending artery
Lateral	I, V5, V6, aVL	Left circumflex artery

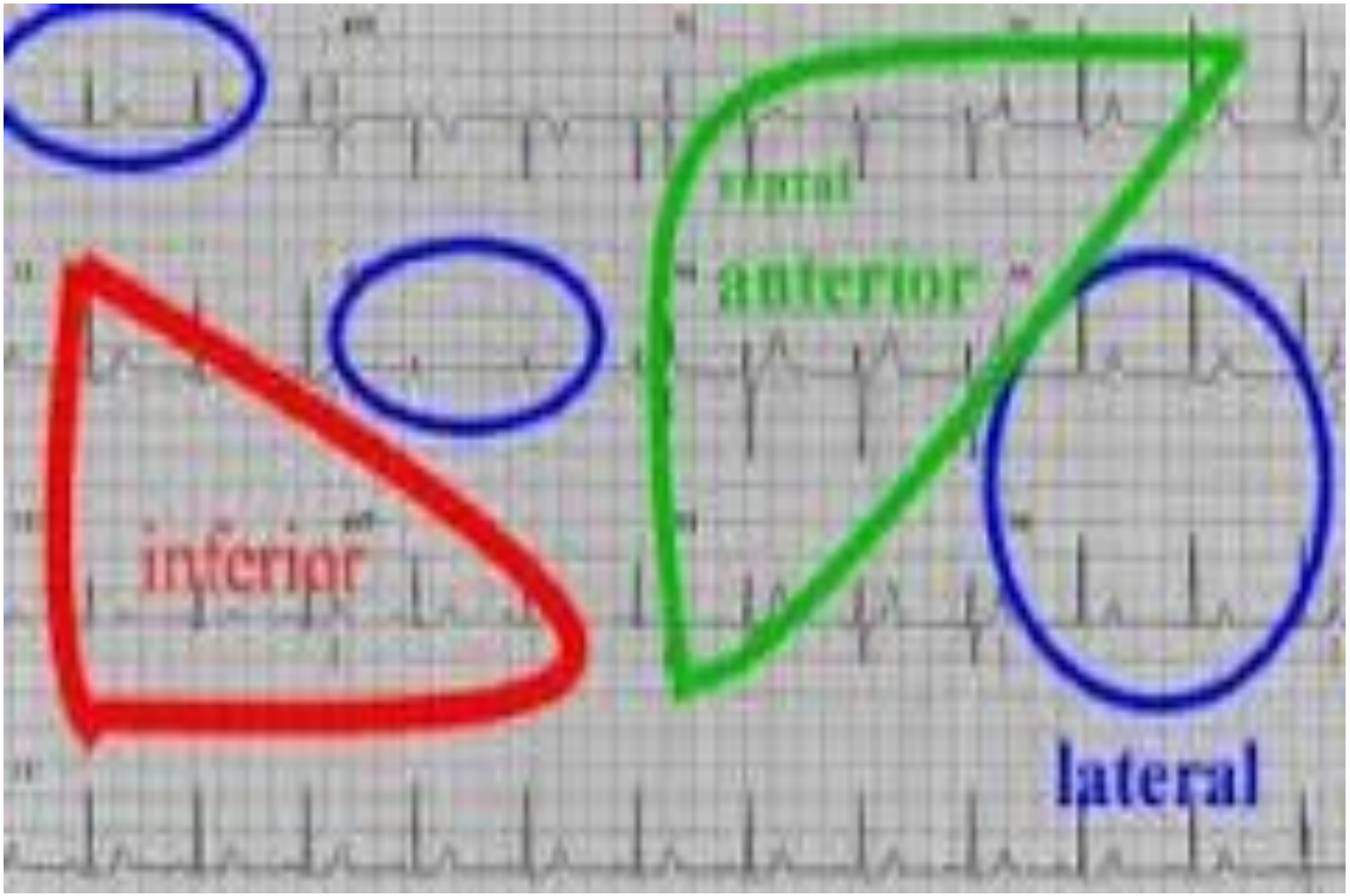
Viewing of the heart

I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

Viewing of the heart



Viewing of the heart



12 lead ECG

CARDIAC AXIS

Cardiac Axis

- The average direction of spread of the depolarization wave through the ventricles is called the '**cardiac axis'**

- The cardiac axis gives us an idea of the **overall direction of electrical activity when the ventricles are contracting**

Cardiac Axis

- During ECG interpretation the direction of electrical impulses, may be normal (physiologic) or abnormal (pathologic), suggesting abnormal cardiac conductivity.

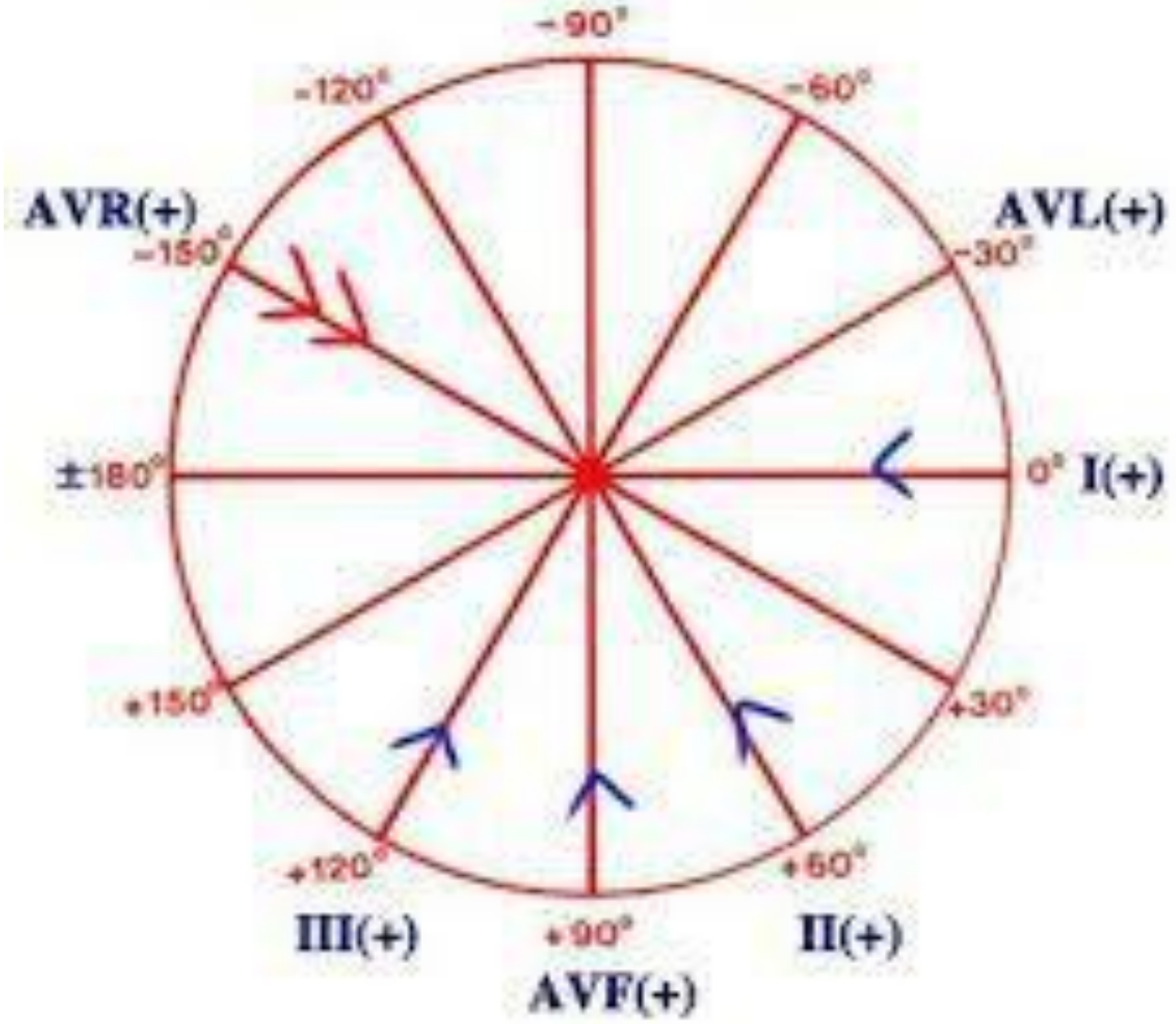
- The HEXAXIAL REFERENCE SYSTEM was developed to evaluate the degree of vector direction each lead looks at, which will help us determine the QRS axis.

Cardiac Axis

- The cardiac axis is often represented as a circle divided into four quadrants.

- The cardiac axis only uses the frontal leads i.e. the standard limb leads and the augmented leads only.

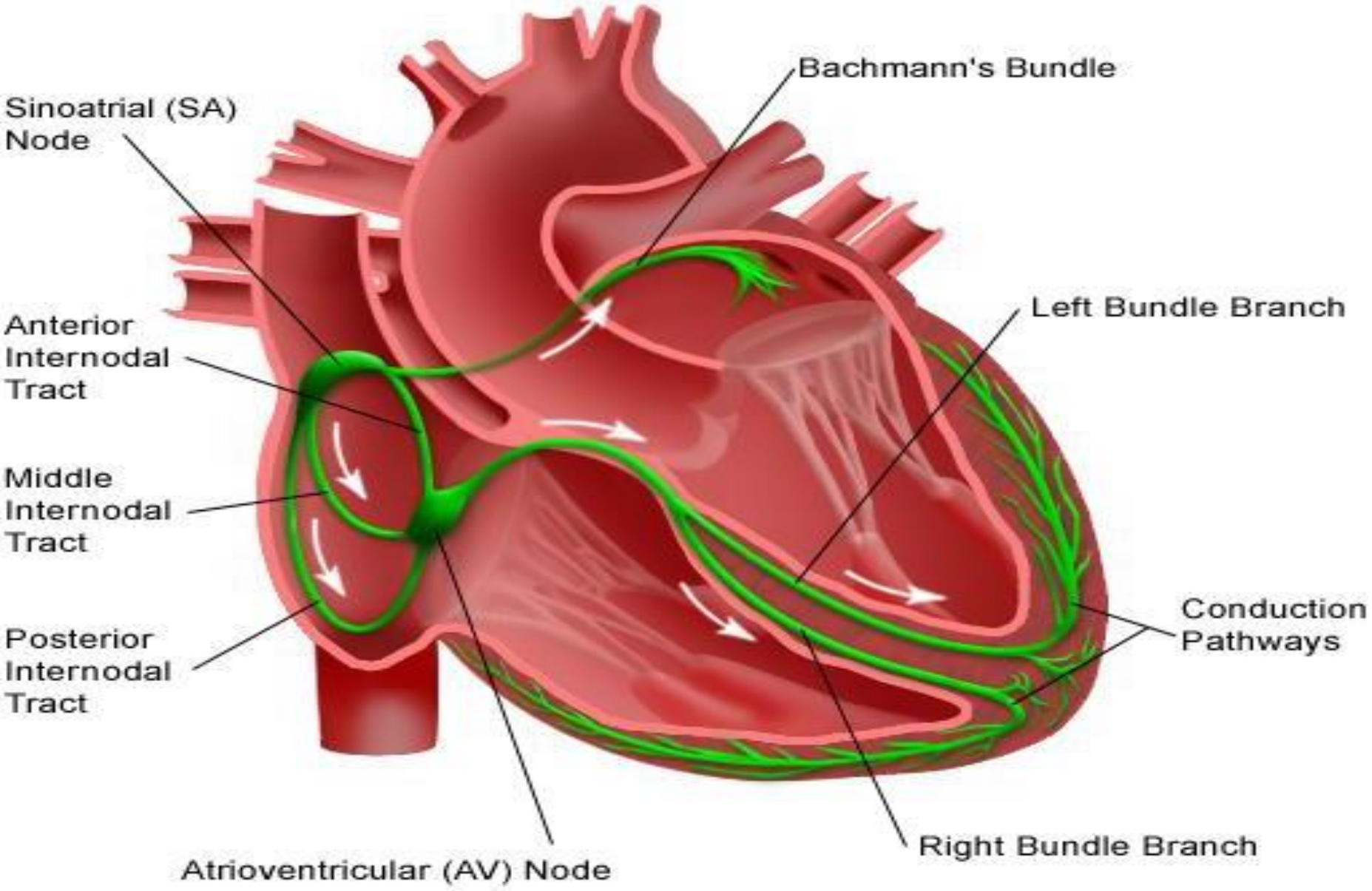
Hexaxial Reference System

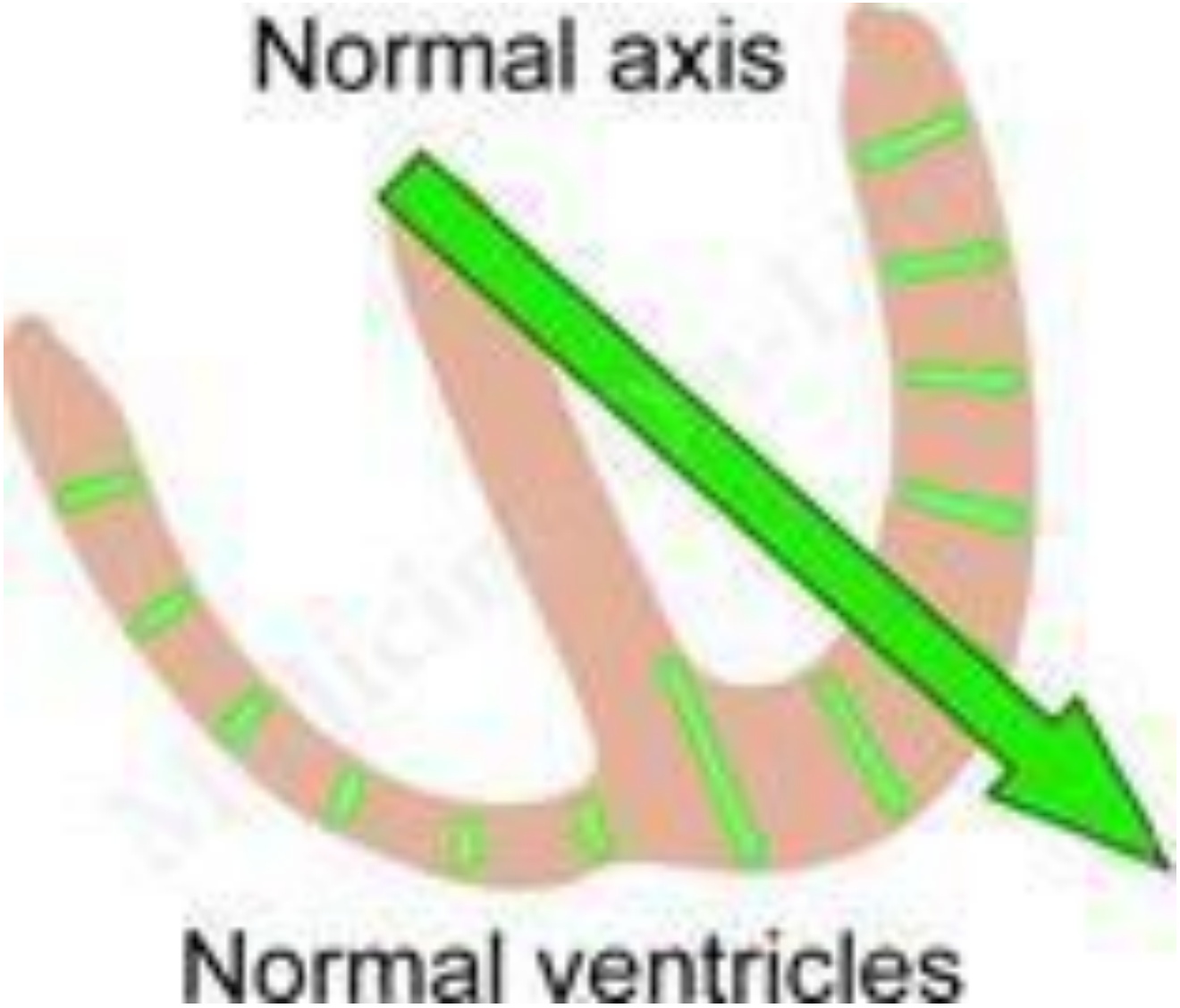


Normal cardiac axis

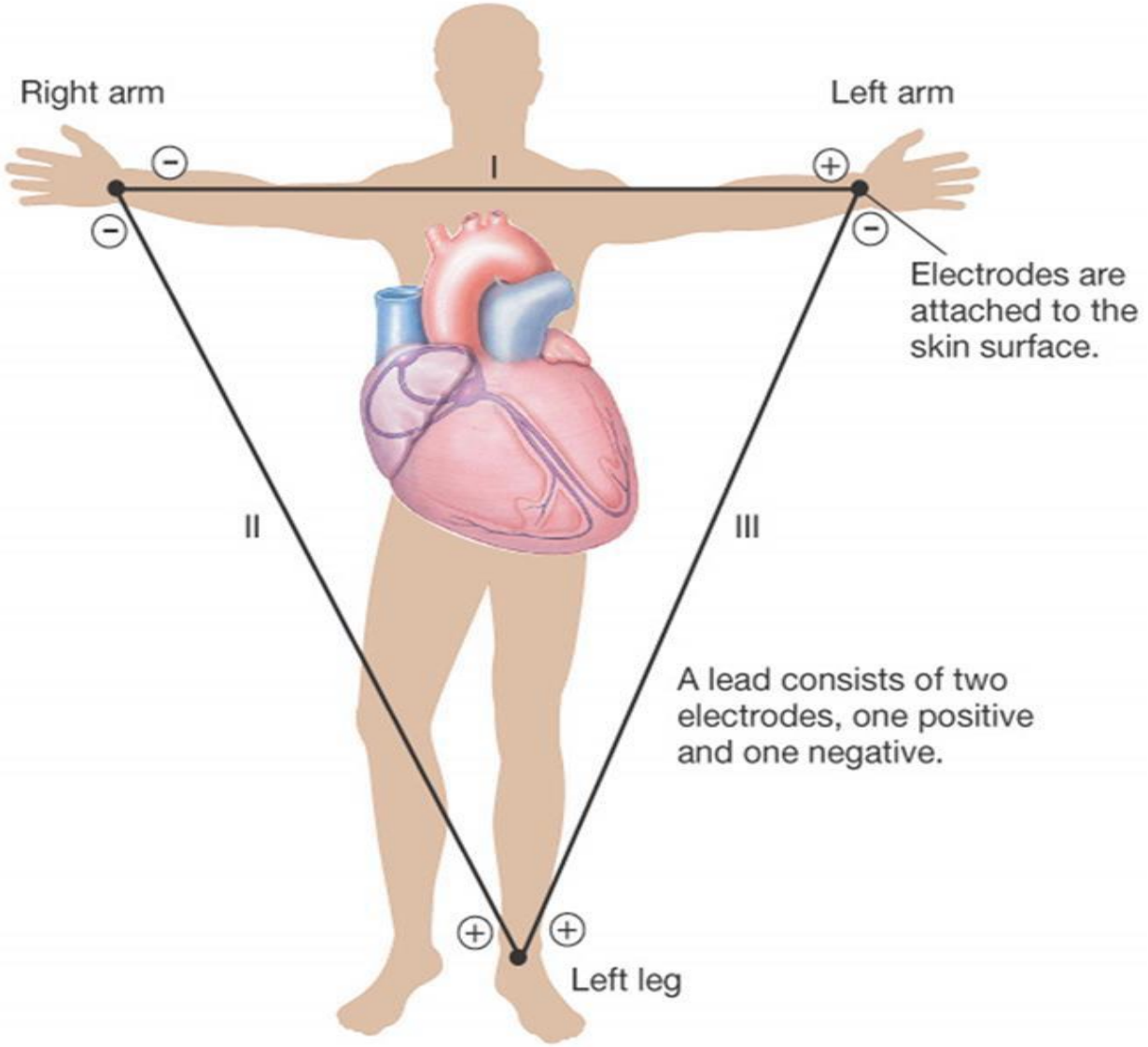
- The electrical activity of the heart starts at the SA node then spreads to the AV node then down the bundle of HIS and purkinje fibers to cause ventricular contraction
- **Because the left ventricle wall is thicker than the right wall the arrow indicating the direction of the depolarization wave is directed to the left ventricle**
- Hence when determining the cardiac axis we look at the **QRS complex that indicates the "ventricular depolarization**"

Electrical System of the Heart

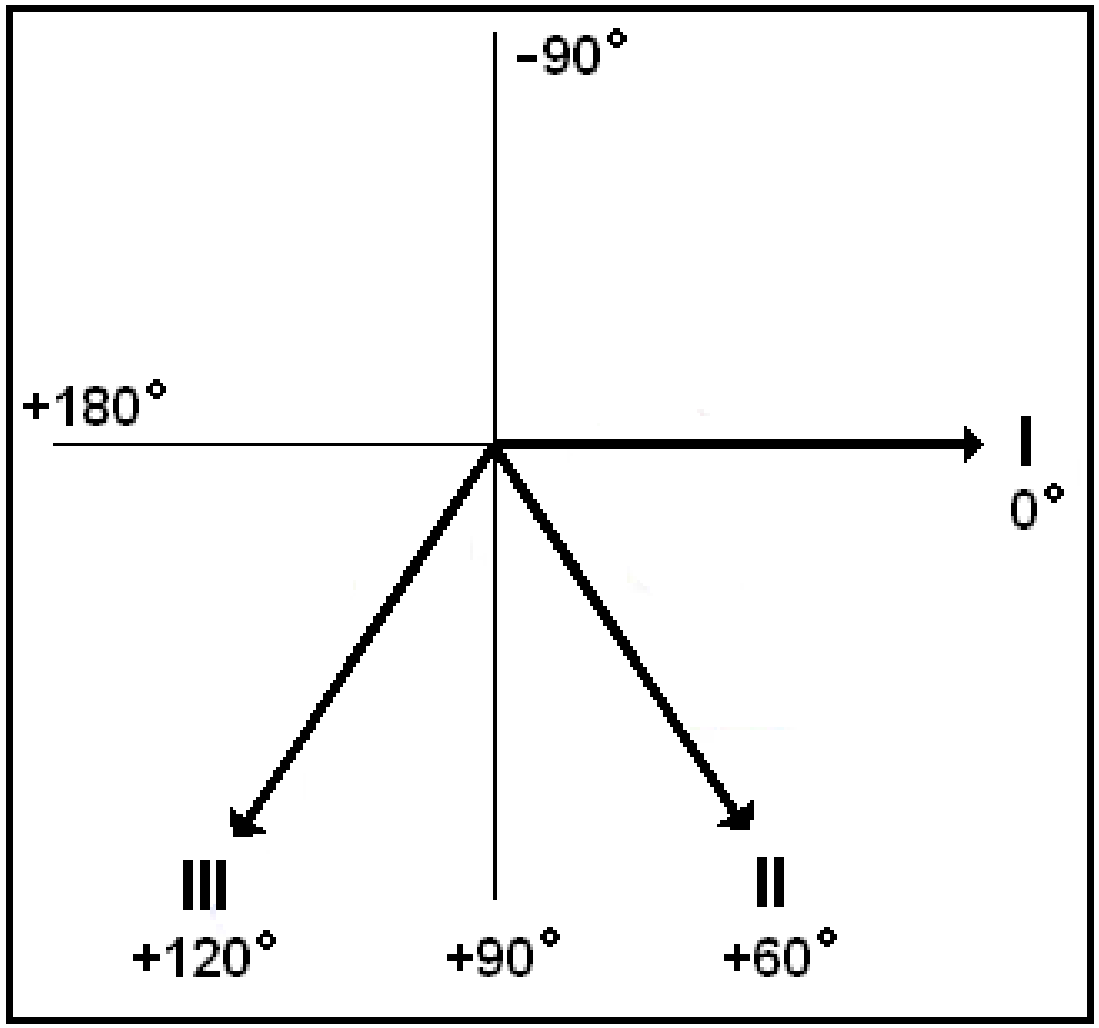



Normal axis
Normal ventricles

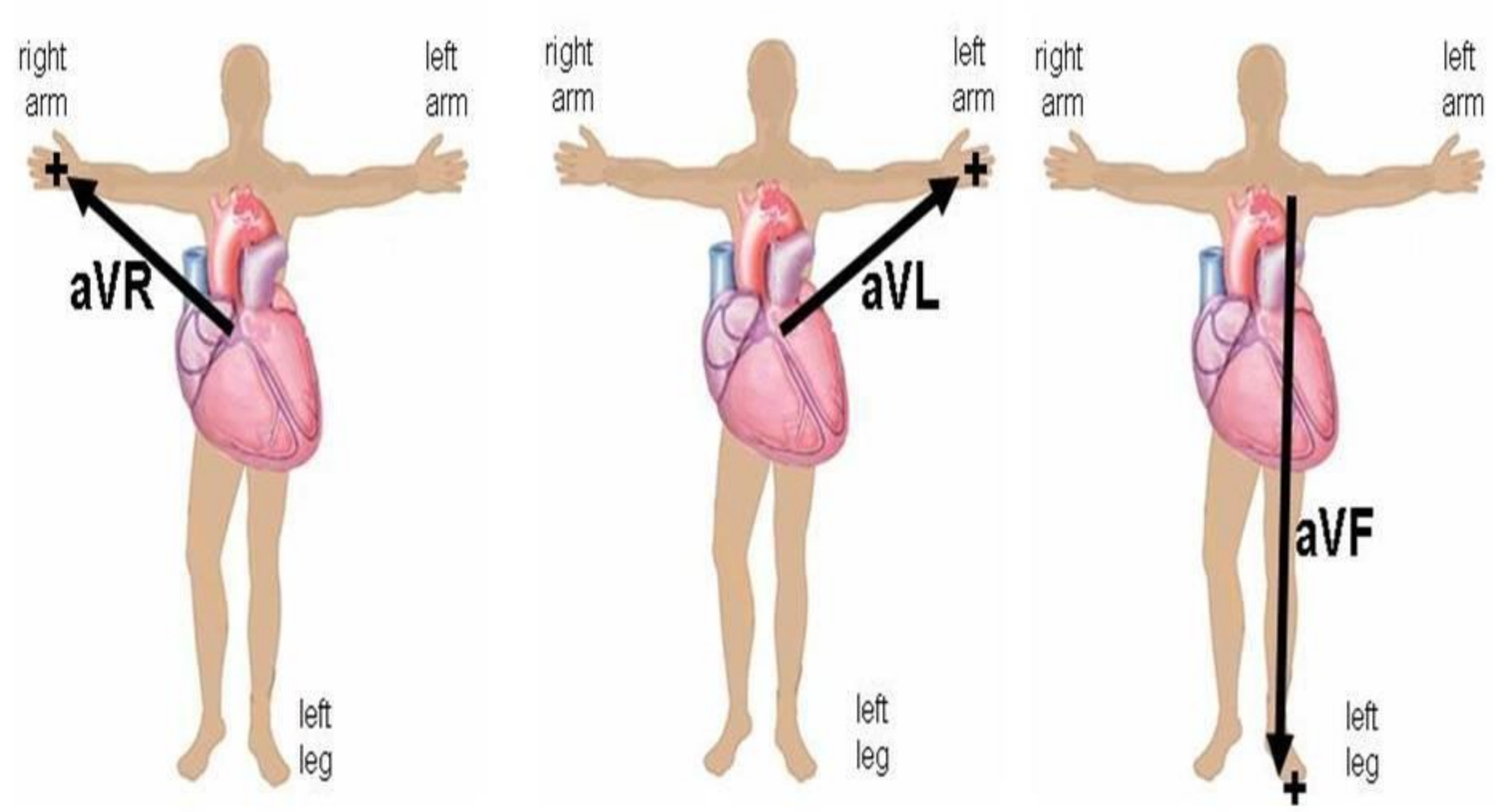
Remember:Standard Limb Leads



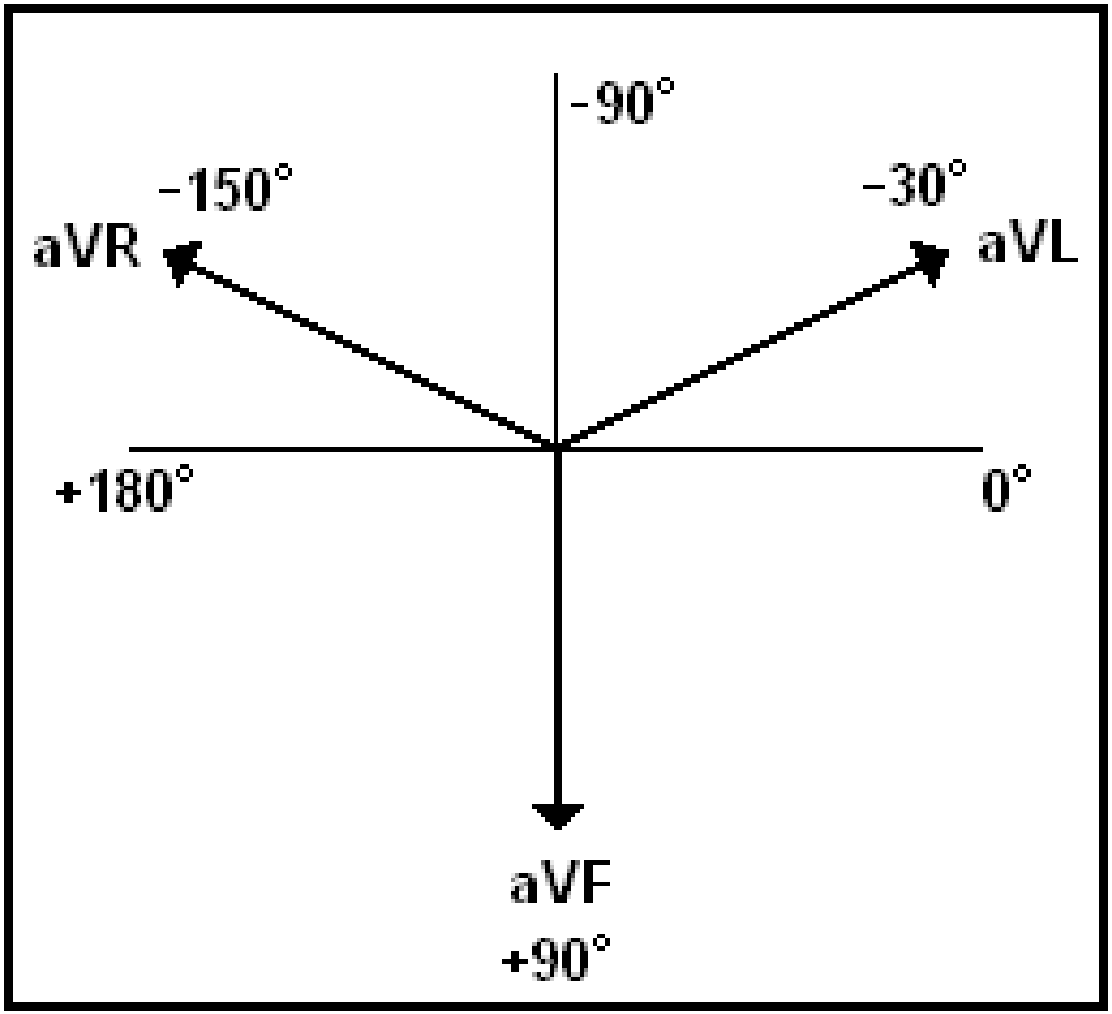
Standard Limb Leads



AUGMENTED LIMB LEADS (aVR, aVL, aVF)

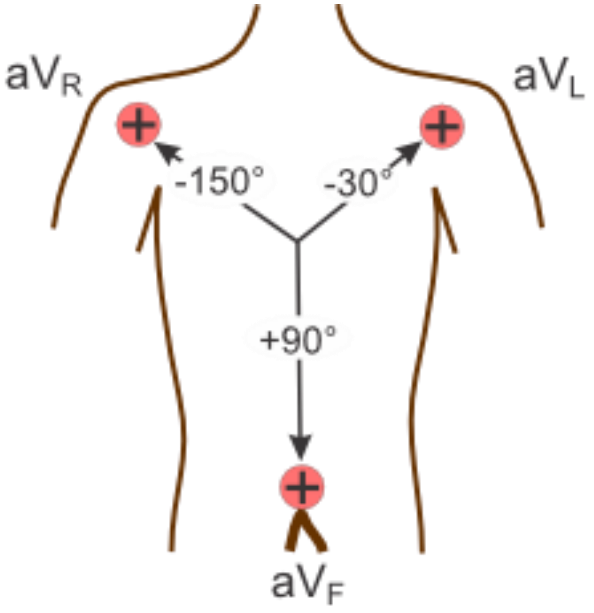


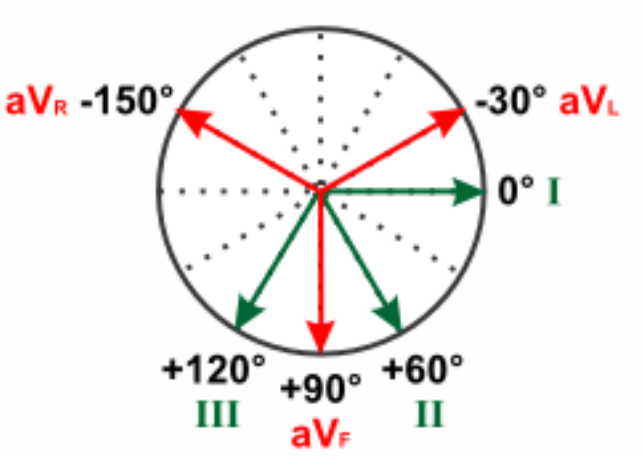
Augmented Limb Leads



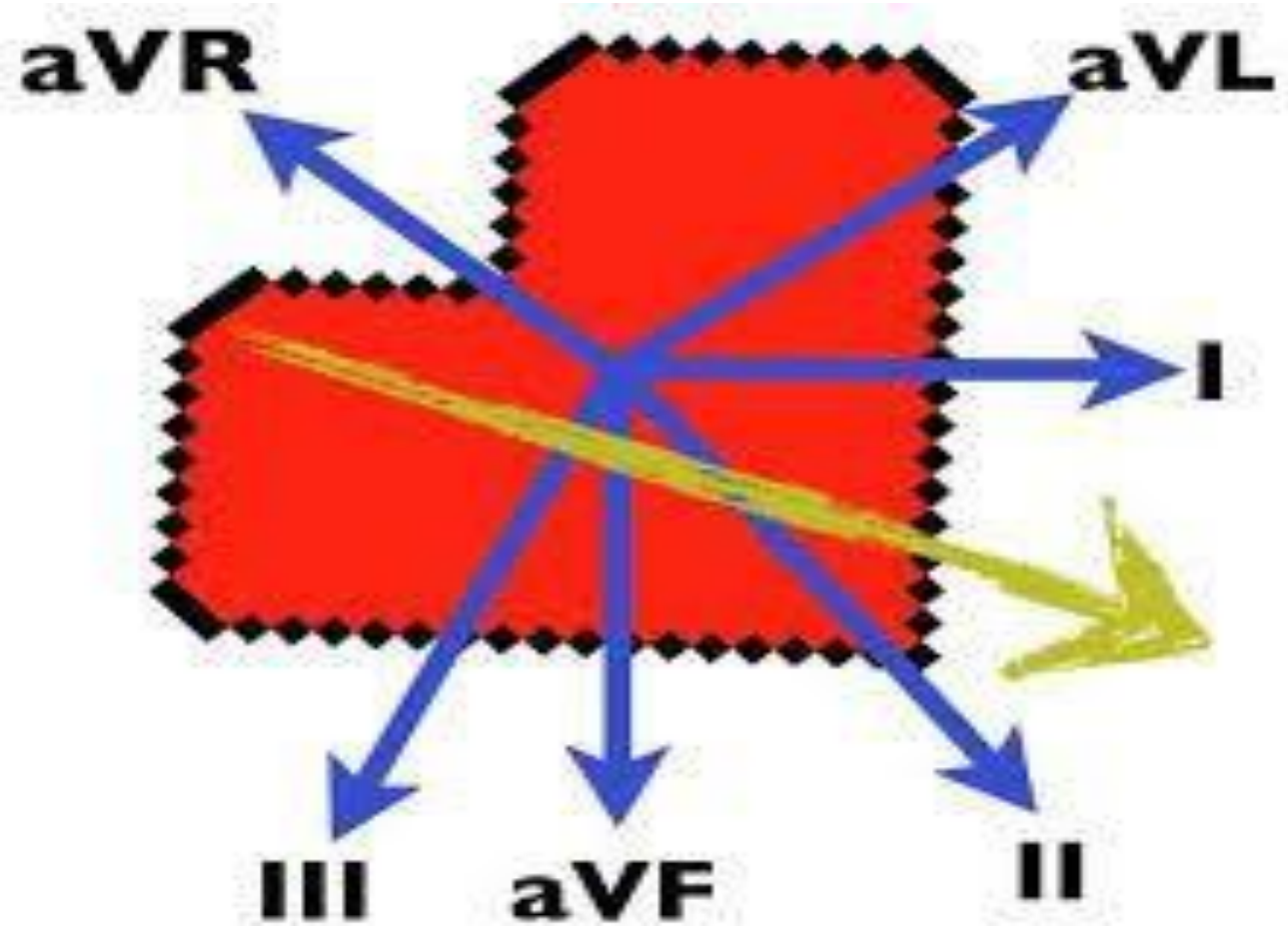
Normal Cardiac Axis

- Lead I is taken as looking at the heart from 0°; lead II from +60°; and lead III from +120°
- The aVL lead is at -30° relative to the lead I axis; aVR is at -150° and aVF is at +90°.



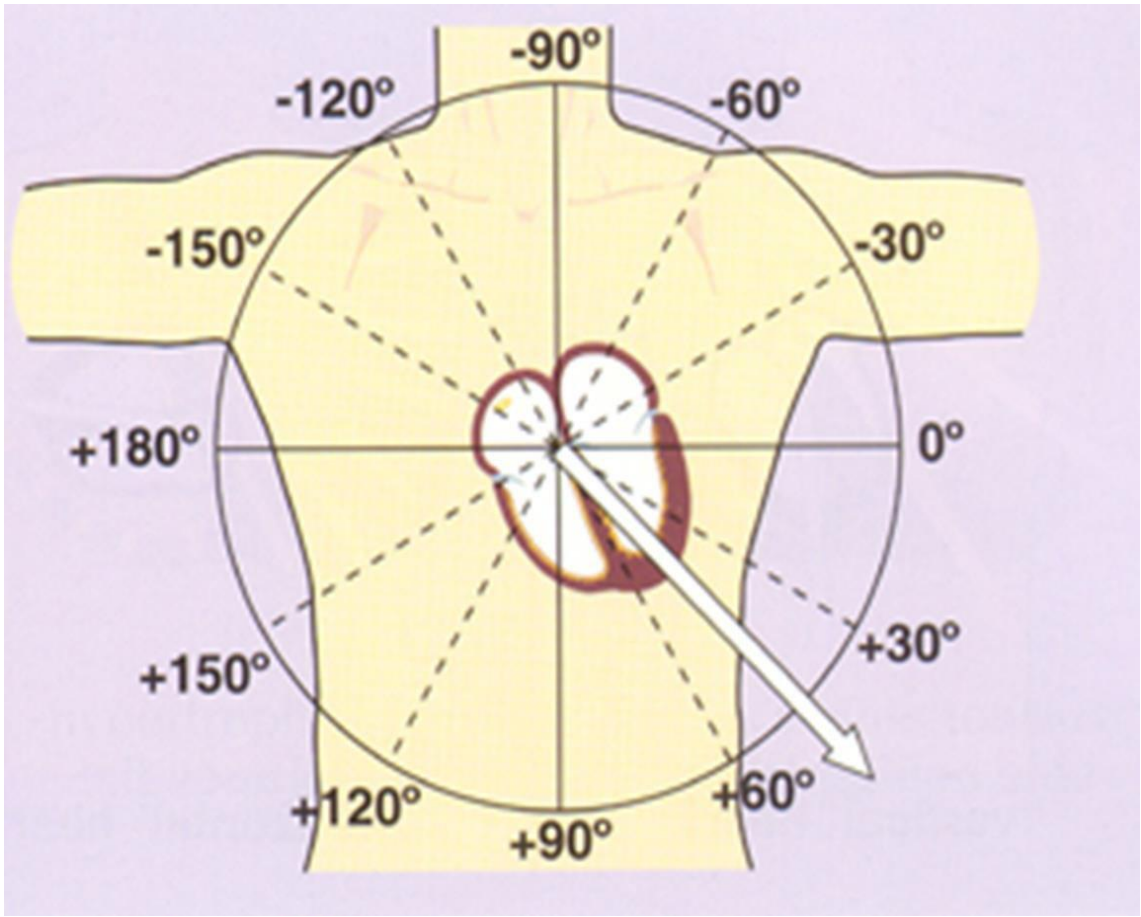


Normal cardiac axis



Cardiac Axis

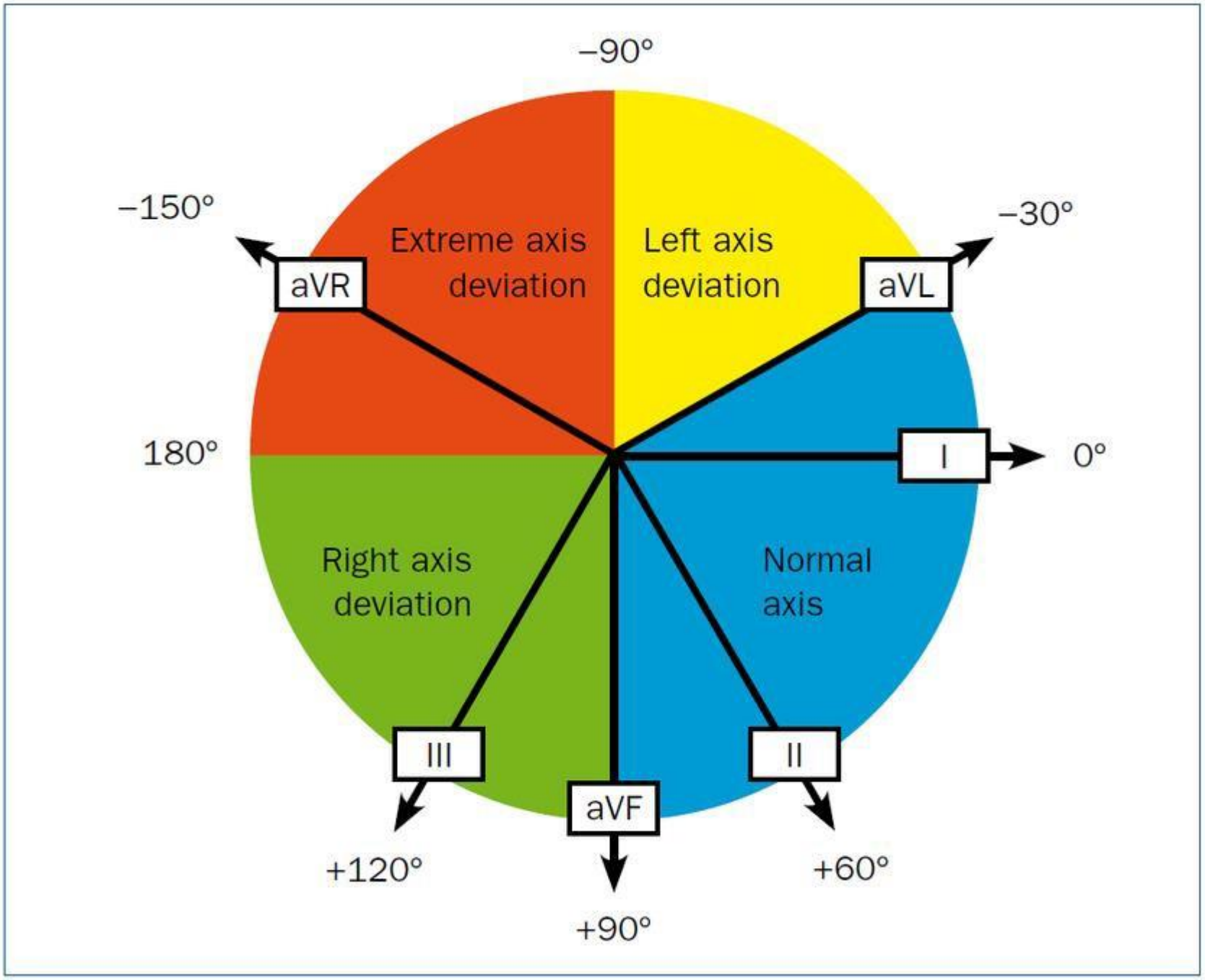
- **In healthy individuals the cardiac axis lies between –30° to +90°**



Deviations in Cardiac axis

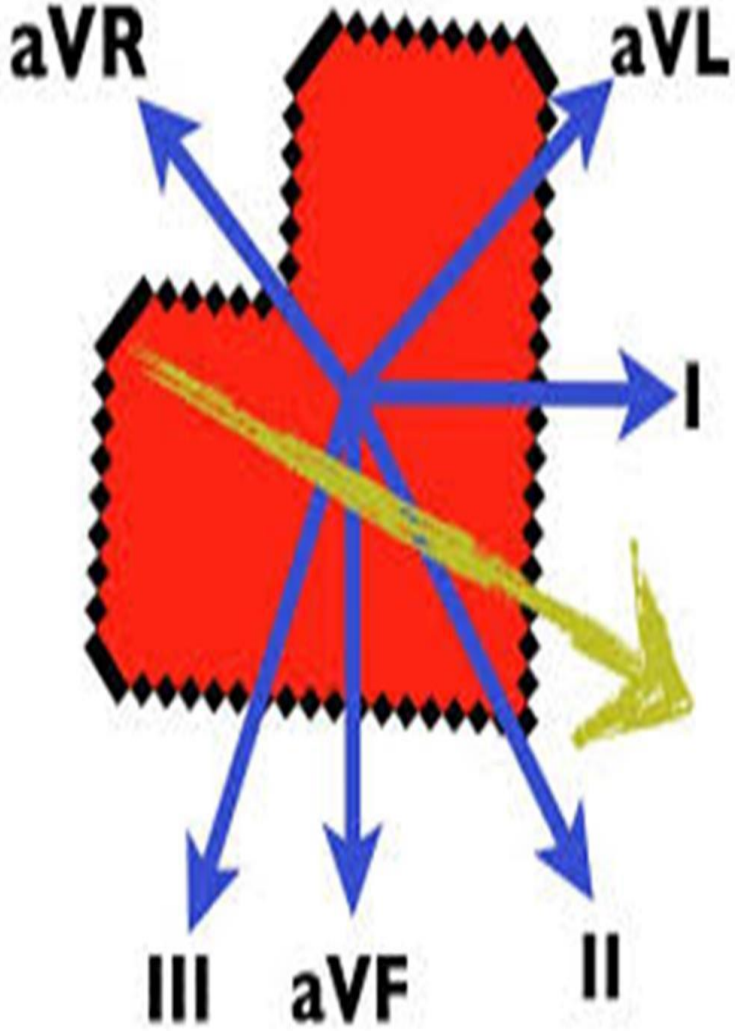
- **Right axis deviation (RAD):**
- The overall direction of electrical activity is distorted to the right (between +90º and +180º)

- Hypertrophied heart muscle causes a stronger positive signal to be picked up by leads looking at the right side of the heart

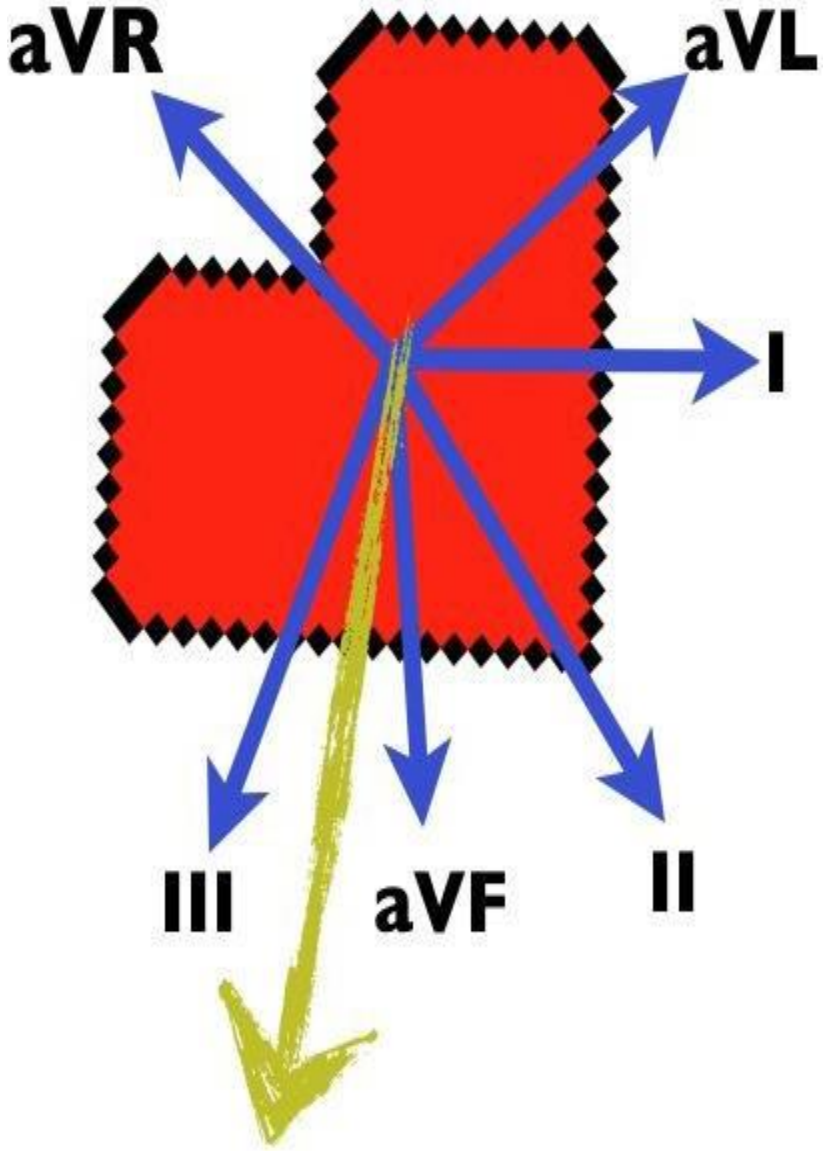

−90°
−150°
−30°
Extreme axis deviation
Left axis deviation
aVR
aVL
180°
0°
I
Right axis deviation
Normal axis
III
II
aVF
+120°
+60°
+90°

Deviations in cardiac axis

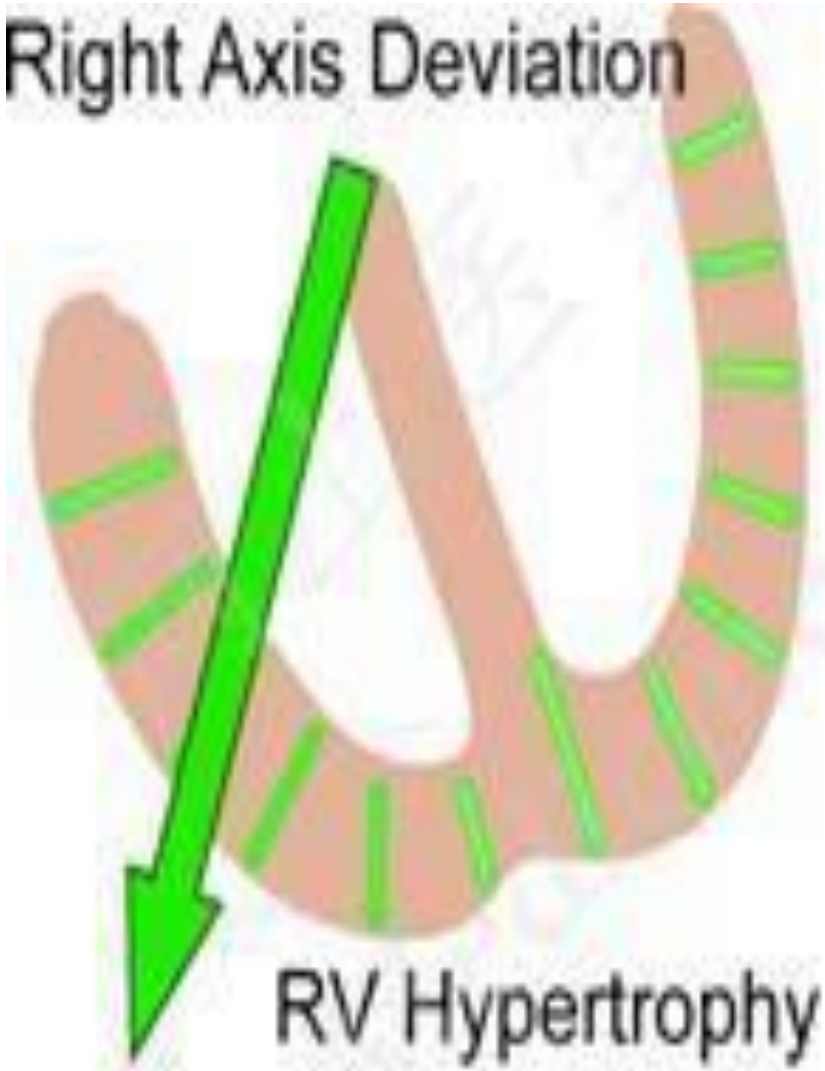
- **Causes of RAD:**
- Right ventricular hypertrophy
- Left ventricular infarction
- Tall, thin persons- normal occurrence

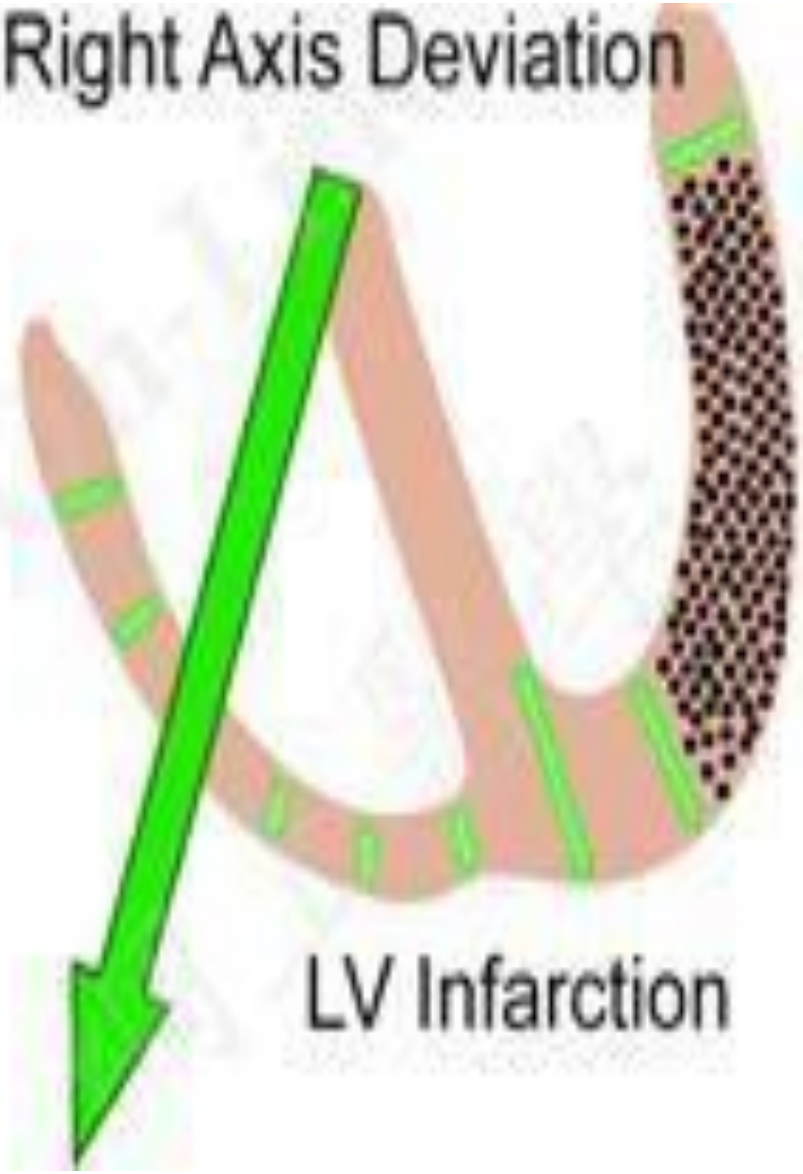


Normal cardiac axis



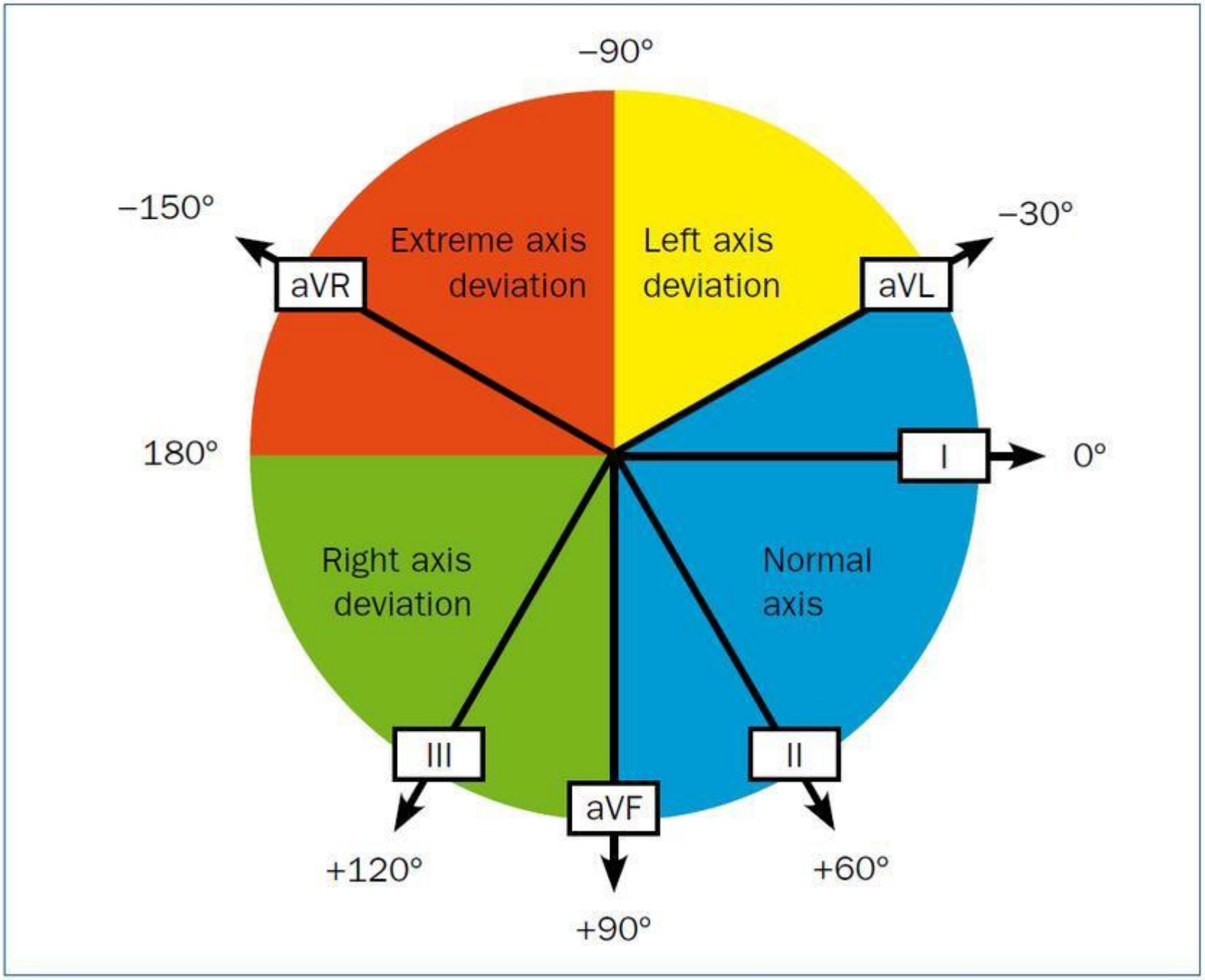
Right axis deviation


Right Axis Deviation
RV Hypertrophy


Right Axis Deviation
LV Infarction

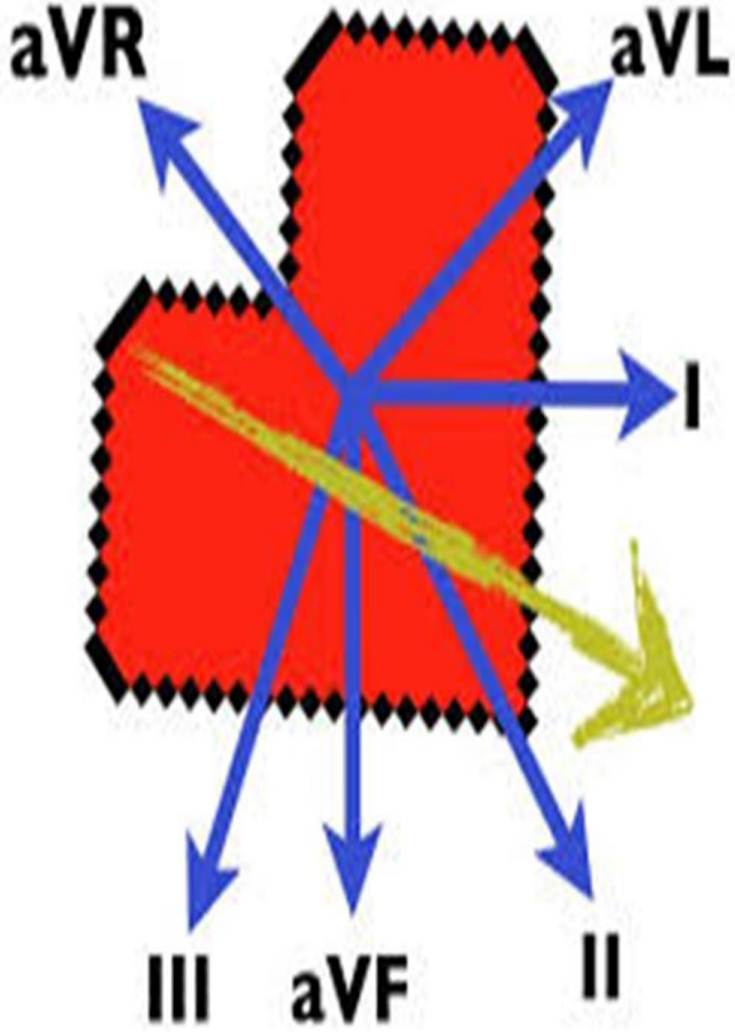
Deviations in Cardiac axis

- **Left axis deviation (LAD):**
- In left axis deviation (LAD) the direction of overall electrical activity becomes distorted to the left (between -30° and -90°)
- LAD is usually caused by conduction defects

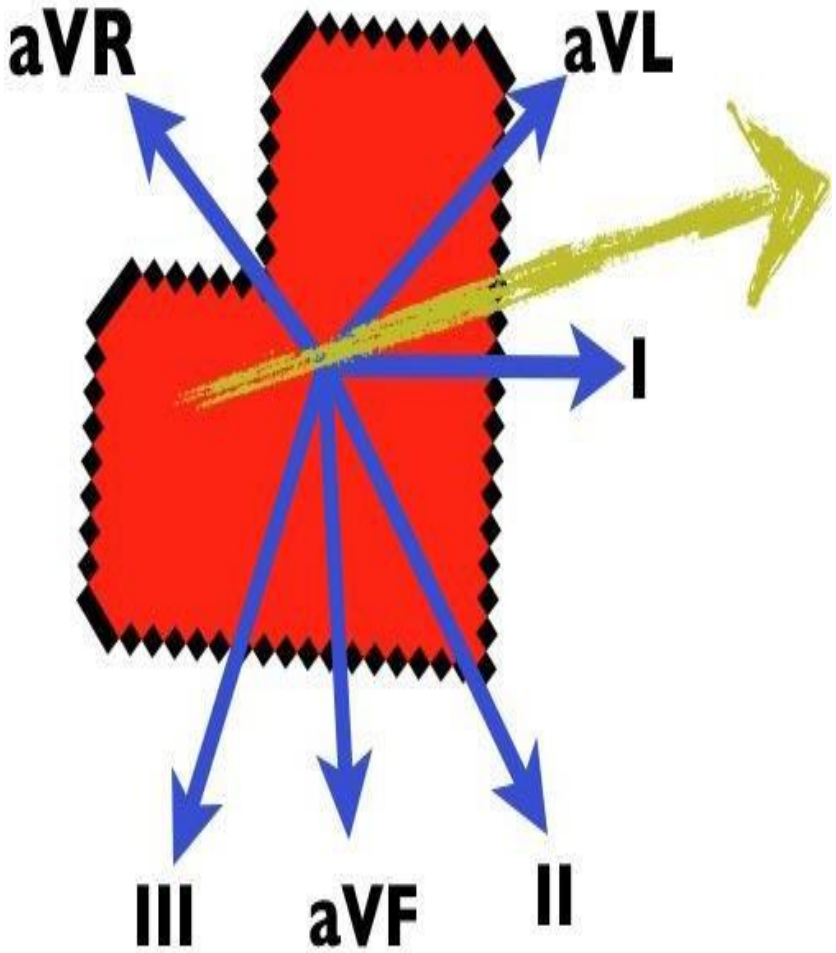

−90°
−150°
−30°
Extreme axis deviation
Left axis deviation
aVR
aVL
180°
0°
I
Right axis deviation
Normal axis
III
II
aVF
+120°
+60°
+90°

Deviations in cardiac axis

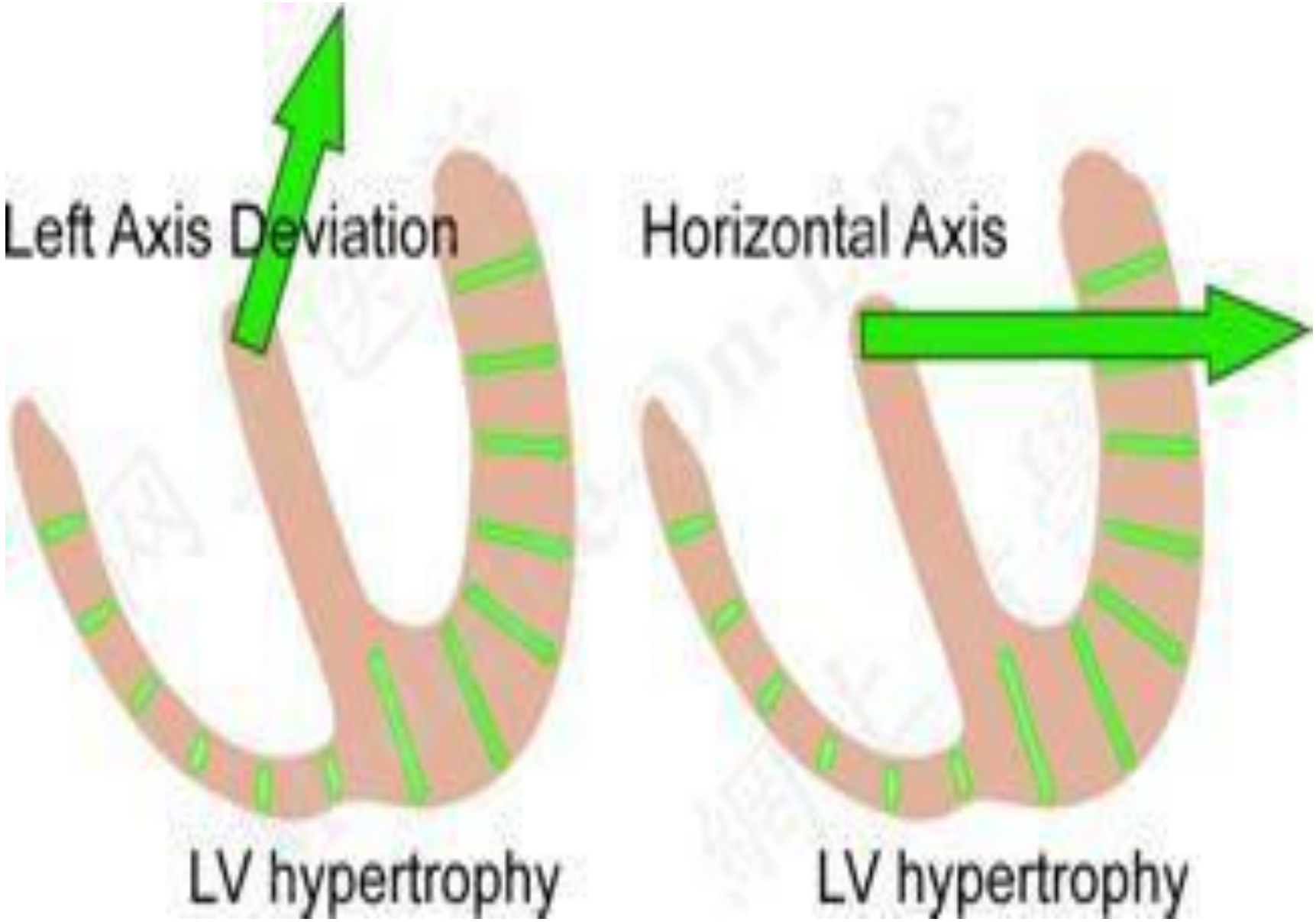
- **Causes of LAD:**
- Left ventricular hypertrophy
- Inferior Myocardial infarction
- Short wide persons (normal occurrence)



Normal cardiac axis

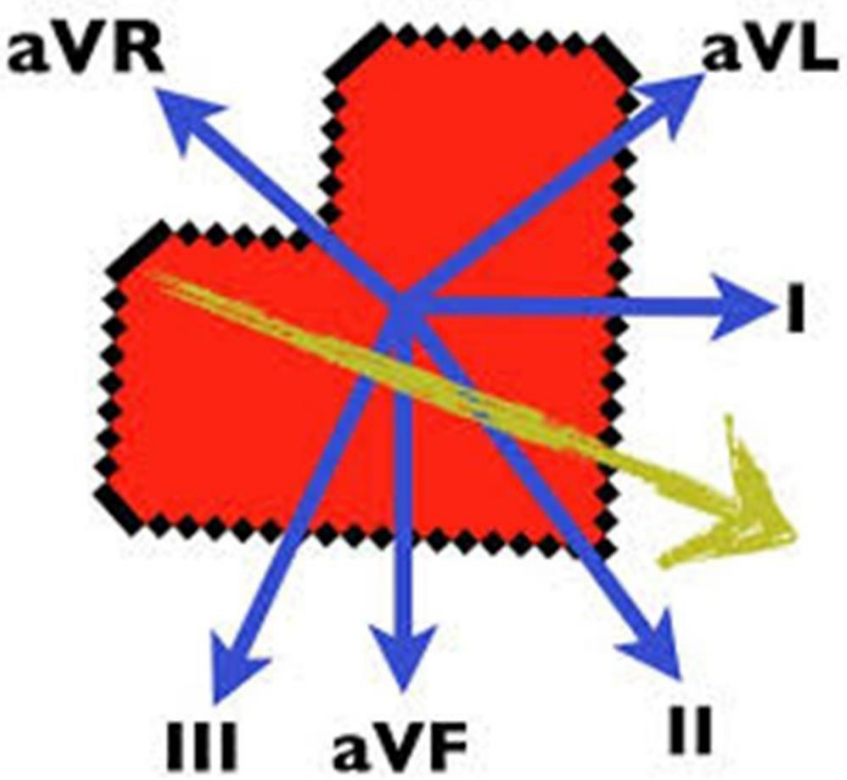


Left axis deviation


Left Axis Deviation
LV hypertrophy
Horizontal Axis
LV hypertrophy

Cardiac Axis

- **In healthy individuals the cardiac axis lies between –30° to +90°**
- In an ECG, the direction of the QRS complex in leads I and aVF determines the axis quadrant in relation to the heart since they are perpendicular to each other.

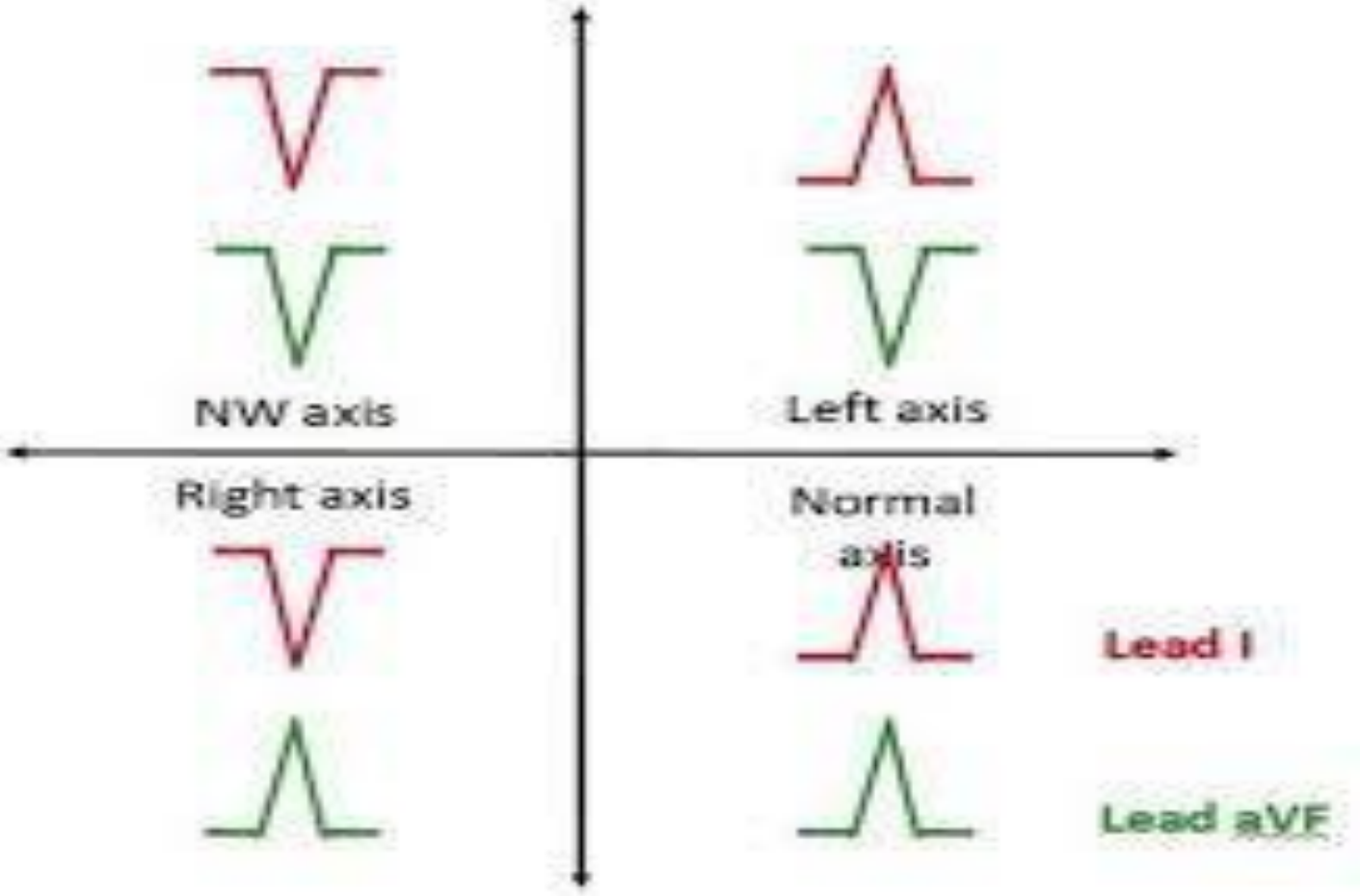


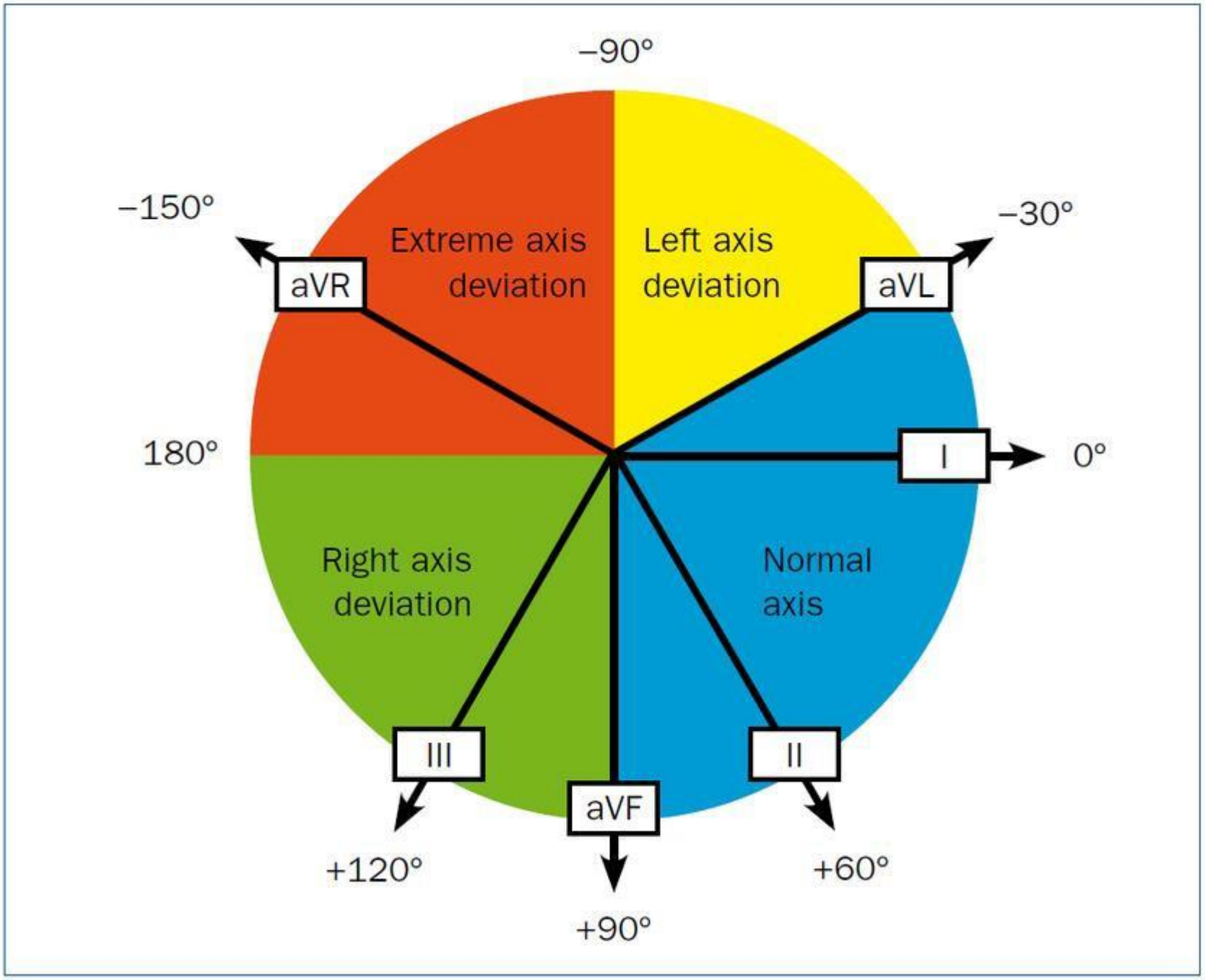
Deviations in Cardiac axis

- Since lead I and aVF are perpendicular to each other, they are usually used to quickly determine axis by viewing the QRS complex direction.

		aVF	
Lead I		**POSITIVE**	**NEGATIVE**
	POSITIVE	Normal Axis	LAD
	NEGATIVE	RAD	Indeterminate Axis

Cardiac axis




−90°
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180°
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Right axis deviation
Normal axis
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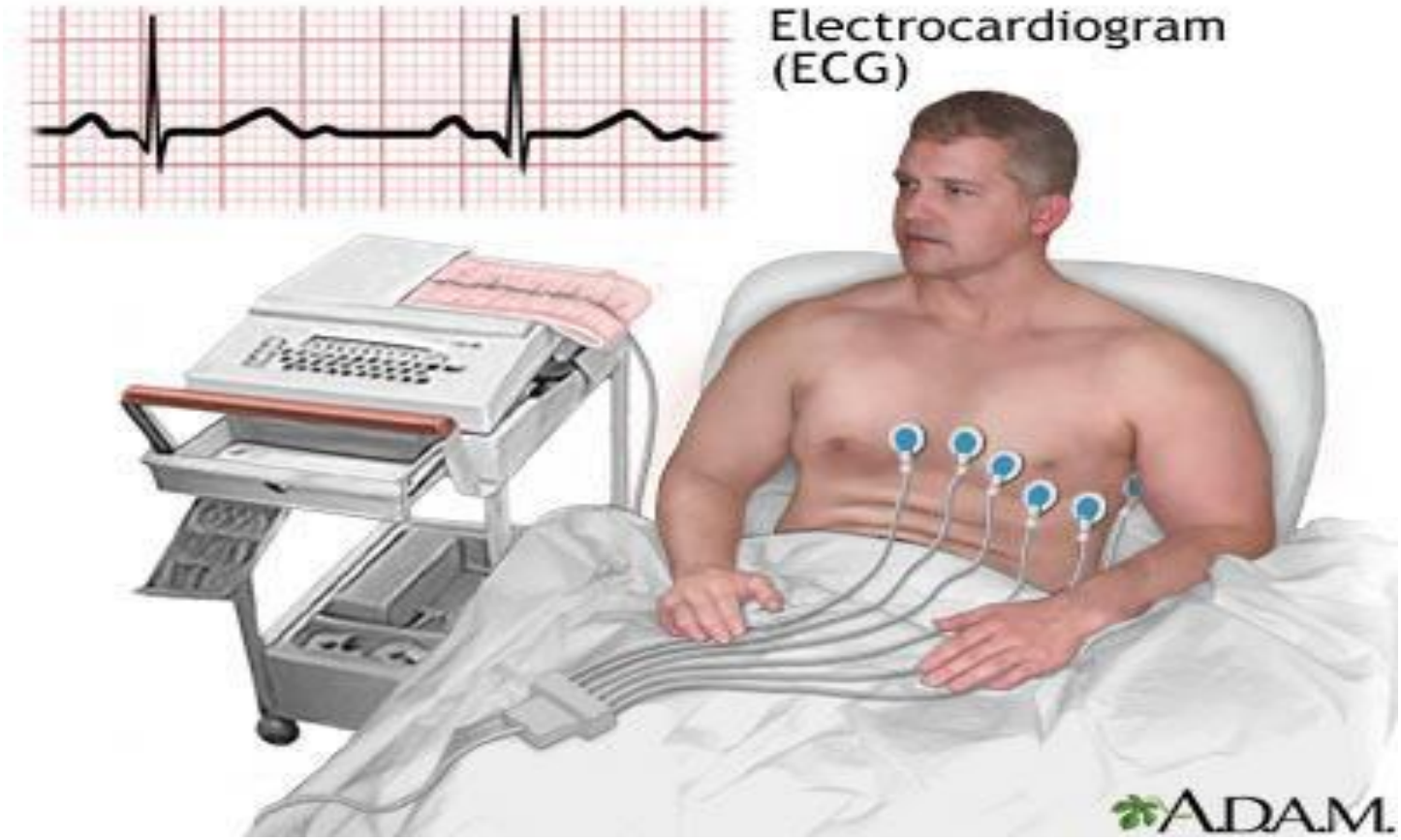
II
aVF
+120°
+60°
+90°

Types of ECGs

- Resting ECG (12- lead ECG)
- Continuous ECG (ICU monitoring)
- Exercise ECG (treadmill)
- 24 hour ECG (Holter monitor)

Resting ECG (12- lead ECG)



Continuous ECG

Exercise ECG (treadmill)

Exercise ECG (Treadmill)

- Patients with coronary artery blockages may have minimal symptoms while at rest.
- Stress (exercise) may unmask these symptoms
- During exercise, healthy coronary arteries dilate causing more blood to be delivered to heart muscle supplied by the artery.
- Narrowed arteries have reduced flow causing the involved muscle to "starve" during exercise.
- This may produce symptoms e.g. chest pain and the ECG may produce characteristic abnormalities

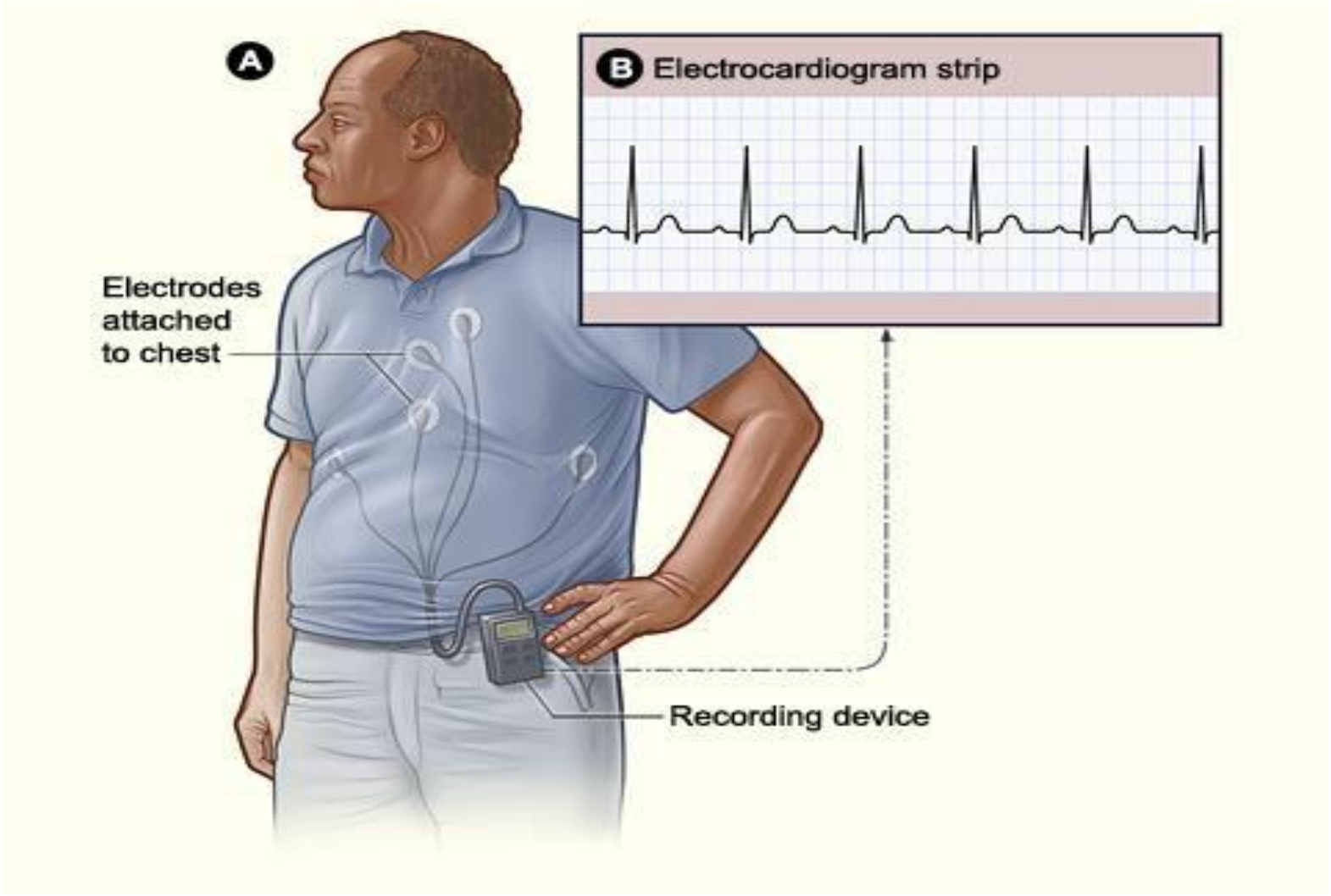
Exercise ECG (Treadmill)

- **Indications for an ECG stress test:**
- Patients with symptoms or signs that are suggestive of coronary artery diseases (CAD).
- Patients with significant risk factors for CAD.
- To evaluate exercise tolerance when patients have unexplained fatigue and shortness of breath.
- To evaluate blood pressure response to exercise in patients with borderline hypertension.
- To look for exercise-induced irregular heart beats.

Exercise ECG (Treadmill)

- **The test is carried out until:**
- Patient achieves a target heart rate.
- Patient develops chest pain or a change in blood pressure that is concerning.
- ECG changes show that the heart muscle is not getting enough oxygen.
- Patient is too tired or has other symptoms, such as leg pain, that keep them from continuing.
- The heart rhythm changes.

24 hour ECG (Holter monitor)

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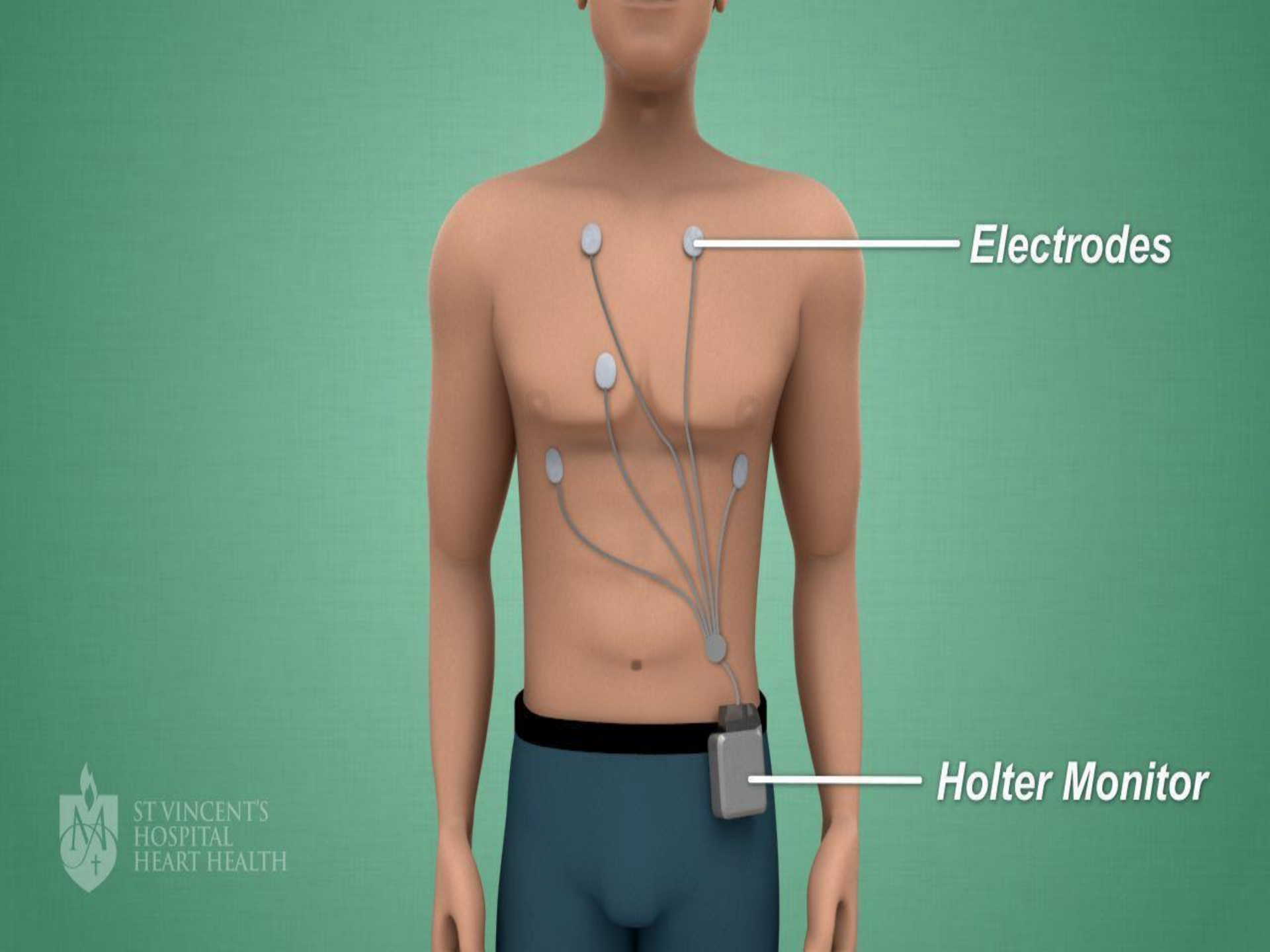
RP1

Holter monitoring

- A Holter monitor is a small, portable, battery-powered machine that continuously records the heart's rhythms.
- The monitor is worn for 24 - 48 hours during normal activity.
- Holter monitor testing is also sometimes called ambulatory electrocardiography
- The holter monitor is used if an arrythmia is suspected in a patient and it doesn’t show up during a routine ECG test


Electrodes
Holter Monitor
ST VINCENT'S
HOSPITAL
HEART HEALTH

Summary

- Described the bipolar leads
- Described the augmented leads
- Described the precordial (chest) leads
- Described the cardiac axis
- Discussed types of ECGs
- Performed a practical on ECG

THE END!!!!