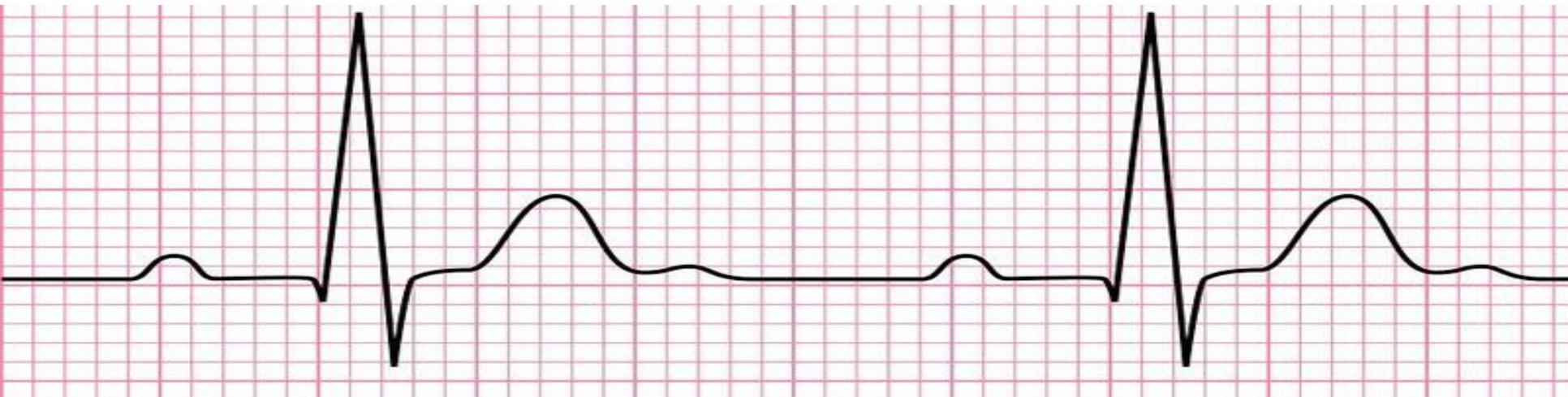


INTRODUCTION TO ECG

Dr. Tamara Alqudah



What we will learn today

- Definition of ECG
- The components of an ECG strip
- The characteristics of the ECG paper
- The ECG machine and its electrodes
- 12- lead ECG
- How to properly perform an ECG

The electrocardiogram (ECG)

- The ECG is a recording of the electrical activity of the heart.
- When the cardiac impulse passes through the heart, electrical current also spreads into the adjacent tissues all the way to the surface of the body.
- If electrodes are placed on the skin on opposite sides of the heart, electrical potentials generated by the current can be recorded
- A simple & non-invasive diagnostic test

The Normal ECG

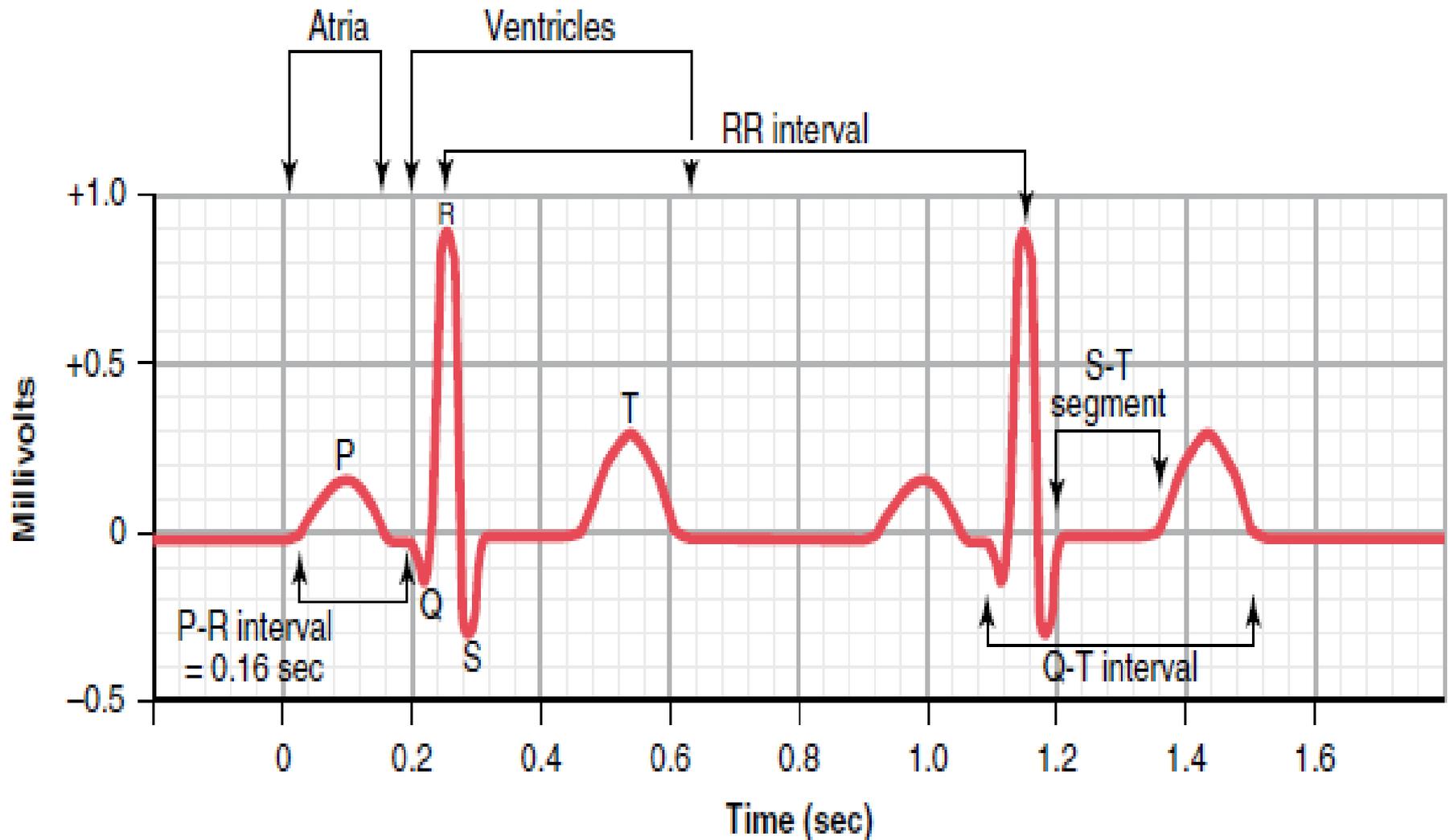


Figure 11-1 Normal electrocardiogram.

- ECG is a plot of voltage on the vertical axis against time on the horizontal axis
- The ECG waves are recorded on a special graph paper that is divided into standard-sized squares. Each large square is 5 mm long and each small square is 1 mm long.
- ECG is recorded at a speed of 25mm/sec, So:
 - Each large square on the horizontal axis represents =0.2 sec (200ms)
 - Each small square on the horizontal axis represents =0.04 sec (40ms)
- Vertically, the ECG graph measures the height (amplitude) of a given wave or deflection, 10 mm (10 small squares) equals 1 mV with standard calibration.
- Paper speed and voltage are usually printed at the bottom of the ECG paper strip.

Main Components of ECG

- The **P wave** is caused by electrical potentials generated when the atria depolarize.
- The **QRS complex** is caused by potentials generated when the ventricles depolarize. The first downward deflection is called a Q wave. An upward deflection is called an R wave. Any downward deflection following an R wave is called an S wave
- The **T wave** is caused by potentials generated as the ventricles repolarize.
- The repolarization wave of the atria occurs at the same time as the QRS complex that's why it's not seen on the ECG record **normally**.

➤ PR interval

- From the beginning of the P wave till the beginning of the QRS complex. It is about 0.16 second.

➤ QT interval

- From the beginning of the QRS complex to the end of the T wave (ventricular depolarization & repolarization). This interval is about 0.35 second.

➤ R-R interval

- Represents one cardiac cycle & is essential in calculating the heart rate.

➤ PR segment

- Extends from the end of P wave to the beginning of QRS complex. It should be isoelectric.

➤ ST segment

- Extends from the end of QRS complex to the beginning of T wave. It should be isoelectric.

Electrocardiograph Machine

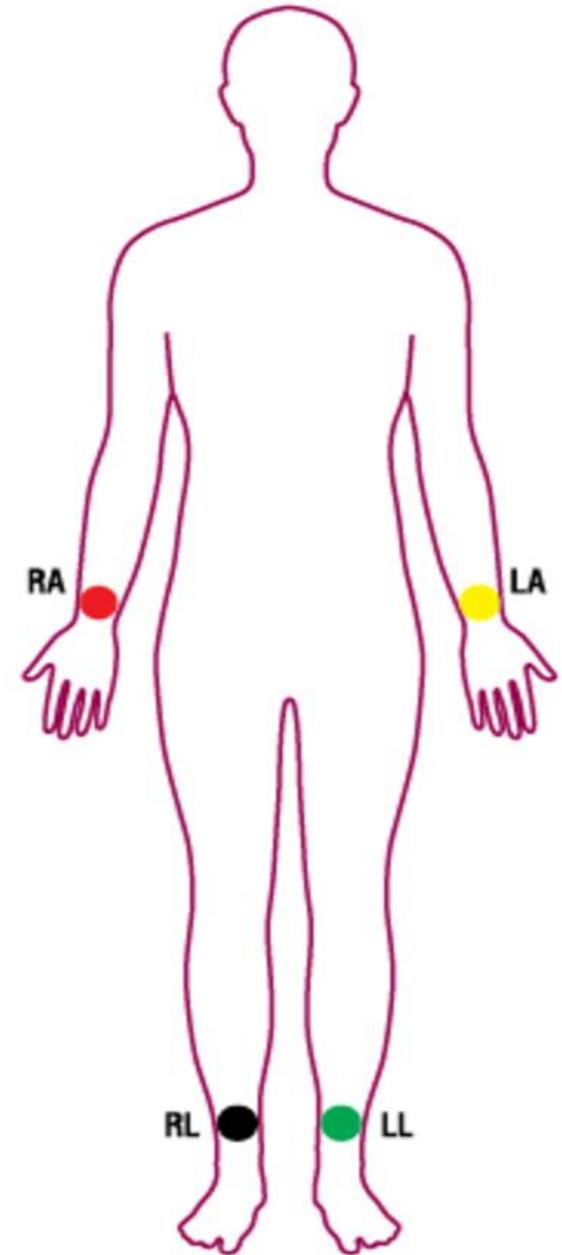


The ECG machine

- This machine compares, amplifies and filters the electrical potential differences recorded by the ELECTRODES and presents the results as LEADS
- Electrode is a conductive pad which is attached to the skin and allows recording of electrical currents
- An ECG lead is a graphical description of the electrical activity of the heart from a particular angle across the body. It is created by analysing the data obtained from two or more electrodes

12-lead ECG

- 12-lead ECG is generated from 10 electrodes.
- These 10 electrodes allow the electrical activity of the heart to be looked at from 12 different positions. There are 4 limb electrodes and 6 chest electrodes.
- Limb electrodes:
 - LA – Left arm
 - RA – Right arm
 - LL – Left leg
 - RL – Right leg
- ✓ RL is a neutral lead and is solely present to complete the electrical circuit. It plays no role in the formation of the ECG itself.



Limb electrodes



Clamp Electrodes



Disposable, adhesive

Limb leads (Frontal Plane)

➤ Bipolar Limb Leads

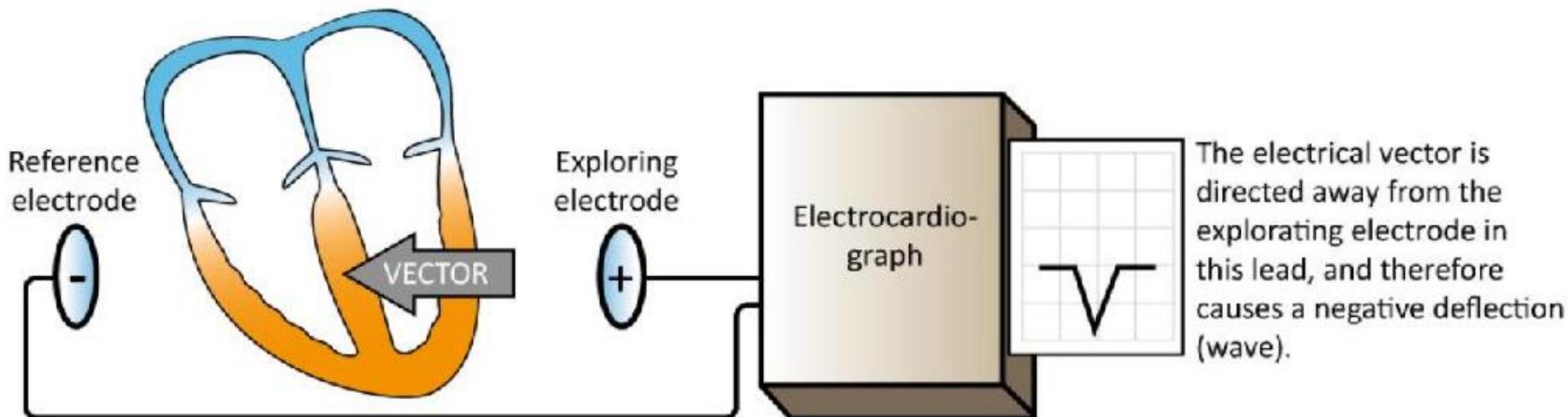
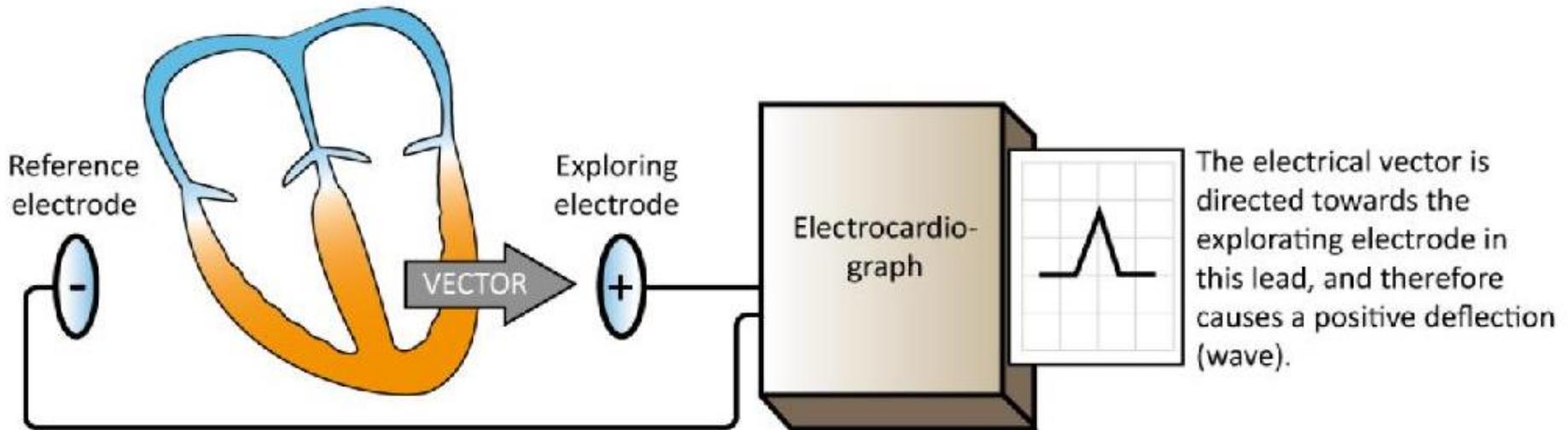
- Lead I: RA (-) to LA (+)
- Lead II: RA (-) to LL (+)
- Lead III: LA (-) to LL (+)

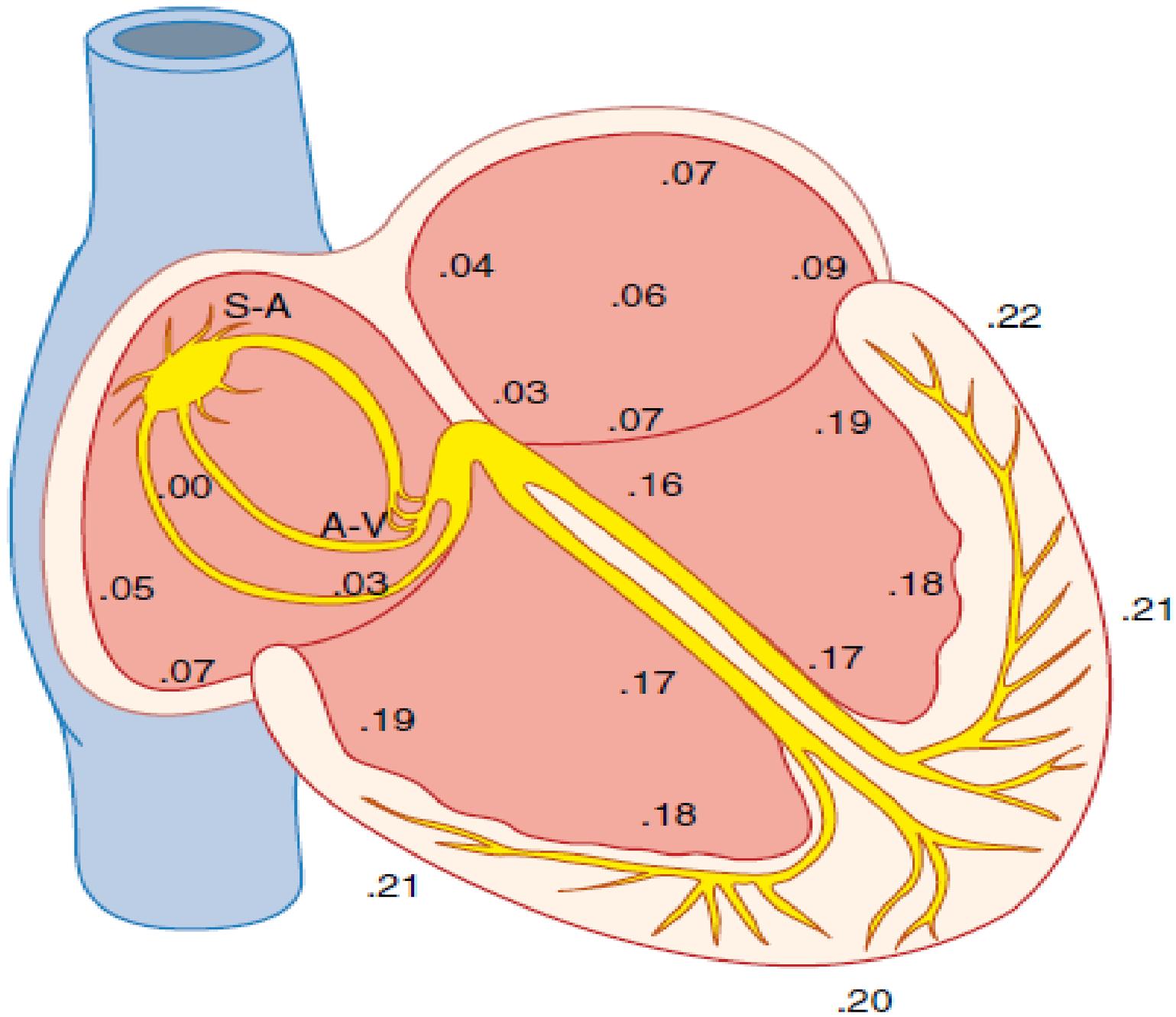
➤ Augmented Unipolar Limb Leads

➤ Connect two limbs to the negative (reference) electrode through very high resistance (the recorded voltage will be almost zero). The third limb is connected to the positive (exploring) electrode and its voltage is thus recorded.

- Lead aVR: RA (+) to [LA & LL] (-)
- Lead aVL: LA (+) to [RA & LL] (-)
- Lead aVF: LL (+) to [RA & LA] (-)

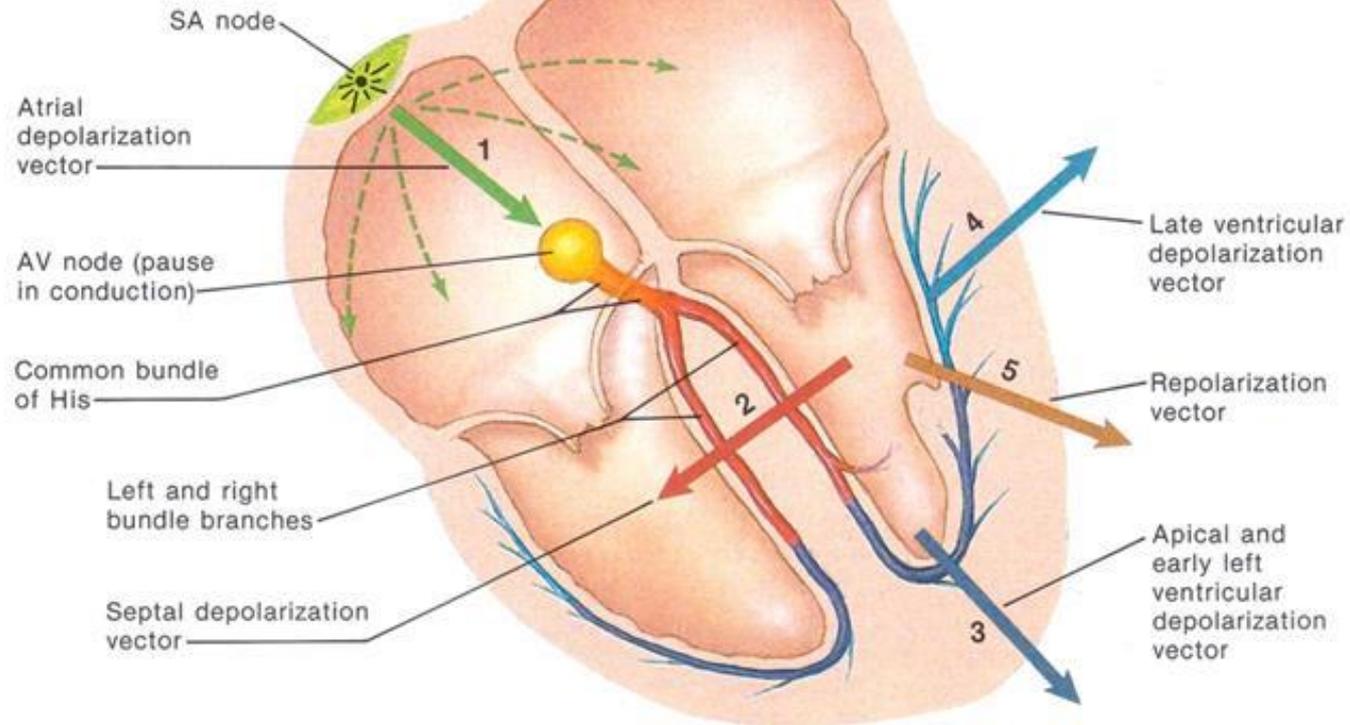
Recording a wave of depolarization





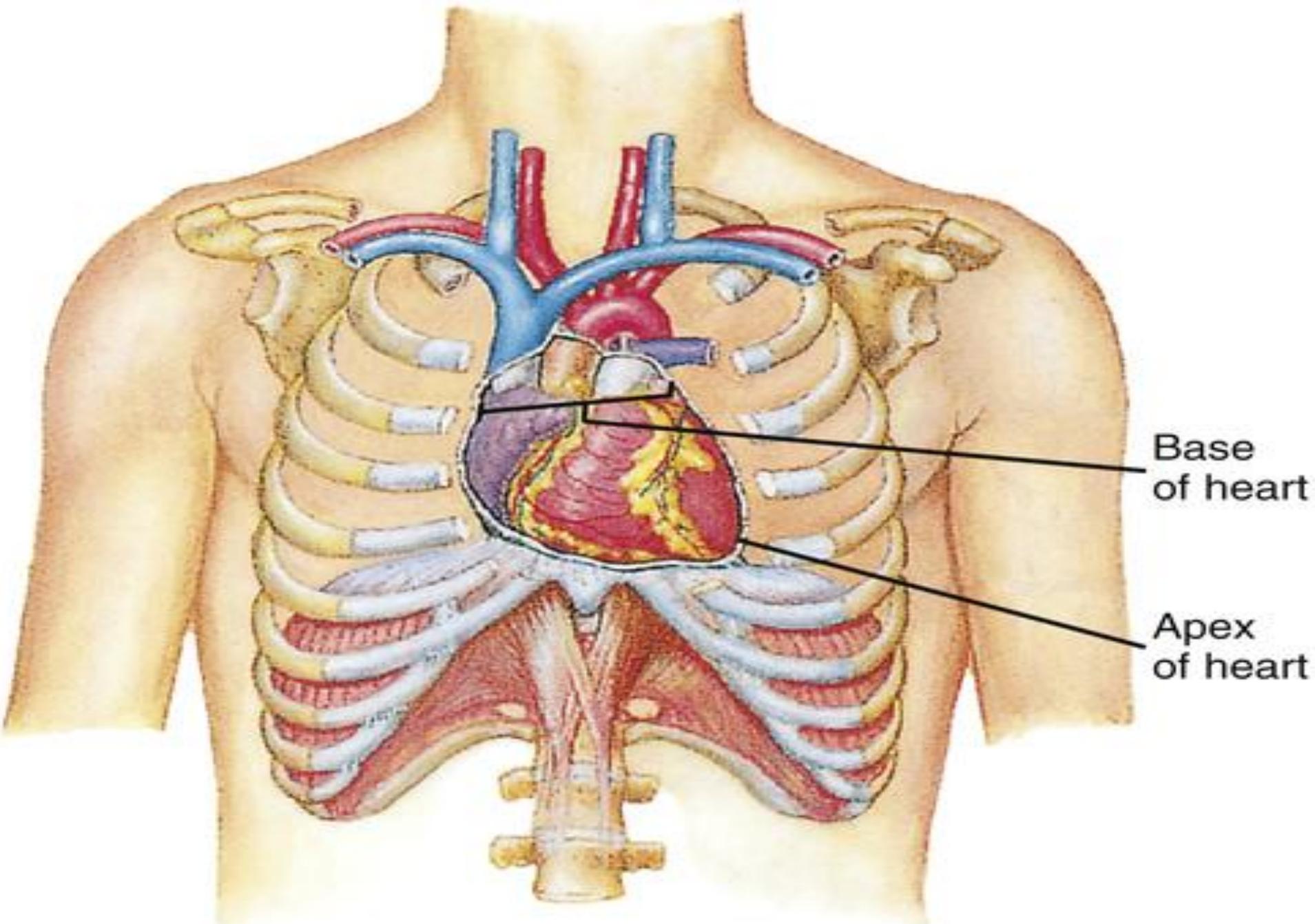
F. Summary of cardiac electrical activity

F. Netter M.D.
© CIBA



QRS axis is a summation of all vectors during ventricular depolarization





Base
of heart

Apex
of heart

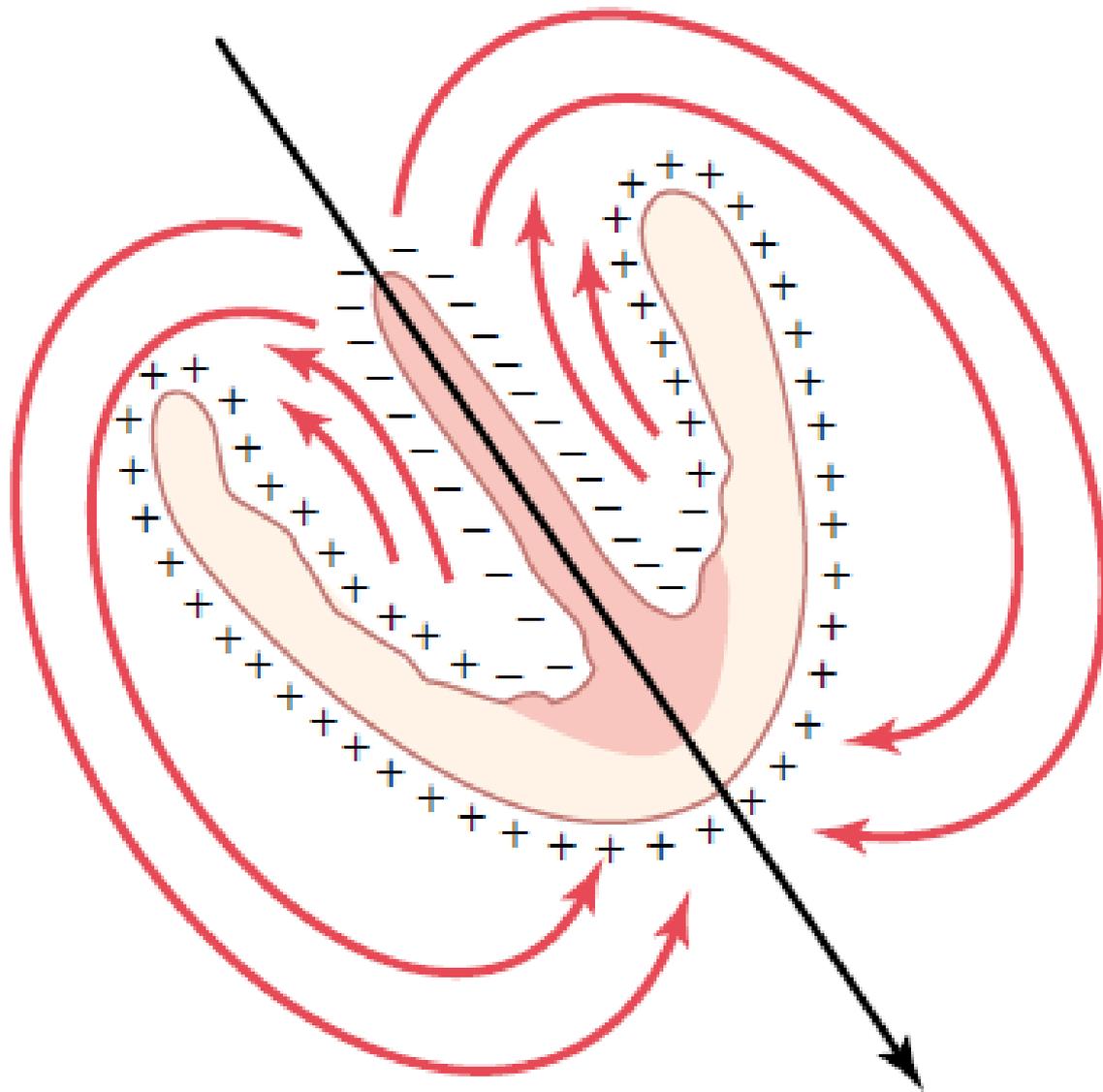
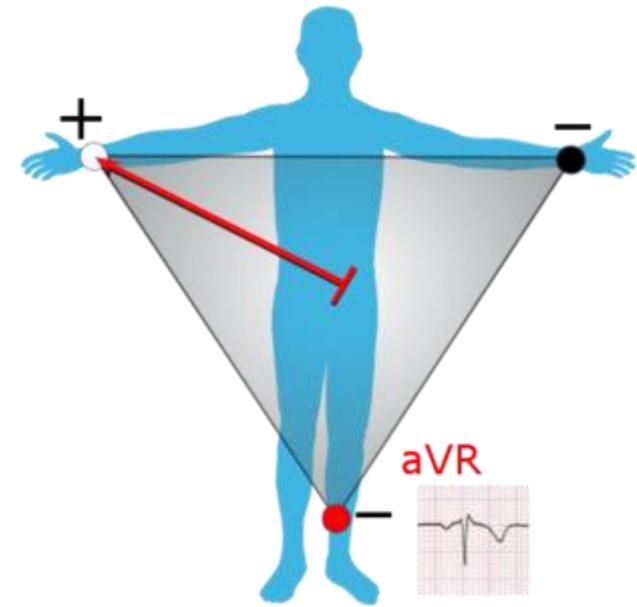
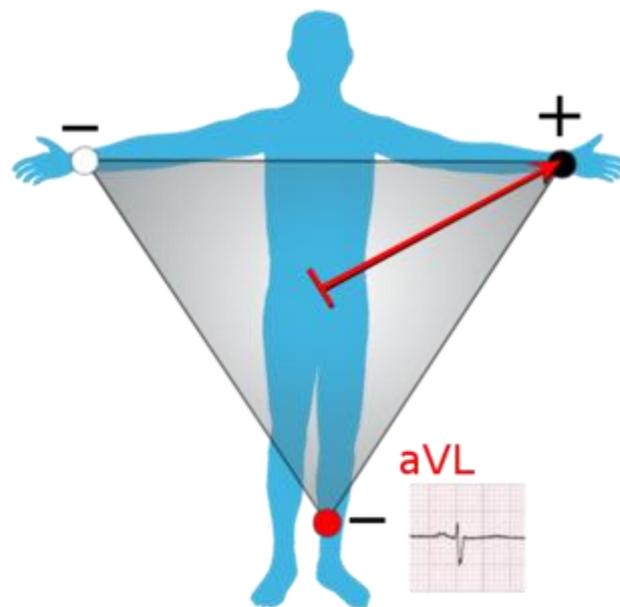
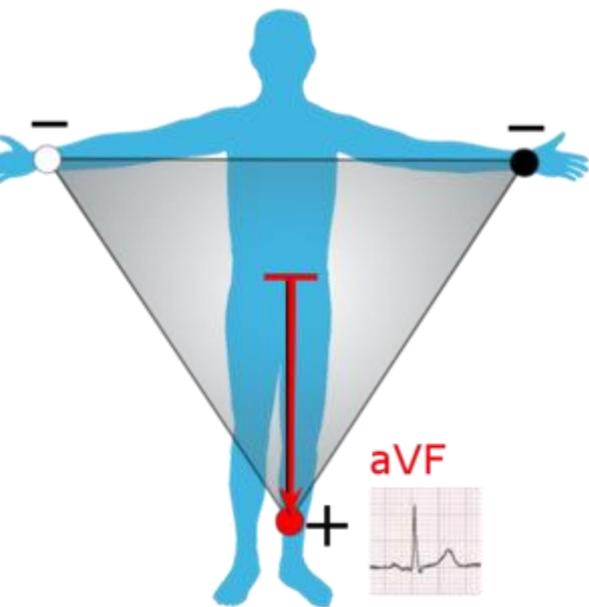
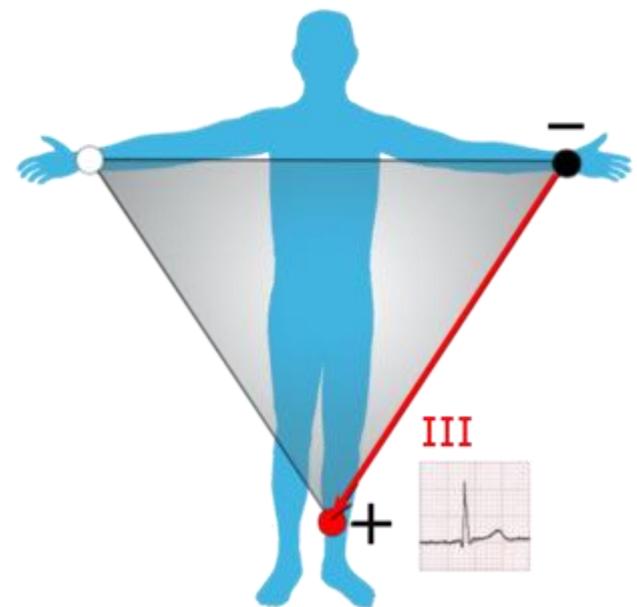
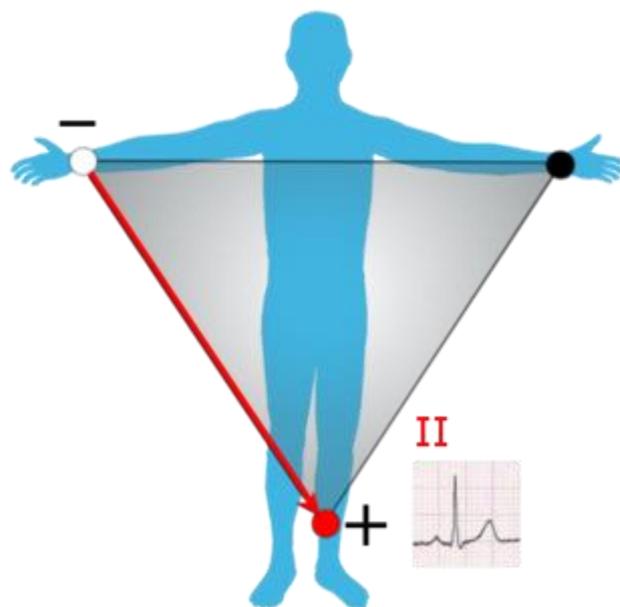
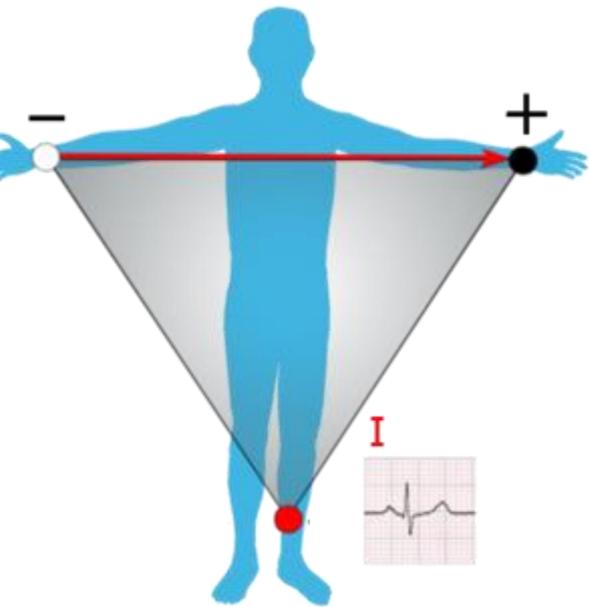
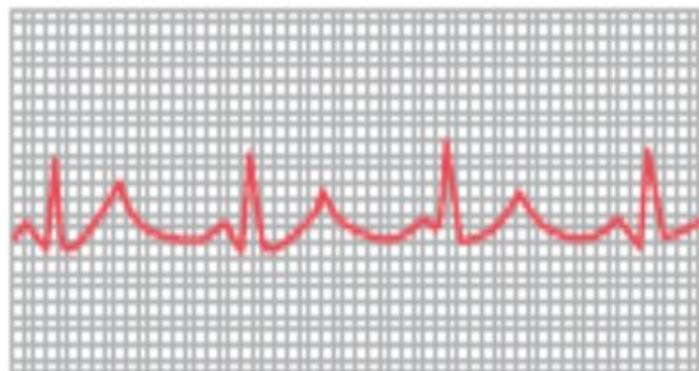


Figure 12-1 Mean vector through the partially depolarized ventricles.

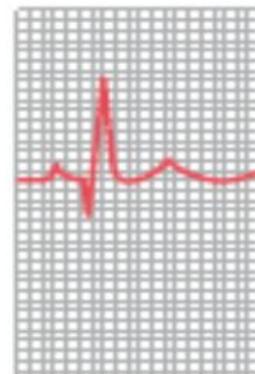




aVR



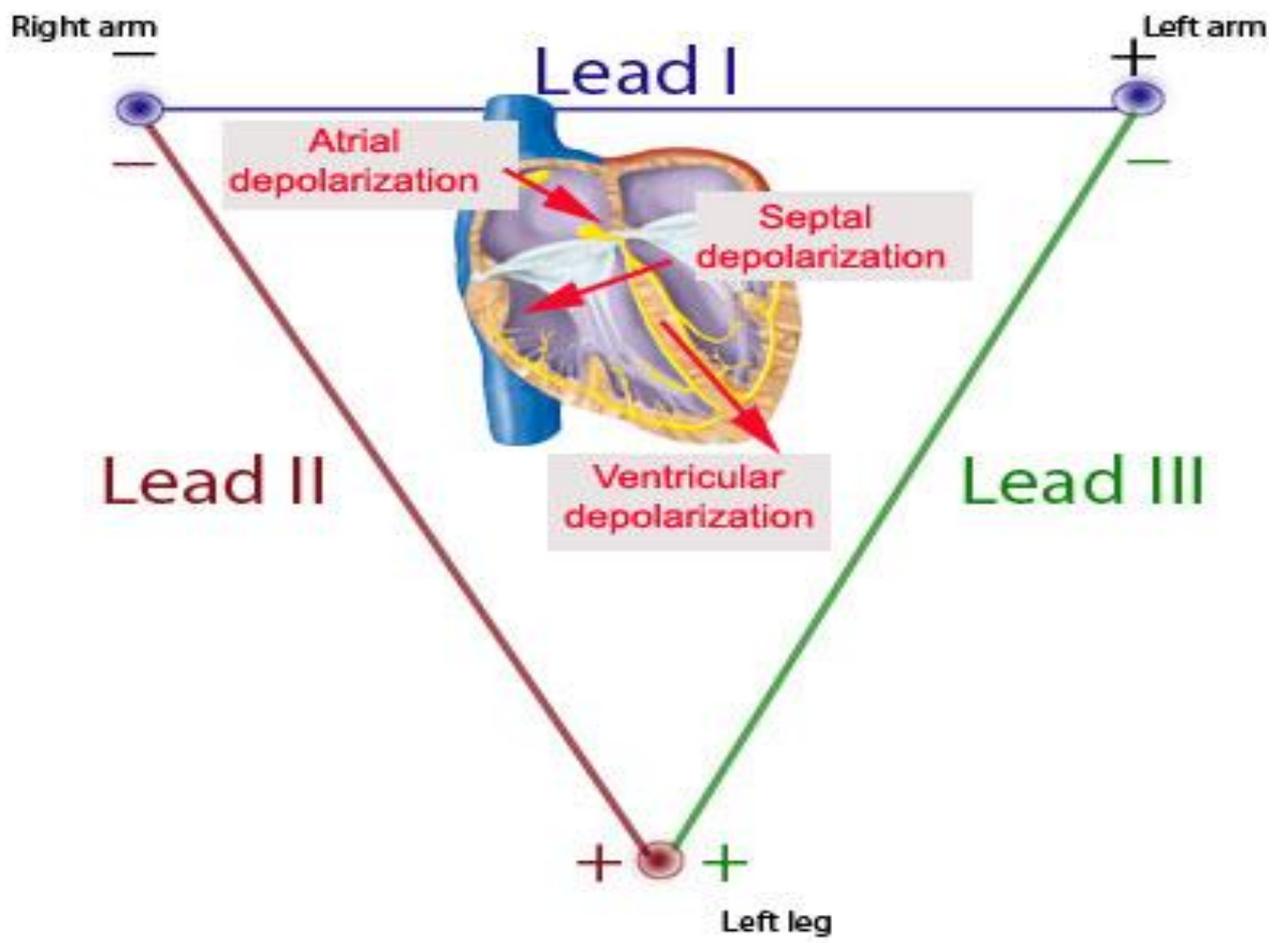
aVL



aVF

Einthoven's Triangle & Law

- Einthoven's triangle, the two arms and the left leg form apices of a triangle surrounding the heart.
- Einthoven's law states that if the electrical potentials of any two of the three bipolar limb leads are known at any given instant, the third one can be determined mathematically. Because:
- The sum of the voltages in leads I and III equals the voltage in lead II



Chest electrodes

Position of the chest electrodes:

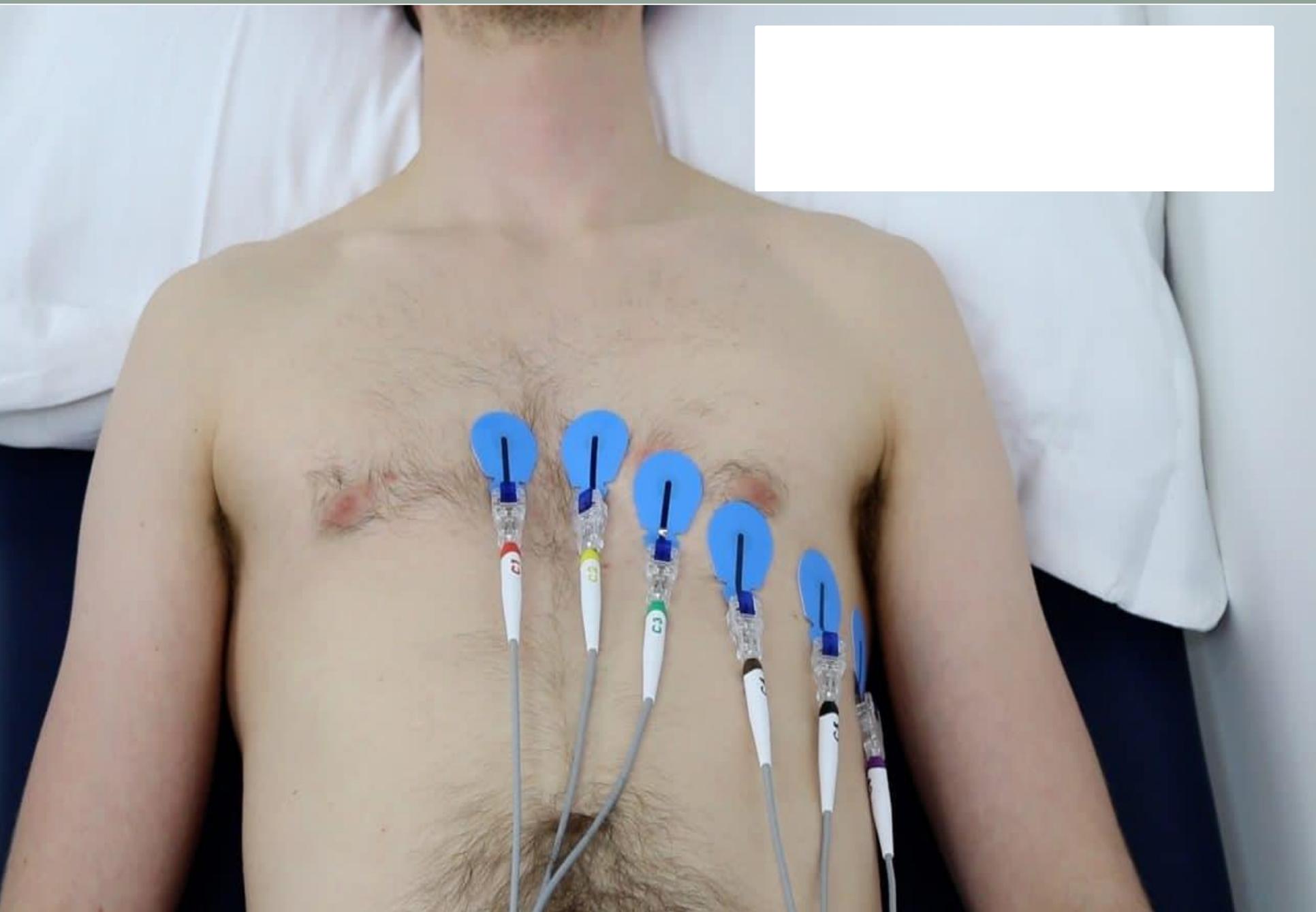
- V1: Right sternal edge, 4th intercostal space
- V2: Left sternal edge, 4th intercostal space
- V3: Midway between V2 and V4
- V4: Left mid-clavicular line, 5th intercostal space
- V5: Left anterior axillary line, 5th intercostal space
- V6: Left mid-axillary line, 5th intercostal space



Disposable, adhesive



Suction bulb electrodes



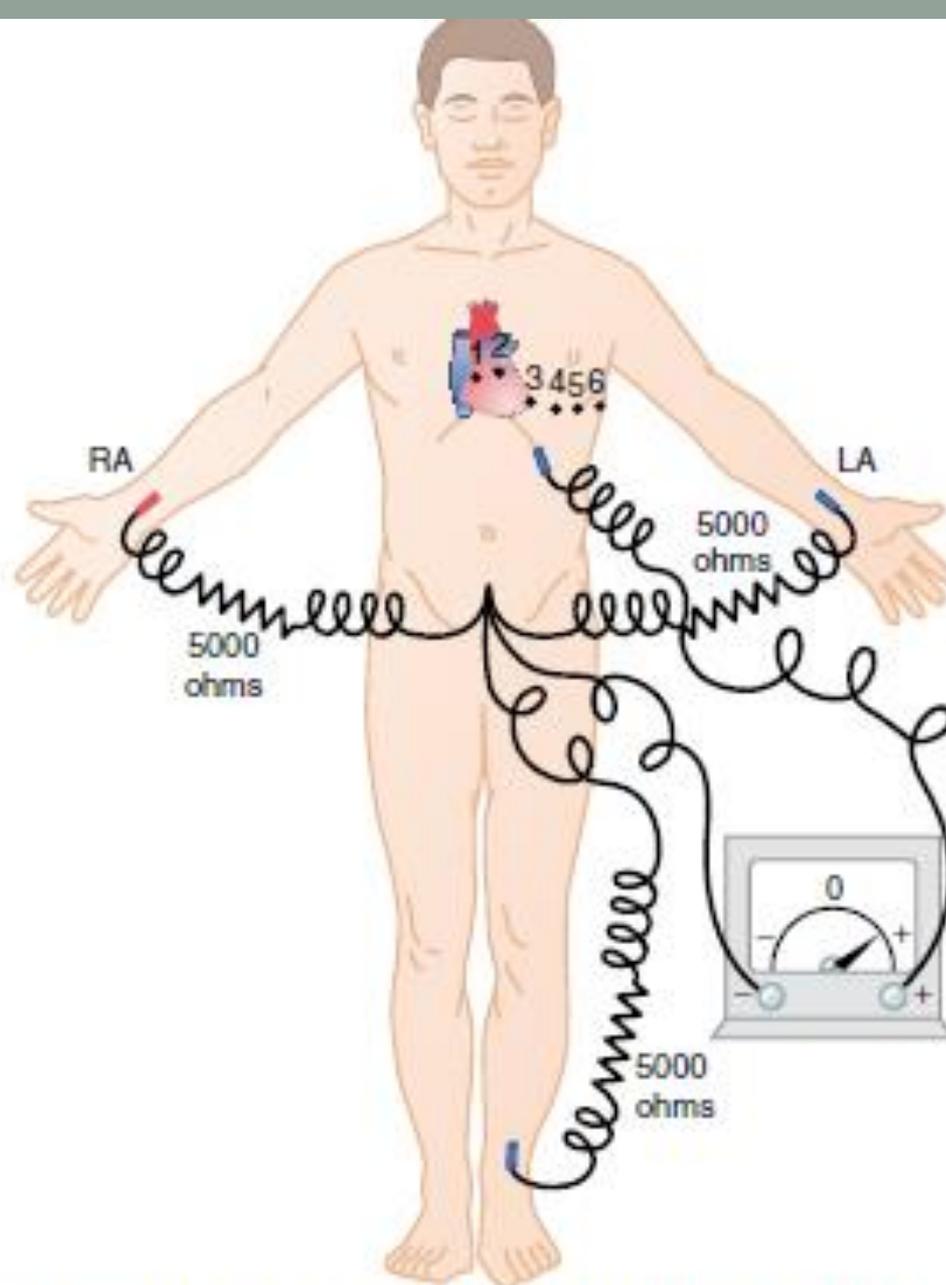
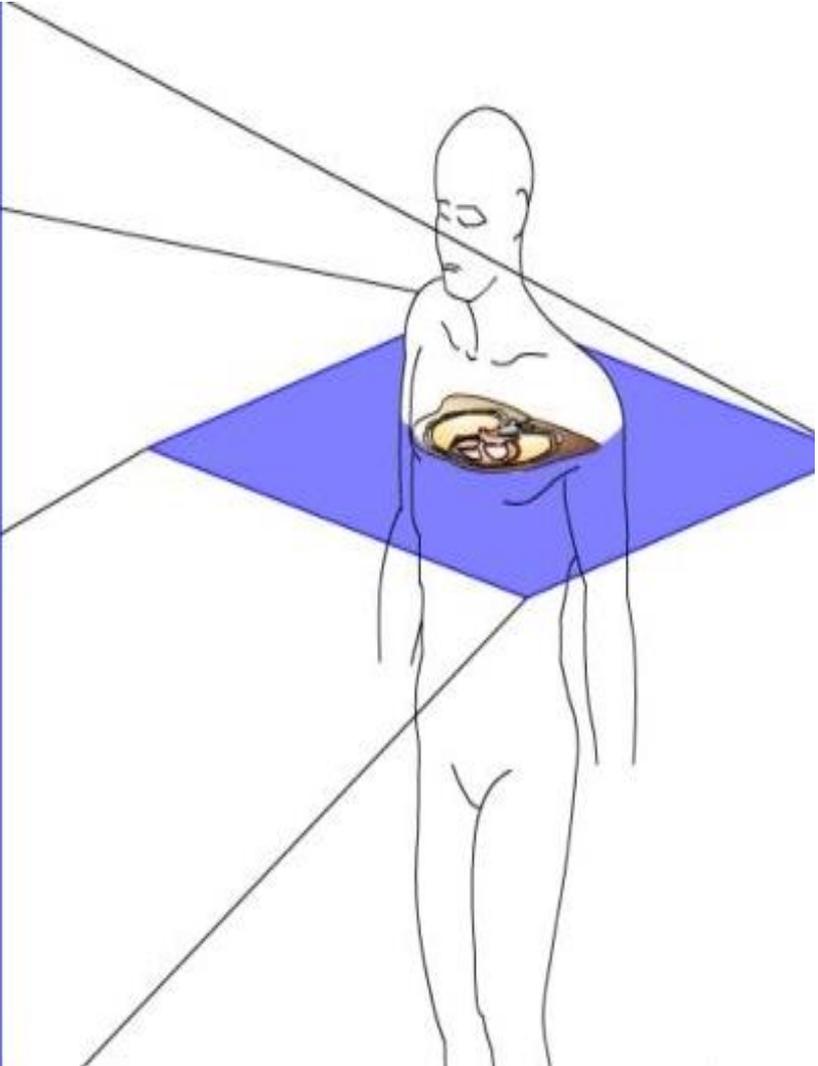
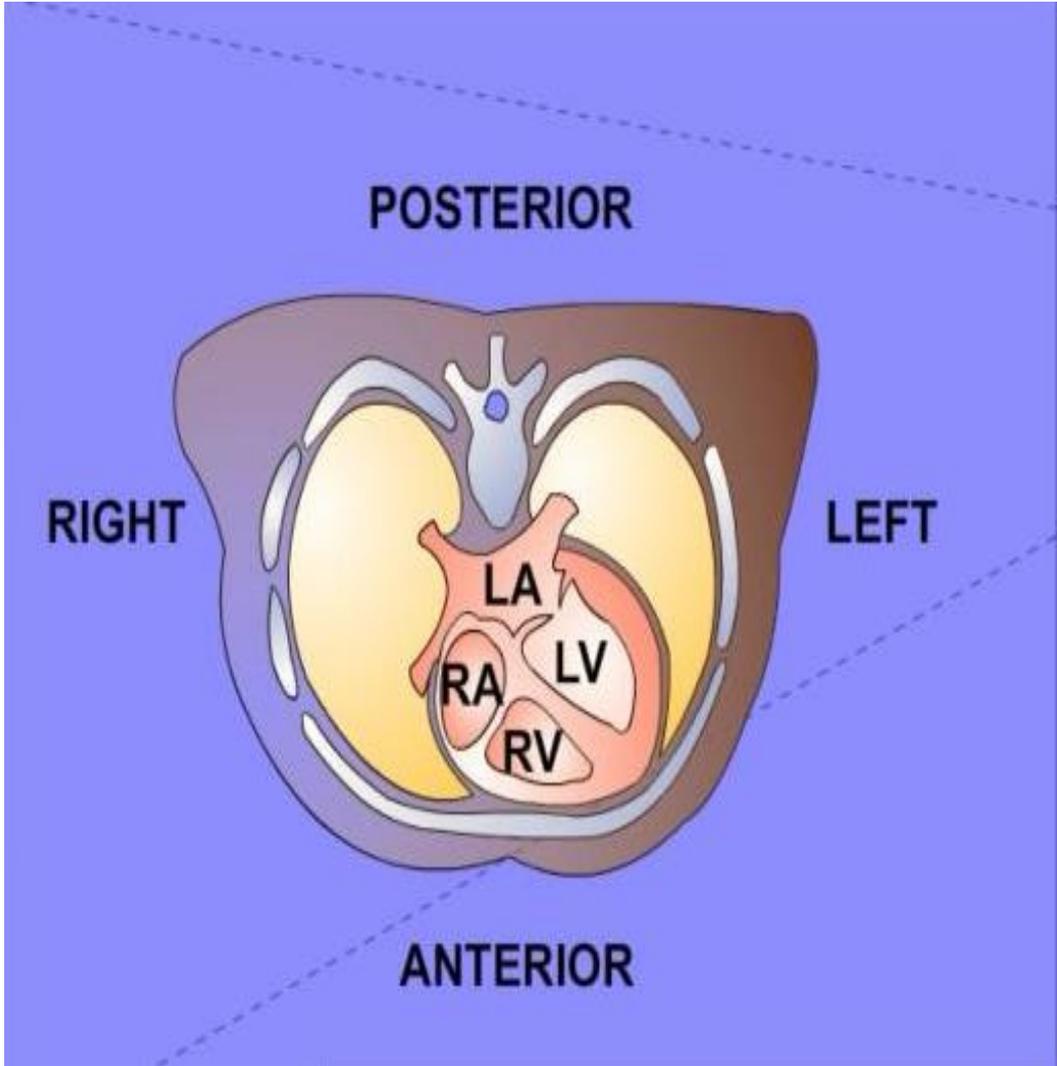
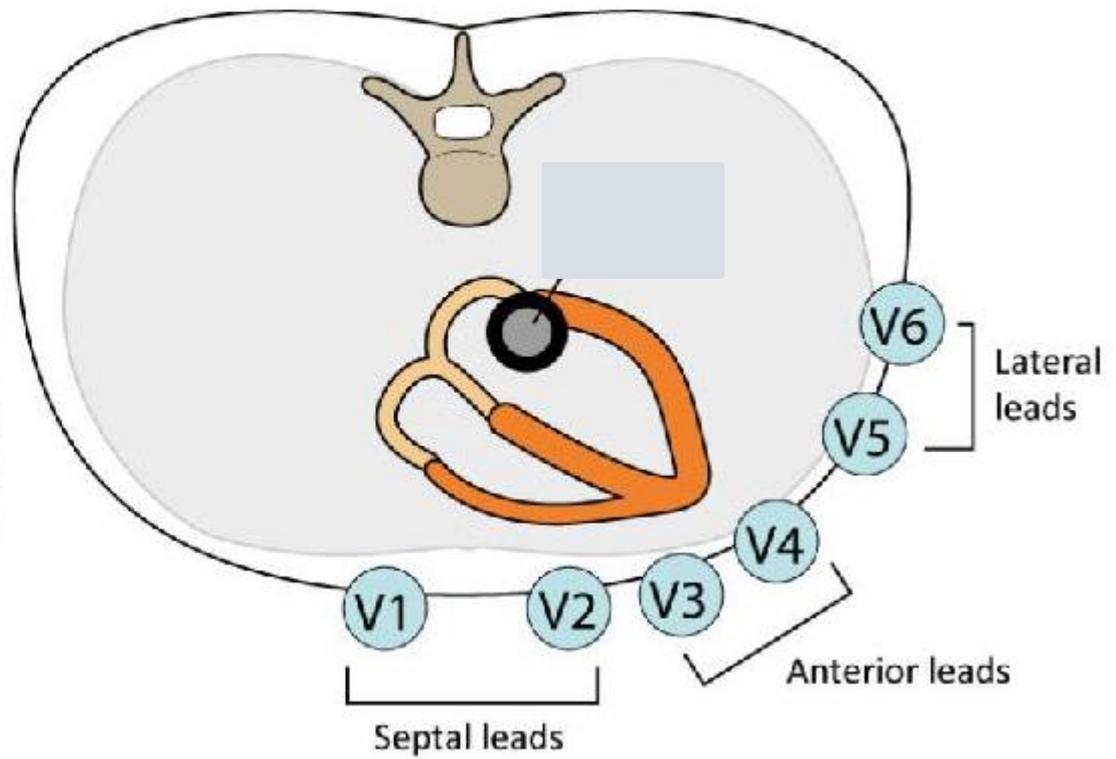
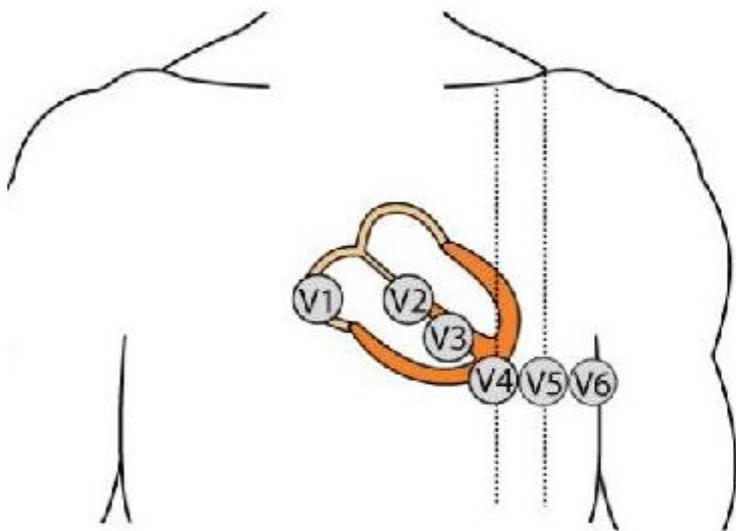


Figure 11-8 Connections of the body with the electrocardiograph for recording chest leads. LA, left arm; RA, right arm.

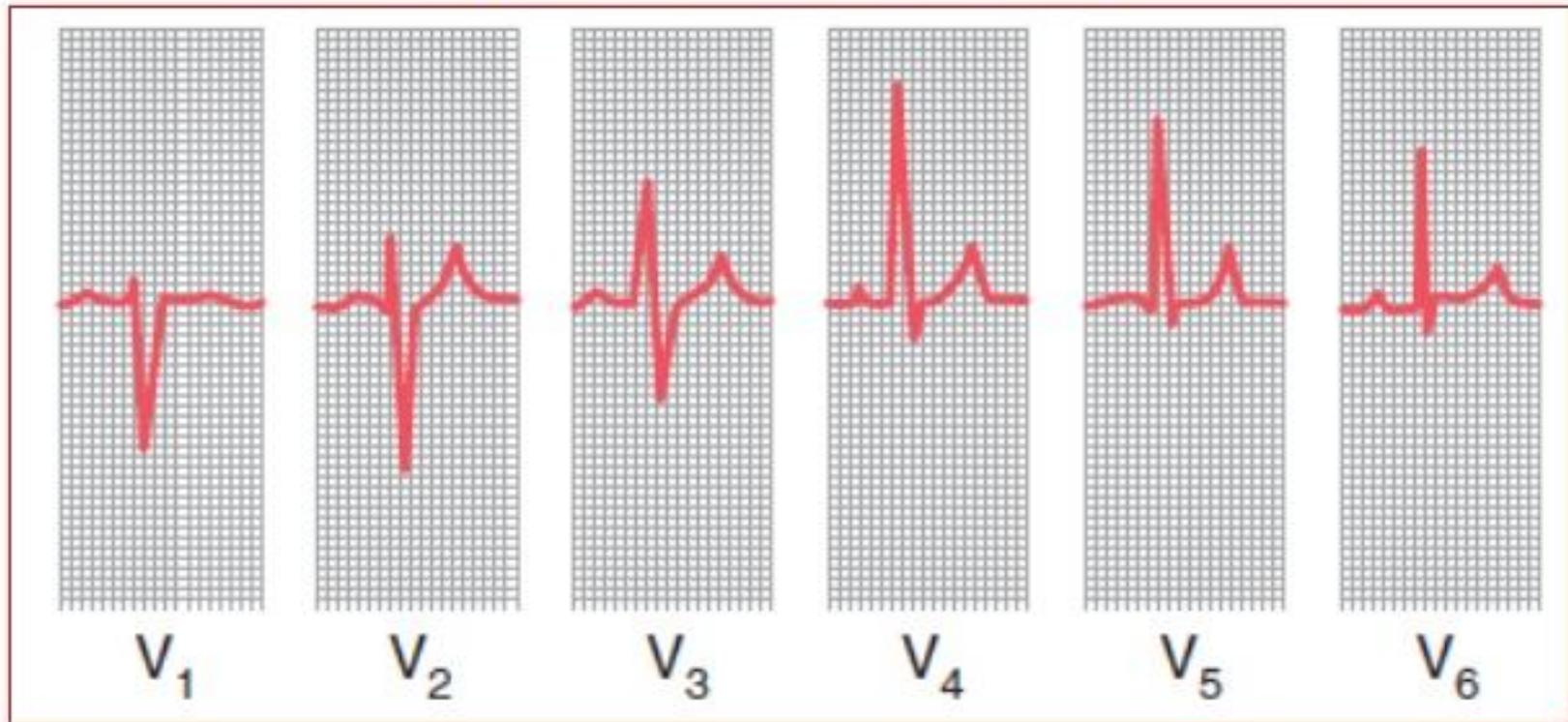




Chest Leads (Horizontal plane)

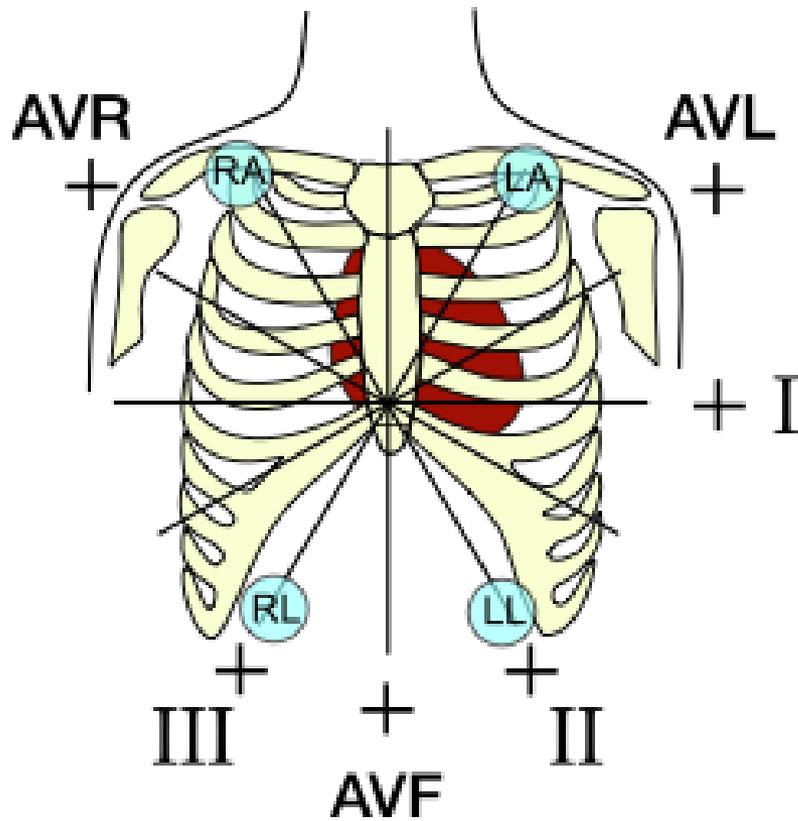
- These are unipolar leads.
- The positive (exploring) electrode is placed on the anterior surface of the heart and the negative (reference) electrode is attached to the three limbs through very high resistance
- Leads V1 & V2 look at the right ventricle and the septum.
- Lead V3 look at the anterior wall of the left ventricle
- Leads V4, V5 & V6 look at the lateral wall of the left ventricle.

CHEST LEADS (PRECORDIAL LEADS)

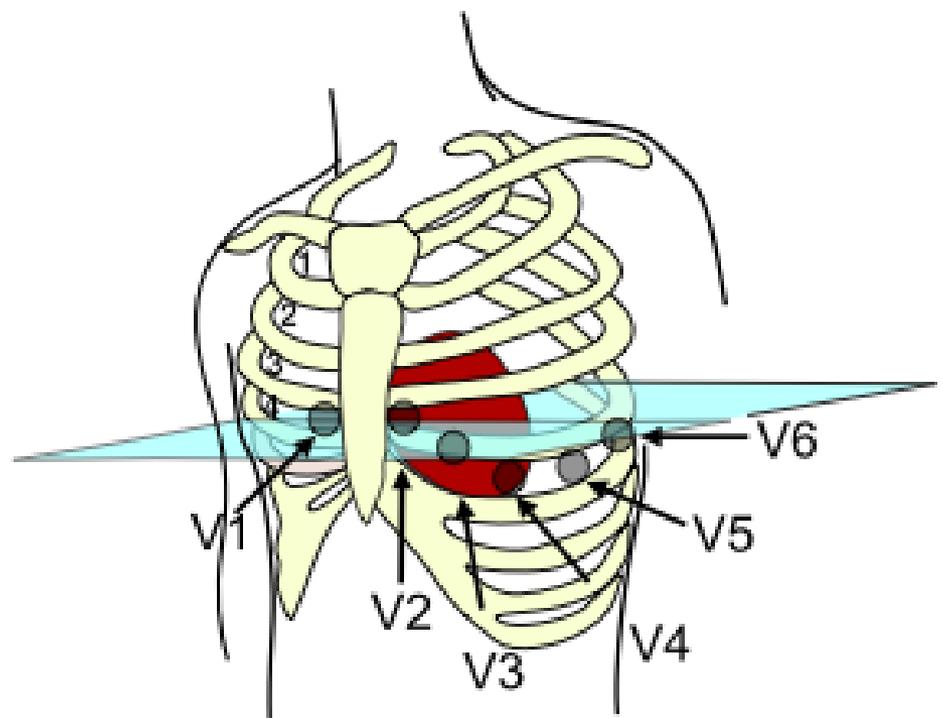


Normal ECGs of chest leads

The 6 Limb Leads



The 6 Left Chest Leads



View of heart	Leads
Inferior	II, III, aVF
Lateral	I, aVL, V4, V5, V6
Anterior	V1, V2
Septal	V3



What do we need to perform a 12 lead ECG

- ECG machine
- 4 limb electrodes
- 6 chest electrodes
- Razors and skin cleansing wipes (alcohol swabs)
- Conducting gel



MAKING A RECORDING – PRACTICAL POINTS

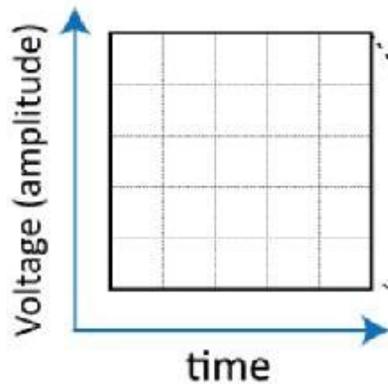
- Fully explain the procedure to the patient
- Make sure the patient is relaxed, warm and lying in a Semi-recumbent position comfortably
- Ask the patient to take off any jewellery, belts and clothes with metallic parts and to turn off the cell phone.
- Shaving might be necessary since hair is a bad conductor of electrical activity.
- Make sure the skin is clean and dry
- The electrodes should be accurately positioned.
- Apply the gel in sufficient quantities.
- Ensure good contact between the electrodes and the skin.
- Make sure the patient isn't moving or talking while making the record
- Check the calibration & speed settings on the machine.

- You can watch this video for further clarification
- [//www.youtube.com/watch?v=1k4B_fIX_t0](https://www.youtube.com/watch?v=1k4B_fIX_t0)

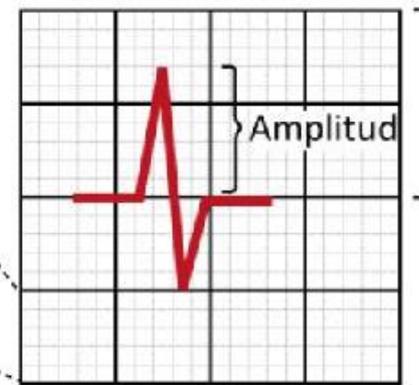
ECG paper speed

50 mm/s

25 mm/s

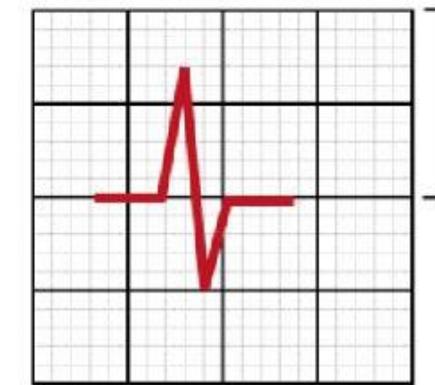


0,2 seconds
0,1 seconds
0,02 seconds



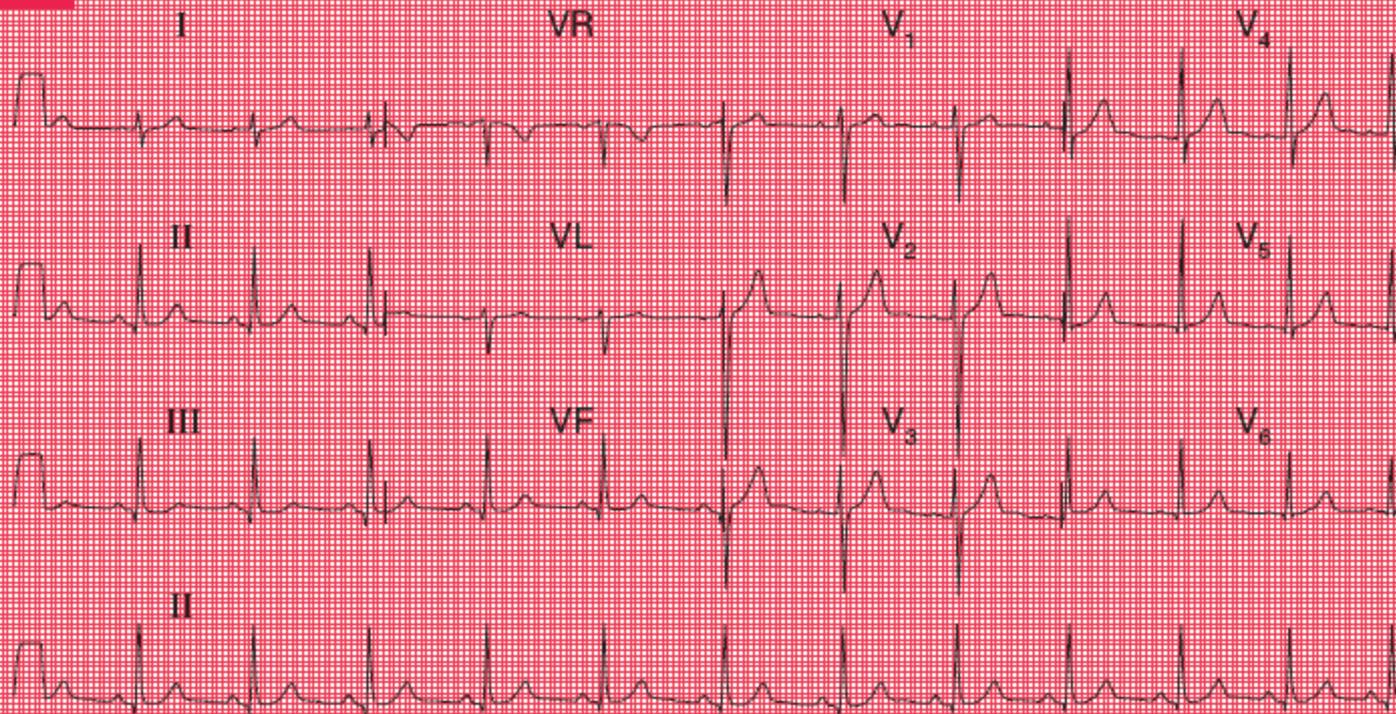
10 mm = 0,2 seconds

0,4 seconds
0,2 seconds
0,04 seconds



10 mm = 0,4 seconds

Fig. 1.22

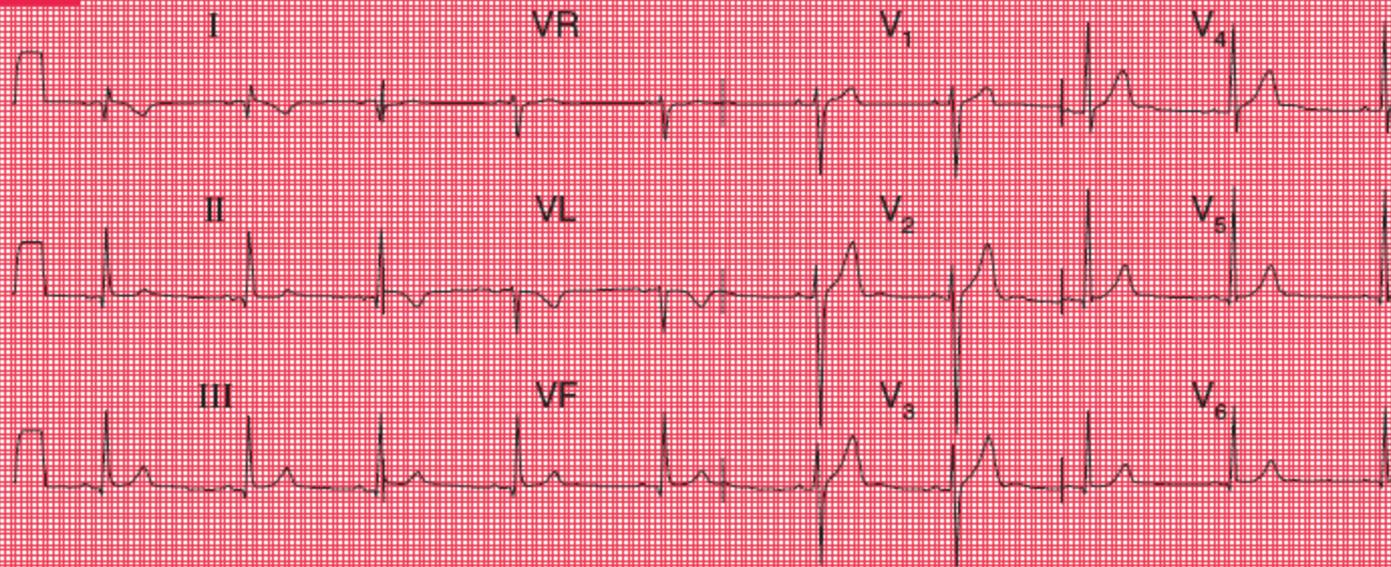


A good record of a normal ECG

Note

- The upper three traces show the six limb leads (I, II, III, VR, VL, VF) and then the six chest leads
- The bottom trace is a 'rhythm strip', entirely recorded from lead II (i.e. no lead changes)
- The trace is clear, with P waves, QRS complexes and T waves visible in all leads

Fig. 1.23

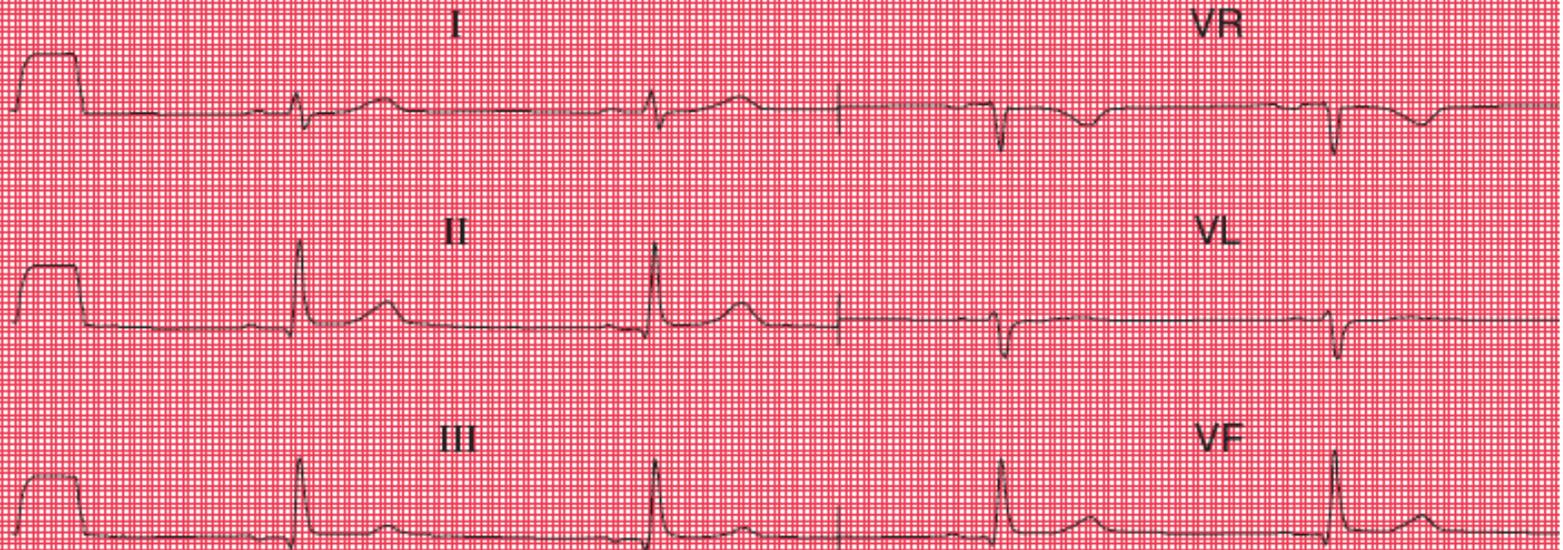


The effect of reversing the electrodes attached to the left and right arms

Note

- Compare with Figure 1.22, correctly recorded from the same patient
- Inverted P waves in lead I
- Abnormal QRS complexes and T waves in lead I
- Upright T waves in lead VR are most unusual

Fig. 1.29

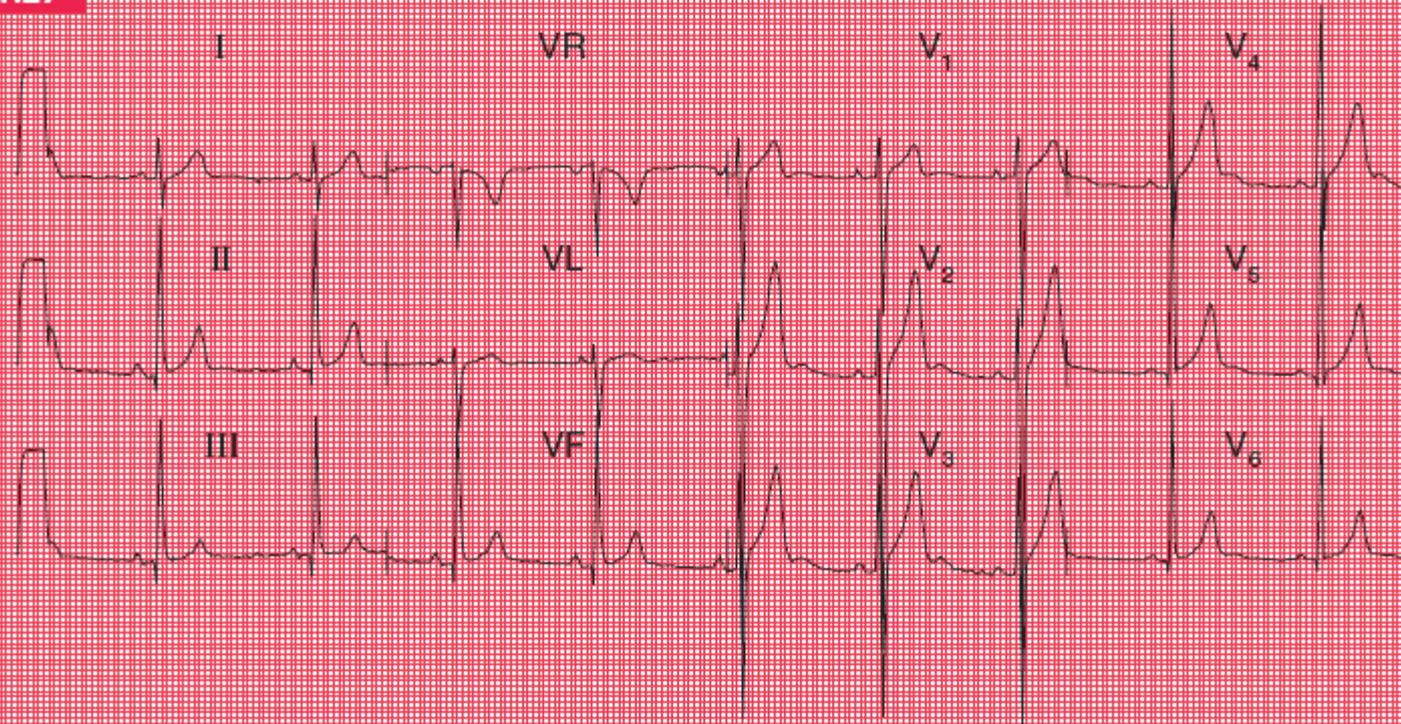


Normal ECG recorded with a paper speed of 50 mm/s

Note

- A paper speed of 50 mm/s is faster than normal
- Long interval between QRS complexes gives the impression of a slow heart rate
- Widened QRS complexes
- Apparently very long QT interval

Fig. 1.27



The effect of over-calibration

Note

- The calibration signal (1 mV) at the left-hand end of each line causes a deflection of 2 cm
- All the complexes are large compared with an ECG recorded with the correct calibration (e.g. Fig. 1.22, in which 1 mV causes a deflection of 1 cm)

Fig. 1.28

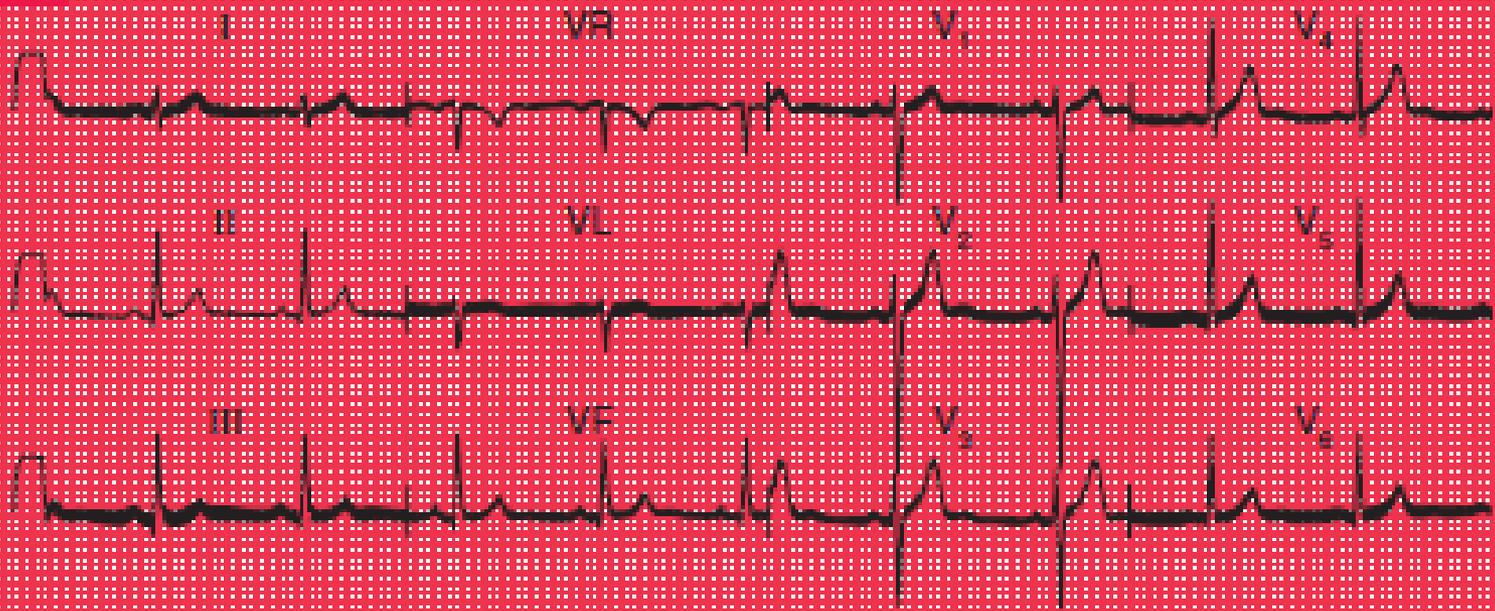


The effect of under-calibration

Note

- The calibration signal (1 mV) causes a deflection of 0.5 cm
- All the complexes are small

Fig. 1.26

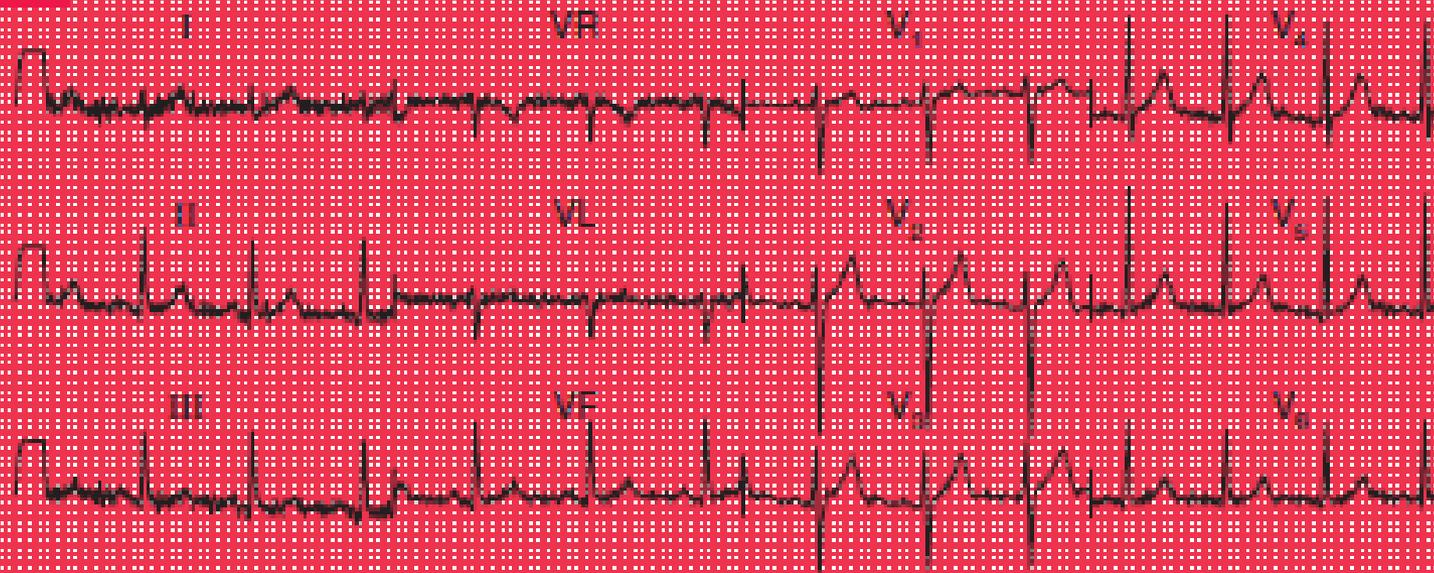


The effect of electrical interference

Note

- Regular sharp high-frequency spikes, giving the appearance of a thick baseline

Fig. 1.31

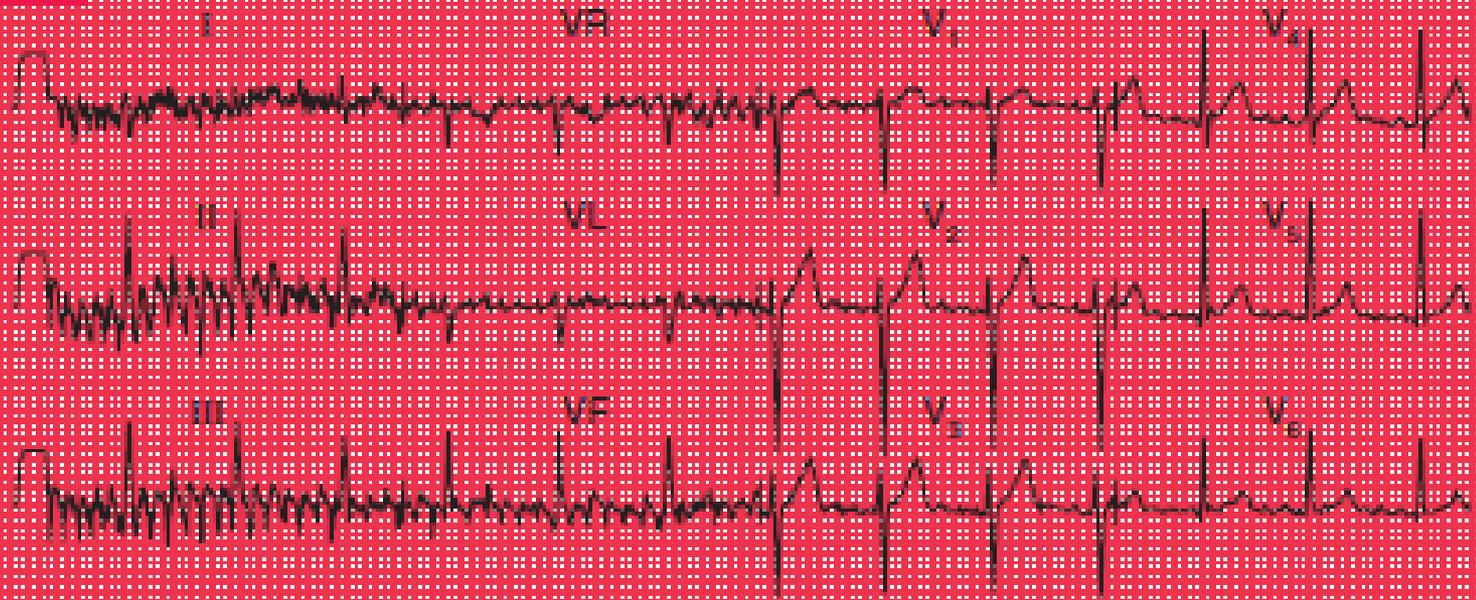


An ECG from a subject who is not relaxed

Note

- Same subject as in Figs 1.22–1.30
- The baseline is no longer clear, and is replaced by a series of sharp irregular spikes – particularly marked in the limb leads

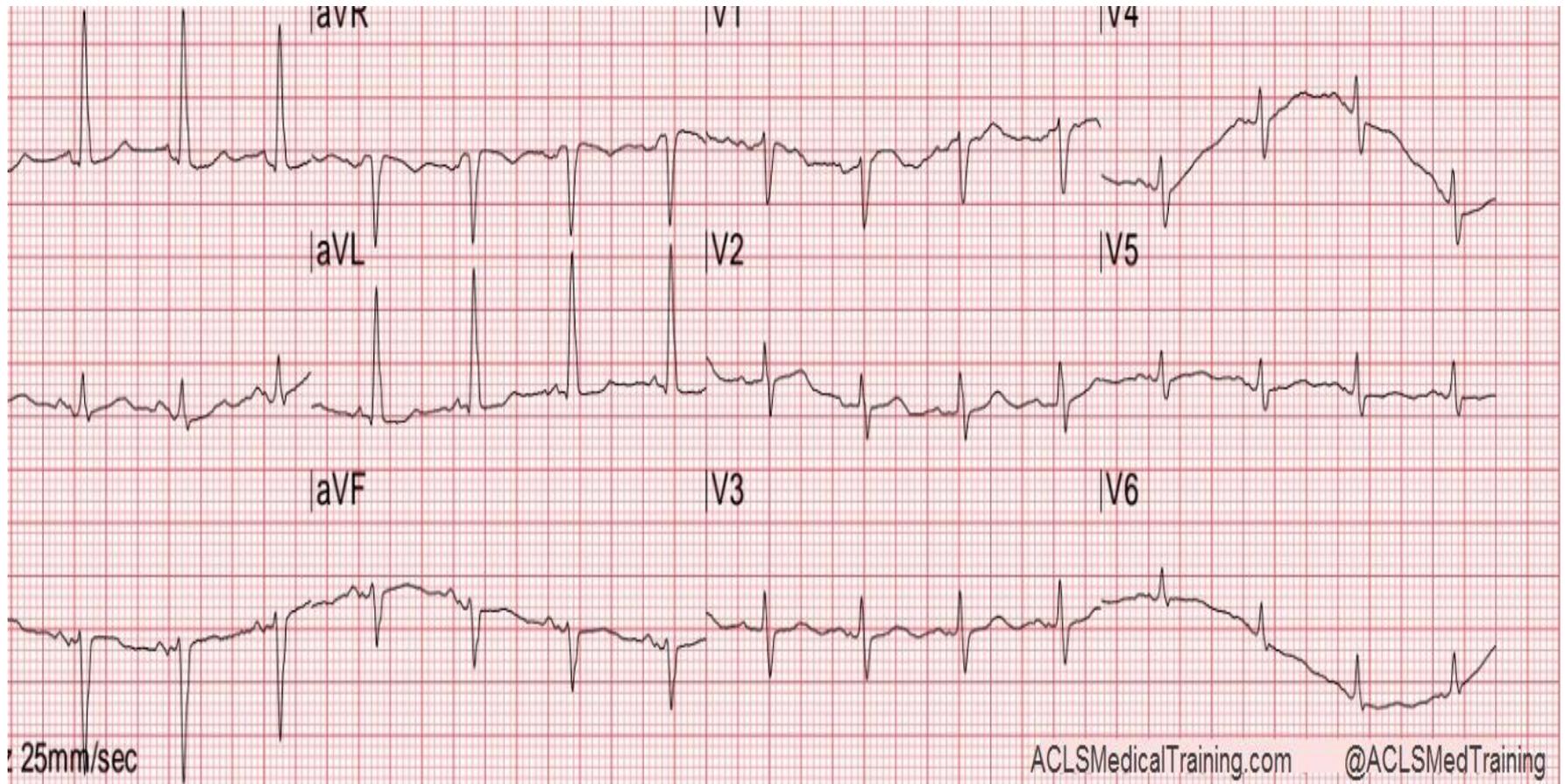
Fig. 1.32



The effect of shivering

Note

- The spikes are more exaggerated than when a patient is not relaxed
- The sharp spikes are also more synchronized, because the skeletal muscle groups are contracting together
- The effects of skeletal muscle contraction almost obliterate those of cardiac muscle contraction in leads I, II and III



Wandering baseline : Patient movement or abnormal breathing, loose electrodes

THANK YOU



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