ECG REVIEW: ECGS MADE EASY

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PRE-READING MATERIAL

SECTION I:

ANATOMY AND PHYSIOLOGY

THE ELECTROCARDIOGRAPHY MACHINE

GRAPH PAPER & MEASUREMENTS

ANATOMY AND PHYSIOLOGY

The Heart is a hollow muscular organ that lies in the middle of the thoracic cavity behind the sternum, between the lungs and just above the diaphragm. Blood supply to this organ comes directly from the arch of the major artery (aorta) of the body. This blood supply is called the coronary circulation.

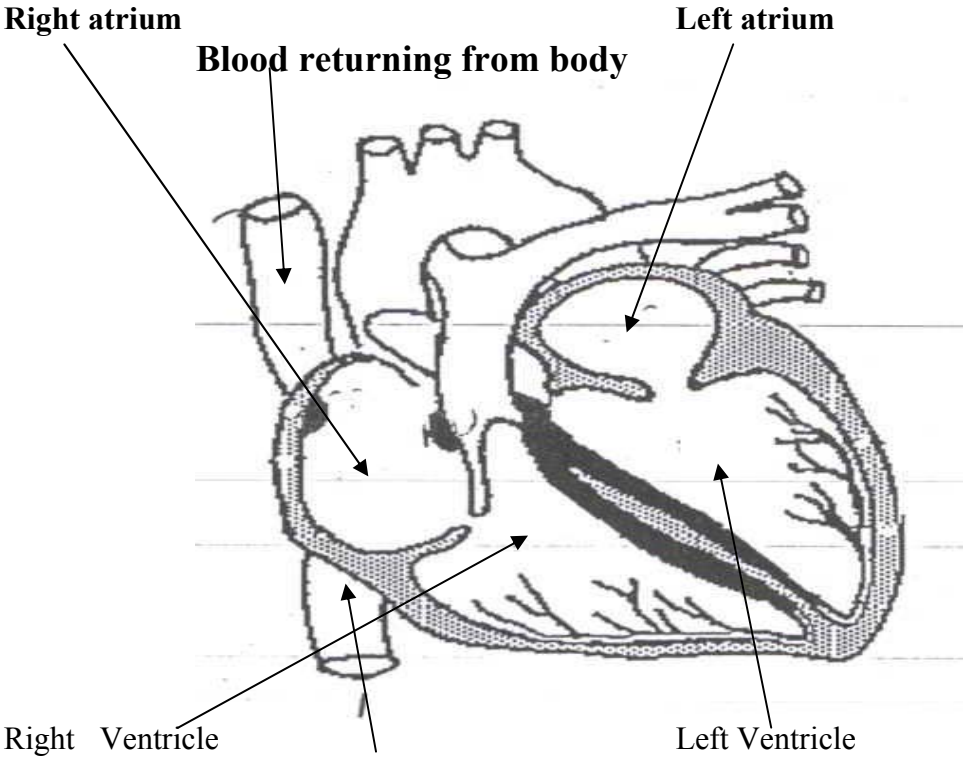
The heart has four chambers:

right atrium and left atrium
right ventricular and left ventricular.

Blood enters the heart from the major veins of the body:

The superior and inferior vena cava (these veins feed into the right atrium.

(THE HEART CHAMBERS & BLOOD FLOW)



A heartbeat consists of two contractions:
When the atriums contract, blood is squeezed simultaneously from the right atrium into the right ventricle through the tricuspid valve and from the left atrium into the left ventricle through the mitral valve.
When the ventricles contract, blood is squeezed simultaneously from the right ventricle, through the pulmonary valve to the lungs and from the left ventricle, through the aortic valve and outwards through the body.
Valves are necessary for efficient heart function because they permit the blood to flow in a single direction.

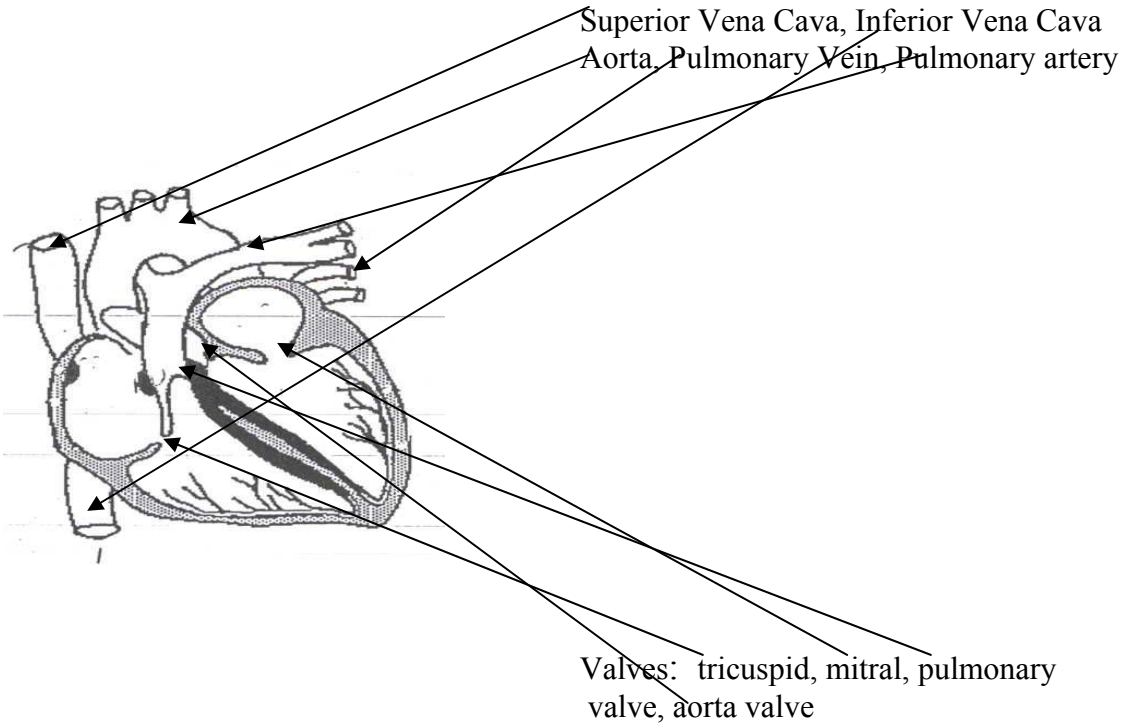
The left ventricle has a large muscle mass than the right ventricle. Both are much larger and more muscular than the atria.

The Septum

The muscle mass which divides the heart (down the middle) is the *septum*. Between the right and left atria lies the interatrial septum.
The inter-ventricular septum divides the right and left ventricles.
A ring of fibrous tissue separates the atria and the ventricles, so that the muscle bundles of these chambers are not continuous.
The ring does not conduct electricity.
The conduction between the atria and the ventricles is through the Bundle of His. This bundle of nerve fibres is situated mainly in the *inter-ventricular septum*.

The Major Blood Vessels

Two major veins, the *superior vena cava* and the *inferior vena cava*, deliver blood from all areas of the body into the right atrium.
The *pulmonary artery*, which divides directly above the heart into right and left braches, goes from the right ventricle to the lungs. In contrast to other arteries of the body, the *pulmonary artery* carries de-oxygenated blood.
Pulmonary veins lead from the right and left lungs to the left atrium. In contrast to other veins of the body, the *pulmonary vein* carries oxygenated blood.
The *aorta* receives blood from the left ventricle. It divides immediately into major arteries, which feed the head, coronary circulation, and the rest of the body.



Review of the blood flow:

Blood enters the right atrium from all parts of the body through the superior and inferior vena cava veins.
When the heart beats (contracts), the blood is forced through the tricuspid valve into the right ventricle. Blood that was already in the right ventricle is pushed out into the pulmonary artery and carried to the lungs for oxygen take-up and carbon dioxide removal. At the same time, blood returns from
the lungs to the left atrium and is forced through the mitral valve to the left ventricle.
Blood from the left ventricle enters the arterial circulation of the body through the aorta.
When ventricle contraction occurs, it begins at the apex (bottom) of the heart. The left ventricle has the most muscle and therefore produces the strongest contraction. This strength is needed, since it sends blood to all
areas of the body.

Cardiac Muscle

Each muscle cell in the heart can receive and electrical charge, reacts to it by contraction, and passes it on. Each cell is very complex and depends on an exchange of electrical charge (stimulus).

The Position of the Heart in the Chest Cavity.

The heart “floats” in the chest; it is kept in place by a bag, shaped from the lining of the chest cavity (pericardium) and the large blood vessels. It lies behind the sternum (the bone in the centre of the front of the chest to which the ribs are attached).

THE HEART & CONDUCTION SYSTEM

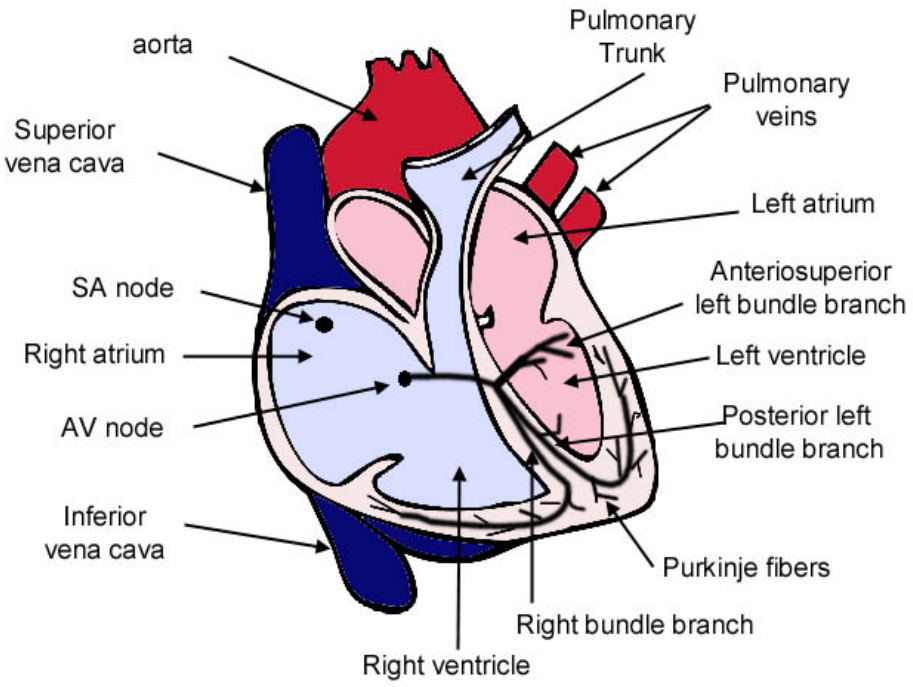
The heart's conducting system consists of:

SA Node (sinoatrial)

AV Node (atrioventricular)

Ventricular Conduction System: His Bundle, bundle branches (Right and Left) and the Purkinje fibres.

The electrical impulse that causes rhythmic contraction of heart muscles arises in the SA node, which is the intrinsic pacemaker of the heart. From the SA node, the impulse spreads over the atria muscles causing atria contraction. The impulse is also conducted to the AV node (atrioventicular) . From the AV node the electrical impulse is conducted to ventricular muscles via the bundle of His, the bundle branches (left and right) and the Purkinje fibres. The bundle branches and the Purkinje fibres are collectively called the **ventricular**



Sinoatrial Node (SA node)

Location:

The sinoatrial node (SA node) consists of a cluster of specialized cells that have pacemaker activity (automaticity). These cells are responsible for initiating the electrical impulse that stimulates the heart muscles to contract rhythmically. The SA node is located high on the right atrium close to whether the superior vena cava enters the right atrium.

Sinus rhythm

The SA rhythm is the normal pacemaker of the heart, firing at about 60-100 beats per minute. A heart controlled by the SA node is said to be in normal sinus rhythm. The electrical impulse from the SA node spreads over the right and left atria and causes atria contraction. The impulses are also conducted to the AV Node. It takes about 0.03 seconds for the impulse to travel from the SA to AV node. A few people believe that there are three internodal tracts (anterior, middle and posterior) that conduct the impulse to the AV node. The existence of these three tracts is controversial since their presence has not been firmly proven. In sinus rhythm, a QRS complex follows every P-wave, the R-R interval is regular and the P-R interval is less than 0.2 seconds (one big box on the EKG paper).

Fast and slow sinus rhythm

A fast sinus rhythm, faster than 100 beats a minute, is known as ***sinus tachycardia***. While a slow rhythm, slower than 60 beats a minute, is known as ***sinus bradycardia***.

Innervations by the Autonomic Nervous System

The SA node under the influence of the autonomic nervous system. The sympathetic system innervates the heart and causes increase the heart rate via B_1 adrenergic receptors, for instance in fight or fright.
The parasympathetic system, via the vagus nerve, slows the heart rate and establishes the resting heart rate of about 60-70 beats per minute. If parasympathetic activity is blocked by anti-cholinergic drugs or the vagal nerve is cut, the heart rate increases. If parasympathetic stimulation is increased, for instance by massaging the carotid sinus (baroreceptors), the heart rate decreases.

The reason the rhythm originates in the SA node.

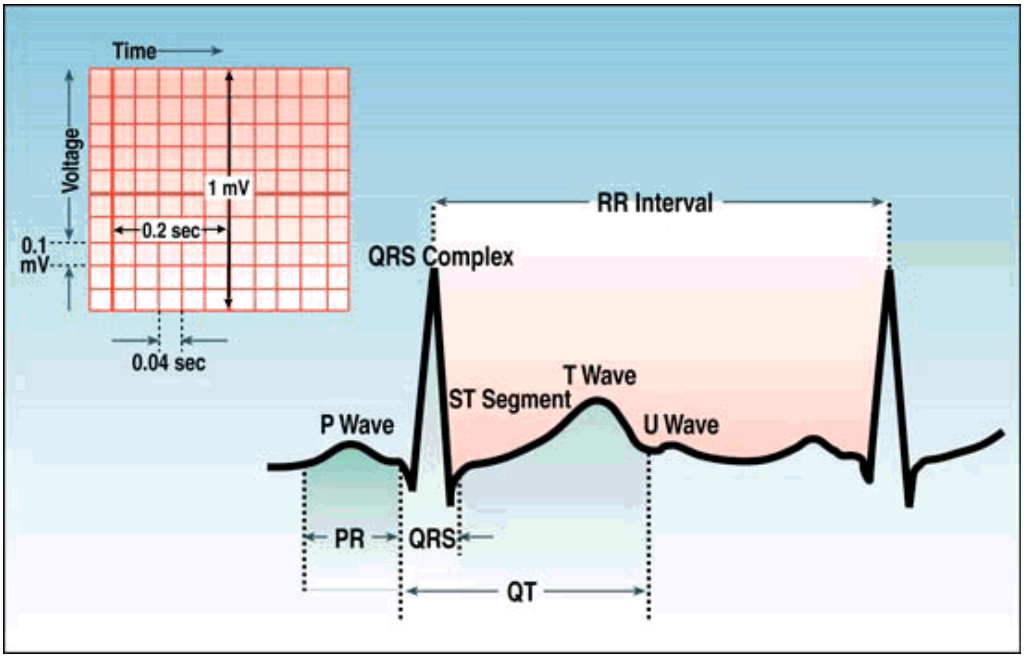
The rhythm originates from the SA Node because the SA node depolarizes more frequently (60-100 beats per minute) than the AV node (40-60 beats per minute) and ventricular conducting system (30-40 beats per minute) so the AV node and ventricular conducting system are 'captured' by the sinus impulse and driven at 60-100 beat per minute.

The Electrocardiography Machine.

The small currents from the cardiac conduction system are recorded by the electrocardiography, an instrument that is a basic galvanometer.
Electrical disturbance produce a deflection of a writing device, thus converting electrical energy into mechanical activity. The electrical energy is amplified to provide a large enough implementation of the writer, (stylus) to be readable. These deflections are recorded on graph paper that moves at a constant speed against the writer (stylus) so as to record all deflections as a coordinated of time.

Each deflection on the electrocardiograph represents the summation of all the action potentials of all the cells of the heart at that particular instant.

Standard Paper speed (moves at 25mm/sec)
Standard Voltage setting (10mm or 1mV)



The machine receives electrical impulses from the body, which are recorded in the form of a line tracing on graph paper. The ECG machine can be either manual machine or an automatic mode machine.

Manual Single channel ECG machine
– the technician has to select each lead and push to start and end the recording as well as move the chest electrodes to the different sites on the chest.

Automatic 3 channel ECG machine
- the technician hooks up all electrodes at once and pushed an auto record button, the machine then selects, records and marks each lead and prints out on one sheet of paper.
TYPES OF ELECTRODES:

Disposable electrode - usually have a hypoallergenic adhesive, a sensing element and a tab so an alligator clip can be attached or a pre-attached lead wire
Metal electrode - made up of a sensing element of silver/silver chloride.
Welch cups - (metal cups with rubber ball)- has the metal electrode (as above) with a rubber ball
With metal electrodes one needs to use a conduction gel with them.

ELECTRODE PLACEMENT

The standard 12-Lead ECG is a collect of tracings of electrical activity occurring in the heart. Each lead provides a tracing, which is characteristic of a different view of the same electrical activity. Other words we take 12 different angles (pictures) of the same activity.

In a standard 12-lead ECG there are 6 limb leads with a *three-electrode* connection made to the *Right arm, Left arm and Left leg.* The right leg is also hooked up to the machine but this is your ground lead and does not generate a signal on the ECG.

LIMB LEADS:

The limb electrodes are colour-coded as well as lettered.

From these three electrode sites we produce *6 Limb Lead*s are as follows:
3 standard limb leads (bipolar leads)– Lead I (ra & la) Lead II (ra & ll) and
Lead III (la & ll)
3 augment leads (unipolar leads)– AVr, AVl and AVf

This is the AHA configuration, which is used mostly in North America.

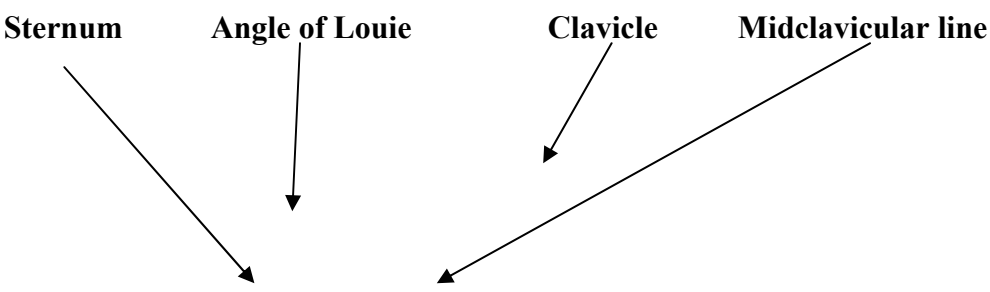
White --------right arm -------RA
Black --------left arm ---------LA
Red ---------left leg -----------LL
Green-------right leg----------RL

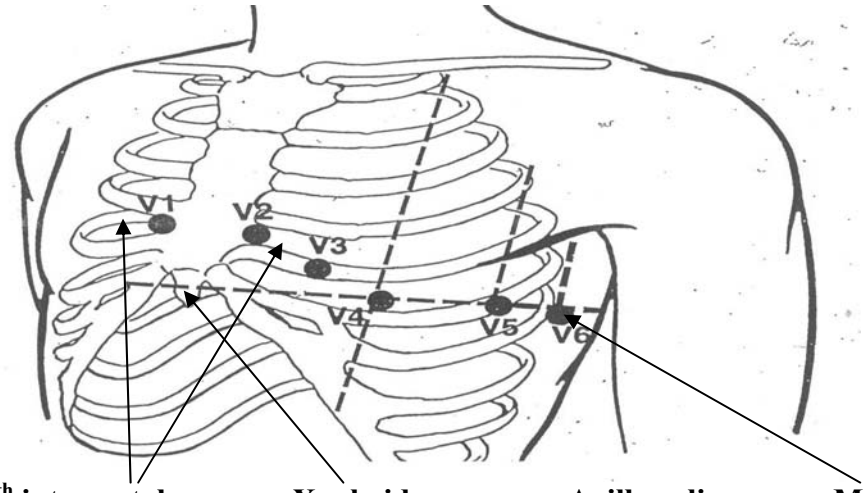
All limb electrodes are placed on the fleshy part of the arm from the hand to the shoulder, making sure to place right arm and left arm in same area. The leg electrodes are usually placed on the fleshy part of the calf, but can go any where from the foot to the hip.

The electrodes will either be a disposable electrode or a metal electrode that is help in place with either a strap of clip. If using a strap or clip they should not bit into the flesh or crease (pinch) the skin. Gel (conduction cream) is used on the metal electrodes.
The wires joining the electrodes to the ECG machine (patient cable) should each run straight to the main connector without kinking or being caught on the patient's body or the bedclothes. This may cause damage to the wire connections or artefact may appear on the tracing.

CHEST ELECTRODES:

The chest electrodes are labelled "V" and are numbered from 1 to 6.
The placement of these electrodes needs to be exact to give the optimum information as possible. If the electrodes are placed incorrectly on the chest, the tracing will reveal duplication of some information, while other areas will not be represented properly.
<u>*Incorrect placement of the electrodes can lead to serious errors of interpretation*</u>.





4th intercostals space Xyphoid process Axillary line Midaxillary line

<u>*Correct placement of the chest leads is critical*</u>. Be sure to study the above picture carefully.
Practice finding the fourth intercostals space on yourself, and volunteers.

There are six chest leads: V1, V2,V3,V4, V5 and V6.
V1 at the fourth intercostal space, at the right margin of the sternum
V2 at the fourth intercostal space, at the left margin of the sternum
V3 midway between the position of leads V2 and V4 (in a straight line)
V4 at the fifth intercostals space at the junction of the left midclavicular line
V5 midway between the position of leads V4 and V6 (straight down from the axillary Line on the same horizontal position as V4 and V6
V6 at the horizontal position of V4, at the left of the midaxillary line.

Note the first two chest leads sense mostly the right ventricle and the right atrium. The other four chest leads, being situated directly over the left ventricle (which has the largest muscle mass).
A standard must be produced on each lead tracing- this is done automatically on the 3-channel ECG machines. On the manual machine the technician will have to do this manually.
Sensitivity should always be at 10mm/mV
Speed should always be at 25mm/sec. unless directed differently by a physician.

RECORDING PROCEDURE:

Operation Check
Before operating an ECG machine, please review the Operator's Guide for any additional information specific to that machine.
Do an operation check on the ECG machine before the first ECG, once a day is sufficient for a machine in good running order.

Pre-reading ECG review

Check that the paper runs smoothly and that there is enough paper for a least one 12-lead ECG.
Check to see if machine is programmed for the correct speed and voltage.
Speed 25mm/sec gain (voltage) 10mm/1mV

Reference material:
1. Rapid Interpretation of ECGs – dale dubin m.d.
2. Eletrocardiography – mary boudreau conover
3. Kadish Et Al., Acc/Aha Clinical Competence Statement On Electrocardiography And Ambulatory Electrocardiography
J Am Coll Cardiol 2001;VOL:page-pageACC/AHA Clinical Competence Statement on Electrocardiography and Ambulatory Electrocardiograp III. Twelve-Lead Electrocardiogram
4.Web site: Learning Centre/spencer s. ecless