Practical 3

INVESTIGATIONS OF THE CARDIOVASCULAR SYSTEM IN MAN

1. Clinical Examination of the Heart

The time-honoured sequence of operations used in the clinical examination of any region or organ is **inspection, palpation, percussion** and **auscultation.** Put in more direct terms, you look at it, feel it, tap it, and finally listen to it (like a wrapped Christmas present). The heart is an ideal organ on which to practice this sequence, so persuade one of your group to strip to the waist and lie on the examination couch at an angle of about 45^{o}.

(i) Inspection.

Look at the chest; if the light is suitable you may be able to detect a rhythmical movement near the left nipple, corresponding with the heart beat. You may also be able to see arterial pulsations in the neck region.

(ii) Palpation

(a) Standing on the right side of the subject, place the pulps of the fingers of your right hand lightly on the chest wall over the heart (the precordium). You should be able to feel the pulsation of the heart. The furthest point downwards and laterally at which this can be felt is called the ***apex beat;*** mark this with a ball point pen, and work out its position with respect to intercostal space and the mid-clavicular line.

(b) Place your right hand flat on the chest wall between the apex beat and the midline. With practice it is possible to make an assessment of the force of the heart's contraction (the cardiac impulse). In the resting healthy subject this is not very pronounced, but it is accentuated by exercise.

(iii) Percussion.

This is an important diagnostic technique which would you do well to master at an early stage. The procedure is to place the fingers of your left hand flat on the chest of the subject and strike the middle phalanx of the middle finger sharply with the tip of the middle finger of the right hand. The sound that is produced varies with the character of the structures that lie under the body wall. Try this technique on the right side of the chest, and work downwards until your hand is over the liver; you should be able to detect a change from resonant to dull in the percussion note. Then try to map out the outline of the heart and mark it on the skin with a pen.

(iv) Auscultation

Auscultation is a difficult technique, but it is of enormous importance and you should practice as much as possible. Stethoscopes vary in design, especially the form of the chest piece. There are two types: the bell, which is particularly good for lower-pitched sounds provided that it is applied lightly to the chest wall, and the diaphragm, which gives a greater overall sound intensity but emphasises the high-pitched sounds in particular. Many people find this the most useful for all purposes at first, but when their discrimination of the sounds is a particular persons conversation in a crowded room where many people may be in conversation simultaneously. The art of doing this must be acquired by practice.

There are two important heart sounds: the first ('LUBB') is associated with

closing of the artrio-ventricular valves and the early part of ventricular contraction, and the second ('DUPP') is produced by closure of the pulmonary and aortic valves. The relative contribution of the valves to the sounds that are heard varies with the listening position, and selected areas are used for each. These areas do not correspond necessarily with the surface marking of the valve; they are simply the places in which the particular valve can be heard more distinctly.

Pulmonary area	-	2nd left intercostal space, close to midline
Aortic area	-	second right intercostal space, close to midline
Tricuspid area	-	bottom of sternum
Mitral area	-	at the apex beat

Listen to these areas and note the difference in intensity and quality of the sounds that are heard. Note the time interval between the 1st and 2nd sounds of a cardiac cycle and between the 2nd sound of one cycle and the 1st sound of the next. Which of these intervals is longer?

Listen carefully over the pulmonary area to the 2nd heart sound (P2) and note the changes in this sound immediately after the subject completes a deep inspiration. The second sound appears to be composed of two separate sounds (splitting). How may this be explained?

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2. Arterial Blood Pressure And Pulse At Rest And In Muscular Exercise

Arterial blood pressure.

At each contraction of the heart (systole) blood is discharged into the arteries so that the pressure within them rises. The highest pressure caused by systole is called the systolic pressure. During diastole the blood continues to flow from the arteries into the capillary bed. The arterial pressure therefore falls and the lowest level reached in diastole is called the **diastolic pressure.** The average systolic pressure of a young adult is about 115 mm.Hg. and the diastolic pressure about 70mm. The difference between systolic and diastolic pressure is called the **pulse pressure**.

Arterial blood is measured in man by indirect manometry using the *sphygmomanometer*. (1) The cuff or armlet is a rectangular rubber bag covered by cloth and connected to a long band of cloth so that it can be wrapped around the arm. The bag should be at least 10 cm. wide (for an adult) and long enough to encircle the upper arm. There are two rubber tubes connected to the bag, one leading to a hand pump by which the bag can be inflated with air, the other can be connected to the mercury manometer. Make this connection, close the screw of the pump and inflate: note the distension of the bag and the rise of the mercury column: in the manometer. The manometer is graduated in mm. Hg., in divisions of 2 mm. Hg from 0-300. Open the screw to let out the air and detach the cuff from the manometer.

As the method requires listening to certain audible but weak sounds you would do well as a beginner to choose a quiet place.

The subject bares his right upper limb to the shoulder, sits near one corner of a

table and places the arm comfortably on the table. His upper arm should be roughly at the same level as his heart in order to avoid the effects of hydrostatic pressure. Sit opposite him. Wind the cuff neatly around the middle of his upper arm, the two tubes going astride the elbow. The winding should be free of gross creases in order to give uniform support to the bag. Tuck the tail end of the cloth into one of the folds so that the cuff stays in place.

Palpation method.

Feel the subject's radial pulse on the same side (right). Pump air into the bag, watching manometer and radial pulse. As long as the air pressure in the bag, and therefore the pressure on the artery, is less than the systolic pressure, blood would still pass the obstruction at each systole and the pulse would still be felt at the wrist. When the air pressure exceeds the systolic pressure, the obstruction cannot be overcome. Watch for the disappearance of the radial pulse. Does it vanish suddenly or gradually fade away?

Pump up by about 20mm. mercury more and then let out the air at moderate rate. Note the reading of the manometer when the pulse reappears; this is the systolic pressure (in the right brachial artery). Let out air rapidly and completely after this. It is not possible to determine the diastolic pressure by palpation method. We have assumed that the pressure of the air in the bag is transmitted across the soft tissues of the arm without loss so that a manometer reading 120 mm mercury means that the pressure on the brachial artery is 120 mm mercury and not more or less. This assumption may be taken as more or less correct, as the soft tissues behave like water - an incompressible fluid -- transmitting pressure in all directions, provided that (a) the muscles are relaxed (the arm rests on the table) (b) the cuff fits snugly but not so tightly as to exert pressure on the artery even before air is pumped in (c) there is only one bone in the part (thus the forearm is unsuitable as the two bones of the forearm shield the artery so that the pressure of the cuff is not fully transmitted to the arteries).

Auscultatory method.

Place the receiver (bell or diaphragm) of a stethoscope on the bend of the elbow at a point where the pulsations of the brachial artery can be felt. Pump up the mercury column to about 160 mm then release the air at a moderate rate. As long as the cuff pressure is above systolic, no blood passes the obstruction and no sounds are heard through the stethoscope. When it is just below systolic, a little blood is forced past the obstruction, giving rise to a series of taps in your ears. As the mercury falls more blood becomes murmurish. Later still, there is a rapid decline in the loudness and the sounds vanish. The point at which the sound disappears is the diastolic pressure. Repeat several times for practice's sake. To spare the subject much discomfort, do not keep the mercury column up for more than the minimum time necessary for your determination.

Effect of muscular exercise on arterial blood pressure (B.P) and pulse rate

The Harvard step test is a standard exercise test used in assessing physical fitness. It consists of stepping on and off a stool 20 ins. high at the rate of 30 cycles per minute. Each cycle consists of the following consequence. Right leg up, left leg up, right leg down, left leg down. The movements may be timed with a metronome.

Record resting (sitting) BP and pulse rate. The subject then performs the Harvard step test, with the cuff fixed, in place on his right upper arm. As soon as the exercise is over, the subject sits down, and pulse counting and blood pressure determinations commence.

Determine

(a) the number of pulse (or heart) beats during the first second, third... 10th periods of 30 seconds each after exercise.

(b) the BP (systolic and diastolic) at 1,2 and 3 minutes after exercise.

(c) pulse rate and BP at frequent intervals thereafter (e.g. 2-min. intervals until resting levels have been restored. Draw graphs showing the relation between time after exercise (abscissa) and pulse and blood pressure, as (ordinates).

Calculate the following exercise fitness indices:-

(a)

$$\frac{\textbf{Duration of exercise in seconds x 100}}{\textbf{Σ (pulse rate at 1,2 \& 3 min after exercise)}}$$

(b) Take the sum **S** of the number of pulse beats in the following periods.

(1) 1' to 1' 30"

(2) 2' to 2' 30"

(3) 4' to 4' 30"

$$\textbf{Fitness index} = \frac{\textbf{Duration of exercise in seconds x 100}}{\textbf{2S}}$$

Interpretation: Above 90, excellent
80 - 89, good
65 - 79, high average
55 - 64, low average
Below 55, poor.

(c) $\frac{\text{Duration of exercise in seconds x 100}}{\text{sum of systolic pressure at 1,2 and 3 min after exercise}}$

(Pressure in mm. of mercury). Average normal is about 80.