

CARDIOVASCULAR PRACTICALS 1. HEART SOUNDS

OBJECTIVES

1. To understand why the different heart sounds are produced.
2. To know the sites at which heart sounds are best recorded.
3. To recognize the value of phonocardiography.

HEART SOUNDS USING AN AUSCULTATORY METHOD

1. THE STETHOSCOPE

The stethoscope consists of:-

- a. earpieces
- b. rubber tubing – approximately 30cm in length with an internal diameter of 3mm and
- c. chestpieces – usually both diaphragm and bell.

The diaphragm can be used to listen to high frequency sounds and should be pressed very firmly against the chest wall. Both the first and second heart sounds are of high frequency. The bell, an older device, collects sounds from a smaller surface area and may be selected with confidence to listen to high frequency sounds. It is, however, also useful for more effective listening to low frequency sounds e.g., the third heart sound. The bell should be applied lightly against the chest wall.

Either the diaphragm or the bell can be chosen but not both simultaneously. A one-way valve system prevents sounds being transmitted by the bell when the diaphragm is being used and vice versa.

2. THE POSITION OF THE PATIENT

The heart should be auscultated when the patient is in:-

- a. the supine
- b. the left lateral and
- c. the sitting positions

3. CLINICAL METHODS

a. Inspection

Examine the chest wall carefully for any visible pulsation.

b. Palpation

Locate the apex beat.

The apex beat is the outermost and lowermost distinct cardiac pulsation

c. Auscultation

The following areas should be auscultated for both normal and abnormal (murmurs) sounds:-

- i. the mitral area – the site of the apex beat. This is found in the 5th left intercostal space, approximately 1cm inside the mid-clavicular line and 9cm from the mid-line.
- ii. the pulmonary area. This is found in the 2nd left intercostal space at the sternal border.
- iii. the aortic area. This is found in the 2nd right intercostal space at the sternal border.
- iv. the tricuspid area which lies just to the left of the lower sternum.

HEART SOUNDS USING PHONOCARDIOGRAPHY

Phonocardiography is the sensitive technique by which a record can be made of all four heart sounds. The following steps (which will be demonstrated) are taken to produce a phonocardiogram (PCG).

1. A transducer is placed on specific areas of auscultation.
2. Standard limb leads are connected to the subject so that an ECG can simultaneously be recorded.

HEART SOUNDS PRERECORDED ON TAPE

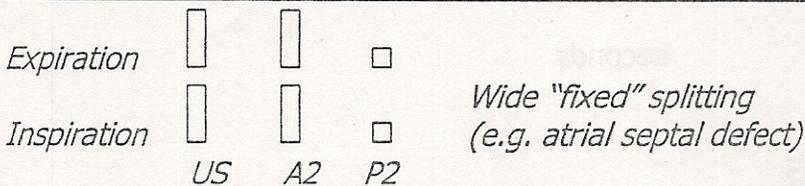
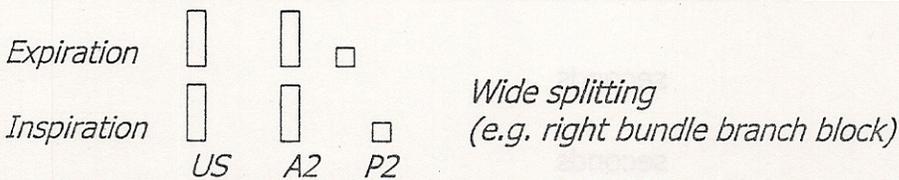
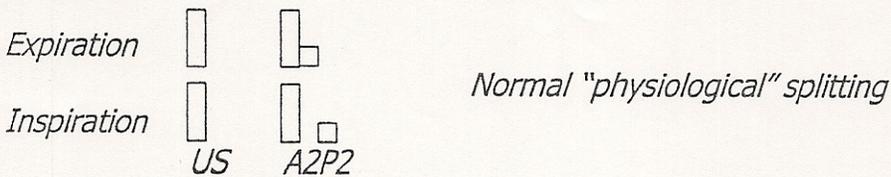
Tape recordings have been made of the normal and some of the abnormal heart sounds that medical students are likely to come across during their preclinical and clinical courses. These include:-

- a. normal heart sounds, including their splitting*,
- b. several systolic and diastolic murmurs.

*Splitting of heart sounds

If either the first or second heart sound has two distinct components they are said to be split. Such splitting can be recorded more frequently of the second heart sound. Indeed, second heart sound splitting is a normal physiological phenomenon, especially during inspiration.

Variations of the second heart sound. US = unsplit 1st, A2 and P2 = aortic and pulmonary components.



Abnormal heart sounds (cardiac murmurs)

Murmurs are caused by:-

- (a) diseases that cause structural damage to the heart valves and/or
- (b) haemodynamic changes e.g. increased blood flow velocity, altered resistance or decreased blood viscosity.

Heart murmurs are classified as systolic, diastolic or continuous.

1. Systolic murmurs occur between the first and second heart sounds. These can be subdivided into:-
 - i. Pansystolic, in which the murmur occurs during the whole of systole e.g. in patients with mitral regurgitation or with ventricular septal defects.
 - ii. Early systolic – rare.
 - iii. Mid-systolic or ejection systolic e.g. aortic stenosis.
 - iv. Late systolic e.g. mitral valve prolapse.
2. Diastolic murmurs occur between the second and first heart sounds. Examples of these are:-
 - i. Early diastolic e.g. aortic regurgitation.
 - ii. Mid-diastolic e.g. mitral stenosis.
3. Continuous murmurs occur in both the systolic and diastolic periods e.g. the machinery murmur resulting from a patent ductus arteriosus.

6. What is a thrill?

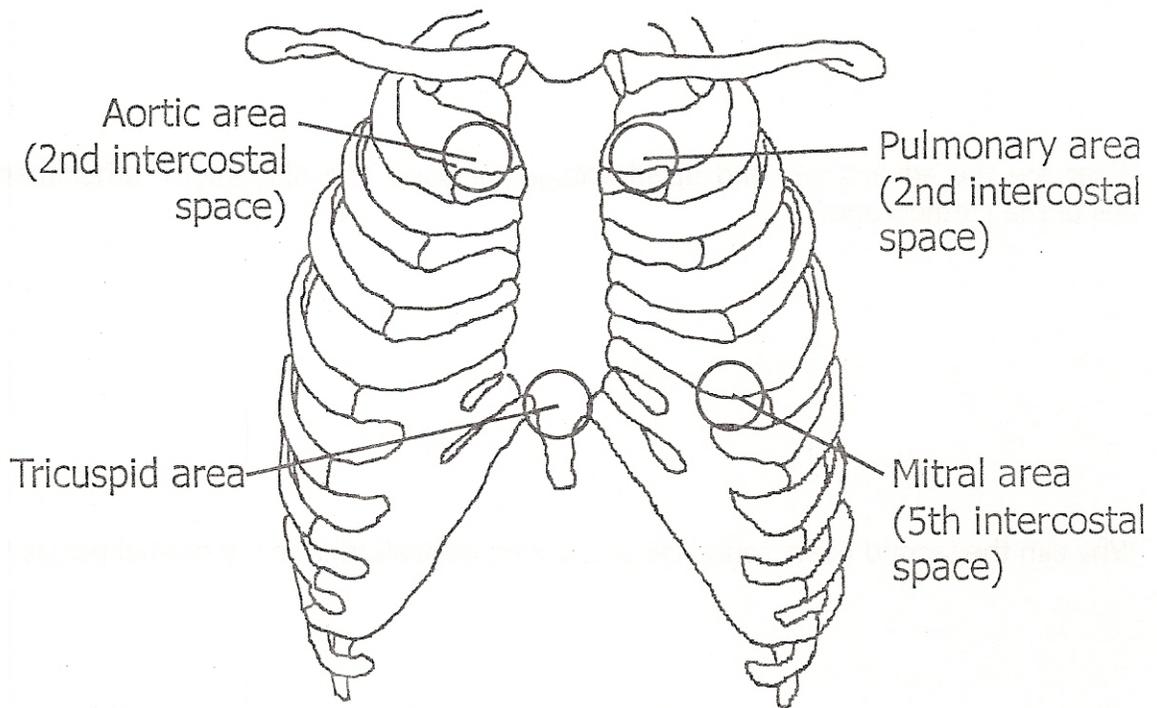
7. Why should the heart be listened to with the subject or patient in several different positions?

8. What are the advantages and disadvantages of using the diaphragm rather than the bell of the stethoscope?

9. Why can the second heart sound be split during inspiration in many normal people?

10. Under what circumstances might the first heart sound be split?

STETHOSCOPE POSITIONS FOR LISTENING TO NORMAL HEART SOUNDS



CARDIOVASCULAR PRACTICALS

3. THE ELECTROCARDIOGRAM (ECG)

OBJECTIVE

To understand and record normal electrocardiograms.

EQUIPMENT AND METHODS

1. ECG PAPER

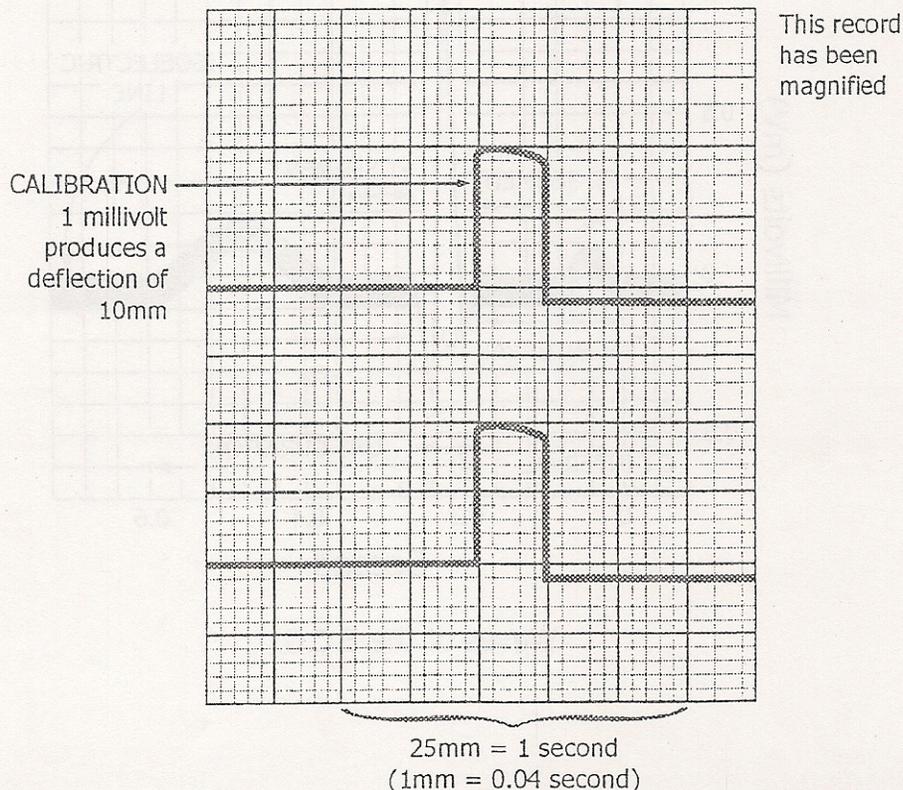
The ECG is recorded on graphic paper and the lines are 1mm apart. On the vertical axis changes of voltage are recorded while on the horizontal axis time is measured in seconds. The standard paper speed is 25mm/second. Therefore 1mm represents 0.04 seconds.

2. BEFORE RECORDING

The subject should be supine and relaxed. The temperature of the room should be neither too hot nor too cold i.e. it should be comfortable (neutral). Sweating and muscle movements should be avoided so as to minimize artifacts.

3. CALIBRATION OF THE ELECTROCARDIOGRAPH

Before an ECG recording is made, calibration of the electrocardiogram is essential. The standard calibration is:- 1 millivolt = 10mm



Chest leads

V1 – Right sternal border, 4th intercostal space.

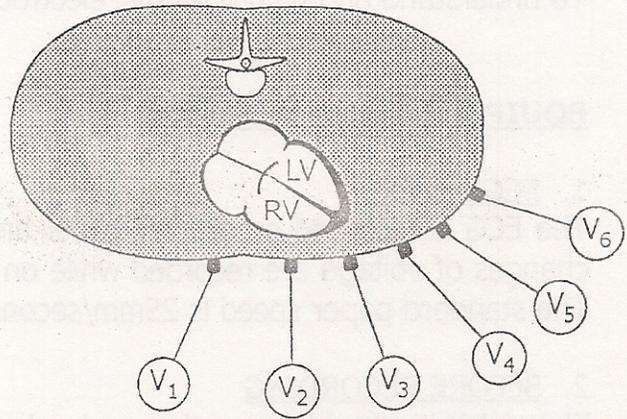
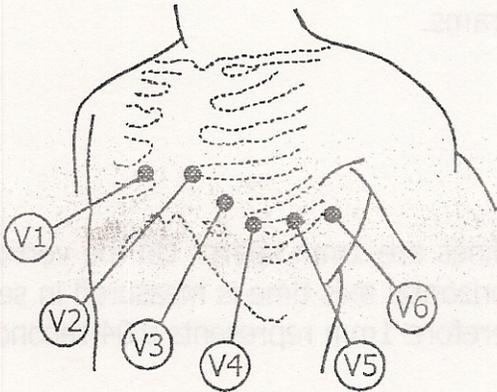
V2 – Left sternal border, 4th intercostal space.

V3 – Halfway between leads V2 and V4.

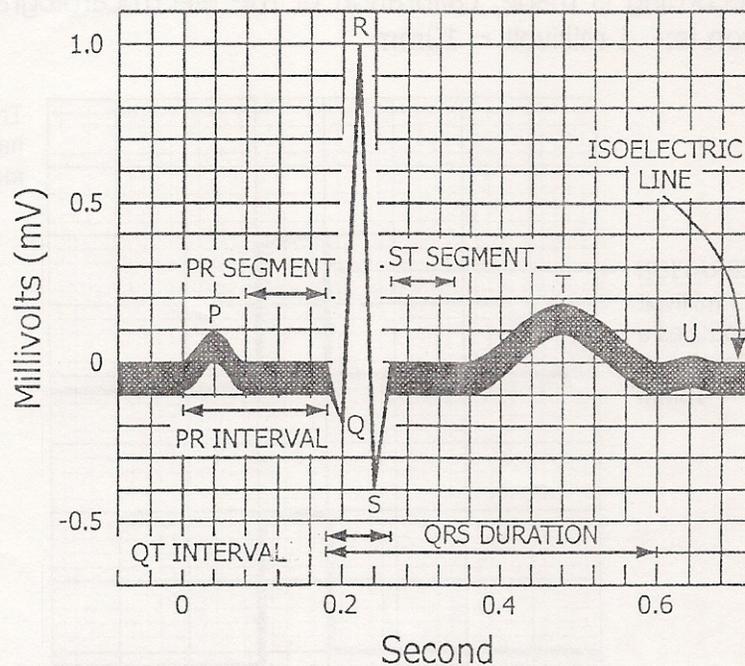
V4 – Left mid-clavicular line, 5th intercostal space.

V5 – Anterior axillary line, 5th intercostal space.

V6 – Mid-axillary line, 5th intercostal space.



THE 6 CHEST LEADS. LOOK AT THE HEART IN THE HORIZONTAL PLATE – FROM THE FRONT AND THE LEFT SIDE



Waves of the E.C.G.

Carefully label the records collected for P, Q, R, S and T waves.

QUESTIONS AND PROBLEMS

1. Calculate the heart rate.

$$\text{Heart rate} = \frac{1500}{\text{the R-R interval}}$$

Where:-

Heart rate is measured in beats per minute

The R-R interval = the distance between 2 R waves in mm.

1500 = the length (in mm) of the E.C.G. record when the paper speed is 25mm/second (60 x 25)

2. Is the rhythm of the heart regular or irregular? Are there any changes occurring during respiration in these records?

3. Calculate the cardiac axis.

There are many ways to determine the axis of the heart. Two methods will be considered in this practical session.

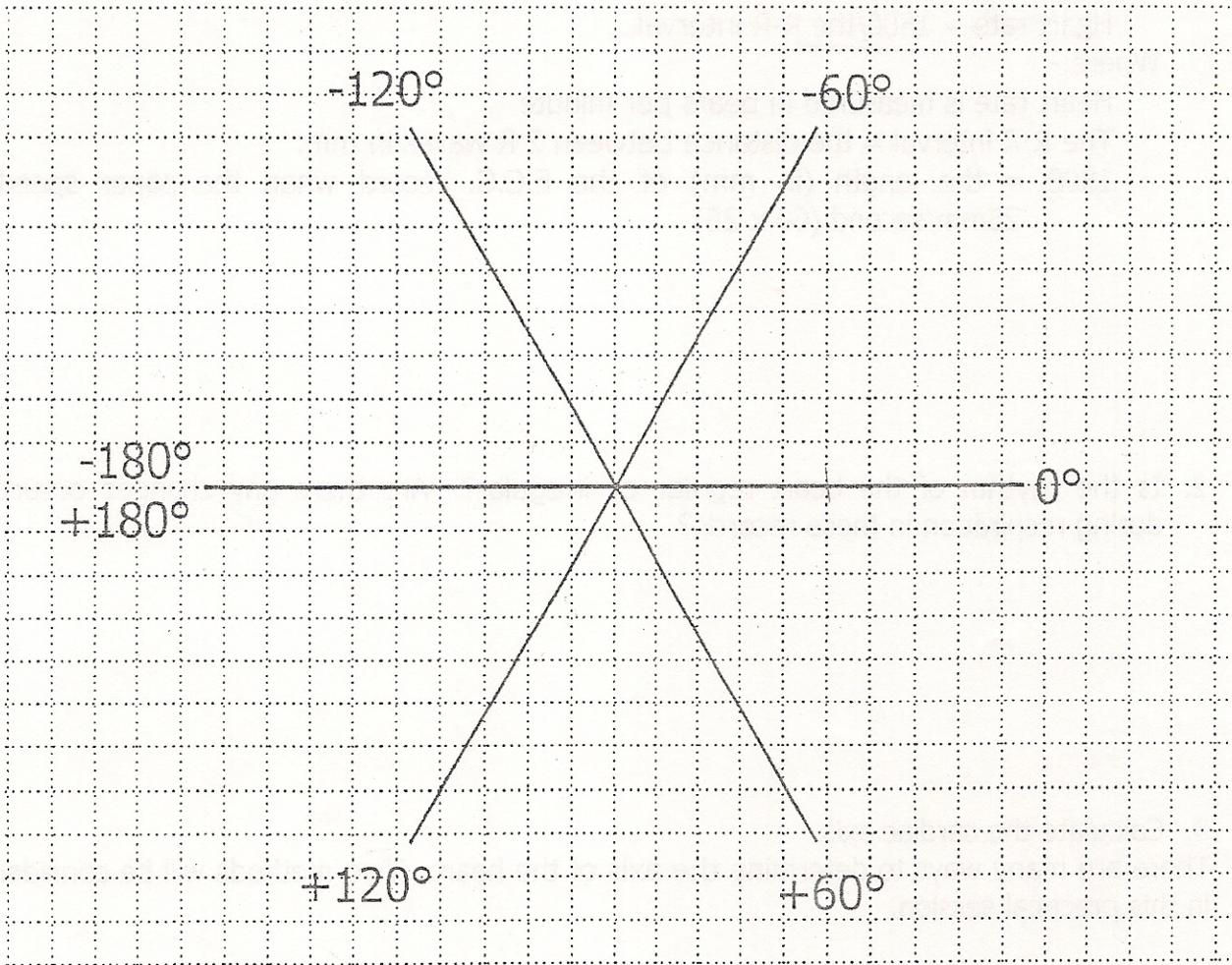
Method No. 1

This can be done quickly. Study the accompanying figures. Look at the direction of the major deflection in lead I and in lead III.

If they are going in the same direction (i.e., upwards) then this is a normal axis.

If they are going in the opposite direction (i.e., away) then this is indicative of left axis deviation.

If they are going towards one another (i.e., meeting) then this is indicative of right axis deviation.



CARDIAC AXIS OF _____

4. Comment on:-

(a) The R wave of lead II. How does it compare with that recorded with lead I and III and the augmented leads?

(b) The waves recorded with lead aVR.

(c) The changes in the R and S waves from V1 to V6.

5. Calculate the following (using lead II):-

At rest

After exercise

(a) PR interval _____

(b) QT interval _____

(c) QRS duration _____

(d) ST segment _____

(Note the shapes of the P, Q and T waves)

Normal values (in seconds)

	Average	Range
PR interval*	0.18**	0.12 – 0.20
QRS duration	0.08	To 0.10
QT interval	0.40	To 0.43
ST interval (QT – QRS)	0.32	

*Measured from the beginning of the P wave to the beginning of the QRS complex.

**Shortens as the heart rate increases from 0.18 seconds at 70 bpm to 0.14 at 130 bpm.

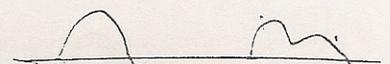
6. What events are occurring in the heart during:-

(a) The PR interval?

(b) The QRS duration?

(c) The ST interval?

7. E.C.G. recordings have been taken in which a U wave is observed. What is the U wave? What is its significance?



CARDIOVASCULAR PRACTICALS 3. THE RECORDING OF JUGULAR VENOUS AND CAROTID ARTERIAL PULSES

OBJECTIVES

To be able to:-

- (a) identify
- (b) understand the events causing the different waves of the jugular venous and carotid pulse tracings.

A. THE CAROTID ARTERIAL PULSE

METHOD

- (a) The subject is asked to lie quietly on a couch.
- (b) Feel the carotid arterial pulse* on the medial side of the sternomastoid muscle.
- (c) Apply the transducer over the carotid artery using a soft rubber band and connect it to the recorder.

*Note

When blood is forced into the aorta during ventricular systole two things happen:-

1. Blood is moved forwards.
2. A pressure wave is set up which travels along the wall of arteries (faster than the flow of blood). The pressure wave expands the arterial walls as it travels. The expansion of the arterial wall is palpable as the pulse.

B. THE JUGULAR VENOUS PULSE

METHOD

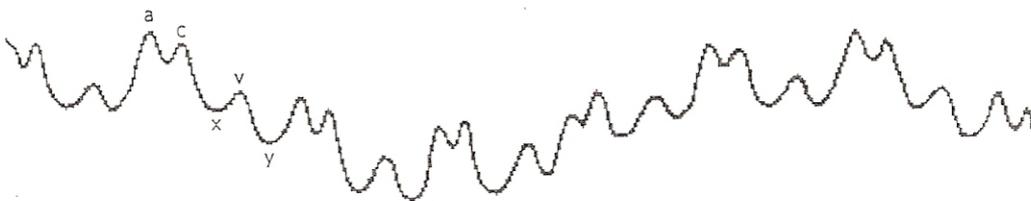
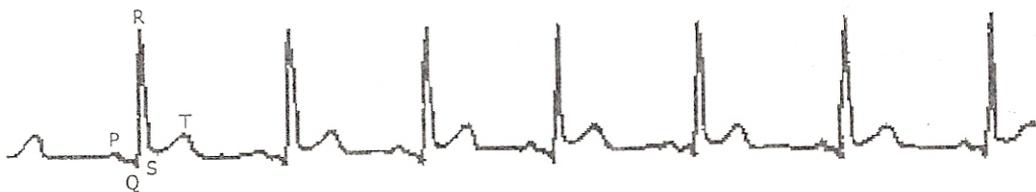
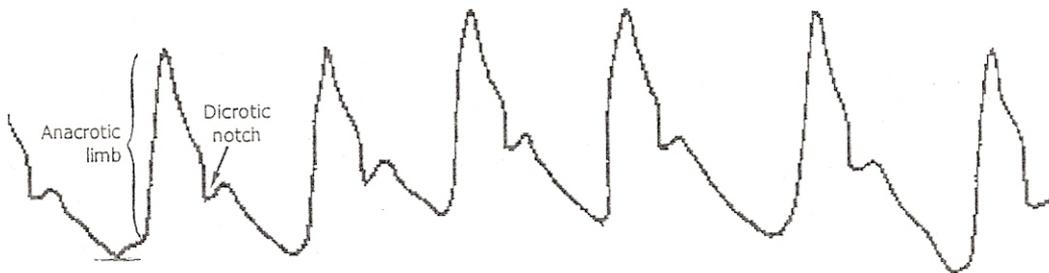
- (a) The subject is asked to perform a Valsalva manoeuvre (a deep inspiration followed by a forced expiration against a closed glottis). As a result the internal jugular vein becomes prominent.
- (b) Choose a position on the internal jugular vein* away from the carotid artery.
- (c) Place the pulse transducer over the vein and keep it in position with a self adhesive plaster.
- (d) Connect to the recorder.

*Note

Pressure changes in the right atrium can be recorded from the internal jugular vein as there are no valves between this vein and the right atrium. The external jugular vein cannot be relied upon because this vessel:

- a. has valves, and
- b. may be obstructed by the fascial and muscular layers through which it passes.

The following tracings of the carotid artery and jugular venous pulses are presented to provide an opportunity to practice identifying the different waves.



Results

Subject:

Date:

A. Carefully label the different waves of the carotid arterial pulse tracing recorded.

B. Carefully label the different waves of the jugular venous pulse tracing. N.B. First of all identify a 'v' wave. An 'x' descent and a 'y' descent are to be found on either side of a 'v' wave. The 'a' and 'c' waves precede the 'x' descent.

QUESTIONS AND PROBLEMS

1. What is the significance of:-
 - a) the anacrotic limb?

 - b) the dicrotic notch?

 - c) the dicrotic limb?

2. Determine the duration of ventricular systole from the arterial pulse tracing.

3. What is the arterial blood pressure likely to be at the start and the peak of the carotid arterial pulse tracing?

4. What information can be obtained from an examination of the arterial pulse?

5. What are the causes of:-
 - a) the 'a' wave

 - b) the 'c' wave

 - c) the 'v' wave

 - d) the 'x' wave

 - e) the 'y' wave

6. What are the causes of:-
 - a) prominent 'a' and 'c' waves?

 - b) the absence of 'a' waves?

CARDIOVASCULAR PRACTICALS

4. ARTERIAL BLOOD PRESSURE

OBJECTIVES

1. To be able to measure arterial blood pressure using a sphygmomanometer.
2. To recognize the effects of (a) gravity and (b) muscular exercise on the arterial blood pressure.

EQUIPMENT AND METHODS

1. EQUIPMENT

- (a) A stethoscope
- (b) A sphygmomanometer
- (c) A bicycle ergometer and/or a treadmill

2. METHODS FOR MEASURING ARTERIAL BLOOD PRESSURE

A. PALPATORY METHOD

This method only gives an estimate of the systolic blood pressure.

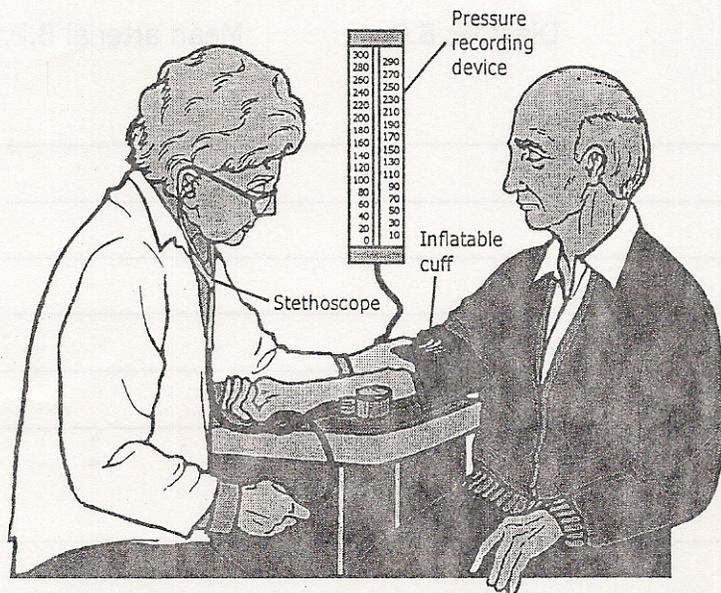
- (1) The subject's arm should be resting comfortably so that it does not need to be actively supported while the blood pressure is being taken.
- (2) A standard cuff* (12 x 24 cm) is applied like a bandage about 4cm above the elbow joint. Take care that the free margin of the cuff is not on the arterial course (brachial artery). It is important that the manometer should be at the same level as the heart. It should be in the vertical position. Check that there is an adequate amount of mercury in the bulb of the instrument. This can be done by seeing whether the mercury level is at the zero position of the manometer (A large cuff is recommended for obese subjects while a smaller one is available for use with children).
- (3) Inflate the cuff until the radial pulse cannot be felt. By compressing the brachial artery the pulse (or pressure wave) can no longer be transmitted to the radial artery.
- (4) Deflate the cuff slowly. Note the pressure at which the radial pulse can be felt for the first time. This is the systolic blood pressure.

B. AUSCULTATORY METHOD

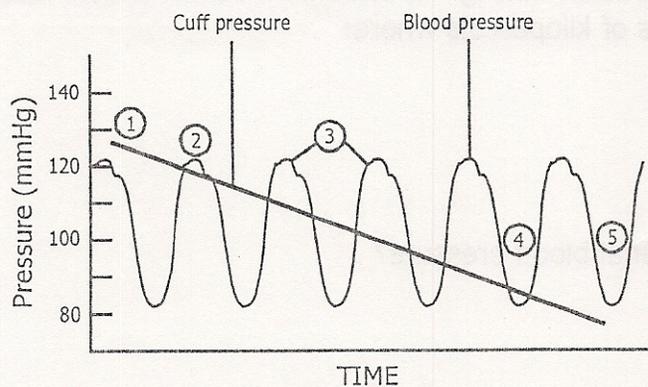
This method allows both systolic and diastolic blood pressure to be measured.

- (1) Inflate the sphygmomanometer cuff until there is no radial pulsation.
- (2) Place the diaphragm (or bell) of the stethoscope over the brachial artery just above and on the medial side of the elbow joint.
- (3) Deflate the cuff slowly. A series of sounds are usually heard. These are called the Korotkov sounds. They have been identified as follows:
 - Phase 1 The appearance of a clear tapping sound.
The pressure at which this is heard is the systolic arterial blood pressure.
 - Phase 2 A blowing or swishing sound.
 - Phase 3 The sounds become sharper and crisper.
 - Phase 4 An abrupt muffling of sound.
 - Phase 5 All sounds disappear.
The pressure at which sounds disappear is recorded as the diastolic arterial blood pressure.

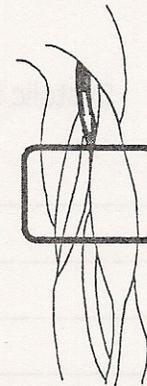
(A)



(B)



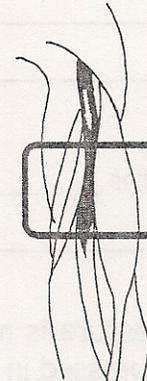
(C) When blood pressure is 120/80



Cuff pressure is greater than 120mmHg.

No blood flows through vessel.

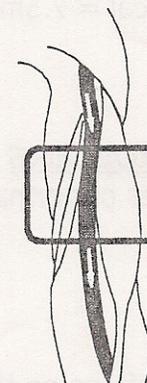
No sound is heard.



Cuff pressure is between 120 and 80mmHg.

Blood flows through vessel is turbulent whenever blood pressure exceeds cuff pressure.

Intermittent sounds are heard as blood pressure fluctuates throughout cardiac cycle.



Cuff pressure is less than 80mmHg.

Blood flows through vessel in smooth, laminar fashion.

No sound is heard.

THE AUSCULTATORY METHOD OF BLOOD PRESSURE MEASUREMENT

PROCEDURE

Practice these methods:-

- While the subject is resting in a supine position. Repeat each measurement at least three times to establish the reproducibility of the results.
- When the subject is resting in a sitting position.
- After about 10 minutes exercise on either a bicycle ergometer or a treadmill. Blood pressure should be determined both immediately and 5 minutes after the exercise.

RESULTS

Subject: _____

Date: _____

	Systolic B.P.	Diastolic B.P.	Mean arterial B.P.
<u>Effect of posture</u>			
Supine	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Sitting	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
<u>Effect of exercise</u>			
Immediately after	_____		
5 minutes after	_____		

N.B. Arterial blood pressure is measured in mmHg. It should be remembered that many other pressures are expressed in terms of kilopascals where:

$$1 \text{ kilopascal} = 7.5 \text{ mmHg}$$

QUESTIONS AND PROBLEMS

1. What are the ranges of normal arterial blood pressure?
2. What is the effect of age on the arterial blood pressure?
3. Explain how the Korotkov sounds are produced.

