Introduction to Medical Science
Laboratory Exercise 4a

Heart Rate and Blood Pressure - Part 1

Blood pressure

As we know from physics, each fluid exerts some pressure against the walls of the container, in which it is placed. Similarly, the blood flowing through the blood vessels affects their walls, exerting certain force. Blood flow is a dynamic process so the blood pressure is subjected to short-term changes. Depending on the phase it takes on different values. Consider a single cycle of the heart. When the heart contracts it pumps out a certain amount of blood. Blood is pumped into the arteries. During systole blood pressure rises to its maximum value, called the systolic pressure (SP). This phase lasts approx. 1/3 of the total cycle time. The remaining 2/3 of the time is left for diastole. In this stage heart relaxes, the blood flow slows down and blood pressure is reduced to its minimum value, i.e. diastolic pressure (DP). The reading of blood pressure to be 120/80 informs us about the values of systolic and diastolic pressure. It is usually measured in millimeters of mercury (mmHg). Blood pressure equal to 120/80 mmHg means that the patient's blood pressure during cardiac cycle oscillates between these values.

Blood pressure is also subjected to continuous long-term changes (which is affected by age and health condition), and med-term changes (depending on the time of day, patient's activity and mental state, or consumed stimulants). There are several types of blood pressure: systemic arterial pressure - systolic and diastolic, pulse pressure, mean arterial pressure, systemic venous pressure, pulmonary pressure. The most common type of blood pressure measured is systemic arterial pressure.

Blood pressure measurement

Systematic measurements of blood pressure are one of the basic methods of controlling the health state in cases of hypertension and other diseases of circulatory system. Measurements are often done according to Korotkov method using a medical sphygmomanometer and a stethoscope. Blood pressure can also be measured using semi-automatic methods, such as wrist pressure meters, more comfortable in domestic use. Blood pressure is measured at the brachial artery, which is the largest upper limb artery, providing it with arterial blood. Pressure measured at different points of the circulatory system usually takes different values. Correct pressure in the brachial artery is approx. 80 (60-80) mmHg in diastolic pressure and 120 (110-135) mmHg for systolic pressure.
The origins of blood pressure measurements are associated with two methods: Riva-Rocci method and Korotkov method.

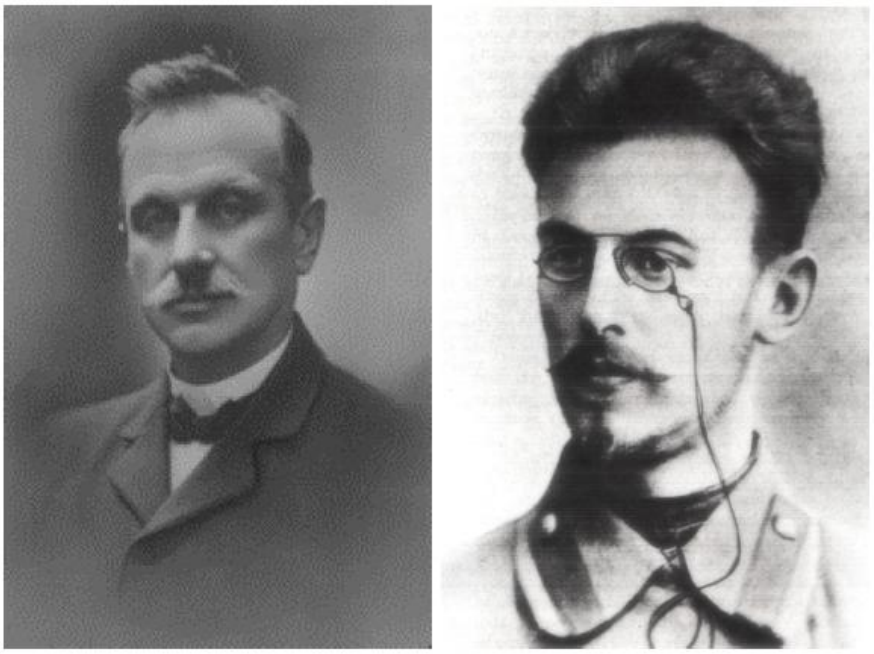

Figure 1
(a) Scipione Riva-Rocci, podiatrist and inventor of sphygmomanometer
(b) Nikolai Korotkov, modified Riva-Rocci method by adding auscultation of heart rate

Riva-Rocci method

Scipione Riva-Rocci invented sphygmomanometer - the device for indirect measurement of arterial pressure. This device consists of a pressure gauge (eg. mercurial, spring or electronic), air pump, the cuff with air chamber and a valve for deflating the cuff.

Figure 2
(a) mercurial sphygmomanometer
(b) electronic wrist sphygmomanometer

Riva-Rocci method was introduced in 1896. The procedure is as follows: the sphygmomanometer is put on the arm. With one hand the patient has to pump air to the cuff, while the other hand is used to monitor the pulse on the radial artery. The cuff is filled with air up to the value about 20 mmHg above the pressure at which the pulse is no longer perceptible, and then the air is slowly released from the cuff. The force produced by the cuff as a result of transmural pressure closes the artery. The value of systolic pressure value is the

one corresponding to the pressure at which the pulse is again perceptible – the start of turbulent blood flow (Figure 3).

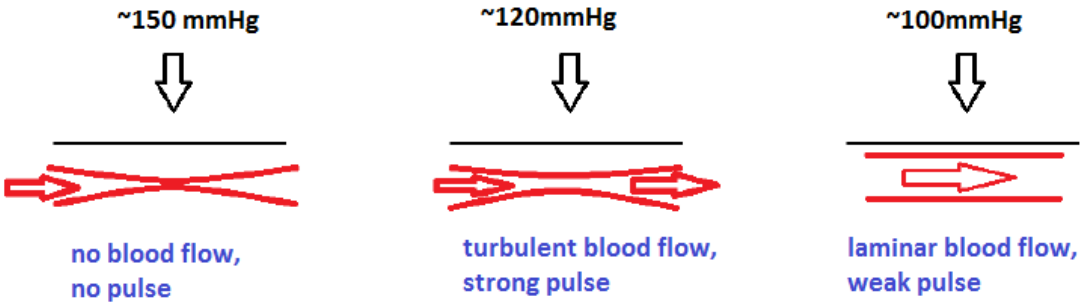

Figure 3

Korotkov method

Russian surgeon Nikolai Korotkov introduced a modification of Riva-Rocci method in 1905. The steps are as follows:

- Pump up the air to sphygmomanometer until the pulse is no longer perceptible
- Continue increasing the pressure in the sphygmomanometer by 20mmHg
- Slowly deflate the cuff of sphygmomanometer – 2mmHg/sec.
- Listen to the sounds of heart beat using the stethoscope
- Write down the pressure value for which the sound of the heart beat becomes audible (perceptible) – systolic pressure – 1st Korotkov phase
- Write down the pressure value for which the sound of the heart beat is no longer audible – diastolic pressure – 5th Korotkov phase
- Deflate the sphygmomanometer cuff
- Write down the result of blood pressure measurement

There are five Korotkoff sounds:

- Phase I—The first appearance of faint, repetitive, clear tapping sounds which gradually increase in intensity for at least two consecutive beats is the systolic blood pressure.
- Phase II—A brief period may follow during which the sounds soften and acquire a swishing quality.
- Phase III—The return of sharper sounds, which become crisper to regain, or even exceed, the intensity of phase I sounds.
- Phase IV—The distinct abrupt muffling of sounds, which become soft and blowing in quality.
- Phase V—The point at which all sounds finally disappear completely is the diastolic pressure.

OBJECTIVES

In this experiment, you will:

- Learn about the methods of measuring heart rate and blood pressure.
- Determine the blood pressure using 3 different methods.
- Correlate the values of blood pressure with physical effort.

MATERIALS

- LabQuest 2 interface
- Vernier Blood Pressure Sensor
- Manual sphygmomanometer with stethoscope

PROCEDURE

Repeat measurements for all members of the group.

1. Measure blood pressure using Riva-Rocci method. The subject should sit still and be relaxed. Write down the results and observations in Table 1.
2. Measure blood pressure using Korotkov method. The subject should sit still and be relaxed. Write down the results and observations in Table 1.
3. Connect the Blood Pressure Sensor to Channel 1 of the Vernier LabQuest2 interface.
4. Attach the Blood Pressure Sensor to the blood pressure cuff if it is not already attached. There are two rubber tubes connected to the cuff. One tube has a black Luer-lock connector at the end and the other tube has a bulb pump attached. Connect the Luer-lock connector to the stem on the Blood pressure Sensor with a gentle half turn.
5. Attach the Blood Pressure cuff to the upper arm, approximately 2 cm above the elbow. The two rubber hoses from the cuff should be positioned over the biceps muscle (brachial artery) and not under the arm (see Figure 2).

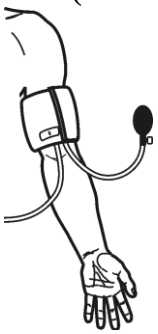

Figure 2

6. The subject should sit quietly in a chair and avoid moving his or her arm or hand during blood pressure measurements.
7. Click ► to begin data collection. Immediately begin to pump until the cuff pressure reaches at least 160 mm Hg. Stop pumping.
8. During this time the systolic, diastolic, and mean arterial pressures will be calculated by the software. These values will be displayed on the computer screen. When the blood pressure readings have stabilized (after the pressure drops to 50 mm Hg), the program will stop calculating blood pressure. At this point, you can terminate data collection by clicking ■. Release the pressure from the cuff, but do not remove it.
9. Enter the values of systolic and diastolic pressures and your observations in Table 1.
10. Using arbitrary method measure blood pressure after 2 minutes of exercising. Repeat measurements 4 times with 1 minute breaks. Enter the values to Table 2.

DATA

Table 1 - Baseline Blood Pressure

	Riva-Rocci metohod (value and comments)	Korotkov metod (value and comments)	Electronic sphygmomanometer (LabQuest2) (value and comments)
Subject 1			
Subject 2			
Subject 3			
Subject 4			
Subject 5			

Table 2 - Blood Pressure after Exercise

	Blood pressure				
	1st	**2nd**	**3rd**	**4th**	**5th**
Subject 1					
Subject 2					
Subject 3					
Subject 4					
Subject 5					

DATA ANALYSIS AND CONTROLL QUESTIONS

1. Is the blood pressure constant in time?

2. What will be the values (general trend) of blood pressure measured at different point of the circulatory system?

3. What is the difference between Riva-Rocci and Korotkov methods?

4. Discuss the results obtained for measurements of blood pressure using different methods.

5. Discuss the results of blood pressure values measured after physical effort.