LABORATORY WORK № 7

STUDYING THE WORK OF THE ELECTROCARDIOGRAPH

PURPOSE OF THE WORK:

1. Study of the theoretical foundations of electrocardiography.
2. Study of the principle of operation and the device of the electrocardiograph.
3. Learning to use the cardiograph.
4. Removing an electrocardiogram and determining its main characteristics.

EQUIPMENT:

Electrocardiograph, electrodes, gauze pads, saline.

In laboratory work, a single-channel electrocardiograph with thermal recording is used to record an electrocardiogram. The block diagram of the device is shown in Fig. 1. Bioelectric signals from the electrodes through the lead cable and switch 1 are fed to the input of the amplification unit 2. From the amplifier, the signal is fed to the electromechanical transducer 3, where the electrical signal is converted into movement of the heat pen. With the help of the tape drive mechanism 4, the heat-sensitive paper moves, an electrocardiogram is recorded on it.

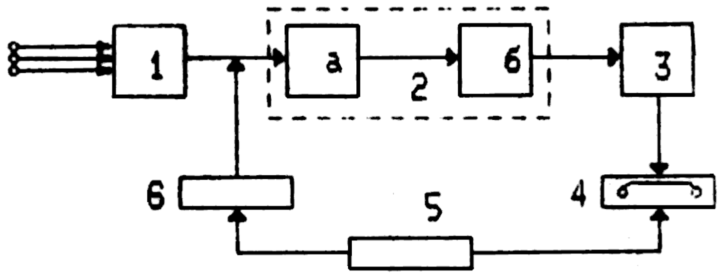

Fig 1. Block diagram of the electrocardiograph (1 - lead switch, 2 - voltage (a) and power (b) amplifier, 3 - electromechanical converter, 4 - tape drive mechanism, 5 - power supply, 6 - calibration voltage source).

To take an EKG, electrodes are applied according to the system of standard leads to the inner surfaces of the forearms and lower legs. Gauze pads moistened with saline are placed under the electrodes. The wires of the cable are connected as follows: red to the electrode on the right hand, yellow to the left hand, green to the left leg, black to the right leg.

Electrodes are specially shaped conductors connecting the measuring circuit with the biological system. In principle, the electrodes can be used both for picking up an electrical signal and for supplying an external electromagnetic effect. Certain requirements are imposed on the electrodes: they must be quickly fixed and removed, have high stability of electrical parameters, be durable, do not interfere, and do not irritate.

The electrodes are strengthened with rubber bandages or suction cups. By appointment, the electrodes for taking biomedical information are divided into four groups:

1) for short-term use,

2) for long-term use,

3) for use on mobile subjects,

4) for emergency use.

Depending on the research task, electrodes of various shapes and sizes can be used. For example, in physiological experiments, microelectrodes are used, the metal end of which has a diameter of the order of a few microns or less, or glass capillaries filled with a saline solution. In electrocardiography, plate-like surface electrodes made of non-metals are most often used. With the help of shielded wires, the electrical signal from the electrodes is fed to the lead switch at the input of the device, and then transmitted to the amplifier.

The specificity of biopotential amplifiers is determined by the following features:

a) biopotentials - weak signals,

b) biopotentials - signals that change relatively slowly over time,

c) the input impedance of the amplifier must be high enough.

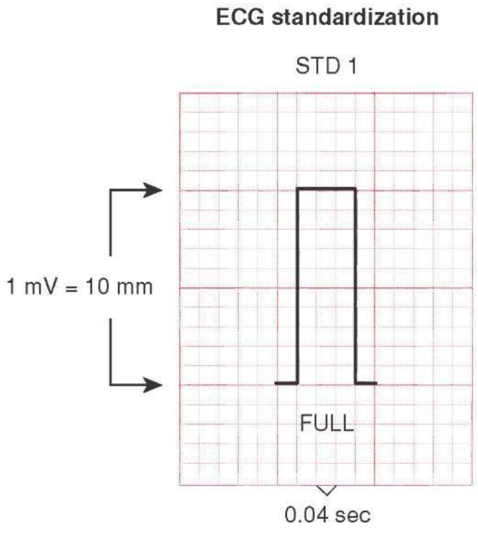

Fig. 2

Electrocardiographs contain a calibration signal source. This is a precisely calibrated voltage (1 mV), which is applied to the input of the amplifier and is recorded on the tape as a rectangular pulse.

Certain requirements are imposed on the recording devices, since they can also add additional distortion to the recording result. The recording device is usually based on an electromagnetic polarizing galvanometer or vibrator. The principle of the recording itself may be different.

The magnetoelectric vibrator has a powerful permanent magnet in the field of which there is a coil connected to the stylus. When a current is passed through the coil from the output stages of the amplifier, a magnetic field of the coil is created, which, interacting with the magnetic field of the permanent magnet, causes the coil to deviate from its original position. Vibrators of the electromagnetic system allow you to register oscillations in the range from 0 to 150 Hz.

There is a method of writing on thermal paper covered with a thin layer of a white waxy mass. The tip of the vibrator pen contains a heating element that, when moved, melts the outer layer and leaves a color mark on the paper.

WORK ORDER

1. Prepare the device for operation.
2. Connect the corresponding wires of the cardiograph to the electrodes:
   - red - to the right hand;
   - yellow - to the left hand;
   - green - to the left leg;
   - black - to the right leg.

Fig 3

3. Turn on the electrocardiograph and record the calibration signal and 4-8 heart cycles.

4. Determine the sensitivity of the electrocardiograph using the calibration signal

$$\mathbf{S} = \frac{h_K}{U_K} \text{ (mm/mV)},$$

where h_K is the height of the calibration pulse, U_K is the standard calibration voltage (for this electrocardiograph U_K=1mV).

5. Write down the speed of the tape drive in mm/s (12.5, 25 or 50 mm/s).

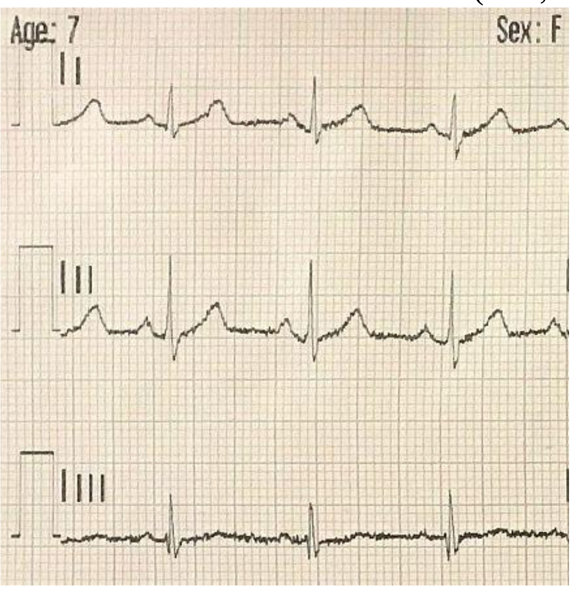

Fig 4

6. Measure for each lead the height **h** of the waves. Enter the results of measurements and calculations in the Table 1. Calculate the potential difference U corresponding to each tooth using the formula **U = h/S**. Enter the results in the table.

7. Measure for each lead the length of the L intervals in the leads. Enter the results of measurements and calculations in the Table 2. Calculate the duration of the intervals by the formula **t = L/v**, v is the speed of the tape of the recording device. Enter the results in the table.

Table 1

Wave height	Calibration impulse	P			R			S			T		
Norm, mV	1	0.1 - 0.2			0.5 - 2.0			up to 0.6			0.2 - 0.6		
h, mm													
U, mV	1												

Table 2

Time intervals		R-R '			PQ			QRS			QT		
Norm, s		0.8-1.1			up to 0.2			up to 0.1			0.35		
L, mm													
t, s													

8. Calculate heart rate per minute using the formula: $\mathbf{HR=60/t_{R-R'}}$

9. Compare the results with the norm, make a conclusion.

CONTROL QUESTIONS

1. What are the main blocks of the electrocardiograph? Draw a block diagram of the electrocardiograph.
2. How, using an electrocardiogram, to determine the value of the biopotentials of the heart at different moments of the cardiac cycle, the frequency of heartbeats (HR) and the position of the anatomical axis of the heart?
3. List the possible interferences that distort the EKG.
4. Formulate the requirements for electrodes.

SITUATIONAL TASKS

1. How will the distance between RR teeth and the time of one cardiac cycle change if the belt speed is increased from 25 mm/s to 50 mm/s?
2. Calculate the time interval between the RR teeth if the speed of the chart strip is 25 mm / s (Fig. 3).
3. Calculate the EMF of the R wave shown in Fig.3. In what units is the EMF measured?
4. Calculate the patient's heart rate if the speed of the chart tape is 25 mm / s (Fig. 4).
5. The electrocardiogram was recorded at a certain sensitivity of the electrocardiograph. Let the

sensitivity of the cardiograph be increased by 1.2 times. How will the heights of the teeth and EMF of the electrocardiogram teeth in the same lead of the same patient change compared to the original recording?

LITERATURE

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