METHOD OF SIMULTANEOUS RECORDING OF THE ELECTROGRAM AND MECHANOGRAM OF THE SPECIFIC MUSCLE OF THE VENTRICLES

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A method of simultaneous recording of the electrogram and mechanogram of the specific muscle of the left branch of the bundle of His of the rat's, rabbit's and dog's heart is described. A photoconductive cell responding to light of a focussed beam reflected from the contracting surface is used.

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The ability of the specific muscle of the heart to contract automatically was described as long ago as in the 1920s [6, 8, 9, 11].

The work of Smirnov and co-workers [1-4] showed that the specific muscle and myocardium are two distinct structures of the heart, interconnected through a functional synapse.

There is information in the literature on methods of recording potentials from the Keith–Flack and Aschoff–Tawara nodes and the bundle of His [7], and also the electrogram and mechanogram of a single muscle fiber [5, 10].

This paper describes a method of recording biopotentials and mechanical contractions of the specific muscle of the isolated heart of a warm-blooded animal, the intact heart being kept alive by perfusion.

Investigations were carried out on 40 animals (dogs, rabbits, rats). Under acute experimental conditions (morphine–urethane, urethane, or ether anesthesia) the heart was removed, the aorta cannulated, and coronary perfusion performed with Ringer–Locks solution (37-38°C) saturated with oxygen (full details of the method are given in Byull. Éksperim. Biol. i Med., No. 9, 1967).

Contractions of the specific muscle of the left branch of the bundle of His were studied. Cold arrest of the myocardium was produced (absence of ECG and mechanogram from the outer surface of the heart, visual control through a binocular loupe giving magnification of 12-15 ×). An incision was made in the wall of the ventricle over the interventricular septum, and contractions of the specific muscle of the left branch

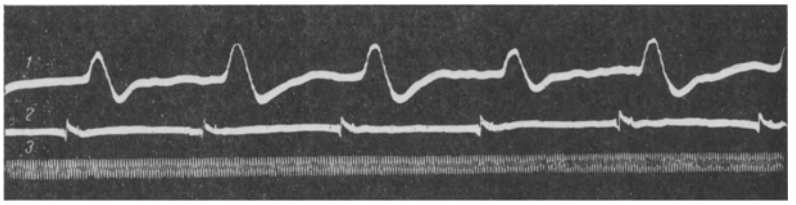

Fig. 1. Mechanogram and electrogram of isolated rabbit's heart (second day of survival). 1) mechanogram; 2) electrogram; 3) time marker (50 msec).

* The principle of the method was described by A. I. Smirnov at a plenary meeting of the staff of the Department of Medico-Biological Sciences of the AMN SSSR and Societies of Physiologists, Pathophysiologists, and Cardiologists on November 14, 1967.

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of the bundle of His examined under the loupe. Electrodes for recording the electrogram were inserted beneath the endocardium in the upper third of the branch, allowing for the anatomical arrangement of the fibers. The photoconductive cell for recording the mechanogram was placed above the zone of contracting surface of the branch from which the potentials were recorded. Simultaneous recording of the electrogram and mechanogram was carried out on a type MPO-2 loop oscillograph (Fig. 1).

The potentials were fed into a type UBP-02 amplifier connected to the MPO-2 loop oscillograph. The potentials were detected by metallic electrodes (less than 15 μ in diameter) attached to two points of the contracting surface of the branch of the bundle of His or to its ramifications. The third, reference electrode, for grounding was inserted into a point corresponding to the apex of an equilateral triangle formed by the surface of the specific muscle between the attached working electrodes. By arranging the electrodes in this way, electrical interference was minimized during recording of the electrogram.

Mechanical contractions were recorded by a photoconductive cell connected to a bridge circuit with a 22 V battery. The bridge was balanced by means of variable resistors. During recording, the area tested together with the attached electrodes for the electrograms were illuminated by a focussed beam of light from a special lamp; flashes from the flickering surface were detected by the photoconductive cell. As a result, an e.m.f. of unbalance was produced at the output of the bridge, modulated by movement of the recorded area of contracting specific muscle, fed into the input of a low-frequency amplifier. The amplifier from a type ÉNO-1 oscillograph coupled with a cathode follower was used. When recording the mechanogram by this method, background illumination by daylight was permitted, reducing the inertia of the photoconductive cell, particularly when operating at weak intensities of illumination.

An advantage of the photoconductive cell is that it does not touch the investigated surface and, consequently, does not introduce distortion into the dynamics of contractions of the muscle when moving with little force, and also that no trauma is inflicted on the test object as a result of setting or fixing the detector during recording of the mechanogram.

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