CHANGES IN MEMBRANE POTENTIAL OF MYOMETRIAL CELLS IN RESPONSE TO STRETCHING

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UDC 612.731:612.628

A sucrose bridge method was used to study changes in membrane potential of strips from the cervical and tubal portions of the uterus of castrated rats. A decrease in membrane potential by 10-50% was found during stretching of the strip. Membrane depolarization was not accompanied by the appearance of spontaneous discharges of action potentials.

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Cells of visceral smooth muscle possess the properties of a receptor and effector organ. The electrogenic mechanism of regulation of contraction of some types of smooth muscle (taenia coli, retractor penis muscle) is known [1-3]. Contraction in them is produced by depolarization of the cell membrane and generation of action potentials (AP), the magnitude of the contraction depending on frequency of the AP. Myometrial cells in different states are subjected to considerable mechanical forces (stretching), and during parturition the various parts of the uterus contract to a different extent. This difference in contractile activity is explained by differences in the structure, innervation, content of actomyosin and elastic tissue, and so on. The influence of an electrogenic mechanism of regulation of contraction likewise cannot be ruled out.

In this investigation the effect of mechanical stimulation on the membrane potential of cells in various parts of the myometrium was studied in castrated animals.

EXPERIMENTAL METHOD

Experiments were carried out on albino rats weighing 120-150 g, 2-4 weeks after preliminary castration. The uterus was placed in Krebs' solution at room temperature. Pieces cut from the tubal and cervical portions of a uterine cornu, 15-20 mm in length, were used in the experiments. After a short time the preparation was placed into the chamber of a sucrose bridge so that the two extreme ends of the strip were bathed in Krebs' solution and the middle portion in isotonic sucrose solution (10%). The Krebs' solution under the inactive electrode and the sucrose solution were kept at room temperature, while the temperature of the Krebs' solution and the test solution of potassium sulfate was 37°. A mixture of 95% O_2 and 5% CO_2 was constantly supplied to the test chamber.

The ends of the preparation were fixed in manipulators (taken from 2 microscopes), by means of which it could be stretched by 10, 25, and 50%. The length of the strip of uterus in situ (15-20 mm) was taken as 100%. After each stretching the preparation was bathed in Krebs' solution until its initial polarization level was restored.

The level of the membrane potential (MP) was recorded 30 min after it had been adequately warmed and permeated by all the solutions. Potentials were detected by 2 nonpolarizing calomel electrodes and fed through a cathode follower connected to the recording instruments: a type S1-19 CRO and a type N-373 ink-writing apparatus. Altogether 46 strips of uterus from 18 rats and also 7 strips from the fundus of the human uterus (material obtained during operation for uterine fibroids and ovarian cysts) were investigated.

EXPERIMENTAL RESULTS

After the strips had remained in the Krebs' solution for 30 min, transfer to isotonic K_2SO_4 solution led within 1-2 min to depolarization of the active end of the preparation, reaching a maximum after 6-10 min. Depolarization in this solution was similar in value to the MP of smooth-muscle cells [4]. The mean

Department of Normal Physiology, Sverdlovsk Medical Institute (Presented by Academician V. V. Parin). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 66, No. 10, pp. 10-11, October, 1968. Original article submitted October 18, 1967.

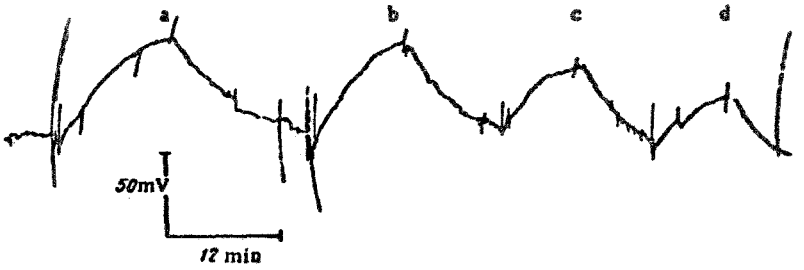

Fig. 1. Membrane potential of strip of cervix uteri of rat in unstretched state (a) and during stretching by 10% (b), 25% (c), and 50% (d).

MP for a preparation of the cervical part of the uterus in an unstretched state was 43.3±4.3 mV (M±σ), i.e., rather higher than that given by other authors [5, 6].

During slow stretching of the preparation by 10%, membrane depolarization amounted to 35.8±11 mV. During stretching by 25 and 50%, the MP fell to 33.8±8.7 and 33.2±11.6 mV respectively (Fig. 1).

Cells of the tubal portion of the uterus behaved in a similar manner. In an initial state, K_2SO_4 solution caused depolarization of the cells by 52±17.6 mV (M±σ). During stretching by 10% the membrane potential fell to 41 ± 17 mV, and during stetching by 25 and 50% it fell to 39.2 ± 18.4 and 37.2 ± 19 mV respectively.

The mean MP of strips of human myometrium was 44.5±6 mV. Stretching the strip by 10% increased the MP to 50.3±9.2 mV, and stretching by 25 and 50% increased it to 55.8±12.8 and 53±23.2 mV respectively.

No spontaneous activity was generated by myometrial cells of the castrated rats. This is in agreement with other published findings [5, 6].

Results of these investigations show that cells of different parts of the myometrium react to stretching by a decrease in their MP. However, in contrast to smooth-muscle cells of the intestine and retractor penis muscle, where stretching causes depolarization with generation of AP, the cells of the castrated rat uterus respond to stretching by depolarization without generation of spikes.

The qualitative difference between changes in MP of myometrial cells from man and castrated rats in response to stretching, namely hyperpolarization of the membrane in the first case and depolarization in the second, may perhaps be attributed to differences in the hormonal background. When fibroids are present, the estrogen level in the body is raised, and estrogen [5] elevates the MP. It may be considered that under conditions of estrogen saturation, the response of the cell membrane to stretching is modified.

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