FURTHER STUDY OF NERVE BIOPOTENTIALS ON INTRADERMAL INJECTION OF ANTIGENS

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(Received October 3, 1956. Presented by Academician A.D. Speranskii)

Our previous investigations [1] established that intradermal injection of typhoid, dysentery and paratyphoid vaccine elicited stimulation of receptors. The local excitation is conducted along sensory nerves to the central nervous system. Certain differences are noted in the character of the nerve biopotentials when different vaccines are administered which indicates certain specificity of receptor excitation elicited by one or another antigen.

The present work is a continuation of those investigations and consists of studies of the character of bioelectric potentials on intradermal administration of B. coli and staphylococcus antigens.

EXPERIMENTAL METHOD

Experiments were performed on dogs. Dissection and division of the auditory nerve were carried out under hexenal anesthesia. Separate nerve bundles were placed on electrodes with interpolar distance of 3 mm; the electrodes and the nerve were placed within a thin rubber tube.

The biopotentials were recorded with the help of an amplifier of AMN SSSR manufacture. Experiments were staged in a screened chamber. The records were made on a moving strip of oscillographic paper, using a 9-loop oscillograph ("Siemens and Halske ," 1951 model). The antigen was given intradermally in the dose of 0.2 ml. Vaccines prepared at the Rostov Institute of Vaccines and Sera, containing four billion cells per ml, were used in the experiments.

EXPERIMENTAL RESULTS

In the first series of experiments (14) changes in the bioelectric activity of the auditory nerve on intradermal injection of B. coli and staphylococcus vaccine were studied.

Prior to vaccine injection action potentials of 35-50 cps frequency and amplitude of 4 to 12 μv were recorded from the auditory nerve. Sometimes biopotentials of 20-25 cps and amplitude of 5-10 μv were seen.

Immediately after injection of B. coli antigen a slight increase in amplitude of 35-50 cps activity was observed, as well as isolated potentials of the "spike" type. The electric activity remained essentially unchanged in character over a period of 0.5-0.8 minutes. After 1-3 minutes continuous impulses of fast frequency and with sharp wave forms and high amplitude appeared. The bioelectric activity diminished on the seventh minute and after 10-12 minutes returned almost to the initial state (Figure 1).

Records of biopotentials after administration of physiologic solution were made as controls. No changes apart from rare single "paroxysms" were observed.

Administration of 0.2 ml staphylococcus antigen produced a rapid reaction which manifested itself in fast oscillations, occurring in trains or singly, and in high voltage slow waves. In some cases diphasic waves of high amplitude were noted. The reaction reached a maximum on the second to fifth minute and in most cases ceased by the tenth minute (Figure 2).

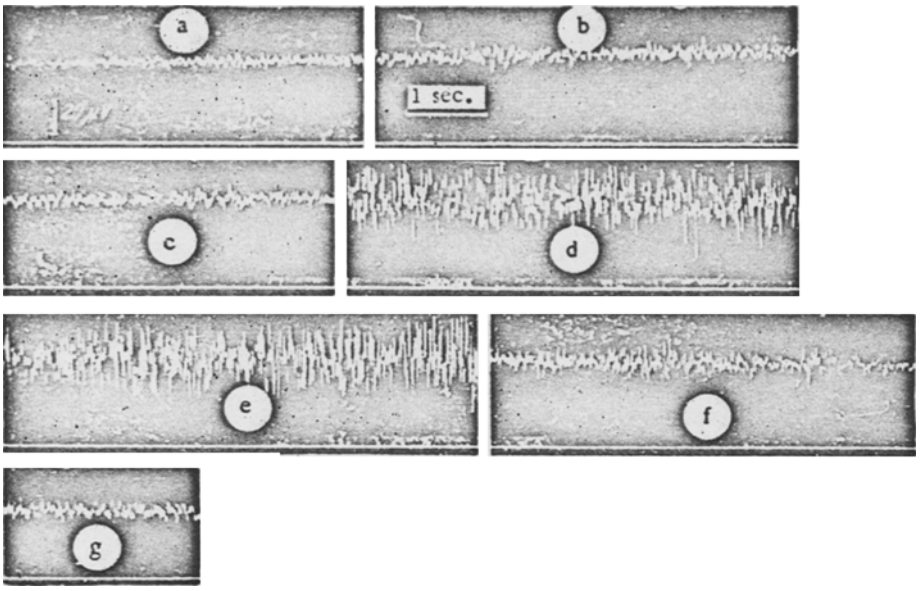

Fig. 1. Changes in electrical activity of the auditory nerve after intradermal injection of B. coli: a) initial background; b) immediately after injection of antigen; c,d,e,f, g) the same, 1, 3, 5, 7 and 10 minutes after injection of antigen.

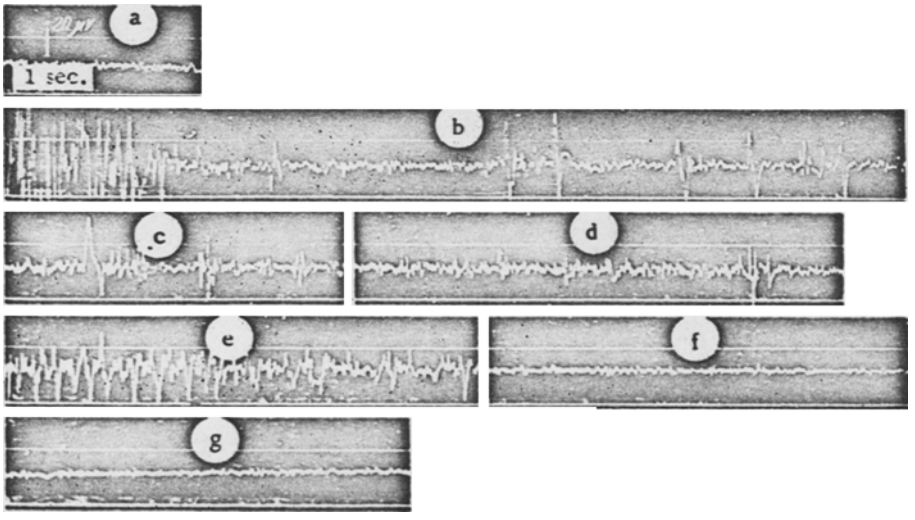

Fig. 2. Changes in electrical activity of the auditory nerve after intradermal injection of staphylococcus antigen: a) initial background; b) immediately after injection of antigen; c,d,e,f,g) the same, 1, 2, 3, 4 and 5 minutes after injection of antigen.

In the second series of experiments an attempt was made to discover to what extent the phenomena observed depended on the influence of the central nervous system. It could be postulated that intradermal injection of the antigen caused a pain reaction and the latter gave rise to a reflex contraction of the muscles of the ear which was recorded as changes in nerve biopotential. Such a suggestion could be excluded on the basis of the reaction developing under anesthesia. However, for the sake of greater certainty, we staged experiments with transection of the auditory nerve.

As in the first series, dissection of the auditory nerve was performed under anesthesia; the nerve was then divided. The peripheral part of the nerve was dissected and the separate fibers placed on electrodes in a rubber tube. The rest of the procedure was the same as in the first series of experiments.

These experiments showed that intradermal injection of B. coli vaccine elicited the appearance of fast activity of "paroxysmal discharge" and "spike" type in the peripheral part of the sectioned nerve also.

In some experiments in this series part of the auditory nerve fibers was sectioned and part left intact, with subsequent simultaneous recording from the peripheral end of the transected nerve and from the intact nerve.

Intradermal injection of antigen caused a more rapid and stronger reaction in the transected nerve.

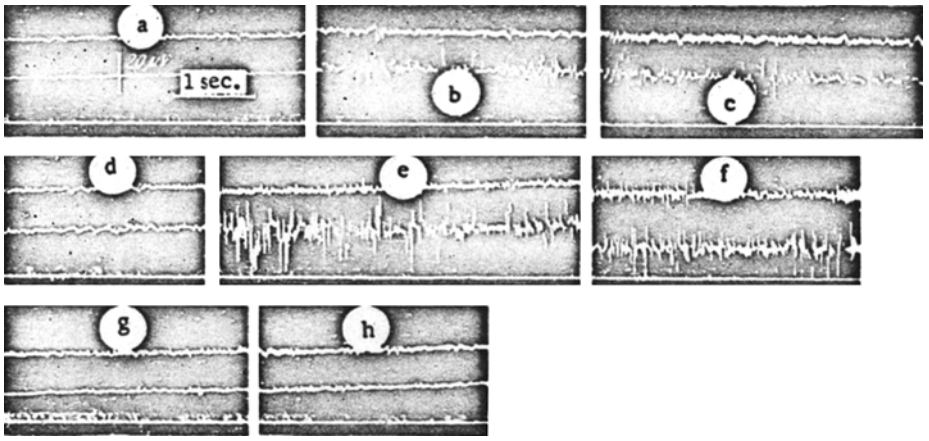

Fig. 3. Changes in electrical activity of intact auditory nerve (upper) and peripheral end of transected auditory nerve (lower) after administration of staphylococcus antigen: a) initial background; b) immediately after injection of antigen; c,d,e,f,g,h) 30 seconds, 1, 3, 5, 7 and 10 minutes after antigen injection.

Similar experiments were staged with administration of staphylococcus antigen. Intradermal injection of staphylococcus antigen gave rise to a quick reaction with the appearance of diphasic, sometimes monophasic negative potentials (up to 20-30 μv with sharp outlines) in the nerve. Simultaneous recording from intact and peripheral end of transected nerves showed that a marked reaction to administration of staphylococcus antigen occurred in both. The reaction in the peripheral end of the transected nerve then increased and fairly frequent sharp wave biopotentials were observed (Figure 3).

The present experiments undoubtedly indicate that B. coli and staphylococcus antigens elicit direct stimulation of cutaneous receptors which become transformed into excitation manifested by changes in the biopotentials of a sensory nerve. The latter depends not on contraction of muscles but on stimulation of receptors by the antigen. The central nervous system exerts an influence on the process of receptor excitation and alters somewhat the character of the impulses which finds expression mainly in the rapidity with which the reaction appears and the amplitude of the potentials.

SUMMARY

It was established by experiments on dogs that the intradermal injection of the antigen of B. coli caused

stimulation of receptors. This results in the change of oscillations of the bioelectric potentials of a sensory nerve. These changes take place in intact as well as in divided (peripheral portion) nerves.

Intradermal injection of staphylococcus antigen causes characteristic changes in the action potentials in sensory nerves, which differ from the oscillations of potentials taking place when B. coli are injected intradermally. Antigens are able to stimulate the skin receptors. There, during the process of excitation, the stimulation is transformed and causes changes of biopotentials in the sensory transmitters.

LITERATURE CITED

[1] A.N. Gordienko, V.I. Kiseleva, et al., Biull. Eksptl. Biol. i Med. Supplement to No. 1, 1957.*

*See English translation.