THE EFFECT OF PENTAPHENE AND STRYCHNINE ON THE POLYSYNAPTIC REFLEXES OF DIFFERENT SECTIONS OF THE SPINAL CORD

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It has been established in a series of works [5, 15, 16] that the polysnaptic reflex arcs of the lumbar section of the spinal cord are more sensitive to the action of certain anesthetics than are the analogous reflexes of the cervical portion.

The purpose of this investigation was to ascertain whether other pharmacological agents (non-anesthetic) have a preferential effect on the caudal segments of the spinal cord.

The agents selected for this purpose were strychnine, an anesthetic antagonist, and Pentaphene (diethylaminoethyl ester of phenylcyclopentacarbonic acid), a cholinolytic substance which, like anesthetics, inhibits cerebrospinal activity.

METHOD

The experiments were performed on adult cats, the spinal cord of which had been sectioned at the level C_1 under deep anesthesia. The anesthesia was discontinued immediately after the transection, and the animal was kept warm and under artificial respiration for the duration of the experiment. We recorded the bioelectric currents of the biceps femoris and the biceps brachii developing in response to single threshold stimulations consisting of square-wave stimuli 0.12 millisecond in duration applied to the central sections of the transected sensory and mixed nerves of the extremities.

Pentaphene and strychnine were introduced intravenously. Preliminary experiments were carried out in order to establish the doses with which the clearest results could be obtained. This dose was found to be 10 mg/kg for Pentaphene and 0.05 mg/kg for strychnine. In each experiment, we injected the specified dose of the substance 2-3 times. Since the effects of the first and second injections were about the same, the results of all the observations were processed together.

The bioelectric potentials were recorded before the injection of the experimental substance and then 1, 3, 5, 10, 15 and 20 minutes after the injection. The value of the reflex response to a single stimulation was determined by measuring the area of the bioelectric currents. All the values (the areas of the bioelectric potentials) were calculated in percent of the original effect. The data obtained were statistically processed. A result with $d < 0.05$ was assumed to be authentic.

We performed a total of 15 experiments with Pentaphene on six animals and 16 experiments with strychnine on seven animals.

RESULTS

Experiments with Pentaphene. We observed inhibition of all the experimental spinal polysynaptic reflexes after the administration of Pentaphene, but the effect was more pronounced at the level of the lumbar reflex arcs. Fig. 1 (a and b) graphically depicts the changes in the average values of the reflex responses of the arm and leg muscles after the administration of Pentaphene. One can see a sharp deterioration of reflex activity the very first minute. The effect reached its maximal point the third minute. Thereafter, the reflex responses gradually increased. The character of the reaction was about the same regardless of whether the sensory nerves (a) or the mixed nerves (b) were stimulated. Fig. 2 gives data from one of the experiments. The figure shows the complete inhibition of the reflex responses of the biceps femoris muscle (c and d) after the administration of Pentaphene and the reduced, but evident response of the biceps brachii muscle (a and b).

Experiments with Strychnine. Although the administration of strychnine sharply intensified all the experimental polysynaptic reflexes, there was a much greater increase in the reflex responses of the biceps femoris muscle than in those of the analogous arm muscle. This is clearly shown in Fig. 1 (c and d). The reflex response of the biceps femoris muscle became 4-7 times stronger after the

* Deceased.

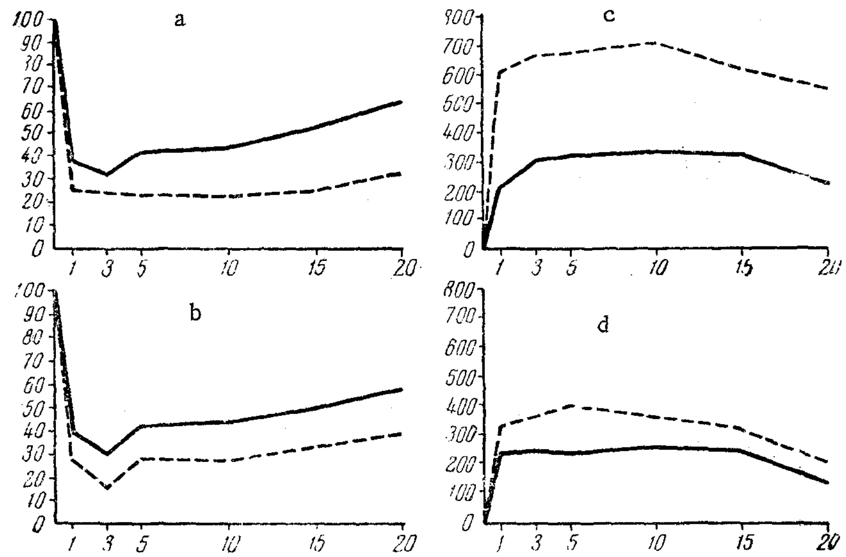

Fig. 1. Graph showing the effect of Pentaphene (a and b) and strychnine (c and d) on the polysynaptic reflexes of spinal animals. On axis of abscissa is shown the time (in minutes); on axis of ordinate is shown the area of the bioelectric reflex responses of the muscles (in percent of original value). a, c) reflex responses of the biceps brachii (——) and the biceps femoris (– – – –) muscles to stimulation of the sensory nerves (respectively, the medial cutaneous and saphenous nerves); b, d) reflex responses of the same muscles to stimulation of the mixed nerves (respectively, the ulnar and tibial nerves).

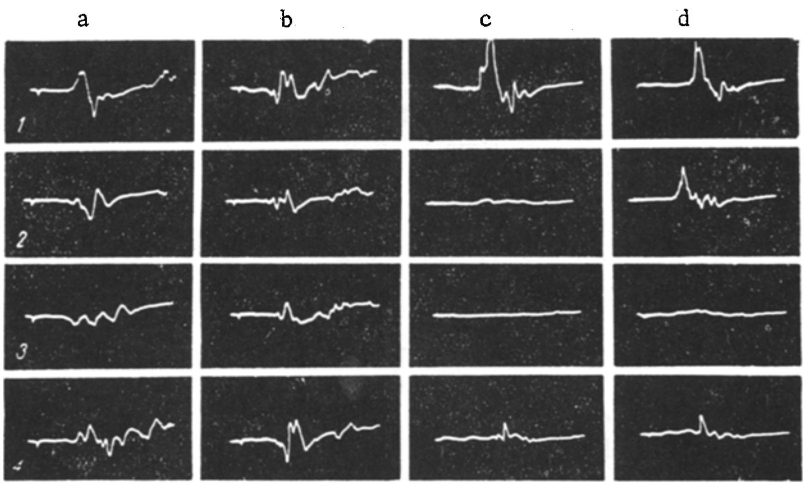

Fig. 2. Effect of Pentaphene on the polysynaptic reflexes of a spinal animal. a) biceps brachii muscle with stimulation of medial cutaneous nerves; b) biceps brachii muscle with stimulation of ulnar nerve; c) biceps femoris muscle with stimulation of saphenous nerve; d) biceps femoris muscle with stimulation of tibial nerve; 1) initial reflex responses; 2-4) respectively, 1, 5, and 10 minutes after the administration of 10 mg/kg Pentaphene.

administration of strychnine, while the response of the biceps brachii muscle became 2-3 times stronger. In this case, there was a greater degree of increase in the reflex response to stimulation of the sensory nerves.

With the administration of strychnine, as in the case of Pentaphene, the difference in value of the changes in the reflex reactions under comparison was statistically justified throughout the investigation.

Fig. 3 shows that strychnine causes greater intensification of the reflex responses of the biceps femoris muscle (c and d) than of the reactions of the analogous arm muscle (a and b).

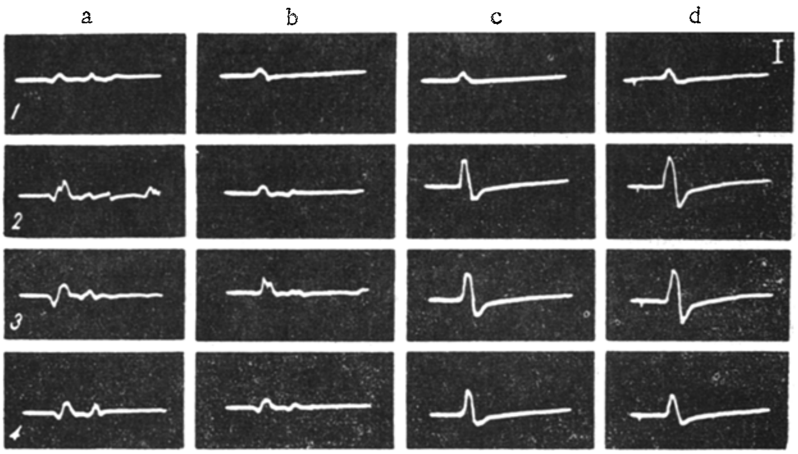

Fig. 3. Effect of strychnine on the polysynaptic reflexes of a spinal animal. a) biceps brachii muscle with stimulation of medial cutaneous nerve; b) biceps brachii muscle with stimulation of ulnar nerve; c) biceps femoris muscle with stimulation of saphenous nerve; d) biceps femoris muscle with stimulation of tibial nerve; 1) initial reflex responses; 2-4) respectively, 1, 5, and 20 minutes after the administration of 0.05 mg/kg strychnine. Calibration equals 1 mv.

From the literary data, it is known that in many pathologic conditions attended by injury to the motor apparatus, change in the cerebrospinal function moves in cranial direction.† When anesthetics are administered to intact animals, for example, the first changes observed in the animalsare ataxia and paresis of the posterior extremities [7, 11-14]. A study of pathologic reflexes from the abdominal cavity of animals demonstrated that, first, asthenia of the posterior extremities develops, then paralysis of the latter and only after this does paralysis of the anterior extremities develop [9]. One of the first symptoms of rabies is mild paresis of the posterior extremities. In rabies, the posterior portion of the body becomes paralyzed before the anterior [8, 10]. In certain forms of tetanus, when the focus of injury is not predominant in the disease picture, the posterior extremities are affected before the anterior [3]. Paralysis in poliomyelitis usually travels from bottom to top [4]. The functions of the posterior extremities are the first to fail in high partial oxygen pressure [1, 2]. With the administration of Novocain and many anesthetics, the reflex activity of the lumbar portion of the spinal cord is more disturbed than that of the cervical region [5, 6, 15, 16].

These data suggest that the facts we obtained regarding the preponderant effect of Pentaphene and strychnine on the reflex activity of the caudal segments of the spinal cord are a specific case of a more general rule governing change in the reflex activity of the spinal cord under pathologic conditions. It is difficult to say at this time just what the reasons for and the mechanisms of this rule are.

SUMMARY

The effect of Pentaphene and strychnine on the polysynaptic reflexes of the cervical and lumbar sections of the spinal cord was studied on spinal cats by electrophysiological methods. The material was statistically analyzed. It was established that Pentaphene preponderantly depresses, and that strychnine enhances the reflex activity of the lumbar spinal cord segments.

It is known that it is toward the cranium that the changes of the spinal cord functions develop in many pathologic processes attended by affection of the motor apparatus. This suggests that the data obtained regarding Pentaphene and strychnine are a particular case of a more general rule governing the reflex action change occurring in the spinal cord in pathologic conditions.

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† Here, we are speaking of the alteration processes, the course of which is not determined by the localization of the pathologic focus.
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