ELECTRICAL ACTIVITY OF THE CAUDAL MESENTERIC GANGLION IN WAKING CONDITIONS

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It is currently considered [2-4, 15, 16, 18, 19] that the caudal mesenteric ganglion is a lower reflex center regulating the activity of the pelvic organs. Morphological confirmation of this view is given in several publications [6-9, 11, 17]. In the present investigation the electrical activity of the caudal mesenteric ganglion was studied in normal functioning conditions.

EXPERIMENTAL METHOD

Electrodes were implanted in the ganglion by the author's method [14]. The electrical potentials were amplified with a type UBP1-01 amplifier and recorded on a type N-102 loop oscillograph. The apparatus also included a special amplitude selector [13] by means of which, as the recording was made on the film, selection of the incoming stream of impulses by amplitude could be carried out and their frequency determined. Experiments were performed on 10 adult dogs.

EXPERIMENTAL RESULTS

In the absence of special stimulation the "spontaneous" electrical activity in the caudal mesenteric ganglion of waking dogs consists of three types of impulses (Fig. 1, 1): slow impulses of low voltage, fast impulses of high voltage, and impulses with an irregular rhythm.

The slow impulses of low voltage consisted of ungrouped biphasic potentials with a duration of about 20 msec and an amplitude of up to 15 μV, following at a mean frequency of up to 50-80 per second.

In the fast impulses of high voltage the duration of each impulse between the two phases was 10 msec and the amplitude for the two phases was 20 μV or higher. The impulses were grouped to correspond to the rhythm of the pulse (2-3 oscillations in each parcel), with a mean lag of 80-100 msec behind the EGG. In addition, grouping to correspond to the rhythm of respiration was observed. Each respiratory group appeared at the beginning and disappeared at the end of inspiration. The total number of grouped impulses was inconstant and varied from 30 to 50 oscillations.

The impulses with an irregular rhythm were fast and their amplitude ranged from 20 to 30 μV (Fig. 1, 4). Their appearance coincided neither with the pulse nor with the respiratory movements. The beginning of a wave of these impulses could be recorded during either inspiration or expiration or during the interval between them.

Comparison of the flow of impulses recorded in the ganglion with the character of the afferent impulses in the pre- and postganglionic structures of the same ganglion (with simultaneous recording) showed that ungrouped impulses of low voltage and grouped impulses in the rhythm of the pulse and respiration were common to all three. Impulses with an irregular rhythm were recorded only in the ganglion itself and in its preganlionic structures.

Data concerning the morpho-functional organization of the caudal mesenteric ganglion, according to which part of the fibers passes through it without interruption (type B fibers), while the other fibers regularly relay in it [20, 22], explain why pulse and respiratory groupings are found in the recordings made from the ganglion, because they arise from the fibers passing through it [4, 21, 23]. Grouping of the impulses in this manner was described previously by the author [14] when investigating the afferent impulses recorded in the pre- and postganglionic branches of the caudal mesenteric ganglion in chronic conditions. So far as the

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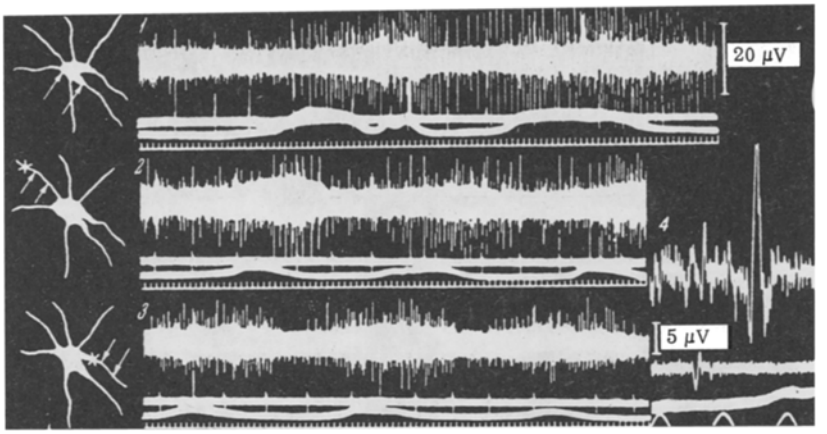

Fig. 1. Character of the "spontaneous" electrical activity in the caudal mesenteric ganglion and its branches. 1) Impulses recorded in the ganglion itself; 2) afferent impulses in the preganglionic trunk; 3) afferent impulses in the postganglionic trunk; 4) oscillations of the impulses with an irregular rhythm. On each oscillogram, here and in Fig. 2, from top to bottom: electrical activity of ganglion, EGG, pneumogram, time marker (10 cps).

irregular rhythm is concerned, it can be assumed that it reflects the functional state of the receptor structures found in the caudal mesenteric ganglion itself [6-9 , 11, 17]. According to the views of B. I. Lavrent'ev [10], N. G. Kolosov [8], I. A. Bulygin [2], and others these receptors play an important role in checking the transmission of excitation from the preganglionic fibers to the postganglionic, and in the reflex regulation of the functional state of the ganglion itself.

Following the administration of pharmacological agents [1] with a specific, selective action on the transmission of nervous impulses in the sympathetic ganglia, their effect is observed not only on the character of the responses evoked by stimulation, but also on the "spontaneous" electrical activity recorded at the same time. Accordingly, special experiments were carried out in which substances possessing adrenergic or cholinergic action were injected; the object of these experiments was to examine the changes in the "spontaneous" impulses in the ganglion in chronic conditions.

Injection of hexamethonium (1-3 mg/kg) caused marked depression of the "spontaneous" electrical activity. This depression affected the frequency of the impulses of both low and high voltage. Under the influence of hexamethonium, the impulses with a regular rhythm disappeared completely (Fig. 2, A). A similar depression of the electrical activity was observed after administration of large doses of adrenalin (100-200 μg/kg). The beginning of the reaction and restoration of the activity depended on the dose of the preparation, and the maximum was reached 3-5 min after injection.

A sharp increase in the frequency of the potentials (with both low and high voltage) was observed after injection of acetylcholine (100 μg) and eserine (0.2 mg/kg) which are known to facilitate synaptic transmission in the ganglion. The reaction in these cases appeared faster than after adminsitration of ganglion-blocking agents. Within the first minute the frequency of the waves rose sharply. Nociceptive stimulation of one of the branches of the sciatic nerve was also accompanied by stimulation of the electrical processes in the ganglion.

To assess the action of the pharmacological agents, it was useful to record the efferent impulses in the postganglionic structures. For this purpose, besides being implanted into the ganglion, electrodes were also implanted into the hypogastric and pelvic nerves. The impulses were isolated by means of local reversible cooling [14]. The experiments showed that the changes in the efferent impulses in the postganglionic trunks following injection of hexamethonium, acetylcholine, eserine, and adrenalin developed simultaneously with the changes in the electrical activity of the ganglion, from which they showed no essential difference in magnitude and duration.

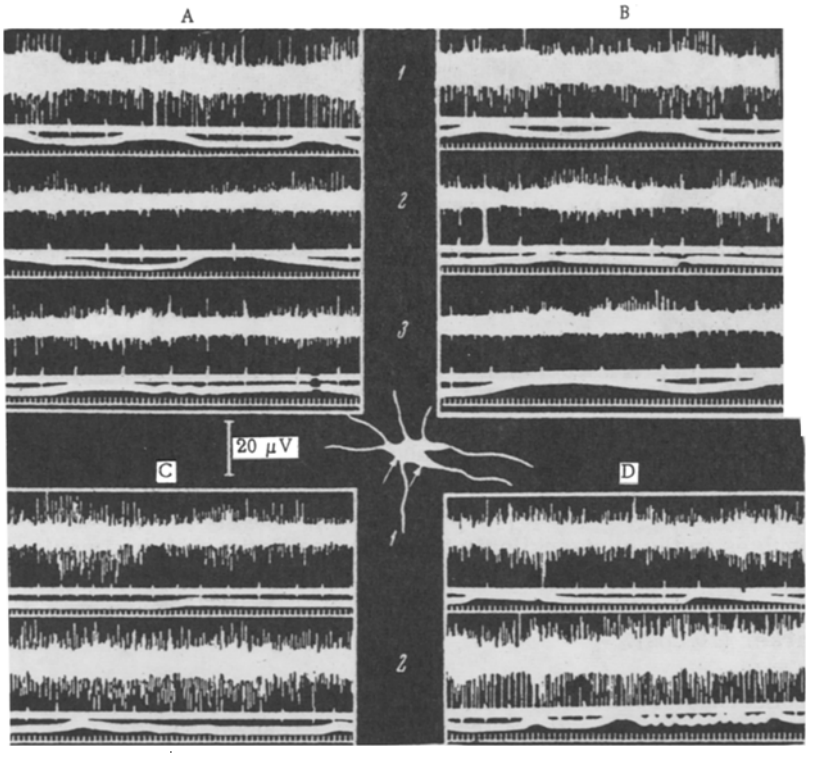

Fig. 2. Changes in the electrical activity in the caudal mesenteric ganglion under the influence of drugs with adrenergic and cholinergic action and of nociceptive stimulation of a branch of the sciatic nerve. A—Changes in electrical activity in the ganglion after subcutaneous injection of hexamethonium in a dose of 1-3 mg/kg: 1) initial background, 2) 3 min, 3) 5 min after injection; B—the same after subcutaneous injection of adrenalin in a dose of 200 μg/kg; C—increase in the electrical activity of the ganglion as a result of intravenous injection of 100 μg acetylcholine: 1) initial level of electrical activity, 2) 1 min after injection; D—the same after nociceptive stimulation of a cutaneous branch of the sciatic nerve.

The action of substances depressing or activating ganglionic transmission also influenced the character of the electrical activity of the fibers passing through the caudal mesenteric ganglion without interruption. The effect of their action may be understood if it is remembered that these fibers had already relayed in the higher paravertebral ganglia, on which these substances act just as they do on the caudal mesenteric (prevertebral) ganglion. Consequently, we can regard these fibers as postganglionic, and the changes in their electrical activity have already been discussed above.

The results of the experiments in which adrenergic and cholinergic substances were administered thus show that the electrical reactions recorded in the caudal mesenteric ganglion of waking animals run basically the same course as in acute experiments under general anesthesia.

The results obtained demonstrate that in chronic conditions the electrical activity of the caudal mesenteric ganglion of the waking animal is marked by constant discharges of a biphasic character. In their amplitude, duration of discharge, and frequency, these potentials resemble those recorded separately in the pre-and postganglionic structures of the ganglion in waking conditions. The comparatively high amplitude of the impulses, a special feature of the functioning of ganglia in acute experiments and brought about by the synchronization of simultaneously working fibers, is much lower in chronic conditions. Evidently in waking animals some degree of desynchronization is introduced by subordinating messages sent both to the synapses and to the peripheral receptors. A distinctive feature of the "spontaneous" impulses in the caudal mesenteric ganglion of waking animals is the stream of impulses with an irregular rhythm,

evidently reflecting the functional states of the receptors in the ganglion. The electrical activity of the ganglion is also characterized by the slow onset and the more prolonged course of the response reaction to the substances admistered than in the acute experiment under anesthesia. This feature, revealed in these experiments in relation to the afferent and efferent impulses [12, 14], is probably a general feature in the activity of sympathetic nerve conductors in a waking state.

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