CONDUCTION OF NERVOUS IMPULSES IN FIBERS OF THE GREATER SPLANCHNIC NERVE RUNNING TO THE ADRENAL MEDULLA IN CATS

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Electrophysiological and pharmacological analysis of the conduction of excitation in the main trunk of the splanchnic nerve and its branches supplying the adrenals demonstrate the presence of a synapse along some of the fibers running to the adrenal, in the semilunar ganglion of the solar plexus.

Most workers [6, 8-10] consider that the adrenal medulla is innervated by preganglionic sympathetic fibers of the greater splanchnic nerve which are axons of neurons located in the lateral horns of the spinal cord. This view followed largely from the work of Cheboksarov [5] and Elliott [7], who showed that the splanchnic nerve is a secretory nerve for the adrenal medulla. Other work by morphologists showed that fibers of the splanchnic nerve supplying the adrenal medulla are interrupted by synapses: in the semilunar ganglion of the solar plexus, in the adrenal capsule, and at the boundary between the adrenal cortex and medulla [1, 2, 4]. The existence of crossed innervation of the adrenals has also been observed [3].

In the investigation described below, synaptic interruption of fibers of the greater splanchnic nerve running to the adrenal on cells of the semilunar ganglion of the solar plexus was studied by means of an electrophysiological method.

EXPERIMENTAL METHOD

Experiments were carried out on adult cats anesthetized with nembutal (40-50 mg/kg body weight, intraperitoneally). The main trunk of the greater splanchnic nerve was dissected immediately below the diaphragm, and the semilunar ganglion of the solar plexus and branches of nerve fibers running to the adrenal were identified. The trunk of the splanchnic nerve was taken up on a ligature immediately below the diaphragm, divided, and placed on stimulating electrodes. Recording electrodes were placed distally along the course of the splanchnic nerve and proximally to the semilunar ganglion (first pair of electrodes), and distally to the semilunar ganglion on branches of nerve fibers running to the adrenal (second pair of electrodes). Usually there were two or three small branches. The trunk of the splanchnic nerve was stimulated with square pulses (0.02-20 V, 0.1-0.5 msec, 2-200/sec) from an electronic stimulator with radiofrequency attachment. Action potentials were recorded after preamplification on a CRO. A cholinolytic (hexamethonium bromide) was injected intravenously in a dose of 2-5 mg/kg body weight.

EXPERIMENTAL RESULTS

The evoked electrical activity in the main trunk of the greater splanchnic nerve consisted of rapid, biphasic waves with a short latent period, on the average not more than 1 msec (Fig. 1). Potentials of stable amplitude and duration, synchronized with the rhythm of stimulation, were recorded at frequencies of up to 30/sec. A further increase in frequency, with constant strength and duration of the stimulating pulses, evoked a gradual decrease in amplitude of the action potentials.

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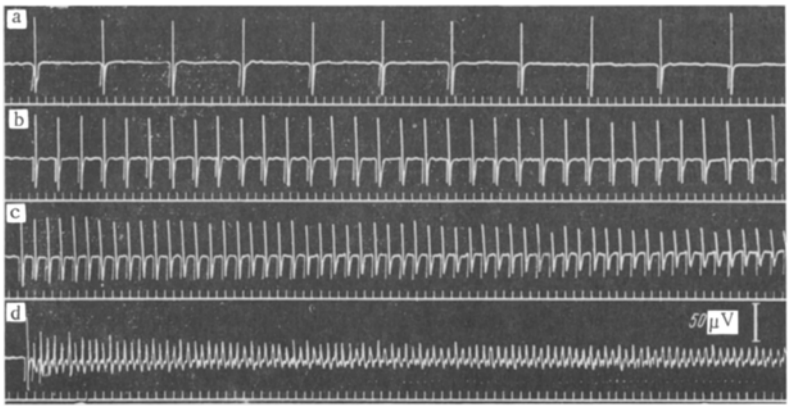

Fig. 1. Action potentials in main trunk of greater splanchnic nerve of cat. Parameters of stimulation 0.1 msec, 1 V, frequency: a) 7; b) 20; c) 30; d) 60/sec. Time marker in this and all subsequent figures 20 msec.

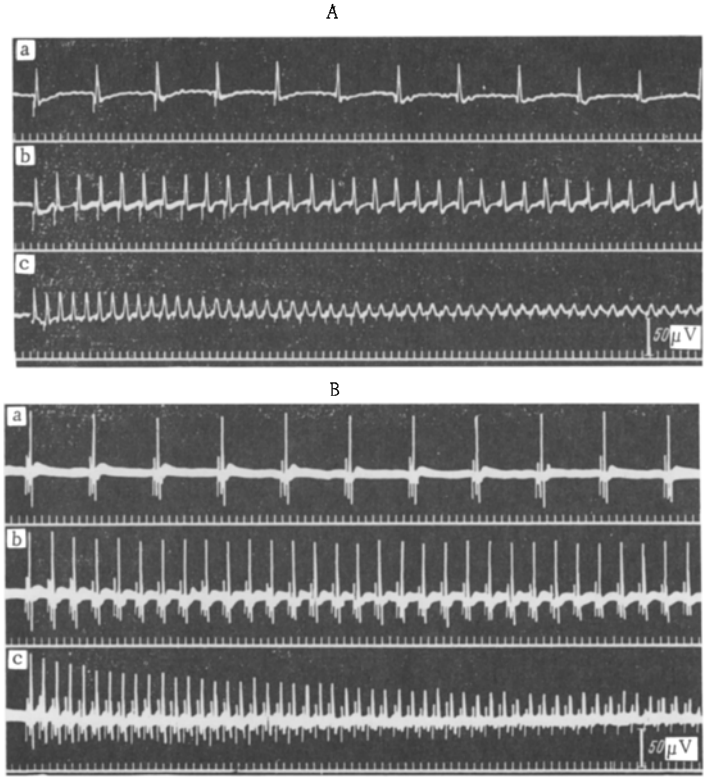

Fig. 2. Action potentials recorded from two separate groups of nerve fibers (a and b) supplying adrenal in a cat. Parameters of stimulation: A) 0.1 msec; 4 V; frequency: a) 7; b) 20; c) 30/sec; B) 0.1 msec; 3 V; frequency: a) 7; b) 20; c) 30/sec.

The evoked activity in isolated groups of fibers running to the adrenal consisted either of a single negative deflection (Fig. 2A), or an action potential of more complex shape, consisting of two negative waves of different durations and unequal latent periods (Fig. 2B). The latent period for the fast component of the action potential was 1-2 msec, and for the slower component it averaged 10-20 msec.

Recordings of action potentials in separate groups of fibers running to the adrenal during stimulation of the main trunk of the splanchnic nerve at different frequencies showed that a marked decrease in amplitude

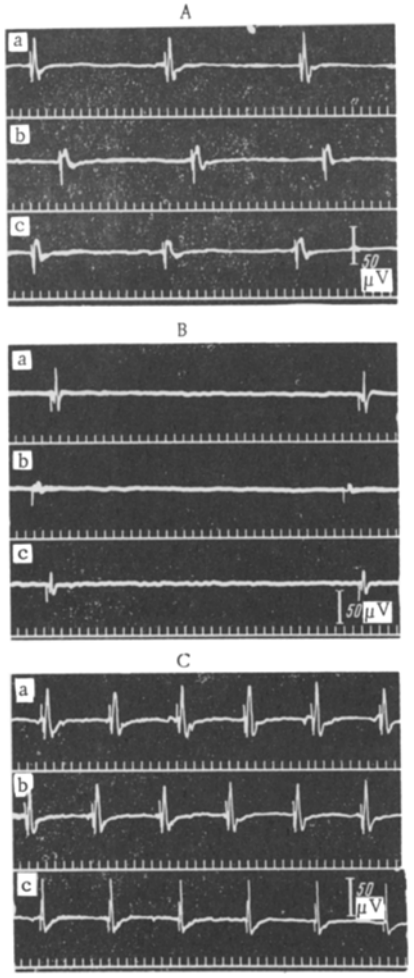

Fig. 3. Effect of hexamethonium bromide (2 mg/kg) on evoked action potentials recorded from nerve branches supplying the adrenal in a cat: A) combined recording from branches; B and C) separately from each branch. Parameters of stimulation: A) 0.1 msec, 4 V, frequency 4/sec; a) initial background; b) 11 min; c) 15 min after administration of hexamethonium: B) 0.1 msec, 4 V, 2/sec; a) initial background; b) 15 min; c) 30 min after administration of hexamethonium; C) 0.1 msec, 4 V, 7/sec; a) initial background; b) 20 min after administration of hexamethonium; c) during antidromic stimulation.

of the potentials was observed in both cases when the frequency was 30/sec, whereas in the main trunk action potentials of stable amplitude continued to be recorded at this frequency. Comparison of the character of the evoked action potentials in the main trunk of the splanchnic nerve and in the separate branches of the fibers running to the adrenal shows that these action potentials differed from each other both in duration and in the latent period of this origin. The differences in the character of impulse conduction themselves afford some evidence that some of the fibers innervating the adrenal are interrupted by synapses in the semilunar ganglion. Further proof was obtained in experiments with hexamethonium bromide, which blocks synaptic transmission in ganglia. To investigate the effect of hexamethonium on synaptic transmission of impulses in the semilunar ganglion, combined recordings were made of action potentials from two branches simultaneously and also separately in each of them against the background of stimulation of the main splanchnic nerve trunk. During combined recording of evoked potentials from two groups of nerve fibers running to the adrenal, after administration of hexamethonium bromide a decrease in the amplitude of the recorded action potentials was constantly observed (Fig. 3A). When potentials were recorded in separate branches against the background of hexamethonium bromide, it was found that the action potentials almost completely disappeared in one of them, their amplitude decreasing sharply (Fig. 3B), while in the other branch they remained unchanged (Fig. 3C). Antidromic recording of the action potentials in the splanchnic nerve trunk during stimulation of the fibers in this branch shows that the fibers running in it through the semilunar ganglion to the adrenals do so without interruption (Fig. 3C).

Electrophysiological and pharmacological analysis of the conduction of excitation in the main trunk of the splanchnic nerve and in its branches supplying the adrenal in cats thus demonstrate the existence of synaptic interruption of some fibers in cells of the semilunar ganglion of the solar plexus.

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