TYPES OF FIBERS CONDUCTING IMPULSES DURING NOCICEPTIVE STIMULATION OF THE SKIN

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Fibers of groups C_1 and $A\beta$ were shown to conduct impulses arising after injection of KCl in a nociceptive concentration (250 mM) into the cutaneous blood vessels of a cat. The role of fibers of groups C_2 and $A\delta$ in the transmission of impulses during nociceptive chemical stimulation was inconstant in character, and activity was observed in these fibers after injection of KCl in a concentration of 250 mM into the cutaneous blood vessels only in some experiments. Low KCl concentrations had no nociceptive action, and the number of active fibers of groups C_1, C_2, and $A\delta$ after injection of KCl in a concentration of 31.2 mM into the cutaneous vessels was small; the number was slightly greater in the group of $A\beta$ fibers.

It has been shown that the pseudoaffective response, accompanied by pressor reflexes of type II [6], arises in response to injection of many different substances, including chlorides of the alkali metals [2, 3]. Among the substances of this group, KCl evokes a type II pressor reflex in the smallest concentration. Injection of KCl into the blood vessels of a perfused area of skin of the cat's hind limb in a concentration of 15.6-31.2 mM has been shown [5] to produce a small pressor reflex of type I, while in a concentration of 250-1000 mM it evokes a considerable pressor reflex of type II. The magnitudes of these reflex responses must depend on differences in the information reaching the central nervous system.

The object of the present investigation was to determine the types and relative numbers of fibers conducting excitation in response to injection of different concentrations of KCl into the blood vessels of the cat's skin.

EXPERIMENTAL METHOD

Cats were anesthetized with urethane and KCl in concentrations of 31.2 and 250 mM was injected through a cannular in the retrograde direction into their saphenous artery [7]. During the injection of KCl the saphenous artery was clamped proximally to the origin of its genicular branch. The saphenous nerve was divided in the groin and stimulating electrodes were applied to its distal end. Recording electrodes connected to a type UBP-I-01 amplifier were placed on the genicular branch of the saphenous nerve.

The dissected segments of the nerve with the electrodes were covered with mineral oil. The nerve was stimulated with square pulses of sufficient strength to excite all the group A medullated fibers and group C nonmedullated fibers. The frequency of stimulation was 10/sec for the group A fibers and 2/sec for the group C fibers.

Evoked potentials were recorded on cathode-ray and loop oscillographs. The identification of the groups and determination of the relative numbers of fibers along which impulses of excitation spread in response to injection of KCl were carried out by the colliding impulses method [4, 8].

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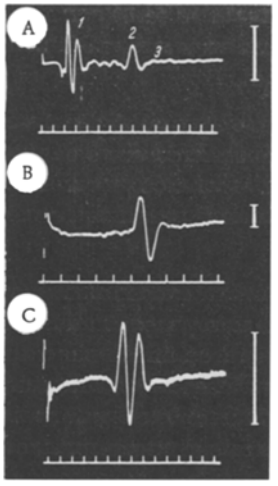

Fig. 1

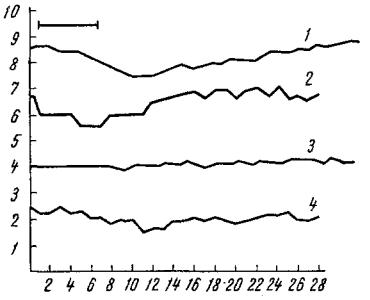

Fig. 2

Fig. 1. Evoked potential in cat's saphenous nerve: A) potential in fibers in group A; 1) β component; 2) δ, 3) post-δ component. Time marker 1 msec, calibration 250 μV; B) potential of fibers of group C. Time marker 20 msec, calibration 50 μV; C) potential of fibers of groups C_1 and C_2. Time marker 20 msec, calibration 50 μV.

Fig. 2. Changes in amplitude of evoked potentials in saphenous nerve after injection of KCl in concentration of 31.2 mM into cutaneous blood vessels. Abscissa, time (in sec); ordinate, relative amplitudes of potentials in individual groups of nerve fibers: 1) group Aβ, 2) C_1, 3) Aδ, 4) C_2. Horizontal line marks injection of KCl.

EXPERIMENTAL RESULTS AND DISCUSSION

The type A evoked potential of the saphenous nerve consisted of $\beta-\delta$ and post-δ components, and the C potential in many experiments consisted of C_1 and C_2 components (Fig. 1).

After injection of KCl orthodromic impulses traveled along the segment of the nerve between the electrodes in the opposite direction to the antidromic impulses. This led to their mutual extinction only in fibers in which collisions took place, with a consequent decrease in amplitude of particular components of the evoked potential. The larger the number of fibers in which impulses collided in the segment between the electrodes, the lower the amplitude of the components of the evoked potential.

Injection of KCl in a concentration of 31.2 mM reduced the amplitudes of the Aβ and C_1 potentials. In most experiments the Aδ and C_2 potentials were completely unchanged in amplitude (Fig. 2). This means that, in response to injection of KCl into the skin, orthodromic impulses travel along Aβ medullated fibers and C_1 nonmedullated fibers, and they are evidently responsible for the small type I pressor reflex.

Injection of KCl in a concentration of 250 mM led to considerable changes in amplitude of the Aβ and C potentials (Fig. 3). Where the C potential consisted of C_1 and C_2 components, a decrease in amplitude of both C_1 and C_2 potentials was observed. However, the decrease in the C_2 potential was less marked than in the C_1 (Fig. 3). The Aδ potential was unchanged under these circumstances, or its amplitude was very slightly reduced, to about the same degree as in response to injection of KCl in a concentration of 31.2 mM. This suggests that during injection of KCl, if impulses appear in the Aδ fibers, they do so at very low frequency [9]. The probability of collisions between orthodromic and antidromic impulses in the segment of the nerve between the electrodes is therefore low [1]. In experiments in which the frequency of orthodromic impulses in the Aδ fibers was greater than the frequency of the antidromic impulses, the amplitude of the recorded potential was reduced.

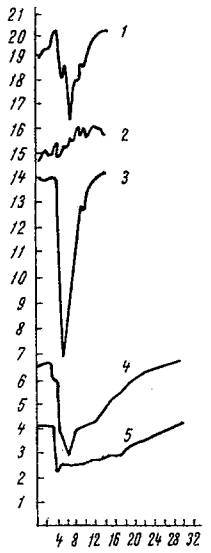

Fig. 3. Change in amplitude of evoked potentials in saphenous nerve during injection of a nociceptive concentration of KCl (250 mM) into blood vessels of the skin. Abscissa, time (in sec); ordinate, relative amplitudes of potentials of individual groups of nerve fibers: 1) Aβ, 2) Aδ, 3) C, 4) C_1, 5) C_2. Horizontal line marks injection of KCl.

During injection of KCl in nociceptive concentrations the number of active Aβ and C fibers is thus increased by comparison with the number of active units of these groups during injection of low, subnociceptive concentrations of KCl. A similar increase in the number of active fibers of type C was observed in response to the action of such harmful stimuli as pinching, pricking with a pin, or burning on the skin [11]. The post-δ fibers are of great interest with respect to the mechanism of the pressor reflexes in response to different types of stimulation [10, 12]. However, it was impossible to detect impulses in these fibers in response to injection of KCl by the colliding impulses method because of the low amplitude of the antidromic post-δ potential recorded.

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