Effect of Polychromatic Polarized Light on Afferent Traffic in Skin Branches of Somatic Nerves

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Short-term irradiation of rat hind limb with polychromatic polarized light at 400-2000 nm produces a long-term inhibition of baseline afferent traffic in *n. saphenus*, while nonpolarized light produces biphasic changes in baseline activity: transient activation is followed by long-term inhibition of discharges in the nerve. Subcutaneous injection of sodium nitroprusside (10 μg/ml) with subsequent irradiation of the hind limb with polarized light significantly increased afferent activity in the sciatic nerve and *n. saphenus*, which attests to involvement of nitric oxide in activation of cutaneous nerve terminals during irradiation with polarized light.

Key Words: *polarized light; cutaneous afferent fibers; impulse activity; nitric oxide; EEG; desynchronization*

Polarized light is now widely used in the treatment of local and systemic inflammation [1,5,7,9,10]. In this connection, it is of interest to study the mechanisms of curative effect of various physical factors, in particular, near-visible light radiation.

Our aim was to study changes in impulse traffic in cutaneous branches of the femoral and sciatic nerves under the action of stimuli of the same modality, but various degree of polarization (linearly polarized and nonpolarized light within 400-2000 nm). It was expected that monitoring of impulse activity in cutaneous nerves would reveal specificity of the discharge patterns in dependence on parameters of electromagnetic stimulation.

MATERIALS AND METHODS

Experiments were carried out on 12 male rats weighing 250-280 g. The animals were kept under standard vivarium conditions. The rats were intraperitoneally narcotized with urethane-nembutal (400 and 30 mg/kg, respectively) and fixed in a stereotaxic apparatus. Afferent activity in branches of *n. saphenus* and *n. ischiadicus* was continuously recorded in a computer-assisted setup using bipolar AgCl electrodes covered with mineral oil [3,6]. The total impulse area was calculated (an integral value depending on the frequency, amplitude, and duration of discharges). The data were analyzed with original software developed in Belorussian Academy of Sciences.

Polarized (Bioptron AG) or nonpolarized (ITMO, Belorussia) light (λ=400-2000 nm, beam power 40 mW/cm^2) was applied to depilated (with a special paste) area (1.8 cm^2) of hind limb. Irradiation was performed for 5-15 min after preliminary recording of baseline impulse traffic in the nerve for at least 5 min. After irradiation, impulse activity was recorded for at least 20 min. The sequence of irradiation with polarized and nonpolarized light was alternated in each experiment. Sodium nitroprusside (10 μg/ml, 0.05 ml, RBI) was injected subcutaneously into the tibial part of the hind limb.

The results were analyzed statistically using Student's *t* and ANOVA tests.

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RESULTS

Irradiation of rat hind limb skin with light of the same intensity, but various degree of polarization induced different characteristic changes in afferent traffic in *n. saphenus* and *n. ischiadicus* branches. In experiments with nonpolarized light, the most pronounced and prolonged decrease in afferent activity was observed after termination of irradiation (Fig. 1, *a*), while polarized light gradually decreased impulse activity during stimulation, and this decrease became more pronounced after its termination (Fig. 1, *a*, *b*). The most drastic differences in the reaction of cutaneous afferent fibers to light stimuli of various degree of polarization were observed after activation of cutaneous receptors. To this end, sodium nitroprusside (NO donor) was injected subcutaneously under the receptive field. The preparation enhanced afferent traffic in *n. saphenus* (Fig. 2), which agrees with the evidence on the activating effect of NO on various receptors [2,6,8].

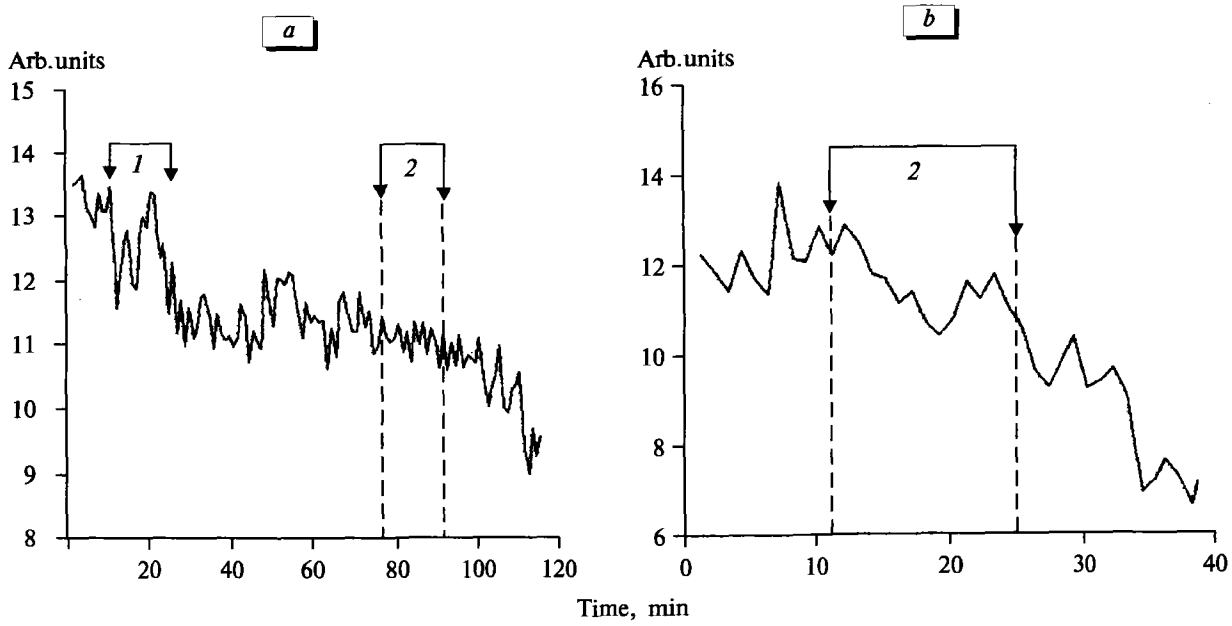

Fig. 1. Effect of irradiation of rat hind limb with nonpolarized (*1*) and polarized (*2*) light on intensity of afferent traffic in *n. saphenus*. Ordinate: total area of nerve impulses.

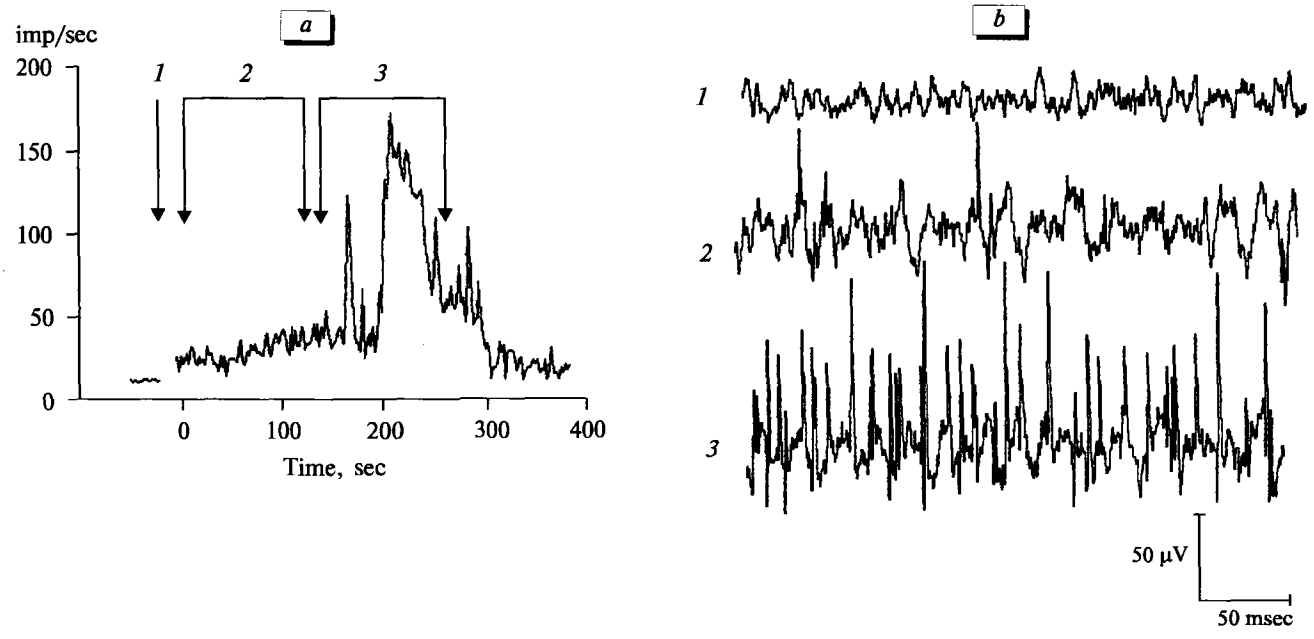

Fig. 2. Discharge frequency (*a*) and neurograms (*b*) of afferent traffic after subcutaneous injection of sodium nitroprusside (*1*) with following irradiation of hind limb with nonpolarized (*2*) and polarized (*3*) light.

Subsequent irradiation with nonpolarized light gradually increased discharge frequency from 11.8± 1.0 to 35.7±1.5 Hz (n=5, p<0.01, Fig. 2). Irradiation of the receptive field with polarized light drastically increased afferent traffic (Fig. 2): the discharge frequency reached a maximum value of 141.4±3.7 Hz (p<0.01 compared to both previous reactions). Taking into consideration the fact that in the absence of mechanical stimulation the baseline afferent traffic in cutaneous nerves predominantly reflects firing of cold and warm receptors [4], it can be concluded that stimulation with light of the same intensity and different degree of polarization produced characteristic changes in afferent discharge patterns depending on polarization parameters (Fig. 2). Since light activates the release of NO by donors [8], it can be assumed that enhanced subcutaneous accumulation of NO induced by linearly polarized light is caused by its increased permeability through the skin. Our experiments confirmed the evidence that the initial functional state of tissues is an important factor determining tissue response to stimulation. The direction of changes in cutaneous afferent activity depends not only on the parameters of electromagnetic radiation in the range of 400-2000 nm, but also on the initial activity of cutaneous receptors in the stimulated area.

Hence, peculiar changes in the neural activity under the effect of polarized and nonpolarized light were revealed in the experiments with irradiation of skin, but not the retina. It can be assumed that the revealed peculiarities in the responses of somatic afferent fibers to stimulation of skin with electromagnetic radiation of various degree of polarization partially underlie systemic and local effects of linearly polarized light observed in clinical practice.

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