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EFFECT OF REFLEX THERAPY ON TIME COURSE OF ULTRASTRUCTURAL CHANGES IN MUSCULAR BRANCHES OF THE BRACHIAL PLEXUS

A. M. Zagrebin, O. A. Khonny, V. M. Chuchkov, A. V. Isaev, and T. B. Shirokova

UDC 615.841.1-015.44:[616.833.34+616.747.1]-018.1

KEY WORDS: myelinated nerve fivers; reflex therapy

Reflex therapy, the effectivensss of which has been proved by centuries of practical experience, has become widely used in medicine in recent years. However, the general mechanisms of this phenomenon have not yet been studied. There have been only isolated investigations of nerve fibers at acupuncture points [5] and data have been published on the composition of receptors at the Ximen, Jianshi, and Neiguan points of reflex therapy [4]. The fact that if a needle is inserted into man at an acpuncture point a wide range of somatic sensations arises (a feeling of bursting burning pressure, pain, and heat) indicates activation of the nervous system. The sensations mentioned above can be induced in man by stimulation of well known somatic receptors [3]. According to data in the literature [7] during acupuncture the needle penetrates to a depth of not more than 2.5 cm, i.e., it is often in muscle tissue. Meanwhile, no publications could be found in the accessible literature dealing with the study of the time course of changes in nerves of skeletal muscles at the ultrastructural level under the influence of reflex therapy.

The aim of this investigation was to study the trend of changes in myelinated nerve fibers during reflex therapy at the ultrastructural level.

EXPERIMENTAL METHOD

Experiments were carried out on mature male albino rats weighing 150-170 g. Active points on the forelimb were located by means of a small searching instrument, designed and made by engineers in the Research Department of Appliances and Methods of Measurement, Ustinov Mechanical Institute. Determination of acupuncture points by means of this apparatus is based on the principle of a lower resistance at the point to a direct current than in the zones immediately surrounding it. During the search a direct current with a voltage of 1-10 V was applied for not more than 500 μsec. By means of the instrument it was possible to look for points with different levels of sensitivity (10 different levels). The active point was recorded acoustically by changes in the sound heard in earphones. Muscular branches of the biceps and triceps muscles and also of the flexor digitorum sublimis and extensor digitorum of the forelimb, taken on the 1st, 3rd, 5th, and 10th days of stimulation and 10 days after the end of acupuncture, were used as the test objects. Acupuncture needles up to 5 mm long were inserted under ether anesthesia at points of the forelimb determined with the instru-

Department of Normal Anatomy, Ustinov Medical Institute. (Presented by Academician of Medical Sciences of the USSR V. V. Kupriyanov.) Translated from Byulleten' Eksperimental'noi Biologii i Meditsiny, Vol. 103, No. 1, pp. 109-111, January, 1987. Original article submitted March 10, 1986.

 0007-4888/87/0103-0128$12.50

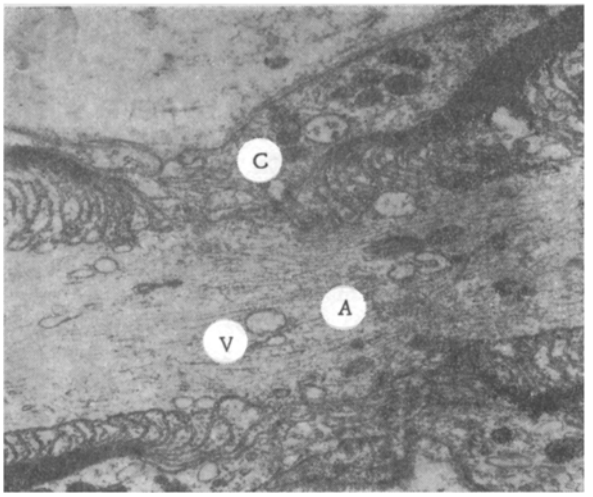

Fig. 1

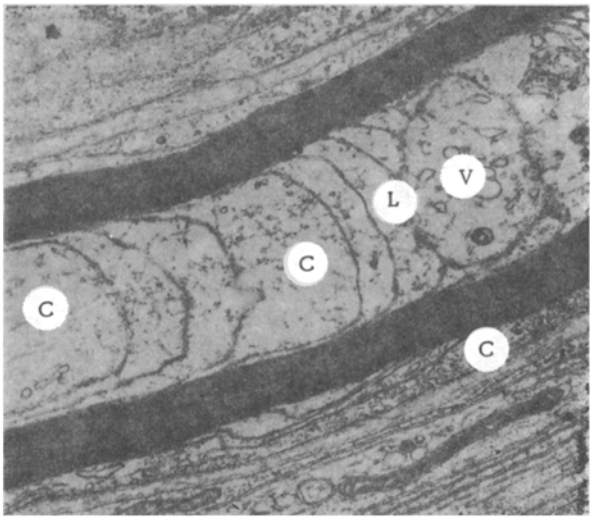

Fig. 2

Fig. 1. Ultrastructure of Ranvier node in rat median nerve 24 h after a single acupuncture session. A) Axon; L) loops of node; C) cytoplasm of lemmocyte; M) mitochondria; Mt) mictorubules; Nf) neurofilaments; V) vesicles. Here and in Fig. 2, 20,000 ×.

Fig. 2. Ultrastructure of paranodal region of Ranvier node in rat median nerve on 5th day of acupuncture stimulation. L) Greatly widened loops of node with translucency of matrix and aggregation of floccular material; C) cytoplasm of lemmocyte; V) concentrations of vesicles in cytoplasm of paranodal loops.

ment. The duration of one session was 20 min. Muscular nerves of intact rats, anesthetized with ether, served as the control. The isolated muscles together with long branches of the brachial plexus were fixed in 2.5% glutaraldehyde solution. Later, using the MBS-2 binocular attachment, muscular branches were isolated and treated by the usual methods of electron microscopy. Ultrathin longitudinal sections were studied in the JEM-7A electron microscope.

EXPERIMENTAL RESULTS

The ultrastructure of the nerve fibers and glia 24 h after a single stimulation for 20 min was indistinguishable from the control. Many myelinated and nonmyelinated fibers, surrounded by lemmocytes, were visible in these sections. Myelinated nerve fibers had the ordinary structure. Neurofilaments and microtubules, mitochondria with clearly distinguishable cristae, and single vesicles were found in the axoplasm of these fibers. The myelin sheath had smooth outlines and retained its compactness. The structure of components of the myleinated nerve fiber such as Schmidt—Lantermann clefts and Ranvier nodes was undisturbed (Fig. 1).

In sections taken on the 3rd day of stimulation the early signs of reactive changes in the nerve fibers were noted. Most fibers were indistinguishable in their ultrastructure from the controls, but early changes were observed in some fibers, in the form of swelling of the cytoplasm of the glycocytes. The Ranvier nodes and Schmidt—Lantermann clefts were swollen to a greater degree. The general appearance of the swollen clefts and nodes was highly characteristic. The paranodal loops of the nodes and cytoplasmic tongues of the clefts were altered in shape, they became widened, and were filled with translucent edematous cytoplasm, with accumulation of floccular material. Many vesicles, often grouped and confluent with the surrounding membranes, appeared in both the glioplasm and the axoplasm. These changes were observed primarily in the peripheral loops of the nodes, i.e., further from the intersegmental space.

On the 5th day of stimulation the reactive changes were observed to have progressed. Virtually all the nerve fibers showed some degree of re-organization. Swelling of the Ranvier nodes (Fig. 2) and of the Schmidt—Lantermann clefts was more marked than the edema had spread to the central regions. Areas of translucency with aggregation of floccular material also appeared in the axoplasm. In it, just as in the glioplasm, structures not typically found in the intact state appeared: lysosomes, membrane bodies, and many vesicles and vacuoles. Deformed mitochondria with remnants of cristae were often seen. The axoplasm of these

altered fibers was characterized by the appearance of many neurofilaments and by a corresponding decrease in the number of mictotubules. Increased adhesion of the membranes was noted, with the appearance of submembranous aggregates and their association with nearby membranes. On the 10th day of stimulation a similar picture was observed. The ultrastructure of preparations obtained 10 days after the end of stimulation was similar to the control, except that in individual nerve fibers a slight degree of edema of the glioplasm still remained in the region of the nodes and clefts, and the vesicles remained rather more numerous than in the control. At the end of stimulation, a gradual return of the ultrastructure of the nerve fibers to its original state evidently takes place.

The nerve fiber is known to respond to any stimulation by a combination of structural changes, which are not specific in character, i.e., they follow a similar course irrespective of the character of stimulation [6]. The response of the neuron to stimulating agents and to pathological states also was investigated at the ultrastructural level. The changes developing under these circumstances also were considered to be nonspecific [1]. Reactive changes affecting both the axon and the glial cell were manifested, first, as destruction, of certain ultrastructures, principally mitocohodria, microtubules, and the endoplasmic reticulum, and second, as increased formation of others, manifested as a marked increase in the number of vesicles, lysosomes, and membrane bodies. Responses of the neuron and glia discovered in this investigation are also, evidently, nonspecific to stimulation by the acupuncture needle.

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EFFECT OF COLCHICINE AND PILOCARPINE ON SECRETORY ACTIVITY OF TYPE II ALVEOLOCYTES IN THE RAT LUNG

M. S. Pokrovskaya

UDC 612.212.014.1.014.462.8.014.46: [615.277.3: 547.944.6+615.216.84:547.944.8

KEY WORDS: surfactant; secretion; colchicine; pilocarpine

Under physiological conditions secretion of alveolar surfactant is of the merocrine type and takes place by exocytosis from the apical surface of type II alveolocytes (AII) [6]. Under the influence of colchichine, secretory activity from the apical surface of the cells is reduced and a basal type of surfactant secretion appears, i.e., the release of osmiophilic material from the basal region of the cell into the interstices [1]. Meanwhile, we know that pilocarpine, as a parasynpathomimetic, stimulates alveolar surfactant secretion from the apical surface of AII into the lumen of the alveoli [4, 5, 7].

With these considerations is mind it was decided to study how the simultaneous action of colchicine and pilocarpine affects the character of secretion of alveolar surfactant.

Laboratory of Pulmonology, Research Institute of Human Morphology, Academy of Medical Sciences of the USSR, Moscow.

(Presented by Academician of the Acdaemy of Medical Sciences of the USSR D. S. Sarkisov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 103, No. 1, pp. 111-114, January, 1987. Original article submitted May 6, 1986.

0007-4888/87/0103-0130$12.50