EFFECT OF DESTRUCTION OF THE ORAL AND CAUDAL TRIGEMINAL NUCLEI ON NOCICEPTIVE SENSATION IN CATS

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UDC 616.8-009.7-092.9-092-08

KEY WORDS: trigeminal nuclei, pain.

To understand the physiological mechanism of pain formation and of successful treatment of pain syndromes in the facial region, the study of the functional role of nuclei of the trigeminal complex is very important. Two of them, the oral and caudal nuclei (OTN and CTN, respectively), are regarded as the principal afferent channels by which nociceptive signals are received. However, the relations between the nociceptive information arriving through them and the role of each nucleus in the integral perception of pain and response to it remain unexplained [3, 8].

The aim of this investigation was to study changes in the structure of nociceptive responses in animals after injury to OTN and CTN separately.

EXPERIMENTAL METHOD

Experiments were carried out on 14 unrestrained adult cats. At the first stage, electrodes for stimulating the dental pulp and lip were inserted under pentobarbital anesthesia (40 mg/kg body weight). The electrodes, made from nichrome wire, were taken subcutaneously to the mucous membrane of the upper lip and the upper canine tooth on both sides. To stimulate the dental pulp the electrode was introduced into the pulp canal and secured with acrylic glue. The electrode socket was fixed to the animal's skull with screws and acrylic glue.

OTN (seven cats) and CTN (seven cats) was damaged unilaterally, electrolytically. The opposite side served as the control. The animals were tested in an experimental chamber 6 days after the operation for 2-3 weeks. Electrical stimulation was applied to the dental pulp and lip in series of 3 pulses, each 1 msec in duration, with an interval of 100 msec, and with an intensity of 2 to 100 V. At the end of the experiment the lesions were verified histologically.

EXPERIMENTAL RESULTS

Four levels of response were distinguished, on the basis of the degree of integration of behavioral reponses to stimulation of the lip (Table 1), to correspond to the types of responses described for rats [1] and monkeys [13]. The main components of these four different

TABLE 1. Characteristics of Behavioral Responses to Stimulation of the Lip

Experimental conditions	Level of response			
	I	II	III	IV
Control	Twitching of whiskers, eyelids, ears	Mouth opening reflex, holding the head back, compressing the ears	Thrusting the head forward, limb movements, shaking of the body	Restlessness, vocalization, defensive reaction
Injury to CTN	The same	The same	The same	Lying down, curling into a ball, indistinct feeble vocalization
Injury to OTN	» »	» »	Thrusting the head forward, standing still, generalization of movements	Aggression, loud vocalization

Central Scientific-Research Institute of Reflex Therapy, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR G. N. Kryzhanovskii.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 102, No. 8, pp. 134-136, August, 1986. Original article submitted April 4, 1985.

 0007-4888/86/0008-1020 $12.50

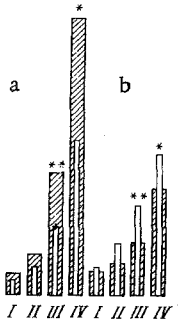

Fig. 1. Changes in profile of nociceptive sensitivity after injury to CTN and OTN. Columns show thresholds of level I-IV of response to stimulation of lip: a) injury to CTN; b) to OTN. Unshaded columns — intact side. *$p < 0.05$, **$p < 0.01$.

levels were twitching of the whiskers, the mouth opening reflex, throwing the head forward, and a defensive response. Responses to stimulation of the dental pulp were weaker and confined mainly to reflex mouth opening and holding the head back. As nociceptive threshold of tolerable stimulation, level III was used, whereas level IV characterized the emotional-affective component of the animal's nociceptive response.

Injury to the medial part of CTN caused general inhibition of behavioral response to stimulation of the lip. The thresholds of levels III-IV were 80% higher after the operation than on the intact side (Fig. 1). Some elevation of the thresholds of levels I-II was observed ($P < 0.1$). The character of the behavioral responses at levels III-IV was changed. A passive defensive response came to be more characteristic of level IV. In response to stimulation the animals lay down and curled into a ball. Occasionally this response was accompanied by unease and by feeble vocalization.

Stimulation of OTN led to different changes in behavioral responses. Thresholds of levels III-IV of response to stimulation of the lip were 25-40% lower than on the intact side. Some elevation of the thresholds of levels I-II was observed ($P > 0.05$).

Sudden recoiling of the whole body to one wide began to form part of the structure of level III. The thrusting forward of the head became more prolonged: The animal began to stand motionless in a strained posture, the head thrust forward and the eyes tightly closed. Defensive responses at level IV became more active in character, in the form of repeated thrusts with the paw, running about, biting the stimulating wire, and loud vocalization. These responses continued for some time even after the end of stimulation.

During stimulation of the dental pulp nociceptive reaponses (levels III-IV) strengthened after injury of botn OTN and CTN.

In these experiments the mouth opening reflex to weak stimulation was not accompanied by typical manifestation of pain. This fact, and also the possibility of evoking the reflex both from the dental pulp and from the lip, is evidence that it cannot serve as a criterion for the evaluation of pain, and they confirm the conclusion that weak stimulation of the dental pulp does not evoke nociceptive responses in conscious animals [6, 13] and man [10, 11]. OTN plays the decisive role in the mouth opening reflex, although modulation by CTN also is not unimportant. Our experiments showed that injury to CTN leads to inhibition of the reflex. Similar results also were observed after complete excision of CTN [9]. Meanwhile CTN has an inhibitory influence on the masseter muscle [4], which participates in the mouth closing reflex. An increase in the relative flow of afferent impulses through CTN after injury to OTN leads to strengthening of inhibition of the masseter muscle. This can explain the facilitation of the mouth opening reflex which we observed after injury to OTN.

In our experiments injury to the reticular part of CTN leads primarily to inhibition of the emotional-affective component of pain. Loss of nociceptive and temperature sensitivity, but with only minor changes in tactile sensitivity, were caused by total excision of CTN as a result of dorsolateral division of the medulla in man [14] and primates [15]. Similar changes were observed after injury to other structures of the nonspecific projection system: the frontal cortex [7] and the parafascicular complex of the thalamus [12], connected with the conduction of the protopathic component of pain [2]. Conversely, as a result of injury to the specific structure of OTN generalization and prolongation of the nociceptive responses were oberved. Similar changes (inability to respond adequately to stimulation, a more general and marked response even to weak stimulation) follow removal of the second somatosensory area of the cortex [5]. Thus injury to the specific projection system intensifies the flow of impulses along the nonspecific system which, in turn, is expressed as more acute perception

of pain and of its protopathic component. The results confirm the view [1, 2] that integral perception and adequate response to nociceptive stimulation depend on the mutual balance between activity of the specific and nonspecific systems of the brain.

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MODULATING EFFECT OF ANGIOTENSIN II AND BRADYKININ ON NEUROTRANSMITTER SENSITIVITY OF CENTRAL NEURONS

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UDC 612.825.015.3.014.46:[577.175.822+577.175.852/.853

KEY WORDS: neuron; angiotensin II; bradykinin; neuromodulators; neurotransmitters.

Much attention has been paid in recent years to the study of the participation and functional role of biologically active compounds, especially those of peptide nature, in the molecular processes of integrative activity of the brain and single neurons [1, 2]. A characteristic feature of endogenous neuropeptides, such as angiotensin II and bradykinin, is their marked polyfunctional properties: They induce many diverse peripheral and central effects and influence learning and memory processes, motivations, neuronal electrogenesis, and synaptic transmission [3, 7, 8]. However, the concrete cellular and molecular mechanisms of the central action of many neuropeptides remain inadequately studied and have been investigated mainly in whole brain structures, after systemic and intraventricular injection.

The aim of this investigation was to study the effects of endogenous neuropeptides — angiotensin II and bradykinin — on chemical sensitivity of cerebral cortical neurons to the neurotransmitters acetylcholine and noradrenalin.

EXPERIMENTAL METHOD

Experiments were carried out on sensomotor cortical neurons of unanesthetized male rabbits weighing 2.5-3 kg, immobilized with muscle relaxants, and lightly fixed in a frame. After trephining, a miniature micromanipulator, in which the microelectrode was placed, was fixed to the animal's skull by means of quick-hardening plastic (Noracryl). Electrical activity was recorded extracellularly and the test substances applied microiontophoretically by

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(Presented by Academician of the Academy of Medical Sciences of the USSR I. P. Ashmarin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 102, No. 8, pp. 136-139, July-August, 1986. Original article submitted July 3, 1985.

0007-4888/86/0008-1022 $12.50