CORTICAL PROJECTIONS OF THE VENTROLATERAL THALAMIC NUCLEUS OF THE CAT

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UDC 612.826.4 : 612.825.1

The distribution of cortical projections of the ventrolateral nucleus (n. VL) of the thalamus was investigated in cats anesthetized with chloralose. Projections of the ventromedial part of n. VL were shown to run chiefly into region 4γ of the motor cortex and to be organized in accordance with the somatotopical principle.

KEY WORDS: thalamus; motor cortex; ventrolateral thalamic nucleus.

The motor cortex of the cat is the principal projection region of the ventrolateral thalamic nucleus (n.VL) [9, 14, 15]. Efferent fibers terminating in n.VL originate in that region of the cortex [4, 7, 8, 11]. Electrophysiological investigations have shown that interaction in n.VL between the cerebellar striatal systems and also the influence of nonspecific thalamic nuclei on n.VL determine the character of the information reaching the motor cortex [1, 2, 5, 10, 13].

However, anatomical studies of cortical projections of n.VL have given contradictory results. Some workers [15, 16] consider that n.VL projects only into the motor cortex, but others [6, 14] point to more extensive projection zones, including the motor, sensory, prefrontal, and association areas of the cortex. Unfortunately the contradictory nature of these results has prevented the problem from being finally solved.

The object of this investigation was to study cortical projections of the ventrolateral thalamic nucleus.

EXPERIMENTAL METHOD

Acute experiments were carried out on cats anesthetized with chloralose (80 mg/kg) using a stereotaxic technique. All painful points during fixation of the head were previously infiltrated with 1% procaine. To obtain complete immobilization, listhenon was injected intravenously and the animals were artificially ventilated. Stimulation of n.VL was carried out by means of a concentric macroelectrode (diameter 0.8 mm), which was used for stimulating or recording depending on the purpose in mind (parameters of stimulation of the nucleus 5 V, 0.2 msec). Biopotentials were recorded by a monopolar technique from the cortical surface by a silver electrode. Bipolar needle electrodes were used for peripheral stimulation. At the end of the experiment the location of the tip of the stimulating electrode in n.VL was verified histologically in the usual way.

EXPERIMENTAL RESULTS

Previously [3] the writers showed the presence of contralateral somatotopic organization of the projection of cutaneous afferents in n.VL; the representation of the forelimb was located in the ventromedial part of the nucleus and that of the hind limb in the dorsolateral part. In the present investigation, projections of the ventromedial region of n.VL (coordinates A 10.5, L 3.5, H +0.5 on the atlas of Jasper and Ajmone–Marsan) to the cortex were investigated. The localization of the electrode tip was judged from the focal potential evoked in the nucleus by stimulation of the fore and hind limbs. It will be clear from Fig. 1 that no response appeared to stimulation of the hind limb (2B), whereas in response to stimulation

Laboratory of Physiology of Subcortical Brain Structures, Institute of Normal and Pathological Physiology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR A. M. Chernukh.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 78, No. 11, pp. 3-5, November, 1974. Original article submitted February 7, 1974.

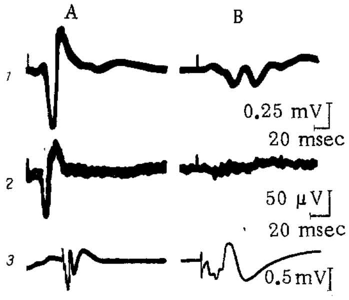

Fig. 1

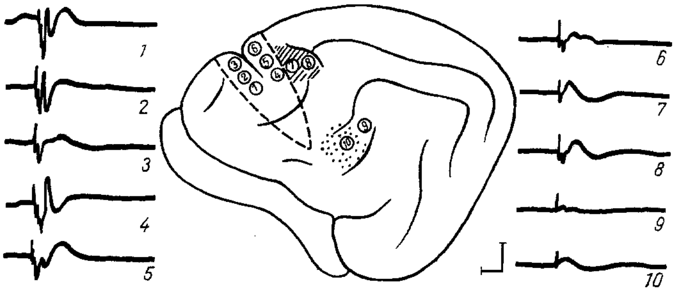

Fig. 2

Fig. 1. Responses in motor cortex (area 4γ) and n.VL of the thalamus to stimulation of contralateral limbs: 1) response in motor cortex in zone of representation of forelimb to stimulation of fore (A) and hind (B) limbs; 2) response in n.VL to stimulation of fore (A) and hind (B) limbs; 3) thalamo-cortical response in motor area of cortex to stimulation of n.VL with slow (A) and fast (B) sweep.

Fig. 2. Distribution of responses in sensomotor area of cortex evoked by stimulation of n.VL. Numbers denote potentials recorded from corresponding points of the cortical surface. Broken line marks boundary of motor cortex. Shaded area is zone of representation of forelimb in somatosensory area 1, dotted area ditto in somatosensory area 2. Calibration: 0.5 mV, 15 msec.

of the forelimb (2A) a well-marked positive–negative potential appeared after a latent period of 10 msec. Simultaneously, for control purposes, the primary cortical response was recorded in the lateral part of the pericruciate gyrus to stimulation of the forelimb (1A) and hind limb (1B).

Once the region of representation of the forelimb in n.VL had been found in this manner the next step was to stimulate this region of the nucleus. During stimulation of n.VL characteristic thalamo-cortical evoked potentials were recorded in the cortex after a short latent period of 1-2 msec. The response consisted of a positive–negative–positive complex (Fig. 1: 3B).

A scheme of the brain in which numbers denote points on the surface of the cortex from which the evoked potentials were recorded is given in Fig. 2. The largest responses were recorded from area 4γ of the motor cortex (Fig. 2: points 1, 2, 4, 5), the region of representation of the contralateral forelimb. The amplitude of the responses increased with increasing distance from this region (Fig. 2: points 3, 6).

In the zone of representation of the forelimb in somatosensory area 1 the responses were much smaller in amplitude and they differed in configuration from the typical thalamo-cortical response recorded in the motor cortex (compare points 7, 8 and 1, 4 respectively). Responses were virtually absent in somatosensory area 2 (points 9, 10).

The problem of projections of n.VL in cortical somatosensory areas 1 and 2 is not clear. The small amplitude of potentials recorded there, and the configuration of these potentials, uncharacteristic of the typical thalamo-cortical response, do not permit definite conclusions to be drawn regarding the possible existence of these projections.

The results of this investigation thus show that the projections of thalamic n.VL run chiefly into the motor cortex (area 4γ) and that they are organized on the somatotopic principle (the region of representation of the forelimb in n.VL sends it projections into the zone of representation of the same limb in the motor cortex). The results are in good agreement with the anatomical findings [15] and also with the results of electrophysiological studies [12, 13] using a completely different approach.

Bearing in mind the results of the earlier work [3] there are good grounds for considering that the whole pathway of the somatic afferents from the periphery to the motor cortex has a topographic organization. From the functional point of view these data provide grounds for the conclusion that there are narrowly localized mechanisms for the sensory control of voluntary movements in the neocortex.

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