

ASCENDING INFLUENCES OF THE PONTINE NUCLEI ON THE PARIETAL ASSOCIATION CORTEX NEURONS

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The projection that connects the cerebral cortex to the cerebellum is probably one of the most important pathways through the central nervous system [15,16]. It is realized by the fiber system that involves the pontine nuclei, as the major input intercalated structure and, to the minor extent, other precerebellar nuclei, which are associated with the reticular formation, and inferior olive [2]. Evolutionary the formation of the cortico-ponto-cerebellar loop went on parallel with the development of the cerebral hemisphere and the cerebellum, and it accompanies improvements in motor skills. About 40 million cerebral fibers target the pontine nuclei in humans [17]. The pyramidal tract axons also send their collaterals to the pontine nuclei, however their numerical contribution is not large [1]. About half of many fibers in cortico-cerebellar loops originate in the pontine nuclei and contact the cerebellar granular layer as the mossy fibers. It has been calculated that in humans more than 90% of all corticofugal fibers in cerebral peduncle connect to the pontine nuclei and approximately the same percentage of all cerebellar mossy fiber carry signals from cerebral cortex handed over by the pontine nuclei [17]. Among these structures the major parts of cerebral cortex and cerebellum are involved in communication, due to the large size of cortico-ponto-cerebellar projections [16]. The cortical afferents to the pontine nuclei originate from the extensive cortical area. In rats, virtually all, and in primates about two-third of all cerebrocortical areas project to the pontine nuclei, which include [6,9] the primary motor and sensory, frontal and parieto-occipital areas. The cerebral cortex also influences the cerebellum through its another system of connection: climbing fibers, whose source, the inferior olive, receives cerebral signals directly or indirectly via mesencephalic nuclei [14].

The opposite influence from cerebellum back to the cerebral cortex is realized by the ventral thalamic nuclei (the motor thalamus). In cats and monkeys this projection involves not only the primary motor cortex, frontal and prefrontal areas [11], but also the parietal area [5,19]. During the investigation of communication loop of cerebral cortex - pontine nuclei-cerebellum-thalamus-cerebral cortex peculiarities of synaptic responses were revealed in efferent neurons of parietal association cortex of cats, evoked by the stimulation of the central cerebellar nuclei [4]. It has been shown that the latencies of cerebellofugal - induced excitatory postsynaptic potentials (EPSPs), evoked in parietal cortex neurons, correlate with the latencies of antidromic invasion of the same cells

during the analysis of different parietal cortex efferent projections (cortico-cortical, cortico-pontine, cortico-rubral) [4,5]. Along with the thalamic relay for the ascending projection of brainstem fibers, by applying retrograde transport method in combination with immunohistochemical technique, numerous cholinergic fiber ascending to forebrain were revealed. These cells are the important component of the central tegmental pathway, forming the extra-thalamic relay for functioning of the brainstem pathways, particularly from the periventricular pontine gray substance to the cerebral cortex [7].

The present work represents the further investigation of the above-mentioned communication loop. The synaptic responses of the cat parietal association cortex neurons to the pontine nuclei stimulation were investigated.

Material and Methods

The experiments were performed on the cats, anesthetized by intraperitoneal injection of the mixture of chloralose (45mg/kg) and pentobarbital (15mg/kg). In a part of the experiments the cats were immobilized by flaxidile and maintained on artificial ventilation. Stimulating tungsten bipolar electrodes with interpole distance of 1.0 mm and resistance 10-20 $k\Omega$ were inserted into the lateral and the medial groups of pontine nuclei proper. The rectangular current pulses of 0.1 ms duration and 0.4 mA were used for stimulation. Intracellular registration of the activity was performed by means of glass micropipettes, filled with 2.5 KCL of resistance 10-20 $M\Omega$. The activity was registered from the anterior suprasylvian and anterior lateral gyri of parietal association cortex. Localization of the electrodes was controlled histologically [13].

Results and Discussion

In the parietal association cortex of cats the stimulation of the medial and the lateral groups of the pontine nuclei proper were registered in 137 neurons, 83 of which were excited synaptically and 54 - antridomically. Antridomic action potential, investigated during the activation of the efferent neurons of parietal cortex, were characterized by a short and fixed latent period at different intensities of stimulation, short refractory period (mean 0.89 ms), reveled by double-shock stimulation, ability to reproduce high frequency stimulation of axons, and absence of preceding slow prepotential. At threshold, suprathreshold and high frequency stimulation, the latency of the antidromic potentials remained fixed and equal to 0.62-1.51 ms (mean 1.07±0.20 ms; n=38). The recording of antidromic action potential indicated the existence of anterior suprasylvian and anterior lateral gyri neurons, sending axons to the pontine nuclei proper. Along with the antidromic action potential in the parietal association cortex to the pontine nuclei stimulation EPSPs were recorded. The latent period of EPSPs was equal to 2.0-6.0 ms (mean 3.7±1.09 ms; n=41), rising phase of EPSPs was equal to 3.0-9.5 ms (mean 5.13±1.47 ms; n=35), duration of EPSPs fluctuated within 6.21-18.7 ms (mean 12.08±1.61 ms; n=16). The oligosynaptic EPSPs in which the rise time of depolarization changed insignificantly by increasing intensity of stimulation were rarely recorded. These EPSPs were characterized by relatively long latencies (2.0-3.9 ms) which excluded its monosynaptic origin (fig.1). At increasing stimulation intensity the second, more long-latency component of EPSP was recorded (fig.1 C,D). In most neurons at the critical level of depolarization equal to 5.5-12.8 ms (mean 8.024±2.26 ms; n =22) action potentials were generated (fig.1 E,F; fig.2 C,D, E). Along with the oligosynaptic EPSPs, in most

neurons of the anterior suprasylvian and anterior lateral gyri to the medial and the lateral groups of the pontine nuclei stimulation were recorded EPSPs with unstable latent periods (4.0–6.0 ms) (fig. 2 A,B). It was proposed they are polysynaptic by origin.

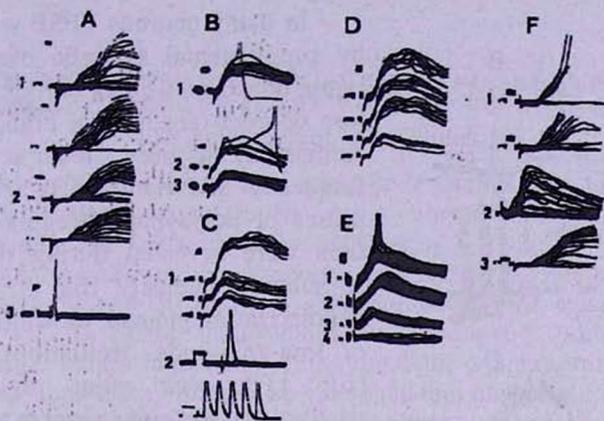


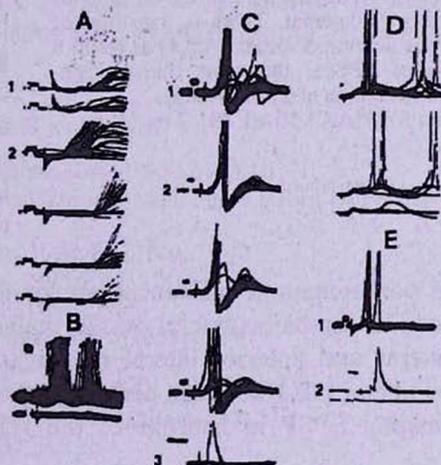
Fig. 1. Oligosynaptic activation of parietal neurons by stimulation of the pontine nuclei proper
Intracellular activity was recorded in six neurons in the anterior suprasylvian (A-C) and anterior lateral (D-F) gyri to stimulation of lateral (A,B,D,F) and medial (C,E) groups of the pontine nuclei proper. A gradual increase of stimulation from bottom to top (A,1,2;B,C,1;D,E; F,1). Axosomatic (B-E) and axosomatic (A,F) EPSPs. Revealing polysynaptic component depending on the increase of the stimulation of intensity (B,2;C,1- upper trace;E,1,2). Antidromic action potentials evoked by stimulation of red nucleus (A,3) and medial part of anterior sigmoid gyrus (C,2). C,2 lower trace—effects of high-frequency stimulation of 800/s.
Calibration: 0.5 mV(F,1,3), 5 mV (A 1,2;B-E;F,2), 25 mV(A,3), 1 ms (A;C,2;F), 2ms (B;C,1;D;E). In this and the following figures potentials were recorded by a d.c. amplifier. Five to 10 sweeps are superimposed at a frequency of repetition about six per second.

Some neurons to the pontine nuclei stimulation generated subsequent antidromic and orthodromic action potentials. Such kind of activation of neurons was recorded under the gradual increase of stimulation intensity. Antidromic action potentials are evoked by a higher threshold of stimulation. Rarely neurons having lower threshold for antidromic

Fig. 2. Oligo- and polysynaptic potentials of parietal neurons to stimulation of the pontine nuclei proper

Responses of five neurons of the anterior suprasylvian (A,B,E) and anterior lateral (C,D) gyri to stimulation of the lateral (A,B,C) and medial (D,E) groups of the pontine nuclei proper. The potentials at gradual (from bottom to top) intensity increase of stimulation and change of its polarity (A;C,2;D). Axosomatic (C,E) and axosomatic (A,D) EPSPs. Antidromic action potentials evoked by stimulation of anterior part of the posterior sigmoid gyrus (C,3) and red nucleus (E,2).

Calibration: 0.5 mV(A), 5 mV(C,1,2;D;E,1), 25 mV (B;C,3;E,2), 1 ms (A;C,3;D;E,1), 2 ms (B;C,1,2;E,2).



activity, similar to the threshold for revealing of orthodromic action potentials were recorded. According to the peculiarities of synaptic activation, the registered potentials could be, probably, ascribed to axosomatic and /or axodendritic EPSPs.

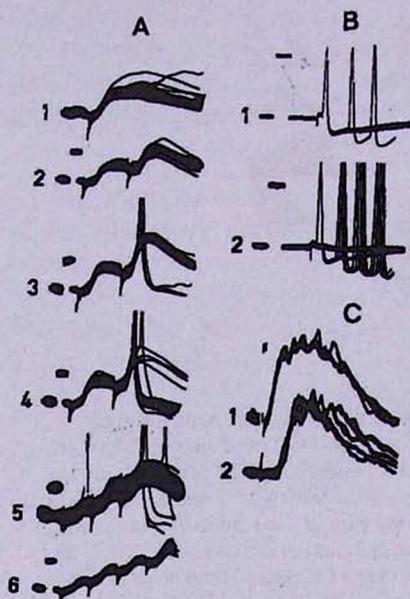


Fig.3. Peculiarities of the synaptic activation of parietal association cortex neurons to stimulation of the pontine nuclei proper

Intracellular activity was recorded in three neurons of anterior suprasylvian (A) and anterior lateral (B,C) gyri to stimulation of lateral (A,C) and medial (B) groups of pontine nuclei proper. Single (A,1) and paired pulse stimulations with increasing intensity from top to bottom (A,2-4;B,1,2) and from bottom to top (C) with identical interstimulus interval. There is transition of EPSPs to the action potentials (A,3,4) as result a summation of EPSPs; the same during high-frequency stimulation of 277/s (A,5,6). Calibration: 5 mV(A,C), 50 mV (B), 2 ms (A-E).

In many neurons EPSP was complicated by supplemental synaptic oscillation on its rising phase, as well as during the depolarization descent (fig.3). The high level of EPSP summation has been shown at the paired and frequency stimulation (fig.3A). The single pulses of polysynaptic regular action potentials were revealed during the increase of stimulation intensity (fig. 3, B). Prolonged depolarization plateau, on which large number of low-amplitude oscillations were applied (fig 3,C), was often registered. These oscillations are quite similar to the dendritic spikes which were described in the pyramidal neurons of cats hippocampus and cerebellar Purkinje cells of alligator [10]. The decrease of the response's latent period during the increase of stimulation intensity can be explained by multiple entrance of impulsations with the involvement of new ways (fig. 3C).

The results obtained are indicative of the existence of ascending excitatory ponto-cortical influences. The polysynaptic character of these influences allows us to suppose their realization through the cerebellum and the thalamus. It shows the registration of prolonged depolarization plateau, on which a large number of spike-like potentials have been applied, obviously having dendritic origin, that probably indicates to the possibility of the thalamic relay involvement to the way of EPSPs generation in the parietal association cortex in response to the medial and the lateral groups of the pontine nuclei stimulation [8].

The ponto-cerebral influences are quite well observed and analyzed [16,17]. The influences of cerebellar nuclei on the thalamic structures is especially realized through ventrolateral and anterior lateral nuclei as well as ventromedial, reticular and other thalamic nuclei [12,18]. It has been shown, that the cerebellar nuclei stimulation evoked monosynaptic EPSP in neurons of the ventrolateral, ventroanterior and ventromedial

thalamic nuclei [20]. Thalamo-cortical neurons are the last link of the observed ascending ponto-cortical pathway. It includes fast [21] as well as slow [3] neurons of pyramidal tract, which receive monosynaptic excitatory inputs from the ventrolateral thalamic nuclei.

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**ԿԱՍՏՐՁԻ ԿՈՐԻՉՆԵՐԻ ՎԵՐԸՆԹԱՑ ԱՉԳԵՑՈՒԹՅՈՒՆՆԵՐԸ ՈՒՂԵՂԻ
ԳԱԳԱԹԱՅԻՆ ՉՈՒԳՈՐԴԱԿԱՆ ԿԵՂԵՎԻ ՆԵՅՐՈՆՆԵՐԻ ՎՐԱ
Վ.Բ. Ֆանարջյան, Ե.Վ. Պապոյան**

Նարկոզի ենթարկված կապուների կամրջի և կողմնային սեփական կորիզային խմբերի զրգռման դեպքում զագաթային կեղևի նեյրոններում ներքջային զրգռման ժամանակ առաջացել են անփոփոխ և սինապսային պոպենցիալներ: Առաջինները արտացոլում են կեղև-կամրջային արտարար նեյրոնների ակտիվացման արդյունքները, երկրորդները ներկայացնում են մոնո- և բազմասինապսային դրոշող հերսինապսային պոպենցիալներ (ԴՆՄ), որոնք առաջանում են ազդակների ուղեղիկի ու տեսաթմբի միջոցով զագաթային կեղևի նեյրոններ մուտք գործելու արդյունքում: Նկատվել է ուղեղի զագաթային կեղևի նեյրոնների սամայի ու դենդրիտների ներգրավում ակտիվացման մեջ: Ներագրվել են նշված ԴՆՄ-ների առանձին հարկությունները, որոնք հանդիսանում են ուսումնասիրվող ուղեղի կեղև-կամրջի կորիզներ-ուղեղիկ-տեսաթմբ-ուղեղի կեղև կոմունիկացիոն օղակում վերջին հանգույցի ակտիվացման արդյունք:

**ВОСХОДЯЩИЕ ВЛИЯНИЯ ЯДЕР МОСТА НА НЕЙРОНЫ ТЕМЕННОЙ
АССОЦИАТИВНОЙ КОРЫ МОЗГА**

В.В.Фанарджян, Е.В.Папоян

У наркотозированных кошек на раздражение медиальной и латеральной групп собственных ядер моста в нейронах теменной коры при внутриклеточной регистрации возникали антидромные и синаптические потенциалы. Первые отражали результат активации эфферентных кортико-понтитных нейронов, вторые представляли олиго- и полисинаптические возбуждающие постсинаптические потенциалы (ВПСП), возникающие в результате поступления импульсации к нейронам теменной коры через мозжечок и таламус. Отмечалось вовлечение в активацию сомы и дендритов нейронов теменной коры мозга. Исследованы особенности указанных ВПСП, являющиеся результатом активации последнего звена в изучаемой коммуникационной петле кора мозга – ядра моста – мозжечок – таламус – кора мозга.

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