GENICULATE RELAY OF INTERHEMISPHERIC TRANSMISSION OF VISUAL INFORMATION

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KEY WORDS: lateral geniculate body; visual commissural pathways; evoked potentials; interhemispheric transmission of visual information.

The commissural systems of the brain play an important role in interhemispheric transmission of visual information from the retina to various regions of the cerebral cortex [2, 3, 8, 14]. However, the possibility of a subcortical relay of visual information arriving from the opposite hemisphere has not been adequately studied. Some workers regard cortico-cortical commissural projections as the principal structural basis for interhemispheric conduction of sensory impulses [5, 13]. Nevertheless, the results of morphophysiological investigations, revealing the existence of callosal connections of the lateral geniculate body [1, 4, 12], suggest that visual commissural influences can be relayed at the level of this subcortical relay.

The aim of the present investigation was accordingly to study the functional organization of visual commissural inputs of the lateral geniculate body with different degrees of reduction of visual afferent pathways. The use of methods of recording evoked potentials (EPs) and of neurosurgical methods of interrupting classical and commissural inputs of the lateral geniculate body in this investigation made it possible to demonstrate the important role of this subcortical relay in the interhemispheric transmission of visual information from the retina to the cerebral cortex.

EXPERIMENTAL METHOD

Experiments were carried out on 12 cats, divided into three groups: 1) intact animals, 2) cats with division of the left optic tract, 3) animals with division of the left optic tract and commissures of the telencephalon, diencephalon, and mesencephalon. Division of the optic tract interrupted retinal projections of the ipsilateral lateral geniculate body (LGB). Division of the brain commissures included division of the corpus callosum, of the anterior, hippocampal, interthalamic, intercollicular, and posterior commissures, and of the septum and fornix. After combined division of the left optic tract and the brain commissures, LGB in animals of group 3 could receive visual afferentation only along two theoretically possible pathways: the floor of the third ventricle and the mesencephalic reticular formation. Bilateral implantation of nichrome electrodes (diameter 0.3 mm) into LGB was carried out on all animals, using stereotaxic coordinates [9] (4 months after the operation on cats of groups 2 and 3). The reference electrode was a nichrome wire (0.4 mm in diameter) passed in a circle through the frontal sinus and occipital crest. Experiments were carried out on unimmobilized, waking animals. Flashes 0.2 msec in duration and with a frequency of 0.1-1.0 Hz were used for photic stimulation. The experiments lasted 7-10 days, for 30-40 min each day. Electrical responses were recorded on a four-tract magnetic tape recorder (Brüel and Kjaer) and subsequently analyzed by computer. The computer plotted averaged EPs for 50-100 realizations within an interval of 100 msec and with discretization steps of 0.5 msec. The arithmetic mean and dispersion ($M \pm \sigma$) of latent periods and amplitudes of peaks of individual components of the EPs also were determined. At the end of the experiment serial brain sections were stained by Nissl's method as a morphological control.

EXPERIMENTAL RESULTS

Interruption of the classical and commissural visual pathways to LGB in both hemispheres of the animals of groups 2 and 3 had no significant effect on latent periods of

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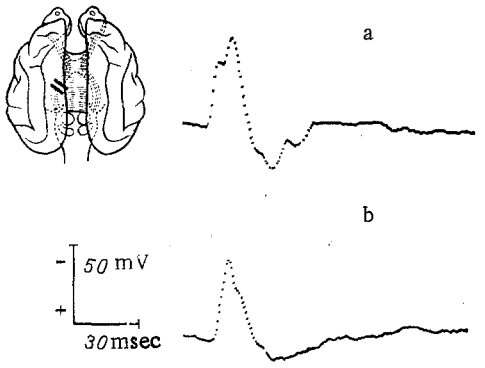

Fig. 1. Averaged EPs to flashes in right (a) and left (b) LGB in cats with division of left optic tract (group 2).

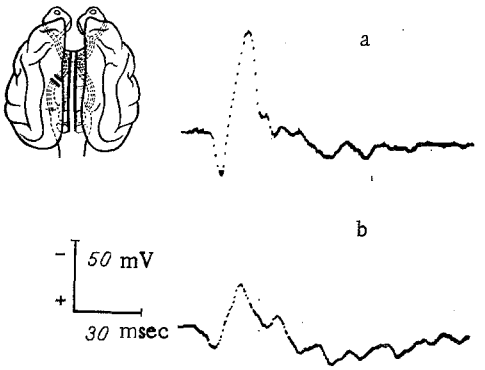

Fig. 2. Averaged EPs to flashes in right (a) and left (b) LGB in cats with division of left optic tract and commissures of tel-, di-, and mesencephalon (group 3).

TABLE 1. Latent Period and Amplitude of Early Components of EPs to Flashes in LGB of Cats (M ± σ)

Group of animals	Hemisphere	Latent period			Amplitude, mV		
		P_1	n_1	P_2	P_1	n_1	P_2
1	Right and left	15,0±0,5	28,4±0,7	61,5±2,2	24,7±2,3	98,5±6,4	83,4±7,2
2	Right	15,1±0,7	28,0±0,9	63,8±1,9	17,5±3,0	77,2±8,1*	56,4±8,2*
	Left	14,8±2,6	26,7±1,30	59,0±2,11	12,3±3,2*	41,0±5,1*	32,7±3,3*
3	Right	15,2±1,4	31,8±1,2	62,4±2,9	10,0±3,2*	62,0±7,5*	30,4±4,0*
3	Left	14,0±0,7	26,5±1,3	71,3±2,3*	5,7±2,1*	18,4±3,0*	11,5±2,9*

Legend. *$P < 0.05$ compared with group 1. P_1, P_2) First and second positive components of EP respectively; n_1) negative component.

individual components of EP to flashes (Figs. 1 and 2; Table 1). The exception was the second positive component of EP, recorded in the left LGB of cats of group 3, whose peak latency was significantly longer than normally, namely 71.3 ± 2.3 msec compared with 61.6 ± 1.2 msec in cats of group 1.

The amplitude of EPs to flashes recorded in LGB of the commissurotomized animals was significantly ($P < 0.05$) less than normally. Visual EPs in groups 2 and 3 were 2-3 times smaller on the side of the divided optic tract. The most marked reduction in the amplitude of EPs was observed in the left LGB in the cats of group 3. The amplitude of their individual components was 5-8 times less than normal (Fig. 2).

The results show that after blocking of the classical visual projections into LGB short-latency EPs to flashes continued to be recorded in that structure, from which it can be concluded that brain commissures play an important role in the transmission of primary visual influences into this subcortical relay. The relatively minor reduction in the amplitudes of EP (by about half compared with normal) indicates the considerable power of the visual commissural inputs of LGB.

A sharp decrease in amplitude of EP in the left LGB in cats of group 3 compared with normal and with the corresponding value in animals of group 2 indicates the relatively greater power of visual commissural projections of the telencephalon to this subcortical relay than of interhemispheric communications of the brain stem. Nevertheless, the latter also carry out interhemispheric transmission of modality-specific visual information to LGB.

Comparison of these results with those obtained in similar experiments on the cat visual cortex [6-8, 10, 11] shows their considerable similarity, suggesting that visual commissural afferentation of LGB and the cortex arises from the same source. LGB is evidently a subcortical relay for visual influences arriving not only along classical, but also on commissural pathways.

It can thus be concluded from these results that LGB is the principal subcortical relay for visual influences travelling along cerebral commissures from the retina to the cortex.

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ROLE OF THE CHOLINERGIC NERVOUS MECHANISM IN REGULATION OF AN ADEQUATE BLOOD SUPPLY TO THE RABBIT CEREBRAL CORTEX

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KEY WORDS: regulation of cerebral blood flow; microcirculation; pial arteries; cholinergic nervous control of the microcirculation.

The principal vascular effector regulating an adequate blood supply to the cerebral cortex is the system of small pial arteries (caliber under 100 μ), including its active parts or sphincters, at places where the small pial arteries branch from larger ones, and terminal segments of the pial arterial network, namely the precortical arteries [1, 5, 6, 12]. The mechanism of regulation of an adequate blood supply to the cortex may involve both direct action on smooth muscles of the vessels, which are effectors of humoral agents formed in brain tissue, and neurogenic vasomotor influences on them, or the combined action of both these mechanisms.

The aim of this investigation was to study the role of cholinergic control in regulation of an adequate blood supply to the cerebral cortex.

EXPERIMENTAL METHOD

Experiments were carried out on 12 rabbits of both sexes weighing 2-3 kg. The animals were anesthetized by intravenous injection of urethane (1 g/kg) and additionally immobilized with the muscle relaxant suxamethonium (10 mg/kg, intravenously). The lungs were ventilated by an artificial respiration apparatus and the depth and frequency of respiration were maintained at the same level as before injection of suxamethonium. After tracheotomy the skull was widely trephined for intravital microfilming of the pial arteries. The pial arteries were photographed under a magnification of 80. The negatives thus obtained were

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