COMPENSATION OF ANISOCORIA IN CATS AFTER DIVISION OF THE OPTIC TRACT: ROLE OF SUBCORTICAL COMMISSURES

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In the modern view [3, 8] anatomical pathways of the pupillary reflex to light have a 4-neuron arc: 1) an afferent neuron in the retina; 2) an interneuron in the pretectal nucleus; 3) a central efferent neuron in the Edinger–Westphal nucleus; 4) a peripheral efferent neuron in the ciliary ganglion (Fig. 1). In addition, interneurons send their axon collaterals into the opposite pretectal nucleus, which ensures symmetry of function of the pupillary system of the two eyes. However, the relative role of the principal and commissural pathways of the pupillary reflex is not yet known. At the same time, results of experimental and clinical investigations have demonstrated the important role of the cerebral commissures in the mechanism of compensatory and reparative adjustments in the CNS after unilateral brain lesions [1, 4-7] and, in particular, in lesions of the principal afferent pathways.

Accordingly the aim of this investigation was to study the role of the neocortical and subcortical commissural pathways in compensation of disturbances in the oculomotor sphere of cats due to injury of the afferent arc of the pupillary reflex by unilateral division of the optic tract. By making additional transections of commissures of the telencephalon, diencephalon, and mesencephalon it was also possible to compare the effectiveness of these structures in restoration of symmetry of the pupillary reaction.

EXPERIMENTAL METHOD

Experiments were carried out on 42 adult cats divided into four experimental groups: 1) cats with division of the left optic tract, 2) cats with combined division of the left optic tract and corpus callosum, 3) animals with combined division of the left optic tract and commissures of the telencephalon, diencephalon, and mesencephalon (corpus callosum, anterior cerebral commissure, hippocampal commissure, interthalamic and intercollicular commissures, posterior cerebral commissure). In the animals of group 4 division of the left optic tract was combined with division of the right half of the tegmentum mesencephali, which interrupted connections between the mesencephalon and the retina and thalamus. The dimensions of the pupils were determined in animals of all the experimental groups for 150 days after the operation every 10 days. The pupils were measured under standard conditions, during uniform average diffuse illumination of both eyes, photographically and visually. The severity of the anisocoria was estimated depending on differences in maximal transverse diameters of the pupils: marked anisocoria (transverse diameters differed by more than 3 times), moderate anisocoria (transverse diameters differed by more than 3 times), moderate anisocoria (differed by more than 1.5 times), and mild anisocoria (differed by less than 1.5 times). At the same time as the pupils were measured, the concordant reaction of the pupils to a change in the intensity of illumination was determined in animals of all groups. In each experiment 5 measurements were made on each account. The results were averaged for each experimental group. The significance of the results was estimated by Fisher's angular transformation [2]. At the end of the experiment the accuracy of the neurosurgical operations was verified in serial brain sections stained by Nissl's method.

EXPERIMENTAL RESULTS

In the first 10 days after the operation symptoms of anisocoria were observed in all animals of the first 3 groups and in 88% of animals of group 4 (Fig. 2). Severe and moderate anisocoria was found in most animals

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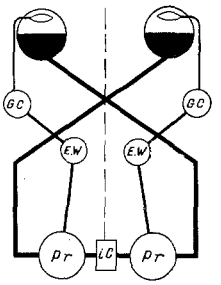

Fig. 1. Scheme of arc of pupillary reflex to light. Pr) pretectal nuclei; EW) Edinger–Westphal nucleus; GC) ciliary ganglion; iC) commissure of superior colliculus.

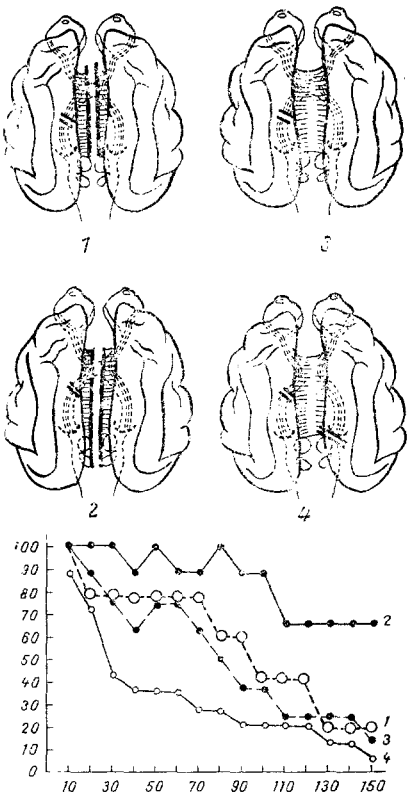

Fig. 2. Time course of symptoms of anisocoria in animals of four groups (1-4). Abscissa, days of experiments; ordinate, number of animals with anisocoria (in per cent).

of all 4 groups in the first 10-20 days of investigation. Later the degree of severity of the anisocoria in the cats gradually diminished except in animals of group 3, in which a marked difference between the dimensions of the pupils persisted for a long time. The concordant reaction of the pupils to light was maintained throughout the period of observation in animals of all groups. After isolated division of the optic tract in cats of group 1 the transverse diameter of the right (R) pupil was greater than that of the left (L) pupil (R > L) in all animals. This predominance also was observed in all cats of groups 2 and 4. The situation in two cats of group 3 was R > L, and in the remaining 8 cats of this group R < L. Symptoms of anisocoria in the animals of groups 1, 2, and 4 were unstable and disappeared during the period of observation in most animals. Anisocoria in the cats of group 4 disappeared faster ($P < 0.05$) than in the animals of the first 3 groups. The slowest return to equality of size of the pupils occurred in cats of group 3, in 66% of which symptoms of anisocoria were detected 150 days after the operation, whereas in the animals of groups 1, 2, and 4 anisocoria was observed only in 7-20% of cases (Fig. 2). The decrease in size of the left pupil compared with the right in cats of group 1 indicates a difference in functional effectiveness of the principal components of the pupillary reflex arc. The effectiveness of these

components is insufficient to maintain equal tone of neurons of symmetrical efferent arcs of this reflex. With the passage of time, however, the role of the commissural components may be enhanced, and this probably leads to equalization of the background level of reactivity of the pupils. Additional division of the commissural pathways (cats of group 3) led to severe and lasting anisocoria. The absence of any appreciable differences in the time course of compensation and repair in the animals of groups 1 and 2 rules out any participation of the callosal system in them. The basic mechanisms of compensation of functions in the pupillary system in these animals evidently utilized subcortical commissures. However, considering the preservation of the pupillary reflex to light in the animals of group 1, the afferent arc of the classical pupillary reflex, which was divided on both sides by the tract and tegmental divisions, the existence of additional afferent projections to the oculomotor centers of the mesencephalon must also be postulated.

It can be concluded from the results of this investigation that injury to the afferent part of the pupillary reflex arc by division of the optic tract leads to reversible anisocoria. The cerebral commissures evidently play an important role in the compensation of these disturbances, for their division significantly delays the time course of repair processes. Deafferentation of the contralateral superior colliculus, on the other hand, accelerates compensation of anisocoria.

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CHANGES IN ACTIVITY OF "ANTIOXIDANT" ENZYMES DURING ISCHEMIA AND SUBSEQUENT REPERFUSION OF THE MYOCARDIUM

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An important role in the regulation of the free-radical lipid peroxidation (LPO) in vivo is played by enzyme systems detoxicating active forms of oxygen, namely superoxide dismutase (SOD), and lipid peroxides, namely glutathione peroxidase (GP) and also glutathione transferase (GT) [4]. The writers showed previously that injury to the liver caused by clamping the vascular pedicle of a hepatic lobule is accompanied by marked activation of LPO and by simultaneous decrease in activity of "antioxidant" enzymes in the ischemic organ [2]. The results of other experiments by the writers also pointed to activation of LPO in ischemic heart disease [5], during experimental ischemia and subsequent postischemic reperfusion, and also in myocardial infarction [3, 9]; it was shown [2, 12], moreover, that certain synthetic and natural antioxidants have an antinecrotic action.

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