DATA CONCERNING THE TRACTS OF THE OPTIC ANALYZER

(UDC 611.814.4 + 611.831.2 + 611.843.3]-086)

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 59, No. 4, pp. 111-113, April, 1965
Original article submitted December 20, 1963

Many reports have now been published, giving a description of the structural organization and the function of the optic analyzer [1-7, 11, 17]. Despite this, many problems relating to the communications between the optic nerves and to the direct connections between the retina and the cortex and subcortical structures of the brain remain unsolved. The object of the present investigation was to examine the afferent and efferent tracts of the optic analyzer.

EXPERIMENTAL METHOD

Experiments were carried out on rabbits, dogs, and monkeys. In 9 rabbits, 2 dogs, and 2 monkeys one optic nerve was divided behind the eyeball in the region of the orbit; in 5 rabbits, 2 dogs, and 1 monkey the cortical end of the optic analyzer was destroyed unilaterally. The animals were sacrificed 5-30 days after the operation. The brain was stained by Nauta's method and serial sections were examined.

EXPERIMENTAL RESULTS

After division of one optic nerve in rabbits, dogs, and monkeys a small number of degenerated fibers was observed in the opposite, intact nerve (Fig. 1). The number of degenerated fibers in the intact nerve was much greater in the monkeys than in the dogs and, in particular, in the rabbits.

In the rabbit most of the optic fibers cross in the chiasma; a few fibers run uncrossed in the homonymous optic tract. In the dog and monkey the numbers of uncrossed and crossed fibers in the chiasma are almost equal. In the optic tracts of the dog and monkey the crossed fibers are situated mainly in the dorso-medial, and the uncrossed fibers in the ventral, portions.

In the rabbit, after division of one optic nerve the crossed fibers terminate in the dorsal and ventral nuclei of the lateral geniculate body, the pulvinar, the dorso-lateral nucleus of the thalamus, the pretectal zone, the cerebral peduncles, the reticular nucleus of the diencephalon, and the layers I and II of the anterior colliculi. Both the crossed and the uncrossed fibers terminate in the region of the nucleus tuberomamillaris and the parvocellular portion of the nuclear zone of the oculomotor nerves. The uncrossed fibers enter layers III and IV of the anterior colliculi and the superficial layers of the posterior colliculi.

In the dog the crossed fibers terminate mainly in the dorsal nucleus of the lateral geniculate body and partly in the zonal layer of the thalamus and the pretectal nucleus. The uncrossed optic fibers in the dog terminate in the pulvinar of the thalamus, the reticular nucleus of the diencephalon, the ventral and dorsal nuclei of the lateral geniculate body, and the pretectal nucleus. A small bundle of optic fibers runs into the posterior commissure. Both crossed and uncrossed optic fibers pass through the roots of the tract to the superficial layers of the anterior colliculi. Some of these fibers pass through the roots to the posterior colliculi, where they terminate in the superficial layers and the commissure of the posterior colliculi. A slender bundle, consisting of crossed and uncrossed optic fibers, terminates in the region of the nuclei of the oculomotor nerves, and individual optic fibers terminate in the nuclei of the cerebral peduncles.

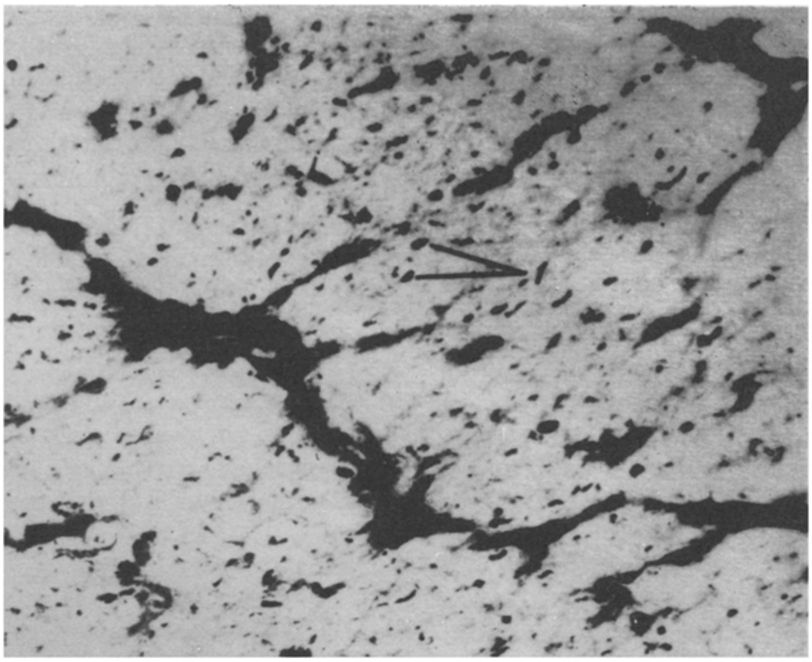

Fig. 1. Frontal section through the left optic nerve of a dog 10 days after division of the right optic nerve. 1) Axon degeneration products. Stained by the Nauta–Gygax method. 300 ×.

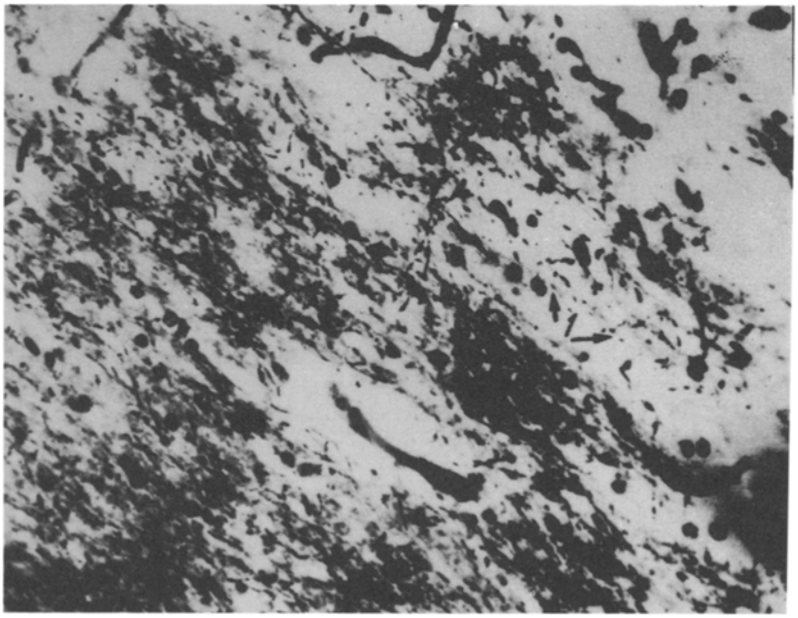

Fig. 2. Frontal section through Area O_1 of the right cerebral hemisphere of a dog 10 days after division of the right optic nerve. 1) Axon degeneration products. Stained by the Nauta–Gygax method. 900 ×.

In monkeys of the species Macacus rhesus the uncrossed optic fibers terminate in layers II, III, and V of the lateral geniculate body, whereas the crossed optic fibers terminate in layers I, IV, and VII of the lateral geniculate body and the pregeniculate nucleus.

The large bundles of afferent optic fibers terminate in the pulvinar of the thalamus, in the reticular nucleus of the diencephalon, in the posterior commissure, and in the pretectal nucleus. More slender bundles of fibers run towards the anterior colliculi in the deep layers of the diencephalon and mesencephalon, and towards the parvocellular portion of the nuclear zone of the oculomotor nerves.

In all the animals investigated, a bundle of optic fibers runs towards the cortical regions of the brain. In the rabbit these fibers terminate in Areas 5, 7, 17, and 18 of the cortex on the side of division of the optic nerve, and in Areas 17 and 18 on the opposite side. In the dog these fibers terminate mainly in Areas O_1, O_2, OP, and, to some extent, Area P (Fig. 2). It should be emphasized that there were more uncrossed than crossed fibers running to the cortex. In monkeys, after division of the optic nerve signs of degeneration were observed in Areas 7, 17, 18, 19, and 39 of the cortex. These phenomena were more marked on the side of division of the optic nerve.

After unilateral destruction of the cortical portion of the optic analyzer in the rabbit, dog, and monkey we observed signs of degeneration of the fibers in the optic tract (on the experimental side), in the chiasma, and in both optic nerves. About 2/3 of the efferent fibers run in the ipsilateral nerve and 1/3 in the contralateral nerve.

It may be concluded from these findings that communications are present between the two optic nerves. This conclusion is indirectly confirmed by several investigations [9, 13, 14]. According to Ranson and Magoun [20], the presence of afferent connections between the retina and the pretectal nucleus is responsible for the reaction of the pupil to light. Frey [13] and Rankov [19] consider that the function of the fibers terminating in the hypothalamus is that of regulation of metabolism. The connections with the reticular nucleus account for the role of the optic analyzer in the regulation of the functional state of the projection systems. The function of the direct connections between the retina and the cerebral cortex is evidently to ensure the more rapid supply of optic information to the higher divisions of the central nervous system—the cerebral cortex.

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