Light Microscopic Observations on the Possible Retinohypothalamic Projection in the Rat*

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Summary. Following unilateral retinal destruction in rats the existence of a direct retinohypothalamic pathway was investigated using the Nauta and the Fink-Heimer methods. Critical analysis of the Fink-Heimer stained sections of the experimental animals suggests that fibres leaving the optic pathway pass to various hypothalamic nuclei: 1. Fibres from the dorsorostral part of the chiasm pass through the lamina terminalis and appear to end in the preoptic and anterior hypothalamic nuclei. 2. Fibres leaving the ventrocaudal border of the chiasm and optic tract pass to the arcuate and ventromedial hypothalamic nuclei. 3. From the dorsocaudal part of the chiasm fibres pass to the suprachiasmatic and ventromedial hypothalamic nuclei. 4. From the caudal part of the inferior bundle of the accessory optic tract fibres pass to the premamillary ventral nucleus.

The amount of apparently terminal degeneration in the preoptic, anterior hypothalamic, suprachiasmatic and premamillary nuclei was small. Heavier terminal degeneration appears to be present in the arcuate and ventromedial hypothalamic nuclei.

Key Words: Visual pathway — Hypothalamus — Rat

Introduction

It is generally accepted that in most mammals, especially in the rat, light influences a large number of autonomic functions and that this influence must be mediated by nervous connections between the retina and the hypothalamus (for reviews and references see Harris, 1955; Critchlov, 1963; Scharrer, 1964). However, there is no agreement as to the nervous pathways which connect the visual system with the hypothalamus.

Since 1862 when Wagner first reported fibres leaving the optic system to enter the hypothalamus in man (see Scharrer, 1964), corresponding observations were made in normal anatomical material in a large number of other animal species (see Knoche, 1960 and Kiernan, 1967, for references). As the chiasomatic region contains a mixture of fibres of different origins, such studies, which were made on Golgi material, can hardly give information on the origin of the fibres which were traced from the chiasm to the hypothalamus.

The assumption that these chiasmohypothalamic fibres, in many species, originate in the retina was supported by anatomical experimental observations of

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Edinger (1911), Knoche (1956, 1957), Blümcke (1958), Riceke (1958), Renzi et al. (1959), Riss et al. (1963), Knapp et al. (1965), Bons and Assenmacher (1969), Ebbeson and Ramsey (1968) and O’Steen and Vaughan (1968), among others. However, conflicting results were obtained in anatomical studies by Jefferson (1940), Nauta and van Straaten (1947), Hayhow (1959), Hayhow et al. (1960), Cowan et al. (1961), Altman (1962), Giolli (1963), Singleton and Pelle (1965), Kiernan (1967), Campos-Ortega and Clüver (1968), and others who did not find degenerating fibres in the hypothalamus of different species after enucleation.

Physiological experiments gave also conflicting results. Massopust and Daigle (1961) recorded in the hypothalamus of the cat, after flash-light stimulation of the eye, long latency potentials which they assume to be mediated by a multisynaptic pathway. Feldman (1964), also after flash-light stimulation of the cat’s eye, recorded short latency potentials in the anterior and long latency potentials in the posterior hypothalamus, and concludes that there is a direct or at least an oligosynaptic pathway to the anterior hypothalamus, while the connections to the posterior part is polysynaptic.

Our results, presented in the following, appear to suggest that there is a direct retinohypothalamic pathway in the rat.

**Material and Methods**

Eighteen adult albino rats with no evidence of eye dysfunction were used. Under light nembutal anaesthesia (in three animals ether was also used) the retina of one eye was removed by evisceration of the eyeball contents in 15 animals. This operation was done instead of enucleation in order to avoid traction of the optic nerve and the consequent possibility of lesion of chiasmatic fibres. In the 3 control animals a sham operation was performed: the retina was left in place while the lens was removed through the cornea. Survival times varied between 5 and 30 days. The animals were killed under nembutal anaesthesia by the perfusion of 50 ml of 0.9% NaCl followed by 100 ml of 10% formalin. The perfusion was made from the abdominal aorta in the rostral direction for a period of at least 10 min. The brain together with the optic nerves and eyeballs were immediately dissected and fixation continued in the same formalin solution for 18—132 days. The brains were cut serially at 25 μ on the freezing microtome, transversely (9 experimental and 2 controls) or sagittally (4 and 1 respectively). One brain was cut horizontally and one in the direction of the lamina terminalis. The sections were collected in groups of 3—10 and kept in the refrigerator between 3°C and 5°C.

Of each brain, one or 2 series of sections were stained according to the Nauta (1957) method; one according to the Klüver and Barrera (1953) method and the remaining series according to the Fink and Heimer (1967) modification I of the Nauta method. The suppressive treatment was varied in the different Fink-Heimer series of most animals in order to obtain different degrees of suppression of the normal fibres. Both eyes were embedded in paraffin, cut and stained with haematoxylin and eosin for control of the damage inflicted on the operated eye and of the integrity of the other eye.

Camera lucida drawings of the Klüver and Barrera stained sections containing the hypothalamus were made and the degeneration observed under the microscope in the corresponding silver stained series was entered on these drawings. The nuclear mapping and the terminology of Koenig and Klippel (1963) was used.

**Results**

1. **Morphology of the Degeneration**

Since “pseudo-degeneration” artifacts have been described (Cowan and Powell, 1956; Christ, 1960) in the hypothalamus of different species with the use of different reduced silver methods, special precautions were taken in the interpretation of the