

Observations on Striatal Connections Following Total Destruction of the Nucleus Medialis Dorsalis in the Cat.* (32098)

W. W. KAELBER (Introduced by W. R. Ingram)

Department of Anatomy, University of Iowa, Iowa City

Previous studies concerning efferent connections of the nucleus medialis dorsalis indicate that projections to the caudate and lentiform nuclei are still open to conjecture(1-5). One explanation suggested for the variable findings is that they depend upon the amount of nuclear destruction. In an earlier study by Khalifeh *et al*(5), wherein parts of the dorsomedial nucleus were eliminated, degenerating fibers could only be found traversing the medial and lateral aspects of the caudate nucleus on their way to the orbitofrontal cortex. In addition, although terminal fibers were described in the globus pallidus and putamen by these authors, they were not plentiful. The present study is a reappraisal of dorsomedial efferent fibers to the striatal nuclei as a consequence of total nuclear destruction.

Materials and methods. Multiple unilateral electrolytic lesions were produced stereotaxically in the nucleus medialis dorsalis of each of 10 cats. The number of electrode placements and subsequent coagulations were determined from the atlas of Jasper and Ajmone-Marsan(6). Each electrode was directed perpendicularly through the cortex to the site of the nucleus. Lesions were made by passing an electric current of 3 ma varying from 30 to 60 seconds through a 22 gauge nichrome electrode insulated except at the tip.

The animals were allowed to survive 10 to 14 days to permit adequate fiber degeneration and were then sacrificed under Nembutal anesthesia and perfused with isotonic saline followed by 10% formol saline. The brains were fixed in 10% formol saline for 2 to 9 months. Serial frozen sections were cut in transverse, horizontal and parasagittal planes at 30 μ for staining by Nauta's silver method (7) and at 60 μ for Weil and cresyl violet stains. Consecutive sections were taken 650 μ apart.

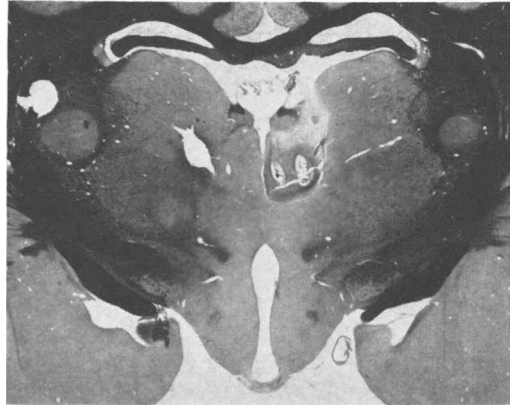


FIG. 1. Weil stained section showing a unilateral lesion of the nucleus medialis dorsalis. This section is taken approximately midway between the rostral and caudal extent of the nucleus. ($\times 3$).

Results and discussion. Complete destruction of the nucleus medialis dorsalis was obtained in 4 animals (Fig. 1). In the remainder different parts of the nucleus were undamaged and this group served as controls. Lesions causing total destruction of the nucleus damaged a variable part of the dorso-lateral "wing" of the nucleus centralis medialis, and the inner (medial) half of the nucleus paracentralis and centralis lateralis. In 2 animals the centrum medianum and nucleus parafascicularis were spared, and in the other 2 they were partially damaged.

The pattern of degenerating fibers, coursing through the medial aspect of the internal capsule into its anterior limb and thence into the rostral part of the body and head of the caudate nucleus, was essentially the same as that previously reported(5). However, in the present study, the fibers were not confined to the medial and lateral parts of the nucleus but were dispersed throughout its substance (Fig. 2). In addition, many of the fascicles were seen terminating upon the caudate neurons themselves; these connections were not observed in animals with incomplete destruction of the dorsomedial nucleus.

Fibers projecting to the lentiform nucleus

* This investigation was supported by USPHS Grant MH 00675.

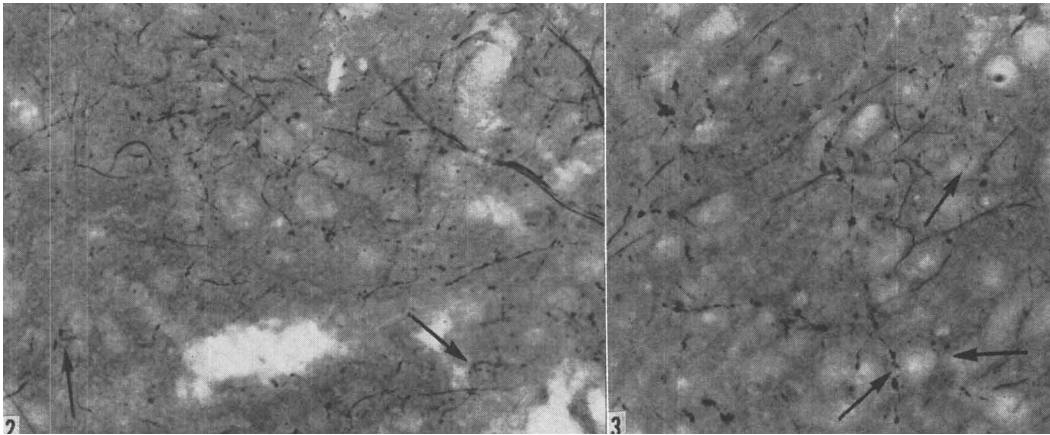


FIG. 2. Photomicrograph showing the diffuse arrangement of degenerating fibers in head of caudate nucleus. Arrows indicate sites of probable axon terminals. ($\times 137$).

FIG. 3. Photomicrograph of degenerating fibers of rather large caliber within the claustrum. Terminal degeneration is shown at the arrows. ($\times 137$).

via the lateral part of the internal capsule were present in greater numbers in the putamen than the globus pallidus as compared to the distribution described previously(5).

A finding of some interest was the presence of terminal fibers in the claustrum (Fig. 3). These were seen in 2 animals in which the centrum medianum and nucleus parafascicularis were spared. Degeneration in this structure was not found by Johnson(3), nor was it observed by us(5) when destruction of the dorso-medial nucleus was incomplete.

Other degeneration, *i.e.*, thalamocortical and intrathalamic, was essentially the same as that previously described by ourselves(5) and others(2,3).

Present findings seem to allow the following conclusions. Terminal connections from the nucleus medialis dorsalis to the caudate nucleus appear to be present in the cat, although their origin from the intralaminar nuclei cannot be completely excluded; however, damage to these latter nuclei was greatest on the medial side compared to the lateral involvement described by Nauta(2). Projections to the putamen and globus pallidus seem highly probable, although few and variable in number. A connection with the claustrum, in addition to that described from the centrum medianum by Nauta and Whitlock

(2), seems to be contributed by the dorso-medial nucleus.

Summary. Complete unilateral destruction of the nucleus medialis dorsalis was achieved in 4 cats. Terminal degeneration was found in the caudate nucleus, in contrast to its absence in animals that had only partial destruction of the same structure. Minimal connections with the globus pallidus and putamen were reconfirmed and a definitive connection with the claustrum was also noted.

I wish to thank Mr. Daryl Wierda and Mrs. Helen Mountford for technical assistance during this project.

1. Showers, M. J. C., *J. Comp. Neurol.*, 1958, v109, 261.
2. Nauta, W. J. H., Whitlock, D. G., *Brain Mechanisms and Consciousness. A Symposium*, Charles C Thomas, Springfield, Ill., 1954.
3. Johnson, T. N., *Exp. Neurol.*, 1961, v3, 556.
4. Nauta, W. J. H., *Brain*, 1962, v85, 505.
5. Khalifeh, R. R., Kaelber, W. W., Ingram, W. R., *Am. J. Anat.*, 1965, v116, 341.
6. Jasper, H. H., Ajmone-Marsan, C., *A Stereotaxic Atlas of the Diencephalon of the Cat*, National Research Council of Canada, Ottawa, 1954.
7. Nauta, W. J. H., *New Research Techniques of Neuro-Anatomy*, Charles C Thomas, Springfield, Ill., 1957, 17.

Received December 19, 1966. P.S.E.B.M., 1967, v125.