AFFERENT CONNECTIONS OF THE CAT CAUDATE NUCLEUS STUDIED BY THE RETROGRADE AXONAL TRANSPORT METHOD

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Sources of direct and indirect afferent connections of the caudate nucleus were investigated in cats by the retrograde axonal transport of horseradish peroxidase method. Different parts of the neocortex were shown to form different types of projections to the caudate nucleus; the sources of these projections have a laminar organization. Connections of the globus pallidus with the caudate nucleus, not previously described, were found. Among the sources of the thalamo-caudate projections, besides nuclei of the intralaminar complex, an important place is occupied by the ventral anterior and mediodorsal nuclei. After injection of horseradish peroxidase into the caudate nucleus, retrograde axonal transport of the enzyme was observed in the caudal direction, as far as cells of the locus coeruleus.

ON the basis of these results a general scheme of afferent projections to the caudate nucleus is drawn up, including its connections with the spinal cord mediated by the thalamic nuclei and mesencephalic reticular formation.

INTRODUCTION

The existence of three main sources of afferents to the caudate nucleus has been established: various parts of the neocortex [2, 3, 6, 20], the thalamic nuclei [10, 13, 14], and the substantia nigra [11, 13]. The detailed organization of these pathways is not yet completely clear. The volume of projections of the various cortical areas and thalamic nuclei to the caudate nucleus is still a subject for discussion [1, 6, 10, 13, 17-19]. A powerful conducting pathway from the caudate nucleus to the globus pallidus has been described, yet there are no data in the literature suggesting the possibility of feedback to the globus pallidus from the caudate nucleus. There have been only a few morphological studies of connections of the amygdaloid complex with the caudate nuclei [7, 17].

To obtain a more complete picture of afferent connections of the caudate nucleus, information is also necessary on ascending connections transmitted by anatomical relay structures located in the brain stem. Data on these relay structures are important for evaluation of physiological investigations aimed at determining the role of the caudate nuclei in the processing of information arriving from lower centers of the brain stem and spinal cord.

The object of this investigation was to obtain precise information on direct afferent connections of various cortical areas and deep brain structures with the caudate nucleus and also of the possible indirect connections of the spinal cord with this nucleus. The new neuroanatomical technique of retrograde axonal transport of horseradish peroxidase (HRP) was used.

EXPERIMENTAL METHOD

Experiments were carried out on 11 cats weighing 2.5-4.0 kg. Under pentobarbital anesthesia the animals were given microinjections of HRP of Boehringer I (West Germany), Sigma VI (USA), and Reanal (Hungary) types into the caudate nucleus and also into various structures of the brain stem. Doses of enzyme injected were small (0.25-1.00 μl of a 30% aqueous solution of HRP), so that it could be localized in particular structures. The needle of the microsyringe was introduced vertically into the brain. During insertion of the needle deep into the brain, it was possible for the enzyme to spread in the channel along its track. To prevent this from happening, silicone oil was used as a guard, so that the HRP remained in the needle in a barrier of oil. When the needle was inserted into the brain, the oil located...
Fig. 1. Distribution of labeled neurons (dots) in brain structures after injections of HRP into caudate nucleus. 1-13) Frontal plans of brain sections in rostro-caudal direction. Zones of injection of HRP and of its diffusion represented by cross-hatching and oblique shading respectively. Labeled neurons of one brain section shown on each plan. Horizontal line shows scale of magnification. Names of structures taken from atlases [8, 15] (see also in text).