SUMMARY

Microstructure of the human hypothalamus was studied, using standard histological techniques. Particular attention was given to the occurrence and siting of cells which had the morphological and tinctorial characteristics associated with secretory ability.

Typical neurosecretory cells were distributed widely throughout the hypothalamus, with concentrations in the regions of the paraventricular, supra-optic and intercalatus nuclei. Cells with similar morphology, but lacking demonstrable neurosecretory material also occurred throughout the hypothalamus. Modified ependymal cells, analogous to the tanyocytes of animal hypothalami, were found in the optic and infundibular recesses of the third ventricle. Use of the Fontana technique indicated that these cells contained numerous large granules of serotonin and/or melatonin.

The presence and siting of these actual or potential secretory cells is discussed with regard to function.

MATERIAL AND METHODS

Human hypothalami (6), obtained within 24 hours of death of the donor, were halved in the median or horizontal plane, and fixed in Bouin's fluid, or in formol-saline (10%). Sections (5 μm) were cut in the coronal, sagittal and horizontal planes after embedding in paraffin wax, and stained with:

- Harris haematoxylin and aqueous eosin (HE);
- chrome alum haematoxylin (CAH);
- phosphotungstic acid-Congo red (PTA-CR);
- silver by the Gleis and Marsland modification of Biełowsky's method;
- the Fontana technique as modified by Andrew—this procedure is used to demonstrate the presence of melatonin or serotonin; and
- periodic acid Schiff (PAS).

RESULTS

General Observations

In general, and irrespective of the plane of section, the hypothalamic microstructure was marked by lack of definitive features. Typical tissue comprised neurons, neuroglial cells, nerve tracts and blood vessels. Nerve tracts tended to lie laterally, whereas medial regions contained neuronal perikaryons. Neurons were present in varying numbers and differed greatly in shape, size and staining characteristics, depending on the field (Fig. 1). The ratio of neuroglial cells to neurons differed widely in different regions of the hypothalamus. Thus, neuroglial cells were particularly numerous, and prominent in the region of the anterior pituitary could pass directly from the pineal gland to the basal hypothalamus via the cerebrospinal fluid (CSF) of the third ventricle. The discovery of ependymal cells with potential secretory and/or absorptive capacity in the optic and infundibular recesses of animal and human hypothalami, draws attention to the necessity of considering yet another type of secretory cell.

Most previous studies of this nature have been conducted on animal tissues. Extrapolation of knowledge gained from animals to man could lead to erroneous conclusions. Accordingly, in this study, the microstructure of the human hypothalamus was investigated, particular attention being given to the occurrence and siting of cells with morphological characteristics which could be construed as indicating secretory activity, and which showed a positive response to the stains claimed to distinguish neurosecretory ability.
superior to the tuberal region. Neuroglial cells were mainly oligodendroglia or neuroglia, although astrocytes also occurred in fair numbers.

Secretory Neurons

Typical neurosecretory neurons are large, multipolar neurons which have a flask-shaped perikaryon (25 - 50 μm diameter) and a single, large, eccentric, vesicular nucleus. The nucleolus is prominent and stains bright red with CAH. Since Nissl-substance is distributed peripherally, a zone of pseudochromatolysis occurs around the nucleus. Neurosecretory material (NSM) can be demonstrated in both perikaryon and axon, by using specialized stains.

Neurons which complied with these criteria, were found primarily in the regions of SON and PVN, but were also seen elsewhere, e.g. in the region anterior to the nucleus intercalatus of the mammillary body (Fig. 2). The size and shape of the perikaryon of the neurons differed in the various regions of the hypothalamus. Thus, in the lateral hypothalamus, the perikaryon was large and angular. In medial regions and in the region of the PVN, the perikaryon was smaller and rounder. Again, neurons with the morphology peculiar to neurosecretory neurons, but lacking demonstrable NSM, were observed in every region of the hypothalamus. In particular, the nucleus intercalatus consisted largely of such neurons (Fig. 3).

Secretory Ependyma

In general, the ependymal cells around the third ventricle, varied in shape from almost squamous to low columnar, with the majority of cells being cuboidal. However, ependyma of modified morphology indicative of secretory (and/or absorptive function) was observed in the areas of the optic and infundibular recesses (Fig. 4).
The pertinent cells in the optic and infundibular recesses lay either in the ependymal layer, or immediately adjacent to it (Fig. 5). Although the cells were stained with CAH, the main morphological features were only revealed after use of the Bielschowsky stain. Cell bodies were pear- or elliptically-shaped and measured some 10 - 12 μm in diameter, and 15 - 20 μm in length. One large process extended towards the tuberal region of the hypothalamus. The pole of the cell distal to the process was either orientated towards, or protruded into, the lumen of the recess (Fig. 5). Small beads of material analogous to NSM were observed in the cell body and process. However, this material was not clearly identifiable in sections stained with CAH. Use of the Fontana stain showed the presence of numerous black granules in the cell body and process (Fig. 6). The granules occurred in varying amounts, were very large, and had no specific localization in the cell body. Material with staining properties similar to that of Nissl-substance was observed in the cell body. The distribution of this material corresponded with that of the Nissl-substance in neurosecretory neurons of the PVN and SON. Cells were PAS-negative.

**DISCUSSION**

Since neurosecretion occurs in many species, and in different regions and for varying reasons within a species, the morphology and tinctorial response of potential neurosecretory cells could be expected to vary considerably. Functionally, the hypothalamus is a region of immense and, as yet, incompletely resolved complexity. In view of these points, the detection of neurosecretory material (NSM) in axons and cell bodies of neurons in regions other than the SON or PVN, is not surprising (Fig. 2). A positive response to CAH or PTA-CR depends on the presence of cystine, or (di)sulphydryl groups. Neurons showing such a response could be either performing a function similar to that of the secretory neurons of the SON or PVN, or engaged in secretion of a different type, but one in which the secretory product contains cystine, or sulphydryl groups.

Again, the presence of numerous, apparently secretory neurons in the region anterior to the nucleus intercalatus, is not surprising (Fig. 3). Other workers have drawn attention to the supreme importance of the neurosecretory system in the so-called hypophyseotrophic region (HTA), i.e. the region of the arcuate, anterior periventricular, ventromedial, and medial retrochiasmatic nuclei. The neurosecretory cells of this region produce the hypothalamic release factors which govern the function of the anterior pituitary. In turn, the cells which produce release factors are influenced by both neural and/or humoral stimuli. The region anterior to the nucleus intercalatus fringes on the HTA.

The widespread cells (Fig. 3) with a morphology similar to that of secretory neurons of the SON or PVN, but lacking a positive tinctorial response, are explicable in terms of the findings of Harris and colleagues. Here, firing in the tubero-infundibular region of individual neuronal processes associated with gonadotrophic function, stimulated cell bodies outside the main HTA.

The modified ependymal cells of the optic and infundibular recesses (Fig. 5) are analogous to the tanycytes of Knowles and Kumar. Tanycytes, it is postulated, link the CSF of the third ventricle with the blood vessels of the hypothalamo-hypophyseal tract and aid control of gonadotropic function of the anterior pituitary. The presence of indole amines in these modified ependymal cells (Fig. 6) suggests a link with the hormones of the pineal gland. Pineal hormones are associated with control of gonadotropic function. Confirmation of the pineal origin of the granules of melatonin/serotonin would aid in establishing the part played by the CSF as a transmitting medium, elucidate the absorptive/secretory role of tanycytes, and help to substantiate the role played by tanycytes in the gonadotrophin control mechanism.
Finally, although the modern concept of neurosecretion excludes the role played by secretory glial or ependymal cells, the secretory activity of these types of cells, irrespective of their embryonic origin, is undoubtedly closely associated with neurosecretion, and is of great functional significance.

REFERENCES


Bilateral Rete Carotidis in Man*

A CASE REPORT


SUMMARY

A case of bilateral rete carotidis in which the intracerebral circulation was supplied completely by the left vertebral artery, is presented. The hypoplastic internal carotid arteries and tortuous anastomizing channels arising from the internal maxillary arteries and supplying the internal carotid arteries in the supraclinoid portions, are shown.


The occurrence of bilateral rete carotidis in man is extremely rare. It is for this reason that we feel the following case is worth reporting. The condition was first described occurring unilaterally by Minagi and Newton.3

*Date received: 21 March 1972.

CASE REPORT

A 39-year-old woman was admitted with a history of recurrent attacks of fainting, severe dizziness, and intermittent claudication. There was no history of epilepsy. On examination the patient was fully conscious, with no localizing signs. The carotid pulses were normal and equal, there was no papilloedema, and the blood pressure was 120/80 mmHg. X-ray films of the skull and chest were normal. The clinical diagnosis was a diffuse vascular disease, but particularly vertebrobasilar artery insufficiency.

Bilateral carotid angiography (Fig. 1) demonstrated hypoplastic internal carotid arteries, large external carotid arteries, and multiple small, tortuous arterial channels arising from the internal maxillary arteries to fill the internal carotid arteries in their cavernous portions. On the right, the middle meningeal artery probably contributed...