Sexual Differences in the Ependyma Lining the Third Ventricle in the Area of the Anterior Hypothalamus of Adult Rhesus Monkeys

T. C. Anand Kumar

Department of Anatomy, the Medical School, University of Birmingham, Birmingham 15; U.K. (Director: Prof. Sir Solly Zuckerman K.C.B., F.R.S.)

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Summary. Previous studies have shown that a circumscribed region of the anterior hypothalamus of the rhesus monkey is lined by tanycyte ependyma and it has been suggested that this ependyma which links the third ventricle with the pars tuberalis may have a functional role in the hypothalamic regulation of anterior pituitary function (Anand Kumar and Knowles, 1967). In view of the known sexual differences in the hypothalamic regulation of pituitary gonadotropin secretion the present investigation was made to determine whether any structural differences were evident in the tanycyte ependyma in male and female rhesus monkeys.

The results of this investigation are based on light and electron microscopic studies of the hypothalamus in 24 rhesus monkeys comprising 12 adult females, 11 sexually mature males and a two month old sexually immature male.

The tanycyte ependyma in the rhesus monkey is double layered. There are bulbous projections on the ventricular surface of the cells in the ependymal layer nearest to the ventricle (the first layer of ependyma). These bulbous projections vary in size in relation to the menstrual cycle. They are well developed during mid-cycle and regressed during menstruation. In the males, where the secretion of pituitary gonadotropins does not occur cyclically as in the females, there was no marked variation in the bulbous projections between different individuals as in the female monkeys.

In the sexually mature males, but not in the females, the two layers of ependyma are separated by a distinct space. The absence of such a space in the sexually immature male suggests that this difference may be related to sexual maturity.

In the adult males the cells in the ependymal layer below the first layer of ependyma have microvilli which extend into the space between the ependymal layers. In the females where such a space is not present, microvilli were not evident.

The precise functional significance of the tanycyte ependyma is not known. It is hoped that the results of the present investigation would draw attention to the need for a more detailed examination of the physiological role of the tanycyte ependyma in relation to reproduction.

It has been shown that the secretory pattern of the pituitary gonadotropins is different in adult male and female mammals. Several studies made in recent years (Davidson, 1966; Plerkko, 1966; Harris and Campbell, 1966) have shown that this diversity in pituitary function is a result of sexual differences in the control of hypophysial secretion by the central nervous system (probably the hypothalamus) and is not a consequence of dissimilarities in the pituitary glands themselves. This conclusion is mainly based on physiological experiments such as heterosexual transplantation of hypophysis (see Harris and Campbell, 1966). As yet there has been no published report of sexual differences in the structure of the central nervous system which would provide an anatomical evidence for this postulate.
Recently attention has been drawn to a circumscribed region of the third ventricle in the anterior hypothalamus of the rhesus monkey which is lined by ependyma that differs from ependyma in other parts of the ventricle. This modified ependyma is distinguished by basal processes extending towards the pars tuberalis (Anand Kumar and Knowles, 1967a). The ependymal processes end on blood vessels and some of them make direct contacts with the cells of the pars tuberalis. The endings of the ependymal processes resemble “synaptoid” endings of neurosecretory processes in as much as both contain membrane-bound, electron-dense granules as well as electron-lucent vesicles; there are however, no additional electron densities of membranes at the site where the ependymal processes terminate.

Studies on the modified ependyma and the cells of the pars tuberalis in rhesus monkeys killed at different stages of the menstrual cycle as well as in ovariectomized monkeys and ovariectomized monkeys treated with either tritiated oestrogen or unlabelled oestrogen, led to the suggestion that this ependyma, which links the third ventricle and the pars tuberalis, may be involved in the hypothalamic regulation of anterior pituitary function (Anand Kumar and Knowles, 1967a, b).

Further investigations have shown that the modified ependyma differs structurally in adult male and female monkeys. The present communication deals with these differences.

Materials and Methods

24 rhesus monkeys comprising 11 sexually mature males, 12 sexually mature females and a two month old, sexually immature male (born in the Birmingham colony) were used in the present study. Of these, 12 sexually mature monkeys (6 of each sex) were used for electron microscopy and the rest for light microscopic studies. Half the number of females were killed during mid-cycle (between the 11th and 23rd day of the menstrual cycle) and the remaining at menstruation.

The animals were anaesthetized with sodium pentobarbitone and the brain first perfused through the carotid arteries with a “balanced salt solution” (Palay, McGee-Russel, Gordon and Grillo, 1962) followed by the fixative. About 500 ml each of the balanced salt solution and the fixative was injected per animal and special care was taken to inject the fluids slowly so as to avoid rupturing the smaller blood vessels. For light microscopy the brains were fixed either in Susa’s or Bodian’s fluid and for electron microscopy glutaraldehyde buffered with sodium cacodylate (Saborant, Bensch and Barnett, 1963) was used at 5°C. After perfusion the hypothalamus was dissected out and immersed in the fixative for a further period of 24 hours.

Hypothalami fixed for light microscopy were embedded in paraffin wax after dehydration, serially sectioned in the coronal plane at 10μ thickness and stained with Gomori’s chromalum haematoxylin.

For electron microscopy small pieces of tissue were taken from the wall of the third ventricle, post-fixed in a 1% solution of OsO4 buffered with Michaelis’ solution (pH 7.4) for 1 hour at room temperature, embedded in Vestopal W after dehydration in ethanol (Rytter and Kellenberger, 1958) and sectioned on a Porter-Blum microtome using glass knives. Sections showing interference colours ranging from silver to gold were mounted on carbon coated grids, stained with a saturated solution of uranyl acetate in redistilled methanol and examined in a Siemens Elmiskop I electron microscope. For histological and topographical comparisons thick sections (0.5—2 μ) were cut and stained with toluidine blue-borax solution for microscopy.

Results

General. The distribution of the modified ependyma is limited to the anterior hypothalamus (Anand Kumar and Knowles, 1967a). In this circumscribed area of the hypothalamus the ependyma is double layered and the cells in both layers