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Myelinated Herring bodies in the median eminence of the cat

F.E. Pastor, J.L. Blázquez, D. Toranzo, B. Peláez, A. Sánchez, A.J. Alvarez-Morujo and P. Amat
Department of Human Anatomy and Histology, Faculty of Medicine, University of Salamanca, Salamanca, Spain

Summary. An electron-microscopic study was carried out on the median eminence of cats during post-natal development. From the moment of birth (observations performed 12 hours later) Herring bodies were seen in the fibrillary layer of the median eminence. At 45 days after birth, myelinated nerve fibres could be observed, some of them containing neurosecretory granules. The number of myelinated fibres in the median eminence increased with age and at 90 days some Herring bodies appeared surrounded by myelin sheaths; these mainly contained neurosecretory granules and a few mitochondria.

Key words: Myelinated Herring body, Median eminence, Ultrastructure, Cat

Introduction

Herring bodies are axonal swellings of the hypothalamo-neurohypophysial tract (HNT), a compact aggregate of unmyelinated nerve fibres which originates from the supraoptic and paraventricular nuclei. Nevertheless, the existence of myelinated neurosecretory axons in the HNT was described several years ago in light microscopy studies (Haymaker, 1969; LuQui and Fox, 1976). Electron microscopy has revealed the presence of myelinated fibres in the median eminence and in the neurohypophysis of several species, though sometimes their character as neurosecretory fibres has not been fully established (Duncan, 1956; Barry and Cotte, 1961; Holmes, 1964; Holmes and Kiernan, 1964; Mazzuca, 1965; Seitz, 1965; Green, 1969; Kalimo and Rinne, 1972; Kalimo, 1975; Silverman and Desnoyers, 1975; Kozlowski et al., 1976; LuQui and Fox, 1976).

Offprint requests to: Prof. P. Amat, Departamento de Anatomía e Histología Humanas, Facultad de Medicina, Universidad de Salamanca, 37007 Salamanca, Spain

The finding of myelinated Herring bodies is rare in ultrastructural studies. These structures have been reported in the rabbit (Duffy and Menefee, 1965; Barer and Lederis, 1966), the cat (Amat, 1978) and the mouse (Yamazaki et al., 1981). Some of these authors (Yamazaki et al., 1981) have drawn attention to the paucity of references in the literature concerning myelinated Herring bodies. The present paper reports on the presence of Herring bodies surrounded by myelin sheaths in the median eminence of the cat during postnatal development.

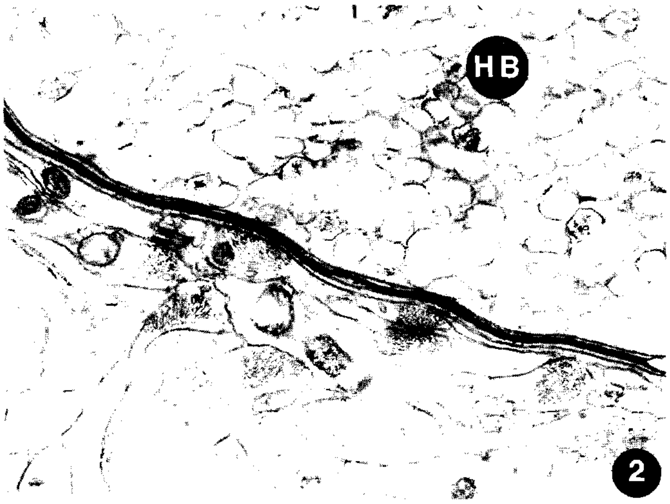
Materials and methods

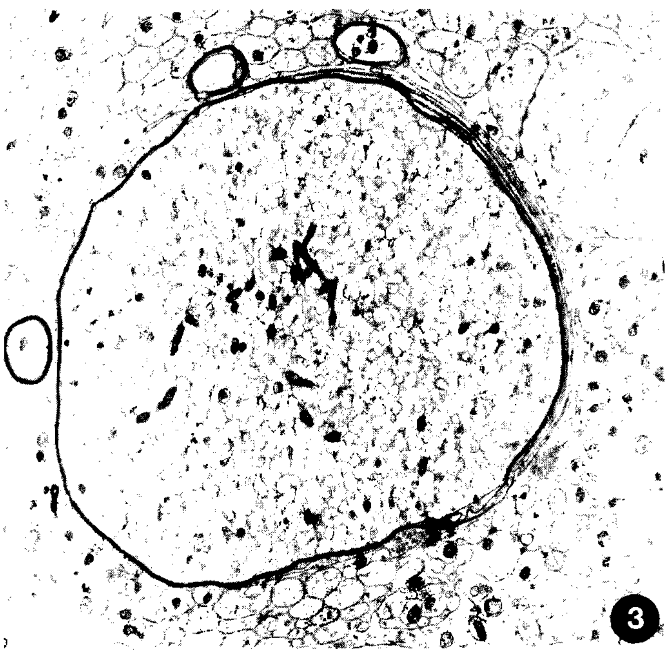
Eighty cats of both sexes were sacrificed at the ages of 12 hours, and at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 18, 20, 30, 40, 45, 60, 75 and 90 days after birth. All these animals were used to conduct an exhaustive ultrastructural study on the post-natal maturation of the hypothalamo-neurohypophysial system. The animals were anaesthetized by intraperitoneal injection of sodium thiopental (50 mg/Kg body weight) and perfused transcardially with 0.15 M sodium chloride solution followed by 5% glutaraldehyde in 0.1 M phosphate buffer pH 7.4 Thin slices of the required diencephalic area were postfixed with 1% osmium tetroxide, in the same phosphate buffer, dehydrated in a graded acetone series and embedded in Durcupan (Fluka). Thin sections were cut using a LKB ultramicrotome (Ultrotrome III 8800). After staining with lead citrate, they were observed under a Philips EM-201 electron microscope.

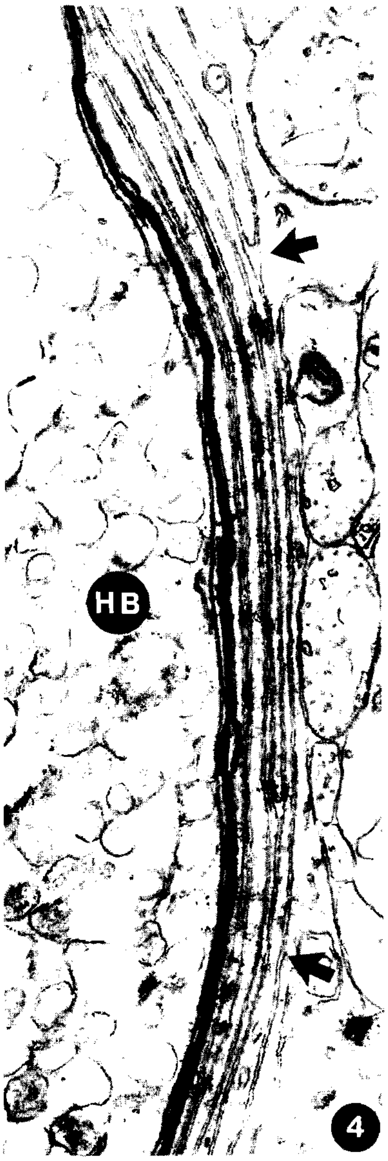
Results

We performed an electron microscopic study on transverse sections of the median eminence of cats during post-natal development, paying special attention to the fibrillary layer in which the axons of the HNT are found. Herring bodies filled with neurosecretory granules could be found in the cats sacrificed at 12 h after

Fig. 1. Median eminence of a cat sacrificed 90 days after birth. Note the presence of several myelinated Herring bodies (arrows). One irregularly-shaped Herring body is partially myelinated (asterisk). ZC = adenoneurohypophysial contact zone. × 338







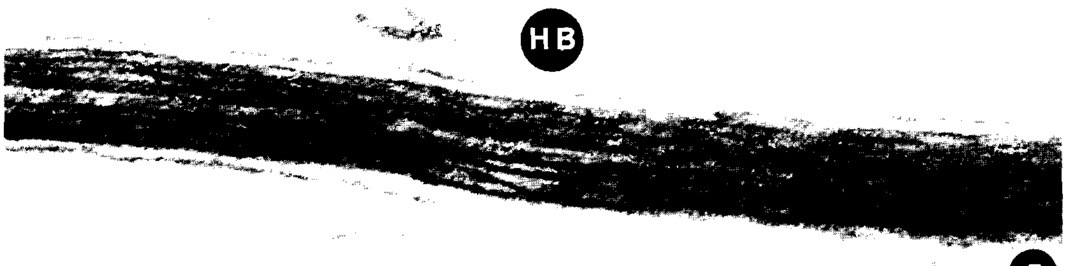


Fig. 2. High magnification of the partially myelinated Herring body of Fig. 1. Processess of fibrous astrocytes are intimately associated with the Herring body (HB). × 17,500

Fig. 3. Myelinated Herring body in the median eminence of a cat sacrificed 90 days after birth. Note the presence of numerous non-myelinated axons and three myelinated nerve fibres. × 6,400

Fig. 4. High magnification of the myelin sheaths (arrows) of Fig. 3. HB = Herring body. × 27,200

Fig. 5. Myelin sheath of a Herring body (HB) showing its characteristic periodicity. × 115,200

birth. During postnatal development Herring bodies of the three types described by Dellman and Rodríguez (1970) were seen, though the commonest were the type I Herring bodies which mainly contain neurosecretory granules and a few mitochondria. In the median eminence of the animals studied it was not possible to observe terminal Herring bodies characterized by the presence of a cluster of microvesicles (Heap et al., 1975; Morris, 1976).

Until an age of 45 days, myelinated nerve fibres in the fibrillary layer of the median eminence were scarce; after this age their numbers increased. Inside some of these axons, typical neurosecretory granules of the hypothalamo-neurohypophysial system were seen, which confirms the notion that they belong to the HNT.

At 90 days, the myelinated fibres were even more abundant and it was possible to note the presence of Herring bodies surrounded by myelin sheaths containing abundant neurosecretory granules and a few mitochondria (Fig. 1, arrows; see also Figs. 2-4). Occasionally, irregularly-shaped Herring bodies could be found, some of them partially myelinated (Fig. 1, asterisk). The myelin sheaths showed their characteristic periodicity; the major dense lines alternating with the intermediate (intraperiod) ones (Fig. 5).

Discussion

The presence of Herring bodies filled with neurosecretory granules in the median eminence of cats sacrificed at 12 hours after birth confirms that the hypothalamo-neurohypophysial system is functional at that moment.

Our findings point to an increase in the number of myelinated fibres in the median eminence from 45 days after birth. We believe that these myelinated fibres are axons because although granules are also found in dendrites of the neurosecretory neurons, myelination of the dendrites is an exceptional finding in the central nervous system (Peters et al., 1976). Furthermore, the dendrites of the magnocellular neurosecretory neurons are not located in the median eminence.

The presence of Herring bodies surrounded by a myelin sheath, observed in the median eminence of cats sacrificed after 90 days of age, is a surprising finding. Our results show that in the cat myelination of the axons of the HNT and of their typical swellings —the Herrring bodies— is age-related. In the median eminence of the guinea pig, Silverman and Desnoyers (1975) have reported a significant myelination during postnatal development. According to these authors, this appears towards the third day of life and is not complete until the tenth. The finding of myelinated Herring bodies in the rabbit (Duffy and Menefee, 1965; Barer and Lederis, 1966) was made in adult animals. Yamazaki et al. (1981) employed mice with ages ranging between 70-140 days and reported the presence of myelinated Herring bodies in the posterior part of the median eminence; however, these authors did not state whether there was any relation to the age of the animals.

What, then, is the origin of the myelin sheaths of the Herring bodies in the median eminence? The answer to this question is difficult. Haymaker (1969) drew attention to the absence of oligodendroglia along the course of myelinated fibres of the HNT. Additionally, it is known that the neurohypophysis is lacking in oligodendrocytes (Polak and Azcoaga, 1969). In the present study we did not find cells with the ultrastructural characteristics of oligodendrocytes in the median eminence either, which poses a problem concerning the origin of the myelin sheaths at this level. Regarding this, it should be noted that although the myelin of the central nervous system is formed by the oligodendrocytes, under certain experimental conditions astrocytes may also be involved (Bunge et al., 1961; Ross et al., 1962). Moreover, Wendell-Smith et al. (1966) and Blunt et al. (1972) have reported that astroglioblasts may participate in the myelination of the optic nerves of the cat (for further information, see Peters et al., 1976). Fernández et al. (1984) found astrocytic lamellae surrounding neuronal processes in the hamster hypothalamus, suggesting that they might be involved in a myelination process. Some of the myelin sheaths observed by us appear to be formed of thinner laminar expansions (Fig. 4) of possible astrocytic origin. We believe that the existence of myelin fibres in a territory lacking in oligodendrocytes can only be explained in terms of the notion that other cells (i.e. astrocytes) might participate in the myelination process. In this sense, it should be noted that processes of fibrous astrocytes can be found intimately associated with the myelinated Herring bodies (Fig. 2); this association is characteristic of the hypothalamo-hypophyseal system (LuQui and Fox, 1976).

We are currently unaware of whether the myelination of the axons of the HNT has any functional meaning; whether it represents a degenerative process, or whether it may have some other origin. Neither are there any conclusive references regarding this point in the literature. Kalimo and Rinne (1972), in Brattleboro rats and Kalimo (1975), in lactating rats, noted the presence of myelinated axons in the HNT, although these authors did not offer information as to any functional significance with respect to their findings. LuQui and Fox (1976) reported on an observation of Ranson and colleagues, concerning a strong degree of myelination in the HNT of a monkey with bilateral hypothalamic lesions that had adiposity, diabetes mellitus, and a moderate disturbance in the capacity to regulate body temperature. A few of these fibres were also observed in monkeys with hypothalamic lesions which did not become obese. Neither did Ranson and colleagues find any explanation for their findings.

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