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HISTO-ARCHITECTURE OF NEUROHYPOPHYSIS WITH SPECIAL REFERENCE TO HERRING BODIES IN MADRAS RED SHEEP

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Abstract: A study on the pituitary gland was carried out to record the histoarchitecture and occurrence of Herring bodies in 30 Madras red sheep. The tissues were processed for histological observations and were stained with standard histological and histochemical techniques. The neurohypophysis consisted of median eminence, infundibular stem, and infundibular process or pars nervosa in all the age groups. The median eminence was divided into zona interna and zona externa. Infundibular stem appeared as a narrow middle segment of the neurohypophysis which comprised of nerve fibres, pituicytes and blood vessels. The infundibular cavity was the extension of the third ventricle covered by the wall of the infundibular stalk and lined by a single layer of ependymal cells. The pars nervosa of neurohypophysis was an expanded terminal part comprised of the unmyelinated axons, blood vessels and pituicytes. The axons of the hypothalamo-hypophysial tract are atypical as they showed Herring bodies which appeared as small distinctly granulated vesicles to large globular bodies varied in size from 12 to 120 µm in median eminence and infundibular stem and increased in size upto 200 µm in pars nervosa.
Keywords: Histology, Herring bodies, Pituitary gland, Sheep.

INTRODUCTION

The posterior pituitary or neurohypophysis is the posterior lobe of the pituitary gland and is part of the neuroendocrine system. The hypothalamic responses are mediated through hypothalamic control of pituitary function by (1) release of hypothalamic neuropeptides synthesized in hypothalamic neurons and transported through the hypothalamo-hypophysial tract to the posterior pituitary, and (2) neuroendocrine control of the anterior pituitary through the release of peptides that mediate anterior pituitary hormone release (Molina, 2013). Thorough knowledge and complete understanding of histological features and physiology of neruosecretion of pituitary gland is important for further research. Various research reports on gross and histology of posterior pituitary glands in domestic animals are available. The

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current observation reveals the histoarchitecture of neruohypophysis and neurosecretion in Madras red sheep with special emphasis on occurrence of Herring bodies during various physiological status.

MATERIALS AND METHODS

The heads were collected from 30 Madras red ewes divided into five age groups, viz. prepubertal, (4 to 6 months), pubertal (7 to 18 months), pregnant (1.5 to 2.5 years), lactating (2 to 4 years) and dry (4 to 8 years) animals. The head of each animal collected was flushed with 2% sodium citrate solution through common carotid arteries and fixed with various standard fixatives, viz. 10% neutral buffered formalin, Zenker's fluid, Carnoy's fluid, and Bouin's fluid.

Pituitary glands were dissected out and processed by routine Alcohol-Benzene schedule and paraffin blocks were made. Sections were cut at 5-7 µm thickness for histological study. The sections were stained with standard histological and histochemical techniques (Bancroft and Gamble, 2003) viz., (1). Standard Haematoxylin and Eosin (H&E) method for the routine histological study, (2). Phosphotungstic acid haematoxylin (PTAH) method for glial cells, nerve fibres and myoepithelial cells, (3). Aldehyde fuchsin method for neurosecretory substance, (4). Bielschowsky's method for staining axis cylinders and dendrites, (5). Lead Haematoxylin stain for endocrine cells in pituitary, (6). Crossman's modification of Mallory's triple staining for connective tissue fibres and cytodifferentiation of acidophils of pituitary gland.

RESULTS AND DISCUSSION

The neurohypophysis consisted of median eminence, the infundibular stem, and the infundibular process or pars nervosa in all the age groups. Median eminence is only occasionally included as part of the posterior pituitary. Infundibular stalk, also known as the infundibulum or pituitary stalk, the infundibular stalk bridges the hypothalamic and hypophyseal systems. Pars nervosa, also called infundibular process, constitutes the majority of the posterior pituitary and is the storage site of oxytocin and vasopressin.

1. Median eminence

The median eminence was found caudal to the optic chiasma, which connected the neurohypophysis with the floor of the brain. Directed caudo-ventrally, it continued as the infundibular stem. Rostro-ventrally and laterally, the pars tuberalis covered it from all sides. Based on the differences in the arrangement of the nerve fibres, pituicytes and the neurosecretory substance, the median eminence was divided into zona interna and zona externa. The zona interna contained of few neurons located just subjacent to the ependyma of the infundibular cavity.

The axonic fibres of these neurons ran longitudinally into the neural stalk and entered finally into the neural lobe. The median eminence had an external glandular layer of delicate nerve fibres with a few nuclei of pituicytes and an internal layer containing ependymal cells, pituicytes and bundles of nerve fibres from supraoptic and paraventricular nuclei.

2. Infundibular stem

Infundibular stem was found as the narrow middle segment of the neurohypophysis located between the median eminence rostro-dorsally and the pars nervosa caudally. The upper part of infundibular stem was a continuation of the median eminence surrounded by pars tuberalis adenohypophysis. The lower part of the stem, however, was devoid of pars tuberalis and continued caudal to merge with the neural lobe as that of bovines (Cummings and Habel, 1965).

Infundibular stem comprised of nerve fibres, pituicytes and blood vessels. The blood vessels in the form of capillary loops were noticed in the neural tissue of the stalk. The nerve fibres of the infundibular stem were compact as compared to the infundibular process and ran longitudinally to enter into the latter in all the age groups of sheep. Das (1979) also noticed a few of these nerve fibres coursed the entire length of the infundibular stem while others entered into the pars intermedia at different levels in buffaloes.

The infundibular cavity (Fig.1) was the extension of the third ventricle covered by the wall of the infundibular stalk and lined by a single layer of ependymal cells. It was directed caudo-ventrally into the median eminence and extended for the variable length in the rostral part of the infundibular stem. The cavity was lined by a single layer of ependymal cells. The nuclei of these cells were irregularly oval to elongate in shape.

3. Pars nervosa

The pars nervosa of neurohypophysis was an expanded terminal part of the posterior pituitary gland in all the age groups of animals. The neurohypophysis extended upto or slightly beyond the caudal limit of the pars distalis adenohypophysis mostly covering from side to side. It was separated from pars intermedia by a thin capsule made up of piamater (Fig.2). The capsule sent trabeculae of variable thickness into the lobe to divide it into a number of incomplete lobules. It comprised of the unmyelinated axons, blood vessels and pituicytes. Two types of pituicytes namely, the fibro-pituicytes and protoplasmic pituicytes were more frequently encountered in the infundibular process.

The nerve fibres at the periphery of the lobules showed a more compact arrangement as compared to the central zone. The nerve fibres coursed through the infundibular stem and terminated irregularly in a network like structure enmeshing the neurosecretory material in between them (Fig.2). It corresponded with the findings of Das (1979) who reported two types of nerve fibres that stained blue with luxol fast blue in pars nervosa of buffalo.

In the sections stained with PTAH, H&E and Mallory's triple staining methods, aggregations of deeply stained neurosecretory material of varying size were found throughout the neurohypophysis and these were the Herring bodies (Fig.2 & 3). They were named after Percy Theodore Herring (1872-1967), who first observed them from histological studies of the pituitary gland that he conducted at The University of Edinburgh. Herring published his findings in the first volume of the ''Quarterly Journal of Experimental Physiology''. Similar structures were noticed as dilations of the axons extending from hypothalamus throughout the neural lobe. These axons of the hypothalamo-hypophysial tract are atypical as they showed numerous very large dilations along their length as well as at their terminations within the neurohypophysis. The transport of neurosecretory material of the hypothalamo-neurohypophysial system (HNS) occurs into large axons of magnacellular peptidergic neurons between the perikaryon origin and its ending in the neural lobe (Kupfermann, 1991).

The swellings of the axon fibres were found throughout the neurohypohysis but they were prominent and highly concentrated in the pars nervosa of pregnant and lactating sheep. They appeared as small distinctly granulated vesicles to large globular bodies. The granular appearance indicated the presence of stored hormones in neurosecretory vesicles that were synthesized in the nerve cell bodies of various nuclei in the hypothalamus, transported down the neuronal axons to their storage sites in the posterior pituitary. The Herring bodies were PAS and aldehyde fuchsin positive granular vesicles and appeared in various sized throughout the neural lobe. The average size of these Herring bodies varied from 12 to 120 µm in median eminence and infundibular stem and increased in size upto 200 µm in pars nervosa.

Tweedle (1983) explained that a single neurohyophysial axon contained about 2,000 of nerve endings and small swellings, but the Herring bodies stand out as very occasional, exceptionally large axonal swellings that contain number of aged neurosecretory vesicles. However, the Herring bodies are not a site of secretion of these vesicles, but are involved in their disposal by an autophagic process. In conclusion, the occurrence of Herring bodies in more numbers and greater size of granules was suggestive of higher concentration of hormonal release during physiologically active stages especially during pregnancy and lactation in Madras red sheep.

FIGURES WITH DESCRIPTION

Figure 1: Photomicrograph of the pituitary gland of pubertal sheep - Infundibular stalk surrounded by pars tuberalis (PD). IC – Infundibular cavity, PT – Pars tuberalis, **Mallory's triple stain x 100**

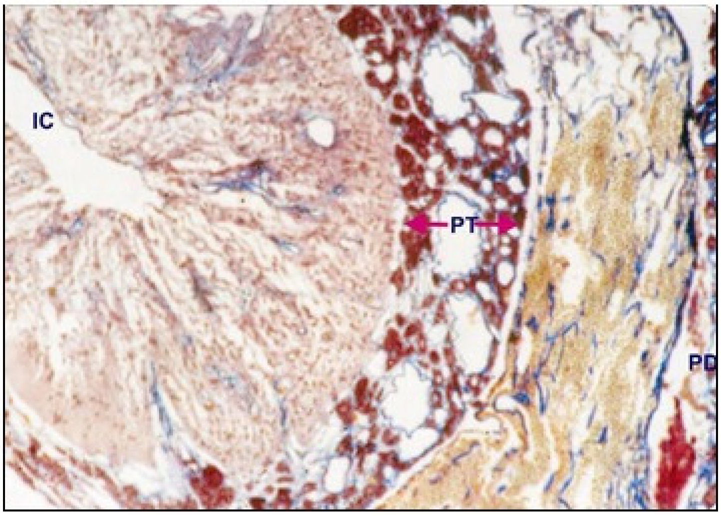


Figure 2: Photomicrograph of the pars nervosa containing the Herring bodies (Hb) of various sizes in pregnant sheep. Piamater (arrow), PI – Pars intermedia. **Mallory's triple stain x 200**

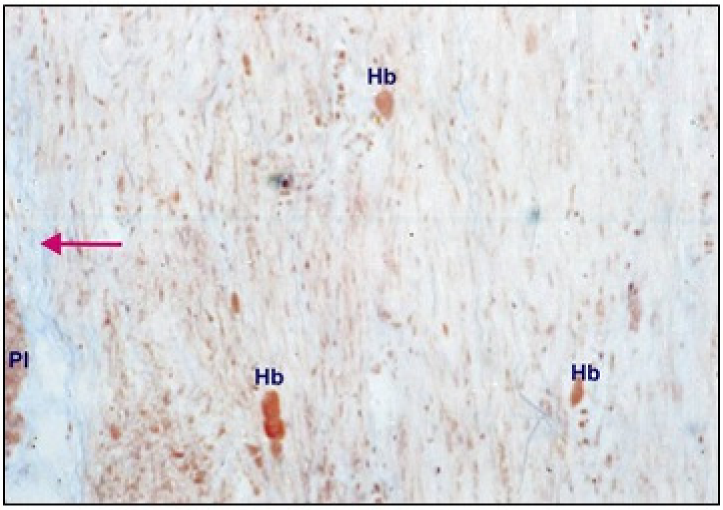
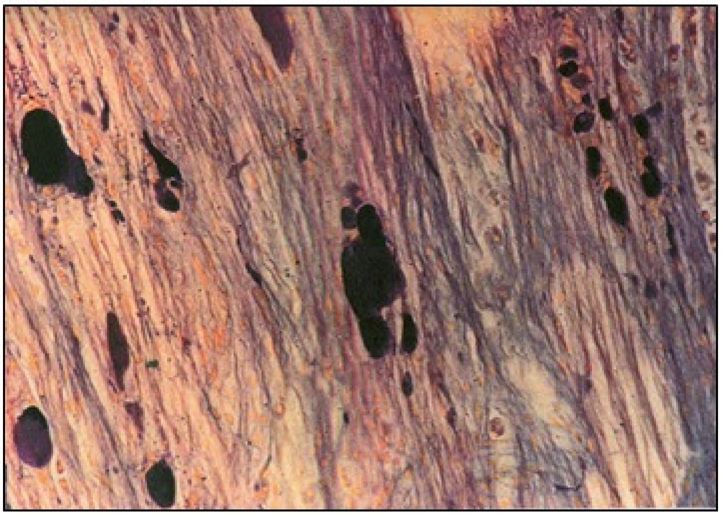


Figure 3: Photomicrograph of the pars nervosa containing the AF positive Herring bodies of various sizes in lactating sheep. **Aldehyde fuchsin stain x 400**



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