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Anatomical and histological characteristics of pituitary gland in domestic animals

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Abstract As it regulates important physical functions and general wellbeing, the hypophysis plays a major role in responding to the increased demand for different hormones. In the current review, we described the anatomical and the histological structures of the pituitary glands in different domestic animals. Unlike other glands, the pituitary gland has two main parts; the adenohypophysis (anterior lobe), which contains multiple populations of endocrine cells and is responsible for producing each of the pituitary trophic hormones. Another part of the pituitary gland is that the neurohypophysis (posterior lobe) secretes granules that contain certain neurohypophyseal hormones, like antidiuretic hormone and oxytocin, which are synthesized in the hypothalamus.

Keywords: domestic animals, effectiveness, hormones, hypophysis, structure

1. Introduction

As a key component of regulating physical functions and general welfare, the hypophysis plays a significant role (Greco 2020). Although the animal's body is complex and has many functions, it is significantly effective, and it is controlled by two main systems: the nervous system and the endocrine system. A nerve's chemical and electrical signals are carried at high speed by the nervous system, resulting in a high rate of organ activity. The endocrine system synthesizes and releases chemicals substances in the body of animals. This system has many functions and presents slowly but persists for a long time (Helena et al 2013).

During development, the pituitary gland has two lobes, the anterior lobe (adenohypophysis) and the posterior lobe (neurohypophysis) (Ye et al 2018). Adenohypophysis develops from the (Rathke's pouch) of oral ectoderm, whereas the neurohypophysis develops from neural ectoderm and diencephalons (Junqueira and Carneiro 2005; West-Eberhard 2005).

The pituitary gland or hypophysis can be considered the master organ in domestic animals, which produced many hormones that directly activated other endocrine organs (Dyce et al 1996; Naji and Zenad 2016; Saleh 2019).

The signals that send to different glands and organs in the body are regulated by the pituitary gland which maintained their function. The messengers are transmitted through many hormones secreted from this gland and passed the information from the hypophysis to distant cells, regulating their activity (Martinez-Lage 2011; Moriarty 1974). As with other glands, their actions are similar, as are those of the adrenal cortex (Alabada and Saleh 2020; Saleh et al 2020). Other body functions and regulations also might be influenced by the action of this gland (Naji and Zenad 2015; Saud 2022; Naji 2017)

2. Anatomical characteristics

Because it is an appendage of the brain, it has significance as a relay between nervosa and hormonal mechanisms that control certain functions in conjunction. Located at the ventral midline of the diencephalon, the hypophysis cerebri is suspended from the hypothalamus by a cylindrical stalk. It is an extension of the median eminence of the hypothalamus, referred to as the pars proximalic neurohypophysis (Marieb and Hoehn 2012; Dyce et al 1987). A gland's oval shape resembles a peanut (peanut-like), a disc in shape in rats, and it is bilaterally symmetrical from a sagittal plane in size and shape. The terminal of the hypophysis in Bactrian camels is a tiny protuberance that served as the neurohypophysis terminal (YE et al. 2018; Whittow 1999; Kang and Liu 1992) (Figure 1).

There are two endocrine glands in the brain, one of these is the Pituitary gland which is gray-red in color and positioned down dorsolaterally, and have an oval shape structure in donkeys (Cagdas and Merih Hazirogle 2009) (Figure 2).

Anatomical structures of the gland are very affected by the seasons, age, and sex of the animals (Dent 1961). The pituitary gland in rats is unpaired. It is a disc in shape (Figure 2) and positioned in the caudal part of the brain (Figure 3).

It is surrounded by a very thin white capsule which is part of the dura mater called the (sella diaphragm) in rats (Mahmood 2014). While in the dogs and donkeys, the gland is rounded in shape, placed in the sella, next to the optic chiasm there is a small slip in the sphenoid bone that is positioned on the base of the brain (Helena et al 2013; Cagdas and Merih Hazirogle 2009) (Figure 4).

The pituitary gland is rectangular in shape fixed by a small narrow trunk and it is located close to the optic chiasm in the bottlenose dolphins (*Tursiops truncatus from the Adriatic Sea*) (Vuković et al 2011) (Figure 6).

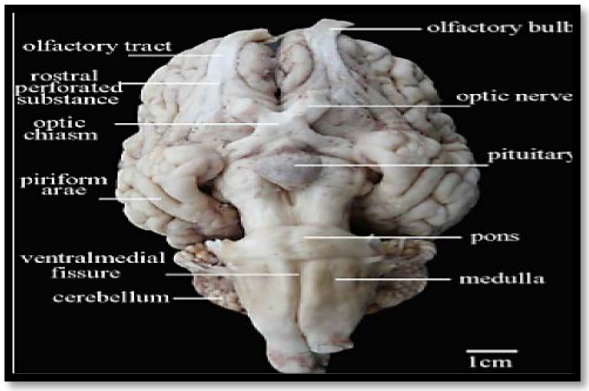

Figure 1 Ventral view of the brain. *Source:* Ye et al (2018)

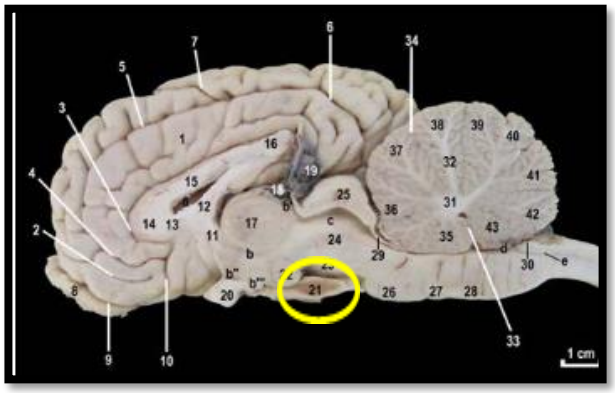

Figure 2 show the pituitary gland in the donkey (yellow color). *Source:* Cagdas and Merih Hazirogle (2009).

Figure 3 showing the pituitary gland located caudal part of the brain in rats. *Source:* Mahmood (2014)

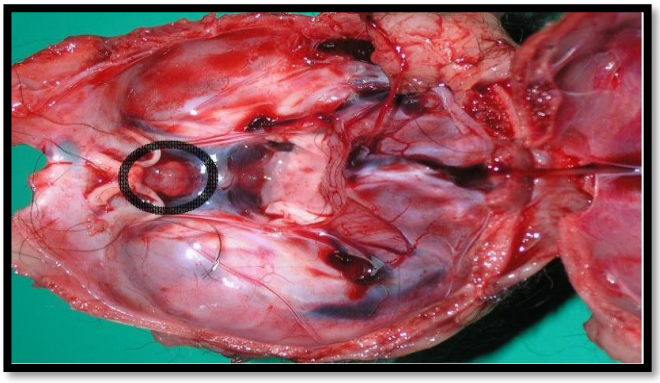

Figure 4 The sella turcica adjesent to the optic chiasm in the pituitary gland of dog. *Source:* Helena et al (2013)

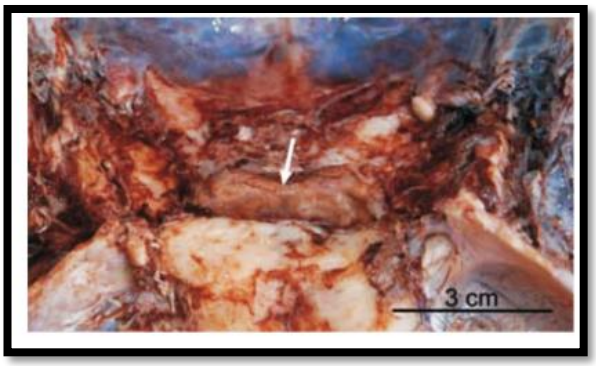

Figure 5 the pituitary gland o in the bottlenose dolphin. *Source:* Vuković et al (2011)

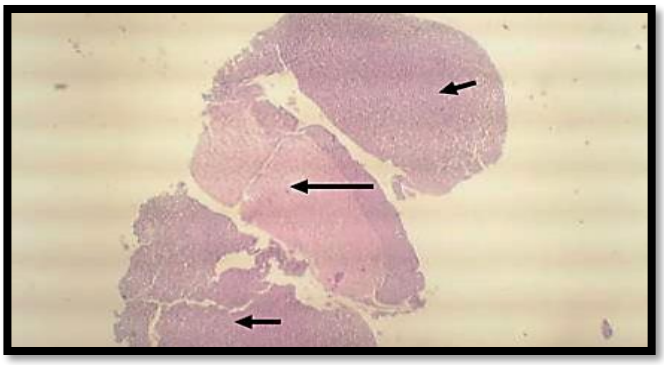

Figure 6 Adeno hypophysis and neurohypophysis of pituitary gland with H&E stain. *Source:* Mahmood (2014)

Hypophysial weight, volume, stalk diameter, and length have been measured (Ye et al 2018) (Table 1). In male and female camels, the weight of glands increases significantly with the development of age, it is highest in male camels at 11 years old compared with a young female that becomes the lowest in weight at 2-4 years (Jaspa et al 2011) (Table 2).

3. Histological characteristics

In the pituitary gland, there are two parts: the anterior pituitary, also known as the adenohypophysis, and the posterior pituitary, also known as the neurohypophysis. The adenohypophysis, is composed of three pars: pars distalis, pars tuberalis and pars intermedia (Mahmood 2014; Hullinger 1993; Ritchie 2014) (Figure 6).

The hypophysis is enclosed by a thinner coat of capsule with connective tissue, mainly collagen fibers and reticular fibers (Ye et al 2018). In addition to the outer adenohypophysis, the inner neural part of the gland (neurohypophysis) exhibits numerous histolocytological features. The adenohypophysis and the neurohypophysis are connected together by thick layers of connective tissue. The adenohypophysis is divided into three zones, pars distalis, pars tuberalis, and pars intermediate. The parenchyma of the pars distalis components are organized as clusters or cords, which are covered by accurate connective tissue stroma that contained cells composed of large sinusoidal capillaries as in the bottlenose dolphin (Vuković et al 2011) (Figure 7).

The pars distalis is based solely on the staining properties of secretory granules within the cells. In camels, secretory granules have an affinity for acidic and basic dyes, allowing histologists to distinguish basophils, acidophilus, and chromophobes based on their staining reaction (Morgan and Williams 1996; Fahmy and Nasr 1963; Ross et al 1989).

Seven types of cells in pars distalis could be recognized by immunohistochemical techniques and electron micrographs (Ye et al 2018; Moriarty 1974). The pars tuberalis forms a sleeve around the stalk of infundibulum. Its thickness is 25-60 µm. It consists of highly vascularized cord, of epithelial cells. In humans, pars tuberalis is not known with certainty (Pernicone et al 1997; Bloom and Fawcett 1968; Stoeckel and Porte 1984; Horvath 1988), the pars tuberalis encircled the infundibulum of the neurohypophysis.

There are four cell types in buffaloes: 1- Light cells: Large pale polygonal cells, 2- Magenta- syncytial cells: The syncytium loaded with ovoid or irregularly triangular nuclei with dark chromatin, 3-Double squamous cells: This type of cells lied at the periphery of the pars tuberalis and encircled the pars nervosa, it consisted of two layers of small squamous cells with fine magenta secretion granules similar to that of the magenta- syncytial cells, 4-Water- clear cells: There are two types of cells, small and large, spherical. It is smaller than the light cells, found in a small number. It has a pale water- clear empty cytoplasm with dark spherical to ovoid nuclei (Malallahand Hussin 2010) (Figure 8).

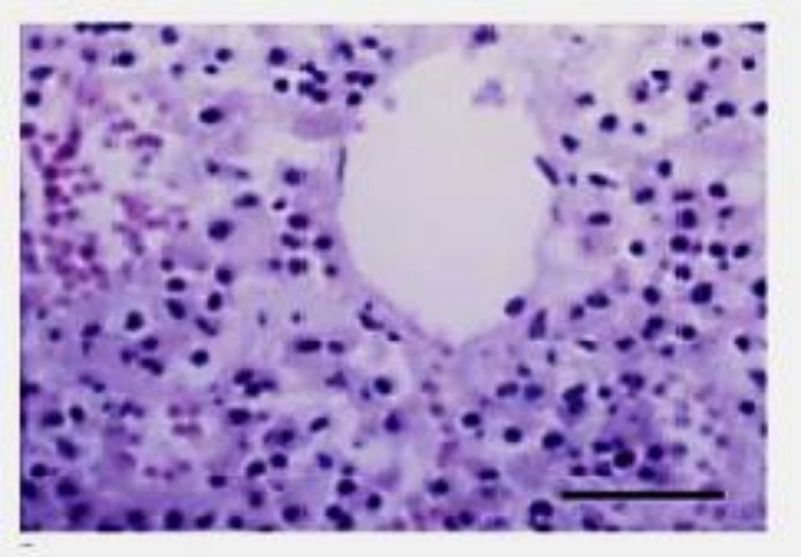

Figure 7 show histology of the adenohypophysis (pars distalis) of pituitary gland in the bottlenose dolphin. *Source:* Vuković et al (2011)

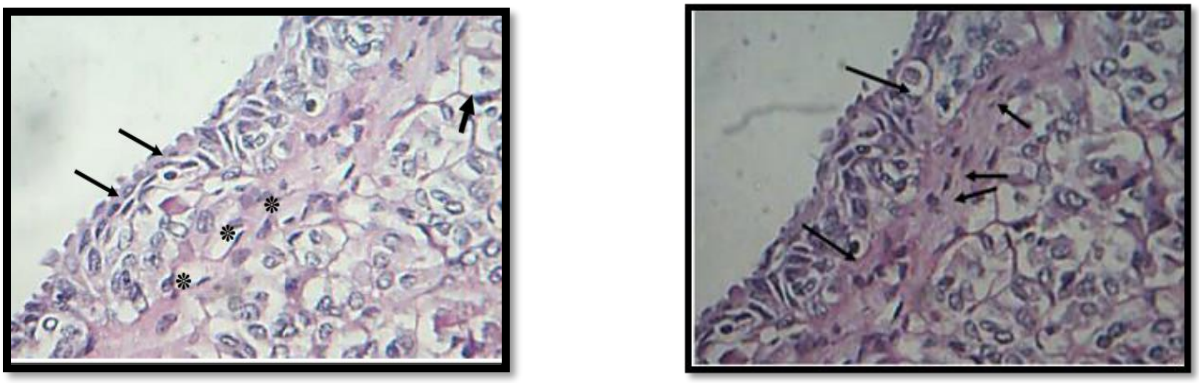

Figure 8 A-Pars tuberalis in buffalo showing light cells (small arrow). Double squamous cells (large arrows). Hypophyseal portal system (asterisks). PAS stain. 40 X. B- Pars tuberalis in buffalo showing water-clear cell (large arrows) and magenta syncytial cell (small arows). PAS stain. 40X. *Source:* Malallah and Hussin (2010)

Rats, pigs, and camels have well-developed pars intermedia (Malallahand Hussin 2010; Hewitt 1950). It lies close to the neurohypophysis and is separated from the pars distalis by a cleft. As a result of dense connective tissue intermingling with cells, the pars intermedia are poor. Many cells migrate from the pars intermedia into the pars nervosa. Two types of cells can be found in the pars intermedia; magenta cells have dark granules, while chromophobe cells are devoid of granules in their cytoplasm (Mahmood 2014) (Figure 9).

The pars nervosa, the infundibular stalk, and perhaps the median eminence are involved in neurohypophysis. The connective tissue, pituicytes, large numbers of nerve fibers without myelin, and capillaries are the main structures of this part (Ye et al 2018) (Figure 10).

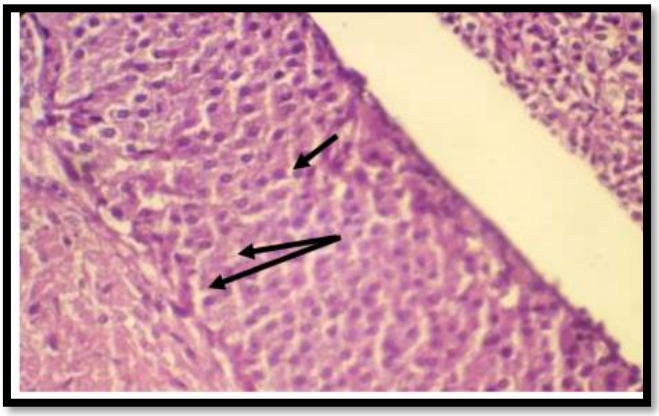

Figure 9 Pars intermedia showing two type of cells, irregular cell (short arrow) and Magenta-syncitium cell (long arrow).PAS stain.40X. *Source:* Mahmood (2014)

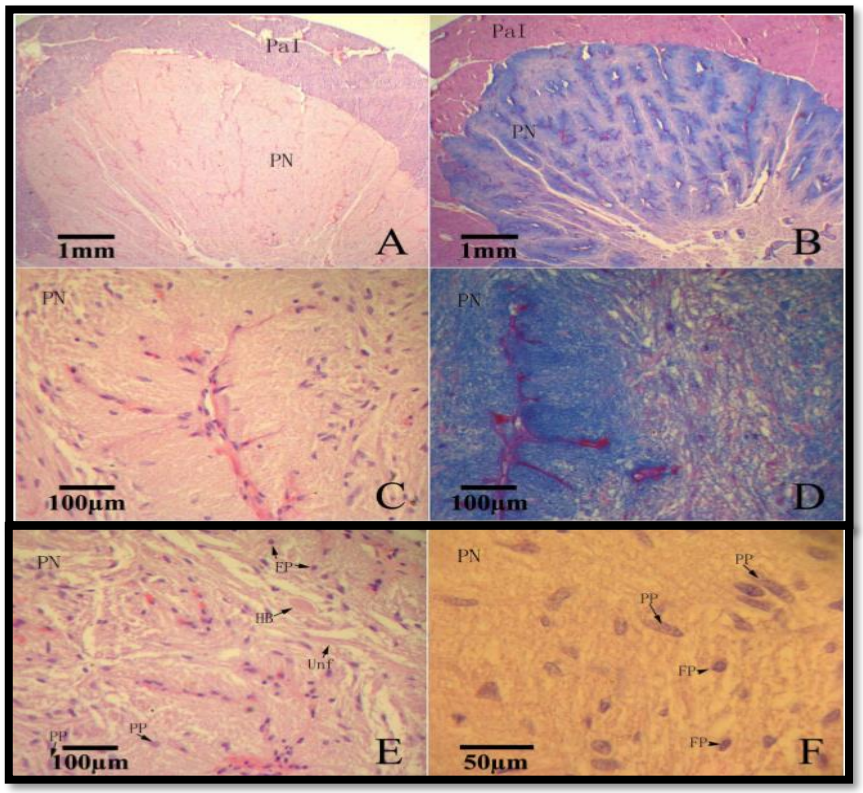

Figure 10 Light micrograph of the pars nervosa in hypophysis: A-F: hypophyseal cleft (HypC), pars intermedia (PaI), pars nervosa (PN), protoplasmic pituicyte (PP), fibrous pituicyte (FP), herring body (HB), unmyelinated nerve fiber (Unf). (A, HE x40; B, SS x40; C, HE x400; D, SS x400; E, HE x400; F, HE x1000). *Source:* Ye et al (2018)

4. Final considerations

In conclusion, the unique structure of the pituitary gland -which consists of two main parts; the adenohypophysis (anterior lobe) contains multiple populations of endocrine cells- is responsible for synthesizing and secreting each of the pituitary trophic hormones. The other part is the neurohypophysis (posterior lobe) is responsible for the secretion of granules that contain the neurohypophyseal hormones, ie, antidiuretic hormone (ADH, vasopressin) and oxytocin, which are synthesized in the hypothalamus.

Conflict of interest

None.

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