Anatomical Study of The Cerebellum in Diurnal Raptor Species (Buzzard)

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الخلاصة

تناولت الدراسة الجوانب الشكلية والنسيجية لمخيخ الـ (Buzzard) من حيث الحجم والمظهر والتغايرات التركيبية ذات العلاقة بالسلوك والوظيفة.

أظهرت نتائج الشكلياء بان المخيخ من النوع الواسع المحدب حيث لوحظ تقدمه للامام مغطيا الدماغ البيني وامتداده للخلف ليعلو النخاع المستطيل.

اظهرت المقاطع الطولية السهمية للمخيخ الفصوص الثلاثة المطواة بشدة للدودة Vermis والوريقات الاولية العشرة المتوسعة والمتفرعة وبالاخص (الرابعة، الخامسة، السادسة، والسابعة).

تضمنت دراسة الجانب النسيجي للمخيخ استخدام المشراح التدويري واستخدام تقنية التصبيغ بـ (الهيماتوكسلين–الابوسين) و (كاشف شف الدوري).

اظهرت نتائج الفحص المجهري الطبقات الثلاثة للقشرة (المادة السنجابية) وهي (1) الطبقة الجزيئية المرقطة الخارجية السميكة (2) الطبقة الوسطية المفردة لخلايا بركنجي الكبيرة الحجم (3) الطبقة الحبيبية الداخلية السميكة. تميزت المادة البيضاء التي تشغل اللب بكونها ذات مظهر كثير التفرع اشبه بتفرعات الشجرة وبوجود مجاميع من الانوية العميقة ضمن مركز اللب .

Abstract

Morphological and histological aspects on the cerebellum of (Buzzard) was Studied to describe the size, design and structural variation that related to birds behavior and function. The results of morphological aspects revealed that the expanded tuber cerebellum was protruded forward to cover the diencephalons and backward to cover the medulla oblongata. The vermis was involved three strongly folded lobes. Ten long and expanded primary folia were found in longitudinal sagittal sections, the folia (IV, V, VI, VII) were expanded and subfoliated. Histological aspects of this organ were studied with the help of rotary microtome and slides stained with heamatoxylin and Eosin (H & E) and periodic acid schift reagent (PAS) methods. The results of microscopic

examination indicated that there are three distinct layers in the cortex (gray matter). 1- Thick outer punctuate molecular layer. 2- Single middle large shaped Purkinje cell layer. 3- Thick inner granular layer. The white matter which formed the medulla has a tree like appearance of deep nuclei groups embedded within the white matter in the center of the cerebellum.

Introduction:

The birds of prey (raptors) are a large group characterized by their powerful feet armed, a cute visual, sensory perception, and a supremely developed power of flight [1]. Raptor's brain was classified as "generalist" brain comparison to other species depends upon the study of multivariate analysis of brain composition [2]. The cerebellum (Latin: Little brain) in strong fliers was expanded and important represented sophisticated system that deal with complexities of movement, and mode of prey capture The highly folded cerebellum functions involved the timing, coordination, and modulation of the motor system with incoming visual, and somatosensory information [3, 4].

One of the most prominent differences among birds is the relative size of the cerebellar primary folia [5, 6, 7, 8]. Other studies have been undertaken by many workers [9, 10, 11] in birds.

These investigations have been made to find out the anatomical aspect of the cerebellum in a diurnal raptor species (Buzzard), that maybe helpful for better understanding of the cerebellum structural variation related to birds behavior and function.

Martial and Methods:

Healthy (Buzzards) are utilized in this investigation, the brains are extracted from the skull by careful dissection, the whole brain and cerebellum submersion fixed in 10% buffered formalin. The brains are bisected in the sagittal plane to examine cerebellar folia.

For histological observation 5-6 micron thickness, sections are cut with the help of rotary microtome, the sections are stained with Haematoxylin and Eosin (H&E), and the periodic acid shift reagent (PAS) as per standard procedures, the tissue sections are washed, dehydrated, cleared, and mounted as per usual method [12, 13].

Result:

The cerebellum: gross anatomy:

The expanded tuber cerebellum was found to protrude forward and backward, Fig.1 shows that the cerebellum situated forwardly to cover the diencephalon dorsally, and backwardly to cover the medulla oblongata dorsally

too, the wide rostarl surface of the cerebellum is accommodated into a V-shape notch between the caudal poles of the cerebral hemisphere and the optic lobes.

The middorsal surface (Vermis) of the cerebellum was presented a seines of transverse coarser gyri and sulci, which was represented the three strongly folded lobes (anterior, middle, and Posterior) which were separated by two deep fissures (Primary x, and secondary y), the flocculi (auricles) are detected as Prominent caudolateral processes at the sides of the cerebellum, are shown in Fig.1 and Fig.2. Longitudinal Sagittal sections shows the ten long and expanded primary lobulii or folia number of (I-X), the folia (IV, V, VI, VII) were expanded and subfoliated. The cerebellum enclosed a small centrally placed cavity continuous by a small passage with the fourth ventricle of the brain.

Fig. 1: Dorsal view of the brain.

Fig. 2: Longitudinal sagittal section of the brain.

Result:

The cerebellum: histomorphology:

The internal structure of the cerebellum was divided into: Outer long single strip of cortex (gray matter) and inner medulla (white matter).

Three distinct layers of the cerebellar cortex (thick outer molecular layer, single middle Purkinje cell layer, and thick inner granular layer) were clearly detected on microscopic examination. Two layers of meninges, covered the cortex consisting of an outer diameter, which were extremely dense and protective, and a secondary meninx were more delicate and vascular, it was invaginated into the fissures between the folia, internally overlied the white matter. Fig.3 shows the outer thick molecular layer have a punctuate appearance, there were a sparse population of two groups of neurons; the superficial stellite cells which found tobe small in size and star shaped, and the larger basket cells.

There were great numbers of nerve fibers distributed in this layer. Fig.4 shows that the Purkinje cells were found in a single row between molecular and granular layers, these cells found tobe oval in shape, in the same places, few cells were in the form of large flasks with oval body, and small narrow neck, these cells were dendrited form a target arbors with many spiny branches up into molecular layer. The innermost thick granular layer were composed of two groups of neurons; the numerous small tiny round granule cells, and the larger Golgi cells, these two groups of neurons are shown together with great numbers of nerve fibers (Figure 4). The white matter which formed the medulla represented the inner bulk of the cerebellum. Fig.5 shows the tree like appearance of deep nuclei groups embedded within the white matter in the center of the cerebellum.

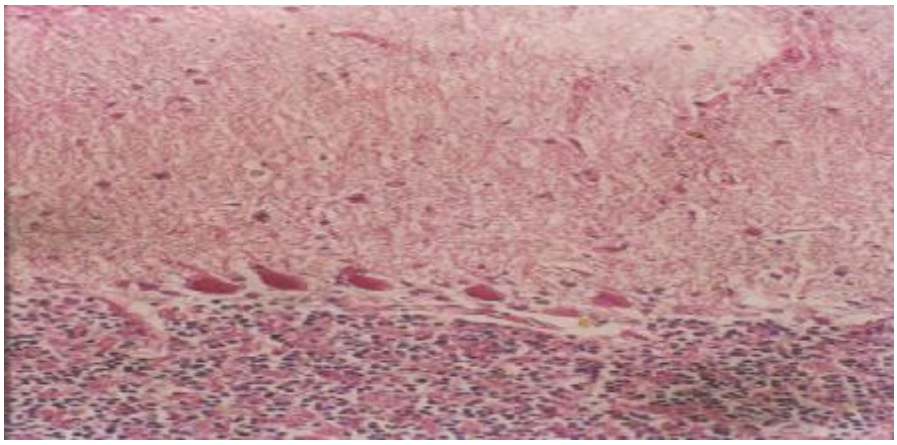

Fig.3: Part of one folium of the cerebellum, showing, the punctuate molecular layer, (PAS) stain 10x.

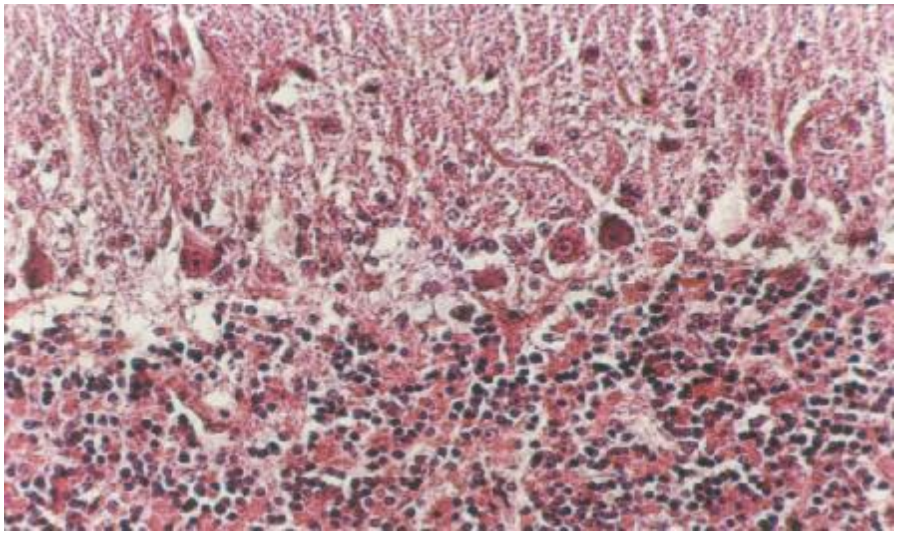

Fig.4: Part of cortical strip showing neurons, Purkinje cells, and nerve fibers (H&E) (20x).

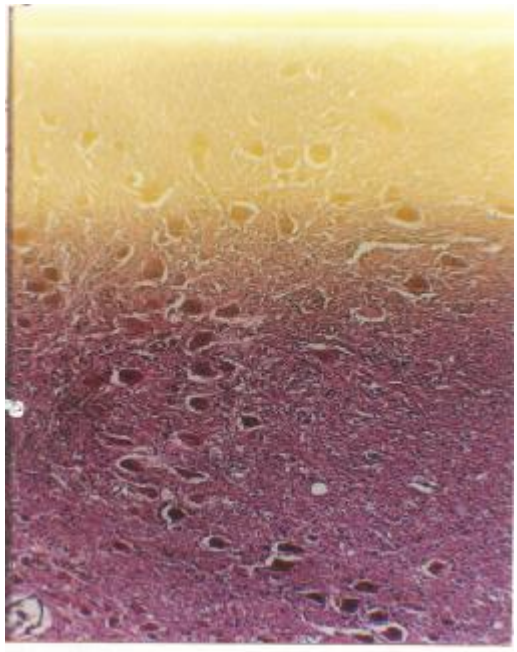

Fig.5: The tree-like appearance of deep nuclei in the center of cerebellum (PAS) (10x).

Discussion:

The results indicate that Buzzard has expanded tuber cerebellum, which was agreed to [3], who stated that birds have greatly expanded and extensively folded cerebellum to control motor coordination, and to maintain equilibration for flying movement, and for catch meals on the wing.

The cerebellum design in buzzard was protruded forward to cover the diencephalon, and backward to cover the medulla oblongata, while in the most

birds it was rounded in outline [10], and situated caudal to the cerebral hemisphere in fowl, [11].

The cerebellum in buzzard involved three strongly expanded folded lobes that divided into ten groups of lobuli or folia, while (humming birds, swifts, nightjars, and Potoos) have reduced anterior lobe [6].

The anterior lobe had four lobuli, the middle lobe was the most variable, and the posterior lobe really consisted of three lobuli in birds [10].

The prominent differences in cerebella folia size was related to cognitive abilites, functional, and specific behavioral differences among birds [5, 6, 7, 14].

Buzzard has expanded, and subfoliated primary folia (IV, V, VI, VII) corresponds with the cerebellum length, these finding were inagreement with [7], who stated that there was a correlation between strong hind limbs, and the expansion of anterior lobe folia. Strong fliers species have expanded folia VI, and VII, this expansion reflect the increased visual processing requirements in rapid and agile flight. The expansion of folia IV, V, and VI were attributed to bird strong wings [6]. The nocturnal raptors were specialized by the enlargement of vestibular, and tailsomatosensory cerebellar regions [15].

The internal structure of the cerebellum in buzzard was divided into outer longe single strip of cortex (gray matter), and inner medulla (white matter), this cortical strip has antero-posterior extension pointed by the wide surface of the buzzard cerebellum morphology which was accommodated into a [V] shaped notch, these findings were in agreed with[5], who stated that the cortical strip varies in it's extension of different bird species.There were three distinct layers of the buzzard cerebellar cortex (thick outer punctate molecular layer, single middle large shaped Purkinje cell layer, and thick inner granular Layer). The size of these layers was greater, and highly developed in birds which fly compared to the flightless [11].

The changes in the size of the primary folia were reflected the differences in the size of cell layers, as well as correlated changes among folia, and extracerbellar regions of the brain [5, 8, 15].

The white matter which formed the medulla was branching in atree-like appearance of deep nuclei groups embedded within the white matter in the center of the buzzard cerebellum, this tree-like appearance in human named arbor vitae (tree of life) composed of four groups deep nuclei that receive inhibitory inputs from the Purkinje cells in the cerebellar cortex, and excitatory inpts from mossy fibers pathways. Most output fibers of the cerebellum originate from these deep nuclei [4].

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