Morphological and Histological Study of The Fore Brain (Cerebrum) In Quail *Coturnix coturnix* (Linnaeus, 1758)

Asmaa B. Abid
Nahla A. Al-Bakri
Dept. of Biology, College of Education for Pure Science (Ibn Al-Haitham), University of Baghdad

Received in :26 November 2015,Accepted in :10January 2016

Abstract

The morphological and histological aspects of fore brain (Cerebrum) in quail (*Coturnix coturnix*) have been investigated, results of the present study revealed that the cerebrum in quail is large size triangular shape, its surface contains folds of shallow grooves.

Microscopical examination declears that cerebrum consists of two regions, the first represents pallium which includes the external corticoid area which consist of hyperpallium and the dorsolateral corticoid area, it consists of piriform cortex and hippocampal complex. The second region is the internal corticoid areas dorsal ventricular ridge which contains the mesopallium, nidopallium and archopallium.

he large size pyramidal neurons appeared in the nidopallium surrounded the crescent shaped lateral ventricles. The subpallium region consists of two regions represented by striatum which contains neuronal fibers and pallium which is appeared small and pale colour and represented the deepest part of cerebrum.

Key words: Cerebrum, Quail, Aves.

Introduction

Prosencephalon represented the largest part of the brain in vertebrates animals. It is receives different stimuli and stores the received information, prorsencephalon consists of two parts, these are telencephalon which represented the dorsal region of the prosencephalon and diencephalon which represented the ventral region of prosencephalon [1, 2 and 3]. Telencephalon in mammals contains large number of folds and sulci [4], and it is large sized in birds and reptiles. In reptiles the cerebrum performs some of mesencephalon functions as it is responsible for learning and memory [5 and 6].

Prosencephalon has been investigated morphologically, histologically, embryologically and physiologically in different vertebrates [7, 8 and 9]. Review of the literature revealed that it is subjected of few investigations done by Iraqi researcher, these are Al-Bakry [10] who studied the embryonic development of the prosencephalon in bony fish embryo, Al-Habeb [11] studied the embryonic development of the brain in mosquito fish *Gambusia affinis*. On the other hand, Najeb *et al.* [12] investigated the embryonic development and histological structure of *Barbus sharpeyi*, Al-Kazelchi [13] study the procencephalon in *Anas platyrhnchos*, Al-Rufaeei [14] studied the morphological description and histological structure of olfactory organ in *Heteropneustes fossilis* and *Rana ridibunda*, Al-Asady *et al*. [15] studied the embryological development and histological structure of olfactory organ in common carp *Cyprinus carpio* and Hussain *et al.* [16] studied the morphological description and histological structure of olfactory organ in local chicken *Gallus domesticus*.

The present study aims to study the morphological description and histological structure of prosencephalon in quail *Coturnix coturnix*.

Materials and Methods

A total of (12) male and female birds of the species under investigation were obtained from the local markets at Baghdad city the age of birds was one month. Brain have been removed from the skull, the weight, length and width of the brain and prosencephalon were measured [17]. Paraffin wax methods employed in histological study according to the methods of (19 and 20 micrometers) and measurement in done by ocular.

Results

1-Morphological study

Results of the present study revealed that the brain in *Coturnix coturnix* consists of three regions represented by prosencephalon, mesencephalon and rhombencephalon (Fig. 1). Telencephalon represented by cerebral hemispheres which appeared as a connected vesicles with folded and sulci at the external surface, both vesicles are surrounded by meninges and they are connected with olfactory bulbs anteriorly. There is a longitudinal cerebral fissure at the middle of the cerebrum this fissure divided the cerebrum into two parts called cerebral hemispheres, there are also another fissure in between the cerebrum and cerebellum called transverse cerebral fissure (Fig 1).

The second part of the brain is mesencephalon which is differentiated by the presence of the large optic lobules. The dorsal wall of the optic lobes formed the optic tectum while the ventral wall formed the tegmentum, the third part of the brain represented the rhombencephalon which consists of the cerebellum from the dorsal side, the cerebellar peduncles from both sides, pons and medulla oblongata from the ventral side, the later connected with the spinal cord (Fig 2).

The ratios of mean weigh, length and width of cerebrum in comparison with the mean of weight, length and width of total brain in quail were (66%), (12%) and (25%) respectively (Table 1).

2-Histological study

Results of the present study revealed that the cerebral hemisphere consists of two regions:

A- Pallium which includes the external and internal cortical area, the external cortical areas situated at a tip of cerebrum and appeared as cap of mushroom. It consists of:

a-Hyperpallium (Wulst), which is represented by a large mass located internally at the dorsal side of each cerebral hemisphere and limited by vallecular, which appears as a lamellate structure which contains:

1. Fibromolecular layer contains different types of cells represented by stellate neurons with mean diameter of (10) µm; spherical neuros with mean diameter (7) µm and the glial cells with mean diameter of (2) µm (Fig 2).
2. Hyperpallium accessorium (HA) which contains a layer of stellate neurons with (9) µm in their mean diameter and spherical neurons with (5) µm in mean diamter (Fig 2).
3. Intercalated hyperpallium accessorium (IHA), this region contains stellate neurons with (8) µm in mean diameter (Fig 3).
4. Hyperpallium intercalates suprema (HISM), this region contains fusiform neurons with (7) µm in mean diameter (Fig 3)
5. Hyperpallium densocellulare (HD), a deep layer contains pyramidal shaped neurons with mean diameter of (18) µm, stellate neurons with (10) µm in diameter, fusiform shape neurons of (10) µm in mean diameter and spherical neurons of in mean diameter (Fig 3).

b-Dorsolateral corticoid area (DLC): It is a superficial layer contain stellate neurons with (10) µm in mean diameter and axon with branched end and dendrites with spine. It contains also spherical neurons of (9) µm in diameter and horizontal neurons of fusiform shape and small size with (20) µm in mean diameter (Fig 4).

c-Piriform cortex: It is a superficial layer contains pyramidal neurons with (7.5) µm in mean diameter. The glial cells also appear in this layer and with (4) µm in mean diameter (Fig 5).

d-Hippocampal complex: It is supra ventrolateral process divided into dorsolateral (DL), dorsomedial (DM) and ventral parts. The pyramidal neurons appeared in these part with mean diameter of (8) µm, they consist of axon extend from the tip toward the superficial layers of the cortex and contain numerous dendrites extend from its base horizontally, fusiform neurons with long axon and (8) µm in mean diameter, stellate neurons with (10) µm in mean diameter and spherical neurons with (7.5) µm in mean diameter (Fig 6). On the other hand the internal cortical areas which called dorsal ventricular ridge (DVR) which are well developed and divided into the following parts:

a- Mesopallium which is located underneath the dorsolateral cortical area and contains pyramidal neurons of (7.5) mm in mean diameter, spherical neurons of (7.5) µm mean diameter, and horizontal neurons with mean diameter of (18) µm. The axons of spiny dendrites of these cells extend to the surface, the glial cells also appear in this layer and they are with mean diameter of (5) µm (Fig 7).

b- Nidopallium which is surrounded the lateral ventricle and contained large pyramidal neurons with mean diameter of (51) µm and contained apical single thick dendrite extended the upper layers of the cortical area, the glial cells also found in this layer with mean diameter of (5) µm (Fig 8).

c- Archopallium which represented cerebrum and situated in caudal region of cerebrum and contained pyramidal neurons, spherical neurons and stellate neurons in addition to the glial cells, they are with mean diameter of (12, 7, 10 and 3) µm (Fig 9).

B- Subpallium which located underneath the nidopallium and occupied the internal parts of cerebrum, it is divided into two parts:

a-Striatum which is represented by a small region of cerebrum and consists of a mass of spherical neurons in between them a large bundles of myelinated axons and they are with afferent spiny dendrites which give this region its striation appearance (Fig 10).

b-Pallium is a small size region in the cerebrum. It appeared deep in its position with pail colour and contains few pyramidal neurons of small size (Fig 11).
Each cerebral hemisphere contains a cavity called lateral ventricle which appears as a crescent shape and surrounded by nidopallium. The anterior choroid plexus appeared the posterior medical region which is formed from a finger like projection differentiae by the presence of villi and each villas contains connective tissue rich with blood capillaries and collagenous fibers derived from pia mater and covered by cuboidal epithelial tissue (Fig 12, 13).

Discussion

Brain in aves is larger as much as to time of the brain in reptiles and mammal [22]. The cerebral hemispheres represented the largest part of the prosencephalon and it contains (90%) of the neurons found in the central nervous system [23]. Embryologically cerebral hemispheres developed as an evagination from the anterior end of the neural tube which represent telencephalon in all vertebrates with the exception of actionopterygains fish (Ray finned) [24, 25].
Quail has large cerebrum represented (66%) of the brain wight, this result agrces with the result of [13]. Kent [26] stated in his study that there are functional of structural differences in cerebral hemisphere depending on the sexes and species and these differences did not appear on the morphology of the cerebrum [27]. The external part of the telencephalon in mammals appear with complex folds and formed from gray matter which arranged as a layers. The internal part of the telencephalon situated at the ventral side of the lateral ventricles and in the reptiles and aves, the external and internal parts of telencephalon composed of nuclei. The cerebrum in primitive vertebrates such as hag fishes and lampreys is represented by a simple structure receives the nerve impulses from the olfactory bulb, while in cartilagenous fish, crosspterigean fish and amphibians represented by a complex structure consists of ventral and lateral parts which represented the pale pallium and the dorsal part which represent the archi pallium in addition to the ventral part which represents the basal nuclei and contains nerve fibers extended to the thalamus.

In actionopterygean fish (Ray finned), the internal surface of the lateral and ventral region formed an evagination inside the lateral ventricles and includes the basal nuclei of the pallium which becomes a complex structure in teleosts fish, and the dorsal surface appears as a membranous structure with lacks of the nervous tissue. On the other hand in amniotes the cerebrum becomes as a complex structure, in reptiles the cerebrum performs some of mesencephalon functions and formed from the large size pale pallium in comparison with amphibians [22 and 28].
In adult birds the pallium represented about (75%) of the telencephalon and acts to connect between the sensory inputs and motor output [29].

The hyperpallium region and archopallium in birds send branches of the neural fibers to the motor nuclei situated in brain stem and spinal cord [30]. These results agree with the results of the present study as it is stated that hyperpallium contains nerve fibers.
Results of the present study revealed that the dorsolateral corticoid area contains horizontal neurons in the upper layers of cerebral, this foundation agrees with results recorded by [29].
Previous studies found that in fish, reptiles, birds and mammals the hippocampus and amygdala contain a pyramidal neurons [28], these results are confirmed by the results of the present study.
The pyramidal neurons play an important roles in the mammary, and represented an inhibited neurons in the cerebrum, they are present also in molecular layer of cerebellum [29, 31].

Sheoherd [29] stated that the fusiform neurons found in the cerebrum layers and they are appeared with long dendrites extended to the surface of cortex and the thalamus. Results of the present study confirmed the above foundation due to the appearance of these neurons in the hippocampal complex.

The Dorsal ventricular ridge (DVR) regions received the somatic sensory impulses and the auditory impulses and send motor impulses to the basal ganglia [32]. In quail the (DVR) contains pyramidal neurons, these results agree with the results recorded by [33] in *Tyto alba*. The axons of the pyramidal neurons extend to the brain stem and spinal cord [29].

The dorsal ventricular ridge (DVR) in birds contains nuclear matter as its represented the motor sensory input and outputs [32, 34]. In bird (DVR) controlled the wings movement and the body position as it occupied (75%) of the size of telencephalon [35] and it is appeared well developed in intelligent birds as in craws, parrots and passerines while it is less developed in pigeons, quail and domestic chickens [30], these results agree with the results of the present study.

The (DVR) consists of three regions represented by mesopallium, nidopallium and archopallium, these results agree with [33] in *Tyto alba* and *Anas olatyhnches* [13].

Bird cerebrum lacks of prefrontal cortex (PfC) which is found in mammals, the nidopallium in birds is homologous to the prefrontal cortex in mammals as it is filled with neurons which connect with brain parts and that is why it represented center for neuronal input and output of the brain [36, 37] these results agree with the results of the present study.
Skimizu [32] stated that the subpallium called basal ganglia as it represented the main center of extra-pyramidal motor system.
The striatum contains the basal ganglia and the bundles of nerve fibers situated in the deep regions of cerebral hemisphere [37], these results agree with the present study results. Puelles *et al*. [38] stated that the striatum is responsible for learning and mammary and it resembles the neocortex region in mammals.

Bi and Poo [28] reported the lacks of pyramidal neurons, in olfactory bulb and striatum of mid and hind brain and spinal cord in fish, reptiles, birds and mammals. The striatum region in vertebrates received several branch sensory nerve fibers from hypothalamus, and the number of these fibers are few in Amphibia in comparison with the other vertebrates. In birds the sensory neuronal impulses are important for nesting and nursing of the young bird [37]. The embryonic studies revealed that striatum represented the first region of the brain appeared during the embryologic development and it is divided into dorsomedial and ventrolateral regions [24].
The pallium which worked for the organizing the behaviors as it is responsible of voluntary movements and it has an important role for the heavy drink and doses of drugs [22].
The comparative embryological studies revealed a homology of telencephalon in birds of mammals as the neurons of subpallium have the same origin and they are migrate to the (DVR) and cortical areas in pallium [38, 39].

The gray matter in lower vertebrates which is situated below the white matter of the brain, while in reptiles the gray matter distributed at the surface of the brain specially in the anterior part of the brain which represented the primitive cortex. On the other hand in mammals cortex covered the cerebral hemispheres completely as in primates which leads to make the paleopallium to the ventral surface of the brain, and the archipallium which surrounded the dorsomedial ridge to from the hippocampus. In placental mammals the corpus collosum developed well and connected the cerebral hemispheres [26, 40].

References

1. Brooker, RJ.; Widmaier, EP.; Graham, LE. and Stiling, PD. (2008). Biology, 2 nd ed. Ch.34, The McGraw-Hill. Com. New York: 717-79.
2. Bevelander, G. and Ramaley, J. (1979). Essentials of histology, 8 th ed. The C. V. Mosby. Comp. USA: 363-366.
3-Kotpal, RL. (2010). Modern text book of zoology: vertebrates. Restage. Publ. New Delhi: 1-846.
4.Hodges, RD. (1974). The histology of the fowl. Academic press. Inc. London: 648 .

5. Kent, CC. and Carr, RK. (2001). Comparative anatomy of the vertebrates, 9th ed. McGraw-Hill. Book. Co. Inc. New York: 824.
6. Northcutt, RG. (2002). Understanding vertebrates brain evolution. Integrative and comparative. Biology, 42(2): 743-766.
7. Redies, C.; Mzdina, L. and Puelles, L. (2001). Cadherin expression by embryonic divisions and derived gray matter structures in the telencephalon of the chicken. J. Comp. Neur., 438: 253-255.
8. Peng, K.; Feng, Y.; Zhang, G.; Liu, H. and Song, H. (2010). Anatomical study of brain of Afreican Ostrich. Turk. J. Vet. Anim. Sci., 34(3): 235-241.
9. Rehkmpera, G; Erahma, H. D. and Cnotkaa, J. (2008). Mosaic evolution and adaptive brain component alteration under domestication seen on the background of evolutionary theory. Brain Behav. Evol., 71: 115-126.
10. Al-Bakri, N. (1995). Study of Neurulation in embryo of bonny fish. PhD. Thesis, College of Education for pare sciece (Ibn Al-Haitham), University of Baghdad: 55.
11. Al-Habeb, R. A. (2006). Eembryogenesis of central nervous system in the gastrula stage until birth to a fish mosquitoes *Gambusia affinis* (Bairds & Girad). MSc. Thesis, College of Science for Women, University of Baghdad: 98. (In Arabic).
12. Najib, M. Q.; Daoud, H. A. M. and Ghali, M. A. H. (1999). Embryogenesis and histology of olfactory organ in brown fish (*Barbus sharpeyi* Gunther), 2-Morphological and histological description of olfactory organ in adult fish. Veterin. Med., 9 (1): 22-32. (In Arabic).
13. Al-Kezlchi, S. A. A. R. (1999). Anatomical and Histological study of the brain in a bird *Anas platyrhnchos* L. PhD thesis, College of Education for pare science-Ibn Al-Haitham, University of Baghdad: 105 pp. (In Arabic).
14. Al-Rufaeei, L. M. (2001). Description morphological and histological structure of olfactory organs in a fish biting *Heteropneustes fossils* and Iraqi frog *Rana ridibinda*. MSc. Thesis, Baghdad University. (In Arabic).
15. Al Assadi, Z. T. S.; Ghali, M. A. H. and Daoud, H. A. M. (2002). Embryogenesis and histology of olfactory organ in carp fish (*Cyprinus capiro* L.), 1-Histological Differentiation of disk olfactory. J. Ibn Al-Haitham Pure and Applied Sci., 15 (14): 29-39. (In Arabic).
16. Hussein, A. A. and Daoud, H. A. M. (2011). Morphological and histological description installation of olfactory organ of the chicken (*Gallus domesticus*), J. Madenat Alellem Coll., 3 (2): 32-47. (In Arabic).
17. Spijker, S. (2011). Dissection of rodent bra. Regions. Neuroproteomies. Neuromethods., 57: 13-20.
18. Bancroft, JD. and Stevens, A. (1982). Theory and practice of histology techniques 2 nd ed. Churchill. Livingston. London: 662.
19. Vacca, L. (1985). Laboratory manual of histochimistiy. Raven press. New York: 238 pp.
20. Luna, LG. (1968). Manual of histological staining methods, 3 rd ed. Mc Graw-Hill. Book. Co. Inc. New York: 258.
21. Humason, GH. (1967). Animal tissue techniques, 2 nd ed. W. H. Freman Com. San Francisco: 489.
22 Figlia, D.; Pasik, P. and Pasik, T. (1982). A Golgi and ultrastructure study of the monkey globus pallidus. J. Comp. Neurol., 212: 53-75.
23. Aspinall, V. and Cappello, M. (2009). Introduction to veterinary anatomy and physiology text bock, Butte Rworth Heinemann an Imprint of Elsevier Ltd., London: 238.
24. Sadler, TW. (2006). Langman's medical embryology, l0th ed., Lippincott Williams and Wilkins., New York: 371.
25. Kaas, JH. (1995). The evolution of isocortex, brain behave. Evol., 46: 187-196.

26. Kent, G. (1987). Comparative anatomy of vertebrates, 6th ed. John Wiley., New York: 385.
27. Leake, LD. (1975). Comparative histology academic press, New York: 378.
28. Bi, GO.; Poo, M. (1998). Synaptic modifications in cultured hippocampal neurons dependence on spike timing synaptic strength and postsynaptic cell type. J. Neurosci., 18: 10464-10472.
29. Shepherd, GM. (1994). Neurology Oxford University.
30. Jarvis, ED.; Gunturkun, O.; Bruce, L.; Csillag, A.; Karten, H.; Kuenzel, W.; Medina, L.; Paxinos, G. (2005). Avian brains and a new understanding of vertebrate brains evolution. Nat. Rev. Neurosci., 6: 151-159.
31. Romer, AS. and Parson, TS. (1977). The vertebrate body, Philadelphia.
32. Skimizu, T. (2009). Why can birds be so smart, background, significance and implication of the revised view of the avian brain. Comparative Cognition and Behavior Reviews, 4: 103-115.
33. Abd-Alrahman, SA. (2012). Morphological and histological study of the cerebrum in a nocturnal bird species (Barn owl) Tyto alba, 3(25): 73-86.
34. Rehnipera, G.; Frahma, HD. and Cnotkaa, J. (2008). Mosaic evolution and adaptive brain comprent alteration under domestication seen on the background of evolutionary theory. Brain behavior and Evolution, 71: 115-126.
35. Iwaniuk, N. and Hurf, PL. (2005). The evolution of cerebrotypesin birds. Brain Behav. Evol., 65(4): 215-230.
36. Brink, T. L. (2008). The nervous system. Physiology: 62 .
37. Weithers, PC. (1992). Comparative animal physiology, Saunders College pub., New York: 949.
38. Puelles, L.; Kuwana, E.; Puelles, E.; Bulfone, A.; Shimamura, K.; Keleher, J.; Smiga, S. and Rubenstein, J. L. (2000). Pallial and subpallial derivative, in the embryonic chick and mouse telencephalon, traced by the expression of the genes Dlx-2, Emx-1, Nkx-2.1, Pax-6, and Tbr-1. J. Comp. Neurol., 424(3): 409-38.
39. Striedter, GF. and Beydler, S. (1997). Distribution of radial glia in the developing telencephalon of chicks. J. Comp. Neuril., 387: 399-420.
40. Rehknipera, G.; Frahma, HD. and Cnotka, J. (2008). Mosaic evolution and adaptive brain component alteration under domestication seen on the background of evolutionary theory. Bran Behavior and Evolution, 71: 115-126.

Table (1): Measurements of whole brain and cerebrum of adult quail.

	Whole brain	Cerebrum	%
Mean of weight (gm)	0.6	0.4	66
Mean of length (cm)	2.5	0.3	12
Mean of wide (cm)	2	0.5	25

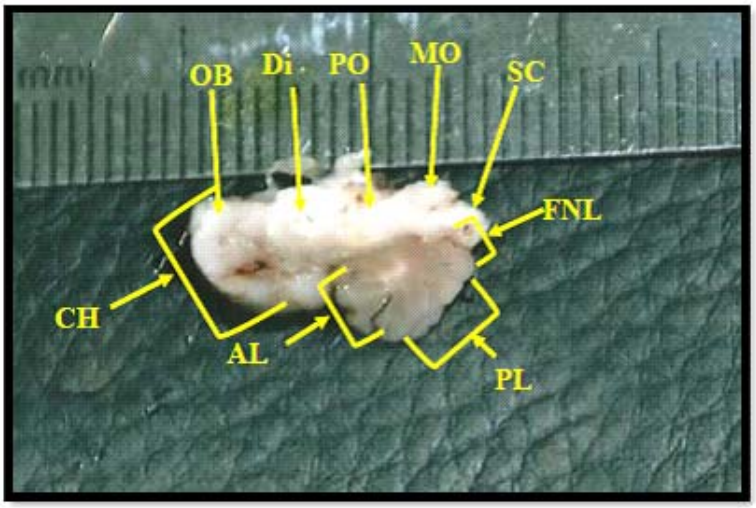

Fig (1): Mid-sagittal through the brain of quail showing the parts of cerebrum. Olfactory bulb (OB), Cerebral hemisphere (CH), Pond (PO), Medulla oblongata (MO), Diencephalon (Di), Spinal cord (SC), Anterior lobe (AL), Posterior lobe (PL), Flocculonodular lobe (FNL).

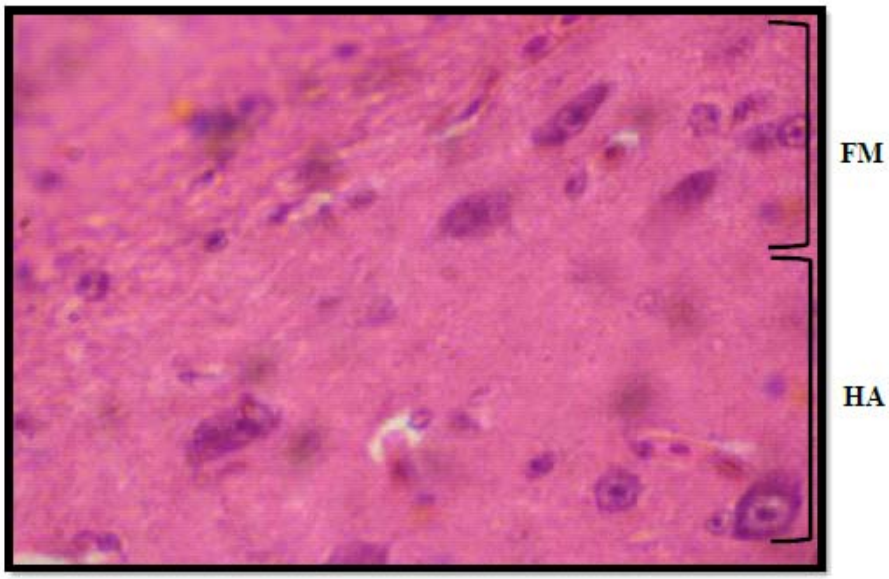

Fig (2): Cross section through the cerebrum of quail showing the fibromolecular layer (FM) and the hyperpallium accessourium (HA) in the hyperpallium (H & E. x1000).

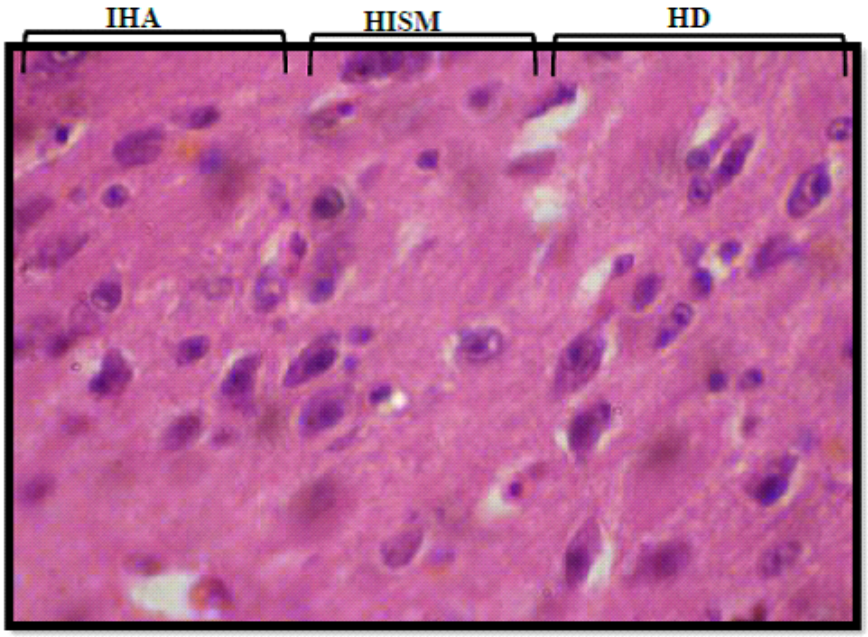

Fig (3): Cross section through the cerebrum of quail showing the intercalated hyperpallium accessorium (IHA), hyperpallium intercalates suprema (HISM) and hyperpallium densocellular (HD). (H & E. 1000x).

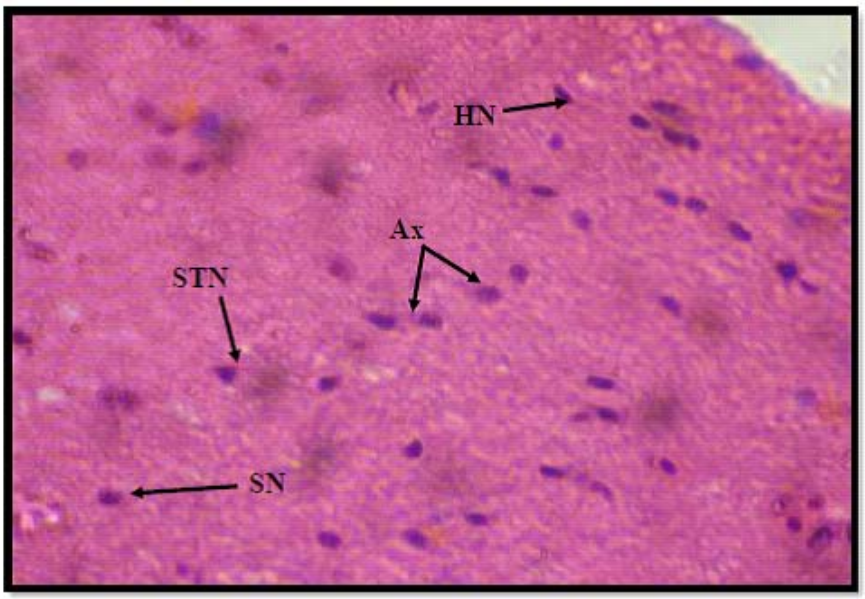

Fig (4): Frontal section through the cerebrum of the quail showing the dorsolateral corticoid area. (H & E. 400x). Horizontal neuron (HN), Spherical neuron (SN), Axon (Ax), Stellate neuron (STN).

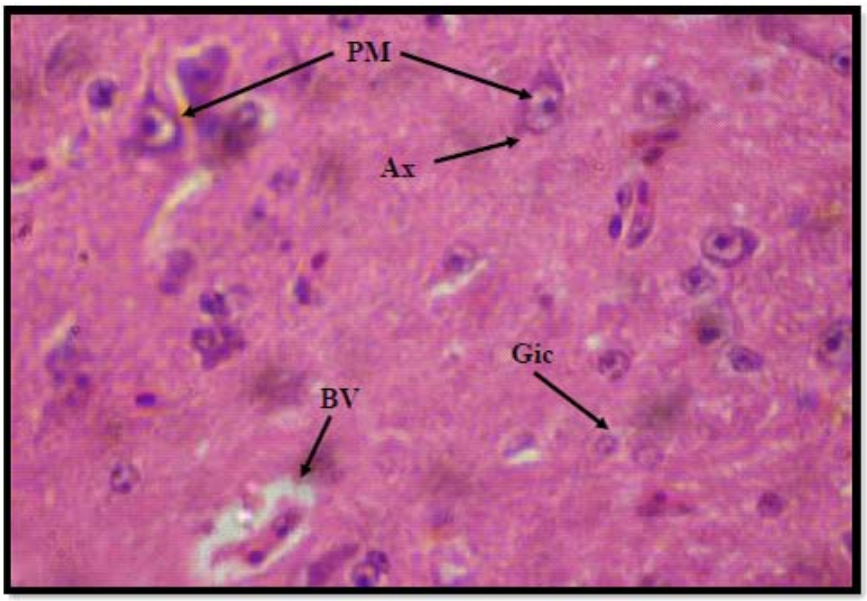

Fig (5): Mid sagittal section through the cerebrum of the quail showing the piriform cortex (H & E. x1000). Blood vessel (BV), Axon (Ax), Pyramidal neuron (PN), Glial cell (Gic).

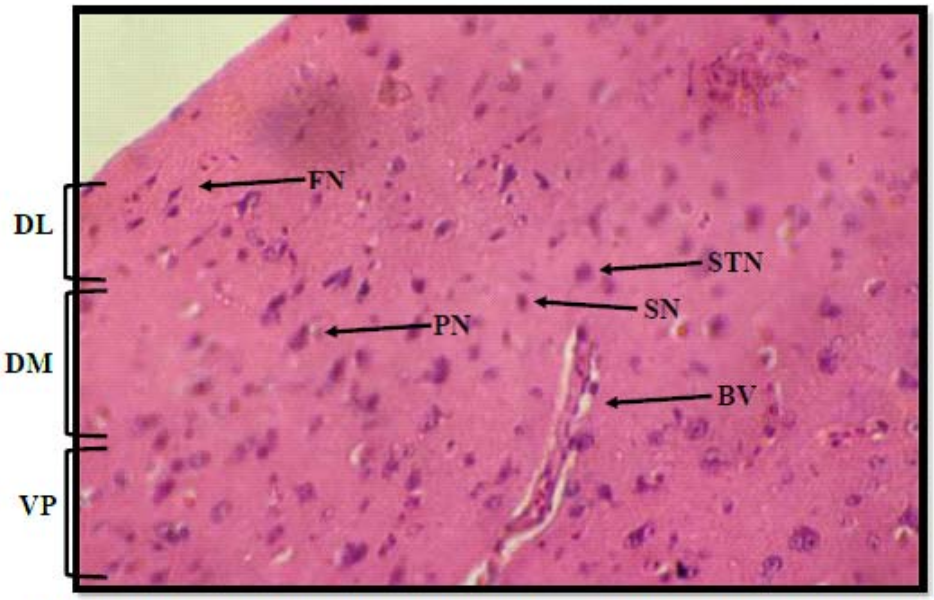

Fig (6): Frontal section through the cerebrum to explain the hippocampal complex region. (H & E. x1000). Dorsolateral (DL), Dorsomedial (DM), Ventral part (VP), Pyramidal neuron (PN), Stellate neuron (STN), Spherical neuron (SN), Fusiform neuron (FN), Blood vessel (BV).

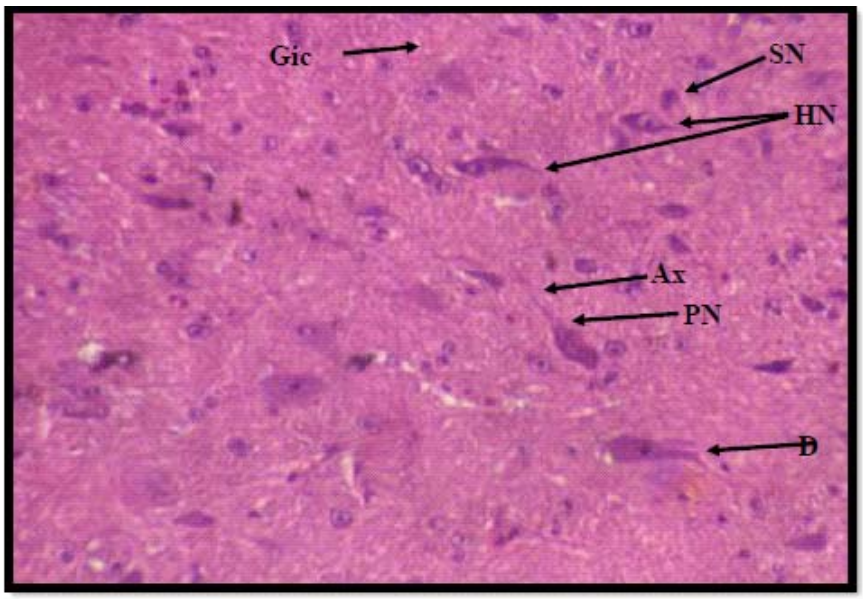

Fig (7): Cross section through the cerebrum of the quail showing the mesopallium region. (H & E., 400x). Pyramidal neuron (PN), Glial cell (Gic), Axon (Ax), Dendrites (D), Spherical neuron (SN), Horizontal neuron (HN).

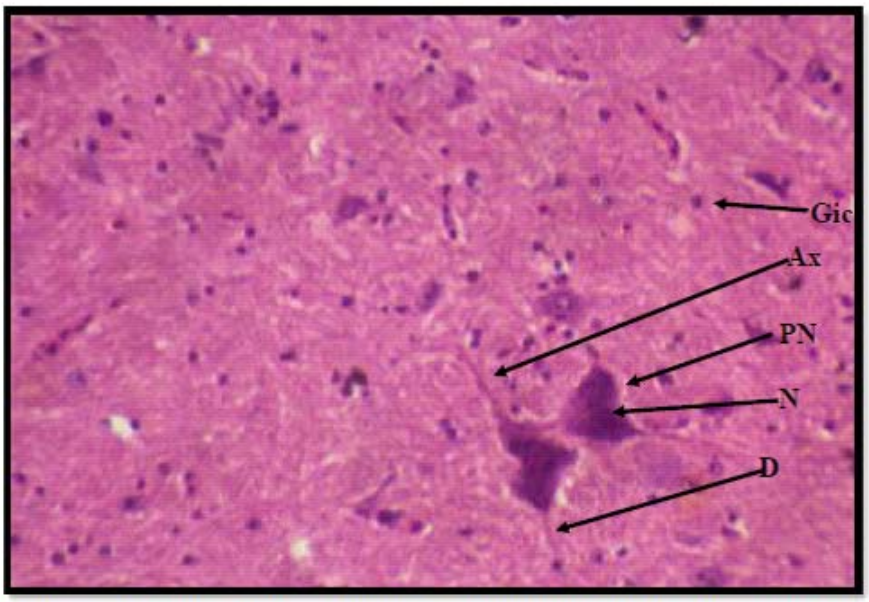

Fig (8): Cross section through the cerebrum of quail showing the nidopallium region (H & E. 400x). Nucleus (N), Pyramidal neuron (PN), Glial cell (Gic), Axon (Ax), Dendrites (D).

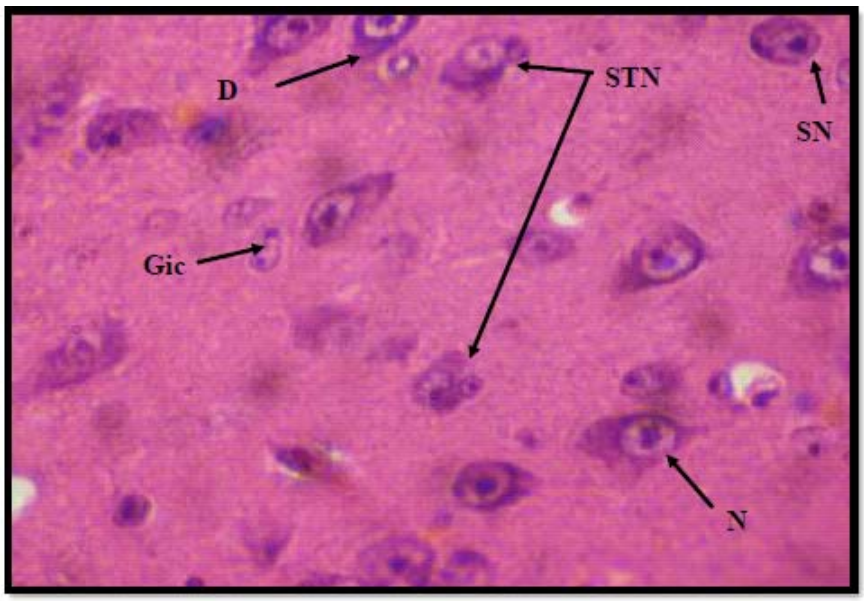

Fig (9): Cross section through the cerebrum of the quail showing the archopallium region. (H & E. x1000). Nucleus (N), Pyramidal neuron (PN), Glial cell (Gic), Spherical neuron (SN), Axon (Ax), Dendrites (D), Stellate neuron (STN).

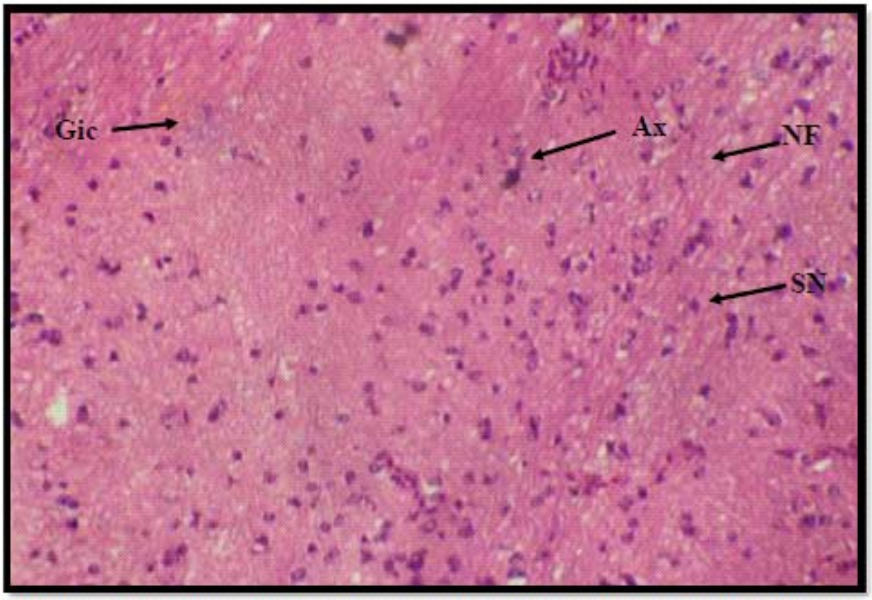

Fig (10): Cross section through the cerebrum of the quail showing the striatum region. (H & E. 100x). Glial cell (Gic), Axon (Ax), Nerve fibers (NF), Spherical neurons (SN).

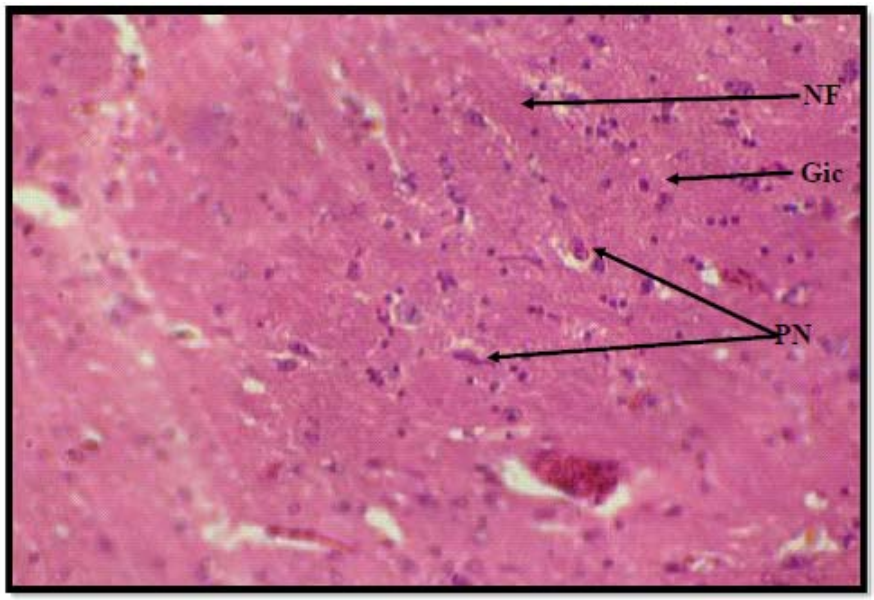

Fig (11): Cross section through the cerebrum showing the pallidum region. (H & E. 100x). Nerve fibers (NF), Pyramidal neuron (PN), Glial cell (Gic).

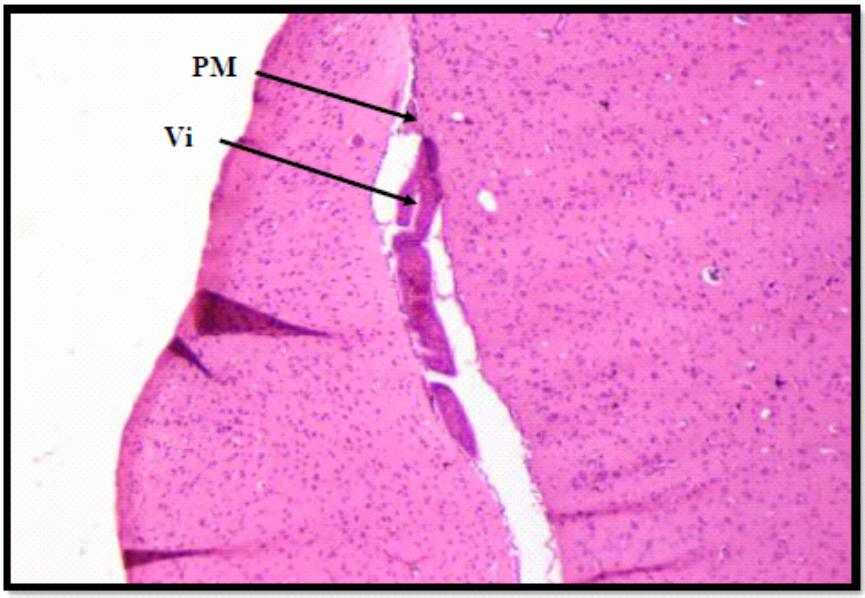

Fig (12): Cross section through the anterior choroid plexus in the roof of cerebrum of quail (H & E. 100x). Villi (Vi), Pia matter (PM).

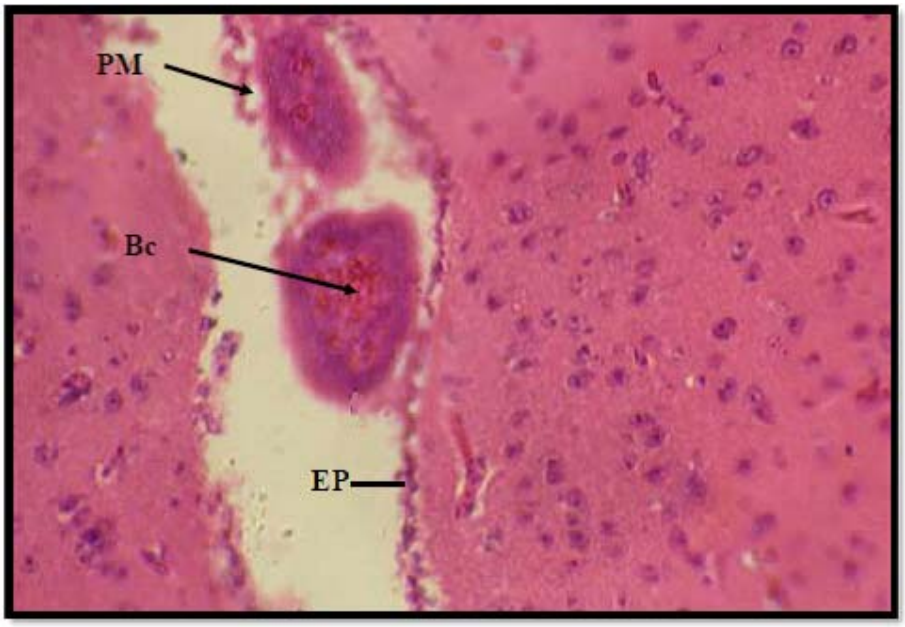

Fig (13): Cross section through the anterior choroid plexus in the roof of the prosencephalon (H & E. 400x). Pia matter (PM), Ependymal cell (EP), Blood vessel (BV).

دراسة شكليائية ونسجية للدماغ الامامي (المخ) في طائر السلوى *Coturnix coturnix* (Linnaeus, 1758)

أسماء بشير عبد
نهلة عبد الرضا البكري
قسم علوم الحياة /(ابن الهيثم)كلية التربية للعلوم الصرفة /جامعة بغداد

استلم في:26تشرين الثاني 2015، قبل في : 10 كانون الثاني 2016

الخلاصة

تناولت الدراسة الحالية الجوانب الشكليائية والنسجية للدماغ الأمامي (المخ) طائر السلوى (Quail)للتعرف على شكل وحجم المخ والتركيب النسجي لطبقاته.

أظهرت النتائج أن المخ كبير الحجم ومثلث الشكل ويحتوي سطحه على طيات وأخاديد غير عميقة .وأظهرت نتائج الفحص المجهري أن المخ يتكون من منطقتين هما اللحاء الذي تضمن المساحات القشرية الخارجية والتي شملت لحاء الدماغ الفوقي والمساحة القشرية الظهرية الجانبية Dorsolateral corticoid area، القشرة الكمثرية ومعقد الحصين اما المساحات القشرية الداخلية)الحرف البطني الظهري Dorsal ventricular ridge (DVR (تميزت باحتوائها على لحاء الدماغ الوسطي وعش لحاء الدماغ ولحاء الدماغ البدائي .

توجد الخلايا العصبية الهرمية الكبيرة الحجم في منطقة عش اللحاء المحيطة بالبطينين الجانبيين ذات الشكل الهلالي، أما منطقة تحت اللحاء فكانت متكونة من منطقتين هما المخطط والشاحب وتميز المخطط باحتوائه على مسالك الألياف العصبية، أما الشاحب فكان فاتح اللون وصغير الحجم وهو أعمق أجزاء المخ.

الكلمات المفتاحية :المخ، طائر السلوى، الطيور.