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Anatomical studies on the brain stem of the Japanese quail (*Courtnix japonica*)

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Abstract
Cerebral peduncles are two cylindrical structures extended between the optic chiasma anteriorly and continued as pons posteriorly. Pons is quadrilateral raised structure comprising largest portion of the brain stem. Medulla oblongata is compressed dorsoventrally. It is broader anteriorly while width decreased towards spinal cord. Histologically cerebral peduncles consisted of small amount of central white matter located towards the cerebral aqueduct. White matter is surrounded by large amount of grey matter. Grey matter consisted of large amount of neuropil. Among the different neuroglial cells the predominant glial cell type seen in cerebral peduncles is oligodendrocyte. Pons consisted of central white mater surrounded by grey mater. The cell bodies of the neurons are organized to form several nuclei. Pons consisted of large amount of neuropil in which the neurons and neuroglial cells are dispersed. Oligodendrocytes are the most predominant cell type found followed by the astrocytes. Medulla Oblongata is made up of central white mater surrounded by white mater. Astrocyte population is predominant. Microglia were a few found near the capillaries.

Keywords: Japanese quail, cerebral peduncles, gross morphology, histology, medulla oblongata, pons

Introduction
The brainstem consists of the midbrain, pons, and medulla oblongata. It serves an important part of the central nervous system. It is the lower extension of the brain connecting the cerebrum, cerebellum, and spinal cord. It has important role in regulating essential functions like breathing, heart rate, consciousness and sleep (Gil *et al.*, 2010) [1]. Histologically all the three parts of brain stem consisted of both white matter and gray matter.

Materials and Methods
Heads of Japanese quail were collected immediately after slaughter from Department of Meat Science, Veterinary College and Research Institute, Namakkal, TANUVAS, Tamil Nadu.
Brain stems were carefully separated by blunt dissection, washed with normal saline and fixed in Neutral buffered formalin (NBF).
Samples were obtained from ten adult birds. Average length, width and thickness will be measured with *verniere callipers*. Tissue peices from brain stem will be obtained and processed for histological and histochemical methods.
Sections of 5micron thickness was made and stained with haematoxylin and eosin for studying the histoachitecture.

Results and Discussion
Gross structure
Brain stem in Quail consisted of three parts the cerebral peduncles, pons and medulla oblongata. In freshly dissected specimen it is light pink in colour. Inferiorly, it has a longitudinal fissure representing the basilar groove extending mid ventrally from the cerebral peduncles to the medulla oblongata which continued back into the spinal cord. Cerebral peduncles are two cylindrical structures extended between the optic chiasma anteriorly and continued as pons posteriorly.

These findings are in accordance with the findings of Peng *et al*., (2010) [5] who stated that brain stem in African ostrich like other domestic animals is composed of midbrain, pons and medulla oblongata.

Pons is a quadrilateral raised structure. Laterally it is related to the middle cerebellar peduncle. It appeared as a continuation of cerebral peduncle anteriorly and demarcated from the medulla oblongata by a faint transverse fissure posteriorly. Dorsally the pons and anterior portion of medulla oblongata are related to the cerebellum. These findings are in accordance with Peng *et al*., (2010) [5] who stated that in brain stem of African ostrich pons and medulla formed the two posterior parts of the brain stem and are located ventrally to the cerebellum. Medulla oblongata is the terminal portion of the brain stem. It is compressed dorsoventrally. Dorsally dorsal median sulcus is seen which continued anteriorly over the pons and cerebral peduncles. Dorsally it formed the ventral border of fourth ventricle.

These findings are in accordance with Ibe *et al.*, (2014) [4] who reported that the central canal of the spinal cord continued into the medulla oblongata which continued in its upper half as the cavity of the fourth ventricle. He further reported that the myelencephalon was conical in shape.

It is broader anteriorly while width decreased towards spinal cord. Anteriorly dorsal surface forms the ventral surface of the fourth ventricle (Figure 1).

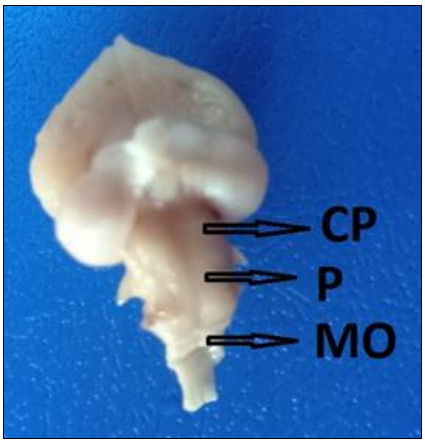

Fig 1: Gross Photograph of brain stem of Quail showing cerebral peduncles (CP), Pons (P) and Medulla oblongata (MO)

These findings are in accordance with Musa *et al*., (2016) who reported that the medulla oblongata in rabbits is conical in shape.

Among the different portions of the hindbrain in Japanese quail the pons formed the widest and thickest part. Medulla oblongata was measured least in terms of width and height. Cerebral peduncles were longest and pons was shortest among the three regions studied. (Table 1).

Table 1: Gross Morphometric observations on brain stem of quail (N=10; Mean ± Standard Error in µm)

Part	Length (mm)	Width (mm)	Height (mm)
Cerebral Peduncles	4.70±0.22	4.35±0.17	1.85±0.10
Pons	2.18±.045	4.71±0.07	2.70±0.13
Medulla Oblongata	2.84±0.03	2.58±0.23	1.34±0.069

Histology

Cerebral peduncles

It consisted of small amount of central white mater located towards the cerebral aqueduct. White mater is surrounded by large amount of grey mater (Figure 2).

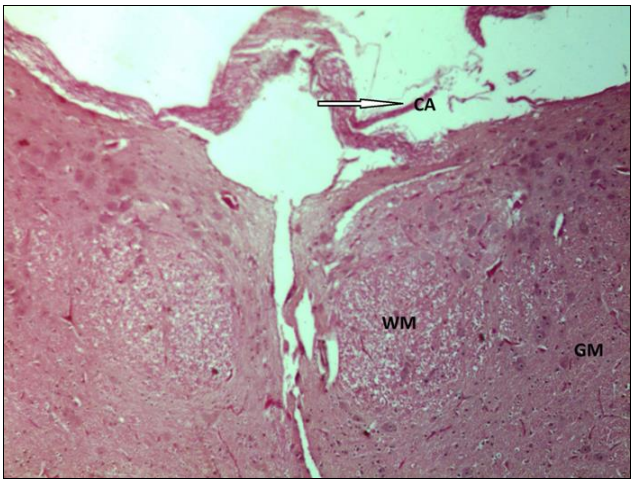

Fig 2: Photomicrograph of Cerebral peduncles in Quail showing white matter (WM), greymatter (GM) and cerebral aqueduct (CA) H&EX100

Grey mater consisted of neurons and neuroglial cells dispersed in large amount of neuropil which is formed by the processes of these neurons and neurolgial cells. Among the different neuroglial cells the predominat glial cell type seen in cerebral peduncles is oligodendrocyte (Figure 3).

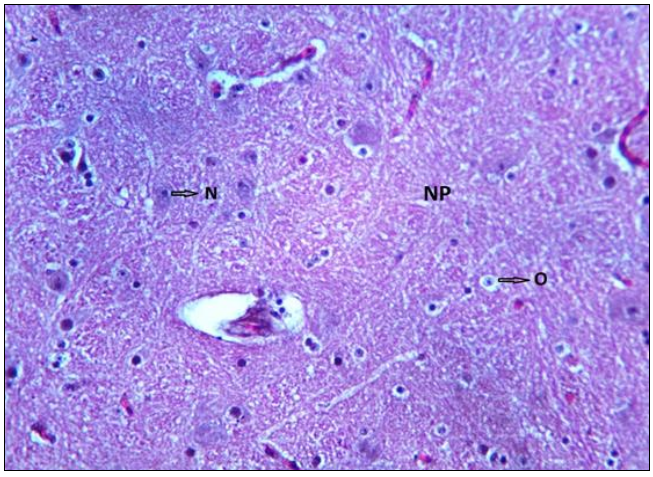

Fig 3: Photomicrograph of Cerebral peduncles in Quail showing neuropil (NP), neurons (N) and oligodendrocytes (O) H&E X400

Pons

Pons consisted of central white mater surrounded by grey mater. On either side of the dorsal fissure neuronal cell bodies are aggregated to form different nuclei (Figure 4).

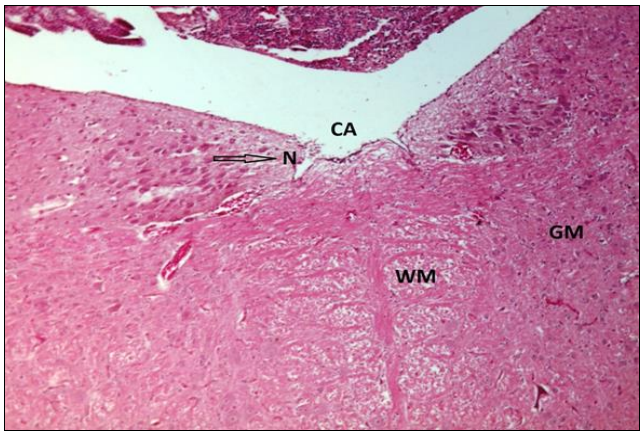

Fig 4: Photomicrograph of Pons in Quail showing Cerebral Aqueduct (CA), Neurons (N), white matter (WM) and grey matter (GM) H&E X100

These findings are in accordance with Hirsch *et al*., 1989 [3] who reported that in humans several cranial nerve nuclei are seen in the pons.

Pons consisted of large amount of neuropil in which the neurons and neuroglial cells are dispersed. Oligodendrocytes are the most predominant cell type found followed by the astrocytes. Just beneath the fourth ventricle transverse fibers are found extending laterally into substance of the pons (Figure 5).

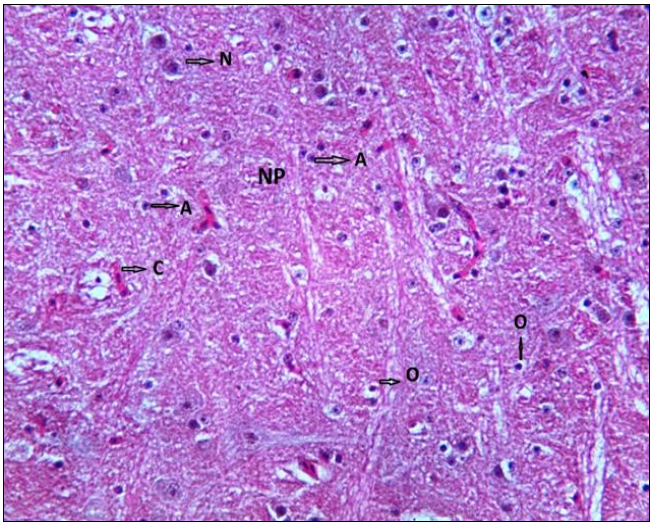

Fig 5: Photomicrograph of grey matter of Pons in Quail showing neurons (N), neuropil (NP), astrocytes (A), oligoderdroglia (O) and capillaries (C) H&E X400

Medulla Oblongata

It is made up of central white mater surrounded by white mater. The major constituent is neuropil which is made of the processes of the neurons and neuroglial cells (Figure 6).

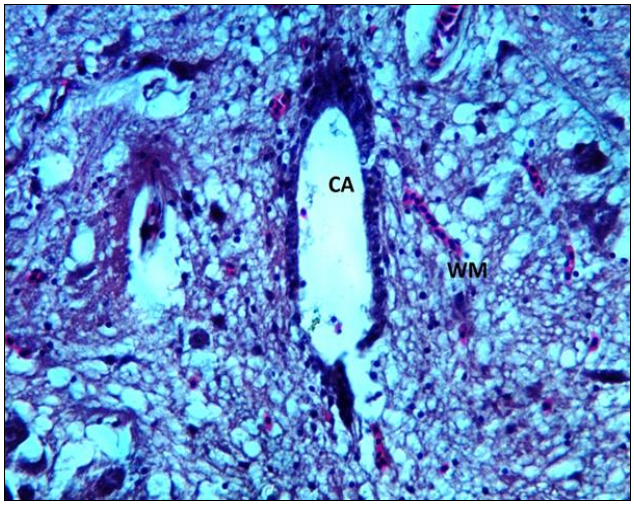

Fig 6: Photomicrograph of medulla oblongata in Quail showing white matter (WM) and cerebral aqueduct (CA) H&EX400

These findings are in accordance with Sharareh *et al.*, (2013) [7] who studied that in Orange Spotted Grouper fish the medulla oblongata majorly composed of neuropil formed by the processes of neuroglial and nerve cells.

Among the neuroglial cells, astrocyte population is more, next in number to astrocytes oligodendrocytes were found widely distributed. Microglia were a few found near the capillaries. The neurons are pyramidal in shape with round nucleus, and dark round nucleolus. The cytoplasm is pale (Figure 7).

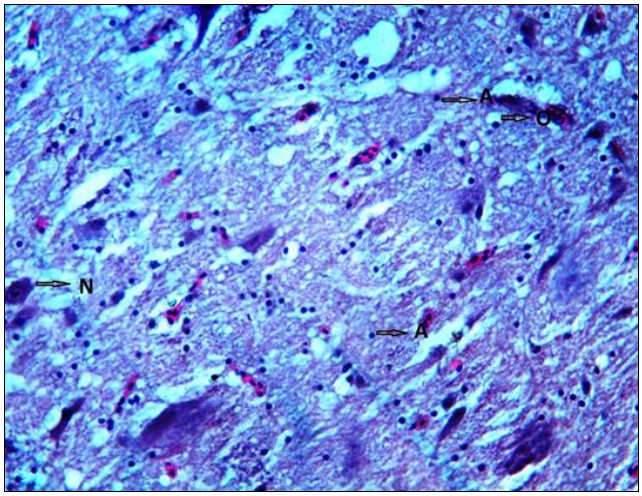

Fig 7: Photomicrograph of grey matter of medulla oblongata in Quail showing astrocytes (A), Neurons (N) and oligoderndroglial (O) H&EX400

These findings are in contrary to the to the observations of Batah *et al*., (2012) [2] who stated that the medulla oblongata in chicken consisted of the middle nerve cells, medial large and lateral small nerve cells.

Histochemistry

Carbohydrates

Cerebral peduncles, pons and medulla oblongata showed a PAS positive reaction all over indicating the presence of carbohydrates (Figure 8).

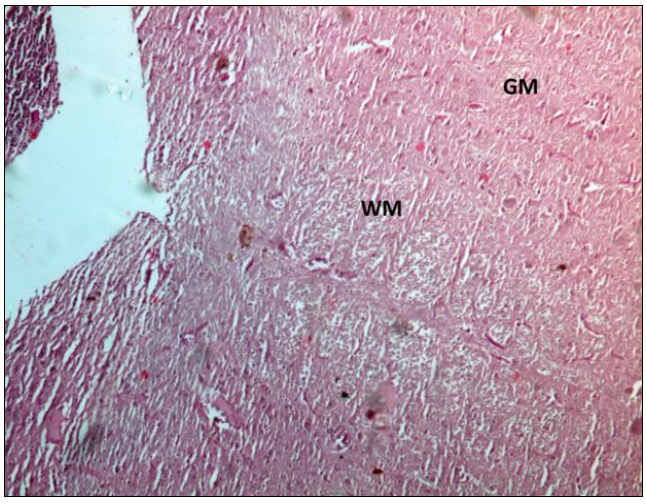

Fig 8: Photomicrograph of grey matter of medulla pons in Quail showing localization of carbohydrates PASX100

Lipids

Cerebral peduncles, Pons and medulla oblongata showed homogenous red color indicating the presence of fat.

Protein

Cerebral peduncles, pons and medulla oblongata showed a moderate positive reaction for the presence of tyrosine.

Enzymes

Alkaline phosphatase

The neurons and glial cells of the cerebral peduncles, pons and medulla oblongata are moderately positive for both acid and alkaline phosphatase reaction. These observations are in agreement with the studies of Mohanakumar and Sood (1980) [6] who stated that nuclei and walls of blood capillaries of

pons and medulla oblongata showed a positive reaction for alkaline phosphatase activity (Figure 9).

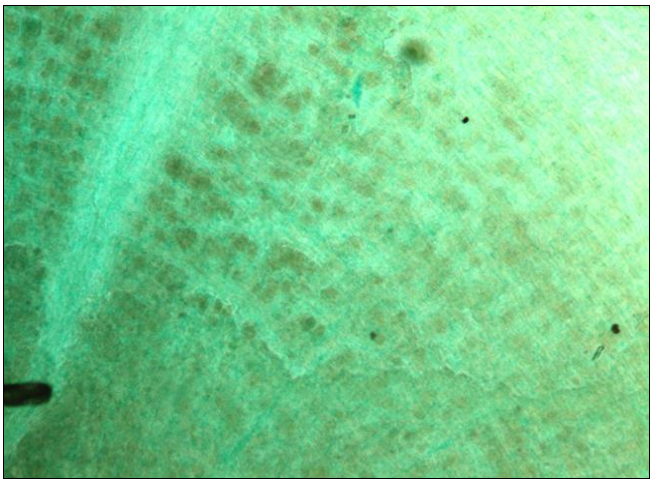

Fig 9: Photomicrograph of grey matter of medulla pons in quail showing localization of alkaline phosphatse X100

Conclusion

In the brain stem of Japanese quail there is central white mater surrounded by large amount of grey mater. In cerebral peduncles oligodendrocyte is predominant neuroglial cell observed. In pons oligodendrocytes were the most predominant cell type found followed by the astrocytes. In medulla oblongata astrocyte population is predominant followed by oligodendrocytes. Microglia were a few found near the capillaries.

Conflict of Interest

Not available

Financial Support

Not available

Reference

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