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Aarti Sharma
Department of Anatomy and Histology, College of Veterinary and Animal Science, Navania, Udaipur, RAJUVAS, Bikaner, Rajasthan, India

Balwant Meshram
Department of Anatomy and Histology, College of Veterinary and Animal Science, Navania, Udaipur, RAJUVAS, Bikaner, Rajasthan, India

Gajendra Singh
Department of Anatomy and Histology, College of Veterinary and Animal Science, Navania, Udaipur, RAJUVAS, Bikaner, Rajasthan, India

Praveen Kaushik
Department of Anatomy and Histology, College of Veterinary and Animal Science, Navania, Udaipur, RAJUVAS, Bikaner, Rajasthan, India

Corresponding Author
Aarti Sharma
Department of Anatomy and Histology, College of Veterinary and Animal Science, Navania, Udaipur, RAJUVAS, Bikaner, Rajasthan, India

Gross anatomical *in-vitro* disquisition on brain and the pituitary gland of Kadaknath (*G. gallus domesticus*) birds

Aarti Sharma, Balwant Meshram, Gajendra Singh and Praveen Kaushik

Abstract
The brain, a power centre of any living multicellular organism comprises several structural components as to cerebrum, cerebellum, optic lobe and medulla oblongata is observed along with the accommodating attire of some endocrine glands and the pituitary gland is one of them. It exerts influence over the functions of many other endocrine glands including control of body temperature and while maintaining the homeostasis it harmonizes with environmental factors after heat fluctuations of the body. The gross anatomical brain is observed in Kadaknath (*Gallus gallus domesticus*) birds. The surface texture was creamy pinkish colored. It had meninges from outward to inwards viz. duramater, arachnoid and piamater. The menengial coverings on brain in Kadaknath were black in color. The olfactory tracts were not observed. Gross anatomical in-vitro disquisition on pituitary glands showed a tiny pituitary gland, also known as hypophysis cerebri. It was observed at the posterior of optic chiasm. The pituitary gland observed lying into the porous bony cavity called sella turcica of the sphenoid bone. Pituitary gland was the rounded disc which observed convex at dorsal and somewhat concave at its ventral side.

Keywords: Gross anatomy, brain, pituitary gland, Kadaknath birds

Introduction
Brain is identified as one of the most complex organ which controls the body by performing several functions. It is the power center of living multi-cellular organism, after which the intelligence of that individual can be decided on the coordinated functional ability of the brain (Ackerman, 2019) [1]. Brain morphology reflects the cognitive capacity, behavioral repertoire and evolutionary process of a species, which comprises several structural components along with the accommodating attire of some endocrine glands and the pituitary gland, is one of them (Kumar *et al.*, 2020) [7]. The pituitary gland or the hypophysis, is a neuroendocrine organ that in conjunction with the hypothalamus, exerts influence over the functions of many other endocrine glands including control of body temperature and while maintaining the homeostasis it harmonizes with environmental factors after heat fluctuations of the body. The pituitary gland receives tropical hormones from the hypothalamus in regulating several bodily processes related to development, growth, reproduction and metabolism, among many others (Jahangirfard *et al*., 2019) [5].
Kadaknath is the important chicken breed in India that is known for its disease resistance trait. It is being reared in this region with the tag of native birds. Kadaknath attains the age of sexual maturity on 181 days, when it lays their first egg (Singh *et al*. 2017 and Haunshi *et al.* 2011) [11, 4]. Therefore the gross studies on brain and pituitary gland are undertaken in attempt to know the anatomical features and their correlative marker while functioning for cognitive capacity and their own development.

Materials and Methods
The present gross anatomical in-vitro disquisition on brain and their pituitary glands was done on twenty each sexually matured Kadaknath (*Gallus gallus domesticus*) birds of either sex. These birds were identified at the meat shops, located in and around City of Udaipur. The heads of these predetermined slaughtered birds were procured at the meat shops and carried on ice at laboratory for desired procedural investigation. The attentive craniotomy was performed in obtaining the brain and also the pituitary gland which was located at the fossa sella turcica. The careful and vigilant disquisition of brain was performed and also the morphometrical measurements of the same were recorded.

Results and Discussion

Gross anatomical in-vitro disquisition on Brain

The gross anatomical in-vitro disquisition was observed methodically on brain in Kadaknath (*Gallus gallus domesticus*) birds. The surface texture was observed in creamy pinkish coloured with its covering as the meninges from outward to inwards *viz*. duramater, arachnoid and piamater. The menengial covering in brain of Kadaknath was observed with the black color. The ventral surface of cranial cavity have not shown the prominent contours while providing attachment with the duramater, also the breed doesn't showed prominent sulci and gyri. The cautious exclusion of brain from the cranial cavity was attempted to have the unbroken, delicate, thin and undifferentiated all the three layers of meninges altogether. It was very difficult to compare the complete brain with any specified geometrical shape. It was also complicated to have any resemblance of the same with any specific structure or object. The average body weight of Kadaknath birds was observed as 1051.80±27.56 Gms and the average weight of brain was observed as 3.046±0.06 gms**.** Pertaining to the percentage of brain against the total body weight of birds was also measured, which was 2.80% Kadaknath birds. Regarding the volume, it was 2.70±0.09 cc (Table-1). However, the weighing of pituitary could not be measured as it observed as the very tiny organ. The similar and comparable observations were mentioned by Gupta *et al*. (2016) [3] in Vencobb and Vanjara breed of birds when they had 1096 and 1370 Gms of body weight for respective birds. Kumar *et al*. (2020) [7] has also given the approval to the present findings after their morphometrical observations in the brain of Guinea Fowl birds.

The cerebrum, cerebellum, optic lobe and medulla oblongata were observed as their different essential components of the brain which showed major variations in shape as to the anatomically distinctive features. The largest part, cerebrum was identified that occupied more than 50% of the whole brain. The left and right cerebral hemispheres were observed with prominent longitudinal fissure as the attachment in between them. It was very much considered as the bifurcating evidential line between left and right cerebral hemispheres. The categorical small transverse fissure was also there between cerebrum and cerebellum. The olfactory bulbs were evident as the small structure on the anterior most part of cerebrum (Fig. 1). The morphological features were the similar but very comparable with the discoveries complied by Kumar *et al*. (2020) [7] in Guinea Fowl and Joshi *et al.* (2019) [6] for the brains in growing Kadaknath birds.

The pineal gland was discovered with the meningeal components of brain which lying in a triangular space formed by both the cerebral hemispheres and the cerebellum. The extreme anterior portion of brain *viz*. optic lobes was observed from the dorsal and ventral side of brain but its major portion was overlapping by the respective cerebral hemispheres. Laterally it was seen as the noticeable large, rounded or spherical bodies. The posterior part of brain showed the presence of medulla oblongata and the same was continued as the spinal cord with creamy white texture and coverings by meningeal components (Fig. 1). Various features of the brain are also considered for detailed disquisition in accordance to their different topographical aspect *viz*. dorsal, ventral and lateral. The dorsal aspect of the brain showed two *viz*. right and left cerebral hemispheres at the anterior part while cerebellum and medulla oblongata as the posterior part. The miniature olfactory bulbs were found located medially at the extreme anterior end of cerebrum. A cerebral longitudinal fissure was presented as the conduit between the right and left cerebral hemisphere and a transverse sulcus between the cerebrum and cerebellum. The formation of the cerebrum appeared like betel leaf or more resembled spade of playing cards. Kumar *et al*. (2020) [7] has comparably observed the similar structure in Guinea Fowl, however Joshi *et al.* (2019) [6] has observed the indifferent results for the brains of growing Kadaknath birds.

The average length of cerebrum was measured in Kadaknath birds, which showed 15.87± 0.41 mm. The average cerebellum length also measured which was 9.24±0.18 mm (Table-2).

The cerebral surface showed smooth texture, and without gyrus and sulcus over it. However, on the dorsal surface of cerebrum, an elliptical arc shaped sulcus was observed in the form of a chamber at either side of cerebrum which was started anterio-sagittal and run posterio-lateral upto the mid of cerebrum and thereafter meet at either side of pineal gland. The groove that was known as the telencephalic vallecula and the either side located protuberance was identified as the sagittal prominence or hillocks. Between these two grooves the pineal gland was observed located at the juncture of the transverse sulcus and the 2 cerebral hemispheres. It was found covered by the duramater. The cerebellum was located behind the transverse sulcus. The average width of cerebrum is measured which observed as 15.87±0.41 mm. The width of cerebellum was also observed on the tune of 7.13±0.29 mm respectively (Table 2). Small amount but noticeable vermis was there at the centre of the cerebellum with some transverse fissures. The transverse fissures were identified as folia or cerebellar convolutions with 8-10 in numbers (Fig. 2). The cerebellar auricle or flocculus was identified on each side of the vermis as the lateral prominence of the cerebellum. The mentioned present findings were substantially parallel to the observations mentioned by several researchers but the observance complied by Reiner (2005) [10] who studied the birds brain while identifying their cognitive, social and motor behaviors and Kumar *et al*. (2020) [7] who studied the guinea fowl birds were very much close to us.

On the ventral aspect of brain, the cerebral hemispheres showed a small olfactory bulb at their anterior part. The olfactory tracts were not observed. The orbital faces of the cerebral hemisphere were located in the anterior part of the brain. The optic chiasm was occured at the centre of the left and right cerebral hemispheres. Developed and clearly visible optic tract and optic nerves were also observed. The nerve fibers located at the optic tract were got travelling laterally to have the linkage with optic lobe of the midbrain. The nerve fiber has formed the anatomical bridge between optic tract and optic lobe. The protruded optic lobe was seen at ventral to lateral part of the midbrain. The parts behind the optic chiasm all belong to the brainstem structure. Diencephalon and midbrain were followed by the hypophysis cerebri. Further regressing backward at the ventral brain stem, a very superficial longitudinal sulcus, and a ventral middle fissure was observed which divided the pons and medulla into two equal parts. The pons and the medulla oblongata were located consecutively posterior at terminal end. No apparent demarcation was observed between the midbrain and the pons. The pons and the medulla oblongata became narrow and thin progressed toward the spinal cord. The brain terminates at the initial of spinal cord (Fig. 2 and 3). The ventrolateral aspect of brain showed the olfactory bulb, the cerebral

hemisphere, pituitary gland, the large optic lobes, which were best visualized laterally, the cerebellum showing the convolutions with cerebellar auricles. The optic lobes were interconnected with rest of brain with fissure. The average length of the optic lobes was recorded as 7.10± 0.16 mm. In respect of the average width of optic lobes, it was recorded as 4.88± 0.12 mm, (Table 2). Pons and medulla oblongata and spinal cord are also visualized. Few cranial nerves could also be seen on lateral side and those can be distinguished on the basis of their location. The major variations in shape with anatomically distinctive developed features are seen. Cerebrum is identified as the largest part which comprised of more than 50% of the whole brain. The left and right cerebral hemispheres were observed firmly attached but there was the inter-hemispheric longitudinal fissure which may be considered as the bifurcating evidential line between left and right cerebral hemispheres. The cerebrum and cerebellum were separated by a small transverse fissure. The olfactory bulb was noticed as the small structure on the anterior part of the cerebrum (Fig. 1 and 3). Various features of the brain were studied according to different topographical aspect *viz*. dorsal, ventral and lateral. The present findings were not dissimilar to the findings of Uemera (2015) who had reviewed the fundamentals of neuroanatomy, Nomura and Izawa (2017) [9] who has given insights of avian birds and also with the findings given by Joshi *et al.* (2019) [6] for growing Kadaknath birds.

Gross anatomical in-vitro disquisition on pituitary glands

A tiny pituitary gland, also known as hypophysis cerebri was observed at the posterior of optic chiasm. The pituitary gland observed lying into the porous bony cavity called sella turcica of the sphenoid bone. The analogues observations were put on record by Gupta *et al.* (2016) [3] in Vencobb and Vanjara breed of birds and also by Mashinini (2020) [8] who revealed about pituitary gland and growth harmone. Recently the high quality mobile are being used in capturing the images with high resolutions. The same was used to capture the images of dig out fixed pituitary gland from sella turcica**.** Pituitary gland was the rounded disc which observed convex at dorsal and somewhat concave at its venral side (Fig. 4). The internal contours of bony cavity might be given the stable connect to the gland and also provide passage for arterial supply. It receives blood from the internal carotid arteries and their branches forming capillary plexus near the median eminence. These vessels drain into the hypophyseal portal veins, which supply the adenohypophysis. This hypothalamic–hypophyseal portal system transports hypothalamic-releasing and release-inhibiting hormones directly to the adenohypophysis for interactions with their specific target cells, the parallel findings were given by Mashinini (2020) [8] who explored the pituitary gland and growth hormone and Ganpathy and Tadi (2021) [2] who had studied on the pituitary gland.

Table 1: Biometrical observations on body weight and brain with pituitary glands in Kadaknath birds

Sample No.	Body weight of birds (Gms)	Weight of Brain with pituitary gland (Gms)	Volume of Brain with pituitary gland (CC)
1	1190	3.627	3.5
2	1340	3.206	3
3	1250	2.961	3
4	930	2.717	2.2
5	800	2.713	2
6	1000	2.915	2.5
7	970	2.71	2.5
8	980	2.9	2.5
9	1050	3.012	3
10	1105	2.95	3
11	972	2.65	2
12	1044	2.956	2.5
13	1140	3.1	3
14	1087	3.06	2.5
15	1021	3.1	3
16	951	2.77	2.5
17	1010	3.3	3
18	1187	3.87	3.3
19	1019	3.37	2.8
20	989	3.05	2.2
AVg	1051.8	3.046	2.7
SD	123.3	0.31	0.42
SE	27.56	0.06	0.09
Avg±SE	1051.8±27.56	3.046±0.06	2.7±0.09

Table 2: Biometrical observations on length and width of brain components in Kadaknath birds

	Optic Lobe		Cerebrum		Cerebellum	
	Length	**Width**	**Length**	**Width**	**Length**	**Width**
1	7.75	5.17	15.87	21.72	10.21	6.58
2	7.12	5.01	19.27	21.9	10.77	9.69
3	6.2	4.5	18.71	20.43	10.11	9.27
4	5.82	4.02	17.74	19.17	9.71	8.11
5	5.51	3.41	14.84	20.41	8.17	7.84
6	6.71	4.87	16.1	19.81	9.81	8.21
7	7.99	5.24	13.98	17.47	8.73	5.87
8	7.9	5.14	13.09	16.17	8	5.91
9	7.2	4.74	16.17	19.51	8.74	5.9
10	7.57	4.81	18.19	21.03	9.07	7.1
11	6.05	4.01	14.01	17.4	8.94	5.7
12	7.27	5.1	16.05	18.95	8.71	5.71
13	7.32	5.17	17.17	19.07	9.41	7.74
14	7.15	5.01	16.17	18.41	9.71	7.84
15	6.82	4.88	15.21	19.51	8.74	6.1
16	7.87	5.52	13.17	16.87	8.23	5.14
17	7.14	5.02	15.74	18.54	9.72	7.07
18	7.84	5.4	17.72	20.51	10.18	8.64
19	6.9	5.03	15.12	18.1	9.87	8.15
20	7.87	5.67	13.23	16.17	8.02	6.14
Avg.	7.1	4.88	15.87	19.05	9.24	7.13
S.D.	0.73	0.54	1.84	1.68	0.81	1.31
S.E.	0.16	0.12	0.41	0.37	0.18	0.29
Avg±SE	7.1±0.16	4.88±0.12	15.87±0.41	19.05±0.37	9.24±0.18	7.13±0.29

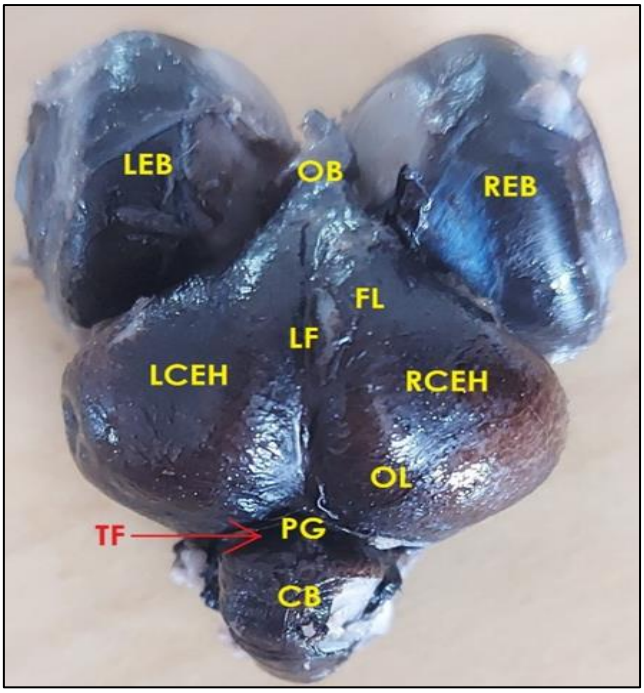

Fig 1: Dorsal view of brain in Kadaknath birds showing LFB-Left Eye Ball, OB- Olfactory Bulb, RFB-Right Eye Ball, FL-Frontal Lobe, LF-Longitudinal Fissure, LCEH-Left Cerebral Hemisphere, RCEH-Right Cerebral Hemisphere, OL- Occipital Lobe, PG-Pituitary Gland, TF-Transverse Fissure and CB-Cerebellum

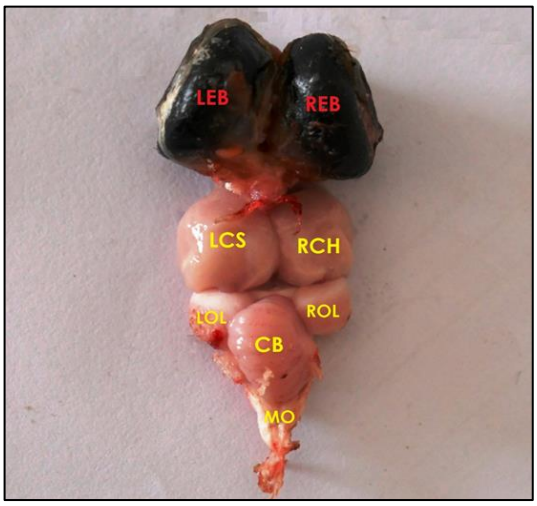

Fig 2: Dorsal view of brain showing LEB-Left Eye Ball, REB-Right Eye Ball, LCH- Left Cerebral Hemisphere, RCH- Right Cerebral Hemisphere, LOL-Left Optic Lobe, ROL- Right Optic Lobe CB-Cerebellum and MO-Medulla Oblongata

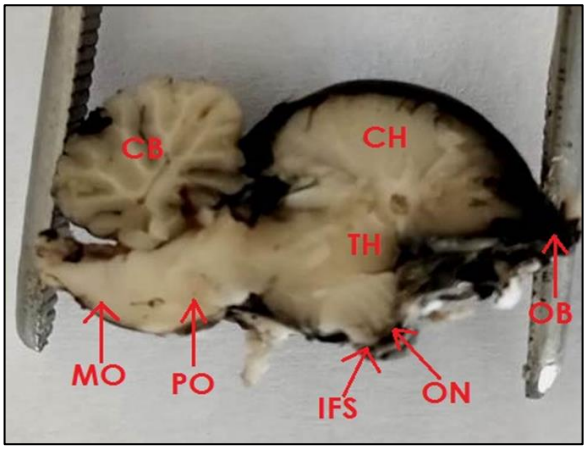

Fig 3: Saggital section of brain showing CB-Cerebellum, MO-Medulla Oblongata, PO-Pons, CH- Cerebral Hemisphere, TH-Thalamus, IFS- Infundibular Stalk, ON-Optic Nerve and OB-Olfactory Bulb

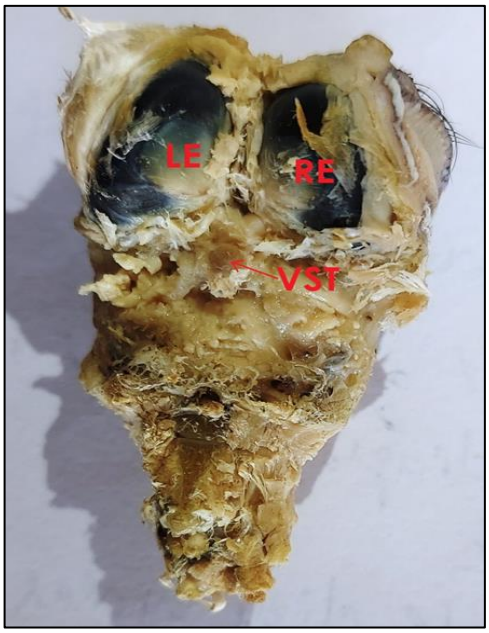

Fig 4: Ventral view showing the VST- ventral surface of sella turcica which holds the pituitary gland, LE- Left Eye Ball and RE-Right Eye Ball

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