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Histological architecture of the caudate nucleus in adult goat brain

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Abstract

The present study was conducted to elucidate the microanatomical features of the caudate nucleus in the brain of the goat (*Capra hircus*). Six brains of apparently healthy adult goats of either sex were collected from local slaughter house in and around Namakkal. Tissue samples from the caudate nucleus were fixed in standard fixatives, processed, sectioned and stained using routine histological techniques. The caudate nucleus exhibited densely packed neuronal and glial cell populations with minimal intercellular spaces. Neurons were mostly triangular with prominent nuclei and distinct nucleoli. Three types of neurons namely small, medium and large neurons were identified, with large neurons being predominant. The ventricular surface was lined by ciliated cuboidal ependymal cells. Oligodendrocytes showed a characteristic “fried-egg” appearance. The study provides baseline histoarchitectural details useful for comparative neuroanatomical and neuropathological research.

Keywords: Goat, Caudate nucleus, Neurons, Glial cells, Histology, Brain

Introduction

India stands second in goat production with a total population of 148.88 million, which contributes about 27.80% of total livestock population during the period of 2023-2024 (Annual report, 2023-24, DAHD).

Goats are reared mainly by poor people in developing countries. In India too, the small and marginal farmers, prominently rear goats, including landless agricultural labourers, mostly in non-green revolution areas where irrigation facilities are poorly developed (Rekib, 1998) [16].

In India, the contribution of livestock sector to Gross Domestic Product (GDP) is rising though the contribution of agricultural sector in general is witnessing a declined trend. In such situation, goats are going to be even more important source of livelihood for many more people in coming years and thus, deserve greater attention at both macro and micro level studies (NCA, 1976).

Goat (*Capra hircus*) are suitable alternative large animal model for preclinical validation of neural implants and reported that they may be used as suitable models for a range of conditions like epilepsy and neurological dysfunction because of their large brain, well developed blood vessels, cortical architecture, longer life span and docile temperament (John *et al.*, 2017) [11].

In the brain the basal ganglia are subcortical nuclear masses located in the inferior part of the cerebral hemisphere lateral to the thalamus. The basal ganglia include caudate nucleus, putamen, globus pallidus and amygdala (Anderson *et al.*, 2004) [2].

The caudate nucleus plays a crucial role in controlling voluntary movements and regulating emotions (Reiner *et al.*, 1998) [15]. It is a key structure involved in regulating mood, some aspect of cognition, motor function and motivation (Butters *et al.*, 2009) [6]. It is essential for behavioral flexibility and decision making (Daw *et al.*, 2006) [7].

Materials and methods

Materials

A total of six brains, without sexual priority comprising both male and females were randomly

collected from apparently healthy adult goat which were slaughtered at local slaughter house in and around Namakkal and in the Department of Meat science, Veterinary College and Research Institute, Namakkal.

The microanatomical studies on the caudate nucleus of brain in goat were conducted at the Department of Veterinary Anatomy, Veterinary College and Research Institute, Namakkal.

Methods

The tissues from the caudate nucleus were collected separately and fixed in fixatives viz., 10% Neutral buffered formalin. Fixed tissues were processed through ascending grades of alcohol, cleared in xylene and embedded in paraffin wax at 58-60 °C as per the method described by Luna (1968) [12].

Sections of 3-5µm thickness were made by using via Leica semiautomatic rotary microtome available in the Department. Haematoxylin and Eosin staining techniques were carried out to study the histoarchitecture of the caudate nucleus of brain in goat. The results were photomicrographed and studied with the help of Leica image analyser.

Results and Discussion

The caudate nucleus had increased proportion of densely stained cellular elements and minimal proportion of lightly stained intercellular spaces. The densely stained areas comprised of neuronal cell bodies, glial cells and nerve fibre bundles. These are in accordance with the observations of Mohamed and Mohamed (2017) [13] in albino rat and Amer *et al.* (2021) [1] in rat.

Neuron

Most of the neurons in the caudate nucleus had roughly triangular cell body with prominent large nucleus. The shape of the nuclei varied from spherical to oval with distinct nucleoli (fig 1). This observation was in concurrence with the

reports of Mohamed and Mohamed (2017) [13] in albino rat.

Neuronal classification

In the caudate nucleus, three different sized neurons viz., small, medium and large neurons were observed (fig 2). This was similar to the findings of (Dimova *et al.* 1980) [8] in adult rat. But, in contrast Garman (2011) [9] broadly classified the neurons only as small and large, medium sized neurons were not mentioned.

Among the neurons, large sized neurons were more in proportion than the medium and small sized neurons. Some of the large sized neurons had darkly stained nucleoplasm and some had lightly stained nucleoplasm whereas the medium and small sized neurons had only darkly stained nucleoplasm. Screening of available literature revealed that the difference in the staining property of nucleoplasm between the different sized neurons were not specified in any species.

Glial cells

Ependymal cells

The surface of the caudate nucleus related to the lateral ventricle was lined by ependymal cells which consisted of a single layer of ciliated cuboidal epithelium (fig 3) in concurrence with the findings of Seidman (1985) [17].

Oligodendrocytes

Oligodendrocytes in caudate nucleus were found scattered among the neuronal cell bodies and were observed as round cells with darkly stained condensed nucleus and their nuclear membranes were clearly defined and darkly stained fragmented nucleoli lay adjacent to the membrane (fig 4). Similar observation was noticed by Bradl and Lassmann (2010) [5] and Hagen *et al.* (2012) [10] in human. In the present study formalin fixed and paraffin processing tissues the oligodendrocytes had distinct perinuclear halo, creating a characteristic “fried egg” appearance as mentioned by Bancroft and Stevens (1996) [4].

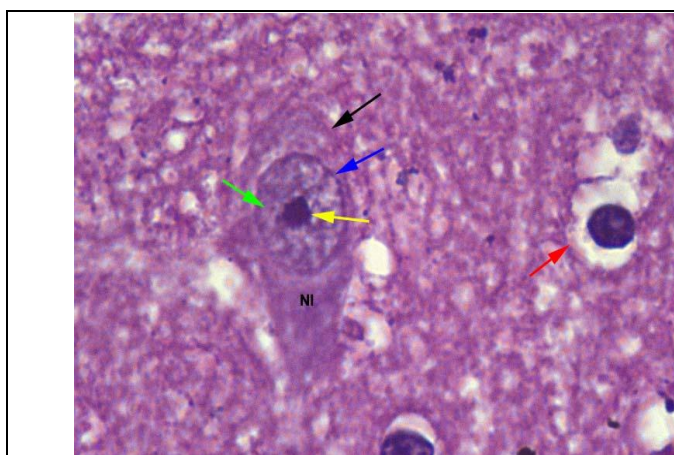


Fig 1: Photomicrograph showing neurons in the caudate nucleus. NL- Nissl substance Green arrow- Nucleoplasm, Blue arrow- Nuclear membrane, Black arrow- Neuronal cell bodies, Yellow arrow- Nucleolus and Red arrow- Oligodendrocytes.
H&E X 1000

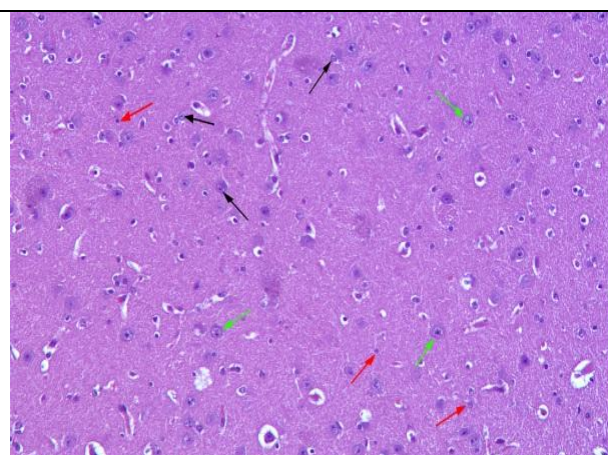


Fig 2: Photomicrograph showing three types of neurons in the caudate nucleus. Green arrows- Large sized neurons, Black arrows- Medium sized neurons and Red arrow- Small sized neurons.
H&E X 100

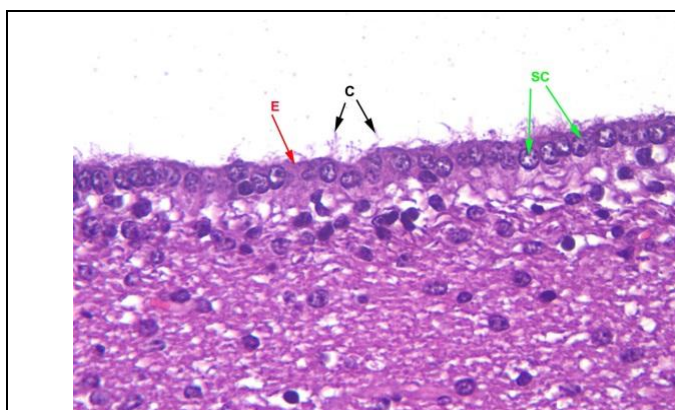


Fig 3: Photomicrograph showing Ependymal layer in the caudate nucleus. C-Cilia, E-Ependymal layer and SC-Simple Cuboidal Epithelium. H&E X 400

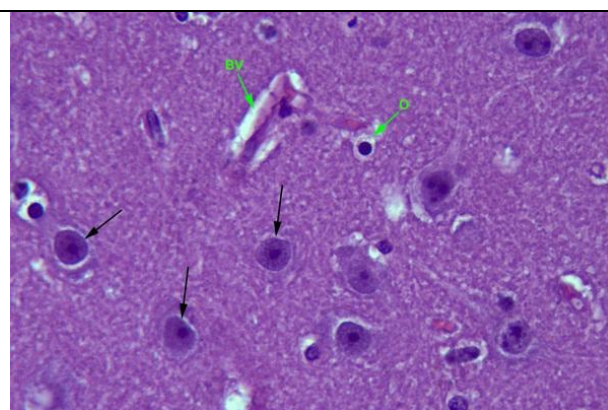


Fig 4: Photomicrograph showing Neurons and Oligodendrocytes in the caudate nucleus. Black arrows- Neurons, O- Oligodendrocytes and BV-Blood Vessels. H&E X 400

Conclusion

The caudate nucleus of the adult goat exhibited distinct histological features characterized by densely arranged neuronal cell bodies and glial elements. Three categories of neurons namely small, medium and large neurons were identified, with large neurons predominating. The presence of ciliated cuboidal ependymal cells, characteristic oligodendrocytes with perinuclear halos indicates a well-organized cellular architecture. These structural characteristics suggest that the goat brain possesses complex neuroanatomical organization comparable to that of other mammalian species, supporting its suitability as a large animal model for neurobiological and neuropathological research.

Conflict of Interest: Not available

Financial Support: Not available

Reference

- Amer AS, Mohamed Saleh NM, Omainaismail I. Degenerative changes in the putamen of growing rats induced by maternal excess iron exposure. *Egyptian Academic Journal of Biological Sciences*. 2021;13(2):119–133.
- Anderson JC, Costantino MM, Startford T. Anatomy, pathology and imaging characteristics of basal ganglia. *Current Problems in Diagnostic Radiology*. 2004;33(1):28–41.
- Department of Animal Husbandry and Dairying. Annual report 2023–24. 2024. <https://dahd.gov.in/sites/default/files/202410>
- Bancroft JD, Stevens A. *Theory and Practice of Histological Techniques*. 4th ed. Churchill Livingstone; 1996.
- Bradl M, Lassmann H. Oligodendrocytes: Biology and pathology. *Acta Neuropathologica*. 2010;119(1):37–53.
- Butters MA, Aizenstein HJ, Hayashi KM, Meltzer CC, Seaman J, Reynolds CF. Three-dimensional surface mapping of the caudate nucleus in late-life depression. *The American Journal of Geriatric Psychiatry*. 2009;17(1):4–12.
- Daw ND, Odoherthy JP, Dayan P, Seymour B, Dolan RJ. Cortical substrates for exploratory decisions in humans. *Nature*. 2006;441(7095):876–879.
- Dimova R, Vuillet J, Seite R. Study of the rat neostriatum using a combined Golgi electron microscope technique and serial sections. *Neuroscience*. 1980;5(9):1581–1596.
- Garman RH. *Histology of the central nervous system*. Toxicologic Pathology. 2011;39(1):22–35.
- Hagan CE, Bolon B, Keene CD. Nervous system. In: *Comparative Anatomy and Histology*. Academic Press; 2012. p. 339–394.
- John SE, Lovell TJ, Opie NL, Wilson S, Scordas TC, Wong YT, Rind GS, Ronayne S, Bauquier SH, May CN. A review of functional mapping and cytoarchitecture. *Neuroscience & Biobehavioral Reviews*. 2017;80:306–315.
- Luna LG. *Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology*. 12th ed. Armed Forces Institute of Pathology; 1968. p. 258.
- Mohamed H, Mohamed H. The effect of prenatal and postnatal administration of manganese chloride on the developing caudate nucleus of the corpus striatum in male albino rats and the possible beneficial role of vitamin E supplementation: A histological and immunohistochemical study. *The Egyptian Journal of Anatomy*. 2017;40(2):203–236.
- National Commission on Agriculture (NCA). Report of the National Commission on Agriculture: Part VII – Animal Husbandry. Ministry of Agriculture and Irrigation, Government of India; 1976.
- Reiner A, Medina L, Veenman CL. Structural and functional evaluation of the basal ganglia in vertebrates. *Brain Research*. 1998;28(3):235–285.
- Rekib A. Grazing resources and livestock productivity with special reference to goat production. *The Indian Journal of Animal Sciences*. 1998;68(8):720–727.
- Seidman RJ. Normal gross brain and microscopy. In: *Neuropathology*. University of Minnesota Medical School; 1985. Chapter 1.

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