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OPINION ARTICLE

An Insight into the Neuroanatomy of the Basal Ganglia in the Cerebral Hemisphere

Abdelmonem Awad Hegazy*

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Abstract

The basal ganglia, or nuclei, are cluster of gray matter masses located within the white matter of the cerebral hemispheres. The anatomy and relationships of the basal ganglia can be confusing due to the varying terms and definitions used to describe this region. Understanding their anatomy is important because of their diverse connections and relationships with motor and cognitive functions. This anatomy must be clearly defined so that clinicians can identify any disorders affecting them. This short article aims to provide a simplified, concise, and up-to-date overview of the basal ganglia of the cerebrum. The basal ganglia are four pairs in number in the cerebrum; caudate nucleus, lentiform nucleus, claustrum and amygdala, plus two more associated with the midbrain called the subthalamic nuclei above the midbrain and substantia nigra within the midbrain. The basal ganglia of the cerebrum are closely connected to surrounding structures including the cerebral cortex, the substantia nigra of the midbrain, and the thalamus. The striatum, consisting of the caudate nucleus and the putamen of the lentiform nucleus, represents the primary input to the basal ganglia, while output information emerges mostly from the inner part of the lenticular nucleus called the pallidum. The basal ganglia are supplied with blood mainly by the middle cerebral artery via the lenticulostriate arteries, which are prone to hemorrhagic stroke in cases of uncontrolled hypertension.

Key Words: *Basal nuclear complex; Nucleus lentiformis; Paleostriatum; Pallidum; Claustrum; Amygdaloid nucleus*

Introduction

The basal ganglia or nuclei are masses of gray matter embedded in the white matter of the cerebrum. The anatomy of the basal ganglia and their relationships can be confusing due to the different terms and definitions used to describe this region [1]. The importance of understanding their anatomy lies in their diverse connections and relationships with motor and cognitive functions [2]. This anatomy, which is the purpose of this short article, must be clearly defined so that doctors can identify any disorder that may affect them. Clear anatomy is also essential for appropriate surgical procedures on or around the basal ganglia [3].

The basal ganglia of the cerebral hemisphere include four gray matter masses: the caudate nucleus, the lenticular nucleus, the amygdala, and the claustrum (Figures 1-3) [4]. In addition to these masses, the substantia nigra and

Professor of Human Anatomy and Embryology, Faculty of Dentistry, Zarqa University, Jordan

**Corresponding author: Abdelmonem Awad Hegazy, Professor of Human Anatomy and Embryology, Faculty of Dentistry, Zarqa University, Jordan, E-mail: ahagazy@zu.edu.jo*

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subthalamic nuclei are also considered as basal ganglia [5]. However, the latter basal nuclei are not located in the cerebral hemisphere, but are connected to the midbrain. While the substantia nigra is part of the midbrain structure, the subthalamic nucleus lies between the diencephalon above and the midbrain below. These nuclei share function with the basal ganglia [6].

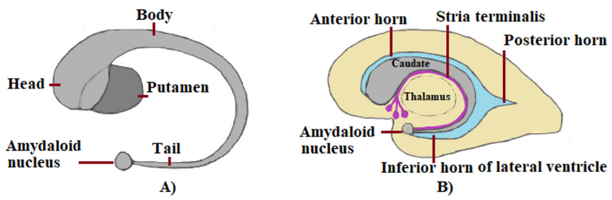

Figure 1) *Basal nuclei diagrams showing: A) Parts of caudate nucleus and its relations to putamen and amygdaloid body; B) Caudate nucleus and its relations to parts of the lateral ventricle of cerebral hemisphere and thalamus.*

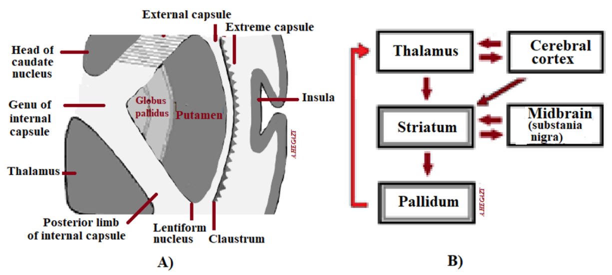

Figure 2) *Basal nuclei: A) Diagram showing basal nuclei relations to different capsules of white matter and thalamus; B) Illustration showing basal nuclei connections.*

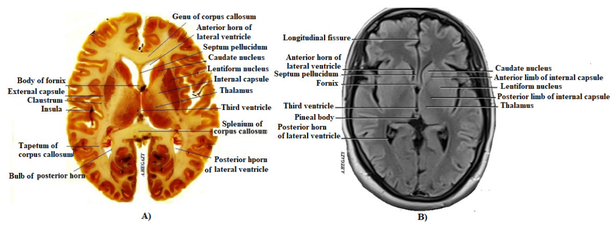

Figure 3) *Axial sections in the cerebral hemisphere: A) Photography of cerebral section; B) Magnetic Resonance Imaging (MRI) of cerebral hemispheres.*

Caudate Nucleus

It is a C- or comma-shaped mass of gray matter consisting of a head, body, and tail (Figure 1). The head of the caudate nucleus is a large anterior part located in the frontal lobe of the cerebral hemisphere and is related medially to the anterior horn of the lateral ventricle, laterally to the anterior limb of the internal capsule, and inferiorly to the anterior perforated substance. The anterior perforated substance is the region of the cerebral cortex through which the central branches of the anterior and middle cerebral arteries enter the cerebrum to supply the caudate head. It is connected to the putamen of the lentiform nucleus by striated bands of gray matter that extend across the anterior limb of the internal capsule and together form the corpus striatum. The body of the caudate nucleus extends posteriorly from its head to form part of the floor and wall of the anterior horn and body of the lateral ventricle, while the tail extends inferiorly and anteriorly from the body to form the roof of the inferior horn of the lateral ventricle, and its anterior end is attached to the amygdaloid body [3,4].

Lentiform Nucleus

It is a large mass of gray matter with a wedge-shaped shape that is convex on both sides. The lenticular nucleus is divided by a thin band of white matter called the external medullary lamina into the putamen, the large lateral part, and the globus pallidus, the small medial part, which is further divided by another band of white matter called the internal medullary lamina (Figures 1-2). The striatum, which includes the caudate and putamen, is the largest structure of the basal ganglia [7].

Amygdaloid Body

It is a small, almond-shaped mass of gray matter located in the temporal lobe, anterior to the tail of the caudate nucleus, connected medially to the uncus. It forms part of the roof of the inferior horn of the lateral ventricle and represents a deep part of the limbic system (Figure 1) [4,8].

Claustrum

It is a thin strip of gray matter located between two capsules of white matter: extreme capsule separating it from the cortex of insula, and external capsule separating it from the lenticular nucleus (Figures 1-3). Its function has not yet been determined [9,10]. It can work to integrate different sensations, however, such as vision, hearing and touch, in one experience [11].

Connections of the Basal Ganglia

The striatum receives input from neighboring nuclei (in the cerebrum, diencephalon, and midbrain) (Figure 2). Through these connections, it controls muscle activity. The striatum represents the primary input to the basal ganglia. In other words, it is the receptive nucleus that receives most of the afferent fibers (information from various sources, especially from the cerebral cortex, thalamus and substantia nigra), while the pallidum represents the output nucleus, that is, it gives off most of the efferent fibers from the striatum [2].

Blood Supply of Basal Ganglia

The basal ganglia are supplied with blood by the central or perforating arteries of the anterior and middle cerebral arteries, which are the terminal branches of the internal carotid artery. The middle cerebral artery represents the main blood supply through the lenticulostriate arteries, which are susceptible to hemorrhagic stroke in cases of uncontrolled hypertension [1,2]. Furthermore, the anterior choroidal artery, a branch of the internal carotid artery, participates in the blood supply to the caudate and caudal parts of the lenticular nucleus [1].

Neurological Disorders Caused by Striatum Lesion

The striatum lesion can result in disturbances in muscle tone and various movement disorders, usually in the form of muscle rigidity, the presence of unwanted movements (i.e., static tremors), and the loss of associated automatic movements (i.e., arm swinging while walking) [12]. The most well-known basal ganglia disease is Parkinson’s disease: a hyperkinetic movement disorder clinically manifested by involuntary movements including chorea [2].

Acknowledgment

All figures included in the paper are original and created by the author.

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