

Analysis of Amygdala Nucleus in the Rat Brain: A review study

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Abstract:

Amygdala is one of the limbic related sub-cortical nuclei lying in the depth of temporal lobe and rostral of the inferior horn of lateral ventricle. In fact, amygdala is a nucleus complex that plays an important role in the emotional response, anger, fear, regulation of cardiovascular system, memory processes and learning and in pathophysiology of many diseases such as epilepsy, schizophrenia, Alzheimer, anxiety and depression. With regard to important of the amygdala in many critical functions, the cerebral disease and because of ethical problems most studies were done on animal models especially rats. Hence, in this review paper we tried to investigate different aspects of the rat amygdala complex including cyto, myelo and receptoarchitectonic.

Keywords: Amygdala; Cytoarchitecture; Temporal lobe, Rat

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1. Introduction

Amygdala is an almond-shaped nucleus that is located in depth of the temporal lobe. It was identified by Burdach in the early nineteenth century (1). Based on the autoradiographic and immunohistochemical studies, amygdala isn't homogenous but it contains many nuclei (1). For this reason is called amygdaloid complex. Amygdala is involved in modulation of behavior, emotions, learning, and autonomic processes. Also, it has been reported to be involved in neurodegenerative disorders, epilepsy, depression and anxiety (1). With regard to ethical problems, it seems necessary to investigate its structure and function in the experimental models such as mice and rat. The aim of this study was the investigation of cyto and myeloarchitectonic as well as receptoarchitectonic of the rat amygdala.

2. Discussions

2.1. Nuclei of the rat amygdala

According to the immunohistochemical and autoradiographic studies nuclei of the rat amygdala are divided into four groups as follows: 1. Deep nuclei can be divided into four major nuclei: lateral nucleus, ventral basolateral nucleus, basolateral nucleus and basal accessory nucleus. 2. Superficial group can be divided into five nuclei: lateral olfactory tract nucleus, anterior cortical nucleus, posterior cortical nucleus, periamygdaloid cortex, bed nucleus of the accessory olfactory tract or vomeronasal amygdala. Superficial group is divided into medial nucleus and central

nucleus. 3. Centromedial nucleus. 4. The last group contains three major divisions: anterior amygdale area, amygdalo-hippocampal area and intercalated nucleus (1).

2.2. Lateral nucleus

Based on Golgi staining, lateral nucleus processes a great cell population of pyramidal, spiny, Golgi type I and Golgi type II. In addition, there is a less amount of chandler, cone and neurogliaform cells. Myelin fibers in the lateral nucleus show heterogeneous distributions that become denser in the lateral part than its ventral part. Dorsolateral part shows a weak reaction, which contrasts with the very severe reaction in ventromedial part of nucleus (2).

2.3. Basolateral nucleus or basal nucleus

Basolateral nucleus involved in the regulation of fear and anxiety, emotional memory and spatial learning processes (3-5). Amygdala's role is not in long-term memory but in modulation of memory in other brain regions, particularly the hippocampus (6, 7). In Nissl preparation, basal nucleus is divided into the BLA and BLP subnucleus that the BLA shows darker staining than the BLP. Bundles of fibers surround this nucleus. The posterior part basolateral nucleus is striated by reason of passing a bundle of fibers that are mostly oriented perpendicularly. In silver preparations the BLA subdivision is distinguished from lateral nucleus by a lighter staining (2).

2.4. Basolateral ventral nucleus

A strong and homogenous reaction is observed based on Nissl staining. Basolateral ventral nucleus is limited by a dense fiber network that in posteroventral of nucleus shows a denser arrangement compared with its medial. In silver preparation displays a strong reaction.

2.5. Basomedial nucleus

Basomedial nucleus is composed of small and medium-sized neurons, lightly staining that its posterior part is heterogeneous, larger and darker than the anterior part (2). The plexus of fine fibers present in two subdivision of basomedial nucleus, however, denser in BMP than that in BMA. Within all of the amygdaloid nuclei appears the least reaction in the BMA and anterior amygdale area. In contrast, the BMP shows a reverse pattern.

2.6. Lateral olfactory tract nucleus

In Nissl preparations, this nucleus shows a three layer pattern with a superficial dense layer that consists of a few scattered small and medium-sized neurons. Intermediate layer contains medium sized pyramidal cells and deep layer form by large multiangular cells. myelinated fibers coursing through layer 1 that can be subdivided into: a sharply fibered sublamina 1; a richly fibered sublamina 1A; and a deeper layer, with fibers less rich than sublamina 1A (8). The sublamina 1 is intensive stained by silver staining that gradually decreases in deep parts of this layer. Sublamina 1A sharply distinguished from sublamina 1 except a small and non stained part. Sublamina 1B shows a strong reaction (9).

2.7. Anterior cortical nucleus

Anterior cortical nucleus made up of small and slender neurons that show non layered arrangement except for a superficial part. Molecular layer processes neurons with different sizes and shapes. Molecular layer has a narrow sublamina, followed by sublamina 1A with dark bundles. Sublamina 1B is made up of dark and fine myelinated fibers. Deeper layer is occupied by a dense plexus of myelinated fibers. Sublamina 1 and 1A layers remain unstained. Sublamina 1B shows a dense staining compared with the deeper layers of the nucleus.

2.8. Posterior medial cortical nucleus

Neuronal population in posteromedial cortical nucleus is homogeneous being made up of ovoid neurons with different sizes. A strong Timm/Danscher's silver deposits in PMCO nucleus except sublamina 1A layer, where remain nonreactive.

2.9. Periamygdaloid cortex or posterolateral cortical amygdaloid

Based on the Nissl studies, five types of neuron aggregate are detected in the PLCO nucleus: oral medial with obvious and small cells, caudal medial with packed superficial neurons, small-cells with small and dense neurons, oral medial and caudal lateral with no clear structure. There is a thin layer of olfactory fibers in sublamina 1. The fibers are less rich in sublamina 1A than sublamina 1. In contrast, sublamina 1B is distinguished by the presence of tangentially coursing fibers. The Layer 2 is constituted by fibers passages which join the stria terminalis. The fibers in (OM) and (CL) are oriented transversely, whereas fibers in (OL) are oriented perpendicularly. In

Timm/Danscher's preparations the PLCO nucleus shows a trilaminar pattern with a negative in layer 1 and 3, and a weakly staining in intermediate layer.

2.10. Bed nucleus of accessory olfactory tract (AOT)

The neurons in this nucleus are larger and more darkly staining compared to other superficial nucleus. No laminated pattern of the AOT nucleus helps to distinguish it from LOT nucleus. A layered pattern is detected in the molecular layer because of fibers passage. Deep layer is occupied by a rich fiber plexus with no lamination. The pattern of silver precipitate shows three zones in AOT nucleus. It shows a nonreactive superficial and deep zone, and a moderately reaction in the middle layer (9).

2.11. Centromedial nucleus

Centromedial nucleus contains medium spiny, together with a small aspiny ones. Medial nucleus can be differentiated from the central nucleus by a rich fiber network. In Timm/Danscher's preparations, both central and lateral subnuclei heavily stained by silver except some part of lateral subdivision, where stained moderately with silver (10).

2.12. Anterior amygdale area

Based on the histochemical data, anterior amygdale area is divided into two parts: the AAV and the AAD. The ventral part is composed of neurons by different shapes and sizes, whereas the dorsal part consists of larger and lighter staining than the ventral part. This area contains a dense and homogenous fiber plexus. Fibers in the molecular layer don't show a layered pattern expect for fibers around sublamina 1 and lateral olfactory tract (11). This area divided into the AAVL and AAVM subnuclei. The AAVL and AAVD subdivisions display a denser staining than the AAVM.

2.13. Amygdalo - hippocampal area

It is made up predominantly of pyramidal-like neurons, together with satellite and neurogliaform cells. In Nissl preparations, antrolateral part shows lighter staining than the posteromedial part. Fiber bundles that oriented longitudinally penetrate this area. Many of these fibers contribute to form component of the stria terminlais.

2.14. Intercalated nucleus

Intercalated nucleus contains medium spiny cells, together with very large aspiny neurons. Myelinated fibers are arranged by three arms. The lateral arm begins of the basolateral nucleus. It turns medially (transverse arm) and change direction again and make its medial arm (12).

3. Conclusion

Amygdale is one of the limbic related sub-cortical nuclei that play an important role in the emotional response, anger, fear, regulation of cardiovascular system, memory processes and learning and in pathophysiology of many diseases such as epilepsy, schizophrenia, chorea of Huntington and Alzheimer. Hence, further studies are needed for mapping of the amagdala.

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Conflict of Interest:

There is no conflict of interest to be declared.

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