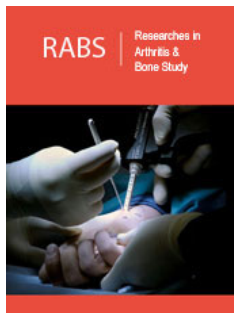


Non-Specific Nucleus of the Thalamus

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Abstract

This article is dedicated to the morpho functional organization of the intralaminar and reticular nuclei of the thalamus. The nonspecific nuclei of the thalamus are described here, which include several groups. These include the interlayer group with the parafascicular complex and the Median Center (MC), the median nuclei and the reticular nucleus. Nonspecific nuclei should be divided into two groups: the first, which includes the parafascicular complex, which is derived from the ventral thalamus, is built from typical reticular cells, and the second, which includes the nuclei of the remaining groups, is built in the same way as the other nuclei of the dorsal thalamus.

Keywords: Brain; Thalamus; Neurons

Introduction

The nonspecific nuclei of the thalamus include several groups [1]. These include the intralaminar group with a parafascicular complex and a Median Center (MC), the midline nuclei and the reticular nucleus [2].

According to Leontovich, non-specific nuclei should be divided into two groups: the first, which includes the parafascicular complex, which are derivatives of the ventral thalamus, is built from typical reticular type cells and the second, which includes the nuclei of the remaining groups, is built in the same way as other nuclei of the dorsal thalamus [3,4]. The neural elements of the intralaminar nuclei are surrounded and permeated by fibers of the inner medullary plate [5]. These fibers cover the dendrites of the cells of the intralaminar nuclei, but only at their ends, in contrast to the dense network surrounding the neurons of nearby specific nuclei.

Parafascicular complex

Analysis of the intrathalamic connections of these nuclei shows that a well-differentiated fiber system originates in the area of the parafascicular complex, which runs in the rostral direction through the entire thalamus and occupies its medial third. A large number of collaterals depart from this fiber system and in this respect, it is very similar to the reticulothalamic tract, which runs laterally to the intrathalamic. It should also be noted a powerful bundle of fibers extending from the parafascicular complex in the caudal direction to the reticular formation of the midbrain [6]. Of particular interest are the fibers surrounding the thalamus from almost all sides. Most of the fibers of the ascending (Reticulothalamic, Intrathalamic) and descending (fibers of the inner capsule) tracts give off extensive collaterals [7]. Of the extra-thalamic connections of non-specific nuclei, the structures of the limbic brain deserve attention [8]. Projections extending as part of the lower leg of the thalamus, to the periamygdallar cortex and the central nucleus of the amygdala have been established. Projections of intralaminar nuclei to the cingulate cortex in the posterior part of it, to the infralimbic region, where the fibers are directed, to the dorsal hippocampus are shown [9].

Connections of the nonspecific nuclei

The question of the connections of the nonspecific nuclei of the thalamus with the cerebral cortex remained unclear for a long time, since local destruction of the cortex was used to study it. The presence of projections of these nuclei into the crust was previously denied. However, with extensive damage to the cerebral cortex and limbic cortical formations, retrograde degeneration in the intralaminar nuclei was observed [10]. Subsequently, the use of the Nauta method and its modifications showed that the anterior section of the intralaminar nuclei directs direct fibers to the cerebral cortex. The local projections of these nuclei into the cortex are organized by thin fibers, which, penetrating the dendritic field, together with a small number of their own field fibers (only about 4% of the axons go to the cortex, and the rest go in the caudal direction) form part of the lower leg of the thalamus. The parafascicular group does not give clear projections into the cortex, but directs them to the field [11]. The nonspecific nuclei of the thalamus also receive, albeit in small quantities, fibers from various parts of the cortex, mainly frontal. These are fibers of small diameter, they pass to the thalamus in the area of the anterior cerebral plate, then as part of the lower thalamic pedicle.

Organization of afferent inputs

Intralaminar nuclei: When studying the response of neurons of the intralaminar nuclei to various afferent stimuli, it was found that most of them are polysensory, i.e. they respond to somatic, visceral, painful, visual and auditory stimuli. The representation of the vagus nerve in these structures was established even earlier by Dell and Olson [12]. The greatest attention of researchers in the direction of the organization of afferent inputs is attracted by the Median Center (MC). MC neurons respond primarily to somatic stimuli, they have widespread receptive fields and, as a result, they respond to skin irritation of all four limbs. Some of the neurons respond to visual and auditory stimuli. In contrast to these data, Durinyan describes the somatotopic organization of the afferent inputs of the CM for visceral and somatic afferent systems: The anterior parts of the body are represented in the mediodorsal part of the MC, the posterior-in the dorsal [13]. It is assumed that somatic afferent influences (and possibly visceral ones) are directed to the intralaminar nuclei (MC, parafascicular complex) through the fibers of the reticulo-spinothalamic tract. Electrophysiological studies have shown the blocking of MC reactions to irritation of somatic nerves by preliminary irritation of the reticular formation of the brainstem. When various structures of the reticular formation are irritated, reactions occur in the CM that resemble the responses of this nucleus to somatic irritations. It can be assumed that the transmission of influences from other afferent systems is also carried out by extralemniscal pathways.

A modulating effect of the nuclei of the cerebellum: A modulating effect on the activity of MC neurons from the nuclei of the cerebellum is shown. Irritation of the dentate nucleus of the cerebellum causes several types of reactions of MC neurons, among which two deserve the greatest interest: inhibition of spontaneous

activity and synchronization (type of neuronal recruitment). Neurons of the nonspecific nuclei of the thalamus (medial group) are influenced by cortical structures. The most pronounced effect on the activity of neurons of the intralaminar nuclei is exerted by the frontal cortex [14].

Organization of afferent inputs

The reticular nucleus of the thalamus: Neurons of the K field, like other nonspecific nuclei, respond to irritation of various afferent systems. In terms of effectiveness, the stimuli activating the neurons of the inputs were distributed in the same way as those that excited the neurons of other nonspecific nuclei. Somatic irritations are the most effective, visual and auditory ones are less effective. Inhibitory effects are observed only with somatic irritations. Convergence of afferent signals of various sensory systems can be observed in neurons of the K field. According to Voloshin and Prokopenko, heterotopic convergence was observed in 25% of P.K. neurons and heterosensory convergence was observed in 16%. These data were obtained on neurons of the rostral pole of the P. K., while the sites of the P. K. Surrounding the ventral and lateral sections of the thalamus do not have somatotopically organized afferent inputs or have heterosensory convergence [15]. At the same time, it was found that the neurons of P. They have afferent inputs identical in localization with neurons of nearby relay nuclei [16]. It was found that the neurons of P. respond to stimuli of the relay nuclei of the thalamus in the form of a high-frequency discharge and in this respect resemble neurons of P. UA. Neurons of P. receive afferent signals from other sources as well. In particular, more than 50% of them react to irritations of the reticular formation of the medulla and medulla oblongata, as well as the central gray matter. Responses of neurons n. Responses to irritation of the prefrontal cortex are predominantly inhibitory in nature. Convergence of influences from the listed structures on P. K. neurons is also detected [17].

Synchronizing mechanisms of the thalamus

The question of the source of various forms of rhythmic activity is important for understanding intra-central relationships, as well as the functional role of brain structures where this kind of activity is observed. In addition, elucidating the mechanisms of synchronizing activity can be a crucial moment in understanding such fundamental brain states as sleep and wakefulness, awakening reaction (agoism), orientation reflex, etc. The fact that fusiform and explosive barbituric activity with a frequency of 8-12Hz occurs synchronously in the cerebral cortex and non-specific nuclei of the thalamus has led to the assumption that the primary source of their occurrence is the thalamus (non-specific nuclei). This assumption was strengthened after it was found that cortical removal does not suppress explosive activity in the thalamus in both non-anesthetized animals and under barbituric anaesthesia [18]. Finally, after partial destruction of the thalamic structures or cutting of the thalamo-cortical pathways, one can observe the disappearance of any forms of rhythmic brain activity, the frequency of which corresponds to the alpha rhythm [19].

Conclusion

This article includes such sub-topics as organization of the parafascicular complex, description of the connections of the nonspecific nuclei of the thalamus with the cerebral cortex and of the intralaminar nuclei, organization of the reticular nucleus of the thalamus and the issue of synchronizing mechanisms of the thalamus has been considered.

References

1. Bon EI, Maksimovich NY, Moroz EV (2023) Thalamus of the rat's brain cyto and chemo architectonics. *International Journal of Clinical and Medical Case Reports* 2(1): 1-4.
2. Robert P Vertes, Stephanie B Linley, Amanda KP Rojas (2022) Structural and functional organization of the midline and intralaminar nuclei of the thalamus. *Frontiers in Behavioral Neuroscience* 16: 964644.
3. Bon EI (2019) Structural and functional organization of the rat thalamus. *Orenburg Medical Bulletin* 3: 34-39.
4. Smirnitckaya IA (2021) The thalamic nuclei classification in relation to their engagement in the correction of initial movements. *Advances in Neural Computation Machine Learning and Cognitive Research V*, pp. 142-148.
5. Vinod J Kumar, Klaus Scheffler, Wolfgang Grodd (2023) The structural connectivity mapping of the intralaminar thalamic nuclei. *Scientific Reports* 13(1): 11938.
6. Berezhnaya LA (2007) Primary structural modules of the dorsal nuclei of the thalamus and motor cortex in humans. *Neurosci Behav Physiol* 37(2): 89-95.
7. Peter W Campbell, Gubbi Govindaya, William Guido (2024) Development of reciprocal connections between the dorsal lateral geniculate nucleus and the thalamic reticular nucleus. *Neural Dev* 19(1): 6.
8. Torsunova YUP, Afanasyeva NV (2023) Morphology and functioning of the limbic system: literature review. *Perm Medical Journal* 40(1): 61-77.
9. Saalman YB, Kastner S (2015) The cognitive thalamus. *Frontiers in Systems Neuroscience* 9: 39.
10. Robert P Vertes, Stephanie B Linley, Amanda KP Rojas (2022) Structural and functional organization of the midline and intralaminar nuclei of the thalamus. *Frontiers in Behavioral Neuroscience* 16: 964644.
11. Min Zhao, Zhaoqin Wang, Zhijun Weng, Fang Zhang, Guona Li, et al. (2020) Electroacupuncture improves IBS visceral hypersensitivity by inhibiting the activation of astrocytes in the medial thalamus and anterior cingulate cortex. *Evid Based Complement Alternat Med*, p. 2562979.
12. Hisse Arnts, Stan E Coolen, Filipe W Fernandes, Rick Schuurman, Joachim K Krauss, et al. (2023) The intralaminar thalamus: A review of its role as a target in functional neurosurgery. *Brain Communications* 5(3): fcad003.
13. Alba V, Lyutikova TM, Krysova IMI (2009) Morpho cytochemical analysis of neural populations of the posterior group of thalamus nuclei *Rattus norvegicus* and *Rattus norvegicus*. *Morphological Bulletin*, pp. 20-23.
14. Yonk A Joseph (2024) The role of posterior medial thalamic nucleus in the modulation of striatal circuitry and choice behaviour. *Rutgers The State University of New Jersey, School of Graduate Studies ProQuest Dissertations & Theses, New Jersey, USA*.
15. Fernando S Borges, Joao VS Moreira, Lavinia M Takarabe, William W Litton, Salvador D Bernal (2022) Large-scale biophysically detailed model of somatosensory thalamocortical circuits in NetPyNE. *Frontiers of Neuroinformatics* 16: 884245.
16. Alain Destexhe, Diego Contreras, Mircea Steriade (1998) Mechanisms underlying the synchronizing action of corticothalamic feedback through inhibition of thalamic relay cells. *J Neurophysiol* 79(2): 999-1016.
17. Zakaria I Nanobashvili, Irine G Bilanishvili, Irine G Vashakidze, Maia G Barbakadze, Megi G. Dumbadze, et al. (2023) Some characteristics of neurons in the reticular nucleus of the thalamus (preliminary data). *Journal of Behavioural and Brain Science* 13(3): 45-54.
18. James M Shine (2021) The thalamus integrates the macrosystems of the brain to facilitate complex, adaptive brain network dynamics. *Prog Neurobiol* 199: 101951.
19. Halassa MM, Kastner S (2017) Thalamic functions in distributed cognitive control. *Nature Neuroscience* 20(12): 1669-1679.