AGE-RELATED HEMISPHERIC DIFFERENCES IN THE SPINE DENSITY OF NEURON DENDRITES IN MALES

M.V. Ivanov

Research Center of Neurology, Moscow

Putamen@list.ru

Disturbance of the motor corticostriatal circuit functions plays an important role in motor functioning decline both in normal and pathological aging [11]. Putamen ia an important part of the motor corticostriatal circuit and refers to the basal ganglia. Together with the caudate nucleus and the nucleus accumbens, putamen forms the striatum. MRI studies indicate an assymetrical age-related reduction of the putamen volume: the shrinkage degree is higher in the right hemisphere compared to the left one in initially rightward asymmetry of putamen [1, 3]. The morphometric study of the putamen nucleus in subjects aged from 62 to 90 years revealed no significant differences in the small-cell density with aging [8]. However, age-related volume decrease of different brain structures is related to neuronal loss, but is also to neuronal shrinkage, decreased number of spines and synapses [2]. Therefore, the phenomena shown on MRI could be explained by studyind age-related structural changes in the 'receptive apparatus' of putamen neurons, in particular, dendritic spines in different hemispheres of the brain [1, 3]. The aim of this study was to distinguish the density of different types of dendritic spines of putamen neurons in brain hemispheres in mature and old males.

Materials and methods

The autopsy findings of brain hemispheres of mature (33 and 54 years old) and old (80 and 90 years old) males, died neither from neurological nor psychiatric disorders, were studied. The autopsy material was obtained within 5-11 hours after death. 5 mm-thick brain blocks that contained putamen were impregnated with silver by the Golgi method [6]. Then blocks were dehydrated in ascending ethanol concentrations (60-100%; 30 minutes each), plunged into 10% celloidin and cut into 120-150 μm-thick coronal sections with Sannomiya microtome. The sections were placed on a large cover glass and in balm then. 5 slices of each case were taken for further investigation. Then 30 precise sketches of spiny neuron dendrites were made with a microscope «ORTHOLUX II» (Leitz Wetzlar, Germany), equipped with a drawing device, with immersion magnification (x1000). The structure and the number of spines were analyzed in the 100-μm area of each dendrite. All the spines were classified into four types based on their morphology (presence of the neck and the head size): stubby, thin, mushroom and branched [4, 9, 10]. The Mann-Whitney test was used to compare the number of spines in the 100-µm area of dendrite in groups of mature and old males, right and left hemisphere.

Results and discussion

The overall spine density of dendrites in the putamen was obtained in the right and left hemisphere of mature and old males (Table 1). Statistically significant hemispheric differences, with predominance of the left hemisphere, were detected in the density of stubby and mushroom spines, an overall density of spines in the mature male group and the density of mushroom spines in the old male group (Table 2).

Table 1. The overall spine density of dendrites in the putamen in the right and left hemisphere of mature and old males.

Age	Right hemisphere				Left hemisphere			
	S	M	T	O	S	M	T	O
Mature	13,15± 0,47	24,72± 1,13	28,71± 1,70	68,26± 2,80	15,37± 0,70	31,13± 1,42	32,89± 2,15	81,28± 3,15
Old	11,71± 0,63	14,0± 0,69	19,16± 1,1	45,91± 1,83	13,36± 0,69	19,52± 0,9	16,88± 1,0	50,44± 1,94

Abbreviations: S – density of stubby spines, M – density of mushroom spines, T – density of thin spines, O – overall spine density. Mean ± SEM.

There were no hemispheric differences in the density of thin spines in both groups. We didn't compare the density of branched spines because of their small number: in all groups the average number of spines in the 100-µm area of dendrite didn't not exceed 1-2.

Table 2. The difference in the spine density of spine neuron dendrites of the putamen in brain hemispheres in mature and old male groups.

Age	Stubby	Mushroom	Thin	Overall spine density
Mature	L>R by 14%	L>R by 21%	–	L>R by 16%
Old	–	L>R by 28%	–	–

Abbreviations: R – spine density in the right hemisphere, L – spine density in the left hemisphere. The dash line indicates the absence of statistically significant difference in right and left hemispheres.

It was detected that density of all types of spines and the overall spine density were lower in both hemispheres in the old male group compared to the mature male group (Table 3). Thin and branched spines are more prone to age-related atrophy. Age-related decline of the dendritic spine density in the striatum was previously shown in animals only [5, 7].

Table 3. The difference in the spine density of spine neuron dendrites of the putamen between mature and old male groups in right and left hemisphere.

Hemisphere	Stubby	Mushroom	Thin	Overall spine density
Right	M>O by 11%	M>O by 43%	M>O by 33%	M>O by 33%
Left	M>O by 13%	M>O by 37%	M>O by 49%	M>O by 38%

Abbreviations: M – mature male group, O – old male group.

According to our data, decline of the overall spine density in the left hemisphere was more significant (by 38% in the old male group compared to the mature group) due to almost double reduction of the thin spine density and a significant reduction of the mushroom spine density. In the right hemisphere mushroom and thin spines undergone more pronounced atrophy, respectively, by 43% and 33%.

Results of this study show a left-sided asymmetry of the spine density in mature males and an asymmetric atrophy of dendritic spines in the putamen with aging. In mature males, the spine density is higher in the left hemisphere, but the atrophy rate is also higher in the left hemisphere with aging, therefore in old males the spine density is the same in both hemispheres.

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