

## AGE-RELATED MORPHOMETRIC ASSYMETRY OF THE RIGHT AND LEFT PUTAMEN IN HUMAN

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Scientific literature contains numerous evidence of hemispheric asymmetry in the structural-functional organization of different brain regions [1, 11-13]. Putamen, which is a part of the striatum and related to the basal ganglia, is also an asymmetric structure. Right-handed people, regardless of gender and age, have a trend to rightward asymmetry of putamen volume [9].

Aging is accompanied by a deterioration in motor performance [5]. Therefore, it is very important to study the mechanism of age-related changes in the basal ganglia, which refers to so-called motor circuit, to understand these functional changes [3]. MRI studies show age-related shrinkage of the putamen in healthy individuals [2, 4, 7, 10]. Shrinkage of the putamen is more pronounced in the right hemisphere compared to the left one in initially rightward asymmetry of the putamen [2, 6]. Age-related volume decrease of different brain structures is connected with neuronal loss, but is probably also with neuronal shrinkage, decreased number of spines and synapses [5].

Therefore, the phenomena shown on MRI could be explained by studyind

age-related asymmetrical structural changes in the putamen.

Nowadays, there is no information in the literature about structural lateralization and age-related morphologic changes of medium spiny neurons that are the main putamen neurons.

Thus, the aim of this study was to determine the hemispheric asymmetry in the structure of the 'receptive apparatus' of spiny putamen neurons in individuals (males) of different age.

### Materials and methods

The autopsy findings of brain hemispheres of 6 males (30, 33, 54, 71, 80 and 90 years old), 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 the putamen were impregnated with silver by the Golgi method [8]. Then blocks were dehydrated in ascending ethanol concentrations (60-100%; 30 minutes each), plunged into 10% celloidin and cut into 120-150  $\mu\text{m}$ -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 of each putamen were made with a microscope «ORTHOLUX II» (Leitz Wetzlar, Germany), equipped with a drawing device, with magnification of x400 and x630. Morphometric study of the somatodendritic structure of spiny neurons included the measurement of drawn neurons on the digitizer (D-Scan, Model No. DT-3600, Japan.), connected to the computer (software was developed in the laboratory). 7 parameters were estimated: area of the neuronal soma (Scl), the number of dendrites (d), the number of free branches of dendrites (Bd), the largest radius of the dendritic field (R), the total length of dendrites (Ld), space of dendritic area (Sda) and actual density

of spines on dendrites (Nds) [8]. The Mann-Whitney test was used to compare all the parameters.

### Results and discussion

Seven morphometric parameters of the spiny neurons of the putamen in both hemispheres were obtained in each case. Neurons of the right and left putamen were compared by 7 parameters to detect a hemispheric asymmetry.

Statistically significant hemispheric differences were obtained only in few parameters in 3 cases of 54, 71 and 80 years old (Table). At the same time there were no hemispheric differences in the youngest (30 and 33 years) and the oldest (90 year) male. There was no linear regression of any parameter with age (30, 33, 54, 71, 80 and 90 years) in males (Fig.).

**Table. Hemispheric differences in morphometric parameters of putamen dendrites in all the cases.**

Case №	Age	Scl	d	Bd	R	Ld	Sda	Nds
1	30	–	–	–	–	–	–	–
2	33	–	–	–	–	–	–	–
3	54	17% L > R	20% L > R	–	–	–	–	–
4	71	–	–	–	10% L > R	16% L > R	11% L > R	–
5	80	–	12% R > L	–	–	–	18% L > R	10% R > L
6	90	–	–	–	–	–	–	–

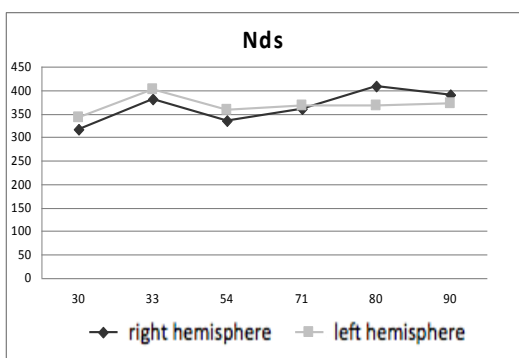
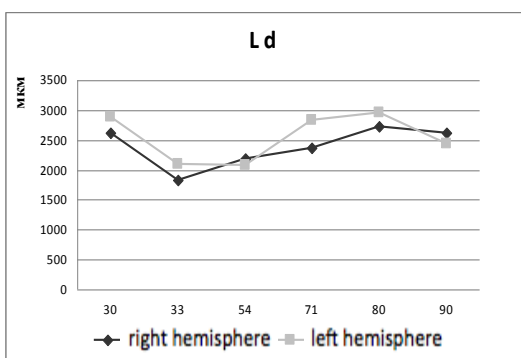
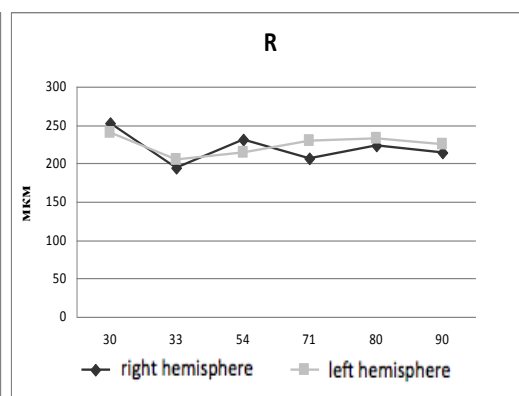
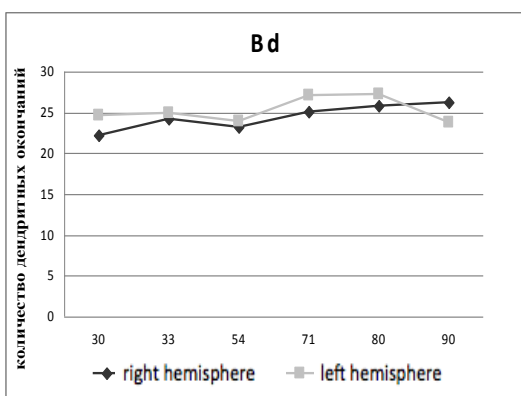
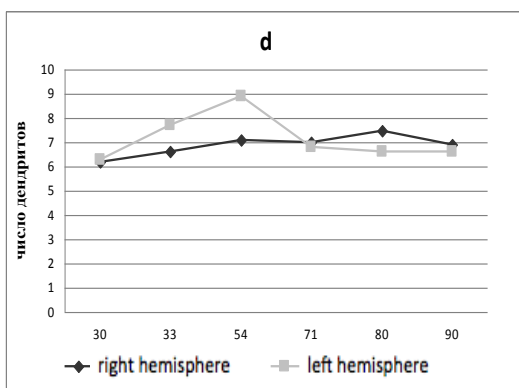
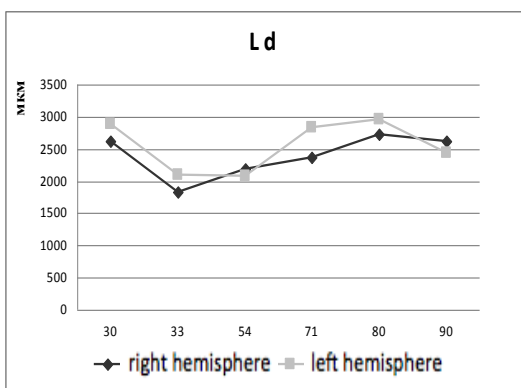
*Abbreviations:* R – right hemisphere, L – left hemisphere. The dash line indicates the absence of statistically significant difference in right and left hemisphere. Statistically significant differences showed in percentage.

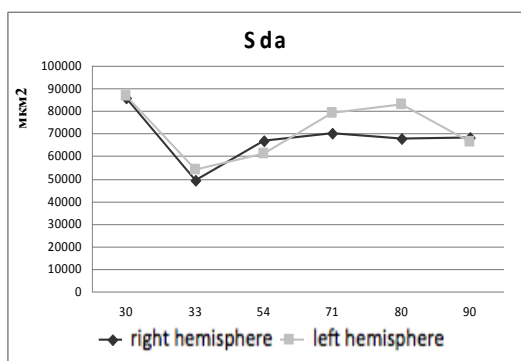
Thus, 6 cases of 30, 33, 54, 71, 80 and 90 years old males were studied. Hemispheric differences of

somatodendritic structure of putamen spiny neurons were found in 3 cases

(54, 71 and 80). Two men (54 and 71 years old) showed leftward asymmetry in the number of dendrites and soma size (case №3, 54 years old), in the radius of the dendritic field, total length of dendrites and space of dendritic area (case №4, 71 years old). Peterson et al. (1993) suppose that neostriatum asymmetry is associated with handedness: right and left. The use of dominant hand leads to volume increase of the contralateral striatum compared to the ipsilateral one [9].

Results of our study showed mild hemispheric asymmetry of somatodendritic structure of putamen spiny neurons with the use of various parameters in men of different age in 3 cases: 54, 71 and 80 years old. Therefore, our results may represent the individual variability of parameters and we can not say about hemispheric differences in the structure of somatodendritic structure in human (males) in general.





**Figure.** Age-related hemispheric differences in morphometric parameters of putamen spiny neurons in males.

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