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Age-Dependent Loss of Neurons in Brainstem Reticular Formation

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Abstract

Age-dependent structural changes in brainstem reticular formation were studied. The significant decrease of mean number of neurons in reticular formation was revealed with age increase. The loss of neurons at maximal level was revealed in patients aged 70 years or over. The loss of neurons may result in constant significant damage to functions of reticular formation and may underlie the dysregulation pathologic processes.

Keywords: reticular formation, neurons, loss of neurons

1. Introduction

Reticular formation plays a significant role in brain functions and organism as a whole. This structure is a set of interconnected neural cells that are connected with other brain structures. The neuronal organization and functional features of reticular formation are still not studied enough. Particularly age-dependent changes are not studied at all.

Vital regulatory centers that control visceral functions are located in the brainstem reticular formation: cardiac and vasomotor center and respiratory center. The features of cardiac and vasomotor center are much more less studied than of respiratory one.

The brainstem reticular formation not only controls autonomic regulatory functions but controls the activity of motor centers of spinal cord. The reticular formation plays a central role in regulation of states of consciousness and sleep.

Morphologic changes in brainstem reticular formation as the result of senescence are not studied yet. The loss of neurons in brainstem as a whole is described in a small number of research papers. For example, Frolkis (1988) presented data that demonstrated irregular age-dependent loss of neurons in various brain structures. Some works demonstrate age morphology of brainstem in animals (Baskerville et al., 2006).

The aim of the study: to reveal age-dependent morphologic changes in brainstem reticular formation which may underlie dysregulation pathologic processes. Here we present the evidence age-related loss of neurons in this structure.

2. Materials and Methods

The research was undertaken on autopsy material. This approach is useful to reveal the changes to the brainstem reticular formation that have accumulated within the span of an individual's life (Kolomiytsev, 2012). Fragments of human medulla oblongata were fixed in 10% formaldehyde and underwent standard histological processing. Cross-sections of medulla oblongata were prepared and stained by means of standard histological and histochemical methods. The calculation of numbers of neurons in the reticular formation in right and left parts of medulla oblongata per field of vision (420x) was undertaken with mean number identification. This method was applied to standardize the research as in this case we are able to estimate the number of neurons in a certain volume of brain tissue.

3. Results and discussion

60 autopsies were studied, from subjects demonstrating cardiovascular pathology varying in age from 32 to 80 years. The following results were obtained.

1. Mean number of neurons per field of vision in reticular formation in the right and left parts of medulla oblongata differs insufficiently in every case.

2. The study revealed progressive decrease in the mean number of neurons in reticular formation with age increase. In the age group of 31-40 years the mean number of neurons per field of vision equals 6.7 in the age group of 41-50 years- 5.85, in the age group of 51-60 years- 5.05, in the age group of 61-70 years- 4.6, in the group of 71-80 years- 4.45. The study revealed an 33,58% decrease in the mean number of neurons in reticular formation in the age group of 71-80 years as compared with the age group of 31-40 years (Table 1).

Statistics. The results presented are statistically significant. We calculated Student criterion ($P<0,01$) and Pearson criterion X^2 which reflected the significance of distinction of parameters of the group. This criterion provides methods that estimate the significance of difference between the obtained values and theoretical values. As the result it is possible to test a consent, i.e. to compare the experimental

and theoretical data distribution. We used Pearson criterion X^2 for comparison of various conditions of the same qualitative indication: presence and absence of neuronal loss with age increase. Criterion X^2 equals 70, 85; this result exceeds critical meaning $X^2= 10.82$ for 0.1% level of significance.

We revealed the regularity expressed in substantial age- dependent decrease of number of neurons in brainstem reticular formation. Such a changes may result in constant damage to the function of reticular formation that in its turn may result in dysregulation pathology persistence. For instance, these changes may play a significant role in respiratory and cardiovascular system regulation disorders and even in sudden death etiology but this possibility requires additional study.

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Competing interests. The author declares no conflicts of interest.

Ethics approval. RostGMU Bio-Ethical Committee.

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Table 1. Number of neurons in brainstem reticular formation as age-dependent value.

	Age groups				
	31-40 (1)	41-50 (2)	51-60 (3)	61-70 (4)	71-80 (5)
Mean number of neurons	6,7	5,85	5,05	4,6	4,45
Percentage (to 1)	100	87,3	75,37	68,65	66,42

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