# THE ROLE OF RADIODIAGNOSIS IN ASSESSING NATURAL AGING OF THE BRAIN

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ANNOTATION. Study the human brain in vivo, with the help of radiation research methods, understanding the nature and location of age-related changes is of increasing interest. Changes in brain volume over time in healthy adults are highly variable. Although brain volume loss is widespread, its extent varies in different brain regions. Brain aging is based on many factors, and they are expressed differently in each individual. Brain volume decreases with age, even in relatively healthy adults without evidence of general cognitive decline. Brain aging is nonlinear, and no sex differences in age-related trends in brain aging have been observed. Individual differences in the degree and type of changes are substantial and, in some important brain regions, are enhanced or mediated to some extent by vascular risk factors.

Key words: brain aging; brain volume; vascular risk factors.

**Introduction.** Brain aging refers to a decrease in brain volume, changes in its vascular network, and a decrease in specific functions [1]. With age-related decrease in brain volume, cerebral circulation is impaired, white matter is damaged and brain function decreases, the level of neurotransmitters and hormones decreases [2], and the ratio and amount of neurotransmitters and neuropeptides changes [3, 4]. The density of neurons decreases, the number of neuroglia increases, which ultimately leads to glial changes of varying severity [5]. These processes are irreversible and natural. But there are a number of protective factors that reduce cardiovascular risks, such as regular exercise, diet, and reducing alcohol consumption. A healthy lifestyle, both physically and mentally, promotes longer-lasting normal brain function. At present, the fundamental problem of the neurobiological basis of the observed pattern of brain aging remains unresolved. But there are a number of studies showing that brain changes in adults are a continuation of processes observed in children and adolescents [6]. V.N. Krutko et al. identify four basic mechanisms of aging: systemic intoxication of the body, which is the incomplete elimination of exogenous and endogenous toxins; loss of non-renewable elements of the body; accumulation of damage and deformation; unfavorable changes in regulatory processes and decreased systemicity of the body [7]. Today, the theory that explains not only aging, but also the initiation and progression of many modern human diseases is the theory of oxidative stress (OS) [8]. Timely detection and correction of OS are considered as an urgent need of clinical medicine; with their help, it is possible to manage the health indicators of an aging person. All patients with any age-associated pathology have OS, the negative manifestations of which increase with age [9]. M.A. Paltsev et al., in their review study, studied in detail the mechanisms of aging from the perspective of the commonality of signaling molecules produced in three regulatory systems of the body - nervous, endocrine and immune [10]. It has been shown that neuroimmunoendocrine

hormonal regulation of homeostasis occupies an important place in the complex chain of processes leading to the aging of cells, tissues, organs and the body as a whole. Particular attention is paid to the morphofunctional involution of the nervous, endocrine and immune systems, which is accompanied by a disruption in the production of signaling molecules. A detailed analysis and further development of integral theories about the molecular community of regulatory systems at the central and especially at the local levels open up new broad prospects for deepening knowledge about the mechanisms of aging, as well as for the prevention, diagnosis and treatment of diseases associated with age, in the pathogenesis of which plays an important role incoordination neuroimmunoendocrine signaling mechanisms. The presented data indicate that aging affects all parts of the diffuse neuroimmunoendocrine system, which leads to dysregulation of homeostasis both in individual organs and systems and in the body as a whole. Expanding research into the mechanisms of aging will allow us to better understand the structural and functional basis of age-related involution and develop ways to prevent and correct pathological processes associated with age [10].

**Methods for diagnosing brain aging**

Numerous studies of brain aging have assessed the average rate of involutional changes in correlation with age, the rate of these changes, and individual differences between them. The most commonly used neuroimaging methods were magnetic resonance imaging (MRI), multislice and single photon emission computed tomography (SPECT). The study of brain atrophy by tomographic methods began in the 1980s, when a group of Japanese authors evaluated CT scans of 228 patients. During the work, the ratio of brain volume to cranial cavity (cranial index) was quantitatively measured. The value of this index in persons aged 20 to 49 years was constant and amounted to 92±3 conventional units. This value was considered the standard for a normal brain. However, after 50 years, the cranial index began to decline sharply and at 80 years old it was 89 ± 6 c.u. [eleven]. Various scientific data indicate that in healthy adults with successful aging, the decrease in brain volume is more pronounced in the gray (especially prefrontal) matter, with the formation of the Leukoaraiosis phenomenon , which is also observed in the presence of multifocal vascular atherosclerotic lesions [12], and a decrease in sensory and entorhinal cortical functions are practically absent. An increase in the number of periventricular and subcortical areas of white matter changes, a change in the MR signal in the basal ganglia, an increase in the volume of the cavity system of the brain and an expansion of the subarachnoid space in the frontal lobes, which is accompanied by a decrease in psychomotor functions, are determined [13, 14]. There are studies showing a significant decrease not only in the prefrontal, but also in other areas of the brain [15]. In addition, some studies included participants with cardiovascular disease, which is common in older adults. Vascular changes have a noticeable negative impact on the brain and its functioning [16]. In the diagnosis of age-related changes, SPECT is actively used as a method for studying the physiological activity of the brain in natural conditions. In particular, N-isopropyl-p- iodoamphetamine SPECT was used to assess regional cerebral blood flow. In this age category, it is extremely difficult to find patients with isolated physiological aging of the brain; many acquire various degenerative and vascular diseases

of the brain over the years of their lives. Thus, in a comparative study by WJ Jagust et al . in 1987, brain SPECT was performed on patients with Alzheimer's disease (AD), multi-infarct dementia, and relatively healthy elderly control subjects. According to the results obtained, all patients with AD had a deficit of blood flow in the temporo-parietal cortex of the brain on both sides, and the ratio of activity in the temporo-parietal cortex on both sides to the activity in the entire section made it possible to differentiate all patients with AD as from the control group and patients with vascular dementia. In addition, this ratio showed a strong correlation with disease severity in a group of patients with asthma [17], which is also observed in cerebrovascular diseases [18]. Dilatation of the ventricular system according to CT and MRI, and consequently an increase in cerebrospinal fluid (CSF), is one of the most common age-related signs [19]. All this occurs as a result of a decrease in brain mass and volume. Based on many CT studies [20], an increase in the index of the anterior and central parts of the lateral and third ventricles was revealed depending on age. From the first year of life to the age of 90, the ventricular -cerebral index increases from 2 to 17%, and the ratio of CSF volume to cerebral volume increases from 24 to 48%. These changes are characteristic not only of the lateral ventricles, but also of the third ventricle [21]. Studies examining the subarachnoid space have described its enlargement with age in many people. Starting at age 40, the volume of cerebrospinal fluid increases by 1 ml every year, and the ratio of cerebrospinal fluid volume to intracranial volume increases by 1% every 10 years [21]. When assessing age-related changes in the brain using MRI and CT, visual data are taken into account: expansion of the sulci, subarachnoid space, general and regional sizes of the brain. An analysis of the shape and structure of the brain shows a relationship between age and more sharply and steeply curved convolutions of the cortex, as well as with enlarged and less curved sulci. Different brain structures have different degrees and severity of age-related changes. For example, the age-related decrease in volume in the prefrontal association cortex is significant, while in the pontine structures it is moderate. Taking this feature into account, a position was formulated on a model of differentiated age-related vulnerability of brain structures caused by phylogenetic or ontogenetic differences [22].

Imaging of the human brain has revealed that the cortex undergoes anatomical changes during aging. Thanks to the ability to study the human brain in in vivo, using MRI, understanding the nature and location of these changes is of increasing interest [14]. Parameters common to different studies include brain surface area, cortical thickness and volume, sulcal depth, local gyrification index , and curvature indices. The results obtained indicate the influence of age on the average thickness of the cortex, brain volume, sulcal depth and characteristics of their curvature [29]. Changes in brain volume over time in healthy adults are highly variable. Although brain volume loss is widespread, the extent varies depending on the region of the brain. The largest average decrease was observed in the caudate nucleus and cerebellum, hippocampus and tertiary association cortical fields, and to a lesser extent in the secondary associative cortex. The decrease in the entorhinal cortex was minimal, and the volume of the primary visual cortex remained unchanged [29].

**Conclusion**

Based on the studies conducted, we can conclude that the age of 50 years is the generally accepted starting point for irreversible involutive changes in the brain. Initial brain size and learning are controversial neuroprotective predictors that have not yet been scientifically validated. Brain volume decreases with age, even in relatively healthy adults without evidence of general cognitive decline. And this continues to be the case even as cognitive markers that are more sensitive to the negative effects of brain aging, such as decline in intelligence, show averages over time, variations in these changes, and associations with changes in brain volume. The rate of decrease in brain volume increases linearly or nonlinearly in different brain regions. With successful brain aging, volume loss is more pronounced in the prefrontal gray matter, while there is virtually no decline in sensory and entorhinal cortical functions. Starting at age 40, the volume of cerebrospinal fluid increases by 1 ml each year, and the ratio of cerebrospinal fluid volume to intracranial brain volume increases by 1% over the next 10 years. From 30 to 49 years and from 50 to 91 years, the volume of the cerebral pons decreases by 0.88 and 0.95 times, respectively. The volume of the cerebellum progressively decreases. In patients with concomitant arterial hypertension, more pronounced involutive changes were detected in the hippocampus. Brain aging is nonlinear, and no sex differences in age-related trends in brain aging have been observed. Individual differences in the degree and type of changes are substantial and, in some important brain regions, are enhanced or mediated to some extent by vascular risk factors. It is not age itself, but the experience of hypertension and the age of its manifestation that influence the rate of atrophy of individual brain regions; in addition, the age-hypertension relationship suggests not only cumulative, but also progressive effects of arterial hypertension. In hypertension, the prefrontal white matter, hippocampus and orbitofrontal cortex are more additive to the influence of age. Since vascular risk factors are curable , their control may help reduce the rate of brain aging.

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