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MORPHOLOGICAL SIGNIFICANCE OF THE STRUCTURE OF CEREBRAL VESSELS IN RATS

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Abstract:

The problem of community-acquired pneumonias in children remains acute at present. Complicated forms, which include pleural empyema, abscess, necrotizing or destructive pneumonia, bronchopleural fistula and acute respiratory distress syndrome are not becoming less, despite the modern antibacterial therapy and availability of vaccination against pneumococcus. The main pathogens associated with lung destruction in children remain S. pneumoniae and S. aureus, often MRSA. Much less often the role of other pathogens in necrotizing pneumonias is reported: Streptococcus pyogenes, Haemophilus influenzae, Pseudomonas aeruginosa, Fusobacterium nucleatum, Legionella pneumophila, Klebsiella pneumoniae, anaerobes. However, not only pathogenic factors of the causative agent are important in the pathogenesis of the disease. Often viral prodrome, often associated with influenza A (H1N1) virus, precedes the development of complicated pneumonia.

Keywords: community-acquired pneumonia, anticoagulants,children,etiology

Abstract: The rat is one of the widely used objects of experimental research to study the pathology of the cerebral circulation and its effect on the morphofunctional features of the cerebral cortex.

Key words: blood circulation, neurons, brain.

INTRODUCTION. The blood supply to the rat brain includes blood flow through the internal carotid arteries and vertebral arteries. The villous circle in the rat is similar to the arterial circle of the human large brain.Relationship of angioarchitectonics with cytoarchitectonics of the brain. The presence of the modular organization of the cerebral cortex neurons is associated with the similar structure of vascular networks, since the formation of the latter depends on the organization of neuronal ensembles.

In order to study the consequences of ischemia and other cerebral circulatory disorders in rats and humans, adequate animal models are required. The brain in humans and higher vertebrates, including the rat, is intensely supplied with blood. The rat is one of the widely used experimental objects for studying the pathology of the cerebral circulation and its influence on the morphofunctional features of the cerebral cortex. For possible extrapolation of the data obtained in the experiment to humans, it is necessary to understand the peculiarities of the cerebral blood circulation in the rat. Vascular structures are an important element in the organization of the nervous system, which has a decisive importance in the plasticity and functional activity of neurons [1]. Energy in the brain is produced by glucose oxidation, therefore neuronal activity is highly dependent on the state of cerebral blood circulation and is sensitive to its disturbance. Inadequate blood supply to the brain and decreased functional activity of neurons cause cerebrovascular pathology, leading to disability of the organism, as well as death.

Figure 1: Experimental rats in which the brain was examined

According to modern concepts, the blood supply to the rat brain includes blood flow through two pairs of major blood vessels: the internal carotid arteries and the vertebral arteries. After the vertebral arteries reach the level above the cervical vertebrae, they merge into the common basal artery, which runs at the base of the bridge along a special hollow. The internal carotid artery gives off, among others, the anterior and middle cerebral arteries: the first branch branches off in the corpus callosum and on the inner surface of the hemisphere, the second branch off on the outer surface of the hemisphere [2, 3]. The cerebral sheath arteries and the bringing vessels of its parenchyma are lined by endothelium with a well-developed basal membrane. Superficial to the endothelium lies a layer of circularly arranged smooth myocytes that form the middle sheath. Even more superficial is the adventitial sheath, which in the intracerebral arteries is a continuation of the subarachnoid space. The blood supply to the brain is mainly provided by the carotid arteries, the anterior and middle cerebral arteries, the anterior chorioidal artery, and the vertebrobasilar vascular system. Due to the larger caliber of the internal carotid arteries compared to the main artery, the main blood flow (90%) to the brain in rats is through the internal carotid arteries [2,4]. The internal carotid arteries penetrate the cranial cavity through the laceration and divide into caudal and nasal connecting arteries; the latter pass into the middle cerebral arteries at the level of optic nerve crossing. Then, the nasal connective arteries, dipping into the longitudinal cleft of the brain, either merge into the unpaired nasal cerebral artery or follow parallel isolated trunks [2, 4, 5].

The cerebral arterial (villous) circle is a polygonal anastomosis formed by the proximal parts of the anterior, middle, and posterior cerebral arteries, as well as the right and left posterior communicating arteries [2]. The circle of villi in rats is formed by branches of the internal carotid artery and basilar artery. Rostrally, it is closed by the connecting artery and caudally by the right and left terminal branches of the basilar artery. In rats, the caudal connecting arteries are an important anastomosis between the systems of carotid and vertebral arteries, and the postchiasmatic artery connects the nasal connecting arteries and unites both internal carotid arteries [2, 4, 5]. The arterial circle of rats is very similar to the arterial circle of the human brain by its anatomical structure and morphofunctional characteristics of vessels. The vessels of the cerebral arterial circle of these animals have analogues among the arteries forming the human villous circle. For example, the nasal connective arteries are similar to the human anterior cerebral arteries, the postchiasmatic branch is similar to the anterior connective artery, the caudal connective arteries correspond to the posterior connective arteries, and the caudal cerebral arteries to the posterior cerebral arteries [4-6] (Fig. 2).

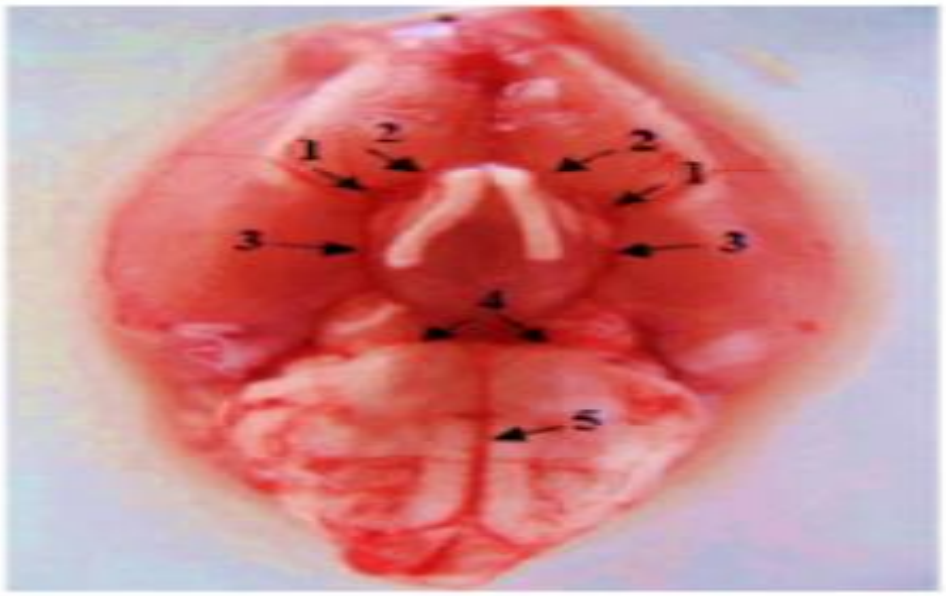

Figure 2 - Structure of the villous circle in the white rat: 1 - internal carotid artery; 2 - nasal connective artery; 3 - caudal connective artery; 4 - caudal cerebral artery; 5 - main artery [4]

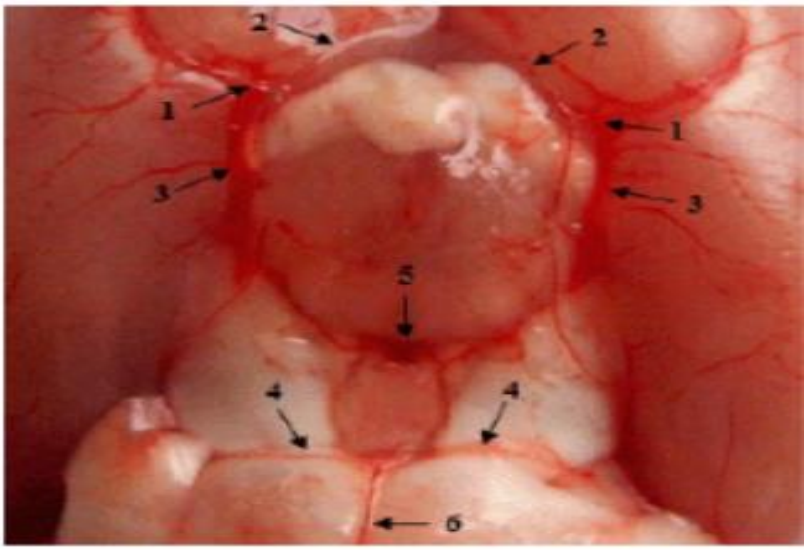

Figure 2 - The villous circle of the white rat in the form of "figure eight": 1 - internal carotid artery; 2 - nasal connecting artery; 3 - caudal connecting artery; 4 - caudal cerebral artery; 5 - artery connecting caudal connecting arteries; 6 - main artery [4].

The greatest variation in the structure of the arterial circle in rats is manifested in the presence of the postchiasmatic artery as well as in the differences in the quantitative parameters and morphometric characteristics of the vessels. For example, the diameter of the caudal connective arteries (each about 0.16 mm) and the caudal cerebral arteries (0.13 mm) is 1.5 times that of the nasal connective arteries (about 0.089 mm), and the size of the internal carotid arteries (each about 0.2 mm) is about 1.2 times that of the main artery (0.17 mm) [4, 6].

Closed villous circle occurs with the highest frequency (75%) in rats. In this case, the nasal connective arteries are connected by a postchiasmatic branch in front of the optic nerve crossing (Fig. 1). In 50% of cases, the arterial circle of the white rat resembles the shape of "figure eight" (Fig. 2): the caudal connecting arteries on the bridge surface are connected by an additional connecting artery, which divides the villous circle into two rings of different diameters - a larger cranial and a smaller caudal one. In 25%, the villous circle is unclosed, and then the right and left nasal connective arteries pass each to the corresponding nasal cerebral artery without anastomosing each other [2, 4].

The venous branches, formed from several capillaries, flow into the trunk of the intracerebral vein at right or obtuse angles. Large cerebral surface veins are built of two layers of endothelium: the vein endothelium proper and the endothelium of its sheath with a layer of amorphous substance located between them. The adventitial sheath of rat brain veins is not expressed and appears only in case of their fibrosis.

The volume of the cerebral venous vessels is 2-3 times greater than that of the arterial system. The regulatory role of the venous system consists primarily in pressure redistribution in the cerebral vascular system. In cavernous sinuses,

blood evacuation is promoted by pulsating sections of the main arteries. Reverse outflow of blood through the veins inside the skull is difficult due to the presence of valves preventing blood recirculation. The pressure in the cerebral venous sinuses is unequal due to their anatomical peculiarities [7, 8].

A network of capillary vessels serves as a connecting link between arteries and veins of the brain. The more functionally important brain structures are, the more intensive is their metabolism and the richer is capillary angioarchitectonics [9, 10]. Blood capillaries of the rat brain have a number of common features of their organization that bring them closer to similar microvessels in organs with pronounced barrier properties. At the same time they are distinguished by the absence of connective tissue environment. Two types of cells - endotheliocytes and pericytes - participate in blood capillaries formation. Endotheliocytes are polarized cells with apical and basal surfaces. Morphologically, the endothelium of brain capillaries has no fenestra, surrounded by pericytes and a well-defined and continuous basal membrane. Differentiated endotheliocytes are characterized by insignificant content of cytoplasmic organelles, except for mitochondria and a small number of vesicles. There are a large number of desmosome-like compounds between the cells. The blood-brain barrier is formed by highly specialized endothelial cells that provide precise control of substances that enter the brain. The structural basis of the blood-brain barrier is formed by a network of complex dense intercellular connections, which limits para-cellular diffusion of hydrophilic molecules. In addition, the lack of fenestration and extremely low pinocytic activity of endothelial cells inhibit the transcellular passage of molecules through the barrier. On the other hand, to meet the high metabolic demands of central nervous system (CNS) tissue, specific transport systems selectively expressed in brain endothelial cell membranes in capillaries mediate the directed transport of nutrients into the CNS or of toxic metabolites from the CNS. In the areas where the blood-brain barrier is absent (neuroendocrine nuclei of the hypothalamus, some areas of brain parenchyma in the immediate surroundings of ventricle III and around the cavity of ventricle IV) blood capillaries have thinned, fenestrated endothelial lining, which has a high degree of permeability for macromolecular compounds and hormones [11-13]. In these zones, a well-developed system of small pores is detected; therefore, the barrier properties are poorly expressed [14-18]. Pericytes are grouped around capillary endothelium and are contractile cells that change lumen diameter and provide adapted blood flow due to the content of actin-like microfilaments. Pericytes are a very important cellular component of the blood-brain barrier. They play a regulatory role in cerebral angiogenesis, formation of dense endothelial cell junctions, differentiation of the hematoencephalic barrier, and contribute to microvascular vasodynamic capacity and structural stability. Pericytes of the central nervous system act as macrophages and form the neuroimmune network of the blood-brain barrier. They possess unique functional characteristics critical for the pathogenesis of a number of cerebrovascular, neurodegenerative and neuroimmune diseases. The pericapillary sheath is formed by glial cells astrocytes [18].

A study of blood vessel changes in the cerebral cortex, corpus callosum, septum and caudate nucleus of the rat brain using angiography and histological analysis revealed a homogeneous distribution of vessels in each of the studied areas. However, the density of vessels per unit volume in different brain areas is different. The distribution of microvessels in the brain parenchyma is the most important indicator of energy consumption and trophic supply of neurons and depends on the distance of microvessels from a neuron, the size and shape of the cell body, hemodynamic conditions, and the content of oxygen and nutrients in the incoming blood [9].

The cortex covering the surfaces of the large cerebral hemispheres is represented by a layer of neurons organized according to the screen type. Each cortical layer is characterized by a certain set of cellular elements - cytoarchitecture. The structural and functional unit of the cortex is a module - a vertical column of neurons running through all cortical layers. A module is an elementary unit of information processing. The presence of the modular organization of the cerebral cortex neurons is associated with the similar structure of vascular networks, since the formation of the latter depends on the organization of neuronal ensembles. An example of the modular organization of the nervous system is the columnar organization of the neocortex of both rat and human brains. The cytoarchitectural regions of the neocortex consist of smaller units; local neuronal circuits repeat iteratively in each region. The modules may differ in the type and mode of neuronal data processing. Within the same large brain region, they have a similar organization. Columns in cytoarchitectural regions located at some distance from each other but with some common properties can be related to each other. However, the vascular modules and their relation to the cytoarchitectonics of the brain have not been sufficiently studied. In the cortical modules of the primary visual and soma-tosensory cortex, the vascular organization corresponds to the neuronal cytoarchitectonics [18]. Vascular architecture (angioarchitectonics) determines cerebral blood flow and oxygen metabolism in the brain. Vascular structures correspond to the borders of neuronal modules and are surrounded by astrocytes that isolate structural and functional units of the brain. A neurovascular unit is a morphofunctional structure consisting of neurons, astrocytes, pericytes and endothelial and smooth muscle cells that regulate blood flow in a certain brain area [17]. There are a number of studies confirming the existence of a correlation between the angioarchitectonics and cytoarchitectonics of the large hemispheres of the rat brain. When studying the distribution of microcirculatory channel vessels between the modules of rat somatosensory cortex, a positive correlation between the distribution of the mitochondrial enzyme cytochrome oxidase and electrical and metabolic neuronal activity was established. In the rat parietal cortex, the relationship between the activity of the mitochondrial enzymes cytochrome oxidase and succinate dehydrogenase and the density of microcirculatory blood vessel distribution in the brain parenchyma was confirmed. The distribution of vessels directly depends on the functional activity of brain regions and different cortical modules [13].

Significant structural rearrangements of cerebral angioarchitectonics accompanied by morpho-functional changes of astrocytes are observed with age. When studying age-related changes in the cytoarchitectonics of the rat brain, it was found that
in the somatosensory cortex and nuclear centers of the trunk, the distribution of microcirculatory blood vessels is somewhat different in time from the changes in electrical and metabolic activity of neurons [2, 7]. After injuries and age-related structural and functional rearrangements of the brain, the changes in angioarchitectonics and astrocytic environment of vessels are mostly irreversible. The relationship between angioarchitectonics and cytoarchitectonics is also conditioned by the level of vascular endothelium permeability and mediator-hormonal factors: synthesis and release of noradrenaline, serotonin, acetylcholine, GABA or other bioactive substances specific for a certain brain region by neurons.

CONCLUSION: Thus, the above-mentioned data on a considerable similarity of the sources of formation of the villous circle and its topography in rats and humans, as well as comparable anatomical structure, morphometric parameters of vessels and organization of blood circulation in the rat brain indicate the possibility to use rats to model various cerebral pathologies of vascular genesis and further extrapolate results to humans.

LITERATURE

1. Valverde Salzmann, M. High-resolution imaging of vessels in the isolated rat brain / M. F. Valverde Salzmann, N. Logothetis, R. Pohmann // Proc. Intl. Soc. Mag. Reson. Med. - 2011. - Vol. 19. - P. 282.
2. Uston, C. Dr. Thomas Willis' Famous Eponym: The Circle Of Willis / C. Uston // Turk. J. Med. Sci. - 2004. - Vol. 34, N 4. - P. 271-274.
3. Трушель, Н. А. Сравнительная характеристика строения сосудов виллизиева круга головного мозга у человека и лабораторных животных / Н. А. Трушель // Воен. медицина. - 2009. - № 2. - С. 47-51.
4. Anatomical arrangement and distribution of the cerebral arterial circle in rats / A. Esteves [et al.] // J. Morphol. Sci. -2013 Jan. - Vol. 32, N 2. - P. 132-139.
5. Frederickson, R. G. Blood vessels and tissue space associated with the brain of
6. M. I. Kamalova, N.K.Khaidarov, Sh.E.Islamov,Pathomorphological Features of hemorrhagic brain strokes, Journal of Biomedicine and Practice 2020, Special issue, pp. 101-105
7. Kamalova Malika Ilkhomovna, Islamov Shavkat Eriyigitovich, Khaidarov Nodir Kadyrovich. Morphological Features Of Microvascular Tissue Of The Brain At Hemorrhagic Stroke. The American Journal of Medical Sciences and Pharmaceutical Research, 2020. 2(10), 53-59
8. Khodjieva D. T., Khaydarova D. K., Khaydarov N. K. Complex evaluation of clinical and instrumental data for justification of optive treatment activites in patients with resistant forms of epilepsy. American Journal of Research. USA. № 11-12, 2018. С.186-193.
9. Khodjieva D. T., Khaydarova D. K. Clinical and neuroph clinical and neurophysiological ch ogical characteristics of teristics of post-insular cognitive disorders and issues of therapy optimization. Central Asian Journal of Pediatrics. Dec.2019. P 82-86
10. Sadriddin Sayfullaevich Pulatov. (2022). Efficacy of ipidacrine in the recovery period of ischaemic stroke. World Bulletin of Public Health, 7, 28-32.
11. Tukhtarov B.E., Comparative assessment of the biological value of average daily diets in professional athletes of Uzbekistan. Gig. Sanit., 2010, 2, 65–67.
12. Исмоилов, О., Камалова, М., Анваршед , Т., & Махмудова , С. (2021). Кратко об анатомо-физиологических особенностяхстопы и применение некоторых комплексных упражнений для устранения плоскостопия. Збірникнауковихпрацъ SCIENTIA. вилученоіз https: //oj s .ukrlogos. in.ua/index.php/scientia/article/view/9999
13. Ergashovich, K. B., & Ilhomovna, K. M. (2021). Morphological Features of Human and Rat Liver and Biliary Tract Comparisons (Literary Review). *International Journal of Discoveries and Innovations in Applied Sciences*, *1*(4), 27–29.
14. Камалова, М., Исмоилов, О., Азимова, А., Бекмуродова, Д., & Исматова, С. (2021). Варианты конституции тела человека. *Збірник наукових праць scientia*.
15. Маматкулов Б., Камалова М., Аширов М. Причины, механизмы повреждения, основные типы переломов пяточной кости //Збірник наукових праць SCIENTIA. – 2021.
16. Kamalova M., Khaidarov N., Shomurodov K. Microscopic examination of brain tissue in hemorrhagic stroke in uzbekistan //Матеріали конференцій МЦНД. – 2021.
17. Kamalova, M., Ismatova, S., Kayumova, S., Gulomova, S., & Akhmedova, J. (2021). Blood supply to the shoulder and forearm muscles in the human foetus. *Збірник наукових праць ΛΌГОΣ*.
18. Khaidarov Nodir Kadyrovich, Shomurodov Kahramon Erkinovich, &Kamalova Malika Ilhomovna. (2021). Microscopic Examination OfPostcapillary Cerebral Venues In Hemorrhagic Stroke. The American Journal of Medical Sciences and Pharmaceutical Research, 3(08), 69–73.