Frontiers in Health InformaticsISSN-Online: 2676-7104 www.healthinformaticsjournal.com
2024; Vol 13: Issue 3 Open Access

Pathomorphology of damaged areas of the brain in spastic diplegia

[1]Israilov Rajabbay, [2]Mamasaidov Jamolidin Turg'inbayevich, [3]Yo'ldoshev Yorqinjon Ismoiljon o'g'li, [4]Madaminov Faxriddin Ahmadovich

[1]Director of the Center of Scientific and Practical Pathological Anatomy of the Republic of Uzbekistan, docent, professor

[2] Head of department of Advanced medical training, Dsc, Associate Professor Fergana Institute of Public Health

ORCID: 0009-0006-2643- 495X

mamasaidov61@mail.ru

[3]Fergana Institute of Public Health, Assistant of Neurology department ORCID**: 0009-0003-2957-2408**

yorqinjon.doc@gmail.com

[4]Senior lecturer of the Department of Epidemiology and Infectious Diseases, Nursing, Ph.D

ORCID: 0009-0001-9521-6597

faxriddin.madaminov1988@gmail.com

Cite this paper as: Israilov Rajabbay, Mamasaidov Jamolidin Turg'inbayevich, Yo'ldoshev Yorqinjon Ismoiljon o'g'li, Madaminov Faxriddin Ahmadovich (2024) Pathomorphology of damaged areas of the brain in spastic diplegia. *Frontiers in Health Informatics, 13* (3), 5889-5895

Annotation. *The article illustrates that the changes that develop in the damaged areas of the brain in spastic diplegia of children's cerebral palsy were studied. As a material, brains were extracted from the corpses of 10 children with spastic diplegia form of cerebral palsy, who underwent autopsy in 2019-2022 at the department of pediatric pathology of the republican pathological anatomy center of the Ministry of Health of the Republic of Uzbekistan. According to the results of microscopic examinations, the main morphological changes were detected in the upper third of the frontal fold of the cerebral hemispheres, the cerebral hemispheres, the internal capsule of the intermediate brain, the pons, the anterior part of the reticular formation, the subcortical nuclei, often in the red nucleus.*

Key words: *Cerebral palsy in children, spastic form, brain, forehead piece, reticular formation, internal capsule, red nucleus.*

The urgency of the problem. A form of spastic diplegia (G80.1) is a common type of cerebral palsy, accounting for ¾ of spastic palsy and is Littla's disease. Bilateral muscle disorders are observed, often the function of the muscles of the legs, arms and face is impaired. In this form of DTsP, tetraparesis, dysarthria, retardation of language and mental status are observed. Sometimes the cranial nerves, including the optic nerve, atrophy, squint, speech and hearing disorders are observed. Spastic diplegia is characterized by contractures, deformation of the spine and bones (1, 2, 3). Children's mental and language development is lagging behind, pseudo bulbar syndrome, dysarthria is observed. In this syndrome, both hemispheres of the brain are damaged at the same time, and in most cases, the pyramid and extrapyramidal system are damaged. In its pathogenesis, cerebral hypertension develops, blood circulation in the collateral vessels on the surface of the hemispheres is disrupted, leading to stronger changes, the motor area of the cortex and parasympathetic areas are damaged (4, 5, 6)).

Spastic diplegia, or Little's disease, can be diagnosed by the following symptoms, including: inability to hold the head up, inability to see sharp colors, inability to sit up independently, inability to crawl, inability to stand upright, inability to move one or both arms. As a pathogenesis of spastic diplegia, damage to the egates adjacent to the center of the cerebral cortex, that is, dysfunction of the pyramidal pathway, which provides movement. Pathomorphologically, the above-mentioned areas of the brain are damaged in the ischemic-hypoxic mechanism due to the immaturity of the brain tissue in children born prematurely. The main pathogenetic factor is hypoxia of the fetus in the womb and during delivery. In rare cases, spastic diplegia develops as a result of brain injury during childbirth.

Materials and methods. Brains were extracted from the corpses of 10 children with spastic diplegia of BTsF, who were autopsied in 2019-2022 in the department of pediatric pathology of the Republican Pathological Anatomy Center of the Ministry of Health of the Republic of Uzbekistan. Firstly, the anatomical indicators of the brain were studied, that is, the position of the hemispheres, their symmetry, the surface of the hemispheres, the anatomical position of the egates, their correspondence on both sides, the intermediate parts of the brain, the position of the ventricles, the anatomotopographical structure of the cerebellum and the medulla oblongata. The brain was cut by Flexing method, 1.5x1.5 cm pieces were cut from each hemisphere, from the midbrain. Sections were fixed in 10% phosphate-buffered formalin for 72 hours, then washed in running water for 4 hours. Slices were dehydrated in increasing concentrations of alcohols and chloroform, and sections were embedded in paraffin wax and embedded. Histological sections with a thickness of 5-7 μm were obtained from paraffin blocks, deparaffinized in a thermostat, and stained with hematoxylin and eosin for gross morphology. In order to determine the amount and location of collagen fibers in the cerebral blood vessel wall, picrofuchsin was stained by van Gieson method. Blood vessels were stained with Altian blue to assess the amount of acidic glycosaminoglycans accumulated in and around the vessel wall. Histological and histochemical preparations were studied under 10, 20, 40 lenses of a light microscope, and microphotographs were downloaded from the necessary places to the computer.

Research results and their discussion. Маълумки, Cerebral palsy in children in the form of spastic diplegia, it is observed that the upper third of the frontal lobe of the cerebral hemispheres is underdeveloped, the cerebral hemispheres are small, the internal capsule of the intermediate brain, the pons, the anterior part of the reticular formation, the subcortical nuclei, and often the red nucleus are damaged. When the brain is examined macroscopically, it is revealed that the large hemispheres are adjacent to the central brain, microgria, secondary and tertiary brains are underdeveloped, and the size of the cerebrum is small. In total, 6 of the 10 cases we studied showed microgria, 3 had a small size of one hemisphere, 4 had a small size of the cerebellar hemispheres, and 2 had a small size of the occipital lobe of the hemispheres.

A macroscopic examination of the area characteristic of spastic diplegia, that is, the upper third of the precentral folds of the cerebral cortex, revealed that, it was observed that this area is bordered by the central edge of the frontal lobe of the brain from the front, the central edge from the back, the transverse fissure from the medial side, and the lateral edge from the lateral side. In spastic diplegia, the precentral folds are markedly lower and smaller than the central folds, especially the upper third of which is flattened. It is found that the atrophy of the precentral fold leads to the flattening of the surrounding central and precentral egates. Microscopic examination of brain tissue sections obtained from this area revealed the following information. It is known that, histologically, a large part of the precentral gyrus is Brodmann's area 4, and the remaining small part is the premotor cortex, which is Brodmann's area 6. Microscopically, this fold area is wide compared to other areas of the bark, reaching up to 4.5 mm. Row V neurons consist of giant cells called Bets, row IV neurons receive

afferent information from the thalamus, and this area is poorly developed. In this frontal lobe of the brain, the axons of neurons of the precentral gyrus area 4 form the motor pyramidal pathway. Neurons of this area innervate the swallow and the sphincter. And ascending axons innervate the face, hands, body, legs. The motoneuron axons of area 4 control the movement of skeletal muscles by passing to the opposite side of the body in the lower part of the diencephalon (7, 8, 9). In the form of spastic diplegia of BTsF, microscopic examination of the 4th area of the precentral gyrus of the frontal lobe of the brain revealed that the Bets giant neurons in it were destroyed, deformed, and their rows were broken to varying degrees, and some neurons penetrated into the adjacent area. These giant neurons are different in shape and size, some are elongated and have branched growths, while others are atrophied and reduced in size (Fig. 1). It is determined that the nuclei of relatively large and oval-shaped neurocytes are hypertrophied, and large concentrations of heterochromatin have appeared in their karyoplasm. In order to determine the amount and location of the giant cells called Bets, Nissl staining revealed that the axon and dendrite fibers were destroyed, and the thygroid substance was sharply reduced. It is observed that the number of glial cells between the neurons is sharply reduced, the preserved ones are also destroyed, and their nuclei are karyopyknosis. It is found that the interstitial substance of the brain tissue is thickened due to edema and encephalomalacia, and vacuoles have appeared. The motoneurons in the 4th area are also almost complete, all the cells have different appearance due to dystrophy, necrobiosis and destruction, most of them are atrophied and not swollen, the nucleus is concentrated, heterochromatin has become hyperchromic, and a strong pericellular tumor has developed around it. It is found that the tissue structures of the wall of blood vessels located in this area are completely destroyed, the cavity is narrowed, and perivascular edema has developed around it.

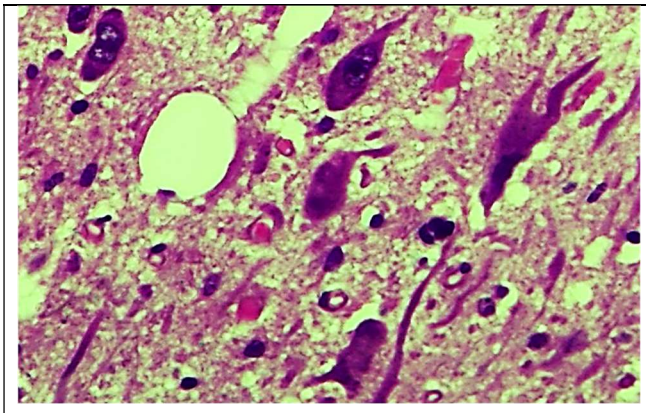

Figure 1. Destruction and deformation of Betz giant neurons, precentral gyrus, area 4. Paint: G-E. Size: 10x100.

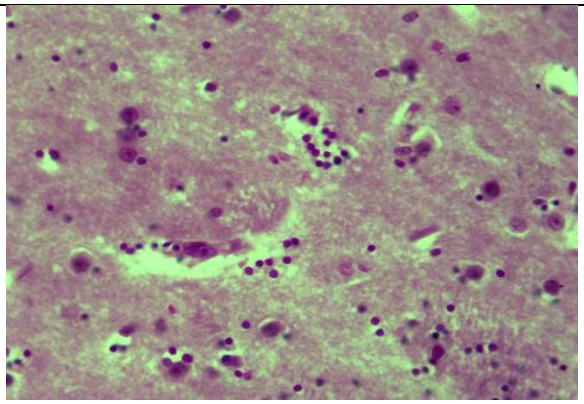

Figure 2. In the precentral fold, area 6, the neurons are atrophied, the nuclei are hypochromic, and a focus of gliosis has appeared around the destroyed neurons. Paint: G-E. Size: 10x40

In the 6th area of the frontal lobe of the brain, neurons are sharply reduced, their sizes are reduced, they have become small round, the cytoplasm area has almost disappeared, the heterochromatin in the nucleus is reduced, the karyoplasm is pale and hypochromic. Another peculiarity of this field is that glial cells proliferate and accumulate around blood vessels and destroyed neurons, creating a gliosis center (Fig. 2). It is found that the interstitium of the brain tissue is encephalomalacia and edema around the blood vessels, while in other areas it is relatively preserved its substance and structure.

Another area of the brain that is damaged in spastic diplegia is the internal capsule in the diencephalon. It is a thick curved plate of white matter, bordered laterally by the chechevitseiform nucleus, medially by the head of the caudate nucleus, and posteriorly by the thalamus. The internal capsule consists of axons and dendrites of neurons that connect with other structures of the brain. The thalamocortical pathway to the postcentral gyrus of the cerebral cortex passes through the posterior pedicles of the internal capsule, and it transmits information from pain, fever, and deep tactile sensations. Corticospinal and corticonuclear motor pathways pass through the internal capsule joint. They go to the cranial nerves and the motoneurons of the spinal cord.

Microscopic examination of the internal capsule of the intermediate brain in spastic diplegia revealed that this area is mainly composed of axon and dendrite fibers, nerve fibers are torn, most of them are fragmented, sparsely located, vacuoles and pale eosinophilic substance appear between the fibers (Fig. 3). Glial cells between nerve fibers are also dystrophied and destroyed, their nuclei are karyopyknosis. Stasis of erythrocytes is observed in small blood vessels.

It is determined that the articular part of the internal capsule of the midbrain consists of bundles of axon and dendrite nerve fibers with thin conduction paths. These nerve fibers are sparsely located, most of them are destroyed and fragmented, it is observed that a collection of glial cells has appeared between the fibers (Fig. 4). It is determined that the gliosis center consisting of glial cells thins and destroys nerve fibers. Fibrinoid thickening and fibroelastosis processes have developed in the vascular wall of the internal capsule, and coarse and dark eosinophilic coarse protein has appeared in its cavity. It is observed that the interstitium is swollen and inflamed.

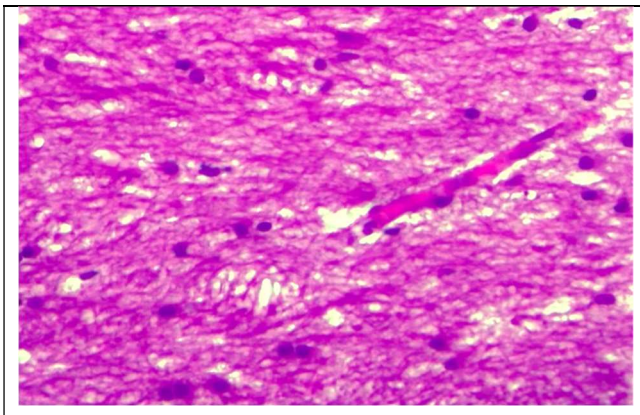

Figure 3. The internal capsule of the mesencephalon, axon and dendrite fibers were destroyed, swelling and vacuolization appeared between them. Paint: G-E. Size: 10x40.

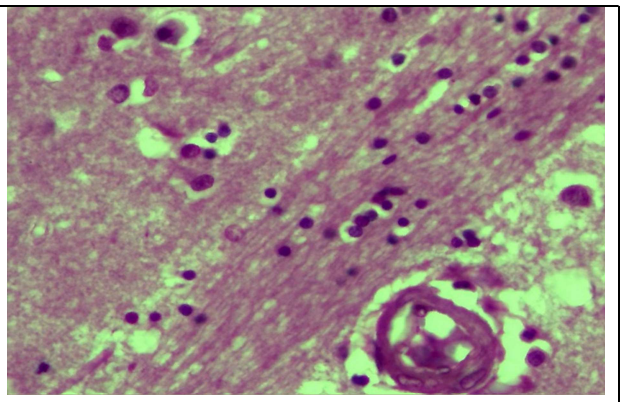

Figure 4. The articular part of the internal capsule, the nerve fibers are shriveled, destroyed and subjected to gliosis. Paint: G-E. Size: 10x40.

Another area of the brain damaged in spastic diplegia is the reticular formation in the brainstem. **Reticular formation** (lat. reticulum - net, formatio - structure) is a structure located along the brain stem. As the name suggests, it consists of nerve cells that are intricately connected to each other in a mesh structure. It consists of a large network of reticular nuclei and neurons arising from axon and dendrite branches, activates the brain, controls reflex activity of the spinal cord, and receives information from the thalamus nuclei. The nucleus of the reticular formation secretes special neurotransmitters and activates the cerebral cortex. Some neurons

synthesize noradrenaline, others acetylcholine. Another nucleus synthesizes serotonin, which induces sleep. Therefore, the reticular formation assesses the importance of all the signals going to the brain and transfers the most important signals to the cortex. In spastic diplegia, the following functions related to damage to the reticular formation are disturbed: human behavior, physical activity, collecting and writing reflexes, endocrine control of internal organs, emotional arousal, learning process, memory process, sleep control. In the reticular formation, the lateral, paramedial reticular nucleus, pontine reticular nucleus, giant cell nucleus, small cell nucleus, cerebellar nucleus, trigeminal nerve nucleus, inferior and medial vestibular nucleus, lateral nucleus, commissural nucleus, Edinger-Westphal nucleus, vagus nerve nucleus, the thalamus nucleus, the salivary nucleus, the nuclei that control breathing and blood vessels are located. Of these, damage to the respiratory and vasomotor centers leads to rapid death. Damage to the nuclei of the reticular formation leads to comprehensive complex syndromes. Cataplexy - complete paralysis due to emotional influences. Sometimes there is half-anxiety and unexpected movements develop. Lethargic syndrome is an intermittent sleep syndrome, sometimes sleeping for several days. Damage to the intermediate nucleus causes irregular eye movements. Damage to the nucleus accumbens causes severe laughter and crying due to a lack of serotonin. Damage to the nucleus of the giant cell leads to impaired control of behavior and an emotional and anxious state. Bluish core damage causes disruption of sleep phases. So damage to the nuclei in the reticular formation causes changes specific to each of them.

In spastic diplegia, the nucleus of the giant cell of the reticular formation was studied microscopically, and it was found that the giant neurons in the nucleus violated their histotopography, the size and shape of the neurons became different, and the axon and dendrite growths were destroyed and lysed. Cytoplasm is almost absent in one of the giant neurons, while in the other, it is darkly stained and branched in different ways. The nuclei of these neurons are large, round in shape, the karyoplasm is strongly swollen, there is almost no heterochromatin, the nucleus is smaller, light in color, the outer karyolemma is thinned and tense (Fig. 5). Histologically, dark stained giant neurons are densely located, most of them are elongated, the cytoplasm is dark eosinophilic, the nucleus is deformed, the heterochromatin is not expanded, and it enters the state of karyopyknosis, which confirms the destruction and death of the neuron.

Microscopic examination of the nucleus of small neurons of the reticular formation revealed the following information. It is observed that the neurons in the nucleus are relatively small, chaotically located, most of them have undergone dystrophy and necrobiosis. The cytoplasm of relatively little changed and preserved neurons is dystrophied, vacuolated in some, dark eosinophilic in others, the nucleus is vacuolated and pale in some, karyopyknosis, not swollen and reduced in size in others (Fig. 6). In destroyed neurons, the nucleus and cytoplasm are not distinguished, the cell is whole because it is destroyed and does not swell.

In spastic diplegia, microscopic examination of the blue nucleus of the reticular formation revealed that neurons were sparsely and irregularly located compared to other nuclei. Pericellular swelling of all neurons was considered as specific morphological changes in this nucleus. Dispersed pericellular edema and destruction and non-swelling of neurons were confirmed as morphological changes characteristic of the damage of this nucleus. It was found that the cytoplasm and nucleus of the swollen neurons are not swollen, the borders of the nucleus are unclear, the cytoplasm is dark eosinophilic, and the nucleus is hematosinophilic. The fact that the destroyed neurons are located in one area of the nucleus confirms the focal damage. The destruction of these neurons was manifested by the deformation of the cell, vacuolization and disintegration of the cytoplasm, karyopyknosis and karyolysis of the nucleus.

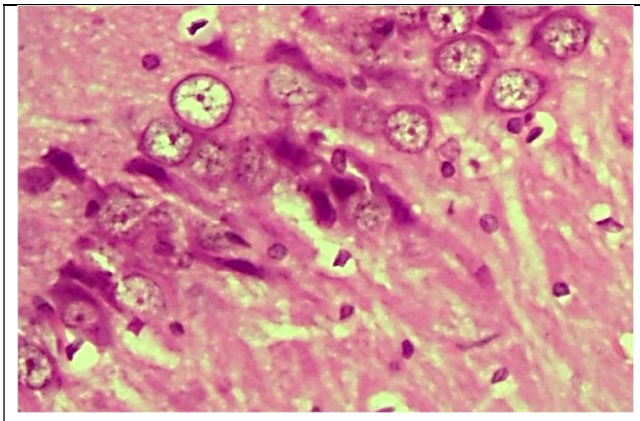

Figure 5. Giant cell nucleus of the reticular formation, destruction of neurons in a chaotic state and necrobiosis. Paint: G-E. Size: 10x40.

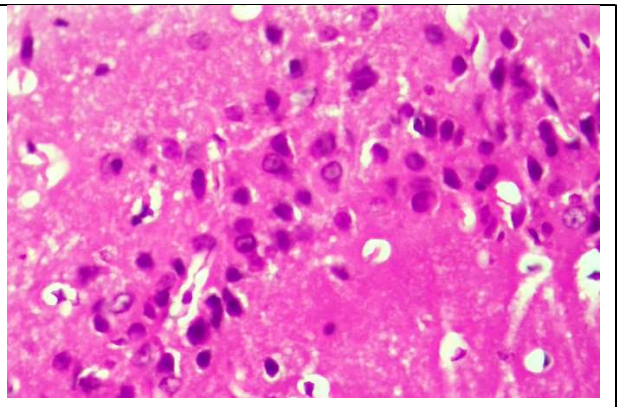

Figure 6. The nucleus of small cells of the reticular formation, neurons are destroyed and necrobiosis to varying degrees. Paint: G-E. Size: 10x40.

Morphological study of the red nucleus, one of the damaged areas of the brain in spastic diplegia, gave the following data. The red nucleus located in the midbrain controls the coordination of movements. It consists of caudal macrocellular and rostral parvocellular parts. The red nucleus is located in the midbrain near the substantia nigra. These two structures are the extrapyramidal motor system of the subcortical centers. The red nucleus controls arm and leg movements in coordination with the motor nucleus of the spinal cord. Microscopic examination of the macrocellular part of the red nucleus of the intermediate brain in spastic diplegia revealed that the number of neurons, deformation of neurons, reduction of chromotaphilic substance in the cytoplasm, reduction of the nucleus, destruction of axon and dendrite growths are the changes characteristic of this area. In the microcellular part of the red nucleus, there is a decrease in the number of neurons due to destruction, complete necrobiosis and necrosis of neurons (Fig. 8), separation of neurons into small fragments due to necrobiosis, a sharp decrease in heterochromatin in the nucleus, vacuolization in the karyoplasm, destruction and loss of glial cells between neurons.

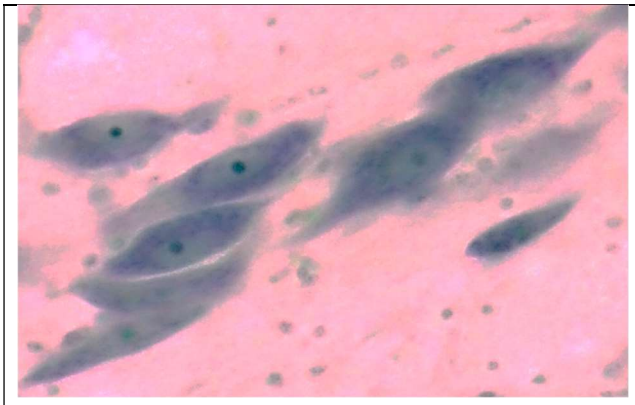

Figure 7. The red nucleus of the middle brain, the macrocellular part, the number of neurons and the amount of chromatophilic substance in them are reduced. Paint: Nissl, Size: 10x40.

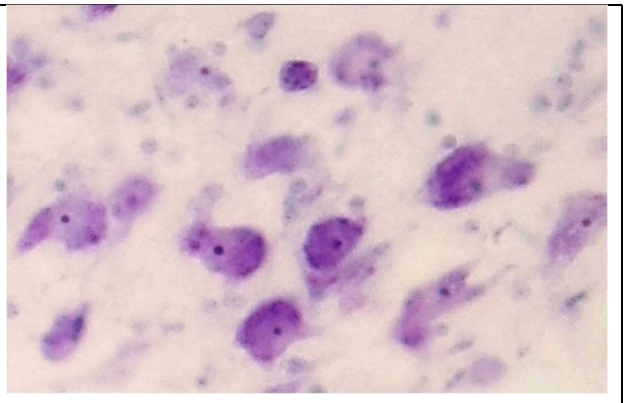

Figure 8. The microcellular part of the red nucleus of the midbrain, neurons are chaotically located, most of them have been destroyed. Paint: Nissl. Size: 10x40.

Conclusions.

Changes characteristic of spastic diplegia are observed in the upper third of the precentral fold of the cerebral hemispheres, the frontal lobe, the cerebral hemispheres, the internal capsule of the intermediate brain, the pons, the anterior part of the reticular formation, the subcortical nuclei, often in the red nucleus.

It was found that the frontal lobe of the cerebral hemispheres is atrophied, flattened and sunken, microscopically, Bets neurons in the 4th area were destroyed and died, sparsely located, and glial cells also underwent necrobiosis and necrosis.

In the inner capsule of the midbrain, the axon and dendrite nerve fibers are shortened, most of them are fragmented, they are sparsely located, vacuoles and light eosinophilic substance have appeared between the fibers, the axon and dendrite nerve fibers are sparsely located in the joint part, most of them are destroyed and fragmented, a collection of glial cells has appeared between the fibers observed.

The changes typical of spastic diplegia include the development of reticular formation in the giant cell nucleus, small cell nucleus, and cyanotic nucleus, the majority of giant neurons have undergone necrobiosis, small neurons have died and are sparsely located, scattered pericellular swelling in the cyanotic nucleus neurons, and destruction and non-swelling of neurons were observed.

In spastic diplegia, there is a decrease in the number of neurons in the macrocellular part of the red nucleus of the intermediate brain, deformation, a decrease in the chromotaphilic substance in its cytoplasm, destruction of axon and dendrite growths, complete necrobiosis and necrosis of neurons in the microcellular part, and separation into small fragments.

References

1. 1. Brodal A., Reticular formation of the brain stem, translation from English, M., 1960;
2. 2. Kolomiytsev A.K. Aging of the body as a property of the structural organization of biosystems. M., 2012, 138 p.
3. Magun G., The Waking Brain, trans. from English, 2nd ed., M., 1965;
4. Rossi J.F., Zanchetti A., Reticular formation of the brainstem, trans. from English, M., 1960;
5. Frolkis V.V. Aging and increasing life expectancy. L., Nauka, 1988, 239 p.
6. Baskerville KA, Kent C, Nicolle MM, Gallaher M, McKinney. Aging causes partial loss of basal forebrain but no loss of pontine reticular cholinergic neurons. Neuroreport 2006 Nov 27;(17): 1819-23.
7. *Nelson K.B., Blair E.* Prenatal Factors in Singletons with Cerebral Palsy Born at or near Term (англ.) // The New England Journal of Medicine : journal. — 2015. — 3 September (vol. 373, no. 10). — P. 946—953.
8. *McIntyre, S; Taitz, D; Keogh, J; Goldsmith, S; Badawi, N; Blair, E.* A systematic review of risk factors for cerebral palsy in children born at term in developed countries (англ.) // Developmental Medicine and Child Neurology (англ.)рус. : journal. — 2013. — P. 499—508
9. *Lungu, Codrin; Hirtz, Deborah; Damiano, Diane; Gross, Paul; Mink, Jonathan W.* Report of a workshop on research gaps in the treatment of cerebral palsy (англ.) // Neurology (англ.)рус. : journal. — Wolters Kluwer (англ.)рус., 2016. — 20 September (vol. 87, no. 12). — P. 1293—1298.