

ISCHEMIC STROKE MODEL: MIDDLE CEREBRAL ARTERY OCCLUSION IN RATS

Palvanova M.S.

Fergana Medical Institute of Public Health

Abstract: Ischemic stroke is one of the leading causes of death and disability worldwide. Experimental models are widely used to study the mechanisms of its development and to find effective treatment methods. One of the most popular and well-established models is middle cerebral artery occlusion (MCAO) in rats. MCAO in rats allows one to reproduce the key pathophysiological changes that occur during ischemic stroke in humans. During this procedure, blood flow in the middle cerebral artery is blocked, which leads to ischemia of brain tissue and causes a cascade of pathological reactions similar to those observed in patients with stroke[1,2,3].

Keywords: ischemic stroke, middle cerebral artery occlusion, neuroprotection, neuroplasticity.

INTRODUCTION.

Ischemic stroke is one of the most significant medical problems of modern society, remaining the leading cause of disability and mortality worldwide. This condition is characterized by a sudden disruption of blood supply to a certain area of the brain, which leads to a deficiency of oxygen and nutrients necessary for the normal functioning of nerve cells[4,5,6]. As a result, irreversible damage to the nervous tissue occurs in the ischemic zone, accompanied by severe neurological symptoms. Adequate experimental models are needed to effectively study the pathophysiological processes underlying ischemic stroke, as well as to develop and test new treatments. One of such models, widely used in neurobiological research, is middle cerebral artery occlusion (MCAO) in rats [7,8].

Objective: The aim of this study is to study the pathophysiological mechanisms of ischemic stroke using the Longo and Koizumi in vivo models. These models allow a detailed study of the dynamics of ischemic brain injury development, assessment of the effectiveness of various therapeutic interventions, and identification of key molecular and cellular processes involved in the development and progression of ischemic stroke.

MATERIALS AND METHODS

Laboratory rats (Wistar), males, 8-10 weeks old, weighing 250-300g. Equipment: stereotaxic apparatus for operations, surgical microscope, dyes for histological studies (tripendium, TTC). Rats are subjected to general anesthesia using isoflurane. A skin incision is made in the neck area to access the common carotid artery.

- Longo model: A nylon thread is inserted through the common carotid artery, advanced to the middle cerebral artery through the internal carotid artery and occluded for a specified time (usually 60-90 minutes).

- Koizumi model: Photochemical injury of the middle cerebral artery is performed using a laser and a photosensitizer.

Monitoring and support of animals. During the entire period of occlusion and subsequent reperfusion period, physiological parameters (body temperature, heart rate, respiration) are monitored[10,11,12]. Animals are maintained hydrated with saline. Assessment of ischemic injury. After completion of the occlusion and reperfusion period (24 hours), the animals are euthanized and their brains are removed. Brain tissue is stained with triphenyl tetrazolium chloride (TTC) to identify infarct areas. Brain sections are analyzed using a microscope and software to quantify infarct volume [13,14,15].

RESULTS AND DISCUSSION

Middle cerebral artery occlusion can be achieved by two methods. In the first method, the internal carotid artery is permanently ligated, while in the second method, the common carotid artery is temporarily clamped. [16].

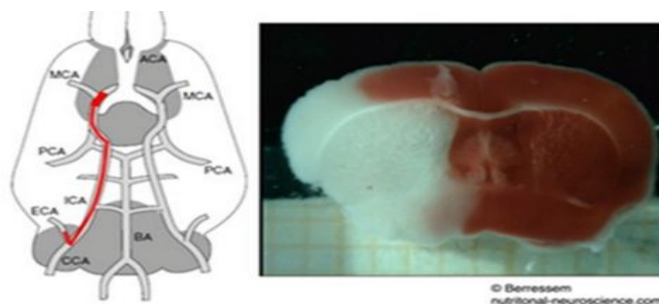


Fig. 1. Middle cerebral artery occlusion

The procedure involves perforating the common carotid artery to occlude the middle cerebral artery. There are two standard methods used for this:

1. Longo's method: Permanent clamping of the internal carotid artery. This method often results in the death of a significant proportion of laboratory animals before obtaining experimental data, which affects the results of the studies[17,18,19].
2. Koizumi's method: Temporary occlusion of the common carotid artery. This method allows for obtaining more significant and reliable experimental data due to improved blood flow control and reduced animal mortality.

In our work, we have partially modified the Koizumi method. In our proposed occlusion method, a silicone tip is inserted into the internal carotid artery canal through a perforation of the common carotid artery on its ventral wall. This allows for temporary occlusion of the common carotid artery without the use of a ligature[20].

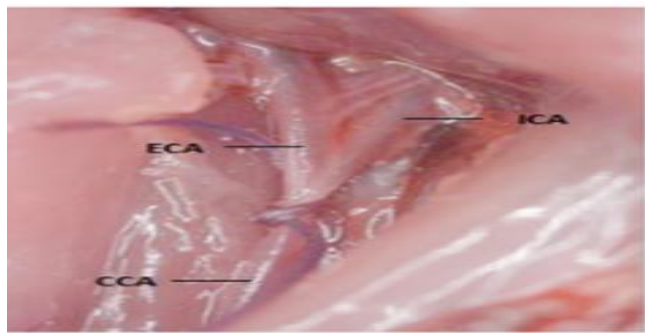


Fig. 2. Surgical area

After After removal of the occlusive device, the artery is punctured with a thin insulin needle and covered with a drop of tissue glue to prevent bleeding. After five minutes, the integrity of the artery is visually confirmed. This modification of the Koizumi method allows the common carotid artery to be occluded without ligation, which reduces the variability of experimental data and helps restore normal blood flow[21].

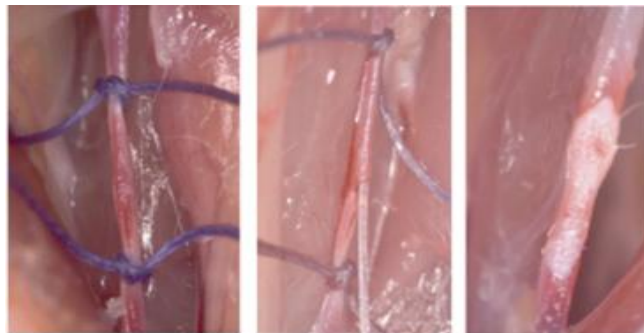


Fig. 3. Common carotid artery covered with tissue glue

In our studies, the middle cerebral artery was also occluded with a thread for 24 hours, which led to the development of ischemic stroke. The procedure involved anesthetizing the rat with isoflurane. The operation was performed by introducing a thread through the external carotid artery into the middle cerebral artery. The rats were observed for 24 hours, after which their brains were removed and stained with a solution of triphenyltetrazolium chloride (TTC) for 30 minutes. As a result, the ischemic brain area was stained white, and healthy cells were stained red.

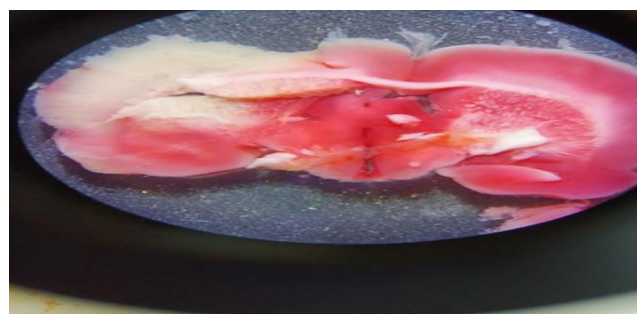


Fig. 4. Brain staining results

CONCLUSION

1. We modified the Koizumi method, which allowed us to successfully occlude the common carotid artery without the need for ligation. This modification reduces the variability of experimental data by maintaining normal blood flow in the common carotid artery in laboratory animals.
2. We simplified the Koizumi and Longo methods by temporarily occluding the common carotid artery on one side, reducing the amount of brain damage associated with stroke. Unlike both of these methods, our approach is aimed at occluding only one side of the common carotid artery, which allows us to preserve the blood supply to brain cells through the other side of the artery, thereby minimizing damage.
3. Unlike the Koizumi and Longo methods, we used tetrazolium bromide instead of triphenyl tetrazolium chloride solution. Tetrazolium bromide is a more economical and convenient substance to use, requiring less time to obtain results.

REFERENCES

1. Bakulin D. A. OCCLUSION OF THE MIDDLE CEREBRAL ARTERY IN WISTAR RATS WITH EXPERIMENTAL DIABETES: CHOICE OF OPTIMAL DURATION OF ISCHEMIA // International Journal of Applied and Fundamental Research. - 2016. - No. 11-6. - P. 1040-1043.
2. Bon' E. I., Maksimovich N. E. Modeling methods and morphofunctional markers of cerebral ischemia // Biomedicine. - 2018. - No. 2. - P. 59-71.
3. Korzhevsky D. E. et al. Modeling unilateral ischemic damage to striatal neurons using short-term occlusion of the middle cerebral artery // Bulletin of Experimental Biology and Medicine. - 2009. - Vol. 147. - No. 2. - P. 217-219.
4. Sysoev Yu. I. et al. Changes in somatosensory evoked potentials in rats that underwent reversible cerebral ischemia // Acta Biomedica Scientifica. - 2022. - Vol. 7. - No. 4. - P. 190-200.
5. Shcherbak N. S., Galagudza M. M. Experimental models of ischemic stroke // Bulletin of the Federal Center of Heart, Blood and Endocrinology named after V. A. Almazov. – 2011. – No. 3. – pp. 39-46.
6. Dzhurabaev A. A. The role of endoscopic examinations in early diagnosis diseases of the esophagus, stomach, and duodenum //Innovations in technology and science education. – C. 264-269.
7. Мадаминов С. М., Джурабаев А. А. Влияние Микробиоты Толстого Кишечника На Развитие Язвенного Колита //Miasto Przyszłości. – 2024. – Т. 49. – С. 811-813.
8. Tishabaeva Nargiza Alimdjanovna. (2021). Torch-Infections As An Actual Problem In Obstetrics And Gynecology Practice. The American Journal of Medical Sciences and Pharmaceutical Research, 3(05), 27–33. <https://doi.org/10.37547/TAJMSPR/Volume03Issue05-05>

9. Palvanova M.S. Morphological changes in the bone tissue of the child's body in the age aspect. World Bulletin of Public Health, 94-96, 2023
10. Р.Т.Юсупова, О.Е. Шаланкова Репродуктивное здоровье девочек-подростков, проживающих в условиях Ферганской долины. Университетская наука: взгляд в будущее, 612-614, 2020
11. Palvanova M.S., Akhmatov B.K. Chronic myeloid leukemia epidemiology in the Fergana region over decade from 2010 until 2020. Science and innovation, Volume1, issue 8, pp. 1020-1025
12. Jaloliddinov Sh.I. "Treatment and prevention of caries disease in children". Ethiopian international journal of multidisciplinary research. volume 10, issue 12 . sjif 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980
13. Jaloliddinov Sherzodbek Ikromjon O'g'li. exploring non-surgical options for managing ventral hernia: a comprehensive guide to conservative approaches "Innovative achievements in science 2024". part 28 Issue 1 pp.113-118
14. Tilyaxodjayeva Gulbahor Botirovna. (2023). THE IMPORTANCE OF HYRUDOTHERAPY IN THE TREATMENT OF MIGRAINE. World Bulletin of Public Health, 29, 21-23.
15. Tilyaxodjayeva Gulbahor Botirovna. ЛЕЧЕНИЕ МИГРЕНИ ГИРУДОТЕРАПИЕЙ. Scientific Impulse Vol. 1 No. 5 (2022) 892-896.
16. N.A. Tishabaeva, Sh.D. Babajanova. Early and late preeclampsia - risk, factors of pregnancy and childbirth, Journal of clinical and preventive medicine 2023.-Т.4.-№4.-S-78-81
17. Isaqova N. et al. Microscopic examination of sputum //development and innovations in science. – 2024. – Т. 3. – №. 6. – С. 63-66.
18. Исакова Н., Усмонова Г. Лабораторная диагностика трихомониза //международная конференция академических наук. – 2024. – т. 3. – №. 6. – с. 59-65.
19. Исакова Н., Усмонова Г. Кишечный дисбактериоз //Models and methods in modern science. – 2024. – Т. 3. – №. 9. – С. 106-112.
20. Raxmatjonovna I. N. et al. Laboratory diagnostics of trichomoniasis disease //Ethiopian International Journal of Multidisciplinary Research. – 2024. – Т. 11. – №. 05. – С. 496-499.
21. Yuldasheva Moxigul Turdaliyevna, Boratova Mohidilxon Abdumajiq qizi. MORPHOFUNCTIONAL CHANGES OF CERVICAL SQUAMOUS EPITHELIUM AFTER CHEMOTHERAPY AND LIGHT THERAPY. International Multidisciplinary Journal for Research & Development 10 Vol. 10 No. 12 (2023).