ANNOTATION

of the dissertation by Yerbol Kairatbekovich Dogalbayev on the topic: "Surgical strategy for the treatment of cerebrovascular disorders associated with bilateral dolichoarteriopathy of the internal carotid artery", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D10102 – Medicine.

Relevance of the Issue

According to official statistics from the Ministry of Health of the Republic of Kazakhstan, the incidence of stroke in various regions of the country ranges from 159 to 330 cases per 100,000 population per year, while the mortality rate reaches 61 cases per 100,000 population annually (Akhmetzhanova ZB, Medukhanova SG, Zhumabayeva GK, et al. Neyrokhir Nevrol Kazakhst. 2019). These are among the highest rates globally.

According to the World Health Organization, stroke remains the second leading cause of death worldwide (Feigin VL, Brainin M, Norrving B, et al. Int J Stroke. 2022).

Acute cerebrovascular accidents (stroke) continue to pose one of the most pressing challenges for public healthcare in Kazakhstan due to their high incidence and the significant rate of patient disability. Efforts aimed at the prevention and management of stroke are therefore considered one of the key strategic directions of the country's social and healthcare policy.

Pathology of the extracranial arteries plays a key role among conditions leading to cerebral circulation disorders, underscoring its importance in the overall structure of vascular diseases (Bentsen L, Nygård A, Ovesen C, et al. Cerebrovasc Dis Extra. 2014). The effectiveness of surgical treatment in patients with this pathology confirms its clinical significance in preventing severe outcomes such as disability and mortality, which highlights the relevance of this direction in modern medical practice (Gavrilenko AV, Kochetkov VA, Abramyan AV, et al. Klin Eksper Khir. 2020). The epidemiology of internal carotid artery (ICA) dolichoarteriopathy in the general population remains imprecise due to the asymptomatic nature of many cases that go undetected. According to various authors, the prevalence of ICA tortuosity in the general population ranges from 10% to 31% (Balevi M. Int J Head Neck Surg. 2020). Notably, in 30.5% of cases, ICA dolichoarteriopathy is bilateral and can be observed both in children and adults (Foiadelli T, Ippolito R, Corbetta R, et al. Childs Nerv Syst. 2020). While in children the etiology is predominantly congenital, in adults it remains poorly understood (Di Pino L, Franchina AG, Costa S, et al. Int J Cardiovasc Imaging. 2021). The association between carotid artery tortuosity and cerebral blood flow insufficiency was first identified by Riser in 1951, marking the beginning of investigations into the pathophysiological mechanisms and therapeutic approaches for this condition (Vannix RS, Joergenson EJ, Carter R. Am J Surg. 1977). The earliest reconstructive surgical interventions for ICA tortuosity, performed by Hsu and Kistin in 1956, were unsuccessful (Hsu I, Kistin AD. Arch Intern Med. 1956). However, in 1959, Quattlebaum, Upson, and Neville reported successful resection of a segment of the common carotid artery (CCA) with an end-to-end anastomosis and ligation of the external carotid artery (ECA), representing a significant milestone in the evolution of

surgical treatment for this pathology (Quattlebaum JK Jr, Upson ET, Neville RL. Ann Surg. 1959).

Reconstructive procedures for ICA dolichoarteriopathy are performed using various techniques, taking into account factors such as the presence or absence of concomitant atherosclerotic stenosis, the type of tortuosity, and the patient's age. However, long-term outcomes of reconstruction largely depend on the specific surgical methods employed (Borshchev GG, Batrashov VA, Zemlyanov AV, et al. Vestn Nats Med Khir Tsentr Im NI Pirogova. 2022).

Despite the long-standing study of ICA dolichoarteriopathy and its high prevalence, the issue of selecting the most effective surgical methods and determining the appropriate staging of treatment for bilateral ICA dolichoarteriopathy remains unresolved in our country.

Research Objective: to evaluate the outcomes of surgical treatment in patients with bilateral dolichoarteriopathy of the ICA.

Research Tasks:

1. To develop a treatment strategy for patients with bilateral dolichoarteriopathy of the ICA based on the principle of staged surgical interventions.
2. To perform a comparative analysis of hemodynamic parameters in patients with bilateral dolichoarteriopathy of the ICA between the main group (surgical treatment) and the control group (medical therapy).
3. To study the dynamics of neurological symptoms in patients treated surgically and those treated with medication.
4. To develop a surgical method for treating dolichoarteriopathy of the ICA and assess its effectiveness.

Study Subjects:

The study included data from two groups of patients:

- Group 1 (main group): Patients with bilateral dolichoarteriopathy of the extracranial portion of the ICA and symptoms of CVI, who underwent staged surgical treatment. Number of patients: 40.
- Group 2 (control group): 28 patients with bilateral dolichoarteriopathy of the extracranial ICA and CVI symptoms who received conservative medical therapy.

The research methods included:

Clinical observation, assessment of neurological deficits, the use of a specialized questionnaire to evaluate the dynamics of neurological symptoms, duplex ultrasound scanning of the brachiocephalic arteries, multislice computed tomography with contrast enhancement of the extra- and intracranial arteries, magnetic resonance imaging of the brain, and statistical analysis of the obtained results.

Scientific Novelty:

- Within the framework of this study, a novel surgical technique for the treatment of dolichoarteriopathy of the extracranial segment of the ICA was developed and implemented.
- A staged surgical treatment protocol for bilateral dolichoarteriopathy of the extracranial ICA was also developed and successfully introduced into clinical practice.
- The clinical efficacy and safety of the proposed stages of surgical treatment for bilateral ICA dolichoarteriopathy were substantiated.

Practical Significance:

1. Practical implementation of an original surgical technique for the treatment of dolichoarteriopathy of the extracranial segment of the ICA, aimed at preventing cerebral circulation disorders and alleviating symptoms of CVI.
2. Justification and application of a staged surgical treatment strategy for bilateral dolichoarteriopathy of the extracranial ICA, providing effective prevention of ischemic-type stroke and improving patients' quality of life.
3. Improvement of outcomes of staged surgical treatment for bilateral dolichoarteriopathy of the extracranial ICA through the reduction of neurological symptoms.

Key Points for Defense:

- A novel original surgical technique for the treatment of dolichoarteriopathy of the extracranial segment of the ICA provides effective prevention of cerebral circulation disorders and reliably alleviates symptoms of CVI.
- The rationale for a staged surgical approach to the treatment of bilateral dolichoarteriopathy of the extracranial ICA has been established, proving its clinical effectiveness and safety.
- Analysis of the results of staged surgical treatment demonstrated significant improvement in hemodynamic parameters and effective resolution of CVI symptoms in the main group compared to the control group.

Recommendations Based on the Results of the Research:

1. Patients suspected of having dolichoarteriopathy of the ICA are recommended to undergo comprehensive diagnostic evaluation, including duplex ultrasonography (DUS) and contrast-enhanced multislice computed tomography (MSCT). Special attention should be given to assessing hemodynamic parameters, such as linear blood flow velocity (LBFV) and flow turbulence.
2. The decision to perform surgical treatment should be based on the presence of clinically significant symptoms of CVI. Surgical intervention is justified in cases of insufficient response to medical therapy and a high risk of ischemic complications.
3. In cases of bilateral ICA dolichoarteriopathy, staged reconstructive treatment is recommended. The priority of surgical intervention should be determined based on the severity of symptoms and the extent of hemodynamic impairment. The interval between operations on the first and second sides should be at least 4 weeks to allow the brain to adapt to altered hemodynamic conditions and to ensure complete healing of the postoperative wound.
4. The choice of surgical technique for ICA dolichoarteriopathy should be based on a thorough preoperative assessment of the artery's anatomical features and the degree of its deformation. A key step is the measurement of the pathological segment and calculation of the redundant length after conditional straightening, which allows for optimal planning of the reconstructive intervention.
5. Postoperative follow-up should include regular duplex scanning of the operated artery to assess LBFV, anastomosis integrity, and to rule out thrombosis. Dynamic observation is recommended every 6 months during the first year after surgery.

Approbation of the thesis:

The results of the dissertation research were presented at scientific conferences, including events with international participation:

1. Hemodynamic Parameters of the Internal Carotid Arteries in Cases of Pathological Tortuosity // 7th Congress of Surgeons of Kazakhstan with International Participation "Surgery: Yesterday, Today, Tomorrow" (Almaty, September 30, 2021).
2. Surgery of Extracranial Artery Lesions: Ways to Improve Treatment Outcomes // 1st Scientific and Practical Conference in Memory of K. R. Abugaliyev (Astana, December 11, 2021).
3. Planning of the Reconstruction Method for Pathological Tortuosity of the Internal Carotid Artery Based on Multislice Computed Tomography // International Scientific and Practical Conference Dedicated to the 85th Anniversary of Professor Zh. Kh. Khamzabayev (Astana, October 11, 2022).
4. Bilateral Pathological Tortuosity of the Internal Carotid Artery // 4th Congress of the Kazakhstan Society of Vascular Surgeons "Current Issues in Vascular Surgery" (Almaty, May 27, 2023).
5. Planning of the Reconstruction Method for Pathological Tortuosity of the Internal Carotid Artery Based on Multislice Computed Tomography // International Scientific and Practical Forum "High Technologies in Modern Surgery" (Astana, September 22, 2024).

Conclusions:

1. The developed treatment strategy for patients with bilateral dolichoarteriopathy of the ICA, based on the principle of staged surgical interventions, allowed for a systematic approach to selecting the sequence of operations and determining the optimal timing for the second stage of reconstructive treatment. The average interval was 38.9 days (M=38.9; Me=33.0; SD=±5.7), which provided optimal conditions for cerebral adaptation to altered hemodynamics, regression of cranial neuropathy symptoms within 13.25 days (M=13.25; Me=13.0; SD=±2.22), and postoperative wound healing by day 10.9 (M=10.9; Me=10.0; SD=±3.13).
2. A comparative analysis of hemodynamic parameters following staged surgical treatment versus medical therapy revealed statistically significant differences in the distribution of turbulent blood flow between the main and control groups ($p < 0.05$). The main group demonstrated a marked improvement in parameters, indicating the effectiveness of surgical correction. In particular, peak systolic blood flow velocity decreased from 163.6±10.2 cm/s to 89.7±6.7 cm/s in the main group, while no significant changes were observed in the control group ($p < 0.001$).
3. The analysis of neurological symptom dynamics between the main and control groups demonstrated significant changes in the neurological status of patients. In the main group, the average score before treatment was 18.7±3.9, which decreased to 8.4±7.0 twelve months after surgery, whereas no improvements were observed in the control group ($p < 0.001$).
4. The developed surgical method effectively restores physiological hemodynamic parameters, as evidenced by a statistically significant reduction in linear blood flow velocity in the third subgroup of patients with coiling-type tortuosity following surgical intervention ($p < 0.001$). Additionally, there was a pronounced positive trend in

neurological symptoms: the average score decreased from 19.13±4.28 to 7.87±7.15 ($p < 0.001$), demonstrating a significant reduction in clinical manifestations of the disease.

Publications:

The results and key findings of the dissertation research have been published in 11 scientific works, including 3 articles in journals recommended by the Committee for Quality Assurance in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan. One article was published in a peer-reviewed journal indexed in the third quartile of the international Scopus database. Additionally, the research findings were presented as 4 abstracts at international scientific and practical conferences. As part of the work, 1 patent for an invention was obtained, 1 certificate of authorship was registered, and 1 set of methodological recommendations was developed.

Dissertation's personal contribution:

The author independently conducted the analysis of the literature, formulated the aim and objectives of the research, and defined the study design and methodology. The doctoral candidate personally participated in patient selection and treatment, the development and implementation of a novel surgical technique, the collection and processing of clinical material, statistical data analysis, interpretation of the obtained results, and the preparation of all publications related to the dissertation topic.