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## OUR EXPERIENCE OF SURGICAL TREATMENT OF CAROTID STENOSES

### Abstract

This paper outlines study of cerebral hemodynamics in 372 patients, who had undergone 429 carotid endarterectomy procedures. It is highlighted that surgical treatment outcome depends on the initial state of cerebral hemodynamics.

**Keywords:** carotid stenosis, circle of Willis, intracerebral dynamics, indications for surgical treatment.

### Introduction

Blood vessel diseases of brain are one of the most critical problems of clinical angioneurology. Strokes and their effects rank 2<sup>nd</sup> -3<sup>rd</sup> in mortality causes [2]. About 30% of patients die within the next month from the start of disease, and 45-48% die by the end of the year. Of stroke survivors no more than 10 -12% return to work, and 25 - 30% remain disabled for life [7]. Ischemic brain damage makes up to 80% in the structure of stroke [1,3]. Currently, the main method of surgical prevention of stroke is carotid endarterectomy (CEA), which is possible only in case of generally accepted indications for CEA. The main indication for CEA in condition of stenosis of extracranial part of internal carotid artery (ICA) is existence of transient ischemic attacks (TIA) or small ischemic stroke [6,8].

The purpose of this study was to assess the state of cerebral hemodynamics in patients with chronic cerebrovascular disease and the results of surgical treatment of these patients. To achieve this goal, the following objectives were set:

1. To study the effect of the functional status of the circle of Willis (CW) and tolerance to cerebral ischemia on the degree of chronic cerebrovascular disease (CVD).
2. To assess immediate and long-term results of reconstructive surgery of carotid arteries, depending on the state of CW, brain tolerance to ischemia, and types of brain protection.

### Materials and methods

The basis of this study is formed by observation of cerebral blood flow and outcomes of surgical treatment of 372 patients in the Department of Cardiovascular Surgery of Clinical Center of State budget institution of Republic of Sakha (Yakutia) "Republic hospital № 1 – National Medical Centre" during the period of 2003 through 2012. In our work we used the clinical classification of chronic CVD by academician of RAMS – A. Pokrovsky.

Patients were examined on a unified plan, which, besides physical examination methods (palpation, auscultation, etc.), included special examination methods: ultrasound examination of vessels, transcranial Doppler (TCD) sonography, duplex scanning, radiopaque angiography of extra- and intracranial parts of arterial system.

In case of indications, echocardiography and coronary angiography, Holter monitoring and bicycle ergometry, computer and magnetic resonance imaging of brain and other research methods were used.

Ultrasound examination of great vessels was performed on devices "Acuson – 128/XP-10" (USA) and "Toshiba SSA – 270A" (Japan) using a 5 MHz linear array transducer and a linear multiHertz transducer in 7 MHz pulsed wave mode. Angiography was carried out on "Angioscop-33 with DSA Digitron Card", 8 frames per second.

In order to study cerebral hemodynamics, patients underwent TCD (TC2 – 64 device) with measuring linear blood flow rate in the middle cerebral artery (MCA) and conducting functional tests to determine the viability of collateral flow. Functioning of CW was estimated on a six-point scale [5].

Cerebral ischemic tolerance of brain was determined by cross-clamping of common carotid artery and study of nature of blood flow in the MCA. On the basis of these studies patients were ranked according to four degrees of cerebral ischemic tolerance [4]: high, sufficient, low, and critical. Determination of cerebral ischemia tolerance by TCD before surgery allows the surgeon to pre-select the optimal method of intraoperative cerebral protection: hypertension, pharmacological methods, and temporary internal shunt (TIS) installation.

Intraoperative monitoring of blood flow in brain vessels was performed by "Pioneer" apparatus of "Electric Medical Systems" Austrian firm using 2 MHz ultrasonic sensor. Drop in blood flow rate in the middle cerebral artery below 20 cm per second indicates failure of collateral blood flow and requires installation of a shunt when cross-clamping the carotid artery during surgery. Also, on the monitor we can count the number of emboli, which may appear after removing

clamps from the internal carotid artery after removing of stenosis in carotid arteries and starting the blood flow.

On the severity and extent of diseases of arteries feeding the brain, all patients were divided into 6 groups:

Group I – focal stenosis of one ICA – 48 patients.

Group II – unilateral stenosis of ICA + stenosis of vertebral artery – 32 patients.

Group III – bilateral carotid stenosis of less than 50% – 72 patients.

Group IV – bilateral carotid stenosis of less than 50% + stenosis of vertebral artery – 44 patients.

Group V – bilateral carotid stenosis of more than 50% – 26 patients.

Group VI – bilateral carotid stenoses in combination with intracranial vascular involvement (MCA, siphon) – 26 patients.

The indications for surgery were: TIA, discirculatory encephalopathy, light residual effects of ischemic stroke, asymptomatic ICA stenosis > 60%, a plaque that may lead to embolism with any degree of stenosis and chronic CVD. 79.8% of patients were aged 40 to 60 years; 286 operations were performed. Of the total number of patients, 38 underwent operations on both sides, and in 10 of them, these operations were carried out simultaneously and were due to occlusion of the internal carotid artery and critical stenosis of the contralateral side. The remaining 28 patients had multi-stage operations performed with an interval of 2 weeks to 3 months.

There were 76 combined operations of cerebral ischemia and lower limbs, 40 single-stage operations, and 36 multi-stage operations on two arterial systems. The decisive argument in favor of having to perform a single-stage combined operation on the carotid and aorto-femoral-popliteal systems was diagnosed critical stenosis of the ICA, and critical ischemia of the lower limbs, in case if patient was in a satisfactory condition.

Analysis of long-term results of surgical treatment (208 patients) was conducted in the period from 6 to 64 months taking into account the initial cerebral vascular insufficiency and cerebral hemodynamic status, depending on the localization of the damage of vessels feeding the brain.

### Results and discussion

We carried out an assessment of results of treatment by the following criteria: improvement, no change, retrogression, mortality. Under improvement we suggested complete subsidence or decrease of frequency of TIA, regression of neurologic impairment and reduction of symptoms of discirculatory encephalopathy. In addition, we considered it plausible to include patients operated

on in the asymptomatic stage (I degree of chronic CVD) into this group, since the operation had prevented developing severe ischemic damage in their brain. Retrogression meant progression of neurologic impairment or postoperative stroke. We considered mortality from the position of cerebral complications or other causes, not related to the operation.

Functional status of CW is essential to determine the patient's treatment strategy, forecast possible cerebrovascular diseases, and allows you to select necessary number of actions to protect brain at the time of cross-clamping of carotid arteries. Dependence of CW function on the localization of cerebral vessels disease is shown in Table 1. It must be emphasized that with spreading localization of vessels disease, CW function is severely impaired, i.e. the lowest score of CW is diagnosed in patients with multiple defects.

Of greatest interest is the study of cerebral ischemia tolerance (Table 2). It is noted that the patients with low and critical degree of cerebral ischemia tolerance (III and IV) are more common in the groups with multiple and intracranial cerebral vessels disease.

In the immediate postoperative period, the following outcomes were observed: improvement – 69.5%, no change – 25.8%, retrogression – 4.8%, and mortality – 0.8%.

It should be noted that the worst outcomes were observed in patients with intracranial vessels disease (15.4%), positive outcomes were achieved in patients with CW functional status 3 and cerebral ischemia tolerance 2.2 (Table 3). The table shows average values in a group of patients.

In the long-term period improvement was achieved in 65.4%, no change – 16.3%, retrogression – 15.4%, mortality of ischemic stroke – 0.9%, of other causes – 1.9%. It must be emphasized that with the increase of the degree of chronic CVD the long-term outcomes get worse. Improvement was observed in patients with chronic CVD of degree I – 100%, degree II – 79.6%, degree III – 48.0%, degree IV – 43.5%.

### Conclusions

1. Positive dynamics of neurological status after CEA surgery was marked in patients with CW functional status over 3 points, as well as high and sufficient cerebral ischemia tolerance.
2. Patients with chronic CVD degree IV and low or critical cerebral ischemia tolerance may be operated only in case of strict indications because of high degree of operational risk.
3. Patients with chronic CVD degree III, IV and intracranial vessels disease should be operated on under the protection of a temporary internal shunt.



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