ANALYSIS OF THE EFFICIENCY OF EXTERNAL CAROTID SURGERY

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The authors confirmed efficacy of external carotid artery plasty in occlusion of the internal carotid artery. The findings of triplex scanning and transcranial dopplerography demonstrated a considerable increment in the blood flow through the middle cerebral artery in the operated zone, amounting to approximately 30% one year after surgical treatment. Twenty-two patients before and after surgery were subjected to single-photon emission computed tomography. The majority of patients after surgery were found to have improved perfusion of the previously ischaemized zone of the brain on the side of operation according to the data of single-photon emission computed tomography.

***Key words**: brachiocephalic arteries stenosis, external carotid artery plasty.*

INTRODUCTION

Surgical prevention of ischaemic stroke developing secondary to stenosing lesions of brachiocephalic arteries by its efficacy is considerably superior to the results of medicamentous therapy [1]. However, while the necessity of carrying out conventional carotid endarterectomy in stenosis of the internal carotid artery has absolutely been proved by the results of numerous multicenter clinical trials, feasibility of improving the blood flow through the common carotid artery (CCA) and external carotid artery (ECA) in the presence of occlusion of the internal carotid artery (ICA) is now called into doubt. This is first of all associated with lack of information on improved cerebral blood supply by the natural collaterals in new haemodynamic conditions after performing endarterectomy of the CCA and ECA [2, 3].

Diagnosis of ischaemic disease of the brain and occlusive lesions of major arteries in the aspect of surgical treatment should be made based on comprehensive examination. The most commonly used and available methods are colour duplex scanning (CDS) of brachiocephalic arteries and transcranial dopplerography (TCD) making it possible to evaluate the functional state of cerebral haemodynamics [4, 5].

Adequate perfusion of the brain may be assessed by single-photon emission computed tomography (SPECT) [6, 7].

The present work was aimed at studying feasibility of performing endarterectomy and plasty of the external carotid artery and analysing the remote results of this operative intervention.

MATERIALS AND METHODS

The work was carried out at the Chair of Neurology of the St. Petersburg Medical Academy of Postgraduate Education and Municipal Hospital No 26 of the city of St. Petersburg. The work was based on the results of examination and treatment of 124 patients presenting with ischaemic impairments of cerebral circulation induced by atherosclerotic-genesis occlusive lesions of the ICA. The patients were divided into 2 groups (Study Group and Control Group) depending on the methods of treatment used.

The Study Group (SG) consisted of seventy-two 48-to-80-year-old (mean age 66.1±13.3 years) patients who were subjected to operation – resection of the internal carotid artery with endarterectomy and plasty of the external carotid artery. The indications for operation

Table 1

Characteristics of the Study Group (SG) and Control Group (CG)

Parameters	Patient Group		p
	SG (n=72)	CG (n=52)	
Men/Women	64 (88.9%)/ 8 (11.1%)	47 (90.4%)/ 5 (9.6%)	0.98
Variants of cerebral circulation impairments			
Asymptomatic course	2 (2.8%)	3 (5.8%)	0.71
TIA	14 (19.4%)	10 (19.2%)	0.99
CCCI	7 (9.7%)	6 (11.5%)	0.77
ACCI	49 (68.1%)	33 (63.5%)	0.73

Note: TIA – transitory ischaemic attack; CCCI – chronic cerebral circulation insufficiency, ACCI – acute cerebral circulation insufficiency.

Table 2

Remote-period complications observed in patients

Complications	Study Group (n=61)	Control Group (n=52)	p
ECA restenosis >60%	0 (0%)	-	-
ECA restenosis <60%	1 (1.6%)	-	-
ACCI+TIA in the contralateral basin	1 (1.6%)	0 (0%)	0.94
ACCI+TIA in the ipsilateral basin	1 (1.6%)	14 (26.9%)	0.01
Mortality from stroke	1 (1.6%)	3 (5.8%)	0.50
Death from other causes	1 (1.6%)	2 (3.8%)	0.89
Total	5 (8.2%)	20 (38.5%)	<0.001

included stenoses of the common and/or external carotid artery of more than 50%, as well as the presence of an embolus-hazardous thrombus in the area of the ICA stump or bifurcation of the CCA and an unstable atherosclerotic plaque.

In order to assess and compare long-term outcomes of surgical treatment we formed a Control Group consisting of 52 patients (mean age 64.0±9.6 years) presenting with ischaemic impairments of cerebral circulation conditioned by atherosclerotic-genesis occlusive lesions of the ICA with diagnosed significant (>50%) stenoses of the ECA on the same side, who for a variety of reasons refused surgical treatment. The Control Group patients had no absolute contraindications to surgical treatment and their somatic status did not significantly differ from the Study Group patients.

The patients of the Study and Control Groups had no statistically significant differences either by the gender or clinical manifestations of cerebrovascular insufficiency (Table 1).

The patients of both the Study Group and Control Group were examined according to the same algorithm.

The scheme of examination of patients included the following stages: collection of complaints and case history, general somatic examination, neurologist's examination, computed tomography (CT) of the brain, CDS of extracranial arteries and TCD (apparatus Vivid 7, General Electric Vingmed Ultrasound (USA); X-ray contrast angiography (apparatus Philips Integris Allura), single-photon emission computed tomography (SPECT).

The patients were selected based on comprehensive clinical and neurological examination with participation of various specialists (neurologist, ophthalmologist, otoneurologist, neurosurgeon, vascular surgeon, cardiologist).

The collateral blood flow of the brain was assessed and efficacy of treatment was controlled in our study by means of single-photon emission computed tomography (SPECT) performed in the Laboratory of Radioisotope Diagnosis at the Clinic of the Russian Scientific Research Centre for Radiology and Surgical Technologies using the single-photon emission computer tomograph E. Cam manufactured by the "Siemens" Company.

The results were statistically processed by means of the standard Statistical Package for Social Sciences Statistica for Windows v. 10.0, followed by analysing the obtained findings. The frequencies of incidence of signs in the two groups of patients were compared by means of the Pearson's criterion x^2, and numerical parameters were compared by means of the Student's t-test. The differences were regarded as statistically significant if $p<0.05$.

RESULTS

The outcomes of surgical treatment were assessed during both the intra– and early postoperative periods (up to 1 month). The remote results were followed up for one year after surgery. The obtained findings were compared with efficacy of medicamentous therapy in the Control Group.

In the early postoperative period only one patient developed acute cerebral circulation impairment. Nine (12.5%) patients were found to have clinical manifestations of reperfusion syndrome characterized by appearance of headache on the side of reconstruction, episodes of spatial disorientation and focal spasms in the limbs. In all patients on the background of the carried out medicamentous treatment in the postoperative period the above-mentioned symptoms regressed during 3–5 days. The remote results of surgical treatment were followed up during one year in 61 (84.7%) of the 72 patients. They were analysed and compared by the analogous parameters with the Control Group patients receiving medicamentous treatment alone (Table 2).

Analysing the results of treatment, mention should be made that the total number of remote-period complications in the Study Group was four times less than in the Control Group [5 (8.2%) versus 20 (38.5%); $p<0.001$]. Relapses of ACCI or TIA were registered in 2 (2.3%) cases, localizing in the first case in the ipsilateral basin, which may be explained by insufficiency of contralateral blood supply in the new haemodynamic conditions, and in the second case in the contralateral basin on the background of paroxysm of ciliary arrhythmia.

The number of relapses of ACCI or TIA in the Control Group was seven times more than in the Study Group, being observed in 14 (26.9%) patients, with stroke having developed in the ipsilateral carotid basin.

Alterations in the neurological status on the background of the carried out treatment, besides CDS of the brachiocephalic arteries, were confirmed by the findings of TCD, studying the parameters of the major blood flow and cerebrovascular reactivity (CVR) in the comparative aspect with analogous parameters before prior to treatment (Table 3).

We observed a considerable increment of blood flow velocity through the MCA on the side of operation – about 30% – 1 year after surgical treatment in the Study Group patients in the subgroups of patients younger than 60 years and those over 60 years of age. There was no statistically significant difference in the Control Group patients.

Taking into consideration that the absolute parameters of LBFV in the intracranial arteries are often insufficiently informative without regard to the relative parameters, all patients were subjected to functional TCD with loads in the form of hypoventilation (breath holding for 30–40 s) and hyperventilation (40–60 s), based on which we calculated the vasomotor reactivity index (Table 4).

Analyzing dynamics of the vasomotor reactivity index one year after treatment showed a considerable increment of the parameter in the Study Group and was more pronounced in patients under 60 years old. These findings suggest that carried out surgical treatment resulted in improvement of compensatory reaction of vasodilatation and, accordingly, decreased the possibility of the development of cerebral hypoperfusion. No differences by this parameter were observed in the Control Group patients during 12 months.

No increment of the vasomotor reactivity index in the Control Group patients during 1 year despite carried out medicamentous treatment correlated with a greater number of remote-period complications in this group.

In order to determine dynamics of cerebral tissue perfusion in patients after surgical treatment, a total of twenty-two patients from the Study Group were subjected to single-photon emission computed tomography (SPECT). All these patients prior to treatment were found to have zones of focal impairments of perfusion of various severity and degree of manifestation. Of these, 2 (9%) patients were found to have extensive foci of hypoperfusion, occupying practically the whole right hemisphere in one case and the left frontoparietal area in the other. The level of regional cerebral blood flow in the zone of lesion amounted to 18 ml/min/100 g and 20 ml/min/100 g, respectively, which was regarded as nonviable tissue, with the normal level of blood flow equalling 44–55 ml/min/100 g [8].

In the remaining 20 (91%) patients, the level of regional cerebral blood flow in the zone of lesion varied from 22 to 31 ml/min/100 g (26.2±3.4 ml/min/100 g) which was regarded as zones of ischaemia. Of these, 13 (59%) patients were additionally found to have scintigraphic signs of impaired perfusion of the deep structures of the brain, as well as dilatation and deformation of the lateral ventricles of the brain.

Dynamic assessment of cerebral perfusion was carried out one month after surgical treatment, with positive dynamics being observed in 13 (59%) patients: foci of hypoperfusion decreased in size and the distribution of the radiopharmaceutical (RPH) became more uniform.

The level of regional cerebral blood flow increased by 6.2±2.4 ml/min/100 g and amounted to 32.5±3.1 ml/min/100 g, which correlated with improved neurological picture (Fig.).

Five (23%) patients were found to have only more uniform distribution of the RPH with no alterations in the values of the regional blood flow. In four (18%) patients the scintigraphic picture remained with no dynamics.

Thus, tomoscintigraphy is a minimally invasive and reliable method of diagnosing perfusion impairment in patients with ACCI and may therefore be used not only for primary diagnosis of cerebral circulation impairments but also for

Table 3

Comparative dynamics of linear blood flow velocity (LBFV) through the middle cerebral artery (MCA) (cm/s) in the remote period by the data of TCD

Group		Before treatment	1 year after treatment	Increment	p
Study Group	under 60 years	37.2±4.5 (n=34)	51.4±6.2 (n=29)	15.1±2.6	<0.001
	over 60 years	29.3±3.4 (n=38)	38.5±6.3 (n=30)	9.7±1.6	<0.001
Control Group	under 60 years	39.9±4.1 (n=24)	42.2±4.0 (n=22)	1.9±0.3	0.06
	< over 60 years	28.4±5.1 (n=28)	31.1±5.9 (n=25)	2.9±0.71	0.08

Table 4

Comparative dynamics of the vasomotor reactivity index according to the TCD data in the remote period on the side of lesion

Group		Before treatment	1 year after treatment	Increment	p
Study Group	under 60 years	0.98±0.25 (n=34)	1.64±0.39 (n=29)	0.67±0.21	<0.01
	above 60 years	0.86±0.41 (n=38)	1.48±0.62 (n=30)	0.62±0.18	<0.01
Control Group	under 60 years	0.99±0.39 (n=24)	1.22±0.48 (n=22)	0.23±0.06	0.08
	above 60 years	0.88±0.30 (n=28)	1.14±0.72 (n=25)	0.23±0.03	0.09

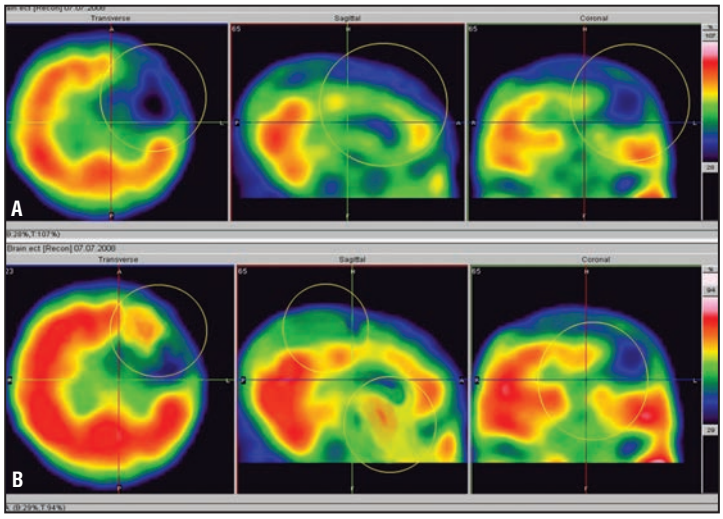

Fig. Increase of cerebral perfusion and regression of scintigraphic signs of focal ischaemia of cerebral tissue in a patient with ischaemic stroke in the right temporoparietal area before (A) and after (B) surgical treatment.
Conventional designations: Red colour – normal distribution of the RPH, blue colour – zone of ischaemia.

controlling efficacy of treatment and prediction of the course of the disease.

DISCUSSION

CDS and TCD still remain reliable, accurate, and readily available methods of assessing blood flow in brachiocephalic arteries. According to the obtained findings we observed a considerable increment of blood flow velocity through the MCA on the side of operation – about 30% – 1 year after surgical treatment in the Study Group patients in the subgroup of patients both under 60 years and those older than 60 years.

Tomoscintigraphy has proved to possess a high diagnostic informative value in detection of acute and chronic impairments of cerebral circulation [6, 9, 10], and this was also confirmed in our study: all patients were found to have before treatment zones of focal impairment of perfusion of various severity and degree of manifestation. Besides diagnosis of cerebral circulation impairments, methods of tomoscintigraphy, being minimally invasive, may be widely used for objective assessment of efficacy of treatment. Thus, in the study by D.F. Cikrit, et al. [7] normalization of cerebral circulation and increase of the cerebral haemodynamic reserve, according to the findings of SPECT were observed after successfully performed carotid endarterectomy. According to our findings, endarterectomy and plasty of the external carotid artery in occlusion of the internal carotid artery yield similar results.

Clinical and haemodynamic efficiency of the operation may be related to the flowing factors:

– possibility of improving perfusion of the brain owing to endarterectomy from the common and external carotid arteries, as well as sympathectomy of the common carotid artery and internal carotid artery, which resulted in improved function of the natural collaterals;

– exclusion of probability of embolism from the zone of bifurcation of the CCA to the branches of the ECA.

Based on the findings obtained in our study the following conclusions can be made:

1. Improved cerebral perfusion on the background of surgical treatment was confirmed by the SPECT findings. 59% of patients demonstrated a decrease in hypoperfusion foci and more uniform distribution of the radiopharmaceutical as compared with the initial data.

2. Resection of the ICA with endarterectomy and plasty of the ECA in patients with occlusive lesions of internal carotid arteries promotes the improvement of collateral blood supply of the brain. According to the findings of TCD, the vasomotor reactivity index and mean blood flow velocity through the MCA in patients one year after surgical treatment are higher than on the background of medicamentous therapy alone.

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