Section: Research Paper

LONG-TERM RESULTS OF MICROSURGICAL TREATMENT OF LARGE AND GIANT ANEURYSMS OF THE BRAIN VESSELS

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The purpose of this work is to evaluate the long-term results of microsurgical treatment of large and giant cerebral aneurysms of the internal carotid artery.

Material and Methods. Patients treated at the Center of Neurosurgery in Tashkent over the period of 2015-2021. Follow-up by mailing medical questionnaires or telephone interviews was collected from 94 (82 %) of 115 patients. The mean follow-up period was 38.2±28.0 months. The mean age of the patients at the time of surgery was 42.55±8.5 years, at the time of follow-up assessment was 49.4±9.8 years. There were 67 men (58.3 %), women - 48 (41.7%). The radicality of surgical treatment of aneurysms was 97.4% (112 patients).

Results. Depending on the variations of the clinical course of large and giant aneurysms, cerebral (30.43% of patients), focal symptoms (34.78% of patients) and meningeal symptoms significantly prevailed in the studied patients. With regard to motor defects, a similar trend was noted: only 12 (10.43%) patients with mild paresis noted the recovery of movements. In 6 (5.3%) patients discharged with moderate and severe paresis, noticeable regression was not noted. The results of treatment can be assessed as successful: favorable outcomes on the Glasgow Outcome Scale (GOS) 4 and 5 were obtained in 99 (86.08%) patients; satisfactory (GOS 3), which means the presence of a severe neurological defect, in 12 (10.43%); there were no outcomes to a vegetative state (GOS 2).

Conclusions. Despite the successful use of modern endovascular techniques for the treatment of large and giant aneurysms in recent years, direct microsurgical interventions do not lose their

relevance. Clipping of aneurysms, as our work has shown, remains a highly effective radical treatment for patients with large and giant aneurysms with favorable early and long-term results.
KEYWORDS: large and giant aneurysms, aneurysm treatment, long-term results

INTRODUCTION

Arterial aneurysms of the brain remain one of the complex and urgent problems of modern neurosurgery. A special group of arterial aneurysms are large and giant aneurysms.

Large and giant aneurysms (LGA) of the internal carotid artery (ICA) are often combined with aneurysms of other localization and form bilaterally ("mirror" aneurysms). Large and giant arterial aneurysms of the brain represent an important medical problem. They differ in the features of the clinical course of the disease, the difficulties of diagnosis and the complexity of surgical treatment [1,2,5,6,8,10,14]. This group of cerebral aneurysms is an extremely difficult task in terms of microsurgical treatment [2,3,4,7,9]. After the onset of the disease, such patients relatively rarely come directly to a neurosurgeon. For a long time, the condition of patients is compensated or subcompensated, and they meet to a general practitioner, neuropathologist or ophthalmologist. At this stage of the examination, it is important to identify the features of the clinical manifestations of giant aneurysms of various localization, which will facilitate the early referral of patients to a neurosurgeon and the conduct of adequate instrumental studies.

MATERIALS AND METHODS

115 patients with large (1.5–2.5 cm) and giant (>2.5 cm) aneurysms of the anterior circle of Willis, operated at the Republican Specialized Scientific and Practical Medical Center of Neurosurgery (RSSPMCN) for the period 2015–2021, were selected. Patients were to provide information of current complaints, the level of social adaptation, functional outcome, the state of visual and motor functions. Follow-up information by mailing medical questionnaires or telephone interviews was collected from 94 (82 %) of 115 patients. The mean follow-up period was 38.2±28.0 months. The mean age of the patients at the time of surgery was 42.55±8.5 years, at the time of follow-up assessment was 49.4±9.8 years. There were 67 men (58.3 %), women - 48 (41.7%). The radicality of surgical treatment of aneurysms was 97.4% (112 patients).

Since the surgical treatment of patients with large and giant aneurysms has no fundamental differences, the treatment results were analyzed jointly. Upon admission to the department, all patients underwent clinical examinations, CT/ MRI of the brain (Fig.1, 2), examinations by an ophthalmologist, neurologist and anesthesiologist. Cerebral angiography was used to determine the location, shape, and size of arterial aneurysms. The severity of the condition of patients before surgery was assessed according to the classification of W. Hunt - R. Hess (HH), the level of wakefulness according to the Glasgow scale (GCS). The anatomical features of the hemorrhage were determined according to the CT classification of intracranial hemorrhage by Fisher et al., the Graeb et al. technique was used to assess the degree of intraventricular hemorrhage. Functional outcomes after surgical treatment were assessed at discharge from the hospital using the Glasgow Outcome Scale.

Figure 1. MRI of the brain. Giant aneurysm of the left ICA

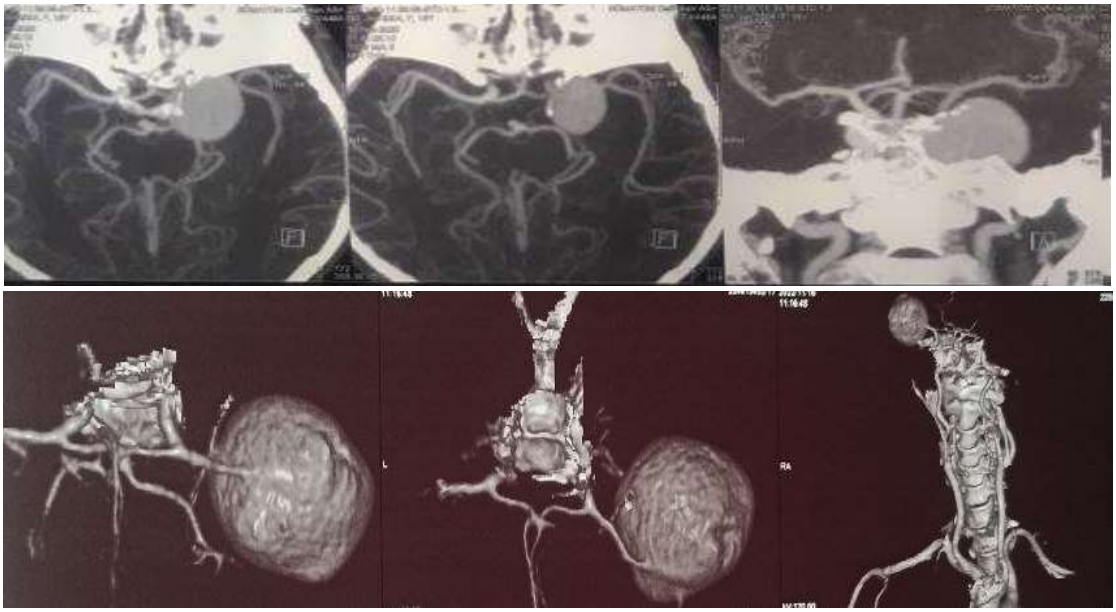

Figure 2. CT angiography of cerebral vessels. Giant aneurysm of the left ICA

RESULTS AND DISCUSSION

When analyzing the dynamics of focal symptoms, it turned out gross motor and visual disturbances (loss of visual fields and insufficiency of the oculomotor nerves) have a weak tendency to recover over time. Functional outcomes assessed by the Glasgow Outcome Scale (GOS) indicate good treatment outcomes in the long-term period. There are noticeably more patients with excellent (5 according to GIS) or good (4 according to GOS) outcomes in the follow-up group, which indicates a certain trend towards regression of neurological disorders over time. With regard to motor defects, a similar trend was noted: only 12 (10.43%) patients with mild paresis noted the recovery of movements. 6 (5.3%) patients discharged with moderate and severe paresis without noticeable regression.

Depending on the variations of the clinical course of LGA (see Table 1), cerebral (30.43% of patients), focal symptoms (34.78% of patients) and meningeal symptoms significantly dominated in the patients, as well as signs of damage to the cranial nerves were due to rupture LGA and subsequent formation of an intracerebral hematoma, but not by the volume of LGA.

Of the 115 patients in our series, aneurysms were clipped in 108 (93.4%), including clipping of the neck of aneurysm in 100 patients (92.3%), clipping of the aneurysm body in 6 patients (5.55%) (see Table 2).

Table 1.
Distribution of patients according to the characteristics of symptoms, depending on the variants of the clinical course of LGA (number of patients)

Variants of the clinical course of LGA						
Symptoms	apoplectiform (*n* =64)		pseudotumorous (*n* =42)		embolic (*n* =9)	
	abs.	%	abs.	%	abs.	%
Cerebral	16	25	12	28.6	7	77.8
Depression of consciousness	5	7.8	0	—	0	—
Meningeal	9	14	0	—	0	—
Focal hemispheric	14	21.9	24	57.14	2	22.2
Damage to cranial nerves	7	10.9	2	4.76	0	—
Cerebellar	1	1.56	1	2.38	0	—
Mental disorders	4	6.25	1	2.38	0	—
Convulsions	8	12.5	2	4.76	0	—

Table 2
Types of surgical interventions in the study group

Type of operation	Number of patients	
	abs.	%
Clipping	108	93.4%
Clipping of the neck of aneurysm	100	92.3%
Clipping through the body	6	5.55%
With simulation of the ICA lumen	2	1.85%

The results of treatment can be assessed as successful: favorable outcomes on the Glasgow Outcome Scale (GOS) 4 and 5 were obtained in 99 (86.08%) patients; satisfactory (GOS 3), which means the presence of a severe neurological defect, in 12 (10.43%); there were no outcomes to a vegetative state (GOS 2) (see Table 3). Mortality was 4 (3.47%) patients. Our data allow us to say that reconstructive surgery has an advantage over those practiced in the 80-90s combined and deconstructive interventions. As Professor V.A.Lazarev points out, excellent and good results with combined treatment (clipping, deconstruction, creation of EICMA, balloon occlusion, etc.) were achieved in 62.5-78%, poor - in 9-17.4% of patients depending on the location of ICA aneurysms. Mortality according to his data was 12.2%. Severe complications with neurological deficits were noted in 20-33% of the operated patients; in our work, they are significantly less: deep hemiparesis was detected in 10.43% [4].

Table 3
Results of microsurgical treatment according to the Glasgow Outcome Scale

Glasgow Outcomes	N (%)
5	62 (62.62%)
4	37 (37.37%)
3	12 (10.43%)
2	0
1	4 (3.47%)
Favorable outcomes (4-5)	99 p-t (86.08%)
Unsatisfactory outcomes (2-3)	12 (10.43%)

In our work, hematomas in the postoperative period were detected in 12 (10.43%) patients, including intracerebral (retraction) in six, subdural - in five patients, epidural - in one patient. In all 12 cases, revision and removal of hematomas were performed, of which in 11 patients - for 1-2 days, in one patient –it was delayed for 5 days after clipping of the aneurysm. In 11 of 12 cases of revisions, the operation was completed by external decompression of the skull; in one case, the bone flap was placed in place.

The reserves for the recovery of movements remain in question, since in most cases the operated patients, most likely, fail to receive high-quality and systematic rehabilitation treatment at the place of residence. To prevent visual impairment, even before manipulations on the aneurysm itself, the surgeon should pay special attention to the mobilization of the optic nerve, and further exposure of the aneurysm should be carried out as sparingly as possible. Information about the high risks of visual impairment must be communicated to patients in an accessible form before surgery.

Until the 1990s, deconstructive operations on the ICA (ligation or its occlusion with a balloon) remained the main method of radical exclusion of paraclinoid aneurysms of large and giant sizes, which, in case of insufficient collateral blood flow, was combined with the imposition of an extra-intracranial microanastomosis (EICMA). Such operations, despite the careful selection of candidates, were accompanied by a high percentage of complications and mortality. So, according to V.A.Lazarev [2], disability , depending on the location and size of aneurysms, was 4.1–21.3%, mortality was 4.1–19.2%. It was obvious that the correct vector for the development of the vascular neurosurgery is reconstructive surgeries with aneurysm clipping. In 1990 H. Batjer, D. Samson [8,12,14] were the first to describe the principle of blood aspiration through the ICA exposed on the neck in order to relax and excise a giant aneurysm. Based on personal data received by mail or telephone interviews, we analyzed the long-term outcomes and results of social adaptation in patients operated on for large and giant aneurysms. The data obtained by us are similar to the results given by the founder of the technique H. Batjer [9] in his later publication, summarizing the experience of treating 89 patients with paraclinoid aneurysms: the radicality of operations, according to the author, was 95.5%, disability — 11%, mortality — 3%. The average follow-up period exceeded 5 years (65.2 months), which suggests a fairly high reliability of our data.

A remarkable fact, which was also noted by other specialists, is the marked predominance of women in the analyzed group - 80.6%. It turned out that persistent general symptoms in the examined patients were headache (55.8%) and elements of asthenic syndrome (45.3%), which can be associated with the consequences of hemorrhages, surgical trauma, the severity of the operation, ischemia of the hemispheres against the background of blood aspiration, etc. At the same time, it cannot be ruled out that these symptoms may be due to other diseases and the natural aging of patients. Among the rare long-term effects of treatment include epileptic syndrome, mental disorders and sleep disorders - all of them occurred in isolated cases. Comparative analysis of outcomes in patients at discharge and on a delayed basis suggests that the recovery of functional abilities of patients continues for some time after surgery: patients with a GOS score of 3–4 "rise" one step higher, to 4–5 according to GOS. It is noteworthy that less than half of the patients (38.4%) succeed in returning to work. In contrast to the literature data [1, 11], the results of treatment of patients in the acute period of subarachnoid hemorrhage did not differ from those in the group of patients without hemorrhage, which, apparently, is due to their small number. Gross motor defects (deep hemiparesis and plegia) and, most importantly, visual disturbances (defects in the visual fields and insufficiency of the oculomotor nerves), recorded at discharge, are characterized by a weak tendency to recovery. The reserves for the restoration of movements remain in question, since in most cases the operated patients, most likely, fail to receive high-quality and systematic rehabilitation treatment at the place of residence. It should be noted that foreign authors point to similar persistent visual defects after operations. So, in the work of A. Raco et al. [11], devoted to the analysis of surgical treatment of 104 patients with carotid-ophthalmic aneurysms, after 6 months of follow-up, visual defects remained unchanged in 42%, and worsened in 7.7%. According to K. Kattner et al. [10], in 50% of patients operated on giant aneurysms, visual defects did not improve with an average follow-up period of 7 years. To prevent visual impairment before manipulations on the aneurysm itself, the surgeon should pay special attention to the mobilization of the optic nerve (perform an opening of the optic nerve canal, the distal dural ring and cross the falciform ligament), and further exposure of the aneurysm should be carried out as sparingly as possible. Information about the high risks of visual impairment must be communicated to patients in an accessible form before surgery.

CONCLUSION

Despite the successful use of modern endovascular techniques for the treatment of large and giant aneurysms in recent years, direct microsurgical interventions do not lose their relevance. Clipping of aneurysms, as our work has shown, remains a highly effective radical treatment for patients with large and giant aneurysms with favorable early and long-term results. Most patients recover well over time and return to their former lives.

Currently, vascular neurosurgery is focused on reconstructive types of operations, which implies both the preservation of blood flow in the afferent artery and more gentle treatment methods. High radicality, minimization of surgical trauma, short rehabilitation periods and high quality of life of patients after surgery are the priorities of modern neurosurgical practice.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board at the Republican Specialized Scientific and Practical Medical Center of Neurosurgery.

AUTHOR CONTRIBUTIONS

MR, GK: substantial contributions to the conception or design of the work. ShT, RH, YA: acquisition, analysis, and interpretation of data for the work. MR, GK: drafting and critical revision of the manuscript for important intellectual content. All authors contributed to the article and approved the submitted version.

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