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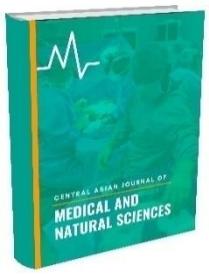

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Modern Methods of Diagnostics and Treatment of Patients with Large and Giant Aneurysms of Internal Carotid Artery

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Annotation: This article presents a review of the literature on large and giant aneurysms of internal carotid artery, devoted to modern diagnostics and methods of treatment. However, there are no studies with a high level of evidence base on the significant benefits of a particular treatment method.

Key words: large and giant aneurysms of internal carotid artery (ICA), microsurgical treatment, endovascular treatment.

Relevance. Arterial aneurysms of the brain remain one of the complex and urgent problems of modern neurosurgery. Giant anf large aneurysms of ICA represent a special group of arterial aneurysms. The incidence statistics for aneurysms reported in the medical literature are based on autopsy series, retrospective clinical trials, or randomized trials, all of which have some sampling bias**.**

Large and giant aneurysms of ICA are often combined with aneurysms of other localization and form bilaterally ("mirror" aneurysms). This group of cerebral aneurysms is an extremely difficult task from the point of view of microsurgical treatment [3,5,7].

The size of saccular aneurysms usually ranges from 5 to 15 mm, however, in some patients, aneurysms of large (from 16 to 25 mm) and giant (more than 25 mm) sizes can be detected [12]. The incidence of giant aneurysms is 2-13% of all cerebral aneurysms [2,6]

Up to 80% of patients in whom giant aneurysms of ICA manifested themselves with any symptoms and were not operated on, die within several years from the onset of the disease due to rupture of the aneurysm or due to an increase in the volumetric effect of giant aneurysms on the surrounding structures of the brain, as well as due to ischemic complications [7].

Age dependence. ICA aneurysms in large and giant sizes are most often detected at 3-5 decades of life, the average age of patients is 42-57 years. Up to 10% of giant aneurysms are diagnosed in children and adolescents. It should be noted that the proportion of large and giant aneurysms in

children is significantly higher than in adults, and ranges from 10 to 44% according to various sources [7, 8, 9, 20]. The most frequent localization of aneurysms in children was the ICA (44.6%), in particular, the cavernous section (15.8%) and ICA bifurcations (14%).

The pathologies associated with the formation of intracranial aneurysms include connective tissue dysplasia (DST), a group of genetic pathological conditions that cause disorders in the development of connective tissue. Another feature that specialists pay attention to is the absence of arteriosclerosis in children, which, possibly, makes the wall more susceptible to deformation. It is possible that the same reason explains the high tendency to form fusiform and dolichoectatic aneurysms in children (30-51%), in contrast to adults, who typically develop saccular aneurysms [4,7,8,].

Localization. The intracranial ICA is the most common site for the formation of large and giant aneurysms. According to B. Wier, 59% of giant aneurysms were localized to the ICA, similar figures are given by other neurosurgeons: H. Nukui - 21%, F. Vinuela - 29.8%, J. Fox - 54%, A. Pasqualin - 34% [67]. Below is a comparative table (table. 1.), characterizing the localization percentage of giant intracranial aneurysms of ICA according to different researchers [2,3,4,6].

Localization of giant intracranial aneurysms

Author, year	Aneurysm	ICA (%)
Foxetal., 1983	1037	553 (53)
Atkinsonetal., 1995	325	235 (72,3)
Лазарев В.А., 1995	368	231 (62,8)
Хиникадзе М.Р., 2007	89	49 (55)
Weietal., 2008	170	72 (42,3)
Крылов В.В., 2011	81	34 (42)
Sughrueetal., 2011	141	62 (44)
Пилипенко Ю.В., 2015	107	75 (70)

Large and giant aneurysms are often partially thrombosed: according to the Italian Cooperative Study of Giant Aneurysms (130 aneurysms, 1988), 59% of patients had peripheral thrombi aneurysms, 4% had central thrombi and 11% were subtotally thrombosed [19, 27]. An unusually high incidence of thrombosis of aneurysms in its series - 92% - is reported by P. Vorkapic [23].

Diagnostics. Large and giant ICA aneurysms include contrast-enhanced computed tomography, arterial magnetic resonance imaging, diagnostic cerebral angiography. The main and most common diagnostic method is diagnostic cerebral angiography, with the help of which it is possible to identify and clarify the main points for planning microsurgical treatment. With the development of neuroimaging methods, the use of CT-angiography of the brain with high-resolution computed tomography has become widespread [5,6,7,17,18]. Particularly important is the preoperative assessment of the adequacy of collateral circulation using the balloon-occlusion test, neurophysiological research, the use of neuroimaging methods with the ability to assess the parameters of cerebral perfusion.

Treatment of aneurysms

The first reports of patients with giant ICA aneurysms who underwent direct surgery, which appeared in the 70s, were distinguished by dramatic results: mortality in Drakeetal. accounted for 50% (6 patients), Kothandarametal. - 20% (10 patients), Thureletal. - 50% (6 patients), Guidettietal. - 19% (32 patients) [6,7,]. The work of Kodamaetal. (1981), dedicated to the treatment of giant aneurysms, is indicative for its decade: surgical activity is relatively low, and deconstructions with disabling neurological symptoms dominate in the structure of operations. Of the 55 aneurysms in the group, ICA

aneurysms accounted for half (29-52%), of which only 13 patients were operated: in eight the aneurysms were clipped, in 17 the ICA was ligated (8 with EICMA), four were not operated. Good results were obtained in three patients, unsatisfactory also in three, two patients died. Of those who were not operated on, three more died in the hospital. The overall mortality rate at work was 18.8%, disability - 31.3%. In conclusion, the authors make the following conclusion: “direct intervention on a giant aneurysm carries excessive risks, so leaving the patient under observation is the best alternative” [15]. In 1981 G. Ferguson and C. Drake published the first work devoted to the surgery of carotid-ophthalmic aneurysms. 32 out of 100 patients had giant aneurysms, of which the vast majority (88%) had various visual impairments.

Unfortunately, the nature of the treatment was described only in patients with visual defects (32 patients), however, it is clear that microsurgical clipping was used to a limited extent (14 patients), and indirect operations predominated - ligation of arteries, occlusion of the ICA, extra-intracranial anastomoses with trapping, revision without turning off the aneurysm, etc. Nevertheless, the authors talk about quite successful results: excellent and good results were obtained in 82% of operated patients, poor in 6%, 12% died (10 patients). Visual defects after surgery improved only in 15 (51.7%) [63]. Microsurgical technique continued to improve, as did the personal experience of neurosurgeons. In the monograph "Microneurosurgery" (1984) prof. M. Yasargil, describing his experience of treating 30 patients with giant aneurysms (10 of them are paraclinoid), indicates that 8 out of 10 patients operated on with ICA aneurysms achieved good results. The nature of the operations is similar: five patients underwent ligation of the ICA (including four with superposition with EICMA), one - trapping, three - clipping of aneurysms, one - decompression of the sac [10,25,26].

In 1983 R. Herosetal. demonstrated excellent results in the treatment of patients with large or giant ICA aneurysms. Clipping was performed in 23 of 34 patients (67.6%), 11 - ligation with anastomosis or trapping. Unsatisfactory outcomes were only 5.9% (2 patients), mortality - 11.7%. The authors were among the first to describe several surgical maneuvers that later became standard for the surgery of paraclinoid aneurysms: the aneurysm was isolated under conditions of temporary trapping with exposure of the ICA on the neck; ECoEG was used to control episodes of temporary shutdown; As an access, the authors used the standard pterional approach and resorted to resection of the roof of the optic nerve canal and removal of the anterior tilted process to expose the cervix. Along with M. Yasargil, the author used in some patients direct blood aspiration with a syringe to relax the aneurysm and release it [11,26,26].

In 1985, V. Dolenc described his experience in treating 14 patients with ophthalmic aneurysms, to extinguish which he resorted to previously not used epi- and subdural resection of basal bone structures to expose the extradural part of the ICA. The approach includes extradural resection of the anterior tilted process, the roof of the optic nerve canal, and opening of the cavernous sinus. This approach makes it possible to fully expose the clinoid segment of the ICA, separate the orbital artery, and perform clipping of complex “low” aneurysms. The access was later named after the author “Dolenctechnique” and was used by M. Yasargil, H. vanLoveren and others for the surgery of cavernous sinus lesions [7,25]. The advantages of access include high radicality of excluding aneurysms, minimal trauma to the visual apparatus (visual impairment was not noted in the series), and the ability to work without spatulas due to a larger angle of attack [25].

The technique and experience of revascularizing operations on cerebral vessels continued to improve. In the literature, reports began to appear on the operations of creating bypass arterial anastomoses designed to replace the blood flow when the giant aneurysms are turned off. In 1982, R. Roski and R. Spetzler described an observation with the creation of EICMA, where the occipital artery was used as a donor one [124] J. Ausman in 1976 presented a case of creating a microanastomosis between the occipital artery and the posterior inferior cerebellar artery, in 1978 - the first case of PICA

revascularization with the use of an intercalated shunt, which became the radial artery. The idea of using an intercalated arterial shunt was borrowed from cardiac surgeons who performed coronary artery bypass grafting in this way. In 1990, he also presented a series of operations with the imposition of extra-intracranial anastomoses using the superficial temporal artery to turn off giant aneurysms of the anterior circle. In 15 of 62 patients, anastomoses were made with ligation of the artery carrying the aneurysm, in 31 aneurysms were clipped, in 16 - ICA deconstruction with the creation of EICMA. The results are highly commendable: good neurological outcomes were obtained in 84%, mortality was 5%

[17.18].

In 1994 Y. Tanakaetal. presents a series of treatment for 25 patients with paraclinoid large and giant ICA aneurysms. All aneurysms were clipped. The authors were the first to raise the problem of the complexity of turning off giant aneurysms with standard clips, using various options for tunnel clips, as well as "parallel" clipping (overlapping branches along each other or towards each other) for more reliable shutdown of the aneurysm. In addition, Japanese surgeons were the first to describe such a dramatic complication as migration (slipping) of clips from an aneurysm with ICA stenosis [17, 19, 23].

In 1998 K. Kattneretal. presented his experience in the treatment of giant ICA aneurysms using the brain protection protocol, which included the administration of barbiturates, monitoring of the EEG and somatosensory evoked potentials. To facilitate access to the aneurysm, the authors used the Dolenz approach and extradural resection of the anterior tilted process. The treatment was highly radical: aneurysms were successfully extinguished in 28 of 29 patients, and proximal control in two patients was performed in the clinoid segment (C3) and in four in the stony segment of the ICA. One patient underwent a petro-supraclinoid venous anastomosis. Disability of patients according to the results of treatment was 20%, mortality 3.4%. It should be noted that when analyzing the follow-up, 50% of the operated patients did not experience any improvement in vision after the operations [2,5,7].

In 1990, a group of American neurosurgeons led by H. Batjer from the clinic of the Southwestern University of Texas published a clinical case of using an alternative technique - retrograde aspiration of blood through the ICA in the neck, which made it possible both to control blood flow in the aneurysm and to relax it by sucking blood through a catheter ...

In 1994, the same authors reviewed a patient series that included 22 giant paraclinoid aneurysms using blood aspiration. Treatment results were good in 13 (59%) patients, satisfactory in 5 (23%), poor in 3 (13%); 1 patient died (5%). The technique was much simpler than that described by Dolenz, and easily performed without special knowledge of skull base surgery [8,15,28].

Conclusion. Despite the rapid development of high-tech methods in neurosurgery, the treatment of large giant aneurysms of ICA remains an urgent and complex problem in neurosurgery. Analysis of the literature indicates high rates of postoperative complications and mortality when performing endovascular and open methods of surgical treatment of large and giant aneurysms of ICA separately. Each case of this pathology requires an individual approach, a combination of endovascular, open methods of surgery in combination with the creation of additional sources of revascularization. Only about half a century ago, attempts to clip large and giant aneurysms of ICA were made quite rarely and were accompanied by high mortality. [5,7] The main method of radical treatment was deconstructive surgery, which in the case of insufficient collateral blood flow was combined with the imposition of an extra-intracranial microvascular anastomosis. Despite careful selection of candidates, these operations were accompanied by a high rate of complications and mortality. An interesting and clinically significant issue, to which little attention is paid in the domestic literature, is the analysis of long-term results of direct surgery of giant aneurysms of internal carotid artery, in particular, the degree of domestic and labor adaptation of these patients, as well as the dynamics of visual and motor defects.

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

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