Analysis of remote results of eversion carotid endarterectomy

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SUMMARY

Analysed herein are remote results of surgical management of patients presenting with atherosclerotic stenoses of carotid arteries by means of eversion carotid endarterectomy.

Over the period from 2002 to 2007, specialists of the Department of Vascular Surgery of the Institute of Surgery named after A.V. Vishnevsky under the RF Ministry of Public Health carried out performed a total of 393 eversion carotid endarterectomies in 356 patients. We assessed the remote results of 338 (86%) operations in 303 (85%) patients, analysing survival, freedom from stroke, patency of the reconstructed internal carotid artery and effects of risk factors on these indices.

The average duration of follow-up amounted to 84±31 months (max - 46 mos). A total of 242 (71.2%) patients survived. The cumulative 5-year survival rate amounted to 84%, with 10-year survival equalling 63%. Severity of the initial atherosclerotic lesion of the arterial bed, progression of atherosclerosis, and control over risk factors for atherosclerosis exerted a statistically significant influence on total survival. Acute impairments of cerebral circulation (of any localization) at a median follow-up of 81±33 months (max – 146 mos) developed in 38 (12.1%) patients, of whom in 15 (4.8%) it terminated with a lethal outcome. Five-year cumulative freedom from stroke amounted to 92%, equalling 80% at 10 years. The risk factors which influenced the freedom from stroke included a history of acute impairments of cerebral

circulation, restenoses of the reconstructed ipsilateral internal carotid artery (>70%), and diabetes mellitus. Amongst the examined by means of ultrasonography 164 patients, patency of the reconstructed ipsilateral internal carotid artery at an average follow-up of 75±28 months (max – 135 mos) amounted to 95%. Haemodynamically significant restenoses (≥ 70%) were revealed in eight (5%) cases. Of these, three (2%) patients had narrowing of 70-89% and the remaining five (3%) patients had narrowing of ≥ 90% (including 2 occlusions of the reconstructed ipsilateral internal carotid artery). We revealed no risk factors influencing the development of restenosis of the reconstructed ipsilateral internal carotid artery after eversion carotid endarterectomy.

The obtained findings give grounds to consider eversion carotid endarterectomy as a safe and reliable method for treatment of atherosclerotic lesions of carotid arteries and, consequently, for prevention of stroke. Control of risk factors may improve remote results of surgical treatment.

KEY WORDS: eversion carotid endarterectomy, survival, acute cerebral circulation disorders, restenosis, remote results

Introduction

Cerebrovascular diseases due to high incidence prevalence and severe aftermaths consequences for population health constitute are of the main medical and social concern. According to the WHO data annually cerebrovascular diseases about approximately 5 million people die of cerebrovascular diseases. The mortality rate of cerebrovascular disease in Russia are highest in the world and unlike the majority of economically developed countries they not only decrease but have a tendency to increase. Annually in Russia approximately 400 thousand newly onset cases of strokes are registered, with up to 90 % of them leading to resulting in invalidization with persistent clinical manifestations [1].

In Russia, there are more than 1 million people with endured stroke, with one third of them being able-bodied people and only each fourth returning to work [2].

According to the present-day modern concepts it is known that amongst all cases of acute cerebral circulation impairments (ACCI) ischaemic stroke accounts for 80% and its cause in the majority of cases is atherosclerosis of carotid arteries [3]. It is also known that the “gold standard” of treatment for stenosing lesions of carotid arteries is carotid endarterectomy, which has been proved confirmed by multicenter randomized trials such as NASCET, ECST, ACAS [4-6]. This operation is currently performed by three main methods: classical carotid endarterectomy (cCEA), eversion carotid endarterectomy (eCEA), and prosthetic grafting of the internal carotid artery [7].

Despite the fact that high efficacy of surgical management has been confirmed by primary results of surgical treatment, there has not yet been defined an optimal method of surgical

treatment capable to maximally decrease the frequency of restenoses of the internal carotid artery (ICA) and strokes in the remote period. Nevertheless, there have recently been published several studies, including randomized ones, demonstrating long-term advantage superiority of eCEA in treatment of stenosing lesions of the ICA as compared with other types of reconstruction of carotid arteries. Thus, Demirel S. et al. having analysed the remote results (follow-up of 24 months) of 206 operations of eCEA and 310 cCEA operations revealed a statistically higher incidence rate of ipsilateral ACCI with the latter method of intervention (0% versus 2.9%) [8]. In a randomized study Markovich D.M. et al. comparing two groups consisting of 103 cases of eCEA and 98 cases of cCEA at follow-up of 38 months revealed that ICA restenoses were encountered statistically less frequently in the first group (0% vs 6.1%) [9]. A lower incidence rate of ICA restenoses in the remote period (form 12 to 76 months) using the eversion method as compared to the classical one was also observed in the meta-analysis of Antonopoulos C.N. et al comparing the outcomes of 8.550 eCEAs and 7.721 cCEAs [10]. Similar results were obtained reported also in one of few Russian publications, i.e., Kazanchyan et al., comparing the remote results of 570 eCEAs and 243 cCEAs at terms up to 15 years with no indication of the average term of follow up. According to the author's data, ICA restenoses at the mentioned terms were diagnosed nearly 3-times less often (3.5% vs 9.8%) after eCEA [11]. Unfortunately, the available literature contains few publications concerning comparison of eCEA with grafting of the ICA. This is primarily related to the fact that the latter is used only when other methods may be associated with higher risk of complications mainly such as secondary repeat intervention due to complications in both short- and long-term postoperative periods. Nevertheless, according to the currently available data, in particular those contained in the publication of Yu.V. Belov et al., comparing the results of prosthetic repairs of the ICA. eCEA and cCEA performed in 38, 30 and 40 patients, respectively, at follow-up terms up to 24.5 months demonstrated advantage of eCEA over other methods in relation to the incidence rate of ACCI and ICA restenoses. In case of eCEA, these indices amounted to 0 and 3%, whereas in cCEA they reached 3 and 18%, and in grafting of the ICA amounted to 3 and 6%, respectively [12].

As follows from the above-mentioned, eCEA may be a safer and more reliable method for treatment of stenosing disease of carotid arteries in the long-term period. Along with it, considering a relatively "young age" of wide use of this method, the majority of studies are limited by a maximal follow-up of 5 years. However, more weighted conclusions require analysis of longer results.

Materials and methods

Over the period from 2002 to 2007, specialists of the Department of Vascular Surgery of the Institute of Surgery named after A.V. Vishnevsky under the RF Ministry of Public Health carried

out a total of 393 eCEAs in 356 patients. At discharge, all patients were given recommendations to undergo control colour duplex scanning (CDS) of brachiocephalic arteries (BCA) once a year, giving up smoking, constant permanent taking of antiaggregants, control over lipid profile and arterial pressure, and for diabetic patients additional control of glycaemia.

Hereinafter for the purposes of analysing the remote results, each operation will be considered as a separate case – patient.

We managed to analyse the remote results of 338 (86%) eCEAs in 303 (85%) patients, with telephone interrogation being used in 207 (61%) cases (including patients having sent the CDS result by mail). Examination at the Department of Vascular Surgery (taking case history, physical examination (with participation of the neurologist, (CDS of BCA and computed tomography of the brain) was carried out in 131 (39%) patients. The data on patency of the ICA by means CDS were obtained from 164 (49%) patients.

By the moment of operation the patients' age varied from 42 to 86 years (mean 64±8.5 years). The patients were subdivided into three groups by the age: below 60 years – 109 (32%) patients, 61-70 years – 154 (46%), 71 and more – 75 (22%) patients. Men were nearly 2.5-times more than women (234 vs 104).

Distribution of patients by the degree of cerebrovascular insufficiency (according to classification of A.V. Pokrovsky, 1976) [3] was as follows: stage I – 103 (30%), stage II – 50 (15%), stage III – 80 (24%), stage IV – 105 (31%).

Of concomitant diseases, the most frequently encountered were arterial hypertension – 313 (92%) cases, less often coronary heart disease – 146 (43%), and diabetes mellitus – 89 (26%) cases.

The degree of restenosis of the ipsilateral ICA and length of the atherosclerotic plaque according to the CDS findings averaged 80±11% and 25±7.3 mm (min 9.5mm, max – 55 mm), respectively. Patients with unilateral lesions were encountered 3 times as often as those with bilateral lesions – 258 (76%) versus 81 (24%). Detailed baseline clinical parameters are shown in Table 1.

The obtained findings were statistically processes using the SPSS "Statistical 7". The data are represented as mean values and standard deviation. Quantitative variables were compared by means of the Student t-test, categorical variables were compared by means of the Pearson's $\chi 2$ test. Censored data were assessed using the Kaplan-Maier method. Cox's regression analysis (for a large sample) and Fisher method (for a small sample) were used for testing effects of the variables on the final results. Probability of erroneous deviation from the zero hypothesis was tested using the χ^2 criterion and Mann-Whitney U-test. Differences were regarded statistically significant if $p < 0.05$.

Results

Of the analysis-available 338 patients with average follow-up of 84±31 months (max – 146 mos) by the moment of examination, 242 (71.2%) patients survived, with a 5-year cumulative survival rate of 84% and 10-year survival of 63% (Figure 1).

All in all, the cause of death (n = 96) in 15 (4.5%) cases was ACCI, in 22 (6.6%) – myocardial infarction, in 20 (6.0%) oncological diseases, in 22 (6.6%) cases other causes (domestic and industrial injury, asphyxia with a "foreign" body, pulmonary disease, gastrointestinal bleeding, acute renal insufficiency, multiple-organ failure, sepsis, ruptured abdominal aortic aneurysm, rupture of an iliac-artery aneurysm), and in 17 (5.1%) cases death occurred due to an undetermined cause. Mention should be made that the structure of lethal outcomes from ACCI included 3 (0.9%) cases of ipsilateral localization, 1 (0.3%) case – contralateral localization, 1 (0.3%) case of vertebrobasilar localization, and 10 (3.0%) cases – unidentified localization (Table 2).

The age of 71 years and more at the moment of operation, male gender, lesion of other arterial basins, lower-limb ischaemia, a history of arterial reconstructions, arterial reconstructions in the remote period, a prolonged (more than 15 mm) atherosclerotic plaque, no taking of statins before and after operation, as well as myocardial infarction in the remote period statistically significantly decreased total survival (Table 3).

Mention should be made that the neurological status was assessed in the remote period in 314 (93%) patients. It was determined that at follow-up of 81±33 months (max – 146 mos) ACCI developed in 38 (12.%) patients (Table 4), of whom in 15 (4.8%) it terminated with a lethal outcome. Tking into consideration the obtained findings in the mentioned terms the cumulative freedom from any-localization stroke at 5 years amounted to 92%, and to 80% at 10 years (Figure 2).

Risk factor influencing the freedom from stroke in the remote period included a history of ACCI prior to operation, ICA restenoses (>70%), and diabetes mellitus (Table 5).

Patency of the reconstructed ipsilateral ICA at follow-up of 75±28 months (max – 135 mos) amounted to 95%. Analysing the results showed that freedom from haemodynamically significant restenoses at 5 years amounted to 98%, and by the 10^{th} year to 92% (Figure 3). Haemodynamically significant were restenoses ≥ 70% revealed in 8 (5%) cases, of which 3 (2%) had a degree of narrowing of 70-89%, whereas the rest remaining 5 (3%) were ≥90%, including 2 (1.2%) occlusions of the ipsilateral ICA.

The clinical picture in patients having developed ICA restenosis varied from asymptomatic occlusion to clinical picture of ACCI (Table 6). In case of primary detection of asymptomatic haemodynamically meaningful restenosis of the ICA in presence of a stable plaque the patients

were dynamically followed up with recommendations to undergo secondary control BCA CDS after 6 months.

We revealed no risk factors influencing the development of restenosis of the reconstructed ICA after eCEA.

Discussion

Prior to analyzing the obtained findings one should first of all dwell upon such factor as their duration. Amongst 9 statistical analyses of remote results of carotid endarterectomy (not less than 300 cases) published over the last 5 years (Tables 7 – 9), 2 works contain the terms of follow up exceeding ours [17, 20], in 4 articles the duration of the remote period approximately corresponds to ours [14, 16, 21, 22], and in 3 more reports the authors limited to shorter terms of follow up [15, 18, 19].

Addressing the literature data on survival (Table 7), at terms of 5 to 7 years it amounted to 82-95%, decreasing by years 10-13 to 42-91% with a simultaneous increase in spread of values. Our findings on absolute (71%) and cumulative at 10 years (63%) survival completely fall within the above-mentioned interval. It is difficult to say to what degree survival is related to the type of carotid reconstruction, but a tendency to higher values of this parameter in cCEA both at 5-7 years [18] and 10-13 years [21] exists. Somehow unclear seems the spread in values of survival by years 10-13 of follow up since these data are presented by representatives of countries with an approximately similar level of development of public health care: USA [14, 22], Belgium [16], Italy [21]. There is only one work on survivability at longer terms of follow up [17] ant it is difficult to comment these findings.

Starting to analyse the structure of mortality in our patients, mention should be made that it, unfortunately, has turned out traditional for our country. Thus, if excluding deaths from undetermined causes (5.1%), the causes of death in virtually three fourths of our patients turned out ACCIs, myocardial infarction, and oncological diseases. All in all, nearly 50% of patients with determined cause of death died of cardiovascular diseases.

What, according to the findings of our study, influenced survivability? If putting apart unchangeable parameters (age and male gender), it would turn out that all the rest risk factor are associated with either severity of the initial atherosclerotic lesion (clinically significant involvement of other arterial basins, presence of lower-limb ischaemia, a history of arterial reconstruction, length of an atherosclerotic plaque in the ICA), or with progression of atherosclerosis (arterial reconstructions and new cases of myocardial infarction in the remote period) or with control of risk factors for atherosclerosis. Attention is paid to the revealed by us effect of taking statins before and after eCEA on survival.

Assessing the remote results based on stroke incidence seems a more difficult task (Table 8). Thus, incidence of ACCI during 5-7 years of follow up according to the literature data amounts to 0.7-12.0% [15, 18] and at term of 10-13 years and more – to 0.5-13% [16, 20-22], with no clear-cut interrelationship between these parameters and types of carotid endarterectomy seen. The mentioned variability of the results is related first to how this parameter is calculated. Thus, some authors take into account all cases of ACCI in the remote period [15, 16, 22]. Some authors consider only hemispheric ones [18, 21], and some consider only ipsilateral sides of reconstruction of the ICA [20]. The next moment complicating analysis of this parameter is what strokes were included into the statistical analysis. A series of authors analysed any-genesis cases of ACCI [15, 16, 22], others – only ischaemic strokes [18, 20, 21]. The total incidence of strokes at follow-up of 12 years in our work amounted to 12.1% which coincides agrees with the literature data [15, 16, 22], suggesting a fundamental therapeutic effect of surgical revascularization of the brain. Well-known studies NASCET and ECST estimated 2-3-year incidence of ACCI in unoperated symptomatic patients at 22-26%, and the ACAS in non-operated asymptomatic patients determined 5-year incidence of strokes at 11% [4 – 6]. Based on the results of the most representative population study, Framingham Study, 5-year incidence rate of ACCI in "natural course" of cerebrovascular insufficiency depending on gender varies within 21-42 % [23]. According to our findings even the total cumulative freedom of any-localization strokes and any degree cerebrovascular insufficiency by the 10^{th} year of follow-up considerably exceeded the above-mentioned outcomes of conservative treatment, amounting to 80%.

It turned out more difficult to assess in our study the real remote incidence rate of ischaemic ipsilateral and hemispheric ACCIs. We failed to reveal the genesis of ipsi- and contralateral strokes in 0.94% and 0.96% of patients, respectively, as well as to determine localization of ACCI in 3.8% of patients. Supposing that the distribution of ischaemic/haemorrhagic ACCIs of unknown genesis in the groups of ipsi- and contralateral strokes coincides with the ratio of such in the proved genesis, the hypothetic incidence of ischaemic strokes in the reconstruction zone may amount to 1.66%, being 2.29% on the opposite side. Also, assuming that the distribution of strokes of determined localization corresponds to that of the undetermined one, in the latter case the conditional frequency of ischaemic ACCIs should reach 1.9%, of these 0.50% of ipsi- and 0.73% of contralateral ones, with the remaining amounting to accounting for 0.67% in the vertebrobasilar basin. Summing up all the above-mentioned calculations and extrapolations it turns out that tentative remote incidence of ischaemic strokes in the revascularized basin in our patients may amount to 2.16% and on the contralateral side to 3.02%. These findings, undoubtedly, are inferior to the results of the majority of literature sources [18, 20, 21]. How could it be explained? Of the patients we operated on, 305 (90%) people lived in Moscow and the Moscow Region. Nevertheless, only 69% paid at least one visit for ambulatory examination

in the remote period after surgical treatment, but this was not a guarantee of complete dispensary follow up. Thus, 30% of patients continued smoking (with 59% smoking prior to operation), 15% of the followed up diabetic patients had a decompensated course of the disease and 45% of patients with persisting existing in the remote period hypercholesterolemia did not receive hypolipidemic therapy, CDS in the remote terms was carried out in only 49% of patients. Most likely, a low level of control over the risk factors (by both patients themselves and ambulatory physicians), lack of real information on the state of the operated ICA and other BCAs in half of patients did contribute to the above-mentioned increase in the incidence rate of ipsi- and contralateral ACCIs in our study as compared with the majority of literature data.

The factors influencing the development of remote ACCIs in our patients were, like in case with survival, virtually the same causes: initial severity of the atherosclerotic lesion (a history of stroke), progression of atherosclerosis (development of restenoses in the remote period), and absence of control over the risk factors for atherosclerosis (diabetes mellitus). In the light of the above-mentioned we should once again repeat the "ridden to death" thesis on the principal significance of revascularization of the brain at the asymptomatic, pre-stroke stage (see Table 5). Nevertheless, up to now 1/3 of patients undergoing carotid endarterectomy had a history of ACCI.

And, finally, about the last analyzed index determining remote results, i.e. restenoses of the reconstructed ICA (Table 9). The majority of authors, as well as we do, use this term in such recurring lesion wherein narrowing of the lumen of the reconstructed artery reaches not less than 70% [15, 18, 20, 21], or were close to this value [14, 16]. The literature data may be divided into three groups: with a frequency rate of restenoses more than 10% (all in cCEA) [15, 16], within the limits of 4% [14, 17] and less than 1% [18, 20, 21], with no clear-cut interrelation with the duration of follow up traced. In all, with due regard for the data of meta-analysis by Antonopoulos CN et al. [10] one should acknowledge uperiority of eCEA over cCEA concerning the risk for the development of restenoses in the remote period. It is possible that the restenosis rate nearly 4% [14, 17] was associated with the fact that a lesser degree of restenosis was taken into consideration than in the studies where the incidence rate of restenoses did not exceed 1 % [18, 20, 21].

The incidence rate of restenoses in our study turned out higher than in the majority of publications [14, 17, 18, 20, 21]. Although we did not reveal apparent risk factors for this parameter in our patients, the causes of such situation most likely corresponds to the stated in relation to the incidence rate of hemispheric strokes by the monitoring of the BCA condition and control over risk factors for atherosclerosis in the operated patients in the remote terms. The utmost importance of timely detection of haemodynamically meaningful restenoses is reflected by the findings presented in Table 6. Thus, 25% of patients with this complication of the remote

period had occlusion of the reconstructed ICA, luckily, with no development of ACCI, another quarter of patients were preventively at the pre-stroke stage operated on and in a further 25% of cases of ACCI in the remote terms, one case terminated in a lethal outcome and in one case we managed to perform a successive repeat revascularization of the brain.

Conclusion

The remote (maximal duration of follow up amounting to 12 years, moderate terms up to 7 years) results of eversion carotid endarterectomies should be considered successful by such indices as survival, stroke incidence, and frequency of restenoses. The fate of the operated patients in the remote terms of follow up is determined by severity of the initial atherosclerotic lesion of the arterial bed, progression of atherosclerosis, and control over risk factors of the latter. The key moments for improving the presented results are dynamic (not less often at least 1 time a year) CDS monitoring of BCA, systematic clinical assessment of the condition of other arterial basins (first of all, the coronary one) and close control of the risk factors for atherosclerosis. Special attention should be paid at correction of dyslipidaemia, including therapy with statins.

Determination of the significance of namely eversion technique amongst the methods of reconstruction of carotid bifurcation requires comparing the presented results with similar findings with the same terms of follow up after classical carotid endarterectomy, and, desirably, after prosthetic repair of the internal carotid artery.

References

1. З.А.Суслина, Ю.Я.Варакин, Н.В. Верещагин. Сосудистые заболевания головного мозга. 2-е изд., доп. и перераб. М.: МЕДпресс-информ. 2009; 8-11.
2. З.А.Суслина, М.А. Пирадова. Инсульт: диагностика, лечение, профилактика. 2-е изд. М.: МЕДпресс-информ. 2009; 11-14.
3. В.С.Савельев (ред.). 50 лекций по хирургии. М.: «Триада-Х». 2004; 68-84.
4. Fergusson G.G., Eliasziw M., Barr H.W., et al. The North American Symptomatic Carotid Endarterectomy Trial: Surgical results in 1415 patients. Stroke. 1999; 30: 1751-1758.
5. European Carotid Surgery Trialist`s Collaborative Group. Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST). Lancet 1998; 351: 1379-1387.
6. Study design for randomized prospective trial of carotid endarterectomy for asymptomatic atherosclerosis. The Asymptomatic Carotid Atherosclerosis Study Group. Stroke. 1989 Jul.; 20(7): 844-849.
7. Покровский А.В., Белоярцев Д.Ф. Адырхаев З.А. и др. Влияет ли способ каротидной реконструкции на непосредственные результаты вмешательства? Ангиология и сосудистая хирургия. 2012;18 (3): 81-91.
8. Demirel S., Attigah N., Bruijnen H., et al. Multicenter experience on eversion versus conventional carotid endarterectomy in symptomatic carotid artery stenosis: observations from the Stent-Protected Angioplasty Versus Carotid Endarterectomy (SPACE-1) trial. Stroke. 2012 Jul.; 43(7): 1865-1871.
9. Markovic D.M., Davidovic L.B., Cvetkovic D.D., et al. Single-center prospective, randomized analysis of conventional and eversion carotid endarterectomy. J. Cardiovasc. Surg. (Torino). 2008 Oct.; 49(5): 619-625.
10. Antonopoulos C.N., Kakisis J.D., Sergentanis T.N., et al. Eversion versus conventional carotid endarterectomy: a meta-analysis of randomised and non-randomised studies. Eur. J. Vasc. Endovasc. Surg. 2011 Dec.; 42(6): 751-765.
11. Казанчян П.О., Попов В.А., Ларьков Р.Н. и др. Клиническая и хирургическая оценка результатов классической и эверсионной методик каротидной эндартерэктомии. Болезни аорты и ее ветвей. 2009; 6: 42-46.
12. Белов Ю. В., Степаненко А. Б., Генс А. П. и др. Протезирование сонных артерий. Хирургия. Журнал им. Н.И. Пирогова. 2005;(8): 36-40.

13. Клиническая ангиология: Руководство. Под ред. А.В. Покровского. В 2т. М: " Медицина". Т1. 2004; 734-803
14. Black J.H., Ricotta J.J., Jones C.E. Long-term results of eversion carotid endarterectomy. Ann. Vasc. Surg. 2010 Jan.; 24(1):92-99.
15. Dorigo W., Pulli R., Pratesi G., et al. Early and long-term results of carotid endarterectomy in diabetic patients. J. Vasc. Surg. 2011 Jan.; 53(1): 44-52.
16. Louagie Y., Buche M., Eucher P., et al. Case-matched comparison of early and long-term outcomes of everted cervical vein and saphenous vein carotid patch angioplasty. Eur. J. Vasc. Endovasc. Surg. 2011 Dec.; 42(6): 766-774.
17. Radak D., Tanasković S., Matić P., et al. Eversion Carotid Endarterectomy—Our Experience After 20 Years of Carotid Surgery and 9897 Carotid Endarterectomy Procedures. Ann. Vasc. Surg. 2012 Oct.; 26(7): 924-928.
18. Baracchini C., Saladini M., Lorenzetti R., et al. Gender-based outcomes after eversion carotid endarterectomy from 1998 to 2009. J. Vasc. Surg. 2012 Feb.; 55(2): 338-345.
19. Wallaert J.B., Cronenwett J.L., Bertges D.J., et al. Optimal selection of asymptomatic patients for carotid endarterectomy based on predicted 5-year survival. J. Vasc. Surg. 2013 Jul.; 58(1): 112-118.
20. Babu M.A., Meissner I., Meyer F.B. The Durability of Carotid Endarterectomy: Long-term Results for Restenosis and Stroke. Neurosurgery. 2013 May; 72(5):835-838.
21. Ballotta E., Toniato A. Da Giau G., et al. Durability of eversion carotid endarterectomy. J. Vasc. Surg. 2014 May; 59(5):1274-1281.
22. Kang J., Conrad M.F., Patel V.I., et al. Clinical and anatomic outcomes after carotid endarterectomy. J. Vasc. Surg. 2014 Apr.; 59(4):944-949.
23. Sacco R.L., Wolf P.A., Kannel W.B., et al. Survival and recurrence following stroke. The Framingham study. Stroke. 1982 May-Jun.; 13(3):290-295.

Table 1

Baseline clinical characteristics of patients

Characteristic	Number of patients
Age, years	64±8.5 (from 42 to 86)
Men/women	234 (69%) / 104 (31%)
Degree of restenosis of the ipsilateral ICA by CDS findings	80±11%
Length of the atherosclerotic plaque by the CDS findings, mm	25±7.3 (from 9.5 to 55)
Stable/unstable ASP	104 (31%) / 234 (69%)
Unilateral/bilateral lesion of the ICA	257 (76%) / 81 (24%)
Pathological tortuosity of the ipsilateral ICA	16%
Initial degree of cerebrovascular insufficiency: 1 asympromatic 2 TIA 3 chronic cerebrovascular insufficiency 4 after stroke	 103 (30%) 50 (15%) 80 (24%) 105 (31%)
Arterial hypertension	92%
CAD including myocardial infarction angina pectoris	43% 20% 36%
Diabetes mellitus	26%
Hyperlipidaemia	69%
Smoking	59%
Lesion of other arterial basins	43%
History of reconstruction of other arterial basins	24%

Table 2

Structure of causes of death in the remote period

Cause of death	Number
Acute cerebral circulation impairment:	15 (4.5%)
ipsilateral localization	3 (0.9%)
contralateral localization	1 (0.3%)
vertebrobasilar localization	1 (0.3%)
undetermined localization	10 (3.0%)
Myocardial infarction	22 (6.6%)
Oncological diseases	20 (6.0%)
Other causes	22 (6.6)
undetermined cause	17 (5.1%)

Table 3

Effect of risk factors on survival

Risk factor	Mortality*		*p*
Age at operation			
below 60 years	22 (20%) of 109		0.08
61-70 years	44 (28%) of 154		0.70
71 years and more	30 (40%) of 75		0.02
Gender	Male (n = 234)	Female (n = 104)	0,04
	74 (32%)	22 (21%)	
Lesions of other arterial basins	yes (n = 146)	no (n = 192)	0.0001
	58 (40%)	38 (20%)	

Lower-limb ischaemia	yes (n = 123)	no (n = 215)	0.0001
	51 (41%)	45 (21%)	
History of arterial reconstructions	yes (n = 81)	no (n = 257)	0.009
	32 (40%)	64 (25%)	
Length of atherosclerotic plaque (by findings of CDS)	>15 mm (n = 242)	<15 mm (n = 35)	0.01
	76 (31%)	4 (11%)	
Myocardial infarction (new cases) in the remote period	yes (n = 38)	no (n = 265)	0.04
	14 (37%)	57 (22%)	
Arterial reconstructions in the remote period	yes (n = 123)	no (n = 167)	0.006
	33 (32%)	30 (18%)	
Taking statins before surgery	no (n=255)	yes (n=60)	0.02
	82 (32%)	10 (17%)	
Taking statins in the remote period Прием статинов в отдаленном периоде	no (n=103)	yes (n=137)	0.0007
	20 (19%)	7 (5%)	

*Note: average mortality in the sample – 28.8%

Table 4

Localization and causes of strokes in the remote period

Localization and type of stroke	Number
In the basin of the ipsilateral ICA	**2.2%**
ischaemic	3 (0.94%)
haemorrhagic	1 (0.31%)
unknown	3 (0.94%)
In the basin of the contralateral ICA	**3.2%**

ischaemic	5 (1.60%)
haemorrhagic	2 (0.64%)
unknown	3 (0.96%)
In the vertebrobasilar basin	**2.9%**
ischaemic	7 (2.26%)
haemorrhagic	1 (0.32%)
unknown	1 (0.32%)
Undetermined localization	**(3.8%)**
ischaemic	2 (0.63%)
haemorrhagic	2 (0.63%)
unknown	8 (2.53%)

Table 5

Effect of risk factors on the development of any-localization stroke

Risk factor	**Stroke incidence***		***p***
History of acute cerebral circulation impairment before surgery	yes (n = 94)	no (n = 220)	0,05
	17 (18%)	21 (10%)	
State of the reconstructed internal carotid artery	restenosis ≥70% (n = 8)	intact or restenosis <70% (n=156)	0,02
	3 (38%)	17 (11%)	
Diabetes mellitus in the remote period	yes (n = 102)	no (n = 176)	0,03
	18 (18%)	16 (9%)	

*Note: average incidence of stroke in the sample – 12.1%

Table 6

Clinical course of restenoses of the ipsilateral internal carotid artery

Clinical manifestations of restenosis and management policy	Number
Asymptomatic occlusion	1
Occlusion with transitory ischaemic attacks	1
Acute cerebral circulation impairment of ipsilateral localization, common carotid-internal carotid prosthetic repair performed	1
General cerebral symptomatology; ICA stenting performed	1
General cerebral symptomatology, endograft repair of the ICA	1
General cerebral symptomatology; hospitalization for ICA stenting was envisaged, but the women died of unknown-localization stroke	1
Asymptomatic course; dynamic follow up	1
General cerebral symptomatology; dynamic follow up	1

Table 7

Survival in the remote period

Author Автор	n	Type of CEA	Duration of follow up, years	Total survival
Kang J. et al., 2014 [22]	3014	eCEA+cCEA	10	42%
Ballotta E. et al., 2014 [21]	2007	eCEA	13	91%
Wallaert J.B. et al., 2013 [19]	4114	all types	5	82%
Baracchini C. et al., 2012 [18]	1458	eCEA	5	95%
Radak D. et al., 2012 [17]	9897	eCEA	19	63%
Dorigo W. et al., 2011 [15]	4305	cCEA	7	88%
Louagie Y. et al., 2011	322	cCEA	10	52-66%

[16]				
Black J.H. et al., 2010 [14]	534	eCEA	10	50%
Institute of Surgery named after A.V. Vishnevsky	393	eCEA	7	71.2%

Table 8

Stroke incidence in the remote period

Author Автор	**n**	**Type of CEA**	**Duration of follow up, years**	**Total incidence of strokes**	**Incidence of ipsilateral strokes**	**Incidence of contralateral strokes**
Kang J. et al., 2014 [22]	3014	eCEA cCEA	10	13% (any ACCIs)	5.4% (any ACCIs)	-
Ballotta E. et al., 2014 [21]	2007	eCEA	13	0.5% (ischaemic)	0.2%	0.3%
Babu M.A. et al, 2013 [20]	1335	patch	16	0.9% (ischaemic)	0.9%	-
Baracchini C. et al., 2012 [18]	1458	eCEA	5	0.7% (ischaemic)	0.3%	0.4%
Dorigo W. et al., 2011 [15]	4305	cCEA	7	12% (any ACCIs)	-	-
Louagie Y. et al., 2011 [16]	322	cCEA	10	5.9 – 9.5% (any ACCIs)	-	-
Institute of Surgery named after A.V. Vishnevsky	393	eCEA	7	12.1% (any ACCIs)	2.2%	3.2%

Table 9

Incidence of restenoses in the remote period

Author	n	Type of eCEA	Duration of follow up, years	Incidence of restenoses*
Ballotta E. et al., 2014 [21]	2007	eCEA	13	0.2% (≥70%)
Babu M.A. et al., 2013 [20]	1335	patch	16	0.4% (>70%)
Baracchini C. et al., 2012 [18]	1458	eCEA	5	0.2% (≥70%)
Radak D. et al., 2012 [17]	9897	eCEA	19	4.3% (>50%)
Dorigo W. et al., 2011 [15]	4305	cCEA	7	21% (>70%)
Louagie Y. et al., 2011 [16]	322	cCEA	10	6.9-11.1% (≥75%)
Black J.H. et al., 2010 [14]	534	eCEA	9	4% (>60%)
Institute of Surgery named after A.V. Vishnevsky	393	eCEA	7	5% (70%)

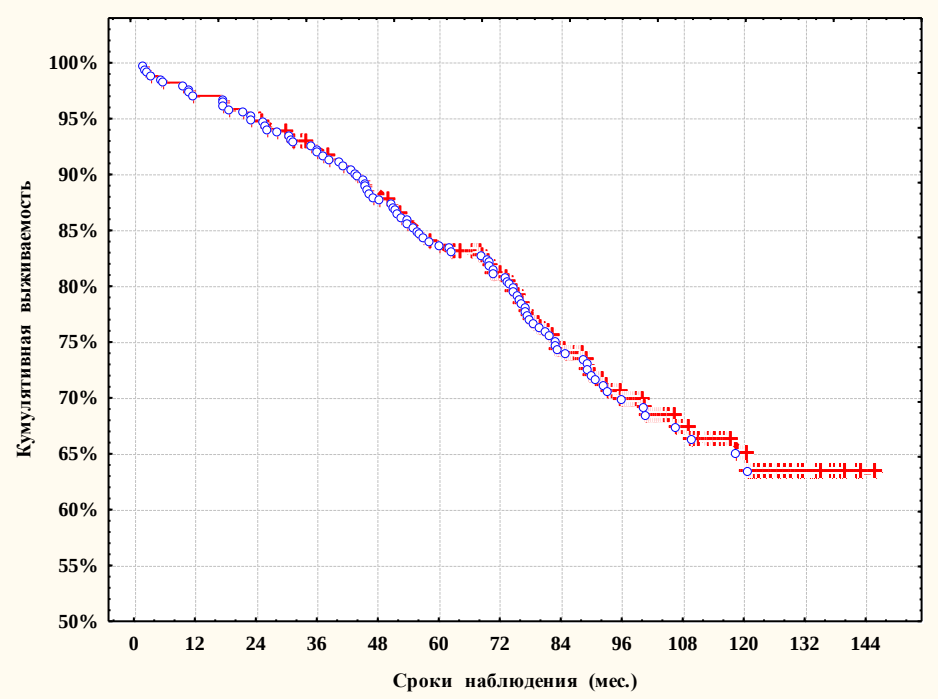

Figure 1. Cumulative survival at 5 and 10 years after surgery

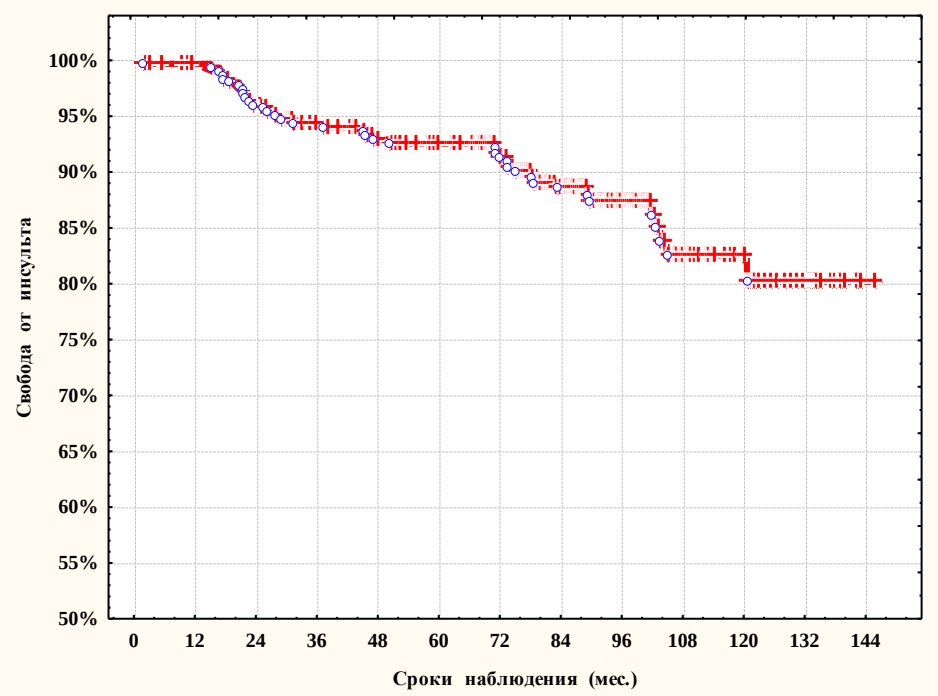

Figure 2. Cumulative freedom from stroke at 5 and 10 years after surgery

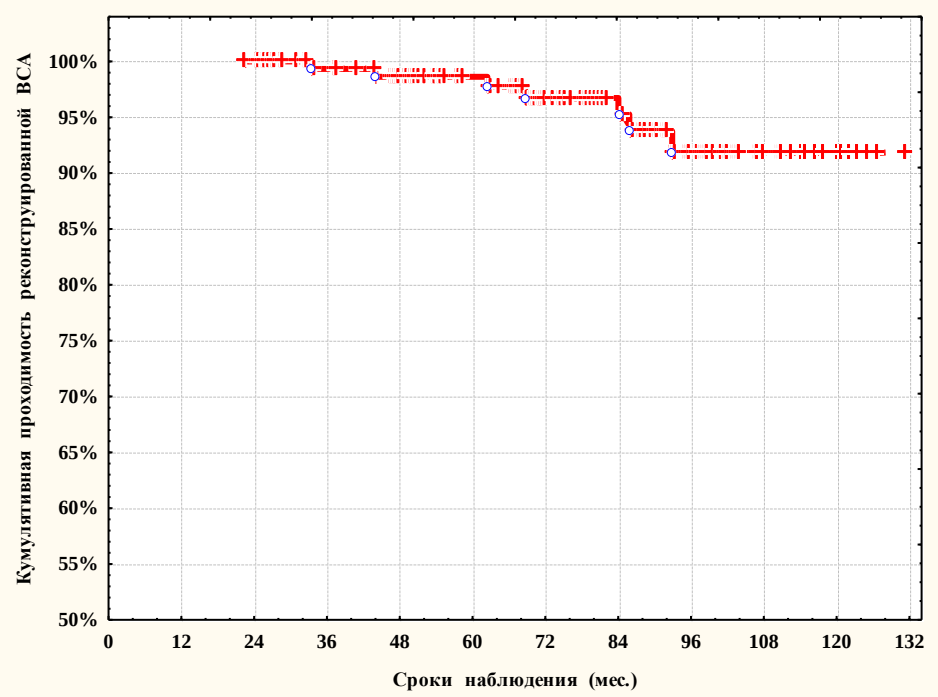

Figure 3. Cumulative patency of the reconstructed internal carotid artery at 5 and 10 years after surgery