УДК 616.133-089.843
DOI: https://doi.org/10.17816/PAVLOVJ104394

Сравнительная оценка результатов различных методик реконструкций каротидной бифуркации

Д. Ф. Белоярцев✉

Национальный медицинский исследовательский центр хирургии имени А. В. Вишневского, Москва, Российская Федерация

АННОТАЦИЯ

Введение. В настоящее время для восстановления проходимости бифуркации сонной артерии при атеросклеротических стенозах используется три основных метода реконструкции: классическая каротидная эндартерэктомия (кКЭАЭ), протезирование внутренней сонной артерии (ВСА) и эверсионная каротидная эндартерэктомия (эКЭАЭ). В работе приведен сравнительный анализ непосредственных и отдаленных результатов этих методик при стенозах бифуркации сонной артерии.

Заключение. В отношении непосредственных результатов анализ литературных источников не позволяет сделать однозначный вывод об очевидных преимуществах того или иного метода вмешательства. Так, ряд авторов зарегистрировали лучшие результаты при использовании эКЭАЭ, другие — не выявили существенного различия между эКЭАЭ и кКЭАЭ, если только речь не шла об использовании прямого шва, причем это относится и к мета-анализам, и к оригинальным исследованиям. В отношении отдаленных результатов практически все литературные источники свидетельствуют о более оптимальных результатах при применении эверсионной методики. На основании проведенного анализа можно сделать вывод о предпочтительности эКЭАЭ, если это позволяют характер поражения каротидной бифуркации и анатомические взаимоотношения в операционной ране.

Ключевые слова: *классическая каротидная эндартерэктомия; эверсионная каротидная эндартерэктомия; протезирование внутренней сонной артерии*

Для цитирования:
Белоярцев Д.Ф. Сравнительная оценка результатов различных методик реконструкций каротидной бифуркации // Российский медико-биологический вестник имени академика И.П. Павлова. 2022. Т. 30, № 2. С. 271–278. DOI: https://doi.org/10.17816/PAVLOVJ104394

Рукопись получена: 03.03.2022 **Рукопись одобрена:** 30.03.2022 **Опубликована:** 30.06.2022

ЭКО•ВЕКТОР

DOI: https://doi.org/10.17816/PAVLOVJ104394

Comparative Assessment of the Results of Different Techniques of Carotid Bifurcation Reconstruction

Dmitriy F. Beloyartsev✉

A. V. Vishnevsky National Medical Research Center of Surgery, Moscow, Russian Federation

ABSTRACT

INTRODUCTION: Nowadays, to restore the patency of the carotid artery bifurcation in atherosclerotic stenoses, three main methods of reconstruction are used, namely, classic carotid endarterectomy (cCEAE), prosthetic repair of the internal carotid artery, and eversion carotid endarterectomy (eCEAE). The study conducted a comparative analysis of the immediate and long-term results of using these methods in the case of stenosis of the carotid artery bifurcation.

CONCLUSION: As regards the immediate results, the analysis of literature does not permit allow making an unambiguous conclusion about the evident advantages of a particular method of intervention. Thus, several authors obtained better results with the use of eCEAE, whereas others did not find any significant differences between eCEAE and cCEAE, if it was not a question about using a straight seam, and this can be referred to both meta-analyses and original studies. Regarding the long-term results, practically all literary sources indicate more optimal results with the use of the eversion technique. The results of the analysis imply the preference for eCEAE if the character of the lesion of the carotid bifurcation and anatomical interrelations in the surgical wound allow it.

Keywords: *classic carotid endarterectomy; eversion carotid endarterectomy; prosthetic repair of the internal carotid artery*

For citation:
Beloyartsev DF. Comparative Assessment of the Results of Different Techniques of Carotid Bifurcation Reconstruction. *I.P. Pavlov Russian Medical Biological Herald.* 2022;30(2):271–278. DOI: https://doi.org/10.17816/PAVLOVJ104394

Received: 03.03.2022 **Accepted:** 30.03.2022 **Published:** 30.06.2022

ECO•VECTOR

LIST OF ABBREVIATIONS

ACVA — acute cerebrovascular accident
cCEA — classic carotid endarterectomy
CF — cranial nerve
eCEA — eversion carotid endarterectomy
ICA — internal carotid artery
PTFE — polytetrafluorethylene

INTRODUCTION

At present, to restore the patency of the bifurcation of carotid artery in atherosclerotic stenosis, three main reconstruction methods are used.

The first is the *open, or classic, carotid endarterectomy* (cCEA) introduced in the clinical practice by M. DeBakey (1953), which is now obligatorily performed with stitching a patch in the arteriotomic opening.

The second is prosthetic repair of the internal carotid artery (ICA) first conducted by F. Denman in 1954.

The third method is eversion carotid endarterectomy (eCEA) proposed by a surgical team of Houston Methodist Hospital in 1959. Today, eCEA is used in two variants: the one proposed by R. Kieny (1985) and the second with some modifications by D. Raithel (1987).

If we turn to the data of the authors' teams with significant experience (more than 1,500 observations) of carotid reconstructions, it turns out that the "monosurgical" approach is used somewhat more often (Table 1) [1–6]. Those who use different methods of the interventions on ICA, do not always discuss the indications for choosing a particular method of reconstruction or do not conduct a comparative assessment of their results [7–11]. In small domestic statistical studies devoted to carotid artery reconstructions, indications for a particular method of intervention are not presented either [12–14].

Table 1. Frequency of Using Different Methods of Interventions on Carotid Arteries According to Modern Literature Data

Authors, Year of Publication	n	Eversion Carotid Endarterectomy	Classic Carotid Endarterectomy	Prosthetic Repair of Internal Carotid Artery	Literature Source
Trisal V., et al., 2002	1648	–	100%	–	[1]
Darling R.C., et al., 2003	3429	100%	–	–	[2]
Raithel D., 2004	19243	61%	26%	6%	[7]
Duncan J.M., et al., 2008	1609	–	100%	–	[3]
Ricco J.B., et al., 2009	1585	–	88%	12%	[8]
Fokin A.A., Babkin E.V., 2010	2240	25%	63%	3%	[9]
Dorigo W., et al., 2011	4305	–	100%	–	[4]
Radak D.J., et al., 2012	9897	100%	–	–	[5]
Kang J., et al., 2014	3014	11%	89%	–	[10]
Ballotta E., et al., 2014	2007	100%	–	–	[6]
Kazantsev A.N. et al., 2020	2130	30%	70%		[11]

Immediate Results of Different Methods of Carotid Artery Reconstructions

In Table 2, the literature sources are given with comparison of the immediate results of eCEA and cCEA.

In meta-analysis of C. N. Antonopopulos, et al., comparing results of 8530 eCEA and 7721 cCEA, it was shown that eCEA is associated with a significantly lower frequency of perioperative acute cerebrovascular accidents (ACVA) and deaths from stroke [15]. It is notable that in a later meta-analysis of K. I. Paraskevas, et al., based on the results of already 16,249 eCEA and 33,251 cCEA, it was shown that the above differences exist only in comparison of eCEA and cCEA with the direct suture. But if to compare the eCEA and cCEA data with a patch plasty, the results appear to be identical [16]. R. A. Vinogradov obtained significant differences both in the frequency of strokes after eCEA (0.3%) and cCEA (2.1%),

Table 2. Comparative Assessment of Immediate Results of Eversion and Classic Carotid Endarterectomy

Authors/Data Base, Type of Study, Year of Publication, Literature Source	Number of Observations, n		Criteria for Comparison
	Eversion Carotid Endarterectomy	Classic Carotid Endarterectomy	
Antonopopulos C.N., et al., *meta-analysis*, 2011 [15]	8 530	7 721	ACVA, mortality from stroke
Paraskevas K.I., et al., *meta-analysis*, 2018 [16]	16 249	33 251	ACVA, mortality from stroke
		patch / straight stitch	
Vinogradov R.A., *original study*, 2019 [17]	1064	195	ACVA, mortality from stroke
Vascular Quality Initiative Database, *registry,* 2020 [18]	12 050	83 712	ACVA, mortality from stroke
		patch / straight stitch	
Gavrilenko A.V. et al., *meta-analysis*, 2020 [19]	1718	1954	ACVA
Kazantsev A.N. et al., *original study*, 2020 [11]	637	1 493	ACVA, mortality, thrombosis
Lazarides M.K., et al., *meta-analysis*, 2021 [20]	431	4 009	ACVA, mortality
		PTFE, xenopericardium / direct suture, vein, dacron, polyurethane	

Note: ☐ — *no statistically significant differences*; ■ — reliably different results; ACVA — acute cerebrovascular accident; PTFE — polytetrafluorethylene

and in ACVA-associated postoperative mortality in these methods of intervention [17].

Analysis of the information of Vascular Quality Initiative Database registry (12,050 eCEA and 83,712 cCEA), did not reveal any differences in the hospital results, unless it was a direct suture (5.1% of cCEA), when 30-day stroke/mortality rate significantly exceeded that in eCEA [18], which coincides with the data of K. I. Paraskevas, et al. [16].

In meta-analysis of A. V. Gavrilenko et al. (2020, 1,718 eCEA and 1,954 cCEA), a statistically significant reduction of the frequency of ACVA in the early postoperative period was found with use of the eversion method [19]. A. N. Kazantsev, et al. (2020) noted the identical frequency of ischemic episodes, mortality and thrombosis with the eversion method and use of a patch [11].

M. K. Lazarides, et al. carried out meta-analysis of 4,400 patients and showed that with use of patches from polytetrafluorethylene (n = 948) or bovine pericardium (n = 249), the immediate results of cCEA are comparable to those after eCEA (n = 431). With use of the direct suture (n = 753), venous (n = 973), dacron (n = 828) or polyurethane patches (n = 258), 30-day stroke or mortality were higher.

In the only work in the literature for comparison of the immediate results of cCEA and ICA prosthetic repair, H. C. Veldenz, et al. did not reveal any differences in the frequency of postoperative ACVA and the endpoint "stroke + mortality from stroke" between 427 cases of cCEA and 51 cases of ICA prosthetic repair (0.7% and 1.9%, 1.2% and 1.9%, respectively) [21].

A comparative evaluation of the immediate results of the three main methods of ICA reconstruction is given only in the work of A. V. Pokrovsky, et al. [22]. The authors studied such results after 630 isolated primary open interventions on the bifurcation of the common carotid artery in atherosclerosis, performed in the vascular surgery department of Vishnevsky Institute of Surgery in the period from January 2008 to December 2010 (Table 3).

The choice of the method of ICA reconstruction was based on the indications given below.

For eCEA:

- anatomical accessibility of ICA for performing eCEA [23];
- brain tolerance to ICA compression;
- absence of evident calcinosis;
- combination of stenosis and tortuosity of ICA.

For cCEA with obligatory plasty with a patch:

- anatomical inaccessibility of ICA for performing eCEA [23];
- extension of arteriotomy to 5 cm;
- brain intolerance to ICA compression.

For ICA prosthetic repair:

- the length of ICA lesion more than 4–6 cm;
- pronounced calcinosis of the artery.

The following results were obtained (Table 3). The frequency of temporary shunting predictably turned out to be significantly higher with cCEA. The incidence of the cranial nerve (CN) injury did not differ statistically between the groups, ICA thrombosis was significantly more frequent after cCEA and ICA prosthetics. If to turn

Table 3. Comparative Assessment of Immediate Results of Eversion Carotid Endarterectomy and Prosthetic Repair of Internal Carotid Artery [22]

Parameter	Eversion Carotid Endarterectomy	Classic Carotid Endarterectomy	Prosthetic Repair of Internal Carotid Artery	p
n (%)	416 (66)	127 (20)	87 (14)	–
Temporary shunting, % of n	1.0	45.7	3.5	< 0.001
Trauma of CN, % of n	4.6	7.1	10.3	> 0.05
Thrombosis of ICA, % of n	0.7	3.9	4.6	< 0.05
Homolateral ACVA, % of n	1.2	2.4	4.6	< 0.001
Stroke + mortality from stroke, % of n	1.4	2.4	5.8	< 0.001

Note: CN — cranial nerve; eCEA — eversion carotid endarterectomy; cCEA — classic carotid endarterectomy; ACVA — acute cerebrovascular accident

to such parameters as the frequency of development of homolateral ACVA and the combination of stroke and mortality from stroke, these endpoints significantly differed only in comparison of eCEA and ICA prosthetics. When comparing the results of eCEA and cEEA, as well as of CEA and ICA prosthetics, these parameters were statistically comparable [22].

Long-Term Results of Different Methods of Carotid Reconstructions

In recent years, some comparative, including randomized, studies have been published, concerning remote results of different variants of interventions on the carotid arteries. As in case with the immediate results, eCEA and cCEA were mostly compared, but the obtained data appeared more uniform (Table 4).

Table 4. Comparative Evaluation of Long-Term Results of Eversion and Classic Carotid Endarterectomy

Authors/Data Base, Type of Study, Year of Publication, Literature Source	Number of Observations, n				Criteria for Comparison and Follow-up Period
	Eversion Carotid Endarterectomy		Classic Carotid Endarterectomy		
Markovic D.M., et al., *original study*, 2008 [24]	103		98		Restenoses, 38 months
Kazanchyan P.O. et al., *original study*, 2009 [25]	570		243		Restenoses, to 15 years
Antonopopulos C.N., et al., *meta-analysis*, 2011 [15]	8 530		7 721		Restenoses, 12–76 months
Demirel S., et al., *original study,* 2012 [26]	206		310		ACVA, 24 months
Vascular Quality Initiative Database, *registry*, 2020 [18]	12 050		83 712		Stroke/mortality, restenoses, 12 months
	patch	direct suture	patch	direct suture	
Gavrilenko A.V. et al., *meta-analysis*, 2020 [19]	1718		1954		ACVA, restenoses
Kazantsev A.N. et al., *original study,* 2020 [11]	637		1 493		Re-occlusions/ restenoses, 48 months
Lazarides M.K., et al, *meta-analysis,* 2021 [20]	431		4 009		Restenoses

Note: ☐ — *no statistically significant differences*; ▫ — reliably different results; ACVA — acute cerebrovascular accident

Thus, S. Demirel, et al., analyzing the long-term results (follow-up period of 24 months) of 206 eCEA and 310 cCEA, noted higher rates of ipsilateral ACVA with the second method of the intervention (0% vs. 2.9%) [26]. In a randomized study, D. M. Markovic, et al. comparing 103 cases of the eversion method and 98 cases of the classic method (follow-up period of 38 months), the incidence of ICA restenoses was lower in the first group (0% vs. 6.1%) [24]. A lower frequency of ICA restenosis in the long-term period (from 12 to 76 months) in the eversion method compared with the classic one (8,550 eCEA and 7,721 cCEA), was also noted in the meta-analysis by S. N. Antonopoulos, et al. [15].

Similar results are given in Russian publications. In the study of P. O. Kazanchyan, et al., the long-term results of 570 eCEA and 243 cCEA were compared (the follow-up period up to 15 years without specifying the mean follow-up period). According to the authors, ICA restenoses were diagnosed almost 3 times less often (3.5% vs. 9.8%) after the eversion method of carotid reconstruction [25]. A. N. Kazantsev, et al. found a two-time difference in the frequency of re-occlusions (5.2% vs. 2.8%) and restenoses (4.2% vs. 2.1%) after use of eversion and classic methods (follow-up period up to 4 years) [11]. Meta-analysis by A. V. Gavrilenko, et al. (1,718 eCEA and 1,954 cCEA) showed a significant reduction of frequency of ACVA, as well as of restenoses, in the remote period of the eversion method of intervention as compared to the classic one [19].

In systematization of the data of Vascular Quality Initiative Database registry, the frequency of stroke/mortality and of restenoses in 1 year after the intervention with use of the primary suture, significantly exceeded those in eCEA in contrast to cases of using patches [18]. In meta-analysis by M. K. Lazarides, et al., the frequency of restenoses after eCEA was the lowest in comparison with any method of arteriotomy closure (direct suture/different kinds of patches) [20].

Unfortunately, there are few publications in the available literature concerning comparison of eCEA with ICA prosthetic repair. This is mostly due to the fact that the latter is used only when other methods entail a higher risk of complications, mainly as a repeated intervention due to complications developed in the early and late postoperative periods.

Nevertheless, according to the existing data, in particular, in the publication of Yu. V. Belov, et al. comparing the results of ICA prosthetics, eCEa and cCEA (n = 38, 30 and 40 patients, respectively, the follow-up to 24.5 months), the advantage of eCEA among other methods is demonstrated in terms of the incidence of ACVA and ICA restenoses. In case of eCEA, these parameters were 0 and 3%, while in cCEA they reached 3 and 18%, and in ICA prosthetic repair — 3 and 6, respectively [14].

CONCLUSION

Concerning the immediate results of carotid reconstructions, the relation between the chosen method of intervention and the obtained results does not seem evident. Thus, a number of authors find a significant advantage in the eversion carotid endarterectomy [15, 17, 19], others do not see any significant difference between eversion and classic carotid endarterectomies [11, 16, 18, 20], unless it is a matter of using direct suture [16, 18, 20], which also refers both to meta-analyses [15, 16, 19, 20] and to the original studies [11, 17].

As for the long-term results, here the situation is more unambiguous: practically all the literature sources show better results of the eversion method [11, 15–17, 19, 20]. The only exclusion is the data of Vascular Quality Initiative Database, and only in the part where the direct suture was not used [18]. Besides, to note, this source uses the shortest follow-up period — only 12 months.

Summarizing the above, one should admit that in carotid reconstructions, a method of choice is eversion carotid endarterectomy, if the peculiarities of lesion of the bifurcation of the carotid artery and relationship between the anatomical structures do not limit the possibility of using eversion method.

ADDITIONAL INFORMATION

Финансирование. Автор заявляет об отсутствии внешнего финансирования.
Конфликт интересов. Автор заявляет об отсутствии конфликта интересов.
Вклад автора: Автор подтверждает соответствие своего авторства международным критериям ICMJE.

Funding. This article was not supported by any external sources of funding.
Conflict of interests. The authors declare no conflicts of interests.
Contribution of the author: Author agree to be accountable for all aspects of the work.

СПИСОК ИСТОЧНИКОВ

1. Trisal V., Paulson T., Hans S.S., et al. Carotid artery restenosis: an ongoing disease process // The American Surgeon. 2002. Vol. 68, № 3. P. 275–280.
2. Darling R.C. 3rd, Mehta M., Roddy S.P., et al. Eversion carotid endarterectomy: a technical alternative that may obviate patch closure in women // Cardiovascular Surgery. 2003. Vol. 11, № 5. P. 347–352. doi: 10.1016/S0967-2109(03)00076-0
3. Duncan J.M., Reul G.J., Ott D.A., et al. Outcomes and risk factors in 1,609 carotid endarterectomies // Texas Heart Institute Journal. 2008. Vol. 35, № 2. P. 104–110.
4. Dorigo W., Pulli R., Pratesi G., et al. Early and long-term results of carotid endarterectomy in diabetic patients // Journal of Vascular Surgery. 2011. Vol. 53, № 1. P. 44–52. doi: 10.1016/j.jvs.2010.08.030
5. Radak D., Tanasković S., Matić P., et al. Eversion carotid endarterectomy — our experience after 20 years of carotid surgery and 9897 carotid endarterectomy procedures // Annals of Vascular Surgery. 2012. Vol. 26, № 7. P. 924–928. doi: 10.1016/j.avsg.2011.09.011
6. Ballotta E., Toniato A., Da Giau G., et al. Durability of eversion carotid endarterectomy // Journal of Vascular Surgery. 2014. Vol. 59, № 5. P. 1274–1281. doi: 10.1016/j.jvs.2013.11.088
7. Raithel D. Would a surgeon operate on patients at 'high risk' of surgery? In: Greenhalgh R.M. Vascular and endovascular challenges. BIBA Publishing;

2004. P. 69–75.
8. Ricco J.B., Marchand C., Neau J.P., et al. Prosthetic carotid bypass grafts for atherosclerotic lesions: a prospective study of 198 consecutive cases // European Journal of Vascular and Endovascular Surgery. 2009. Vol. 37, № 3. P. 272–278. doi: 10.1016/j.ejvs.2008.11.012
9. Фокин А.А., Бабкин Е.В. Инфекционные осложнения реконструктивных операций на сонных артериях при атеросклеротических стенозах // Ангиология и сосудистая хирургия. 2010. Т. 16, № 2. С. 87–90.
10. Kang J., Conrad M.F., Patel V.I., et al. Clinical and anatomic outcomes after carotid endarterectomy // Journal of Vascular Surgery. 2014. Vol. 59, № 4. P. 944–949. doi: 10.1016/j.jvs.2013.10.059
11. Казанцев А.Н., Черных К.П., Лидер Р.Ю., и др. Сравнительные результаты классической и эверсионной каротидной эндартерэктомии // Кардиология и сердечно-сосудистая хирургия. 2020. Т. 13, № 6. С. 550–555. doi: 10.17116/kardio202013061550
12. Казанчян П.О., Попов В.А., Ларьков Р.Н., и др. Сравнительная оценка классической и эверсионной методик каротидной эндартерэктомии // Ангиология и сосудистая хирургия. 2002. Т. 8, № 3. С. 81–86.
13. Седов В.М., Баталин И.В., Кондратьев В.М. Зависимость результатов лечения больных с атеросклерозом артерий головного мозга от технологии каротидной эндартерэктомии // Ангиология и сосудистая хирургия. 2004. Т. 10, № 1. С. 111–115.
14. Белов Ю.В., Степаненко А.Б., Генс А.П., и др. Протезирование сонных артерий // Хирургия. Журнал им. Н.И. Пирогова. 2005. № 8. С. 36–40.
15. Antonopopulos C.N., Kakisis J.D., Sergentanis T.N., et al. Eversion versus conventional carotid endarterectomy: a meta-analysis of randomised and non-randomised studies // European Journal of Vascular and Endovascular Surgery. 2011. Vol. 42, № 6. P. 751–765. doi: 10.1016/j.ejvs.2011.08.012
16. Paraskevas K.I., Robertson V., Saratzis A.N., et al. Editor's Choice — An Updated Systematic Review and Meta-analysis of Outcomes Following Eversion vs. Conventional Carotid Endarterectomy in Randomised Controlled Trials and Observational Studies // European Journal of Vascular and Endovascular Surgery. 2018. Vol. 55, № 4. P. 465–473. doi: 10.1016/j.ejvs.2017.12.025
17. Белоярцев Д.Ф. Каротидные реконструкции: эволюция методик и сравнительные результаты. В кн.: Ревишвили А.Ш., Чупин А.В. II Международная конференция «Сосудистая хирургия в России: прошлое, настоящее, будущее. Диагностика и лечение каротидных стенозов». М.: Фабрика офсетной печати; 2021. С. 156–179.
18. Dakour–Aridi H., Ou M., Locham S., et al. Outcomes following Eversion versus Conventional Endarterectomy in the Vascular Quality Initiative Database // Annals of Vascular Surgery. 2020. Vol. 65. P. 1–9. doi: 10.1016/j.avsg.2019.07.021
19. Гавриленко А.В., Куклин А.В., Аль-Юсеф Н.Н., и др. Метаанализ результатов эверсионной каротидной эндартерэктомии и эндартерэктомии с пластикой заплатой // Ангиология и сосудистая хирургия. 2020. Т. 26, № 1. С. 178–182.
20. Lazarides M.K., Christaina E., Argyriou C., et al. Editor's Choice — Network Meta-Analysis of Carotid Endarterectomy Closure Techniques // European Journal of Vascular and Endovascular Surgery. 2021. Vol. 61, № 2. P. 181–190. doi: 10.1016/j.ejvs.2020.10.009
21. Veldenz H.C., Kinser R., Yates G.N. Carotid graft replacement: a durable option // Journal of Vascular Surgery. 2005. Vol. 42, № 2. P. 220–226. doi: 10.1016/j.jvs.2005.04.004
22. 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. Т. 18, № 3. С. 81–91.
23. Белоярцев Д.Ф. Варианты реконструкций каротидной бифуркации при атеросклерозе: история вопроса и современное состояние проблемы // Ангиология и сосудистая хирургия. 2009. Т. 15, № 1. С. 117–126.
24. Markovic D.M., Davidovic L.B., Cvetkovic D.D., et al. Single-center prospective, randomized analysis of conventional and eversion carotid endarterectomy // The Journal of Cardiovascular Surgery. 2008. Vol. 49, № 5. P. 619–625.
25. Казанчян П.О., Попов В.А., Ларьков Р.Н. и др. Клиническая и хирургическая оценка результатов классической и эверсионной методик каротидной эндартерэктомии // Кардиология и сердечно-сосудистая хирургия. 2009. Т. 2, № 6. С. 42–46.
26. 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. Vol. 43, № 7. P. 1865–1871. doi: 10.1161/STROKEAHA.111.640102

REFERENCES

1. Trisal V, Paulson T, Hans SS, et al. Carotid artery restenosis: an ongoing disease process. *The American Surgeon.* 2002;68(3):275–80.
2. Darling RC 3rd, Mehta M, Roddy SP, et al. Eversion carotid endarterectomy: a technical alternative that may obviate patch closure in women. *Cardiovascular Surgery.* 2003;11(5):347–52. doi: 10.1016/S0967-2109(03)00076-0
3. Duncan JM, Reul GJ, Ott DA, et al. Outcomes and risk factors in 1,609 carotid endarterectomies. *Texas Heart Institute Journal.* 2008;35(2):104–10.
4. DorigoW, Pulli R, Pratesi G, et al. Early and long-term results of carotid endarterectomy in diabetic patients. *Journal of Vascular Surgery.* 2011;53(1):44–52. doi: 10.1016/j.jvs.2010.08.030
5. Radak D, Tanasković S, Matić P, et al. Eversion carotid endarterectomy — our experience after 20 years of carotid surgery and 9897 carotid endarterectomy procedures. *Annals of Vascular Surgery.* 2012;26(7):924–8. doi: 10.1016/j.avsg.2011.09.011
6. Ballotta E, Toniato A, Da Giau G et al. Durability of eversion carotid endarterectomy. *Journal of Vascular Surgery.* 2014;59(5):1274–81. doi: 10.1016/j.jvs.2013.11.088
7. Raithel D. Would a surgeon operate on patients at 'high risk' of surgery? In: *Greenhalgh RM. Vascular and endovascular challenges*. BIBA Publishing; 2004. P. 69–75.
8. Ricco JB, Marchand C, Neau JP, et al. Prosthetic carotid bypass grafts for atherosclerotic lesions: a prospective study of 198 consecutive cases. *European Journal of Vascular and Endovascular Surgery.* 2009;37(3):272–8. doi: 10.1016/j.ejvs.2008.11.012
9. Fokin AA, Babkin EV. Infectious complications of reconstructive operations on carotid arteries in atherosclerotic stenoses. *Angiology and Vascular Surgery.* 2010;16(2):87–90. (In Russ).
10. Kang J, Conrad MF, Patel VI, et al. Clinical and anatomic outcomes

after carotid endarterectomy. *Journal of Vascular Surgery.* 2014;59(4):944–9. doi: 10.1016/j.jvs.2013.10.059
11. Kazantsev AN, Chernykh KP, Lider RYu, et al. Comparative results of conventional and eversion carotid endarterectomy. *Kardiologiya i Serdechno-Sosudistaya Khirurgiya.* 2020;13(6):550–5. (In Russ). doi: 10.17116/kardio202013061550
12. Kazanchyan PO, Popov VA, Larkov RN, et al. Comparative evaluation of classical and eversion methods of carotid endarterectomy. *Angiology and Vascular Surgery.* 2002;8(3):81–6. (In Russ).
13. Sedov VM, Batalin IV, Kondratiev VM. Relationship between the results of the treatment of patients with cerebral artery atherosclerosis and technology of carotid endarterectomy. *Angiology and Vascular Surgery.* 2004;10(1):111–5. (In Russ).
14. Belov YuV, Stepanenko AB, Gens AP, et al. Protezirovanie sonnykh arteriy. *Khirurgiya. Zurnal imeni N.I. Pirogova.* 2005;(8):36–40. (In Russ).
15. Antonopopulos CN, Kakisis JD, Sergentanis TN, et al. Eversion versus conventional carotid endarterectomy: a meta-analysis of randomised and non-randomised studies. *European Journal of Vascular and Endovascular Surgery.* 2011;42(6):751–65. doi: 10.1016/j.ejvs.2011.08.012
16. Paraskevas KI, Robertson V, Saratzis AN, et al. Editor's Choice — An Updated Systematic Review and Meta-analysis of Outcomes Following Eversion vs. Conventional Carotid Endarterectomy in Randomised Controlled Trials and Observational Studies. *European Journal of Vascular and Endovascular Surgery.* 2018;55(4):465–73. doi: 10.1016/j.ejvs.2017.12.025
17. Beloyartsev DF. Karotidnye rekostruktsyi: evolutsija metodik i sravnitelnye resultaty. In: Revishvili AS, Chupin AV. *II Mezhdunarodnaja konferencija "Sosudistaja khirurgija v Rossii: proshloe, nastojatschee, budutschee. Diagnostika I lechenie karotidnykh stenosov".* Moscow: Fabrika ophsetnoy pechati; 2021. P. 156–79. (In Russ).
18. Dakour–Aridi H, Ou M, Locham S, et al. Outcomes following Eversion versus Conventional Endarterectomy in the Vascular Quality Initiative Database. *Annals of Vascular Surgery.* 2020;65:1–9. doi: 10.1016/j.avsg.2019.07.021
19. Gavrilenko AV, Kuklin AV, Al-Yousef NN, et al. Meta-analysis of the results of eversion carotid endarterectomy and endarterectomy with patch plasty. *Angiology and Vascular Surgery.* 2020;26(1):176–83. (In Russ).
20. Lazarides MK, Christaina E, Argyriou C et al. Editor's Choice — Network Meta-Analysis of Carotid Endarterectomy Closure Techniques. *European Journal of Vascular and Endovascular Surgery.* 2021;61(2):181–90. doi: 10.1016/j.ejvs.2020.10.009
21. Veldenz HC, Kinser R, Yates GN. Carotid graft replacement: a durable option. *Journal of Vascular Surgery.* 2005;42(2):220–6. doi: 10.1016/j.jvs.2005.04.004
22. Pokrovsky AV, Beloyartsev DF, Adyrkhaev ZA, et al. Does the method of carotid reconstruction influence the outcomes of the intervention? *Angiology and Vascular Surgery.* 2012;18(3):81–91. (In Russ).
23. Beloyartsev DF. Alternative reconstructions of carotid bifurcation for atherosclerosis: the history and the latest advances. *Angiology and Vascular Surgery.* 2009;15(1):117–26. (In Russ).
24. Markovic DM, Davidovic LB, Cvetkovic DD, et al. Single-center prospective, randomized analysis of conventional and eversion carotid endarterectomy. *The Journal of Cardiovascular Surgery.* 2008;49(5):619–25.
25. Kazanchian PO, Popov VA, Lar'kov RN, et al. Clinical and surgical evaluation of results of classical and eversion carotid endarterectomy. *Kardiologiya i Serdechno-Sosudistaya Khirurgiya.* 2009;2(6):42–6. (In Russ).
26. 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;43(7):1865–71. doi: 10.1161/STROKEAHA.111.640102

ОБ АВТОРЕ

***Белоярцев Дмитрий Феликсович**, д.м.н., профессор;
ORCID: https://orcid.org/0000-0002-7808-3454;
eLibrary SPIN: 6165-3667; e-mail: beloyar@rambler.ru

AUTHOR INFO

***Dmitriy F. Beloyartsev**, MD, Dr. Sci. (Med.), Professor;
ORCID: https://orcid.org/0000-0002-7808-3454;
eLibrary SPIN: 6165-3667; e-mail: beloyar@rambler.ru

* Автор, ответственный за переписку / Corresponding author