

S.P. Grygoruk¹,
M.O. Zorin²,
S.O. Dudukina¹

RESULTS OF TREATMENT OF PATIENTS WITH COMBINED ATHEROSCLEROTIC LESIONS OF THE CEREBRAL AND CORONARY ARTERIES WHO UNDERWENT CAROTID ENDARTERECTOMY AT DIFFERENT TERMS BEFORE AORTIC-CORONARY BYPASS SURGERY

Dnipropetrovsk regional clinical hospital n.a. I.I. Mechnikov¹

Soborna sq., 14, Dnipro, 49000, Ukraine

SE «Dnipropetrovsk medical academy of Health Ministry of Ukraine»²

V. Vernadsky str., 9, Dnipro, 49044, Ukraine

Дніпропетровська обласна клінічна лікарня ім. І.І. Мечникова¹

пл. Соборна, 14, Дніпро, 49000, Україна

ДЗ «Дніпропетровська медична академія МОЗ України»²

вул. В. Вернадського, 9, Дніпро, 49044, Україна

e-mail: grygoruksp@ukr.net

Цитування: *Медичні перспективи*. 2020. Т. 25, № 2. С. 86-92

Cited: *Medicni perspektivi*. 2020;25(2):86-92

Key words: combined atherosclerotic lesions of cerebral and coronary arteries, carotid endarterectomy

Ключові слова: поєднані атеросклеротичні ураження церебральних і коронарних артерій, каротидна ендартеректомія

Ключевые слова: сочетанные атеросклеротические поражения церебральных и коронарных артерий, каротидная эндартерэктомия

Abstract. Results of treatment of patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy at different terms before aortic-coronary bypass surgery.

Grigoruk S.P., Zorin M.O., Dudukina S.O. The quality of life of patients after surgical interventions in those of with combined atherosclerotic lesions of the cerebral and coronary arteries remains a topical issue of modern medicine. The purpose of the study: to analyze the results of treatment of patients with combined atherosclerotic lesions of the cerebral and coronary arteries in the temporal aspect, who underwent carotid endarterectomy as the first stage of treatment. The results of treatment of 112 patients were analyzed. All patients underwent simultaneous cerebral and coronary angiography. After the operation, if new neurological symptoms appeared or a cardiological pathology progressed, the angiographic study was performed again, and the results of this study were used to decide on further tactics. Treatment results were evaluated 30 days, 5 and 10 years after ACBS. With the revealed indications for ACBS, hemodynamically significant stenoses of the operated carotid artery were found in 10.7% of patients. Stenoses of other cerebral vessels that required surgical correction (opposite ICA, VA) in 7.1%. These patients had cerebral artery stenting before ACBS. In 9.8% of patients, indications were found for stenting of cerebral and coronary arteries, which were performed in one session. In 5.4%, only coronary artery stenting was performed. In the remaining 75 patients without indicated surgical correction of cerebral arteries ACBS was performed. So, in 3-5 years after CEE, ACBS TIA was registered only in 4%, ischemic stroke – in 5.3%. The total lethality rate is 4%. The 10-year survival rate after myocardial revascularization was 46% [CI 95% 58%; 34%]. the most intensive decrease in survival function was registered during the first 5 years of follow-up (5-year survival rate 60% [71%; 48%]). Carotid endarterectomy is an effective method of treating atherosclerotic stenosis of the ICA and a method of preventing neurological complications in patients with combined atherosclerotic lesions of the cerebral and coronary arteries with the progression of cardiac pathology.

Реферат. Результати лікування хворих з поєднаними атеросклеротичними ураженнями церебральних та коронарних артерій, яким виконана каротидна ендартеректомія в різні строки перед аорто-коронарним шунтуванням. Григорук С.П., Зорін М.О., Дудукіна С.О. Якість життя пацієнтів після проведених оперативних втручань у пацієнтів з поєднаними атеросклеротичними ураженнями церебральних і коронарних артерій залишається актуальним питанням сучасної медицини. Мета дослідження: проаналізувати в

часовому аспекті результати лікування пацієнтів з поєднаними атеросклеротичними ураженнями церебральних і коронарних артерій, яким першим етапом лікування виконано каротидну ендартеректомію. Проаналізовано результати лікування 112 пацієнтів. Усім хворим проведена одномоментна церебральна і коронарографія. Після операції при появі нових неврологічних симптомів або прогресуванні кардіологічної патології ангіографічне дослідження виконували повторно, за результатами якого приймалося рішення про подальшу тактику. Результати лікування оцінювали через 30 діб, 5 і 10 років після АКШ. При виявлених показаннях до АКШ гемодинамічно значущі стенози оперированої сонної артерії зустрічалися в 10,7% хворих. Стенози інших церебральних судин, які вимагали хірургічної корекції (протилежна ВСА, ПА), у 7,1%. Цим пацієнтам перед АКШ провели стентування церебральних артерій. У 9,8% пацієнтів виявлені показання для стентування коронарних артерій, які були виконані в одну сесію. У 5,4% проведено тільки стентування коронарних артерій. Реітмі 75 пацієнтам, у яких не було показань до хірургічної корекції церебральних артерій, виконували АКШ. Так, через 3-5 років після КЕЕ АКШ виконано 35 хворим, пізніше, ніж через 5 років – 40 пацієнтам. У післяопераційному періоді АКШ ПІА зареєстрована лише в 4%, ішемічний інсульт у 5,3%. Загальна летальність 4%. 10-річна виживаність після реваскуляризації міокарда становила 46% [ДІ 95% 58%; 34%], найбільш інтенсивне зниження функції виживання зареєстровано протягом перших 5 років спостереження (5-річна виживаність 60% [71%; 48%]). Каротидна ендартеректомія є ефективним методом лікування атеросклеротичних стенозів ВСА і методом попередження неврологічних ускладнень у пацієнтів з поєднаними атеросклеротичними ураженнями церебральних і коронарних артерій при прогресуванні кардіологічної патології

In recent years, the main cause of death in Ukraine is cardiovascular diseases, namely heart attacks and brain strokes, the main cause of which is atherosclerosis [1].

Recently, a lot of literature data on the treatment of connected atherosclerotic lesions of the cerebral and coronary arteries in patients with indications to surgery on both circulations appeared. The results of treatment have been well studied, and there is ongoing discussion about the type, sequence, and technique of surgeries [2, 3, 4, 5, 9]. Progress in the diagnosis and treatment of combined atherosclerotic lesions of the cerebral and coronary arteries is unambiguous [7, 8, 10], but the question of quality of life after surgical interventions remains relevant.

The purpose of the study: to determine the results of treatment of patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy (CEE) at various terms before aortic-coronary bypass surgery (ACBS).

MATERIALS AND METHODS OF RESEARCH

The results of treatment of 112 patients with combined atherosclerotic lesions of the cerebral and coronary arteries, who underwent carotid endarterectomy (CEE) at the first stage were analyzed. At the time of the CEE, all patients had atherosclerotic lesions of the cerebral and coronary arteries, determined by using simultaneous coronary and cerebral angiography, but surgical interventions were only indicated on the carotid arteries. Repeated coronary angiography was performed at various terms after the CEE when symptoms of coronary artery disease appeared or progressed. To determine the effectiveness of the performed CEE and the state of all cerebral vessels, cerebral angiography was performed in a joint program simultaneously with coro-

nary angiography. A similar diagnostic program was performed in patients with new neurological symptoms. Treatment results were determined in 30 days, 5 and 10 years after ACBS.

General methods of statistical processing were used in all patients. The presence of a relationship between quality indicators was established on the basis of χ^2 criterion. To determine the strength of the relationship between such indicators, the Kramer conjugacy coefficient was determined based on statistics χ^2 . Evaluation of the survival function of patients was performed using the Kaplan-Meier method [2]. Statistical analysis was performed in the Jupyter Notebook application using Python. Jupyter Notebook is an open source application and is distributed free of charge under a modified BSD license. To evaluate the survival function, we used the lifelines survival analysis library, which is also free and distributed under the MIT license.

RESULTS AND DISCUSSION

In 37 (33%) patients, cerebral arteries stenosis and/or coronary artery stenosis were detected during the examination and their surgical correction was indicated.

With the revealed indications for ACBS, hemodynamically significant stenoses of the operated carotid artery were observed in 12 (10.7%) patients. Stenosis of other cerebral vessels requiring surgical correction (opposite ICA, VA – in 8 (7.1%). These patients underwent endovascular surgery on the cerebral arteries before ACBS. In 11 (9.8%) patients, indications for stenting of the coronary and cerebral arteries were found (in 2 operated – ICA, in 7 – the opposite ICA, in 2 – VA), which were performed simultaneously. Coronary artery stenting was performed in 6 (5.4%) patients. ACBS was

performed in other 75 patients who did not have indications for surgical correction of cerebral arteries, after establishing the indications. So, in 3-5 years after CEE, ACBS was performed in 35 patients, and in more than 5 years – in 40 patients.

Complications after CEE were significantly associated with obesity ($p=0.00003$) – 100% of obese patients had various complications, the presence of

overflows according to CAG ($p=0.000001$) – 30.8% of patients without overflows had complications, and slightly associated with the presence of an ischemic focus according to CT ($p=0.02$) – 28.6% of patients had complications.

The frequency and complications after CEE are presented in the table (Table 1).

Table 1

Frequency of complications after carotid endarterectomy in patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy before aortic-coronary bypass surgery

Complication	Frequency
Angina in the postoperative period	14.7% (11)
AMI	1.3% (1)
TIA	4% (3)
Ischemic stroke	4% (3)
Hyperperfusion syndrome	5.3% (4)
Hypotension	2.7% (2)
PATE	1.3% (1)

Angina in the postoperative period was the most frequent complication of the early postoperative period and was statistically more common in AMI ($p=0.002$) and hypotension ($p=0.022$) than in TIA ($p=0.022$) and ischemic stroke ($p=0.022$). All patients with complications received intensive care according

to international standards. Urgent coronary angiography was performed in patient who was found to have signs of AMI, and no indications for operative revascularization were found.

The general results of treatment after CEE are presented in the table (Table 2).

Table 2

Results of treatment after carotid endarterectomy in patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy before aortic-coronary bypass surgery

Result	Frequency
General improvement without regression of symptoms	44% (33)
Complete regression of neurological symptoms	48% (36)
Partial regression of neurological symptoms	4% (3)
Aggravation of symptoms	1.3% (1)
Without changes	2.7% (2)
Death	0% (0)

The table shows that the statistical majority of patients had complete regression of neurological symptoms and general improvement without regression of neurological symptoms in comparison with other treatment results. The number of patients with worsening and patients without changes in neurological status did not differ statistically ($p=0.3$). After performing CEE, 78.8% of patients without complications and 22.2% of patients with complications had complete regression of neurological symptoms. The presence of factors that influenced the results of treatment: neurological deficit before surgery ($p=0.02$), the absence of flows by CAG

($p=0.02$), the presence of VA stenosis ($p=0.015$), the occurrence of complications ($p=0.003$) was statistically confirmed

During the 10-year follow-up period, 11 (14.7%) patients had general brain symptoms according to the questionnaire, and 8 (10.7%) had TIA.

After ACBS, 81% of patients without complications after CEE and 19% of patients with various complications after CEE had complete regression of cardiac symptoms.

After performing ACBS, the following complications were observed in patients of this group (Table 3).

Table 3

Frequency of complications after ACBS in patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy before aortic-coronary bypass surgery

Complication	Frequency
No complications	61.3% (46)
Angina in the postoperative period	25.3% (19)
AMI	4% (3)
TIA	4% (3)
Ischemic stroke	5.3% (4)

There were statistically more patients without complications than patients with complications ($p=0.00002$). Significantly more patients had angina in the postoperative period than AMI ($p=0.0001$), ischemic stroke ($p=0.0004$), and TIA ($p=0.015$). The

frequency of AMI and ischemic stroke was almost identical ($p=0.69$).

During the statistical analysis, factors affecting the occurrence of complications and treatment results after ACBS were identified (Table 4).

Table 4

Factors affecting the overall results of treatment of patients with combined atherosclerotic lesions of the cerebral and coronary arteries

Factors that influence the occurrence of complications	Factors affecting treatment outcomes
history of AMI ($p=0.001$) obesity ($p=0.003$) neurological deficit before surgery ($p=0.023$) chronic pyelonephritis ($p=0.018$) complications after CEE ($p=0.024$)	gender ($p=0.029$) functional class of angina ($p=0.044$) no overflows according to CAG data ($p=0.039$) AMI history ($p=0.003$) the presence of complications after ACBS ($p=0$) results after CEE ($p=0.00002$)

Thus, complications in the postoperative period after ACBS were observed in 20.7% of patients with a history of AMI, 69% of patients with chronic pyelonephritis, 96.6% of patients with obesity, and 75.9% of patients with neurological deficits. Impro-

vement of the condition after surgery occurred in 100% of patients without a history of AMI, 100% of the deceased patients had a history of AMI, although the overall results of treatment did not differ much except for mortality (Table 5).

Table 5

Results of treatment in patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy before aortic-coronary bypass surgery, depending on the presence of AMI in the history

AMI/result	Improvement of condition	Regression of symptoms	Partial regression	Aggravation of symptoms	Without changes	mortality
None	17.7% (11)	58.1% (36)	14.5% (9)	8.1% (5)	1.6% (1)	0% (0)
Present	0% (0)	46.2% (6)	15.4% (2)	15.4% (2)	0% (0)	23.1% (3)
P	p = 0.225	p = 0.432	p = 0.726	p = 0.764	p = 0.385	p = 0.002

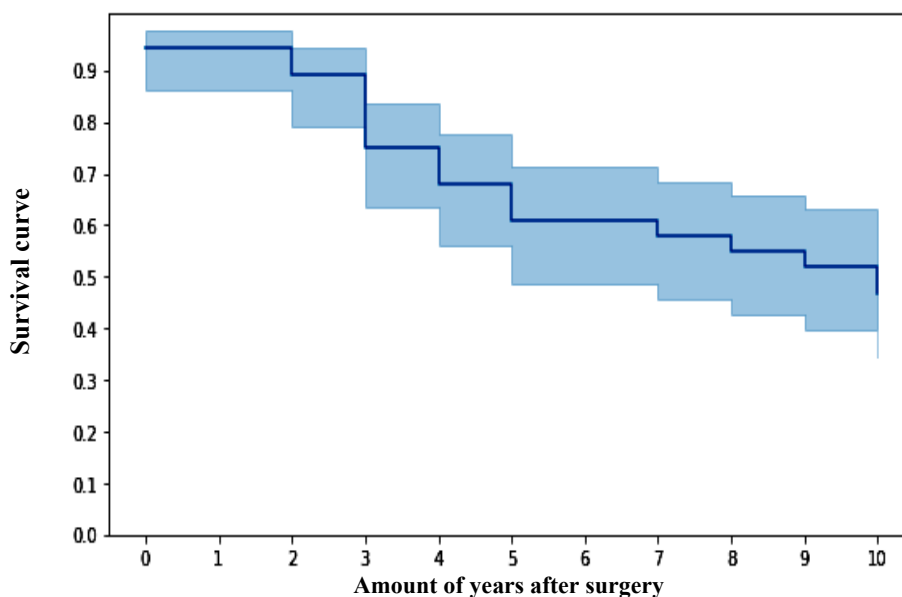
66.7% of patients with AMI in the postoperative period and 5.3% with angina and heart failure that occurred after ACBS died. 33.3% of patients with AMI and 75% of patients with ACA had a deterioration in their condition. Complete regression of cardiac symptoms was observed in 65.2% of patients without complications after ACBS. Partial regression of cardiac symptoms was observed in 15.2% of patients without complications, and in 21.1% with angina in the postoperative period. 25% of patients with ACA had no changes in the course of cardiac symptoms.

In 27.3% of patients with general improvement without regression of neurological symptoms after CEE, there was improvement after ACBS, in 36.4% – regression of cardiac symptoms, in 12.1% – partial regression, in 15.2% – deterioration, in 3% changes were not observed, 6.1% of patients died. In patients with complete regression of neurological symptoms after CEE, only 5.6% had improvement, 80.6% had complete regression of cardiac symptoms, 11.1%

had partial regression, and 2.8% had deterioration. All patients with partial regression of neurological symptoms and deterioration had similar changes in cardiac symptoms. One patient, whose neurological condition did not change after CEE, had a complete regression of cardiac symptoms, and the other died 3 days after ACBS. Complete regression of cardiac symptoms was observed in 56% of patients, partial regression was observed in 14.7%, and deterioration was observed in 9.3% of patients.

The total mortality rate in patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy at different terms before aortic-coronary bypass surgery was 4% (3 patients).

When calculating the survival function in patients with combined atherosclerotic lesions of the cerebral and coronary arteries, who underwent CEE before ACBS, a 10-year survival after myocardial revascularization was 46 % [CI 95% 58%; 34%] (Fig.).



Curve of survival functions in patients with combined atherosclerotic lesions of the cerebral and coronary arteries who underwent carotid endarterectomy before aortic-coronary bypass surgery

Figure also shows that the decrease in survival function was observed more intensively during the first 5 years of follow-up (5-year survival – 60% [71%; 48%], and during the observation period of 5-10 years, the function graph was almost at the plateau level.

CONCLUSIONS

Carotid endarterectomy is an effective method of treating atherosclerotic stenosis of the ICA and a

method of preventing neurological complications in patients with combined atherosclerotic lesions of the cerebral and coronary arteries with the progression of cardiac pathology for 5 years or more.

Conflict of interests. The authors declare no conflict of interest.

REFERENCES

1. [A round table discussion was held in the Verkhovna Rada on the topic: "Overcoming death: key factors influencing the life expectancy of Ukrainians.]. Information Department of the Verkhovna Rada of Ukraine; 2019. Ukrainian. Available from: <https://rada.gov.ua/print/172805.html>
2. Aydin E, Ozen Y, Sarikaya S, Yukseltan I. Simultaneous coronary artery bypass grafting and carotid endarterectomy can be performed with low mortality rates. *Cardiovasc J Afr.* 2014;25:130-3. doi: <https://doi.org/10.5830/CVJA-2014-018>
3. Pinto Sousa P, Teixeira G, Gonçalves J, Veiga C, Sá Pinto P, Brandão P, Canedo A, Vouga L, Almeida R. Carotid Stenosis in Cardiac Surgery Patients. *Rev Port Cir Cardiorac Vasc.* 2017;24:126. PMID: 29701358
4. Donmez AA, Adademir T, Sacli H, Koksall C, Alp M. Comparison of early outcomes with three approaches for combined coronary revascularization and carotid endarterectomy. *Braz J Cardiovasc Surg.* 2016;31:365-70. doi: <https://doi.org/10.5935/1678-9741.20160076>
5. Feldman DN, Swaminathan RV, Geleris JD, Okin P, Minutello RM, Krishnan U, et al. Comparison of Trends and In-Hospital Outcomes of Concurrent Carotid Artery Revascularization and Coronary Artery Bypass Graft Surgery: The United States Experience 2004 to 2012. *JACC Cardiovasc Interv.* 2017;13:286-98. doi: <https://doi.org/10.1016/j.jcin.2016.11.032>
6. Gottesman RF Asymptomatic Carotid Stenosis in Cardiac Surgery Patients: Is Less More? *Stroke.* 2017;48:2650-1. doi: <https://doi.org/10.1161/STROKEAHA.117.018754>
7. Paraskevas KI, Nduwayo S, Saratzis AN, Naylor AR. Carotid Stenting Prior to Coronary Bypass Surgery: An Updated Systematic Review and Meta-Analysis. *Eur J Vasc Endovasc Surg.* 2017;53:309-19. doi: <https://doi.org/10.1016/j.ejvs.2016.12.019>
8. Zhang J, Xu RW, Fan X, Ye Z, Liu PA. Systematic Review of Early Results Following Synchronous or Staged Carotid Artery Stenting and Coronary Artery Bypass Grafting. *Thorac Cardiovasc Surg.* 2017;65:302-10. doi: <https://doi.org/10.1055/s-0035-1566262>
9. Levy E, Yakubovitch D, Rudis E, Anner H, Landsberg G, Berlatzky Y, et al. The role of combined carotid endarterectomy and coronary artery bypass grafting in the era of carotid stenting in view of long-term results. *Interact Cardiovasc Thorac Surg.* 2012;15:984-8. doi: <https://doi.org/10.1093/icvts/ivs398>
10. Aboyans V, Ricco JB, Bartelink MEL, Bjorck M, Brodmann M, Cohnert T, et al. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS). *European Heart Journal.* 2018;39:763-821. doi: <https://doi.org/10.1093/eurheartj/ehx095>

СПИСОК ЛІТЕРАТУРИ

1. У Верховній Раді відбувся круглий стіл на тему: «Перемогти смерть: ключові чинники, що впливають на тривалість життя українців». Інформаційне управління Апарату Верховної Ради України. 2019. URL: <https://rada.gov.ua/print/172805.html>
2. Aydin E., Ozen Y., Sarikaya S., Yukseltan I. Simultaneous coronary artery bypass grafting and carotid endarterectomy can be performed with low mortality rates. *Cardiovasc J Afr.* 2014. Vol. 25. P. 130-133. DOI: <https://doi.org/10.5830/CVJA-2014-018>
3. Carotid Stenosis in Cardiac Surgery Patients / P. Pinto Sousa et al. *Rev Port Cir Cardiorac Vasc.* 2017. Vol. 24. P. 126. PMID: 29701358.
4. Comparison of early outcomes with three approaches for combined coronary revascularization and carotid endarterectomy / A. A. Donmez et al. *Braz J Cardiovasc Surg.* 2016. Vol. 31. P. 365-370. DOI: <https://doi.org/10.5935/1678-9741.20160076>
5. Comparison of Trends and In-Hospital Outcomes of Concurrent Carotid Artery Revascularization and Coronary Artery Bypass Graft Surgery: The United States Experience 2004 to 2012 / D. N. Feldman et al. *JACC Cardiovasc Interv.* 2017. Vol. 13. P. 286-298. DOI: <https://doi.org/10.1016/j.jcin.2016.11.032>
6. Gottesman R. F. Asymptomatic Carotid Stenosis in Cardiac Surgery Patients: Is Less More? *Stroke.* 2017. Vol. 48. P. 2650-2651. DOI: <https://doi.org/10.1161/STROKEAHA.117.018754>
7. Paraskevas K. I., Nduwayo S., Saratzis A. N., Naylor A. R. Carotid Stenting Prior to Coronary Bypass Surgery: An Updated Systematic Review and Meta-Analysis. *Eur J*

Vasc Endovasc Surg. 2017. Vol. 53. P. 309-319.
DOI: <https://doi.org/10.1016/j.ejvs.2016.12.019>

8. Systematic Review of Early Results Following Synchronous or Staged Carotid Artery Stenting and Coronary Artery Bypass Grafting / J. Zhang et al. *Thorac Cardiovasc Surg.* 2017. Vol. 65. P. 302-310.
DOI: <https://doi.org/10.1055/s-0035-1566262>

9. The role of combined carotid endarterectomy and coronary artery bypass grafting in the era of carotid

stenting in view of long-term results / E. Levy et al. *Interact Cardiovasc Thorac Surg.* 2012. Vol. 15. P. 984-988 DOI: <https://doi.org/10.1093/icvts/ivs398>

10. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS) / V. Aboyans et al. *Eur. Heart Journal.* 2018. Vol. 39. P. 763-821.

DOI: <https://doi.org/10.1093/eurheartj/ehx095>

Стаття надійшла до редакції
02.10.2019

