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Angioplasty and Stenting for Carotid Artery Near-Occlusion

Abstract. Carotid near-occlusion (CNO) is the type of severe atherosclerotic stenosis of the internal carotid artery (ICA) with or without collapse of the vessel distally to the narrow part. According to the North American Symptomatic Carotid Endarterectomy Trial (NASCET), severity of ICA stenosis highly correlates with the risk of stroke, except for cases of extremely critical stenosis > 94%, where the risk is lower, and, according to recent guidelines, conservative treatment is preferable. This consideration is questionable due to the recent data about early stroke recurrence and worldwide practice. Rapid improvement of endovascular technique during the last decade makes carotid angioplasty and stenting (CAS) a feasible option for the treatment of patients with CNO and is widely reported in the literature. However, in uncertain circumstances, more scientific data are necessary to fulfill the gap in indications, terms and risks of CAS for CNO.

The aim. To evaluate the results of the treatment of patients with CNO after CAS.

Materials and methods. Three hundred and fifteen patients were surgically treated at Scientific-Practical Center of Endovascular Neuroradiology of the National Academy of Medical Sciences of Ukraine due to ICA stenosis between 2010 and 2020. Among them, 39 (12.4%) patients (11 woman / 28 men (age 57.9±2.1 years) had CNO and underwent CAS at our Center. Patient population, clinical and radiological investigations, procedure complications were investigated. Procedure complications (stroke, hemodynamic depression [HD] and hyperperfusion syndrome [HPS]) were meticulously studied. All the patients had routine ultrasound and clinical check 30 days after the procedure.

Results. All the patients with CNO were successfully stented with the improvement of the site of stenosis after CAS, with only minimal residual stenosis in cases of severe HD. We observed two procedural vascular accidents, first patient had transient ischemic attack (TIA) and one had stroke due to middle cerebral artery occlusion after stent placement and further urgent mechanical thrombectomy. The patient had no neurologic decline and was discharged home. We didn't observe any cases of myocardial infarction (MI) or death in our series during the hospital stay. HD was seen in 13 (33.3%) patients, and mostly resolved after the procedure except for 3 cases that required prolonged intensive care unit stay. HPS was diagnosed in 2 (5.1%) patients and also didn't have any neurologic consequences after supportive care. During 30 days of follow-up, one (2.6%) patient had TIA because of anti-platelets cessation and 1 (2.6%) patient had MI after 1 week since discharge. All control images revealed stents patency without the evidence of critical residual stenosis.

Conclusions. CNO remains important diagnostic and therapeutic challenge. Recent data showed high risk of recurrent stroke in case of CNO on best medical therapy, especially at an early stage, but it remains a preferred option according to guidelines. Considering worldwide improvement of stroke rates after CAS in patients with symptomatic ICA stenosis, further studies are warranted to evaluate its risk-benefit in case of CNO, especially with full collapse. Our data shows that CAS with careful preoperative diagnosis and planning is an effective procedure for selected patients with CNO.

***Keywords*:** *critical carotid artery stenosis, carotid near-occlusion, carotid artery collapse, angioplasty and stenting, treatment outcome.*

Introduction. More than 13 million people suffer from stroke every year worldwide and nearly 80% of them are ischemic [1]. And up to 12% of cases of ischemic stroke are due to atherosclerosis of the internal carotid artery (ICA) with critical stenosis. According to the North American Symptomatic Carotid Endarterectomy Trial (NASCET), severity of ICA stenosis highly correlates with the risk of stroke, except for cases of extremely critical stenosis > 94%, where the risk is lower, and, according to recent guidelines, conservative treatment is preferable [2]. This type of severe atherosclerotic stenosis, which is usually found in the ICA bulb and reaches more than 94%, is called carotid near-occlusion (CNO) and has a lot of different terms in the literature. Among the most common terms: preocclusive stenosis, subtotal stenosis, subtotal occlusion, subocclusion, 99% stenosis, 'string sign', functional occlusion, pseudo-occlusion, and incomplete occlusion etc. [3]. Critical slow flow through stenotic part of the vessel reduces post-stenotic perfusion pressure that in some cases causes the collapse of the distal segments of ICA and the appearance of the 'string sign' [4]. This phenomenon is also combined with delayed filling of distal segments of the ICA and development of hemispheric crossflow through leptomeningeal collaterals [4]. Literature data about clinical significance of CNO is controversial. Besides NASCET, further pooled results from randomized controlled trial that investigated revascularization procedure (carotid endarterectomy [CEA] and best medical treatment [BMT]) concluded the absence of obvious benefit after CEA in case of CNO [5]. Recent European Society for Vascular Surgery (ESVS) guidelines recommend BMT according to post-hoc analyses of the some surgical trials (NASCET, the Veterans Affairs trial, and European Carotid Surgery Trial [ECST]), where authors reported low risk of stroke in case of CNO and no surgical benefit [6]. However, this conclusion is far from routine practice, and more and more studies show that revascularization procedure is probably useful for patients with CNO. In such circumstances, meta-analysis found increased early stroke rate in patients with CNO, and revascularization was considered to be relatively safe and useful for stroke prevention [7]. In such uncertainness, further data are needed to clarify the indications and risks for revascularization considering recent advances in neuroimaging and carotid angioplasty and stenting (CAS).

The aim. To evaluate the results of treatment of patients with CNO after CAS.

Materials and methods. Three hundred and fifteen patients were surgically treated at Scientific-Practical Center of Endovascular Neuroradiology of the National Academy of Medical Sciences of Ukraine due to ICA stenosis between 2010 and 2020. Among them, 39 (12.4%) patients (11 woman / 28 men aged 57.9±2.1 years) had CNO and underwent CAS at our Center. Patient population, clinical and radiological investigations, procedure complications were investigated. Procedure complications (stroke, hemodynamic depression [HD] and hyperperfusion syndrome [HPS]) were meticulously studied.

Clinical characteristics of patients with CNO were studied according to the obtained data. Results are sown in Table 1.

Full clinical and laboratory investigation was conducted in all cases and patients were informed about the procedural risk. They were subdivided into groups of patients with CNO with collapse (13 [33.3%] pts) (Fig. 1) and without collapse (26 [67.7%] pts) (Fig. 2). In case of CNO with critically small ICA lumen, patients received dual antiplatelet therapy and were monitored till improvement of the ICA diameter for safe stenting (Fig. 1). In case of delay, patients with vessel occlusion remained on BMT. Two patients initially had total ICA occlusion, however, follow-up for 4 weeks since BMT found improvement to CNO. Two asymptomatic patients were scheduled for cardiac revascularization, and during clinical investigation, CNO was detected. All the patients received dual antiplatelet therapy (aspirin 100 mg and clopidogrel 75 mg during 5 days before the procedure). Antiplatelet therapy was postponed in case of large ischemic lesion after stroke or because of the other contraindications [15].

The method of CAS at our Center was previously described in the literature and had few peculiarities in case of CNO [15]. Femoral approach with heparinization was preferably used. 8F guiding catheter was put near stenosis, and embolic protection device was navigated distally. In every case balloon predilatation was made and self-expanding stents were opened. Balloon postdilatation with meticulous hemodynamic control was conducted till the restoration of the vessel lumen. Angiographic

Table 1

Patient population before the procedure

Parameters	N of patients (%)		
Male/female ratio	28/11		
Age, y	57.9±2.1 years		
Presentation	Asymptomatic 2 (5.2%)	TIA 13 (33.3%)	Stroke 24 (61.5%)
ipsilateral	–	13 (33. %)	21 (87.5%)
contralateral	–	13 (100%)	3 (12.5%)
Hypertension 24 (61.5%) pts	1 (50%)	9 (69.2%)	14 (58.3%)
Diabetes mellitus 15 (38.5%) pts	–	6 (46.2%)	9 (37.5%)
Smoking 34 (87.2%) pts	1 (50%)	11 (84.6%)	22 (91.7%)
MI 4 (10.3%) pts	2 (100%)	2 (15.4%)	–
Heart failure 8 (20.5%) pts	2 (100%)	1 (7.7%)	5 (20.8%)

TIA, transient ischemic attack; MI, myocardial infarction.

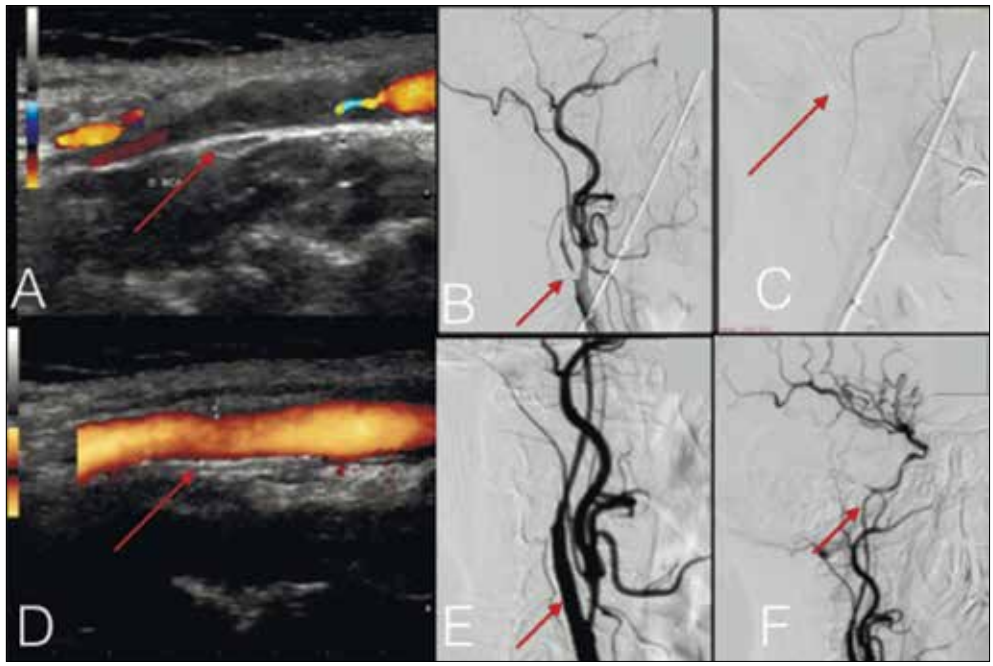

Fig. 1. *Female patient aged 63 after non-disabling stroke. Ultrasound assessment of carotid artery revealed right CNO (arrow) (A). Digital subtraction angiography found CNO with ICA collapse and late filling (arrows) (B and C). The procedure was made with obvious lumen restoration and improvement of ICA lumen (arrow) (E and F). Follow-up ultrasound after 30 days (D) revealed stent patency (arrow)*

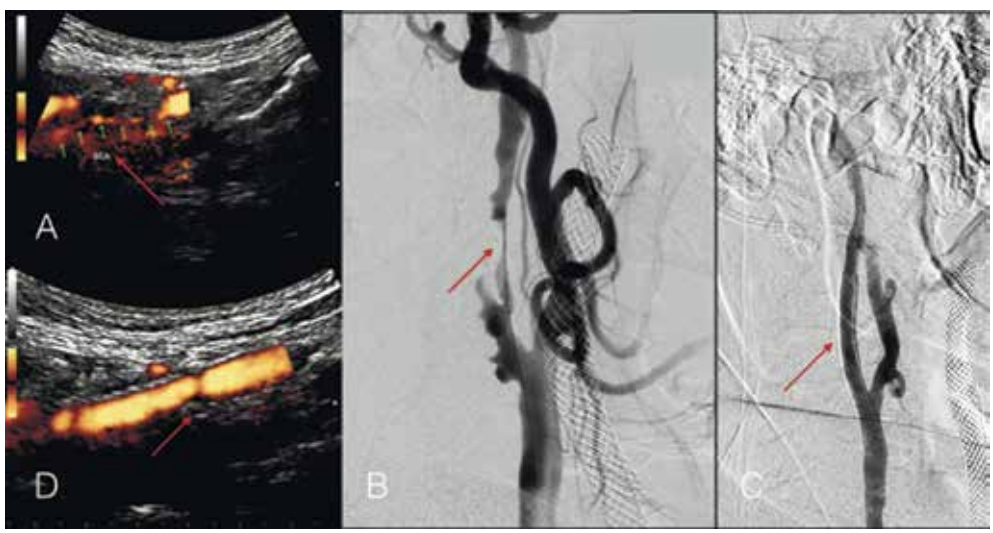

Fig. 2. *Male patient aged 64 after right eye amaurosis fugax and previously stented left ICA. Ultrasound assessment of carotid artery revealed right CNO (arrow) (A). DSA found CNO without ICA collapse (arrows) (B). Procedure was made with restoration of the lumen (arrow) (E and F). Follow-up ultrasound after 30 days (D) revealed stent patency (arrow)*

run of intracranial vessels was made for control of distal embolism. Protection device was withdrawn from the blood stream and the vessel was closed with the sealants.

Systemic hemodynamics were routinely measured and atropine was administered in case of HD, which was treated with crystalloids and colloids. All the patients were transferred to the intensive care unit (ICU) [15]. In the ICU, measurement of blood pressure and heart rate with neurologic examination was made and supportive hemodynamic therapy was provided if necessary.

The procedure complications (stroke, HD and HPS) were meticulously studied. Because of small sample size we used only descriptive statistics, and values were expressed as mean ±SD [15].

Follow-up. All the patients had routine ultrasound or computed tomography angiography imaging 30 days after the procedure, and medical data about clinical endpoints was collected.

Results and discussion. All 39 patients with CNO were successfully stented with the improvement of the vessel lumen after CAS, with only minimal residual stenosis in cases of severe HD (Table 2).

There were two procedural vascular accidents, one transient ischemic attack (TIA) and one stroke due to the distal middle cerebral artery (MCA) embolism after stent placement. Urgent mechanical thrombectomy was conducted with favorable outcome. After 2 passes the vessel was opened with eTICI score 3 at the end. The patient had

Table 2

CAS peculiarities in patients with CNO

Parameters	39 patients
Length of stenosis, mm	14.1±2.1
Stenosis location	
CCA-ICA	20 (51.3%)
ICA	19 (48.7%)
Near-occlusion with full collapse	13 (33.3%)
Ulceration	22 (56.4%)
Calcification	24 (61.5%)
Predilatation	39 (100%)
Neuroprotection device	39 (100%)
Postdilatation	39 (100%)
Total stented length, mm	39.2±4.9
Time of procedure, min	36±15
Fluoroscopy time, min	12.1±3.2
Mean contrast agent dose, ml	70.0±11.2

CCA, common carotid artery.

no neurological decline after the procedure and was discharged home. We didn't observe any cases of myocardial infarction or death in our series during the hospital stay. Patients with procedural complications were analyzed; their data are summarized in the Table 3.

Thirteen patients (33.3%) had bradycardia or systemic hypotension after the procedure. Three of them required additional pressure support and were carefully monitored for 2-3 days till stabilization and hemodynamic improvement. Two patients (5.1%) had HPS, with seizures and neurologic decline after CAS. These patients also needed prolonged ICU stay with complete recovery and resolution of neurological deficits. There were no deaths during hospitalization. Most patients with complications had CNO with collapse, history of stroke and comorbid pathology.

During 30 days of follow-up, one (2.6%) patient had TIA because of anti-platelet cessation and 1 (2.6%) patient had MI 1 week after discharge. All control images revealed stents patency without the evidence of critical residual stenosis.

CNO was first reported by Lippman et al. in 1970 [8]. Its incidence, according to the literature, is up to 2% and continues to grow with the improvement of neuroimaging [3]. Recent classification subdivides near-occlusion by the presence or absence of ICA collapse. Change in its size is the result of physiological response to flow reduction [9] and has high impact on the clinical course. Recent studies showed that CNO with ICA collapse carries high short-term risk of stroke during the first month after debut [10]. In contrast, early NASCET and ECST trials evaluating BMT found a relatively low risk of recurrent stroke, but near

Table 3

Complications of CAS in patients with CNO

Parameter		TIA/Stroke (2 pts)	HD (13 pts)	HPS (2 pts)
Male/female	28/11	2/0	9/4	2/0
Age, y	57.9±2.1	62.2±2.9	58.9±1.5	59.1±4.2
Presentation				
TIA	13 (33.3%)	0	3 (23.1%)	0
Stroke	24 (61.5%)	2 (100%)	10 (76.9%)	2(100%)
ipsilateral	21 (53.8%)	2 (100%)	10 (76.9%)	2(100%)
contralateral	3 (7.7%)	0	0	0
Asymptomatic	2 (5.2)	0	0	0
Hypertension	24 (61.5%)	2 (100%)	10 (76.9%)	1 (50.0%)
Diabetes mellitus	15 (38.5%)	0	3 (23.1%)	0
Smoking	34 (87.2%)	2 (100%)	8 (61.5%)	2 (100%)
History of myocardial infarction	4 (10.3%)	0	1 (7.7%)	0
Heart failure	8 (20.5%)	1 (50.0%)	2 (15.4%)	0
Length of stenosis, mm	14.1±2.1	15.2	14.9±2.3	16.1
Near-occlusion with full collapse	13 (33.3%)	2 (100%)	8 (61.5%)	1 (50.0%)
Ulceration	22 (56.4%)	2 (100%)	3 (23.1%)	1 (50.0%)
Calcification	24 (61.5%)	1	9 (69.2%)	1 (50.0%)
Time of procedure, min	36.3	79.2	45.2	38.1
Fluoroscopy time, min	12.1	33.3	19.1	14.2
Mean contrast agent dose, ml	70.0	85.0	79.5	69.4

a half of all patients with CNO were included 4 weeks or later after last ischemic event, and CNO with collapse was present only in 6.1% patients [11]. According to our data, the present incidence of CNO with full collapse reached 33.3% and can be even higher, nearly 40% in other reports [9, 10]. Nevertheless current guidelines recommend BMT for patients with CNO [6, 12]. This uncertain result demonstrates the need for further studies with careful patient evaluation as it seems that CNO are often overlooked on both ultrasound and computed tomography angiography (CTA) in routine practice [13]. We believe that CNO with collapse as non-functional vessel is the main challenge for treatment strategy, as rescue of this injured vessel can have tremendous impact on whole cerebral circulation and improve cerebral perfusion. Recent rapid advances in CAS technology that continue to improve significantly over the last years decreased complication rate. But these challenging CNO procedures require a high-capacity neuroradiological center, as successful revascularization is highly dependent upon experience of the surgeon. Every case of restoration of this critically stenotic vessel lumen requires professional evaluation of the density of the plague, site and length of the stenosis and risk of HD. In cases of severe HD, we preferred to leave residual stenosis up to 20% to avoid unnecessary hemodynamic complication. Besides, the use of distal protection device is mandatory for every case of CNO to reduce the risk of distal embolism. Nevertheless, our complicated case with MCA embolism occurred in the presence of the protection device. And in such circumstances, mechanical thrombectomy is an irreplaceable procedure which can decrease serious neurologic complications.

Although our case series are uncontrolled, the procedural complications and 30-days follow-up revealed results compatible with literature data [14].

Our study has some limitations. First of all, the retrospective design without control group. However, the main aim of our case series was to highlight the use of endovascular procedure for CNO and to show the discrepancy between literature data. Recent studies debate the postulate about BMT for any CNO, and further studies are needed to find the patients who can succeed with revascularization. In such circumstances, CAS with its technical improvement seems reasonable option with careful planning and multidisciplinary approach.

Conclusions. CNO remains a significant diagnostic and therapeutic challenge. Recent data showed high risk of recurrent stroke in case of CNO on BMT, especially at an early stage, but it remains a preferred option according to guidelines. Considering worldwide improvement of stroke rates after CAS in patients with symptomatic ICA stenosis, further studies are warranted to evaluate its risk-benefit in case of CNO, especially with full collapse. Our data shows that CAS with careful preoperative diagnosis and planning is an effective procedure for selected patients with CNO.

Conflict of interest. We declare no conflict of interest.

References

1. GBD 2016 Stroke Collaborators. Global, regional, and national burden of stroke, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019;18(5):439-58. https://doi.org/10.1016/S1474-4422(19)30034-1
2. Clinical alert: benefit of carotid endarterectomy for patients with high-grade stenosis of the internal carotid artery. National Institute of Neurological Disorders and Stroke Stroke and Trauma Division. North American Symptomatic Carotid Endarterectomy Trial (NASCET) investigators. Stroke. 1991;22(6):816-7. https://doi.org/10.1161/01.str.22.6.816
3. Johansson E, Fox AJ. Carotid Near-Occlusion: A Comprehensive Review, Part 1 – Definition, Terminology, and Diagnosis. AJNR Am J Neuroradiol. 2016;37(1):2-10. https://doi.org/10.3174/ajnr.A4432
4. Akkan K, Ilgit E, Onal B, Cindil E, Solak EP, Oncu F, et al. Endovascular Treatment for Near Occlusion of the Internal Carotid Artery: 30-Day Outcome and Long-Term Follow-Up. Clin Neuroradiol. 2018;28(2):245-52. https://doi.org/10.1007/s00062-016-0546-8
5. Rothwell PM, Eliasziw M, Gutnikov SA, Warlow CP, Barnett HJ; Carotid Endarterectomy Trialists Collaboration. Endarterectomy for symptomatic carotid stenosis in relation to clinical subgroups and timing of surgery. Lancet. 2004;363(9413):915-24. https://doi.org/10.1016/S0140-6736(04)15785-1
6. Naylor AR, Ricco JB, de Borst GJ, Debus S, de Haro J, Halliday A, et al. Management of atherosclerotic carotid and vertebral artery disease: 2017 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). Eur J Vasc Endovasc Surg. 2018;55(1):3-81. https://doi.org/10.1016/j.ejvs.2017.06.021
7. Antonopoulos CN, Giosdekos A, Mylonas SN, Liapis CD. Management of internal carotid artery near-occlusion: the need for updated evidence. Ann Transl Med. 2020;8(19):1263. https://doi.org/10.21037/atm.2020.03.148
8. Lippman HH, Sundt TM Jr, Holman CB. The poststenotic carotid slim sign: spurious internal carotid hypolasia. Mayo Clin Proc. 1970;45(11):762-7.
9. Johansson E, Fox AJ. Carotid Near-Occlusion: A Comprehensive Review, Part 2 – Prognosis and Treatment, Pathophysiology, Confusions, and Areas for Improvement. AJNR Am J Neuroradiol. 2016;37(2):200-4. https://doi.org/10.3174/ajnr.A4429
10. Gu T, Aviv RI, Fox AJ, Johansson E. Symptomatic carotid near-occlusion causes a high risk of recurrent ipsilateral ischemic stroke. J Neurol. 2020;267(2):522-30. https://doi.org/10.1007/s00415-019-09605-5
11. Fox AJ, Eliasziw M, Rothwell PM, Schmidt MH, Warlow CP, Barnett HJ. Identification, prognosis, and management of patients with carotid artery near occlusion. AJNR Am J Neuroradiol. 2005;26(8):2086-94.
12. Brott TG, Halperin JL, Abbara S, Bacharach JM, Barr JD, Bush RL, et al. 2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on

the Management of Patients with Extracranial Carotid and Vertebral Artery Disease: Executive Summary. Circulation. 2011;124(4):489-532. https://doi.org/10.1161/CIR.0b013e31820d8d78
13. Johansson E, Fox AJ. Near-occlusion is a common variant of carotid stenosis: study and systematic review. Can J Neurol Sci. 2022;49(1):55-61. https://doi.org/10.1017/cjn.2021.50
14. Batchelder AJ, Saratzis A, Ross Naylor A. Editor's Choice – Overview of Primary and Secondary Analyses From 20 Randomised Controlled Trials Comparing Carotid Artery Stenting With Carotid Endarterectomy. Eur J Vasc Endovasc Surg. 2019;58(4):479-93. https://doi.org/10.1016/j.ejvs.2019.06.003
15. Shchehlov DV, Svyrydiuk OY, Vyval MB, Sydorenko OF, Nosenko NM, Gudym MS. Simultaneous bilateral angioplasty and stenting for carotid stenosis – a single center experience. J Med Life. 2022;15(2):252-7. https://doi.org/10.25122/jml-2021-0274

Ангіопластика та стентування субоклюзій внутрішньої сонної артерії

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Резюме. Субоклюзія внутрішньої сонної артерії (ВСА) – це особлива форма тяжкого стенозу з частковим або повним спаданням дистального відділу внаслідок недостатнього кровонаповнення. За даними North American Symptomatic Carotid Endarterectomy Trial (NASCET), високий ступінь стенозу ВСА пов'язаний з підвищеним ризиком іпсилатерального інсульту, за винятком випадків критичного стенозу > 94 %, коли медикаментозна терапія є кращою. Але у зв'язку з останніми повідомленнями про ризик повторного раннього інсульту цей висновок піддається сумніву. За таких обставин швидке вдосконалення ендоваскулярних технологій робить каротидну ангіопластику та стентування (КАС) розумним варіантом лікування пацієнтів із субоклюзією ВСА.

Мета – оцінити результати ангіопластики та стентування при субоклюзії внутрішньої сонної артерії.

Матеріали та методи. У ДУ «Науково-практичний центр ендоваскулярної нейрорентгенохірургії НАМН України» з 2010 по 2020 рік було проведено 315 процедур КАС, з них у 39 (12,4 %) пацієнтів (11 жінок / 28 чоловіків, середній вік – 57,9 ± 2,1 року) мали субоклюзію ВСА. Ми досліджували первинні (інфаркт міокарда, інсульт або смерть) та вторинні клінічні результати (гемодинамічна депресія (брадикардія або гіпотензія) та синдром гіперперфузії після процедури. Усі пацієнти проходили планове ультразвукове та клінічне дослідження через 30 днів після процедури.

Результати. Усі процедури КАС були успішними, і відзначено зменшення стенозу після процедури з мінімальним залишковим стенозом у випадках стійкої гемодинамічної депресії. Було два процедурних неврологічних ускладнення, одна транзиторна ішемічна атака та один інсульт через оклюзію середньої мозкової артерії після встановлення стента та подальшої ургентної механічної тромбектомії. Пацієнт не мав неврологічного дефіциту і був виписаний із задовільним результатом, оцінка 1 за модифікованою шкалою Ренкіна (mRS). Інфаркту міокарда або летальних випадків в нашій серії під час госпіталізації не відзначено. У 13 пацієнтів (33,3 %) була гемодинамічна депресія, а у 2 (5,1 %) пацієнтів – гіперперфузійний синдром. Протягом 30 днів спостереження в одного (2,6 %) пацієнта зафіксована транзиторна ішемічна атака через самовільну відміну антиагрегантів, а в 1 (2,6 %) пацієнта стався інфаркт міокарда через 1 (2,6 %) тиждень після виписки. Усі контрольні обстеження виявили прохідність стентів без ознак критичного залишкового стенозу.

Висновки. Субоклюзія внутрішньої сонної артерії залишається діагностичною та терапевтичною проблемою. Останні дані свідчать про високий ризик раннього інсульту у випадку субоклюзії при використанні медикаментозної терапії, проте згідно з рекомендаціями це залишається варіантом вибору у лікуванні. З огляду на світову тенденцію до зниження частоти інсультів після КАС, необхідні подальші дослідження для оцінювання операційного ризику та користі у випадку субоклюзії ВСА, особливо при повному її колапсі. Наші дані показують, що КАС з ретельною передопераційною діагностикою та плануванням є ефективною процедурою для окремих пацієнтів із субоклюзіями.

Ключові слова: *критичний стеноз сонної артерії, субоклюзія сонної артерії, колапс сонної артерії, ангіопластика та стентування сонної артерії, результати лікування.*

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