Case Report

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Emergency Carotid Endarterectomy for Internal Carotid Artery Thrombosis in the Course of COVID-19

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ABSTRACT A case of successful emergency carotid endarterectomy (CEE) in the acute period of ischemic stroke (within an hour after the onset of symptoms) in a patient with acute occlusive thrombosis of the internal carotid artery in the course of moderate-severe COVID-19 with a positive result of the polymerase chain reaction of the nasopharyngeal smear for SARS-CoV-2. The diameter of the ischemic focus in the brain according to multispiral computed tomography did not exceed 2.5 cm. The course of ischemic stroke was characterized by mild neurological deficit (score 5 according to National Institute of Health Stroke Scale). It was demonstrated that the severity of the patient's condition was associated with bilateral, polysegmental, viral penvmonia with 65% damage to the lung tissue, a decrease in SpO_2 to 93%. Laboratory noted coagulopathy with an increase in D-dimer (2837.0 ng/ml), prothrombin according to Quick (155.3%), fibrinogen (14.5 g/l) and signs of a "cytokine storm" with leukocytosis (28.4 10E9/l), an increase in C-reactive protein (183.5 mg/l), ferritin (632.8 ng/ml), interleukin-6 (176.9 pg/ml).
The patient underwent glomus-sparing eversional CEE. The intervention was performed under local anesthesia due to the high risk of developing pulmonary barotrauma when using mechanical ventilation. To prevent the development of acute hematoma, a double active drainage was used into the paravasal space and subcutaneous fatty tissue (SFT). In case of thrombosis of one of the drainages, the second could serve as a spare. Also, upon receipt of hemorrhagic discharge from the drainage located in the SFT, the patient would not need to be transported to the operating room. Removal of skin sutures with revision and stitching of the bleeding source could be performed under local anesthesia in a dressing room. The postoperative period was uneventful, with complete regression of neurological symptoms. Used anticoagulant (heparin 5 thousand units 4 times a day s/c) and antiplatelet therapy (acetylsalicylic acid 125 mg at lunch). The patient was discharged from the hospital on the 12th day after CEE in satisfactory condition.

Keywords: carotid endarterectomy, thrombosis, internal carotid artery thrombosis, arterial thrombosis, thrombectomy, COVID-19, new coronavirus, new coronavirus infection

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BCA – brachiocephalic arteries

CCA – common carotid artery

CDS – color duplex scanning

CEE – carotid endarterectomy

ICA – internal carotid artery

MV – mechanical ventilation

MSCT – multislice computed tomography

NIHSS – National Institute of Health Stroke Scale

TIA – transient ischemic attack

INTRODUCTION

The *COVID*-19 pandemic has changed the understanding of the pathogenesis of arterial thrombosis. Under the conditions of a new coronavirus infection, the latter can develop against the background of a direct effect of the virus on the endothelium, severe coagulopathy and a systemic inflammatory response [1]. The overwhelming majority of works are devoted to the treatment of patients with peripheral arterial thrombosis [2, 3]. They demonstrate that the traditional methods of revascularization, presented in the current domestic and foreign recommendations, have low efficiency, which is manifested by an increase in the number of amputations and deaths [2, 3]. In turn, in the Russian literature today there are no articles devoted to the surgical treatment of patients with acute thrombosis of the internal carotid artery (ICA) and the formation of ischemic stroke against the background of *COVID*-19. The lack of randomized trials and information in the current guidelines creates uncertainty in the choice of the type of revascularization for a given lesion. It remains unclear which treatment will be most effective: drug therapy, endovascular intervention, or carotid endarterectomy (CEE)?

Within the framework of this clinical example, the results of emergency CEE are presented in a patient with ICA thrombosis in the acute period of ischemic stroke against the background of a moderate course of *COVID* -19.

Clinical example

A 61-year-old male patient, admitted to the institution with complaints of hyperthermia (38.5), dyspnea on exertion (SpO_2 = 93%), headache, dry cough. According to multispiral computed tomography (MSCT) of the chest organs, bilateral polysegmental viral pneumonia was diagnosed with 65% of lung tissue lesions. A decision was made to hospitalize the patient in the infectious diseases department.

According to the general analysis of blood, there was a significant leukocytosis ($28.4 \cdot 10^{9}$/l); according to the biochemical blood test: an increase in the level of ferritin (632.8 ng/ml), *C*- reactive protein (183.5 mg/l), interleukin-6 (176.9 pg/ml); according to the coagulogram test: an increase in the level of *D*-dimer (2837.0 ng/ml), fibrinogen (14.5 g/l), prothrombin according to Quick (155.3%).

The patient had a positive nasopharyngeal smear polymerase chain reaction for the presence of *SARS-CoV*- 2. A moderate course of the disease was established, therapy was started according to the 11th version of the Temporary guidelines for the prevention, diagnosis and treatment of a new coronavirus infection (*COVID* - 19) of the Ministry of Health: remdesivir (1st day 200 mg once intravenously; from the 2nd day 100 mg 1 once a day intravenously); baricitinib (4 mg once a day); heparin (5 thousand IU 4 times a day subcutaneously); paracetamol (500 mg once a day). Due to the fact that a year ago the patient underwent percutaneous coronary intervention, without relapse of angina, therapy with acetylsalicylic acid (125 mg 1 time per day) was continued.

Two days after hospitalization, the patient complained of weakness in the right limbs. MSCT of the brain was performed, which revealed signs of ischemic stroke in the basin of the left middle cerebral artery: in the cortical convexital parts of the left parietal lobe, an area of about 17x14x15 mm of reduced density was found (Fig. 1).

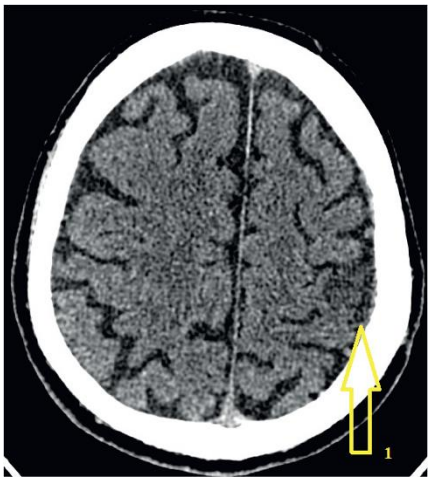

Fig. 1. Multislice computed tomography of the brain. 1 - ischemic stroke in left middle cerebral artery circulation

Neurological status: consciousness - Glasgow coma scale score 15. Contact is available. Oriented in place and time. Motor aphasia. Tongue in the midline. No diplopia. No swallowing disorder. Tendon reflexes: in the leg and arm on the right more than on the left. Limb tone: high in the right limbs. Strength in the upper limbs on the left is 4 points. Strength in the upper limbs on the right 1 point. The strength in the lower limbs on the left is 5 points. Strength in the upper limbs on the right 4 points. Sensitive disorders: no. The patient sways in the Romberg pose. Meningeal signs: negative. Hemiparetic gait. Reduced intellect. Emotional sphere: calm. Hemiparesis in the right hand up to 1 point and proximally up to 3 points, in the right leg 4 points. The nasolabial fold on the right is smoothed.

The patient underwent color duplex scanning (CDS) of the brachiocephalic arteries (BCA), according to which the left ICA thrombosis with retrograde filling of the artery and signs of a floating element was visualized. According to BCA angiography, the presence of thrombosis of the left ICA was confirmed (Fig. 2).

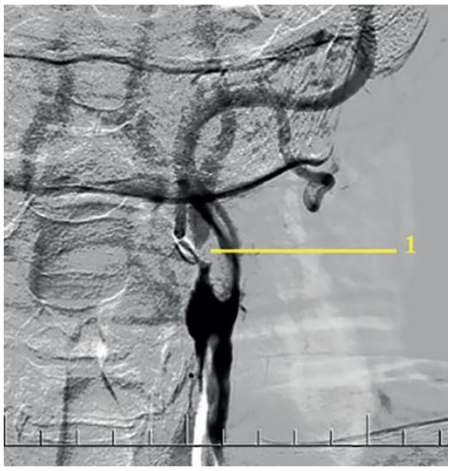

Fig. 2. Angiography of the left internal carotid artery. 1 — thrombotic masses of the left internal carotid artery

Taking into account the minimum size of the ischemic focus, the presence of a slight neurological deficit (5 points on the *National Institute of Health Stroke Scale - NIHSS*), local thrombosis of the ICA with signs of a floating element, - according to the CDS, the multidisciplinary council (cardiovascular surgeon, endovascular surgeon, neurosurgeon, neurologist, cardiologist, therapist, infectious disease doctor, resuscitator, anesthesiologist) decided to conduct an emergency operation carotid body preserving CEE [4–6] according to our technique.

The intervention was performed under local anesthesia. The ICA was cut off from the bifurcation with the capture of the wall of the common carotid artery (CCA) and the external carotid artery, without transection of the carotid body). Then, eversion endarterectomy was performed with artery implantation in the same place. The atherosclerotic plaque (stenosing the lumen of the artery by 60%) with a thrombus was intraoperatively removed (Fig. 3).

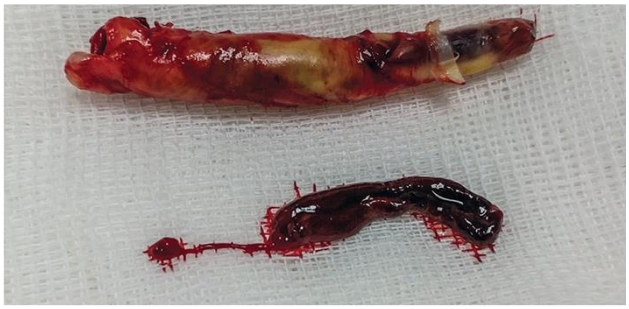

Fig. 3. Removed atherosclerotic plaque with thrombus

The ICA clamping time was 23 minutes. When suturing the wound, a double active drainage was installed into the paravasal space and into the subcutaneous tissue (Fig. 4).

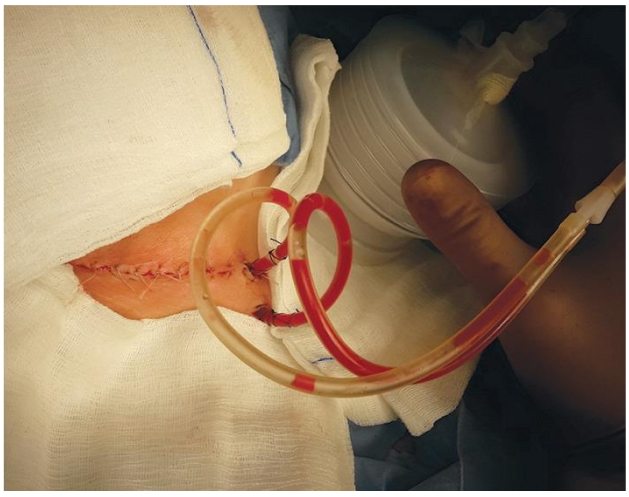

Fig. 4. Installation of a double active drainage in the paravasal space and subcutaneous fat

The postoperative course was uneventful. The ongoing antiviral, anticoagulant, antiplatelet therapy was continued. On the 12th day after CEE, the patient was discharged with complete regression of neurological symptoms. According to the control CDS, the reconstruction area showed no signs of restenosis/thrombosis.

DISCUSSION

According to the Russian electronic library *elibrary.ru, there are* no reports of emergency CEE in ICA thrombosis in patients with *COVID* -19. The world literature *(www.pubmed.gov)* describes several clinical cases of treatment of this pathology. The article of *Y. Álvarez Moreno* reports a case of thrombosis of ICA in a young woman (37-year-old), with no evidence of atherosclerosis, with clinical ischemic stroke (*NIHSS 8*). The patient underwent drug therapy (enoxyparin 60 mg s/c every 12 hours; acetylsalicylic acid 100 mg and clopidogrel 75 mg orally every day). On the 14th day after hospitalization, partial regression of neurological symptoms was noted. The patient was discharged with therapy consisting of: rivaroxaban 20 mg once a day, rosuvastatin 20 mg once a day, amlodipine 10 mg once a day, acetylsalicylic acid 100 mg once a day, clopidogrel 75 mg once a day, and esomeprazole 40 mg once a day. Thirty days after discharge, according to the results of the control CDS, there were no data indicating the presence of ICA thrombosis [7].

In the case presented by *M. Hosseini et al*., the development of CCA and ICA thrombosis in a patient with *COVID* -19 against the background of severe coagulopathy was described. Due to the presence of severe concomitant pathology (oncological process) and severe neurological deficit (4 points on the Rankin scale), invasive intervention was not performed. Drug therapy: apixaban (dosage not reported). After 2 weeks of treatment, the patient was discharged with a severe neurological deficit for the rehabilitation

stage. After 3 months, regression of neurological symptoms was achieved (absence of aphasia, the ability to move independently). Based on the results of the control CDS, no data on the presence of CCA and ICA thrombosis were obtained [8].

T. Singh et al. described a case of emergency CEE in a patient with hemodynamically significant stenosis and thrombosis of the ICA against the background of *COVID* -19. The authors have proven that this type of treatment is not accompanied by complications and, subject to the standards of performance, can be the operation of choice for these patients [9].

The article by *S. Cancer-Perez* describes a case of successful classical CEE in ICA thrombosis, transient ischemic attack (TIA) against the background of *COVID* -19 in a 61-year-old man. According to MSCT angiography, a floating thrombus was visualized in the right CCA. Enoxaparin therapy was started (80 mg/12 h). However, after 1 day, a second TIA developed, so an emergency surgery was initiated. There were no neurological deficits in the postoperative period [10].

The article by *A.Y. Mohamud* demonstrates 6 cases of ICA thrombosis against the background of a mild course of *COVID* -19. At the same time, active surgical tactics in the amount of CEE was implemented in only one patient. Another patient underwent endovascular thromboextraction. Both cases ended with a satisfactory outcome [11].

In an article by *T.J. Pisano et al*. a case of ICA thrombosis in a 33-year-old patient with clinical signs of ischemic stroke (*NIHSS* 15) was reported. The aspiration with stent retriever *Trevo* 4h30 and aspiration catheter *ACE* 68 was performed. However, brain edema developed postoperatively, on the 11th day after the intervention the patient died. The authors came to the conclusion that this method of treatment is ineffective [12].

In a clinical case presented by *F.X. Doo*, a 55-year-old patient was treated with thrombosis of the CCA and ICA and the clinical picture of ischemic stroke, manifested by dysarthria against the background of *COVID* -19. After thrombolysis with eptifibatid (according to control examination data), partial recanalization was revealed. By the time of discharge, a satisfactory condition was noted with a decrease in dysarthria [13].

Thus, the "gold standard" for cerebral revascularization in ICA thrombosis in the presence of *COVID* -19 does not exist today. This is largely associated with the lack of large randomized trials and information in the current guidelines. The presented isolated cases of various methods of treatment most often demonstrate satisfactory results. But their implementation is associated with the risk of developing the consequences of reperfusion syndrome, ranging from hemorrhagic transformation and ending with cerebral edema, as was presented when using a stent retriever in an article by *T.J. Pisano* [12].

Nevertheless, returning to the genesis of thrombosis in *COVID* -19, endotheliitis is one of the key mechanisms of its development [1, 2]. In this case there is a single method of removing thrombus with atherosclerotic plaque and the infected endothelium - CEE. Thus, it can be assumed that this type of revascularization will become the operation of choice, associated with a low risk of retrombosis for this cohort of patients. The accumulated experience of CEE in the acute period of acute cerebrovascular accident in the "pre-COVID period" demonstrates that performing this operation with a diameter of the ischemic focus in the brain not exceeding 2.5 cm, mild neurological deficit and the absence of decompensated concomitant pathology (acute coronary syndrome and etc.) creates a favorable prognosis for the implementation of this intervention [14, 15]. At the same time, an adequate correction of coagulopathy and systemic inflammation, according to the 11th version of the Interim Guidelines for the Prevention, Diagnosis and Treatment of New Coronavirus Infection (*COVID* -19) of the Ministry of Health, is able to create a favorable prognosis for these components of the pathological process with the prevention of recurrent events. Thus, observing the listed parameters, the implementation of CEE in patients with *COVID* -19 can be an effective method of cerebral revascularization in the acute period of ischemic stroke.

Returning to the presented clinical case, it should be noted that this is the first report of emergency CEE in a patient with ICA thrombosis against the background of *COVID* -19 in the Russian Federation, which emphasizes the importance and relevance of the data presented. We have demonstrated that, despite the moderate course of a novel coronavirus infection, bilateral polysegmental pneumonia, coagulopathy, systemic inflammatory syndrome, it is possible to implement CEE with an optimal outcome of revascularization.

The choice of the carotid body preserving CEE technique was associated with reports of preventive mechanisms for the preservation of this structure in the development of labile postoperative arterial hypertension [16]. According to R.A. Vinogradov, in his doctoral dissertation "Increasing the effectiveness

of surgical treatment of atherosclerotic stenosis of the internal carotid artery", 2019, in patients with trauma/transection of the carotid body, the risk of hyperperfusion syndrome with hemorrhagic transformation in the brain increases, which is accompanied by a further negative prognosis [16]. In a situation of severe coagulopathy, against the background of aggressive anticoagulant/antiplatelet therapy, the development of hemorrhagic stroke will become a contraindication for emergency neurosurgical surgery due to the difficulties in achieving adequate hemostasis [14]. Ultimately, this condition will end in fatal cerebral edema. Therefore, the prevention of the development of labile arterial hypertension after CEE in patients with *COVID* -19 is one of the main factors in achieving an optimal outcome [14].

Also, an important role is played by the rejection of anesthesia with mechanical ventilation (MV). In articles devoted to pulmonary barotrauma in patients with *COVID* -19, the risk of pneumothorax, pneumomediastinum, emphysema has been repeatedly reported [17]. Such conditions required urgent surgical correction, which was accompanied by a negative prognosis of the subsequent course of the disease in some cases [17]. Thus, the possibility of performing CEE under local anesthesia is an additional link in a successfully implemented operation in patients with a new coronavirus infection.

It should be noted that severe coagulopathy and the necessary anticoagulant/antiplatelet therapy certainly increase the risks of hemorrhagic complications after CEE with the formation of acute hematoma in the area of intervention [1-3]. Its progression can cause displacement of the trachea, which will significantly aggravate the current respiratory failure. This development of the process necessitates tracheal intubation, switch to mechanical ventilation and revision of the wound in the operating room. The use of double active drainage, which we implemented in the framework of this clinical example, was justified for two reasons. Firstly, in case of thrombosis of one of them, the second could perform a safety function, which would prevent the development of a tense hematoma. Secondly, in case of bleeding from the drain, which was installed in the subcutaneous fat, and not in the paravasal space, removal of skin sutures with stitching of the bleeding source could be performed in a dressing ward, under local anesthesia. Thus, tracheal intubation with re-transport to the operating room is not required under these conditions. However, it should be noted that in this clinical example, no hemorrhagic complications were observed. The presented drainage method has shown itself to be the most effective in patients with severe hypocoagulation/hypoaggregation, which is described in our previously published work [18]. Therefore, after *CEE* against the background of *COVID* -19, we recommend using this method of wound drainage.

CONCLUSION

Carotid endarterectomy in the acute period of acute cerebrovascular accident with thrombosis of the internal carotid artery against the background of *COVID* -19 is characterized by a low risk of complications with the use of carotid body preserving surgery technique, local anesthesia, double active wound drainage, aggressive anticoagulant/antiplatelet therapy and anti-inflammatory therapy.

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