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COVID-19 IN PATIENTS WITH ACUTE LIMB ISCHEMIA

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Abstract. ***Introduction.*** Acute limb ischemia (ALI) is defined as an abrupt decrease in arterial perfusion of a limb with a threat to viability of the limb. Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2, and has been declared as a global pandemic by the World Health Organization. Infection with SARS-CoV-2 has been shown to have a wide range of clinical presentations from asymptomatic in a large percentage of patients to devastating pulmonary failure, sepsis, and death. Patients with COVID-19 have deranged blood coagulation parameters and are prone to thrombo-embolic events. This hypercoagulable state caused by COVID-19 mainly manifests as venous thromboembolism. Peripheral arterial involvement is less frequent. We present 3 cases of a spontaneous ALI in a COVID-19 patient. ***Case.*** A 62-year-old man with an insignificant past medical history presented with ALI 12 days after an initial diagnosis of COVID-19. He was on therapeutic doses of low molecular weight heparin when ischemic symptoms developed. A surgical thrombectomy was unsuccessful. He partially benefited from intravenous unfractionated heparin and iloprost infusions. He was discharged home on postoperative day 14, and is scheduled to have an amputation of the 1st toe. ***Conclusions.*** COVID-19 infection is associated with an increased incidence of thromboembolic events, including ALI. Even young and otherwise healthy patients may develop ALI despite the use of prophylactic anticoagulation. Management of ALI in COVID-19 patients might be harder than expected, due to the hypercoagulable state. Patients may benefit from prolonged post-operative unfractionated heparin administration.

Key words: acute limb ischemia: coronavirus disease 2019; low molecular weight heparin; severe acute respiratory syndrome coronavirus-2; thrombectomy; unfractionated heparin.

COVID-19 У ПАЦИЕНТОВ С ОСТРОЙ ИШЕМИЕЙ КОНЕЧНОСТЕЙ

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Резюме. Острую ишемию конечностей можно определить как резкое снижение артериальной перфузии конечности с угрозой ее жизнеспособности. Коронавирусная инфекция 2019 года (COVID-19) вызвана тяжелым острым респираторным синдромом коронавируса 2. Она объявлена Всемирной организацией здравоохранения глобальной пандемией. Было показано, что инфекция SARS-CoV-2 имеет широкий спектр клинических проявлений: от бессимптомного течения у большого процента пациентов до легочной недостаточности, сепсиса и смерти. Пациенты с COVID-19 имеют нарушения показателей свертываемости крови и склонны к тромбоэмболическим осложнениям. Это состояние гиперкоагуляции, вызванное COVID-19, в основном проявляется как венозная тромбоэмболия. Поражение периферических артерий встречается реже. Представляем три случая спонтанной острой ишемии конечностей у пациента с COVID-19.

Ключевые слова: острая ишемия конечностей; коронавирусная болезнь 2019; низкомолекулярный гепарин; коронавирус-2 с тяжелым острым респираторным синдромом; тромбэктомия; нефракционированный гепарин.

INTRODUCTION

Acute limb ischemia (ALI) is defined as an abrupt decrease in arterial perfusion of a limb with a threat to viability of the limb [1]. The clinical presentation is considered to be acute if symptom duration is less than 2 weeks [1]. The most common causes include embolism from cardiac chambers mainly associated with atrial fibrillation or acute myocardial infarction, embolism from arterial aneurysms, thrombosis of native limb arteries or vascular grafts, iatrogenic thromboembolism during vascular interventions, aortic dissection, and traumatic vascular injuries [1].

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and has been declared as a global pandemic by the World Health Organization [2]. Several reports revealed that patients with COVID-19 have deranged blood coagulation parameters and are prone to thromboembolic events [2–5]. This hypercoagulable state caused by COVID-19 is associated with poor overall prognosis, and mainly manifests as venous thromboembolism (VTE) [4, 5]. Peripheral arterial involvement is less frequent [2, 5].

Herein we present 3 cases of a spontaneous ALI in a COVID-19 patient.

CLINICAL CASE 1

A 62-year-old man presented to the emergency room with complaints of fever, nausea, fatigue and muscle aches. His past medical history was insignificant. Body temperature was 36.7 °C, pulse rate 82 beats per minute, respiratory rate 24 breathes per minute, blood pressure 125/72 mmHg, and oxygen saturation 95%. There were bilateral diffuse fine crackles on auscultation. Laboratory findings were normal except for a D-dimer level of 670 ng/ml (normal range < 500 ng/ml) (Table 1). A computed tomography (CT) scan of the chest revealed bilateral ground-glass opacities (Fig. 1). A swab test result came back positive for COVID-19, and the patient was discharged home on favipiravir, hydroxychloroquine and low-dose subcutaneous enoxaparin.

Table 1

Laboratory findings at initial diagnosis (day 0), hospitalization (day 5), discharge (day 10), re-hospitalization for acute limb ischemia (day 12)

Таблица 1

Результаты лабораторных исследований при первоначальном диагнозе (0-й день), госпитализации (5-й день), выписке (10-й день), повторной госпитализации при острой ишемии конечностей (12-й день)

Parameters	Day 0	Day 5	Day 10	Day 12	Normal range
White blood cell, 10^3/μL	12.4	16	19.6	20.5	4–11
Neutrophil count, 10^3/μL	10.2	12.6	15.2	16.4	2–7
Lymphocyte count, 10^3/μL	1.2	1.4	1.6	2.5	1–3
Platelet count, 10^3/μL	269	306	422	374	100–450
Hemoglobin, g/dL	13.7	14	13.3	11	14–18
Prothrombin time, seconds	15.5	15.1	12.5	12.6	11.5–15.5
Partial thromboplastin time, seconds	23.1	26.2	23.2	22.8	23.5–35
C-reactive protein, mg/dl	0.78	15.4	7.34	13.38	< 0.5
D-dimer, ng/mL	670	950	590	–	< 500
Fibrinogen, mg/dL	280	315	172	–	200–400
Lactate dehydrogenase, IU/L	109	1276	1045	–	0–250
Creatine kinase, IU/L	22	386	103	398	30–200
Serum creatinine, mg/dL	1.14	1.39	1.34	3.54	0.67–1.17

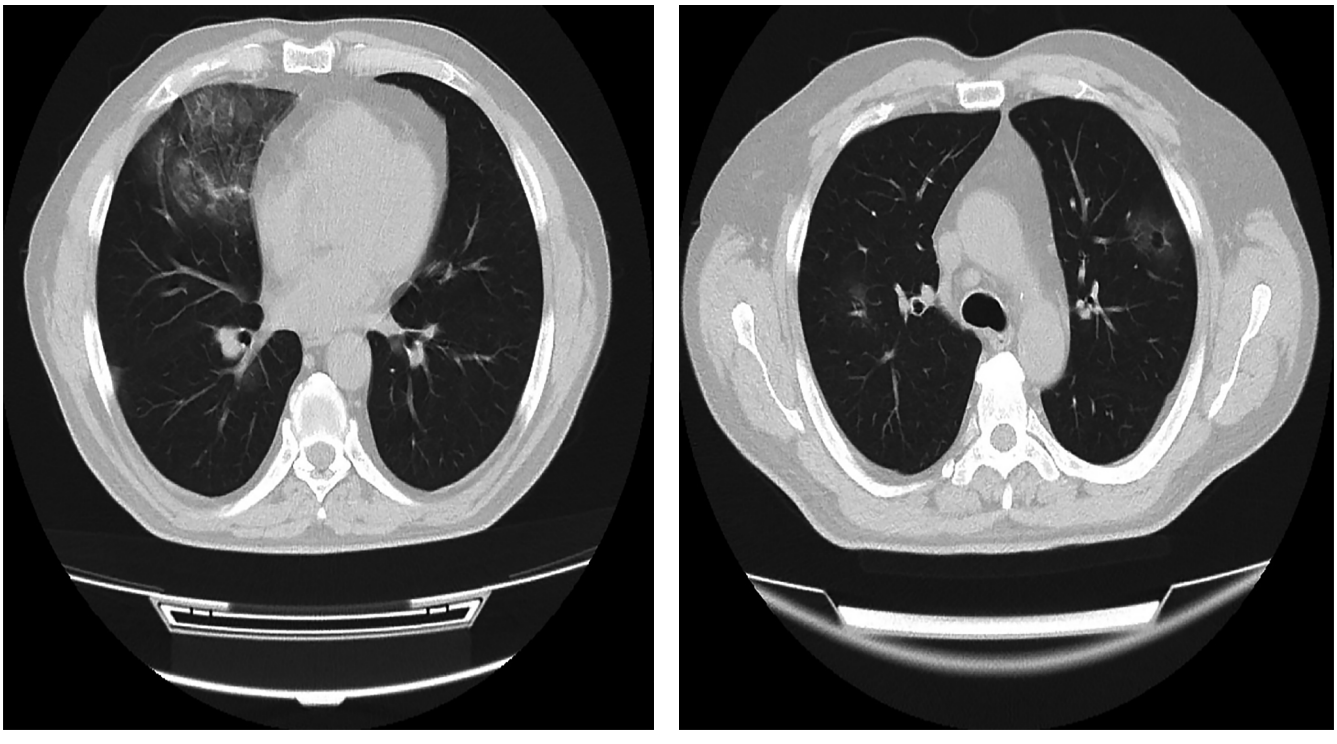

Fig. 1. Computed tomography scan of the chest demonstrating bilateral ground-glass opacities

Рис. 1. Компьютерная томография грудной клетки, демонстрирующая двустороннее просвечивание

Five days later, he was hospitalized for worsening of respiratory symptoms. He appeared severely tachypneic with a respiratory rate of 40 breathes per minute, and dyspneic with an oxygen saturation of 82% on ambient air. D-dimer level was elevated to 950 ng/ml. Low molecular weight heparin dosage was increased to therapeutic doses (enoxaparin 8000 IU twice daily). The patient was discharged home 5 days after his hospitalization with complete resolution of symptoms.

However, 2 days later, he presented to emergency room with a cold, cyanotic and painful left foot. Left pedal pulses were absent with minimal sensory loss and normal motor function. A CT angiography of the lower extremities revealed occlusion of left tibial arteries (Fig. 2). The arterial tree was free of atherosclerotic plaques, and there were no collateral vessels, suggesting an acute occlusion. Transthoracic echocardiography and thoraco-abdominal aortic imaging were negative for proximal sources of thromboembolism. 5000 IU unfractionated heparin (UFH) bolus was administered intravenously. Patient was transferred to the operating theatre for surgical intervention. Popliteal trifurcation was explored through medial infragenicular approach under local anesthesia. Popliteal artery and all of its branches appeared healthy without any atherosclerotic plaques. A longitudinal arteriotomy revealed excellent antegrade blood flow with absent retrograde flow. An attempt was made to remove the thrombus using 2 and 3F Fogarty catheters. However, the thrombus was densely organized and catheters could not be passed across the occluded segment.

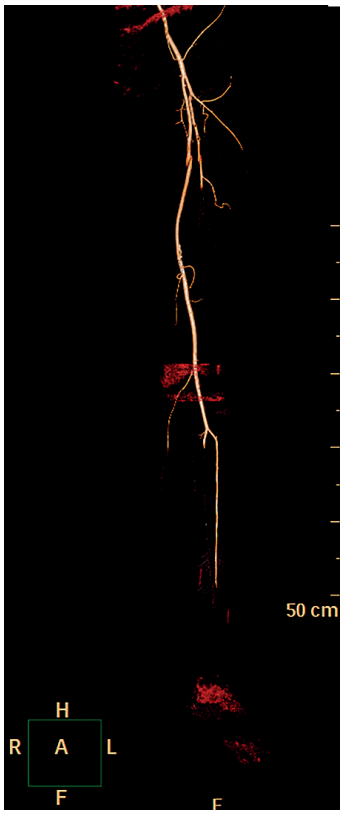

Fig. 2. Computed tomography angiography of the left lower extremity demonstrating occlusion of left tibial arteries, 3-dimensional reconstruction

Рис. 2. Компьютерная томография ангиографии левой нижней конечности, демонстрирующая окклюзию левой большеберцовой артерии, трехмерная реконструкция

We did not perform thrombolysis due to organized nature of the thrombus. The arteriotomy was closed with patch plasty. Patient was transferred toward. Intravenous UFH and iloprost infusions were started. Heparin dose was adjusted to maintain an activated clotting time (ACT) of 200–250 seconds. Continuous iloprost infusion was maintained until discharge. The ischemic foot improved significantly with systemic anticoagulation, and posterior tibial and dorsalis pedis arterial Doppler signals became audible on postoperative 2nd day. However, 1st and 2nd toes and medial aspect of the foot became cyanotic again on postoperative day 5, while the ACT was within the target range (Fig. 3). Posterior tibial artery pulse was once again absent. A more than two fold increase of serum creatinine was observed following the initial CT angiography therefore a repeat angiography was not performed (Table 1). A duplex ultrasound of the lower leg performed prior to discharge revealed biphasic flow pattern in anterior tibial artery, and no flow in peroneal and posterior tibial arteries. The patient was discharged home with dry gangrene of the 1st toe on postoperative day 14 on enoxaparin 8000 IU twice daily and dual anti-platelet therapy with aspirin and clopidogrel. His condition remains stable 1 month after discharge, and a digital amputation is scheduled.

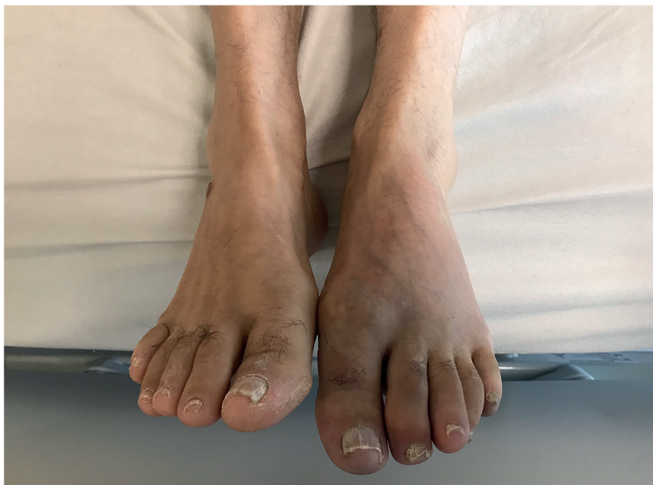

Fig. 3. **Recurrent ischemia of the left foot**
Рис. 3. **Рецидивирующая ишемия левой ноги**

CLINICAL CASE 2

Patient G., 79 years old. Admitted with pain at rest in the left lower limb, with the presence of necrotic ulcer of the 1st finger of the left foot.

Anamnesis: Considers herself ill from more than a year, when pain first appeared in the left lower limb, an ulcer formed in the area of the first finger of the left foot. The patient received conservative treatment, no effect. Worsening in late March 2023, increasing pain syndrome, progressing necrosis of the 1st finger of the left foot.

Date of admission in the hospital: 29.03.2023. The patient was investigated. CT-angiography reports shows: occlusion of tibial arteries of the left lower limb (Fig. 4).

18.04.2023 — Balloon angioplasty of the tibial arteries of the left lower limb (Fig.5).

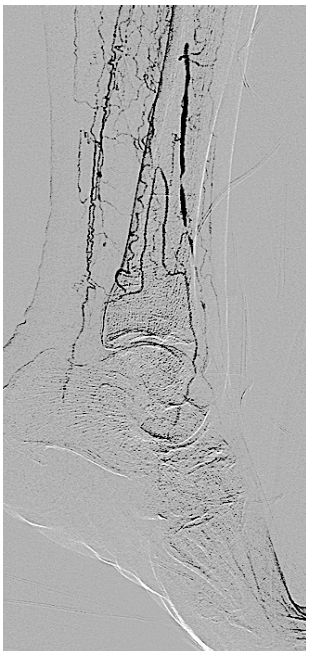

Fig. 4. **Initial (before operation)**
Рис. 4. **Исходная картина**

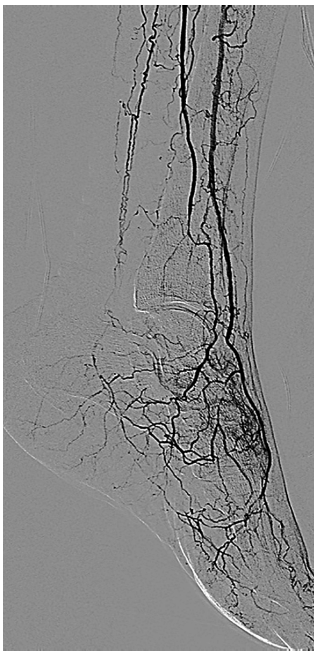

Fig. 5. **Control angiography after TBA**
Рис. 5. **Контрольная ангиография после ТЛБА**

CLINICAL CASE 3

Patient S., 90 years old. Admitted with pain at rest in the right lower limb, with the presence of black necrosis on the fingers of the right foot.

Anamnesis: The patient has been ill from the last two months, when these complaints came in. She approached to clinic affiliated with her residence, she got treatment by conservative therapy. The conservative therapy was without effect.

Date of admission in the hospital: 20.03.2023. The patient was investigated. CT-angiography report shows: occlusion of SFA from proximal/3, Pop artery stenosis 75%, the distal/3 part of Pop artery is occlusive, anterior tibial artery is occlusive, peroneal artery, posterior tibial artery with CTO stenoses up to 90% in right lower limb (Fig. 6).

04.04.2023 — Balloon angioplasty of arteries in right lower limb (Fig. 7).

DISCUSSION

Present report describes a case of ALI in a patient with confirmed COVID-19 infection. The patient was otherwise

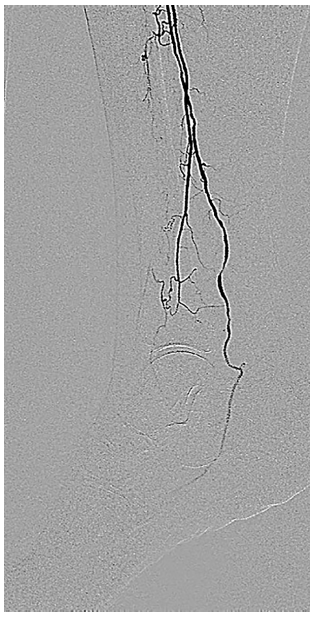

Fig. 6. Initial (before operation)
Рис. 6. Исходная картина

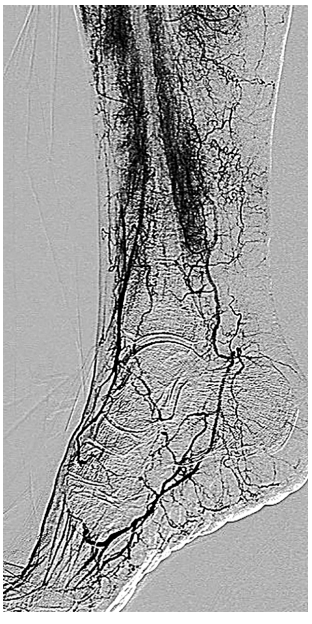

Fig. 7. Control angiography after TBA
Рис. 7. Контрольная ангиография после ТЛБА

healthy and did not have any conventional risk factors for ALI. However, his condition was resistant to treatment, and tended to recur. This finding is in correlation with reports by others [2, 6–8]. Bellosta and colleagues [6] described 20 patients (18 men) with COVID-19-associated ALI over a period of 3 months. Seventeen patients underwent surgical treatment with a successful revascularization in only 12 (70.6%). Authors argued that this lower-than-expected success rate was due to a COVID-19-related hypercoagulable state [6]. They also reported that prolonged use of systemic heparin was associated with better outcomes in this subset of patients [6]. Perini and colleagues [7] reported 4 patients presenting with ALI caused by COVID-19. Two of their patients did not have any comorbidities, were relatively young, and receiving prophylactic doses of LMWH at presentation. One of them, a 53-year-old man, died on postoperative day 2 due to a recurrent aortoiliac occlusion. The other patient, a man aged 37 years with upper extremity thrombosis was successfully managed with UFH administration [7]. Baccellieri and colleagues [8] reported a patient who developed COVID-19-associated ALI while under prophylactic LMWH. The 67-year-old man with no relevant medical history was successfully treated with surgical intervention for simultaneous lower and upper limb ischemia [8].

Thromboembolic events associated with COVID-19 mainly manifest as VTE [5]. This is reasonable since COVID-19 exposes patients to all 3 components of Virchow's triad: (1) there is direct viral infection of endothelial cells [9]; (2) patients are frequently hospitalized and immobilized; (3) blood coagulation parameters are deranged representing a hypercoagulable state [3, 4]. Bilaloglu and colleagues [5] reported less than 1% incidence of ALI in their analysis of 3334 patients hospitalized with COVID-19. Of note, although not as frequent as VTE, incidence of ALI is increased during the COVID-19 pandemic [6].

Evidence from early experience suggests that pathogenesis of arterial thrombosis in COVID-19 patients differs from that of classical arterial thrombosis [10–16]. In-situ arterial thrombosis mainly occurs due to plaque breakdown or reduced perfusion through an atherosclerotic lesion, or stent or graft [14, 17, 18]. However, such as in the present case and others, COVID-19 patients may exhibit acute thrombosis of non-atherosclerotic native arteries [2]. Various mechanisms have been proposed to explain this phenomenon. A dysregulated hyperinflammatory response is thought to be responsible for arterial and venous thromboembolic events seen in patients with COVID-19 [11, 12, 19, 20]. Increased levels of D-dimer, fibrinogen, coagulation factors, acquired antiphospholipid antibodies, and decreased levels of protein C, protein S, antithrombin, and hyperactivation of platelets and neutrophils are observed [10]. A consumption coagulopathy similar to sepsis-associated disseminated intravascular coagulopathy (DIC) is seen in COVID-19 patients. However, thrombotic component is more predominant than hemorrhagic component when compared with DIC [11, 12, 21]. It has been also speculated that direct viral infection of endothelial cells through the angiotensin-converting enzyme 2 receptor may be the cause of arterial thrombosis in patients with COVID-19 [9–11]. It is possible that a combination of these mechanisms, but not one, is responsible for increased rate of arterial thromboembolic events in COVID-19 patients.

CONCLUSION

COVID-19 infection is associated with an increased incidence of thromboembolic events, including ALI. Even young and otherwise healthy patients may develop ALI despite the use of prophylactic anticoagulation. SARS-CoV-2 infection is associated with a high thrombotic risk probably by promoting a systematic inflammatory response and a hypercoagulable state. COVID-associated ALI usually presents in patients with low number of comorbidities, and it is associated with a high mortality and amputation risk. Mortality risk seems to be greater with conservative treatment compared with any intervention, although the amputation risk is similar. Management of ALI in COVID-19 patients might be harder than expected, due to the hypercoagulable state. Patients may benefit from prolonged postoperative UFH administration.

Future studies should focus on identifying optimal medical treatment for these patients as well as potential prognostic factors for mortality and amputation risks.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

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Consent for publication. Written consent was obtained from the patient for publication of relevant medical information within the manuscript.

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Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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