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# Upper-Extremity Phlegmasia Cerulea Dolens With Compartment Syndrome in Coronavirus Disease 2019 Sepsis

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A 54-year-old woman with leukemia presented with coronavirus disease 2019 and a right upper-extremity indwelling peripherally inserted central catheter line for chemotherapy administration. On hospital admission day 9, she developed acute right upper-extremity edema and pain. Ultrasound demonstrated complete superficial and deep venous thrombosis up to the proximal subclavian vein. Her examination result was consistent with acute phlegmasia cerulea dolens and compartment syndrome, but respiratory instability prevented transfer and vascular surgery intervention. Instead, we performed bedside fasciotomies and administered therapeutic heparin, and the limb was salvaged. This case underscores the potential for successful limb salvage in patients with phlegmasia in the setting of coronavirus disease 2019 via compartment release and therapeutic anticoagulation. (*J Hand Surg Am.* 2022;47(7):693.e1-e3. Copyright © 2022 by the American Society for Surgery of the Hand. All rights reserved.)

**Key words** Compartment syndrome, COVID-19 limb ischemia, limb salvage, phlegmasia cerulea dolens, upper-extremity fasciotomies.



**T**HE LITERATURE SUGGESTS that hypercoagulability and increased early venous thromboembolic events occur in coronavirus disease 2019 (COVID-19) patients.<sup>1</sup> In the setting of severe acute deep and superficial venous system thrombosis, phlegmasia cerulea dolens can develop and risk the patient's life and limb. This is defined as an advancement of obstructed venous outflow from an extremity to the point of pain, cyanosis, or severe edema and is considered an immediate precursor to

soft-tissue necrosis. Upper-extremity phlegmasia cerulea dolens causing acute compartment syndrome is exceedingly rare and fatal.<sup>2</sup> The current recommendations include urgent vascular intervention for thrombolysis or thrombectomy and fasciotomies if compartment syndrome is diagnosed.<sup>3</sup> However, given the rising reports on severe arterial and venous thrombosis in critically ill COVID-19 patients, who may be unstable, difficult therapeutic decisions may have to be made.<sup>1,4,5</sup>

We present a case that not only highlights the marked prothrombotic potential of severe COVID-19 infections, particularly in the setting of an indwelling intravenous line, but also characterizes the complexities of medical and surgical decision making in the era of COVID-19.

## CASE AND SURGICAL INTERVENTION

A 54-year-old febrile woman with a history of diabetes mellitus, refractory Ph-like lymphoblastic leukemia, and chemotherapy-related pancytopenia (platelet count

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21,000 platelets/ $\mu$ L) presented to our institution and was diagnosed with COVID-19. She had a peripherally inserted central catheter placed for chemotherapy 2 weeks prior. Per institutional trial and because of the neutropenic fever, she was started on remdesivir along with empiric vancomycin, cefepime, micafungin, and acyclovir. Prophylactic lovenox was delayed until hospital day 4 because of concerns of thrombocytopenia.

The patient's respiratory status deteriorated, and on day 9, she developed acute edema and pain of the right upper extremity. Ultrasound studies showed an occlusive thrombus not only in the cephalic vein associated with the peripherally inserted central catheter line but also in the basilic, brachial, axillary, and subclavian veins. There was no arterial thrombus, but the ultrasound showed complete reversal of arterial blood flow during diastole up to the mid-subclavian artery of the affected upper extremity. A heparin drip was started, and plastic and vascular surgery services were urgently consulted.

On physical examination, the arm was found to be pulseless, cyanotic, and tense, with the hand in an intrinsic negative posture. The patient was intubated because of respiratory decompensation; so, the compartment pressures were checked and found to measure  $>60$  mm Hg. Venous thrombectomy was not offered because of clinical instability, preventing transfer to the operating room, and the concern of mobilizing the thrombus, which could have caused further hypoxemia. Therefore, we performed bedside arm, forearm, and hand fasciotomies and an open carpal release in addition to therapeutic anticoagulation with the aims of releasing the compartmental pressures and improving the blood flow. Viable muscle belly was present upon opening the fascia of the forearm. This procedure was complicated by marked venous bleeding of over 1,000 mL for over 2 hours and hemorrhagic shock, necessitating the administration of vasopressors and initiation of a massive transfusion. Immediately following the procedure, however, palpable radial and ulnar pulses returned and cyanosis improved. Over the next 4 weeks, there was no soft-tissue loss in the extremity and creatine kinase levels were normal. During this time, sedation was weaned to perform reliable sensory and motor examinations, both of which showed a normal function. Ultimately, the patient died because of worsening respiratory compromise.

## DISCUSSION

Severe COVID-19 infections have been shown to be associated with a marked increase in the number of

thromboembolic events.<sup>6</sup> This is 1 of the theories for the unique cardiopulmonary pathophysiology characteristic of this illness.<sup>6</sup> In addition, these thromboembolic events have led to increasing number of reports on acute limb ischemia.<sup>1,7,8</sup> The majority of these cases had either arterial or mixed venous and arterial thromboses, and those resulting in phlegmasia cerulea dolens required an urgent vascular surgical intervention.<sup>7</sup> This report highlights a case of complete venous thrombosis of the superficial and deep systems of the upper extremity, leading to phlegmasia cerulea dolens and acute compartment syndrome associated with a severe COVID-19 infection. Moreover, this was in the setting of chemotherapy-associated thrombocytopenia, which underscores the profound hypercoagulable potential of severe COVID-19 infections. This supports recent evidence suggesting that the use of aggressive therapeutic anticoagulation provides a benefit over prophylactic anticoagulation in patients with severe COVID-19 infection, even in patients with thrombocytopenia.<sup>9</sup>

This patient had an indwelling catheter placed prior to contracting COVID-19 and, therefore, was likely at higher risk of associated venous thrombosis. Even in COVID-19 patients without indwelling catheters, early venous thromboembolic event rates are markedly increased, and they potentially have venous thromboses prior to admission.<sup>8</sup> There are an increasing number of recommendations that institutions should consider aggressive screening protocols for diagnosing venous thromboembolic events early in these patients.<sup>10</sup> Now, our institutional recommendations are to strongly consider removing indwelling catheters once COVID-19 is diagnosed, as could have been done earlier in our patient's hospital course.

Phlegmasia cerulea dolens causing acute compartment syndrome in the upper extremity has been rarely described, and if present, the recommendations are to perform urgent thrombolysis or thrombectomy.<sup>2,3,11</sup> The unique surgical situation that arose in this patient, however, was that given her tenuous cardiopulmonary status in the setting of COVID-19 sepsis, she was unable to be brought to the operating room or interventional radiology suite. The complete reversal of the blood flow up to the subclavian artery during diastole, detected using ultrasonography, displays the striking potential of compartment pressures in this pathology. This difficult scenario, requiring an expedient input from multiple subspecialty teams, including critical care in terms of anesthesiology, vascular surgery, and plastic surgery, led to the decision to perform urgent bedside upper-extremity and

hand fasciotomies in the COVID-19 intensive care unit. Despite the high rate of limb and tissue loss without formal vascular interventions in the setting of phlegmasia, these fasciotomies, along with a therapeutic heparin drip, provided limb salvage in this critically ill patient.<sup>3</sup>

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