Developmental venous anomaly thrombosis in a patient with coronavirus disease 2019-associated hypercoagulability: illustrative case

Natasha Ironside, MBChB,1 Derek Petrosian, BS,1 Salma Abbas, MD,2 Ching-Jen Chen, MD,3 Ryan Kellogg, MD,1 Dale Ding, MD,4 and Min S. Park, MD1

Departments of 1Neurological Surgery, 2Radiology, University of Virginia Health System, Charlottesville, Virginia; 3Department of Neurosurgery, The University of Texas Health Science Center, Houston, Texas; and 4Department of Neurological Surgery, University of Louisville School of Medicine, Louisville, Kentucky

BACKGROUND Spontaneous thrombosis of a developmental venous abnormality (DVA) is a rare complication associated with hypercoagulability. The objective of this case report is to describe an association between DVA thrombosis and mild coronavirus disease 2019 (COVID-19) infection in a vaccinated patient.

OBSERVATIONS A 28-year-old male with hypertension presented with severe headache and left-sided hemiparesis. Five weeks prior to presentation, the patient experienced mild respiratory symptoms and tested positive for COVID-19. Admission brain computed tomography (CT) showed a large right parieto-occipital intracerebral hemorrhage with surrounding edema. CT venography and catheter angiography showed a thrombosed DVA with associated venous infarction as the hemorrhage etiology. The patient was treated with decompressive hemicraniectomy, external ventricular drain placement, and systemic anticoagulation.

The patient was functionally independent (modified Rankin Scale score, 2) at 4-month follow-up. Hypercoagulability work-up was unremarkable.

LESSONS Delayed DVA thrombosis after the COVID-19 infectious period may represent an association between the infection and a protracted systemic viral-induced hypercoagulable state. The severity of COVID-19 symptomatology does not appear to correlate with risk of DVA thrombosis. Young patients with a recent history of COVID-19 infection who present with venous infarction should be evaluated for an underlying thrombosed DVA.

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KEYWORDS case report; COVID-19; developmental venous anomaly; thrombosis; venous infarction; stroke; SARS-CoV-2; severe acute respiratory syndrome coronavirus 2

Developmental venous anomalies (DVA) are the most common cerebrovascular anomaly, are frequently discovered incidentally, and harbor a low rupture risk.1 In rare cases, DVAs have presented with venous infarction.2 Coronavirus disease 2019 (COVID-19) has been associated with hypercoagulability.3 The objective of this report is to describe the second case of an association between DVA thrombosis and preceding COVID-19 infection and the first delayed presentation after mild COVID-19 symptoms in a vaccinated patient.

Illustrative Case
Patient Information
A 28-year-old male with a history of hypertension presented with headache. He had collapsed and had been found after 6 hours and his uncle and grandmother with left-sided weakness. Four weeks prior to presentation, he experienced mild respiratory symptoms and tested positive for COVID-19 using the home antigen test. He was fully vaccinated against COVID-19. Brain magnetic resonance imaging (MRI) performed for other reasons before his COVID-19 infection was notable for a dilated and tortuous right occipital vein consistent with a DVA (Fig. 1).

Clinical Findings
On initial presentation, the patient’s Glasgow Coma Scale (GCS) score was 14 and National Institutes of Health Stroke Scale (NIHSS) score was 20. Neurological examination revealed a right pupil-sparing oculomotor nerve palsy, left homonymous hemianopsia, left lower facial weakness, and left hemiplegia. Over the subsequent

ABBREVIATIONS COVID-19 = coronavirus disease 2019; CT = computed tomography; CVST = cerebral venous sinus thrombosis; DVA = developmental venous anomaly; GCS = Glasgow Coma Scale; MRI = magnetic resonance imaging; NIHSS = National Institutes of Health Stroke Scale.

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4 hours, his GCS score deteriorated from 14 to 11, and his right pupil became fixed and dilated.

Diagnostic Assessment
Admission brain computed tomography (CT) head showed a large right parieto-occipital intracerebral hemorrhage with intraventricular extension. Surrounding parenchymal edema suggested underlying evolving venous infarction as the etiology of the hemorrhage. CT venography showed a nonehancing, hyperdense, dilated, tortuous parieto-occipital vein draining the DVA (Fig. 2). Diagnostic cerebral angiography showed hypoperfusion and a paucity of cortical venous drainage in the parietal and occipital lobes. The DVA and draining cortical vein did not opacify in late venous phase, consistent with complete thrombosis (Fig. 3).

Therapeutic Intervention
The patient underwent emergent decompressive hemicraniectomy and external ventricular drain placement. Postoperatively, he was started on a therapeutic intravenous heparin infusion and subsequently transitioned to oral anticoagulation. A comprehensive hypercoagulability workup was unremarkable and no other hypercoagulability risk factors were identified.

Follow-Up and Outcomes
The patient’s postoperative GCS and NIHSS scores improved to 15 and 12, respectively, and his oculomotor nerve palsy resolved. He was discharged to an acute inpatient rehabilitation facility on postbleed day 18. He underwent cranioplasty 2 months after the initial craniectomy surgery. Therapeutic anticoagulation was discontinued at 3-month follow-up. At 4-month follow-up, he was ambulatory with a cane and functionally independent (modified Rankin Scale, 2).

Discussion
Background
DVAs are abnormally dilated veins that lack smooth muscle and elastic tissue.1 A limited capacity for autoregulation and adaptation to hemodynamic alterations within the vessel is a proposed mechanism for their predisposition to thrombosis. Treatment paradigms for DVA thrombosis are not well described, although favorable outcomes have been reported with anticoagulation.1,2 Resection of DVAs is not recommended due to the risk of venous infarction potentially causing cerebral edema and hemorrhagic transformation.

Severe acute respiratory syndrome coronavirus 2-dependent utilization of angiotensin-converting enzyme 2 to adhere to and enter endothelial cells disrupts the vascular endothelium, which causes microvascular injury, platelet activation, and downstream prothrombotic effects.3 Activation of the innate immune system by viral infection initiates systemic inflammatory responses including cytokines and the complement cascade. This, in turn, activates the coagulation cascade, generates thrombin, and induces vascular endothelial injury. The consequent procoagulant milieu further promotes inflammation, thereby amplifying the hypercoagulable state.

Observations
There have been several reports of associations between COVID-19 and cerebral venous sinus thrombosis (CVST).4,5 Three-quarters of CVST cases in COVID-19 patients have occurred in the absence of other risk factors for hypercoagulability.5 Furthermore, the severity of COVID-19 symptoms does not appear to correlate with risk of CVST.4,5 In the only report of DVA thrombosis in a 35-year-old male with severe COVID-19 symptomatology, no other thrombotic risk factors were identified, congruent with our case.6 Our patient’s mild respiratory symptoms are consistent with reports of severe thromboembolism occurring in mild COVID-19 infections.4,7 This case represents the second report of an association between DVA thrombosis preceding COVID-19 infection and underscores
the lack of correlation between COVID-19 severity and risk of DVA thrombosis, similar to that of CVST. Our patient’s presentation 5 weeks after COVID-19 symptom onset suggests delayed DVA thrombosis in the setting of a protracted systemic viral-induced hypercoagulable state following the infectious period. There have been reports of sustained prothrombotic changes occurring up to 4 months after the infectious period in COVID-19 patients. Complications associated with DVA thrombosis emphasize the importance of draining vein preservation in the management of this entity.

Lessons
DVA thrombosis is a rare complication of systemic hypercoagulability, and it should be considered as a potential cause of venous infarction in young patients with a current or recent history of COVID-19 infection.

References

Disclosures
Dr. Park reported being a consultant for Medtronic outside the submitted work. No other disclosures were reported.

Author Contributions
Conception and design: Ironside, Park. Acquisition of data: Petrosian, Abbas. Analysis and interpretation of data: Petrosian. Drafting the article: Ironside, Petrov. Critical revising the article: Petrov, Chen, Kellogg, Ding, Park. Reviewed submitted version of manuscript: Petrov, Chen, Kellogg, Ding, Park. Administrative/technical/material support: Kellogg. Study supervision: Park.

Correspondence
Natasha Ironside: University of Virginia Health System, Charlottesville, VA. ni8vb@uvahealth.org.