Tectal Hemorrhage in the Setting of COVID-19 Infection

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Introduction: Coronavirus disease 2019 (COVID-19) has emerging evidence of a relationship to intracranial hemorrhage. The hemorrhages described to date often affect patients on anticoagulation, of advanced age, of nonwhite race, and requiring mechanical ventilation. Unusual or rare hemorrhage patterns have not as yet been described in the literature as being associated with COVID-19.

Case Report: A 36-year-old Hispanic male with no significant past medical history presented with isolated tectal intraparenchymal

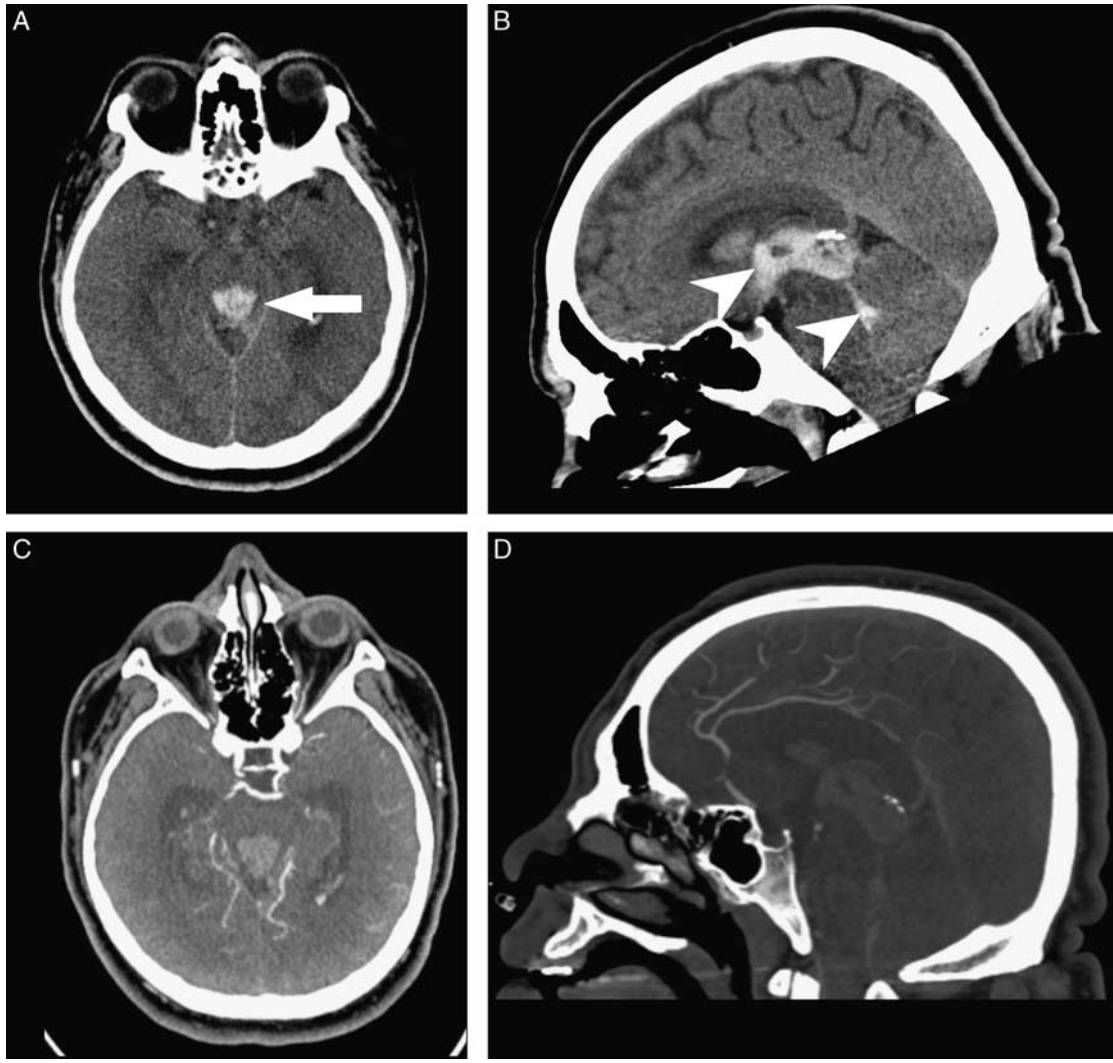

FIGURE 1. Axial (A) and sagittal (B) noncontrasted computed tomography scan demonstrating the patient's tectal based intraparenchymal hematoma (arrow) with intraventricular extension (arrowheads). Axial (C) and sagittal (D) computed tomography angiography demonstrating the hemorrhage with no associated vascular lesion.

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hemorrhage with intraventricular hemorrhage in the setting of no identifiable risk factors other than COVID-19. His management required temporizing with external ventricular drainage and subsequent endoscopic third ventriculostomy for ongoing obstruction of the cerebral aqueduct following the hemorrhage. He was discharged and did clinically well. To our knowledge, this is the first report of an intraparenchymal hematoma of the brain isolated to the midbrain tectum with only COVID-19 as a risk factor.

Conclusion: COVID-19 may predispose patients to rare types of intraparenchymal hematomas which remain amenable to standard management algorithms.

Key Words: COVID-19, midbrain hemorrhage, tectal hemorrhage, hydrocephalus

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BACKGROUND

There is emerging evidence of a relationship between intracranial hemorrhage and coronavirus disease 2019 (COVID-19) infection. This relationship has yet to be fully investigated but several recent studies have described risk factors and outcomes of intracranial hemorrhage in the setting of COVID-19. Cheruiyot et al[1] published a review in November 2020 which described an incidence of intracerebral hemorrhage (ICH) in COVID-19 patients among of 0.7% across 23 studies with a combined total of 148 patients aged 31 to 78, with a mortality rate of 48.6%. Most ICH were intraparenchymal hematomas (IPHs) with subarachnoid, subdural, and intraventricular hemorrhage (IVH) being less common.

Many of the included studies highlighted the use of anticoagulation in these patients as a potential risk factor for ICH in COVID-19 patients. Fifty-eight patients (50.9%) were

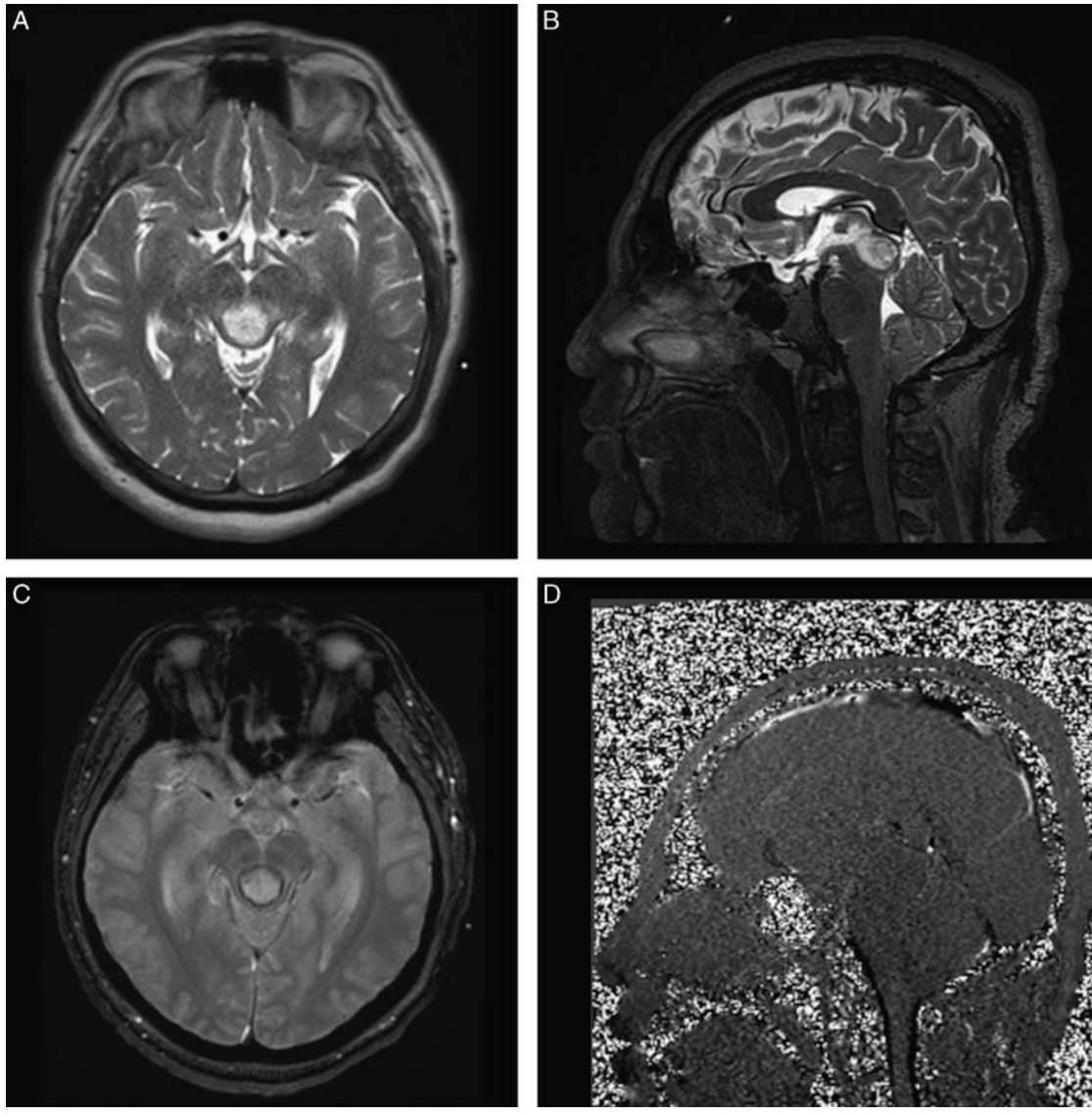

FIGURE 2. Axial T2 (A), sagittal T2 (B), axial GRE (C), and sagittal (D) CINE magnetic resonance imaging demonstrating the evolving tectal hemorrhage. Note the absence of other hemorrhage or associated flow voids, and the ongoing obstruction of the cerebral aqueduct. The CINE sequence demonstrates cerebrospinal fluid pulsation around the brainstem and spinal cord (black blush) but not through the fourth ventricle or the cerebral aqueduct.

on some type of anticoagulation either as part of in-hospital treatment for COVID-19 or other indications.[1] Another study by Melmed and colleagues, assessed risk factors for ICH in COVID-19 found that 34.9% of patients with ICH were on therapeutic anticoagulation with a 5-fold increased risk of ICH in these patients (odds ratio = 5.26, 95% confidence interval: 2.33-12.24, $P < 0.001$). Other significant risk factors associated with ICH on univariate analysis included older age, nonwhite race, and respiratory failure requiring mechanical ventilation ($P < 0.01$ for each variable).[2]

The pathophysiological mechanisms of ICH in COVID-19 have not yet been fully elucidated, but current hypotheses include neurotropism of the virus leading to direct damage of cerebral blood vessels facilitated by the overexpression of angiotensin-converting enzyme 2 and inflammation and cytokine release leading to vascular remodeling and predisposition to ICH.[1] Other hypotheses include a consumptive coagulopathy or disseminated intravascular coagulopathy like reaction and hypoxic damage to the blood-brain barrier causing endothelial dysfunction and cerebral injury.[1]

Isolated spontaneous midbrain hemorrhages are uncommon, and <100 cases have been described in the literature.[3–5] Most midbrain hemorrhages result from secondary extension of a hemorrhage in structures superior or inferior to the midbrain. Etiologies, when identified, include vascular malformations and bleeding diathesis, with hypertension being a less common cause.[3–5] In approximately one third of cases no etiology is identified.[5] Lesions in the midbrain can present with a diverse array of signs and symptoms including ataxia, vertigo, ocular motility disorders, parkinsonian signs, hydrocephalus, and eye movement dysfunction because of the location of vertical gaze centers and nuclei of the extraocular muscles in the midbrain.[3]

The longest case series of spontaneous midbrain hemorrhage was that of Link and colleagues which added 7 patients to the existing pool of 66 cases that have been previously reported in the literature. This discussion reported neuro-ophthalmologic abnormalities to be the most common finding, present in 88% of patients.[4] Other manifestations frequently included altered level of consciousness and headache with hemiparesis, hemisensory loss, and ataxia reported less frequently. Most patients in the cohort recovered with supportive care only. The majority of these patients exhibited no neurological deficit at follow-up or minor deficit most commonly related to cranial nerves III and IV and limitation of vertical gaze.[5]

We present a case of isolated midbrain tectum ICH in the setting of COVID-19 infection as the only identified risk factor.

ILLUSTRATIVE CASE

The patient is a 36-year-old Hispanic male with no significant past medical history (specifically, no history of anticoagulants, antiplatelets, hypertension, or history of illicit drug use) who awoke on the day of presentation to the referring facility with spontaneous headache and vision changes. Of note, he had a diagnosis of COVID-19 infection 13 days before this presentation and had no hallmark COVID-19–related symptoms when he presented to care for this encounter. He had worsening of his neurological status at the referring facility and became somnolent. A noncontrasted computed tomography (CT) scan of the head was obtained which demonstrated IPH in the region of the midbrain tectum with associated IVH filling the lateral, third, and fourth ventricles with obstruction of the cerebral aqueduct (Fig. 1). The patient as transferred to Virginia Commonwealth University Health System (VCUHS) where he was evaluated by the Neurosurgery Department.

An updated noncontrast CT scan demonstrated stability of the IPH. CT angiography was obtained which demonstrated no associated vascular lesion and was of adequate quality to obviate the need for formal angiography. Laboratory data obtained on arrival to VCUHS included: basic metabolic panel notable for mild hyperkalemia due to hemolysis of the sample; complete blood count with differential notable for thrombocytosis with a platelet count of 455×10^9/L; normal coagulation studies (international normalized ratio, prothrombin time, and activated partial thromboplastin time); D-dimer of 0.84 mcg/mL; troponins and creatine kinase-MB which were normal; and a negative urine drug screen. At the time of examination on presentation to VCUHS, the patient was arousable to stimulus, able to say some words, and able to follow simple commands for a Glasgow Coma Scale of 11; of note, bedside cranial nerve examination was normal within the testing limitations of the patient's somnolence. His neurological status declined shortly after arrival, and he required intubation to secure the airway. The patient was urgently admitted to the Neuroscience Intensive Care Unit for close neurological monitoring and an external ventricular drain (EVD) was placed during the first night to treat worsening hydrocephalus secondary to the significant IVH and obstruction of the aqueduct. The patient clinically improved following EVD placement and was weaned from the ventilator and extubated the subsequent day. Further laboratory evaluations were undertaken for the etiology of the hemorrhage which included: hemoglobin A1c of 5.2%; lipid panel with low high-density lipoprotein (27 mg/dL), normal measured low-density lipoprotein (59 mg/dL), and significantly elevated triglycerides (773 mg/dL).

During his hospitalization, the patient complained of intermittent diplopia, but formal visual examination revealed no cranial nerve deficits, and ophthalmology consultation could not identify any structural abnormality or deficit; this symptom was managed with intermittent eye patching. A noncontrasted magnetic resonance imaging of the brain demonstrated resolution of the IVH with persistent obstruction of the cerebral aqueduct due to evolving hematoma in the tectum (Fig. 2). The

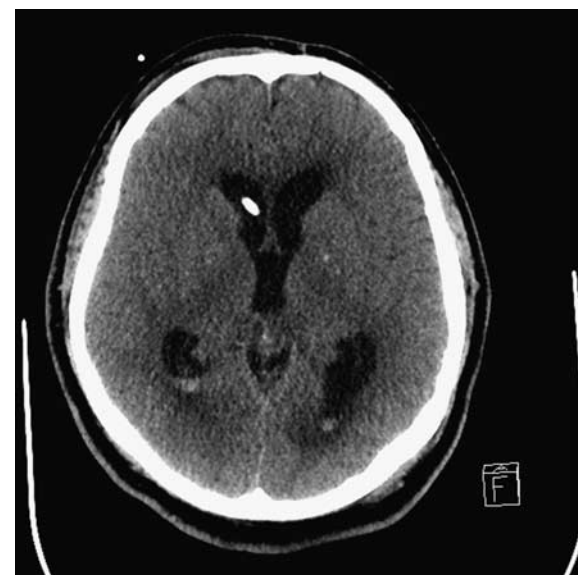

FIGURE 3. Axial noncontrasted computed tomography scan demonstrates hydrocephalus during an external ventricular drain challenge after the patient had been weaned to higher drainage settings. Note the resolution of the intraventricular hemorrhage.

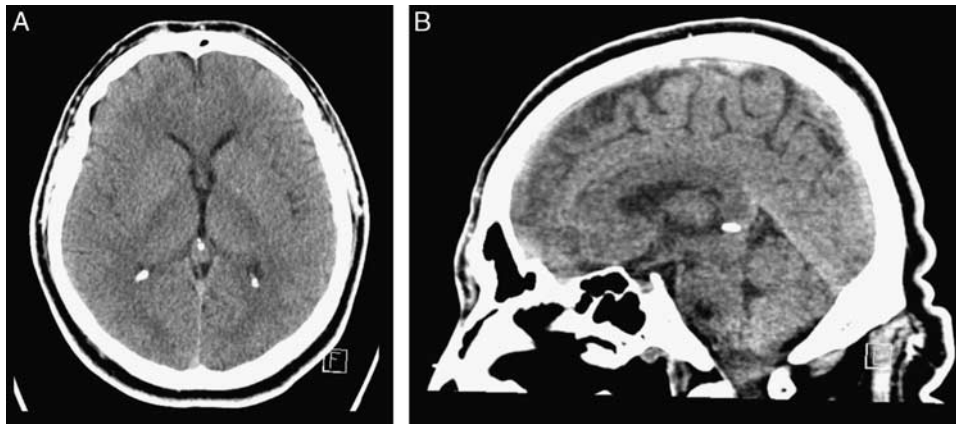

FIGURE 4. (A) Axial noncontrasted computed tomography at the 2-month follow-up visit demonstrates the resolution of hydrocephalus following the endoscopic third ventriculostomy. (B) Sagittal sequence from the same series demonstrates resolution of the hemorrhage but probable ongoing obstruction of the cerebral aqueduct.

patient failed EVD challenge with clinical and radiographic evidence of hydrocephalus and therefore was planned for permanent cerebrospinal fluid diversion (Fig. 3). The patient underwent endoscopic third ventriculostomy and was able to have the EVD weaned and removed. He was discharged home with home health care. He was seen in follow-up 2 months after discharge and was doing neurologically well. He had an unremarkable physical examination yet still had persistent diplopia with plans for further ophthalmology follow-up (Fig. 4).

DISCUSSION

Observations

Hemorrhage in the dorsal midbrain and tectum is a rare occurrence, and often the etiology of the hemorrhage is uncertain. We present a case in which COVID-19 infection is the only identifiable risk factor. The patient had a thorough radiographic workup to exclude an underlying vascular lesion or occlusion and no evidence of coagulopathy on his laboratory evaluation. His initial diagnosis of COVID-19 was 13 days before presentation, and he had no respiratory involvement or other manifestations of the now classic symptoms of COVID-19 infection such as loss of sense of smell. He had an isolated hypertriglyceridemia which would not explain the etiology of the hemorrhage. Since the patient was not on anticoagulation before hospitalization and did not require anticoagulation or antiplatelet therapy for treatment of COVID-19, these commonly identified risk factors in COVID-associated hemorrhage are not present. Age and location of the hemorrhage make other etiology of IPH such as amyloid angiopathy very unlikely as etiologic factors.

Lessons

The case furthers the knowledge base by demonstrating that in addition to causing hemorrhagic cerebral pathology, COVID-19 may be a risk factor for uncommon types of hemorrhage. In addition, the hemorrhage that occurred seems unique in that it is truly isolated to the tectum without further extension. Our case demonstrates that this unique disease presentation remains amenable to standard management techniques for IPH and obstructive hydrocephalus.

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