

# Unusual Post–COVID-19 Presentation With Tetraventricular Hydrocephalus

## A Case Report

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## Abstract

### Objective

COVID-19 infection is suggested as one of the causes for hydrocephalus (HCP) of unknown etiology. COVID-19 infection may present with a range of neurologic symptoms given viral neurotropic and neuroinvasive properties. Postinfectious HCP is a severe complication as a potential sequela of COVID-19 infection.

### Methods

We identified a patient with a history of recent COVID-19 infection who presented with chronic progressive headaches with nausea, vomiting, and blurry vision over 2 weeks.

### Results

Neurologic examination showed bilateral papilledema. The head CT scan showed tetraventricular enlargement and marked fourth ventricular dilation. Cine MRI showed fourth ventricular turbulent CSF flow. The patient underwent external ventricular drain placement and exploratory suboccipital craniotomy, which revealed a subarachnoid web that was microsurgically resected. Reconstituted CSF flow resolved the patient's symptoms and prevented complications.

### Discussion

Fourth ventricular outlet obstruction is a rare cause of tetraventricular HCP. In most cases, it is associated with a history of inflammatory conditions or hemorrhage. In our case, a history of recent COVID-19 infection and normal imaging before COVID-19 make COVID-19 the most probable explanation for HCP. We suggest considering COVID-19 infection in the differential diagnosis of HCP of unclear etiology.

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Although the respiratory system is the primary target of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), it affects some patients' CNS. Various proposed mechanisms support the neurotropic and neuroinvasive tendency of SARS-CoV-2, resulting in numerous neurologic manifestations, either from direct invasion of the CNS or from critical illness and systemic infection.<sup>1</sup> HCP is one of the rare but well-documented postinfectious complications. In this study, we present a case of HCP as a potential complication of COVID-19 infection. We suggest that post–COVID-19 complications can be considered in the differential diagnosis of HCP with unclear etiology.

### Case Description

A 36-year-old African American man presented with chronic progressive headaches over 2 weeks. At first, headaches were intermittent and relieved by acetaminophen; over time, headaches became constant and associated with nausea, vomiting, blurry vision, and intermittent

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horizontal diplopia. Symptoms worsened with exercise and straining and improved with lying flat. The patient denied any history of headaches.

His medical history was significant for hypertension and recent COVID-19 infection (PCR positive) 3 months ago, with mild symptoms. No neurologic workup or hospitalization was required. He was quarantined and then returned to usual activities.

He was alert and oriented; vital signs and general examination were unremarkable, although neurologic examination showed bilateral papilledema (grade 2) and shuffling gait. Compared with previous normal CT and MR imaging of the head 3 years ago, the head CT scan during this admission showed severely enlarged all 4 ventricles with no clear ventricular outflow obstruction, likely communicating. Brain MRI (Stealth protocol) with and without contrast showed tetraventricular hydrocephalus (HCP) possibly related to CSF outflow obstruction around the foramen magnum without any abnormal parenchymal or meningeal enhancement (Figure). The patient was admitted to the neurocritical care unit with a neurosurgical consultation and kept under a close external ventricular drain (EVD) watch. To clarify possible obstruction, cine MRI (CSF flow study) demonstrated turbulent fourth ventricle CSF flow suggesting probable outflow obstruction.

On admission day 2, the patient became bradycardic and hypoxic, with apneic changes requiring EVD placement. An initial opening CSF pressure was 30 mm of Hg. CSF studies showed elevated cell count (WBCs 123, segmented neutrophils 61, lymphocytes 36, RBCs 5.6K, and disintegrated cells) with normal protein and glucose. CSF COVID-19 PCR,

Gram stain/culture, and meningitis panel were negative. Serology was negative for cytomegalovirus and HIV.

Later, the patient underwent suboccipital craniectomy to explore and decompress the foramen magnum area, which revealed the fourth ventricular outflow tract subarachnoid web (proven with biopsy). Microsurgical resection of the web was performed (Figure).

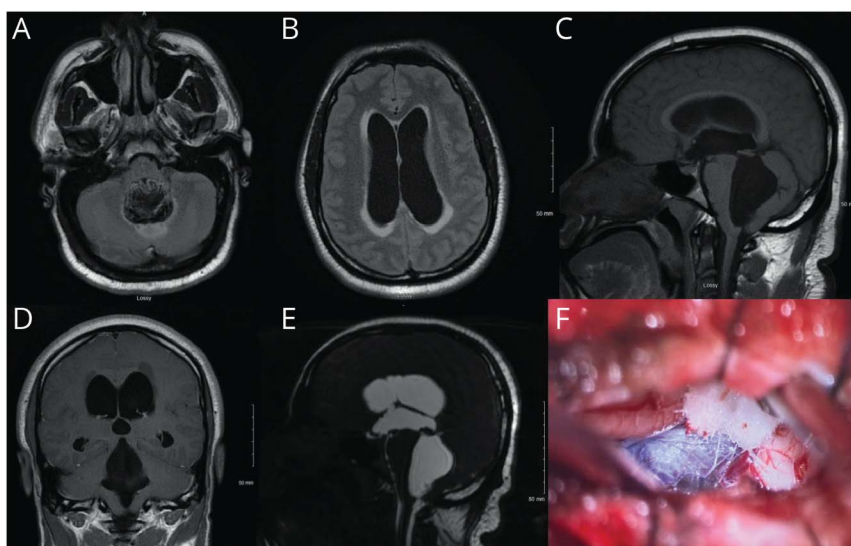
The patient reported symptoms improvement, and the neuroexamination remained stable. Postoperative head CT and MRI scans showed improvement in HCP but still moderately dilated ventriculomegaly. On postoperative day 2, EVD was removed (last recorded intracranial pressure 37). The patient was later discharged with close follow-up.

## Discussion

HCP is a rare infectious complication that can occur at any point during the disease course. In this study, we described a previously healthy patient who developed symptomatic tetraventricular HCP 3 months after having a COVID-19 infection.

The occlusion of the fourth ventricular outlet is a rare but well-known cause of tetraventricular HCP. In most cases, the etiology is attributed to previous parenchymal insults, including infections (such as toxoplasmosis and cysticercosis), inflammation, hemorrhage, neoplasms, Arnold-Chiari malformation, or arachnoid cysts.<sup>2</sup> Arachnoid webs are abnormal formations of the arachnoid membrane in the subarachnoid space that prevents longitudinal CSF movement.<sup>3</sup>

**Figure** MRI Showing Hydrocephalus and Intraoperative Picture Demonstrating Dense Arachnoid Web



(A and B) Selected image of axial sections of T2 fluid-attenuated inversion recovery (FLAIR) of the brain demonstrating enlarged fourth and lateral ventricles with periventricular transependymal edema suggestive of active hydrocephalus. (C) Sagittal T1 W FLAIR demonstrating marked lateral, third, and fourth ventriculomegaly possibly related to CSF outflow obstruction around the foramen magnum. (D) T1 FLAIR postcontrast scan with no abnormal parenchymal or meningeal enhancement. (E) Sagittal FIESTA showing tetraventricular hydrocephalus. (F) Dense arachnoid web at the level of the cerebellomedullary junction (fourth ventricular outlet).

## PRACTICAL IMPLICATIONS

A pearl of wisdom for the practicing clinician: Consider COVID-19 as the cause of hydrocephalus of unclear etiology.

The pathophysiologic mechanism of increased intracranial pressure and HCP is still unclear; a couple of proposed mechanisms could explain CNS invasion in COVID-19. Recent studies have shown that the interaction of SARS-CoV-2 viral spike proteins with angiotensin-converting enzyme 2 receptors on the olfactory epithelium leads to potential transsynaptic retrograde transmission through the olfactory nerve into the CNS.<sup>4,6</sup> Similarly, an abundance of these receptors in the choroid plexus of the lateral ventricles could be another pathway.<sup>4,5</sup> This proposed interaction between the virus and the choroid plexus could potentially alter the CSF flow dynamics, resulting in an arachnoid web formation.<sup>4,5</sup> Another proposed mechanism is bloodstream viral spike protein infecting the cerebral endothelium, which results in blood-brain barrier dysfunction and viral CNS invasion.<sup>4,6</sup>

## Conclusion

We presented a symptomatic tetraventricular HCP case caused by an arachnoid web successfully treated with microsurgical fenestration surgery. Although it cannot be certain that arachnoid web and HCP occurred secondary to COVID-19 infection, the temporal correlation, given the recent viral infection and normal prior imaging, supports a causal relationship, and further studies are needed to understand this association. Nonetheless, recent COVID-19 infection should be kept in the differential diagnosis by the treating physician for HCP of unclear etiology.

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