

Neurological findings associated with neuroimaging in COVID-19 Patients

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Abstract

Patients with COVID-19 and other corona virus infections have been documented as having a variety of neurologic symptoms. In this article, we conducted a thorough evaluation of the imaging results of individuals who had been identified as having neurological symptoms linked to coronavirus infections. The use of CT and MRI has revealed varying radiologic outcomes in the setting of various neurologic presentations. Despite the fact that the majority of patients have normal imaging analyses, certain patients exhibit intra- and extra-axial abnormalities. There have been reports of encephalomyelitis, meningitis, acute disseminated encephalomyelitis (ADEM), ischemic and hemorrhagic strokes, and encephalopathy. In especially during the present COVID-19 pandemic, familiarity with these radiologic patterns can help radiologists and referring doctors investigate coronavirus infections in patients with worsening or progressing neurologic symptoms.

Keywords: COVID-19; Radiology; Imaging; Neurology

1. Introduction

The worldwide unique Coronavirus illness (COVID-19) pandemic, which was initially discovered in Wuhan (China), has drawn much interest. Beyond 605 million cases of COVID-19 and over 6.4 million fatalities had been recorded throughout the world as of August 29, 2022 ¹. Although most infected individuals appear with febrility and respiratory manifestations, multiple unusual presentations, including gastrointestinal issues, cardiac problems, renal failure, and neurological abnormalities, have been observed recently ^{2,3}. A case series that studied 214 COVID-19 hospitalized individuals from hospitals in Wuhan city discovered that 36.4% of them experienced neurological symptoms such as headaches, dizziness, and impairment of consciousness. Additionally, in several additional accounts, neurologic symptoms have been described as the SARS-CoV-2 infection's early presentation ⁴⁻⁶. COVID-19 provoked a tremendous degree of attraction between researchers, medical professionals, and scientists worldwide ⁶.

There has never been anything like the amount of work being done or papers prepared on COVID-19. It was predicted that hundreds of articles would be publicized about the issue starting at the beginning of the year ⁷. Information about many factors of illness prevention, transmission, pathophysiology, symptoms, and management techniques is beginning to emerge ⁸⁻¹⁰. In spite of the fact that COVID-19 positively influences the cardiovascular and respiratory systems, and many COVID-19 patients are also susceptible to neurological complications like acute cerebrovascular diseases, encephalopathy, skeletal muscle injury, and impaired consciousness. These complications include neuralgia, hypogeusia, dizziness, and headache ^{11,12}. Although the literature on COVID-19's characteristic respiratory presentation has received much attention ⁷, there is a dearth of in-depth research on its cerebral symptoms, particularly the radiological findings. Besides other healthcare professionals, Radiologists must be acquainted with the range of neurological abnormalities connected to this virus despite the current scant evidence. It was because of this that we

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decided to perform this systematic evaluation of myriad radiological abnormalities with concurrent neurological complaints in patients with COVID-19.

2. Lessons learned from prior coronavirus epidemics

Similar to the SARS-CoV-2 strains, the previous Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) are members of the coronavirus family. Over 10,000 people worldwide have contracted MERS-CoV and SARS-CoV outbreaks over the past 20 years^{8,9}. According to several studies, neurologic sequelae, such as seizures, Guillain-Barre syndrome (GBS), encephalopathy, anosmia, encephalitis, neuromuscular abnormalities, as well as demyelinating illnesses, may develop in connection with respiratory coronavirus syndromes¹⁰⁻¹³. The ability to invade and live in neural tissue of additional coronaviruses of humans, such as HCoV-NL63, HCoV-HKU1, HCoV-OC43, and HCoV-229E, as well as the potential links to neurological conditions including multiple sclerosis disease (MS), has also been disputed^{14,15}. It has been proposed that the host immunological response, which includes inflammatory cascades including cytokine activation, may be the cause of the said neurological abnormalities.

Meanwhile, postmortem examinations of people who died from SARS illness have shown viral RNA in neurons, suggesting coronaviruses may be capable of infecting neurons¹⁶ by themselves. Cerebrovascular endothelial cells' receptors of angiotensin-converting enzyme (ACE) II may be crucial to this process. We made the decision to review the existing literature on brain imaging results related to COVID-19 in light of the identical viral configurations with similar neurological post-viral consequences. This may help in the fast diagnosis and expeditious therapy for neurological disorders linked to infection with COVID-19, as well as offer insightful information about coronavirus pathogenesis.

3. Discussion

Cases infected with COVID-19 or different coronaviruses have been identified in the company of a variety of clinical neurologic symptoms. On this subject, there is, however, little information. Since the majority of the articles do not contain the matching results from imaging of the brain, there is even less information accessible concerning connected neuroimaging discoveries. Still, in the absence of pulmonary symptoms, coronaviruses may exhibit neurotropic and neuroinvasive characteristics, according to earlier investigations. Similar to this, multiple fresh case reports during the current COVID-19 epidemic have once more raised the possibility of a connection linking neurological signs and infection with COVID-19. Headache, anosmia, myalgia, and cerebrovascular illness, besides encephalopathy, are some of the uttermost prevalent neurologic signs connected to infection with SARS-CoV-2, according to a reasonably recent analysis⁴². Several theories have been put up to explain these anomalies. While some writers have postulated neuronal retrograde dissemination, transcribrial, and hematogenous, routes as a straightforward way of a viral attack on cells of the human brain, others have proposed a hyperimmune reaction related to storms of the cytokine to explain the said neurological manifestations. Additionally, the receptors of angiotensin-converting enzyme 2 (ACE2), which endothelial cells from brain capillary express, may act as a mediator in the CoV neurotropism, particularly SARS-CoV-2. Brain injury that is permanent as a result of cerebral endothelial rupture has a part in the pathogenesis of SARS-CoV-2 neurologic symptoms³⁶⁻⁴⁰. In addition, coronavirus patients may experience cerebrovascular events as a result of raised amounts of D-dimer and CRP brought on by activation of hypercoagulation cascade and a state of high inflammation. As a result, although it is still too early to be confident, a mix of immunological, vascular, and neural variables might be the likely pathways. Beyond one-third of the cases that were hospitalized are said to have CNS involvement from coronavirus infection⁴², with severity ranging from minor to life-threatening diseases. Therefore, particularly during the ongoing pandemic, it should be taken into account in the differential diagnosis of each individual presenting with indefinable increasing neurological symptoms. In these situations, neurologic imaging could be useful since a prompt diagnosis is crucial for preventing additional brain injury. Here, the article evaluated the radiologic symptoms in coronavirus infection of the CNS caused by several coronavirus strains (COVID-19, MERS-CoV, SARS-CoV, and different strains of CoV). According to our information, this is the first systematic study that describes the outcomes of neuroimaging in cases infected with coronavirus, especially COVID-19. Like previously indicated, several results have been made using neuroimaging modalities, including CT and MRI, in the context of diverse clinical settings. In contrast to the other patients who showed imaging irregularities of various regions in the brain, such as acute cerebrovascular occurrences (hemorrhagic and ischemic classifications), demyelinating disorders (ADEM), encephalopathy, meningitis, myelitis, and only a tiny percentage of COVID-19 patients (40 percent) had expected results. The most prevalent neuroradiological anomaly observed in COVID-19 individuals is reported to be cerebrovascular occurrences, including both hemorrhagic and ischemic episodes (27 percent, Table 1).

Individuals with coronavirus infection are thought to be more susceptible to cerebrovascular illness and incredibly sick elderly patients with a variety of vascular risk factors. As was already indicated, the etiology of cerebrovascular disease in these individuals may be significantly influenced by coagulation malfunction and a hyperinflammatory response. According to Munhoz RP and others⁴², between 2.8 and 5.7% of individuals infected with the virus had an acute cerebrovascular illness (primarily ischemic, seldom were venous thrombosis or hemorrhagic). According to Asadi-Pooya AA et al.¹⁸ and also Mao L.³, 5-5.7 percent of COVID-19-related neurologic symptoms are caused by ischemic or hemorrhagic CVD. Due to their augmented danger of acute cerebrovascular events, individuals having robust coronavirus infection and vascular risk factors should be treated with particular caution. In a few cases, myelitis and encephalopathy-related alterations that appear like a parenchymal sign irregularity of various areas in the brain were documented as additional neuroimaging abnormalities (Tables 1,2). Generally speaking, the neurological symptoms linked to infections with coronavirus, particularly SARS-CoV-2, point to a potential causative or synergistic connection between the infection and brain ischemic/hemorrhagic/inflammatory symptoms. It should be emphasized that some of these results could be explained by coincidental events rather than random association. Prolonged neurological consequences have also not been yet researched. Therefore, additional research is necessary to resolve these unanswered problems⁴³⁻⁴⁸.

4. Conclusion

Numerous case reports from the present worldwide COVID-19 pandemic have raised the possibility that SARS-CoV-2 viral infection and neurological manifestations are related, comparable to findings in CNS at the time of and following the earlier SARS and MERS outbreaks. Especially during the present COVID-19 pandemic, being aware of these features can ensure doctors evaluate COVID-19 infection when observing unexplained neurologic symptoms. There is a need for more study on this subject, especially on its long-term neurologic effects, because there is a dearth of information.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

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