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The neuroimaging findings in COVID-19 patients: A literature review.

Yasser Abdelkarim Amin.

Department of Diagnostic Radiology, Faculty of Medicine, Sohag University.

Abstract:

In Wuhan, China, (SARS-CoV-2) began in December 2019 and was rapidly distributed. The disease's clinical hallmark is viral pneumonia with Fever and non-productive cough. Patients may progress suddenly to acute respiratory distress syndrome and, in extreme cases, to death due to Multi-organ or respiratory failure.

The neurological manifestations of COVID-19 disease impact the outcome and the prognosis of the affected patients. The early diagnosis and treatment help in decreasing the acute manifestations and long-term effects. Imaging plays a crucial role in the detection and characterization of the underlying etiology of the CNS involvement giving the clinician the right route for the management. Functioning imaging like positron emission tomography (PET) and diffusion tensor imaging (DTI) are used to understand the changes that occur in the affected area of the neural tissues.

Aim: to clarify and revise the imaging findings in neurological presentations at COVID-19 patients.

Conclusion: Corona-virus-2 affects the neural tissue either directly or indirectly leads to a mild or severe degree of clinical presentations. The clinicians and the neuroradiologist should be aware of early diagnosis and management to avoid a poor prognosis.

Keywords: COVID-19, Neuroimaging, CNS

Introduction:

At the beginning of the COVID-19 pandemic, the respiratory system has the priority of most publications but with the appearance of other system involvement, the other articles discuss the neurological complications of the disease. [1]

The virus responsible for the current epidemic is a single strand RNA. It is a member of the beta-corona virus group. [2]

As the pandemic spreads and the number of COVID-19-infected patients rises, the clinicians begin to focus on neurological symptoms. These neurological manifestations range from mild as headache and anosmia to the severe degree as cerebrovascular stroke. [3]

In a study done at Aswan and Assuit university hospitals -Abo-Elfetoh et al found that 50.6% of inpatients with confirmed COVID-19 had neurological manifestations. [4]

The neurological manifestations and the degree of severity are directly proportionate to the presence of advanced pneumonia and multiple organ dysfunctions. [5]

To limit the COVID-19 spread, neuroimaging study is indicated when a disturbing level of consciousness or focal neurological deficit is present. [2]

The changes at the neural cell level are studied utilizing function imaging with positron emission tomography (PET) and diffusion tensor imaging (DTI), emphasizing the low metabolism and long-term residual effect on neural tissues. [6and7] CNS manifestations may indicate a poor prognosis, so early diagnosis and

treatment are essential for the recuperation of COVID-19 patients. [8]
The MRI and CT imaging results in COVID-19 CNS symptoms should be known to radiologists

Pathophysiology:

The pathophysiology for neurological implications is explained either by direct invasion of the nervous system via olfactory nerves or blood-borne infection, or by an indirect pathway caused by hypercoagulability, endothelial damage, or autoimmune disease, but the exact mechanism of CNS affection is still unknown.. [1]

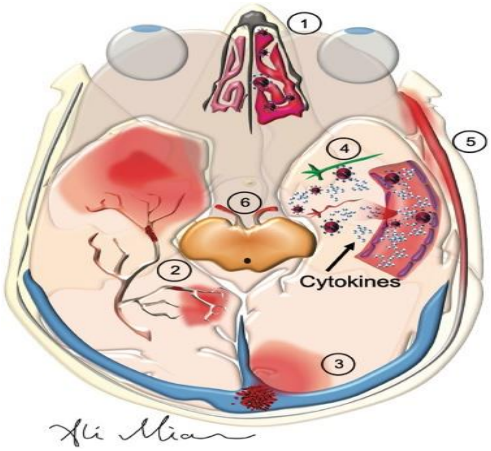

Figure (1); SARS-Cov2: Pathophysiology of action in the nose, cranial nerves, and the brain. 1) By binding and inhibiting nasal (and gustatory - not shown) epithelial cells, it reduces the sense of smell and taste. 2) By activating the cytokines and hypercoagulation pathways in the blood, results in the formation of small and large vessel occlusion in cerebral arteries. 3) Formation of blood clots in the cerebral veins can result in cerebral venous thrombosis. 4) High levels of cytokines in the cerebral vessels can damage the blood-brain barrier, and once infiltrate the brain, damage neurons, and glia which results in seizures and/or encephalopathy. 5) Damage to arteries in the meninges can result in meningitis. 6) Formation of autoantibodies, known as molecular mimicry, may lead to damage to cranial nerves. [9]

Findings in neuroimaging:

1-cerebrovascular stroke: Large vessel ischemic stroke is the most common findings of neurological presentation in COVID-19 patients, it represents about two-thirds of acute ischemic stroke. Posterior circulation ischaemic infarction is recognized in about one-third of cases. The increase in blood coagulability demonstrated by an increase of D-dimer explains the thrombotic mechanism of the vascular occlusion. [10] Multiple infarcted areas are noticed in about 26% of cases. [11]
The incidence of stroke in patients with COVID-19 is directly proportionate to age. [12]

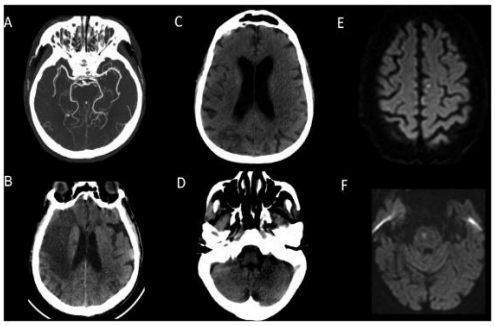

Figure (2): Three different types of strokes A (CTA of the brain) & B (axial scan of the brain) right MCA occlusion, C&D (axial scans of the brain) multiple territories F&E (Diffusion-weighted images) left parietal and pontine lacunar infarctions. [11]

Hemorrhagic stroke manifested in about one quadrant of CO-VID-19 patients with CNS manifestations which is explained by multiple etiologies such as a part of multiple organs failure in severe cases of COVID, the presence of underlying vascular pathologies such as hypertension, DM, and obesity, in patients on anticoagulation therapy and hemorrhagic transformation of ischemic stroke. The intracerebral hemorrhage usually involves the basal ganglia and posterior fossa. It may be a lobar hemor-

rhage or multiple cerebral microbleeds [5,13]

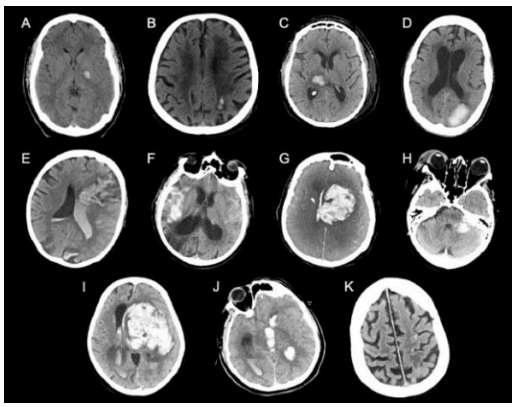

Figure (3): A- (axial scan of the brain) left basal ganglia. B- (axial scan of the brain) subcortical. C-(axial scan of the brain) right thalamic. D. (axial scan of the brain) left occipital. E- (axial scan of the brain) intraventricular. F-(axial scan of the brain) Bilateral f temporoparietal subarachnoid hemorrhage. G- (axial scan of the brain) left basal ganglia, intraventricular and subarachnoid hemorrhage. H- (axial scan of the brain)Left cerebellar hemorrhage. I-(axial scan of the brain) left basal ganglia and intraventricular hemorrhage. J-(axial scan of the brain) pan-ventricular hemorrhage. K-(axial scan of the brain) left sub-cortical and subarachnoid hemorrhage. [13]

Cerebral venous sinus thrombosis:

The frequency of cerebral venous thrombosis with Covid-19 disease stays unknown, but the unexplained neurological presentations should raise the level of suspicion and the indication for neurological imaging [14,15and6]

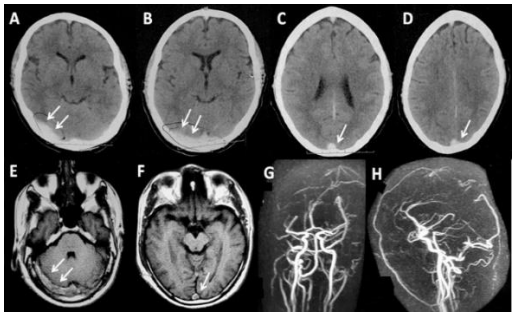

Figure (4)- CT (hyperdense right transverse and SSS), axial T1 (hyperintense signal at right transverse and SSS), and MRV (non-visualized right transverse and SSS sinuses) of right transverse sinus and superior sagittal thrombosis.[14]

Encephalitis:

The diagnosis of encephalitis with COVID-19 disease is recorded as a case report or case series up to the incidence of about 13% of neurological manifestation with COVID-19. Clinically presents by headache, fever, disturbed conscious level, and focal neurological signs. The encephalitis in imaging is suspicious by abnormal signal intensity involves the cortex, deep grey matter, and the white matter with a wide degree of enhancement. [17]

The encephalitis in COVID disease may be caused by direct invasion of the brain tissue or by the auto-immune response for the disease. The presence of medial temporal lobe location and involvement of the claustrum is highly suggestive of para-infectious encephal-itis. [18].

A wide spectrum of clinically manifested encephalitis linked to COVID-19 infection, with varying treatment responses and outcomes.. [19]

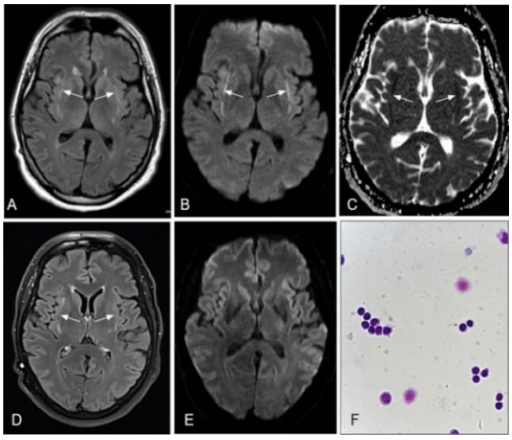

Figure (5): A-E MR scans 2 weeks (a–c) and 4 months (d–e) post symptom onset as well as CSF cytology (f): On axial FLAIR (a), Diffusion-weighted images (b) and the corresponding ADC map (c), the bilateral hyperintense signal within the claustrum regions are depicted (arrows), restricted signal intensity at diffusion. On follow-up imaging (d–e), the FLAIR-hyperintensities persist (d)

whereas tissue diffusion has normalized (e). CSF-cytology (f) showed a slightly elevated lymphocyte cell count. [18]

Cranial nerves affections:

There is increasing documentation that the autoimmune mechanism plays a crucial role in cranial neuropathy in COVID disease [20,21]

The loss of smell is an early symptom that suggests COVID-19 disease explained by acute olfactory impairment which is characterized by the absence of nasal obstruction. [22]

The imaging findings of cranial neuritis are suspicious when abnormal signal intensity with an increase in the size of the affected cranial nerves with post-contrast enhancement.

The results of a case report study on ophthalmoparesis caused by optic and oculomotor nerve palsy, as well as vestibular neuritis, have been published.. [23,24and25]

Guillain-Barré syndrome:

Is an inflammatory process affecting many peripheral nerves that is a clinically recognized condition, according to some research that shows a link between COVID-19 disease and the onset of Guillain-Barré Syndrome? The strength of the relationship between COVID-19 and Guillain-Barré syndrome is still uncertain but awareness of it during the pandemic is essential for early diagnosis and treatment.[26]

In contrast to usual GBS, the majority of COVID-19-related GBS were older, had attendant pneumonia or ARDS, more predominant demyelinating neuropathy. [27]

Conclusion:

The coronavirus-2 has neurological manifestations that may progress to a poor prognosis, early diagnosis and management are essential to save the patients.

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