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Spectrum of computed tomography (Ct)-brain findings in Covid-19 patients with CNS manifestations

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Abstract
Background: Infection with Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-COV-2) results in Corona Virus Disease 2019 (COVID -19) predominantly it affects respiratory system; however it has become apparent that many other organ systems including central nervous system can also be involved. Imaging plays an essential role in diagnosis of all manifestations of the disease and its complications.
Objective: To study the spectrum of neuro-imaging findings on CT in COVID-19 patients with CNS symptoms.
Material and Methods: Non-contrast CT scan of brain was done in 80 patients of either gender having COVID-19, confirmed by reverse transcriptase polymerase chain reaction (RT-PCR) with CNS manifestations. Images were assessed for presence of abnormal findings like Infarcts, hemorrhage, venous/arterial thrombosis, leukoencephalopathy, white matter disease, hypoxic ischemic injury, encephalitis and posterior reverse encephalopathy syndrome.
Results: A total of 80 patients with COVID-19 were reviewed, out of which CT was abnormal in 35 patients (43.7%). findings included various types of infarcts, intra and extra axial haemorrhages, Diffuse axonal injury and PRES (Posterior Reversible Encephalopathy Syndrome).
Our study demonstrated that the neurological imaging of patients with COVID-19 were variable without a specific pattern but is dominated by ischemic infarcts and intracranial haemorrhages.
Conclusion: C0VID-19 is a serious public health crisis and can have neurological manifestations, therefore these patients should be evaluated early for neurological symptoms as timely analysis and management of neurological complications are key to improving the prognosis.

Keywords: Assess refers to process of the critical analysis and valuation and judgement of the status or

Introduction

- Infection with Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-COV-2) results in Corona Virus Disease 2019 (COVID -19), which was declared as a pandemic by the World Health Organization (WHO) on March 11, 2020. COVID-19 affects predominantly the respiratory system, however it has become apparent that many other organ systems including central nervous system (CNS) can also be involved resulting in manifestations like acute cerebro-vascular disease, viral encephalitis and infectious toxic encephalopathy [1, 2].
- The involvement of multiple systems is due to expression of angiotensin-converting enzyme-2 (ACE-2) receptors in extrapulmonary tissues, which results in entry of SARS-COV-2 and thus viral tissue damage. SARS-COV-2 induced coagulopathy significantly contributes to development of CNS manifestations. Inflammation and endothelial cell dysfunction by the virus are the other potential mechanisms contributing to global brain dysfunction [1].
- Imaging plays an essential role in the diagnosis of all manifestations of the disease and related complications.

Aims and objectives

- To study the spectrum of neuro-imaging findings on CT in COVID-19 patients with CNS symptoms.

Methods

- This cross-sectional study is done from 01/02/2021 to 01/06/2021, Patients of either gender having COVID-19 confirmed by reverse transcriptase - polymerase chain reaction (RT-PCR) with CNS manifestations like confusion/delirium, headache, seizure, dizziness, neuralgia, ataxia, focal neurological deficit, anxiety or depression were included in this study. Computed tomography (CT) of brain was done in these patients in supine position (A total of 80 patients were included in this study).

Inclusion criteria

1. COVID-19 confirmed patients of > 18years age with CNS manifestations.
2. Patient with proper consent.

Exclusion criteria

1. Pregnant patients.
2. Patients with any previous history of brain stroke/ intracranial pathology / neurological disorder/head trauma
3. Patients who refused to give consent for the study.

Methodology

Clinical details of the patient, relevant history and clinical examinations findings were recorded and consent for the study was taken.

Technique

CT brain was performed in the patients in supine position and CT images were assessed for Spectrum of neuro-imaging findings like:

Infarct

- Acute infarcts
- Subacute infarcts
- Watershed zone
- Lacunar infarcts

Haemorrhage

Extra-axial haemorrhage

- Intraventricular haemorrhage.
- Subarachnoid haemorrhage.
- Subdural haemorrhage.
- Epidural haemorrhage.

Intra-axial haemorrhage

- Parenchymal /lobar haemorrhage
- Striato-thalamic haemorrhage
- Brainstem haemorrhage
- Cerebellar haemorrhage
- Micro-haemorrhage

1. Cerebral venous thrombosis / Thrombus in intracranial arteries
2. Leukoencephalopathy/White matter disease / Diffuse axonal injury
3. Hypoxic ischemic encephalopathy
4. PRES (Posterior Reversible Encephalopathy Syndrome)
5. Encephalitis.

Statistical Analysis

The data collected will be entered in Microsoft excel and analyzed by SPSS version 24.0

Data analyzed by descriptive statistics namely percentage of proportion, graphs, tables and images whatever applicable.

Results

A total of 80 patients with COVID-19 were reviewed, out of which CT was abnormal in 35 patients (43.7%). findings included various types of infarcts, intra and extra axial haemorrhages, Diffuse axonal injury and PRES (Posterior Reversible Encephalopathy Syndrome).

Our study demonstrated that the neurological imaging of patients with COVID-19 were variable without a specific pattern but is dominated by ischemic infarcts and intracranial haemorrhages.

Patient's demographic parameters

Table 1: Sex distribution of SBO

Characteristics	Number (N)	Percentage(P)
Sex		
Male	49	61.2%
Female	31	38.8%

Table 2: Age distribution of SBO

Characteristics	Number (N)	Percentage(P)
Age		
< 50 years	19	23.8%
> 50 years	61	76.2%

Table 3: Indications for the CT brain in COVID-19 patients

Indications	Number (N)	Percentage(%)
Delirium/confusion	30	37.5 %
Focal neurological deficit	13	16.2 %
Anxiety / depression	11	13.8%
Headache	9	11.2%
Dizziness	7	8.8%
Seizure	5	6.2%
Neuralgia	3	3.8%
Ataxia	2	2.5%

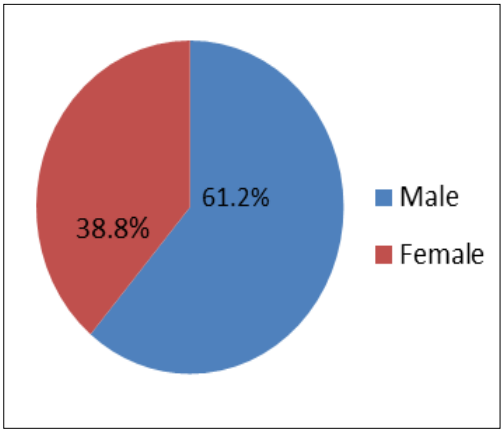


Fig 1: PIE Chart depicting gender distribution of SBO

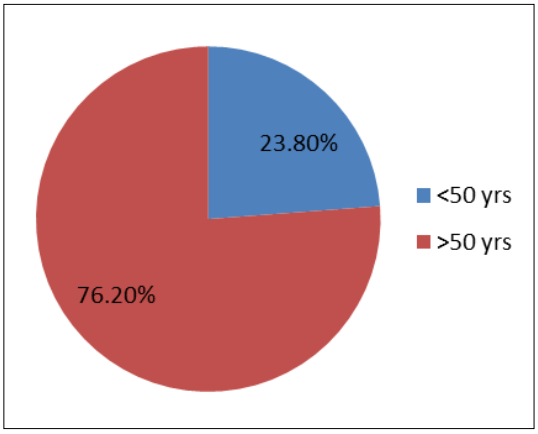
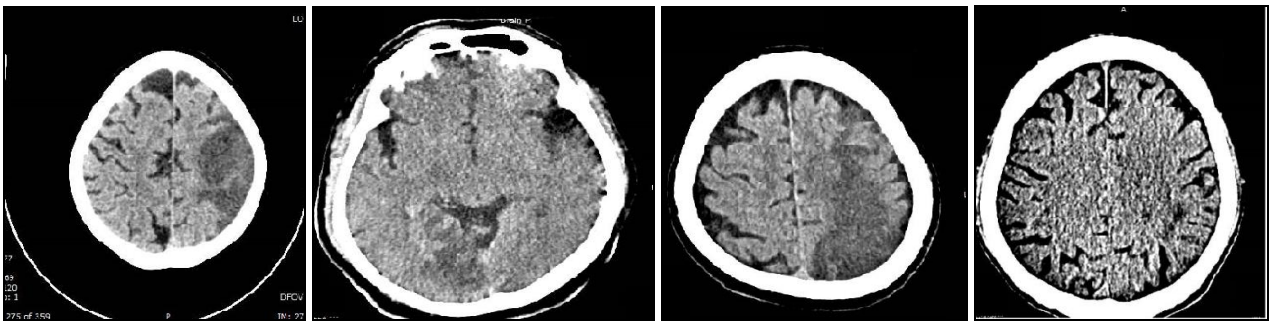


Fig 2: PIE Chart depicting Age distribution of SBO

Table 4: Distribution of various CT brain findings in COVID-19 patients

Ct brain findings:	Number (N)	Percentage (%)
Infarcts	21	60%
- Acute Infarcts	7	(20%)
- Subacute infarcts	6	(17.1%)
- watershed	3	(8.5%)
- Lacunar	5	(14.2%)
Hemorrhages	9	28.5%
Intra-axial Hemorrhages	7	(20%)
- Lobar	4	(11.4%)
- Striato-thalamic	1	(2.8%)
- Micro-hemorrhages	1	(2.8%)
-Brain-stem and cerebellum	1	(2.8%)
Extra-axial Hemorrhages	2	(5.7%)
- Intraventricular	1	(2.8%)
- Subarachnoid	1	(2.8%)
Cerebral venous thrombosis	3	8.5%
-superior sagittal sinus and cortical veins	1	(2.8%)
-Transverse sinus	2	(5.7%)
PRES (Posterior Reversible Encephalopathy Syndrome)	1	2.8%
Diffuse axonal injury	1	2.8%

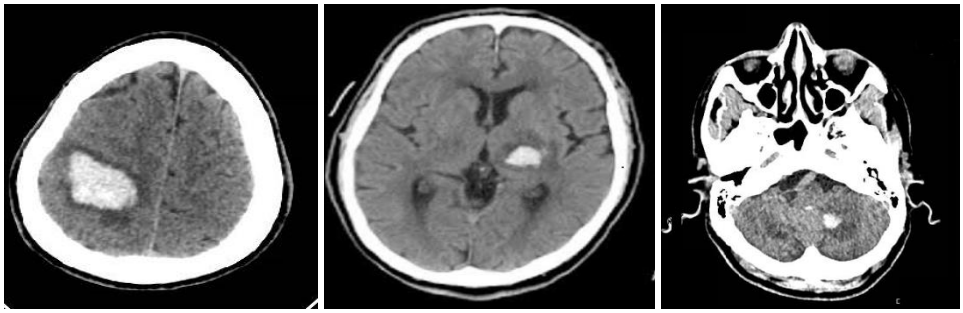
Representative Images
Infarcts



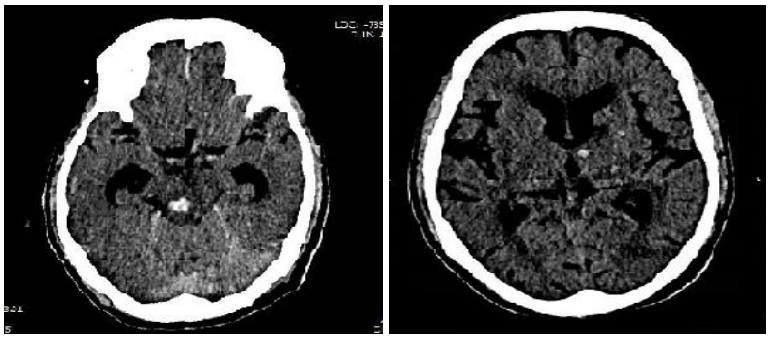
Acute infarct | Sub-acute infarct | Watershed infarct | Lacunar infarct

Fig 3: CT images of various types of infarcts in covid-19 patients.

Hemorrhages
Intra-axial Hemorrhages

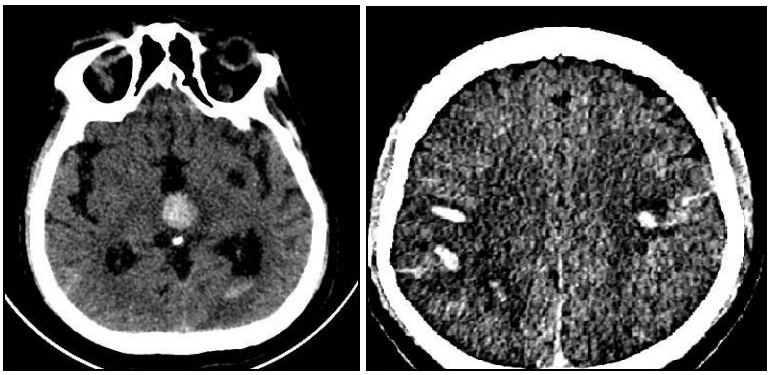


Lobar haemorrhage Thalamic haemorrhage Cerebellar haemorrhage



Midbrain haemorrhage Micro haemorrhages

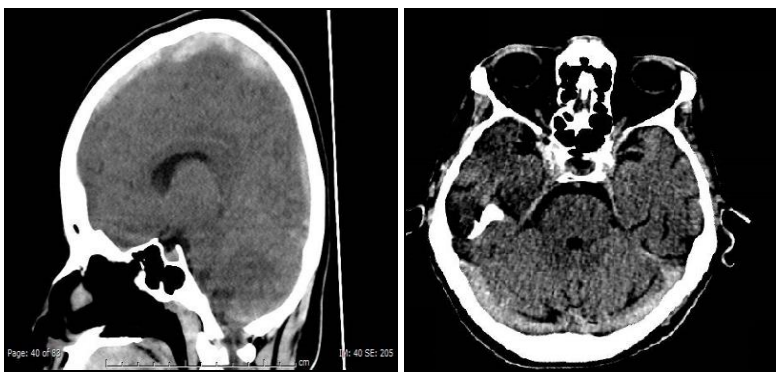
Fig 4: Extra-axial Hemorrhages



Intra-ventricular haemorrhage Sub-arachnoid haemorrhage

Fig 5: CT images of various types of hemorrhages in covid-19 patients.

Cerebral venous thrombosis



Superior sagittal sinus thrombosis Transverse sinus thrombosis

Fig 6: CT images of cerebral thrombosis in covid-19 patients.

Fig 7: CT image of diffuse axonal injury in covid-19 patient.

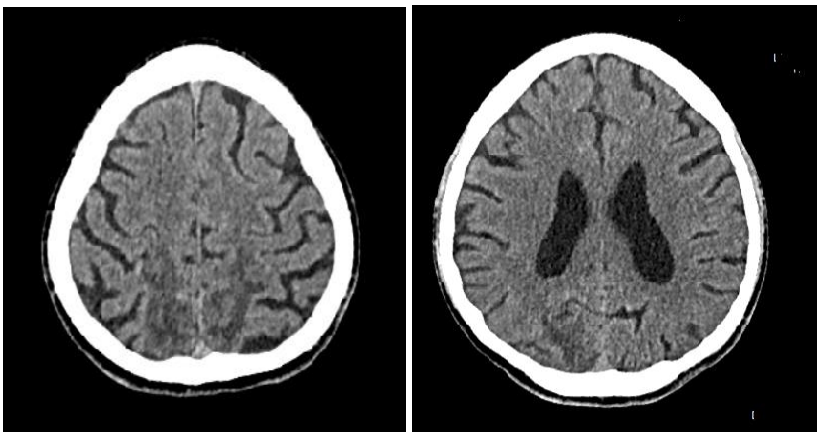


Fig 8: CT images of PRES (vasogenic edema in parieto-occipital region) in covid-19 patient.

Discussion

Infection with Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-COV-2) results in Corona Virus Disease 2019 (COVID -19), it affects predominantly the respiratory system, however it has become apparent that many other organ systems including central nervous system (CNS). The neurological manifestations are hypothesized to be caused by multiple factors such as damage to specific receptors, secondary hypoxia, cytokine-related injury and retrograde travel along the olfactory nerve and bulb.

Additionally global inflammatory markers such as interleukin (IL)-6, (IL)-12, (IL)-15 and tumor necrosis factor alfa can activate glial cells and produce inflammatory responses. Cytokine storm syndrome and secondary hemophagocytic lympho-histiocytosis can occur in a sub-group of patients leading to hyperinflammatory syndrome.

These systemic consequences along with alveolar damage cause severe hypoxia which leads to cerebro-vascular vasodilatation, cerebral edema and ischemia.

The occurance of a diverse mechanism in COVID-19 patients, possibly related to endothelial damage [3,] resulting in impaired microcirculatory function and vascular fragility with micro-hemorrhages or thrombotic microangiopathy[4]

A unique spike glycoprotein receptor binding domain of SARS –C0V-2 confers affinity of virus for the ACE-2 receptors, virus utilizes the ACE-2 receptor for the entry into the host cells. These receptors are also expressed in endothelial cells of blood-brain barrier, therefore patients with COVID-19 may be at risk of thrombogenesis and cerebral ischemia due to both biochemical hypercoagulable states and direct vascular endothelial injury.

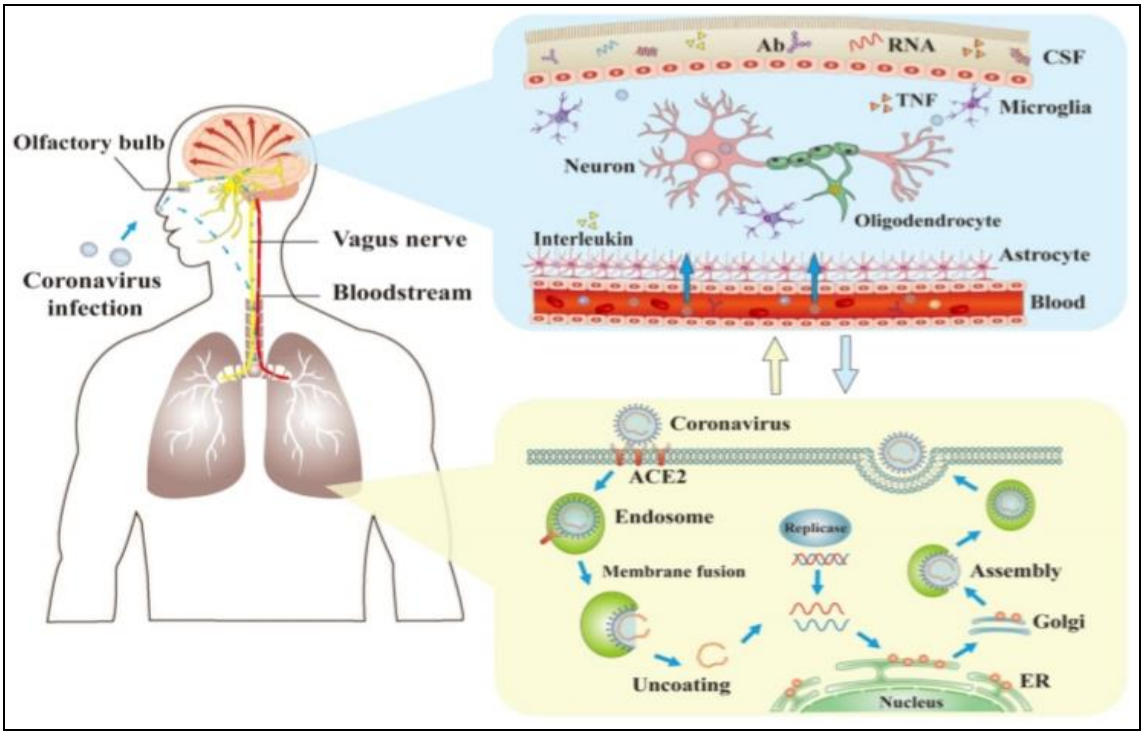


Fig 9: The mechanisms of corona-viruses infections and neurological damage caused by corona virus[2]

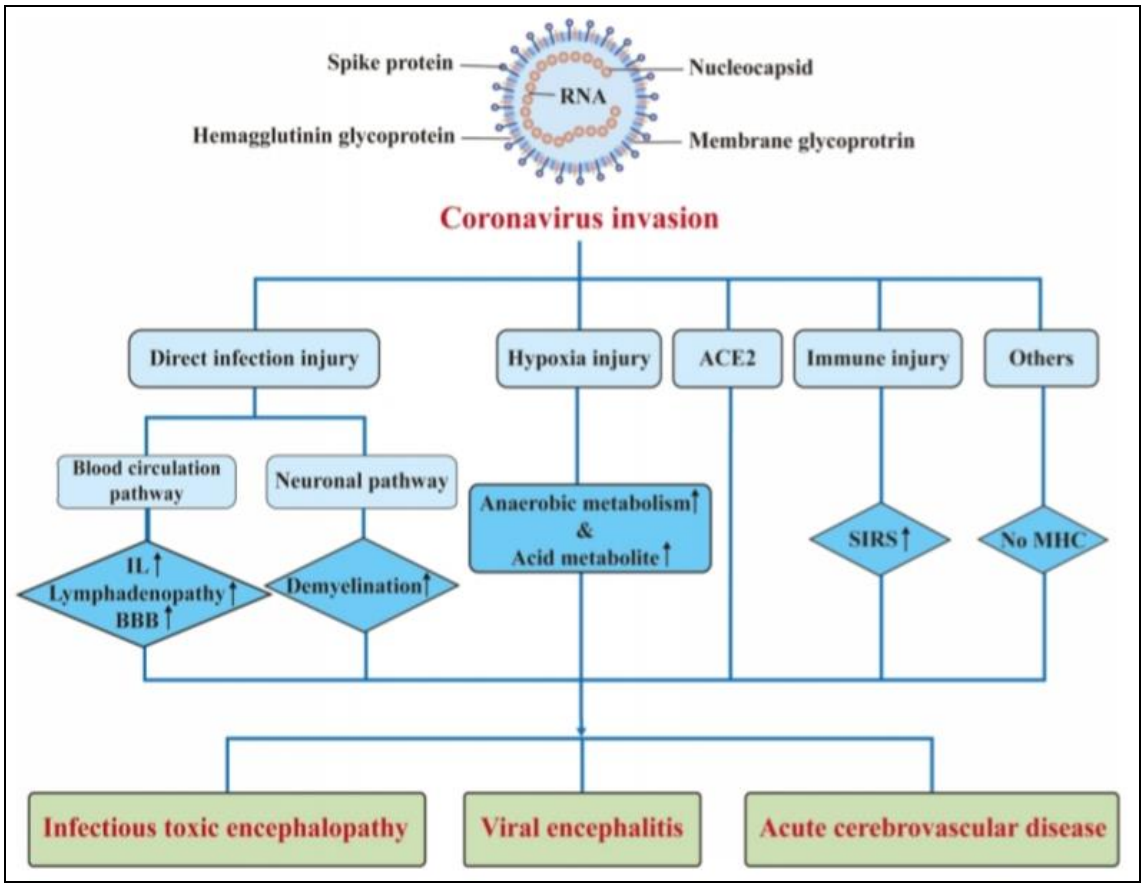


Fig 10: The neurophysiopathogenic mechanisms of SARS-CoV-2[2].

Conclusion

Corona virus-19 (C0VID-19) is a serious public health crisis and can have neurological manifestations. Therefore, patients with covid-19 infections should be evaluated early for neurological symptoms - timely analysis and management of neurological complications are key to improving the prognosis.

Conflict of Interest

Not available

Financial Support

Not available

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