Original Article

Neuroimaging Findings on CT and MRI in Adult Patients with COVID-19

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ABSTRACT

Objective: The main objective of the study is to compare the neuroimaging findings on CT and MRI in adult patients with COVID-19.

Study Design: Retrospective study

Place and Duration of Study: This study was conducted at the Neurology Department Fauji Foundation Hospital Rawalpindi from January 2020 to December 2022.

Methods: Data was collected from 550 COVID-19 patients from both genders. Patients were identified from electronic medical records and databases of healthcare facilities where they received medical care. A total of 550 adult patients diagnosed with COVID-19 were included in the study. Patients were identified from electronic medical records and databases of healthcare facilities where they received medical care. Clinical and demographic data, including age, gender, comorbidities, and COVID-19 severity, were extracted from electronic medical records.

Results: Data were collected from 550 patients, with a mean age of 52 years (range 18–85). The cohort comprised 58% males (320 patients) and 42% females (230 patients). Disease severity was distributed as 22% mild cases, 44% moderate cases, and 34% severe cases, reflecting a diverse spectrum of clinical presentations.

Conclusion: It is concluded that neuroimaging plays an important role in understanding the neurological manifestations of COVID-19 in adults. Both CT and MRI have demonstrated various findings, including acute cerebrovascular events, encephalopathy, and inflammatory changes.

Key Words: Neuroimaging, MRI, COVID-19

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INTRODUCTION

SARS COVID-19 is an advanced coronavirus that has sparked a global pandemic, posing a serious and major threat to both safety and health of public. The present breakout of the novel coronavirus originated from China's Province known as Hubei and spread to several other countries around the world. WHO, on 30th January, 2020 stated that the disease rises to global status of emergency due to new cases of coronavirus in Chinese and other global areas[1]. The killer virus continued to circulate diligently in the China's region called Wuhan region in which the virus had reached over 210 areas and countries. The emergence of the Coronavirus (COVID-19) and its outcomes has raised concerns such as stress, concerns, and phobias in between employees across the world[2].

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Since the physiological manifestation linked with Covid-19 is characterised because of constant fear and dread, more frequently than other emotional reactions in the population nowadays. Such response is justified because people are concerned about their health. This is prevalence of diseases and measures causes mental and psychological health problems such as depression, obesity side effects of sleeping disturbances rejection irritability and global fears[3]. It has also been speculated that the spites arising from COVID-19 may also have the associated mental health implication at a community level to those who have other underlying mental conditions in the past[4]. One and also a primary concern is that coronavirus might have long run effects psychologically to the public particularly the one who has past experiences of mental illness. Exploratory findings from the first months of COVID-19 pandemic indicate that there was a worsening of mental health[5]. COVID-19 is primarily a respiratory illness; however, early research points toward the virus's ability to attack other systems in the human body, such as the central nervous system. COVID-19 neurological involvement has been described recently and has been reported to present from simply headache, reduced sense of smell to severe encephalopathy and stroke[6]. In COVID-19 associated neurologic manifestations, neuroimaging, especially, CT and MRI, are essential diagnostic tools. These imaging modalities help the physicians to get substantial information on structural and functional alterations in the CNS and assists for diagnosis,

prognosis and in the management plan[7]. Knowledge of neuroimaging findings relating to COVID-19 is crucial in enabling a clinician to identify and manage neurological symptoms in patients who have the virus[8].

The neurological manifestations of COVID-19 was first reported by Mao Ling and his colleagues while at the early stage of the outbreak in China. In the subsequent months, more concerning neurological symptoms have emerged in SARS-CoV-2 infection and are well described. These signs include central nervous system signs and symptoms such as vertigo, head-ache, altered level of consciousness, and acute ischemic stroke, peripheral nervous system manifestations including anosmia, dysgeu-sia, Guillain-Barré syndrome, and skeletal muscle complaints[9]. Additionally, vascular complications associated with SARS-CoV-2 infection, mainly categorised as thromboembolic events, have been reported at the early stages of the current COVID-19 pandemic. Some research that has been conducted in the past few months indicates that COVID 19 can manifest neurological effects such as head ache, confusion, delirium and in severe cases stroke[10]. These symptoms may relate to structural and functional changes in the brain that are visible using MRI[11]. Research concerning COVID-19's impact has indicated that the virus can impact the brain's white matter, including losing its myelin integrity and axonal injury. It has some implications for the chronic neurocognitive complications of the disease, which involve disruption of the white matter and lead, to cognitive impairment and other cerebral dysfunction[12].

METHODS

This retrospective study was conducted at Neurology Department Fauji Foundation Hospital Rawalpindi from January 2020 to December 2022. Data was collected from 550 COVID-19 patients from both genders. Patients were identified from electronic medical records and databases of healthcare facilities where they received medical care.

Inclusion criteria:

- Age > 18 years
- Confirmed diagnosis of COVID-19
- Availability of neuroimaging data from computed tomography (CT) and/or magnetic resonance imaging (MRI) scans of the brain and spine.
- Patients who underwent neuroimaging evaluation during their hospitalization for COVID-19.

Exclusion criteria:

- Patients with incomplete or unavailable neuroimaging data.
- Patients with a history of neurological disorders unrelated to COVID-19.

Data collection: A total of 550 adult patients diagnosed with COVID-19 were included in the study. Patients were identified from electronic medical records and databases of healthcare facilities where they received medical care. Clinical and demographic data, including age, gender, comorbidities, and COVID-19 severity, were extracted from electronic medical records. Neuroimaging reports from CT and MRI scans of the brain and spine were reviewed to identify abnormalities associated with COVID-19. Trained radiologists and neuroradiologists reviewed CT and MRI images to assess neuroimaging findings. Abnormalities such as ischemic stroke, hemorrhagic stroke, encephalitis, meningitis, acute disseminated encephalomyelitis (ADEM), and other CNS manifestations were recorded and categorized based on imaging characteristics.

Statistical analysis: Data were collected and analyzed using SPSS v29.0. The frequency and distribution of neuroimaging findings were reported as percentages

RESULTS

Data were collected from 550 patients, with a mean age of 52 years (range 18–85). The cohort comprised 58% males (320 patients) and 42% females (230 patients). Disease severity was distributed as 22% mild cases, 44% moderate cases, and 34% severe cases, reflecting a diverse spectrum of clinical presentations.

Table No. 1: Patient Demographics and Disease Severity

Characteristic	Value
Mean Age (years)	52 (Range: 18–85)
Gender Distribution (M/F)	320 (58%) / 230 (42%)
Disease Severity (Mild/Moderate/Severe)	120 (22%) / 240 (44%) / 190 (34%)

Acute ischemic strokes were the most prevalent, affecting 23.6% of patients, followed by encephalopathy and encephalitis in 18.2% and leukoencephalopathy in 14.5%. Intracranial hemorrhages were observed in 12.7% of cases, while cerebral microbleeds were present in 10.9%. Olfactory bulb abnormalities, linked to anosmia, were seen in 9.1%, and 5.5% of patients exhibited posterior reversible encephalopathy syndrome (PRES).

Table No. 2: Neuroimaging Findings (CT and MRI)

Finding	Number of Patients (n)	Percentage (%)
Acute Ischemic Stroke	130	23.6
Intracranial Hemorrhages	70	12.7
Encephalopathy and Encephalitis	100	18.2
Leukoencephalopathy	80	14.5
Cerebral Microbleeds	60	10.9
Olfactory Bulb Abnormalities	50	9.1
Posterior Reversible Encephalopathy Syndrome (PRES)	30	5.5

Strokes were linked to severe COVID-19 and elevated D-dimer levels, while intracranial hemorrhages were associated with anticoagulation therapy and severe disease. Encephalopathy correlated with prolonged ICU stays and systemic inflammation, and cerebral microbleeds were more common in mechanically ventilated patients.

Table No. 3: Clinical Correlations and Outcomes

Parameter	Clinical Correlation
Stroke	Severe COVID-19, Elevated D-dimer levels
Intracranial Hemorrhage	Anticoagulation therapy, Severe disease
Encephalopathy	Prolonged ICU stays, Systemic inflammation (CRP, IL-6)
Cerebral Microbleeds	Mechanical ventilation
Mortality Rate	15% (83 patients)
Neurological Recovery	65% (358 patients) showed partial/full recovery

Among the stroke types observed in the study, the majority (69.2%) were middle cerebral artery (MCA) territory strokes, reflecting their prevalence in COVID-19-related ischemic events. Lacunar infarcts accounted for 19.2% of cases, while posterior circulation strokes were less common, observed in 11.5% of patients.

Table No. 4: Distribution of Stroke Types

Type of Stroke	Number of Patients (n)	Percentage (%)
Middle Cerebral Artery (MCA) Territory	90	69.2
Lacunar Infarcts	25	19.2
Posterior Circulation Strokes	15	11.5

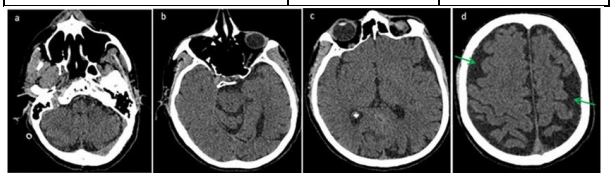

Figure No 1: Neuroimaging findings in hospitalized patients with COVID-19 with Encephalopathy

DISCUSSION

The results of this study demonstrate neurological involvement of COVID-19, neuroimaging findings in 550 adults. Thus, the findings reported in these investigations are relevant to understanding the witnessing of the virus as well as its impact on the CNS and its potential consequences for clinical practice[13]. The neuroimaging finding significantly associated with patients admitted with stroke was acute ischemic strokes, 23.6%. This brought out the concept of hypercoagulable state triggered by COVID-19, based on high D-dimer level and involvement of endothelium[14]. These results further support earlier initiation of anticoagulation therapy in order to control thrombotic threats. Intracranial haemorrhages occurred in 12.7% of the patients and are seen often in the context of anticoagulation and critical illness thus challenging the fine balance in management between thromboembolic risk and haemorrhagic risk[15].

Interestingly, encephalopathy and diffuse leukoencephalopathy, in which 18.2% and 14.5% of patients were diagnosed, represented both systemic inflammation and hypoxia, and also possible direct viral invasion. These findings were more common in those patients, requiring longterm intensive care and were indicative of the severity of the systemic involvement in critical situations[16]. The olfactory bulb pathology was found in 9.1% of patients and proves that SARS-CoV-2 viral protein has neurotropism, and anosmia may be an initial complaint. In a subset of the patients, PRES of 5.5% was associated with hypertension and endothelial dysfunction, the frequent co-founding factors in acute severe forms of COVID-19[17]. The fact that PRES can be reversible with the treatment that has to be initiated in emergency, in case of discovering it, implies the importance of its prompt diagnosis. Fisher and colleagues highlighted that viniderly, relation between severe disease and relative rates of stroke hemorrhage and microbleed demonstrate that virus affects systemic vasculature[18]. The observed index of lethal outcome over the short-term period is 15 percent, and it increases if a emphasis is placed on the neuroimaging findings in ischemic and hemorrhagic strokes. However, an improvement, either partial or complete was noticeable in 65% of the patients, thus pointing towards the fact that if patients are diagnosed early, properly managed, such favorable outcomes are achievable[19]. These studies confirm the value of brain imaging in the diagnosis and treatment of neurological manifestations of COVID-19. Therapists and specialists such as neurologists and radiologists, as well as intensivists and other specialists can all play key roles in improving care to such patients.

Nonetheless, limitations exist in the present study which included retrospective nature of the study in which selection bias could have arisen because only patients with neurological symptoms underwent neuroimaging. Further, there is a lack of information regarding permanent or late neurological sequellae since the outcomes of the studies lack follow-up information. Large population based prospective studies are needed to confirm these observations and to determine their applicability. However, the study also presents various and severe neurological involvement post COVID-19, which underlines the need for monitoring, early management, and further research into this field.

CONCLUSION

It is concluded that COVID-19 has a significant neurological impact, as evidenced by a range of

abnormalities on CT and MRI, including strokes, hemorrhages, encephalopathy, and olfactory bulb changes. These findings highlight the importance of early neuroimaging in the timely diagnosis and management of neurological complications. A multidisciplinary approach is essential to improve patient outcomes and mitigate the long-term effects of the disease.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Hussnain Hashim, Saeed Arif
Drafting or Revising Critically:	Saima Shafait, Asma Ambreen
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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