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FREQUENCY AND TYPES OF CEREBRAL INFARCTIONS ON BRAIN IMAGING IN 2257 HOSPITALIZED PATIENTS WITH COVID-19

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ABSTRACT

BACKGROUND AND OBJECTIVE: SARS-COV (COVID-19) virus is not solely a pulmonary disease but affect multiorgan system including the brain. The objective of this study was to see the frequency of neuroimaging findings especially cerebral infarcts in our covid population.

METHODS: This study is a retrospective observational study conducted in a large tertiary care hospital which was also a Covid center from March 1, 2020 to December 30, 2020. The frequency of neurological manifestations in COVID-19 positive patients admitting in the hospital was observed through charts review. All scans were reviewed by two trained neuroradiologists.

RESULTS: Total of 2257 patients enrolled through ER with symptoms of COVID and were COVID PCR positive, with initial different severity of chest disease. During their disease a total number of 168 patients underwent cross-sectional imaging of the brain secondary to different neurological symptoms. Negative studies were 108, total positive studies were 60, among which CT was done in 20 patients, MRI was done in 22 patients and 18 patients had both. Predilection to MCA stroke was seen with a frequency of 36.6%, other territorial infarction was of PCA (11.6%), watershed infarctions 11.6% and dual territory infarctions (3.3%)

CONCLUSION: Out of 2257 patients only 168(7%) underwent neuroimaging. Out of these 168, 108 (64%) were normal. Acute cerebral Infarction was most common finding present in 42(62%) scans. Other findings include hemorrhage, hydrocephalus, cerebral venous sinus thrombosis, meningitis, and posterior reversible encephalopathy syndrome.

KEYWORDS: COVID-19, stroke, infarction.

ABBREVIATIONS;

CT: computed tomography,

MRI: Magnetic resonance imaging,

MCA: Middle cerebral artery

ACA; Anterior cerebral artery

PCA: Posterior cerebral artery.

INTRODUCTION

With the outbreak of an unknown disease primarily thought to be affecting the chest, started in Wuhan, China, in December 2019, a new virus Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), became the centre of attention.

Neurological involvement in covid 19 is well known.¹Data related to role of neuroimaging and findings is limited. ² The world health organization has

declared COVID-19 as a pandemic². As knowledge of the SARS COV and its symptomatic presentation has shown a wide diversity, and has shown growing literature on neurological manifestations in patients with COVID-19.³⁻⁵

SARS COV virus is a beta coronavirus single stranded RNA virus.it mainly targets the angiotensin converting enzyme receptors (ACE-2) to invade the cell.⁶ It is mainly a respiratory system virus, but its multisystem

involvement had been recognized by the world.

The neurological involvement of the virus is hypothesized by two likely mechanisms in a study, first is the replication of virus in the glial cells and the other is the autoimmune reaction with host immune response.⁷ Other possibilities are presence of cytokine storm with multiorgan damage and other increased coagulation activity, leading to thromboembolic phenomenon resulting in acute CNS involvement.⁸ Most of the studies on literature search were review studies. Original articles on neuroimaging in COVID have been less. To our knowledge, this is the first original study with 60 patients on neuroimaging findings in COVID-19. One of a short case series of 12 patients with encephalopathy and neuroimaging findings was also published in 2021 from our region.⁹

The aim of the study is to elaborate the acute cerebral infarcts and their frequency of distribution in patients with COVID-19 positive PCR who are hospitalized and to discuss and review of the literature for the acquired results. The study is, to our knowledge, the first study on neuroimaging in COVID from our country evaluating frequency and types of cerebral infarcts in covid patients as well as from the imaging point of view, knowledge and discrepancies from other regions should be addressed for better understanding in our population.

METHODS

This is a retrospective cross-sectional study conducted at the Department of Radiology, in a tertiary care hospital, Karachi. The study was approved by the institutional Ethics Review Committee prior to commencement and the need for informed consent was waived due to retrospective nature. The study period is from March 1, 2020 to December 30, 2020. We searched the medical records and imaging database for cases. MRI studies of these cases were retrieved from the Picture and Archive Communication System (PACS) and evaluated. Medical files were also evaluated for COVID PCR. All adult (age more than 18 years) PCR positive patients undergoing Computed Tomography (CT)/ MRI (MRI) Brain for acute neurological symptoms were included in study

Imaging Technique:

Magnetic Resonance Imaging:

Patients were imaged with 1.5 and 3.0 Tesla (Canon Medical Systems), following the same standard sequences. All patients had a customized brain MRI study composed of axial and sagittal T2, coronal FLAIR, axial and sagittal T1-weighted pre and post gadolinium,

and axial Line Scan DWI and SWI sequences. That MRI study was customized to have the shortest scan time possible with enough imaging sequences. CT scans were performed on AVANTO and with head protocol

Imaging Analysis:

All the MRI/CT examinations were reviewed on a workstation by a neuro-radiologist (with more than 10 years of experience with neuroradiology) and a neuroradiology fellow. The scans were reviewed on consensus.

Statistical Analysis:

Data was described using frequencies for categorical variables and using mean median mode and range for quantitative data.

Study protocol was approved by Ethics review committee of Aga Khan University, Karachi

RESULTS

A total of 2257 patients with COVID PCR test positive were admitted during the study period. 587 patients (26%) underwent imaging (CT and MRI) for multiple reasons, among these 168 patients (28.6%; 7% of all) underwent neuroimaging CT/MRI. In those 168 patients 108 studies (64.2%) were normal. 60 studies (3% of all patients) with positive findings (35.7%) are provided in table1. Among these CT was done in 20 patients (33.3%), MRI was done in 22 patients (36.6%) and 18 patients (30%) had both.

Out of these 60 patients, 41 (68%) male and 19 female (31%). Mean age was 59 years (range; 24-85 years). The common neurological symptoms were weakness of the one side of body and drowsiness, less common clinical features were of headache, seizures, and loss of consciousness.

Most common imaging finding was presence of infarction (FIG; 1-3). The findings of MCA infarction among these 60 patients were present in 22 patients (36.6%) with predominance of left side. Pure anterior cerebral artery territory infarct was not seen in any patient.

7 patients (11.6%) had posterior cerebral artery territory infarction which was predominantly involving the cerebellum on right side. The dual territory infarct was seen in two patients only in which one was showing MCA +ACA territory infarction and the other was showing MCA +PCA infarction which were both on right

side. Non territorial watershed infarctions were seen in 7 patients (11.6%) in which one had bilateral watershed territory infarctions and the rest had right sided predominance.

Additional findings include, hemorrhage in 6 patients (10%) with predominant site of thalamus involvement

in 3 patients.

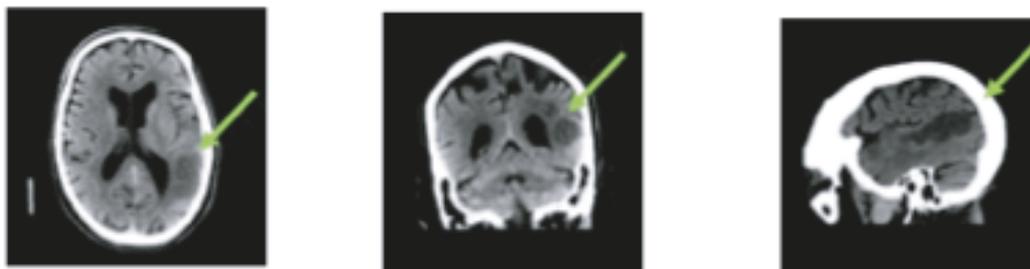
Meningitis and encephalitis was seen in 2 patients. Posterior reversible encephalopathy syndrome (PRES) was seen in 2 patients.

Other less frequent pathologies are summarized in Table 1.

TABLE 1; NEUROIMAGING FINDINGS

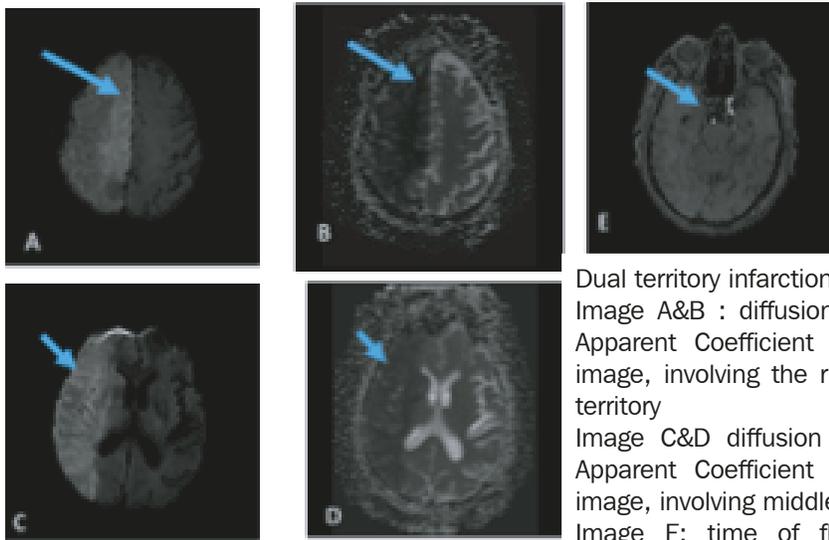
Magnetic resonance / computed tomography	Number of patients (n=60)
Total middle cerebral artery infarcts	22 (36.6%)
Total posterior cerebral artery infarcts	7 (11.6%)
Watershed infraction	7 (11.6%)
Dual Territory Infarctions	2 (3.3%)
Hemorrhagic infraction	4 (6.6%)
Hemorrhage	2 (3.3%)
Hydrocephalus	3 (5%)
Hypoxic encephalopathy	3 (5%)
cerebral venous sinus thrombosis	2 (3.3%)
Meningitis/encephalitis	2 (3.3%)
Posterior reversible leukoencephalopathy syndrome	2 (3.3%)
Osteomyelitis	1 (1.6%)
Brain edema	1 (1.6%)
Orbital cellulitis	1 (1.6%)
Subdural hemorrhage	1 (1.6%)

FIG 1: 82 year old male patient COVID positive, developed altered consciousness.



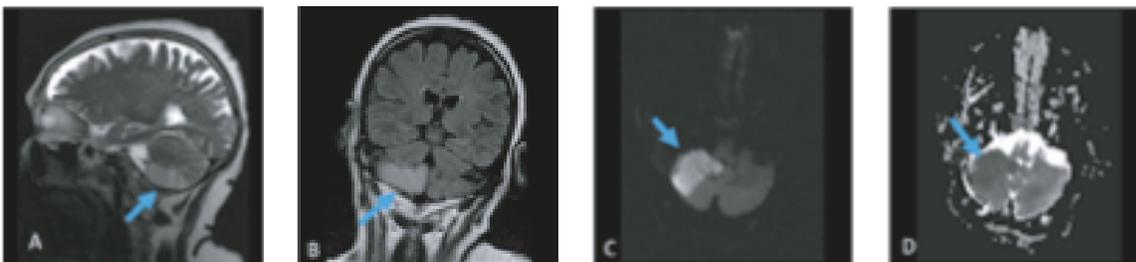
CT head plain images axial, coronal and sagittal showing left middle cerebral artery infarction (green arrow).

FIG 2: 77 year old male with fever, cough and altered level of consciousness presented to ER and found out to be COVID positive.



Dual territory infarction:
 Image A&B : diffusion weighted axial image and Apparent Coefficient of diffusion b 1000 axial image, involving the right Anterior cerebral artery territory
 Image C&D diffusion weighted axial image and Apparent Coefficient of diffusion b 1000 axial image, involving middle cerebral artery territory.
 Image E; time of flight MRA image showing occlusion of right ICA

FIG 3: 82 year old male patient COVID positive, developed altered consciousness.



Acute Posterior inferior cerebral artery territory infarction
 A&B: T2 sagittal and FLAIR coronal image, showing hyperintense signals involving the Posterior inferior cerebellum on right.
 C&D diffusion weighted axial image and Apparent Coefficient of diffusion b 1000 axial: showing diffusion restriction with low ADC values representing acute infarction.

DISCUSSION

The hospitalized patients with neurological symptoms show variable imaging spectrum. In our study, there was male predominance. We found out that the neurological imaging features were predominantly that of acute infarction. There are many papers describing the presence and prevalence of acute ischemic stroke in COVID-19 patients. Majority described the large and medium vessel stroke.^{10,11}

One of the studies by Abdelkader also showed (34/108 patients) 28% of the patients affected with acute infarction of these 15 were in MCA territory.¹² As it was extracted from our study as well that large number of patients 36.6% had MCA infarction (20/60) supporting this statement. However, one of the studies in China has postulated that there is overall low risk of stroke in

Other less frequent findings of meningitis, encephalitis, posterior reversible encephalopathy syndrome, cerebral venous sinus thrombosis (CVST), hydrocephalus, osteomyelitis and orbital cellulitis which was not often seen in the selected patients have been described in many review articles and are not unknown.^{5,16} However, the underlying pathogenesis is not very clear, Shahjouei et al reported 4% of CVST happening among the cerebrovascular events in COVID patients.¹⁷

In our study, we highlighted and elaborated the frequency of cerebral infarction in the COVID-19 patients. It was found in many studies that the patient having predisposed risk factors were associated to have more neurological involvement from Covid 19 as well patient who had severe Covid related ARDS had predominantly involvement of nervous system as compared to the other having mild disease. Presence of cytokine storm with multiorgan damage and other possibility of increased coagulation activity, leading to

COVID 19 patients.¹³ A case series of Khan et al with 22 patients showed large and medium territory vascular events in 18 patients with majority involving the anterior circulation.¹¹

The Posterior cerebral artery acute infarction was noted in 7 patients in which majority were in the territory supplying cerebellar hemispheres (i.e., Anterior inferior cerebellar artery(AICA), posterior inferior cerebellar artery(PICA), superior cerebellar artery (SCA)), only 1 patient had pure occipital infarct involving the posterior cerebral artery. In a case series, the predilection of PICA infarcts was described in six cases presented with Covid-19.⁶ As many of the other case series and case reports showed predominance of posterior circulation infarction.^{14,15} Watershed territory was also seen in 7 patients with involvement of variable regions.

thromboembolic phenomenon resulting in acute CNS involvement.⁸

Despite of having multiple neuroimaging findings there were several limitations of the study: the retrospective design of the study and a small sample size. Considering the emerging neurological manifestations of COVID-19 and changing strains of this virus, it is crucial to study these patients with a larger cohort. Though the overall incidence of neurological event in our study is quite low (2.3%), yet it has greater impact on patients, already fighting from covid symptoms.

CONCLUSION

This study provided an overview of the imaging findings and their frequencies in our population, yet this needs to be carried on adding to the growing knowledge about the possible underlying pathophysiology.

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Author's contribution:

Raima Kaleemi; data collection, data analysis, manuscript writing, manuscript review

Zainab Rauf; data collection, data analysis, manuscript writing, manuscript review

Muhammad Azeemuddin; data analysis, manuscript writing, manuscript review

Mohammad wasay; concept, data analysis, manuscript writing, manuscript review



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