

# Imaging Findings and Neuroradiological Manifestations in Patients of COVID-19.

Janani Baradwaj<sup>1</sup>, Prabash PR<sup>2</sup>, Arun Kumar M<sup>3</sup>, R. Ebenezer<sup>4</sup>, V Parantharaman<sup>5</sup>

<sup>1</sup>Gleneagles Global Hospital, Chennai, <sup>2</sup>Consultant, Department of Neurologist, Apollo Speciality Hospitals, Vanagaram, Chennai, <sup>3</sup>Associate Consultant, Department of Neurology & Epileptologist, Apollo Speciality Hospitals, Vanagaram, Chennai, <sup>4</sup>Senior Consultant & Incharge, Department of Critical Care Medicine, Apollo Speciality Hospitals, Vanagaram, Chennai, <sup>5</sup>Physician Assistant, Department of in Neurology, Apollo Speciality hospitals, Vanagaram, Chennai, India

**Corresponding author:** Dr Arun Kumar M MD;DM Neurology; PDF in Epilepsy, Associate Consultant Neurology & Epileptologist, Apollo Speciality hospitals, Vanagaram, Chennai, India

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## ABSTRACT

**Introduction:** Corona Virus Disease (COVID-19) is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The Epidemic of COVID-19 is reported to have started in Wuhan China in December 2019. Though its primarily a respiratory illness, a sizeable proportion of patients have been found to have neurological symptoms and neuroimaging abnormalities on Computerized tomography and Magnetic resonance imaging. Many patients of COVID 19 have been reported to present only with neurological complications. The role of neuroimaging in such situations cannot be overemphasized. We conducted this study to analyze clinical features and neuroimaging abnormalities in COVID 19 patients who been referred to us for Neuroimaging.

**Material and Methods:** This was a prospective study conducted in the department of radiology in a tertiary care institute situated in an urban area. Patients who had been diagnosed with Covid-19 either on the basis of RTPCR or Rapid antigen test and were referred to our department for neuroimaging were included in this study on the basis of a predefined inclusion and exclusion criteria. Demographic and clinical features were noted down from case papers. Computerized Tomography was done in 27 patients and in remaining patient magnetic resonance imaging was done. An analysis of neurological complaints and neuroimaging finding was done. SSPS 21.0 software was used for statistical analysis and P value less than 0.05 was taken as statistically significant.

**Results:** Out of total 56 patients there were 32 (57.14%) males and 24 (42.86%) females with a M:F ratio of 1:0.75. The mean age of male and female patients was found to be 41.34 +/- 8.89years and 43.04 +/- 8.47years respectively. The mean age of male and female patients was found to be comparable with no statistically significant difference (P=0.473). The most common neurological complaint in the patients was focal deficits including hemiplegia or hemiparesis which was present in 27 (48.21%) patients. Positive finding on imaging was seen in 51 (91.07%) patients. 24 (42.8%) patients had hypodense areas on CT scans and 6 (10.71%) patients had hyperdense areas suggestive of hemorrhagic stroke. In 4 (7.14%) patients COVID related polyneuropathy was seen whereas in 2 (3.57%) patients hyperintense roots on MR neuronography were seen. In 8 (14.28%) patients aseptic meningitis with leptomeningeal enhancement was seen.

**Conclusion:** Neurological manifestations and Neuroimaging abnormalities are seen in a significant proportion of patients with COVID-19. Neuroimaging is an essential part of management of patients with COVID particularly those who have symptoms or clinical signs of neurological involvement.

**Keywords:** COVID-19, Neuroimaging, Stroke, Neurological Manifestations, Radiology in COVID, COVID MRI.

## INTRODUCTION

Corona Virus Disease (COVID-19) is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The Epidemic of COVID-19 is reported to have started in Wuhan China in December 2019.<sup>1</sup> Since its beginning in China this virus have known to have spread to almost every country of the world. However there are some countries such as Palau, Nauru, Samoa, Tonga and Kiribati amongst some others which have officially have not reported any case of

Covid 19 till November 2020.<sup>2</sup> Since its beginning COVID's 19 have infected millions of people and caused hundreds of thousands of deaths.<sup>3</sup> The presenting complaints of Covid19 includes fever, cough, myalgia, anosmia and in some cases gastrointestinal symptoms such as diarrhea. Though in majority of the cases it remains either asymptomatic or mildly symptomatic some cases may progress to dyspnea, respiratory distress and finally may develop respiratory failure.<sup>4</sup> Though SARS-CoV-2 is known to primarily cause respiratory illness and all imaging interest have been for doing

HRCT chest for determination of likelihood and severity of affection in suspected Covid 19 patients there has been reports of patients presenting with neurological complaints such as Giddiness, severe headache, altered sensorium, focal deficits and even cranial nerve palsies. There are many studies which has reported rise in cases of facial nerve palsies during this pandemic.<sup>5</sup> With better understanding of COVID-19 more and more physicians are now recognizing neurological complications of COVID and the fact that there are some patients who only present with neurological manifestation of COVID makes it imperative to have a high degree of suspicion in any patient presenting with neurological symptoms even if classical presenting complaints like cough and fever are absent.<sup>6</sup> Neurological symptoms are found to be more common in patient who have severe disease including respiratory distress and multiorgan dysfunction.<sup>7</sup> Increasing incidence of neurological manifestation caused by SARS-CoV-2 is pointing towards neurotropism of this virus. There are various mechanisms by which SARS-CoV-2 is found to have been affecting nervous system. In addition to neurotropism of SARS-CoV-2 other mechanism such as cytokine storm syndrome, hypercoagulable states and encephalopathy are all various other mechanism.<sup>8</sup> Neurological manifestations in Covid 19 may be either presenting complaint or they may be seen as complications of Covid 19. In either case role of imaging is important to diagnose and assess the severity of neurological complications.<sup>8</sup> The common imaging abnormalities seen in patients with Covid-19 include intracerebral hemorrhage on computerized tomography and white matter hyperintensities on magnetic resonance imaging.<sup>9</sup> Some studies have reported that almost 1/3<sup>rd</sup> of patients of Covid 19 patients sent for neuroimaging have some or the other form of intracranial abnormalities.<sup>10</sup> However it must be understood that while some neurological features such as focal deficits, hemiplegia or cranial nerve palsies may be associated with imaging abnormalities some patients may show neurological symptoms without any abnormality on imaging. Also some of the imaging abnormalities may resolve over time.<sup>11</sup> With this background we conducted this study to analyze the neuroradiological abnormalities in Covid 19 patients who have been referred to us for neuroimaging.

## MATERIAL AND METHODS

This was a prospective study conducted in the department

of radiology in a tertiary care institute situated in an urban area. Patients who had been diagnosed with Covid-19 either on the basis of RTPCR or Rapid antigen test and were referred to our department for neuroimaging were included in this study on the basis of a predefined inclusion and exclusion criteria. Demographic Details of patients such as age and gender were noted. Clinical history was noted down from case papers. All Patients underwent CT brain and in selected cases Magnetic Resonance imaging on 1.5 Tesla MRI machine was done. Common performed sequences included 3 dimensional T1-weighted MRI images, Diffusion weighted imaging, Gradient Echo T2, fluid attenuated inversion recovery (FLAIR) images and MR neurography. Same senior radiologist interpreted the MRI images with peer review.

### Inclusion Criteria

1. Patients diagnosed with Covid 19 on the basis of RTPCR or Rapid Antigen Test.
2. Age more than 18 years.
3. Ready to Give informed written consent to be part of study.

### Exclusion Criteria

1. Age less than 18 years.
2. Those who refused consent.
3. Patients in whom MRI was contraindicated such as patients with cardiac pacemakers or intracranial aneurysmal clips etc.
4. Pregnant patients.

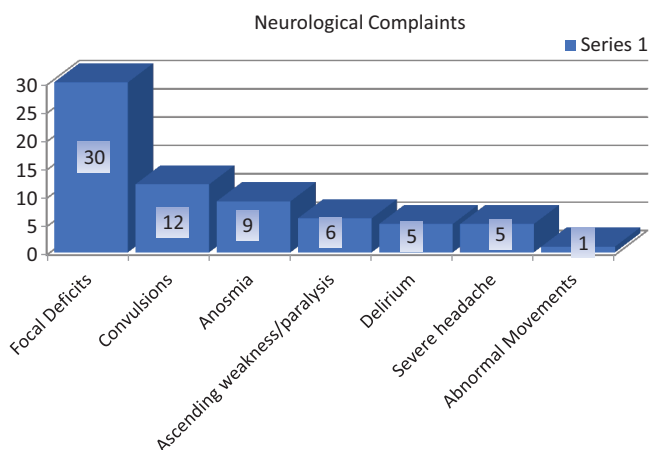
For statistical analysis SSPS 21.0 software was used and P value less than 0.05 was taken as statistically significant.

## RESULTS

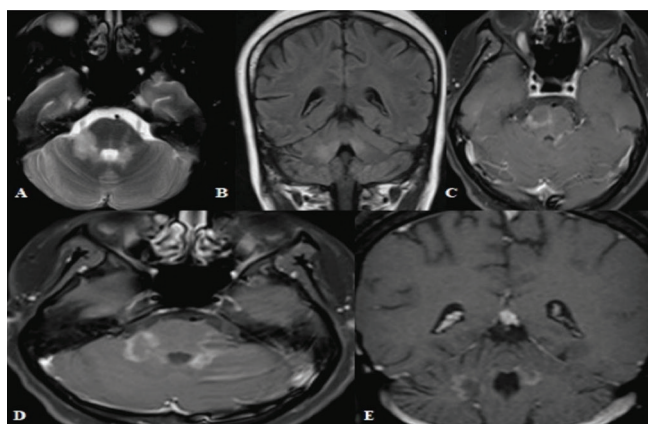
A total of 56 patients having Covid 19 (Either RTPCR or Rapid Antigen positive cases) were studied. Out of total 56 patients there were 32 (57.14%) males and 24 (42.86%) females with a M:F ratio of 1:0.75. The most common affected age group was found to be 41-50 years in males as well as female patients. Out of 56 studied cases 14 (25%) males and 15 (26.79%) females belonged to age group of 41-50 years. The mean age of male and female patients was found to be 41.34 +/- 8.89 years and 43.04 +/- 8.47 years respectively. The mean age of male and female patients was found to be comparable with no statistically significant difference (P=0.473) (Table 1).

Age group	No of patients			
	Males		Females	
	No of patients	Percentage	No of patients	Percentage
18-30 yr.	2	3.57%	1	1.79%
31-40 yr.	11	19.64%	5	8.93%
41-50 yr.	14	25.00%	15	26.79%
51-60 yr.	4	7.14%	2	3.57%
> 60 years	1	1.79%	1	1.79%
Total	32	57.14%	24	42.86%
Mean Age	41.34 +/- 8.89		43.04 +/- 8.47	
P= 0.473 (Not significant)				
Table-1: Age Distribution of the studied cases.				

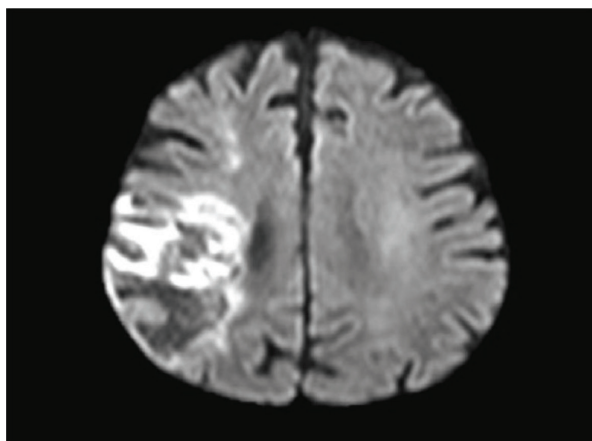
**Table-1:** Age Distribution of the studied cases.



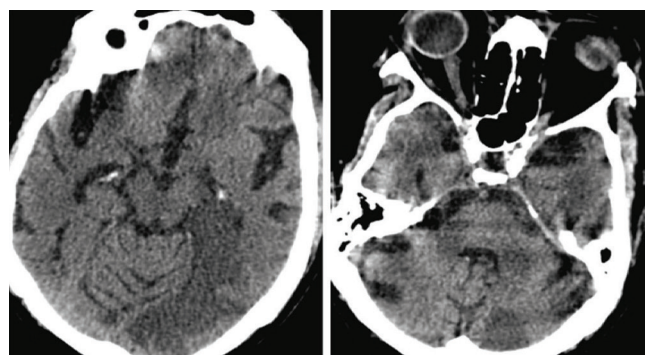
**Figure-1:** Neurological Manifestations in studied cases.



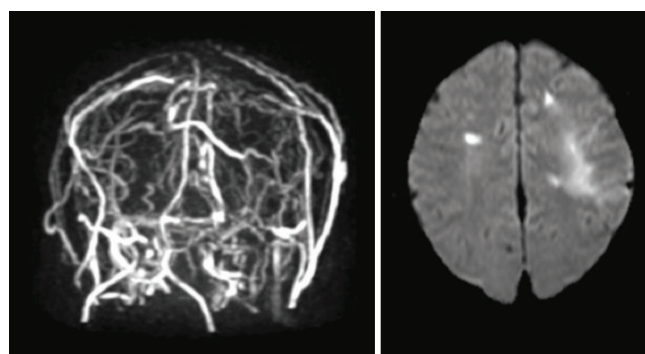
**Figure-2:** Neuroimaging of 20year old male presenting with headache, giddiness and ataxia for a period of 15days with RTPCR positive for COVID. A, B: Axial T2WI and Coronal T2 FLAIR images show hyperintense lesions involving the right hemi-pons and bilateral middle cerebellar peduncles. C, D, E: Axial and coronal post contrast images shows incomplete ring enhancement upon contrast administration – Features suggestive of acute disseminated encephalomyelitis [ADEM].



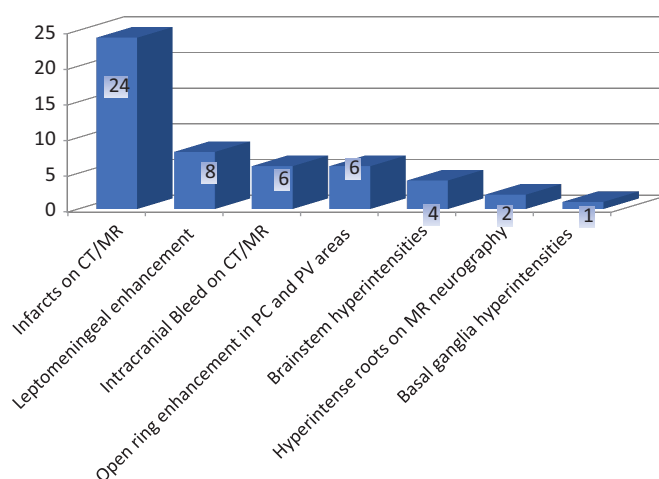
**Figure-3:** Neuroimaging of 31year old female presenting with headache, fatigue, depression, difficulty in speech that progressed to left sided weakness with RTPCR positive for COVID. Axial diffusion weighted imaging indicates diffusion restriction involving the right parietal and frontal region – Suggestive of acute infarct.



**Figure-4:** Neuroimaging of 37 year old male presenting with decreased GCS of 8/15 and altered consciousness and positive RTPCR for COVID. Non enhancing CT brain shows hypodensities involving the left temporo-occipital region, left cerebellum and bilateral inferior cerebellar peduncles – Suggestive of acute non hemorrhagic infarcts.



**Figure-5:** Neuroimaging of 26 year old female presenting with decreased GCS of 6/15 and right focal seizures and positive RTPCR for COVID. MRI brain showed hyperintensities involving the left fronto-parietal region with left dural sinus thrombosis



**Figure-6:** Imaging Findings in Studied cases.

The analysis of patients on the basis of clinical presentation showed that the most common neurological complaint in the patients was focal deficits including hemiplegia or hemiparesis which was present in 30 (53.57%) patients. The other common neurological manifestation in patients included convulsions which was seen in 12 (21.43%) patients, anosmia (16.07%) and ascending weakness or paralysis (10.71%). The

other less common neurological features included delirium (8.93%), severe headache (8.93%) and abnormal movements (1.79%) (Figure 1).

The MRI findings of the studied cases showed that out of 56 cases in whom neuroimaging was done positive finding on imaging was seen in 51 (91.07%) patients. 24 (42.85%) patients had hypodense areas on CT scans and 6 (10.71%) patients had hyperdense areas suggestive of hemorrhagic stroke. No MRI imaging was done in these 27 (48.21%) cases as CT brain was diagnostic of ischemic or hemorrhagic stroke. In rest of the patients MRI was done (Figure 2,3,4,5). In 4 (7.14%) patients COVID related polyneuropathy was seen whereas in 2 (3.57%) patients hyperintense roots on MR Neurography were seen. In 8 (14.28%) patients aseptic meningitis with leptomeningeal enhancement was seen, 6 (10.71%) patients with demyelinating illness showed hyperintense open ring enhancing lesion with mild diffusion restriction in pericallosal and periventricular distribution. In 4 patients encephalomyelitic changes with hyperintensities in brain stem/ spinal cord were seen. Bilateral basal ganglia hyperintensities were seen in 1 (1.78%) patient (Figure 6).

## DISCUSSION

In our study a total of 56 covid 19 patients having neurological manifestations were included. Out of these 56 patients 51 (91.07%) patients showed some or the other kind of neuroradiological abnormalities.

The most common neurological symptoms in our study was found to be focal neurological deficit in the form of either hemiplegia or hemiparesis which was seen in 27 (48.21%) patient. Mao L et al conducted a retrospective study of 214 consecutive hospitalized patients with laboratory-confirmed diagnosis of severe acute respiratory syndrome coronavirus infection.<sup>12</sup> The most common neurological feature in this study was found to be impaired consciousness which was seen in 14.8% patients whereas 5.7% patients had focal deficits. The difference between our study and this review was that our study consisted of patients who presented to us with neurological manifestations whereas this review consisted of Covid 19 patients irrespective of whether they had neurological symptoms or not hence higher percentage of patients having focal deficit in our study is quite plausible. Similarly Chen T et al<sup>13</sup> and Wang HY et al<sup>14</sup> reported that 19% and 18.7% patients had some or the other form of focal deficit in studied cases.

In our study out of 54 patients 6 patients presented with ascending weakness or paralysis consistent with Guillain Barre syndrome. As is well known that GBS is usually a consequence of molecular mimicry after a viral illness in genetically susceptible illness and many other viral illnesses such as influenza, Epstein barr virus, HIV and mycoplasma are known to cause this syndrome. More recently there are case reports of GBS in patients recovering from COVID 19. Toscano G et al reported 5 cases of GBS in COVID 19.<sup>15</sup> The authors found that the interval between the onset of symptoms of Covid-19 and the first symptoms of Guillain-Barré syndrome ranged from 5 to 10 days. Moreover the authors reported that first symptoms of Guillain-Barré syndrome were lower-limb weakness and paresthesia in four

patients and facial diplegia followed by ataxia and paresthesia in one patient. In our study also 1 patients having GBS had ataxia and abnormal movements. Other authors such as Camdessanche JP<sup>16</sup> et al also reported cases of COVID 19 who developed GBS.

Similarly 6 patients presented with acute disseminated encephalomyelitis like picture which is featured by a monophasic acute inflammation and demyelination of white matter typically following recent viral infection/ vaccination. ADEM as a complication of COVID-19 is also reported by the authors such as Abdi S et al<sup>17</sup> and Langley et al.<sup>18</sup>

In our study the most common imaging finding was hypodense areas on CT scan s/o infarcts which were seen in 21 (37.5%) patients followed by leptomeningeal enhancement on MRI which was seen in 8 (14.28%) patients. Intracranial bleed on CT seen as hyperdense areas was seen in 6 (10.71%) patients. In a review study of MRI brain Gulko E et al described Imaging findings of 126 patients. Out of these 126 patients acute or subacute infarcts were seen in 32 (25.39%) patients. This was slightly lower than our study as we found infarcts in 37.5% patients. The other imaging findings reported by Gulko E et al<sup>19</sup> included leukoencephalopathy (13.49%), cortical FLAIR signal abnormalities (11.90%), Leptomeningeal enhancement (11.11%), and microhemorrhages (11.11%). In 1 case (0.79%) Miller-Fisher Guillain-Barre syndrome was reported. Similar to our study infarcts were reported to be common imaging abnormality in patients with COVID by the authors such as Requena M et al<sup>20</sup> and Yaghi S et al.<sup>21</sup>

## CONCLUSION

Though COVID 19 is primarily a respiratory illness central nervous system involvement is reported in considerable number of cases. This neurological involvement may vary from mild headache to serious consequences such as stroke. Our study emphasizes the importance of neuroimaging in patients with COVID particularly in those patients who have symptoms or clinical signs of neurological involvement. Conflict Of Interest: None

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