ORIGINAL ARTICLE

Spectrum of Neurological Manifestations of COVID-19 in Children: A Hospital-Based Study in Uttar Pradesh, India

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ABSTRACT

COVID-19 infection and its neurological manifestations were seen in children. A retrospective study was performed on hospitalized paediatric patients aged between 1 month and 18 years with confirmed SARS-CoV-2 to determine the frequency of different types of neurologic findings of hospitalized children with COVID-19. This study was conducted at Saraswathi Institute of Medical Sciences in Uttar Pradesh, India. Neurological manifestations were defined as the presence of any of the following symptoms: seizure, altered mental status, behavioral/personality change, ataxia, stroke, muscle weakness, smell and taste dysfunctions, and focal neurological disorders. A total of 250 children with COVID-19 were admitted and their mean age was 6.94±4.06 years. 53.6% of the patients were male. The most frequent neurological manifestation was seizure (26%), followed by muscle weakness (10%), loss of consciousness (24%), and focal neurological disorders (24%). Other neurological manifestations included headache (n=40), movement disorders (n=25), behavioural or personality change (n=12), ataxia (n=10), and stroke (n=10). 16% of the patients had leukocytosis. A neutrophil count above 70% was seen in 20% of the patients. 80% had a positive reverse-transcription polymerase chain reaction (RT-PCR) test for SARS-CoV-2. During the pandemic outbreak, hospitalized children with COVID-19 should be evaluated for neurological signs because it is common among them and should not be under-estimated.

Keywords: Children, COVID-19, neurological manifestation, India.

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INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first found in December 2019 in Wuhan, China. This syndrome is mediated by a novel virus from the Coronaviridae family.[1] SARS-CoV-2 is abeta virus, an envelope virus with a helical nucleocapsid and indeterminate positive ribonucleic acid that caninfect mammals.[2,3] By the end of 2020, more than 80 million confirmed cases and roughly 2 million fatalities were reported due to the COVID-19 pandemic.[4] Many non-respiratory manifestations were identified in COVID-19 patients. Although there have been fewer studies with a large sample size reporting neurological abnormalities in COVID-19 patients, findings of neurological features are increasing. Common neurological symptoms of the disease include muscle pain, headaches, and loss of taste (dysgeusia), as well as anosmia, a loss of smell.[5,6] New research has demonstrated that SARS-CoV-2 can manifest as potentially fatal neurological abnormalities such as ischemic stroke, acute demyelinating encephalomyelitis, and subarachnoid hemorrhage.[7-9] Neurological manifestations have also been reported in Middle East respiratory syndrome coronavirus (MERS-CoV) and SARS-CoV.[10,11] Children with COVID-19 may present neurologic symptoms, notwithstanding rarity (COVID-19). The purpose of this study was to evaluate the prevalence of various neurological manifestations in COVID-19-positive hospitalized children.

METHODS

This retrospective study was conducted at Saraswathi Institute of Medical sciences Hapur

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Uttar Pradesh, India, between February 2025 and January 2026. A total of 250 children's records were sought for the study. SARS-CoV-2 infection was confirmed by detection of the virus in a clinical specimen (nasopharyngeal swab, throat swab, nose swab, endotracheal tube aspirates) by reverse-transcription polymerase chain reaction (RT-PCR).[12] The criteria of the Centers for Disease Control and Prevention (CDC) were used to determine MIS-C,[13] with an additional modification to include those with fever for less than 2 days if corticosteroids or intravenous immunoglobulin (IVIG) was administered before day 3 of fever. All clinical and laboratory investigations were performed according to institutional protocols. Chart review was performed by research study personnel at this participating center using a standardized case report form. Study data were collected which included demographics, medical history, clinical data, laboratory investigations, neuroimaging, and treatment modalities.

Neurological manifestations were defined as the presence of any of the following symptoms: seizure, altered mental status, behavioral/personality change, ataxia, stroke, muscle weakness, smell and taste dysfunctions, focal neurological disorders. Regarding the previous condition of patients in neurodevelopment and other children had a history of epilepsy before COVID-19 infection and the rest were normal without any underlying diseases except FC patient.

Data was analyzed using MS-Excel sheet. Descriptive data was reported as frequency and percentage.

RESULTS

Out of 250 patients, a total of 200 (80%) patients had COVID-19 disease (positive RT PCR) and 54(21.6%) of them had neurological symptoms. The mean age of the patients was 6.94±4.06 years, and 134 (53.6%) were male. Non-neurological clinical manifestations of the participants are shown in Table 1. The most frequent neurological manifestation was seizure (26%), followed by muscle weakness (10%), loss of consciousness (24%), and focal neurological disorders (24%). Other neurological manifestations consisted of headache (n=40), movement disorders (n=25), behavioral/personality change (n=12), ataxia (n=10), and stroke (n=10) (Table 2). 16% of the patients showed leukocytosis. A neutrophil count above 70% was seen in 20% of participants. Among the patients, 80% had positive SARS-CoV-2 RT-PCR test (Table 3).

Table 1: Non-neurological clinical manifestations of the study patients (N=250)

Clinical features	Frequency	Percentage
Fever	150	60
Cough	10	4
Dyspepsia	12	4.8
Sore throat	12	4.8
Myalgia	40	16
Fatigue	10	4
Diarrhoea	50	20
Vomiting	15	6
Chills	15	6
History of headache	235	94
Vision related disorder	245	98

Table 2: Neurological clinical manifestations of the study patients (N=250)

Neurological manifestations	Frequency	Percentage
Headache	40	16
Vertigo	12	4.8
Loss of consciousness	60	24
Seizure	65	26
Behavioural/personality change	12	4.8
Muscle weakness	25	10
Ataxia	10	4
Stroke	10	4
Focal neurological disorders	60	24
Movement disorders	25	10

DISCUSSION

The third coronavirus outbreak, following Middle East Respiratory Syndrome (MERS) in 2012 and severe acute respiratory syndrome (SARS) in 2002, is called COVID-19. One of the most significant organs affected by these viruses is the nervous system.[14,15] As a result, paediatrics neurologists and caregivers are strongly advised to take extra precautions to protect these vulnerable children from getting infected..[16]

Myalgia (28.5%) and headaches (14%) were reported in one systematic literature review as usual signs of COVID-19.[17] In contrast to this study, among hospitalized patients, headache was an independent predictor of lower risk of mortality.[18] According to another study, a common manifestation of COVID-19 was severe headaches with the migraine phenotype, especially its bilateral form.[19] Unlike previous studies, 17%

Table 3: Laboratory data of the study patients (N=250)

Laboratory parameters	Category	Frequency	Percentage
WBC (×10⁶ cells/L)	< 4000	6	2.4
	4000-10000	80	32
	> 10000	40	16
Neutrophil (×10⁶ cells/L)	< 50%	60	24
	50-70%	40	16
	> 70%	50	20
Lymphocyte (%)	< 20%	60	24
	20-40%	100	40
	> 40%	40	16
Haemoglobin (g/dL)	< 11	60	24
	11-16	140	56
	> 16	12	4.8
PLT (×10⁶cells/L)	<150	20	8
	up to 450	60	24
Ferritin (ng/mL)	>450	40	16
	<30	6	2.4
CPK (IU/L)	30-220	60	24
	>220	40	16
	< 24	6	2.4
CRP (mg/L)	24-172	60	24
	> 172	80	32
	> 6	40	16
ESR (mm in the 1st hour)	< 6	60	24
	> 10	60	24
LDH (U/L)	< 10	80	32
	< 5	60	24
BE	5-850	80	32
	<-2	140	56
HCO_3 (mEq/L)	-2<n<+2	6	2.4
	< 22	140	56
PCO_2 (mm Hg)	22-26	40	16
	< 35	60	24
	35-45	40	16
P^H	< 7.35	40	16
	7.35–7.45	140	56
	> 7.45	6	2.4
SARS-CoV-2 RT-PCR	Positive	200	80
	Negative	60	24
	No test	110	44
SARS-CoV-2 IgM	Negative	140	56
	(<5)		

WBC=White blood cells; CRP=C-reactive protein; PLT=Platelet; CPK=Creatine phosphokinase; ESR=Erythrocyte sedimentation rate; LDH=Lactate dehydrogenase; BE=Base excess.

of our patients reported headache in the present study. The prevalence of other neurological manifestations in hospitalized pediatrics with COVID-19 was evaluated in this study; after seizure and focal neurological disorder, loss of consciousness was in the third place of the most common symptoms. The seizure was repeatedly neurological manifestation in 26% of our patients.

COVID infection may affect the nervous system either through a direct viral assault or via delayed post-infectious immune responses. Research shows that SARS-CoV-2 enters human cells by binding to ACE2 receptors,[20] which are located on ciliated nasal cells and oligodendrocytes.[21] In some encephalopathy patients, the virus has been detected within the cerebrospinal fluid (CSF), pointing to its ability to invade the brain or strip protective nerve coatings (demyelination).[22,23] Furthermore, scientists have spotted viral fragments directly inside the brain tissue of infected patients.[24] Nevertheless, these findings require careful interpretation, especially since separate analyses of COVID-19 patients without neurological symptoms showed no trace of the virus in their brain tissue or CSF.[25,26]

"Cytokine storm" which refers to the hyper-inflammatory response brought on by excessive cytokine synthesis (e.g., tumor necrosis factor and interleukin-6), is another potential major cause of neural damage in COVID infection.[4] Even though the patients in this specific study did not lose their sense of smell or taste, many other studies show that 20% to 98% of COVID-19 patients did.[27-30] This symptom was actually more common in people who recovered at home than in those who had to stay in the hospital. Interestingly, one study found that patients who lost their sense of smell were less likely to get severely ill or die.[31] In fact, over 70% of these patients started feeling better within four weeks.[32] The reason different studies show different numbers is likely because of how they were set up – such as how many people they tested, whether they looked at hospitalized patients, and if they used official medical tests or just asked patients how they felt.

Cerebrovascular (CV) events such as intracranial hemorrhage (ICH), cerebral venous thrombosis (CVT), and ischemic stroke (IS) were reported in 0.5 to 1.3% of COVID-19 patients.[8,24] Other effective parameters on early mortality were coincidence of COVID-19 and stroke, older age,

higher baseline National Institutes of Health Stroke Scale, and cryptogenic stroke.[33]

A few cases of post-infectious demyelinating disorders (PIDD) of the central nervous system (CNS) following COVID-19 illness have been described.[7,34] Further longitudinal research should evaluate the frequency of these episodes in cases with COVID-19 that have been identified. Following recovery from COVID-19 disease, reports of post-infectious demyelination (PID) of the peripheral nervous system (PNS) were also observed.[35]

In this study, one case developed encephalitis, two patients had transverse myelitis (TM) and one patient had aseptic meningitis. In addition, Guillain-Barre syndrome (GBS) was another complication that involved five patients in our study. Bell's palsy was observed in two of our participants. It was observed in approximately half the patients of the previous report.[36]

According to some of the recent reports, well-planned multicenter studies are required from several Iranian and international locations that closely track the various neurologic manifestations of this infection, utilizing neuroimaging studies, CSF studies, and neurophysiologic studies. Additionally, some of these severe neurologic consequences may be curable, such as non-convulsive seizures that cause agitation and are impossible to identify without regular electroencephalography testing.[37,38]

To my knowledge, this is one of the few studies investigating the neurological manifestations of COVID-19 in children done in India. However, several methodological limitations must be acknowledged. First, the use of a hospital-based rather than a population-based sample introduces potential selection bias. Additionally, the study is limited by the absence of a control group and a brief follow-up period. Consequently, further research is warranted to fully evaluate the incidence of central nervous system demyelinating involvements alongside concurrent parosmia and phantosmia.

CONCLUSION

To conclude, investigating COVID-19 patients, especially those children with simultaneous neurological symptoms, showed that we should notice about underlying problems during our treatment and follow up. For instance, if we have a child who has diabetes, we should notice about his/her diabetic status to decrease neurological sequels.

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Ethical approval: The study was approved by the Ethics Reveiw Committee of the Saraswathi Institute of Medical Sciences, Uttar Pradesh, India.

Author's contribution: P Gupta was solely responsible for concept and design of the study, data collection, compilation, analysis as well as manuscript writing, editing and final submission.

REFERENCES

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497-506.
2. Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status. Mil Med Res. 2020;7(1):11.
3. Malaiyan J, Arumugam S, Mohan K, Gomathi Radhakrishnan G. An update on the origin of SARS-CoV-2: Despite closest identity, bat (RaTG13) and pangolin derived coronaviruses varied in the critical binding site and O-linked glycan residues. J Med Virol. 2021;93(1):499-505.
4. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun. 2020;109:102433.
5. Lechien JR, Chiesa-Estomba CM, De Siati DR, Horoi M, Le Bon SD, Rodriguez A, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study. Eur Arch Otorhinolaryngol. 2020;277(8):2251-61.
6. Mao L, Jin H, Wang M, Hu Y, Chen S, He Q, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. JAMA Neurol. 2020;77(6):683-90.
7. McCuddy M, Kelkar P, Zhao Y, Wicklund D. Acute demyelinating encephalomyelitis (ADEM) in COVID-19 infection: a case series. Neurol India. 2020;68(5):1192-5.
8. Shahjouei S, Naderi S, Li J, Khan A, Chaudhary D, Farahmand G, et al. Risk of stroke in hospitalized SARS-CoV-2 infected patients: a multinational study. EBioMedicine. 2020;59:102939.
9. Swarz JA, Daily S, Niemi E, Hilbert SG, Ibrahim HA, Gaitanis JN. COVID-19 Infection Presenting as Acute-Onset Focal Status Epilepticus. Pediatr Neurol. 2020;112:7.
10. Arabi YM, Harthi A, Hussein J, Bouchama A, Johani S, Hajeer AH, et al. Severe neurologic syndrome associated with Middle East respiratory syndrome corona virus (MERS-CoV). Infection. 2015;43(4):495-501.
11. Tsai LK, Hsieh ST, Chang YC. Neurological manifestations in severe acute respiratory syndrome. Acta Neurol Taiwan. 2005;14(3):113-9.
12. Mahmoudi S, Mehdizadeh M, Shervin Badv R, Navaeian A, Pourakbari B, Rostamyan M, et al. The coronavirus disease 2019 (COVID-19) in children: a study in an Iranian children's referral hospital. Infect Drug Resist. 2020;13:2649-55.
13. Mamishi S, Movahedi Z, Mohammadi M, Ziaee V, Khodabandeh M, Abdolsalehi MR, et al. Multisystem inflammatory syndrome associated with SARS-CoV-2 infection in 45 children: a first report from Iran. Epidemiol Infect. 2020;148:e196.
14. Khatoon F, Prasad K, Kumar V. Neurological manifestations of COVID-19: available evidences and a new paradigm. J Neurovirol. 2020; 26(5):619-30.
15. Umapathi T, Kor AC, Venketasubramanian N, Lim CC, Pang BC, Yeo TT, et al. Large artery ischaemic stroke in severe acute respiratory syndrome (SARS). J Neurol. 2004;251(10):1227-31.
16. Ashrafi MR, Mohammadi M, Shervin Badv R, Zamani G, Tavasoli AR, Heidari M, et al. Children with epilepsy in the era of COVID-19 pandemic. J Pediatr Epilepsy. 2020;9(2):53-4.
17. Fu L, Wang B, Yuan T, Chen X, Ao Y, Fitzpatrick T, et al. Clinical characteristics of coronavirus disease 2019 (COVID-19) in China: a systematic review and meta-analysis. J Infect. 2020;80(6):656-65.
18. Trigo J, García-Azorín D, Planchuelo-Gómez Á, Martínez-Pías E, Talavera B, Hernández-Pérez I, et al. Factors associated with the presence of headache in hospitalized COVID-19 patients and impact on prognosis: a retrospective cohort study. J Headache Pain. 2020;21(1):94.
19. Rocha-Filho PAS, Magalhães JE. Headache associated with COVID-19: frequency, characteristics and association with anosmia and ageusia. Cephalalgia. 2020;40(13):1443-51.
20. Li G, He X, Zhang L, Ran Q, Wang J, Xiong A. Assessing ACE2 expression patterns in lung tissues in the pathogenesis of COVID-19. J Autoimmun. 2020;112:102463.
21. Aghagoli G, Gallo Marin B, Katchur NJ, Chaves-Sell F, Asaad WF, Murphy SA, et al. Neurological involvement in COVID-19 and potential mechanisms: a review. Neurocrit Care. 2021;34(3):1062-71.
22. Moriguchi T, Harii N, Goto J, Harada D, Sugawara H, Takamino J, et al. A first case of meningitis/encephalitis associated with SARS-coronavirus-2. Int J Infect Dis. 2020;94:55-8.
23. Huo L, Xu KL, Wang H. Clinical features of SARS-CoV-2-associated encephalitis and meningitis amid COVID-19 pandemic. World J Clin Cases. 2021;9(5):1058-78.

24. Paniz-Mondolfi A, Bryce C, Grimes Z, Gordon RE, Reidy J, Lednicky J, et al. Central nervous system involvement by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). J Med Virol. 2020;92(7):699-702.

25. Pezzini A, Padovani A. Lifting the mask on neurological manifestations of COVID-19. Nat Rev Neurol. 2020;16(11):636-44.

26. Schaller T, Hirschbühl K, Burkhardt K, Braun G, Trepel M, Märkl B, et al. Postmortem examination of patients with COVID-19. JAMA. 2020;323(24):2518-20.

27. Aggarwal S, Garcia-Telles N, Aggarwal G, Lavie C, Lippi G, Henry BM, et al. Clinical features, laboratory characteristics, and outcomes of patients hospitalized with coronavirus disease 2019 (COVID-19): early report from the United States. Diagnosis. 2020;7(2):91-6.

28. Moein ST, Hashemian SM, Mansourafshar B, Khorram-Tousi A, Tabarsi P, Doty RL, et al. Smell dysfunction: a biomarker for COVID-19. Int Forum Allergy Rhinol. 2020;10(8):944-50.

29. Giorli A, Ferretti F, Biagini C, Salerni L, Bindi I, Dasgupta S, et al. A literature systematic review with meta-analysis of symptoms prevalence in COVID-19: the relevance of olfactory symptoms in infection not requiring hospitalization. Curr Treat Options Neurol. 2020;22(10):36.

30. Avcı H, Karabulut B, Farasoglu A, Boldaz E, Evman M. Relationship between anosmia and hospitalisation in patients with coronavirus disease 2019: an otolaryngological perspective. J Laryngol Otol. 2020;134(8):710-6.

31. Talavera B, García-Azorín D, Martínez-Pías E, Trigo J, Hernández-Pérez I, Valle-Peñacoba G, et al. Anosmia is associated with lower in-hospital mortality in COVID-19. J Neurol Sci. 2020;419:117163.

32. Hopkins C, Surda P, Whitehead E, Kumar BN. Early recovery following new onset anosmia during the COVID-19 pandemic – an observational cohort study. J Otolaryngol Head Neck Surg. 2020;49(1):26.

33. Ramos-Araque ME, Siegler JE, Ribo M, Requena M, López C, de Lera M, et al. Stroke etiologies in patients with COVID-19: the SVIN COVID-19 multinational registry. BMC Neurol. 2021;21(1):43.

34. Zoghi A, Ramezani M, Roozbeh M, Alavi Darazam I, Sahraian MA. A case of possible atypical demyelinating event of the central nervous system following COVID-19. Mult Scler Relat Disord. 2020;44:102324.

35. Sejvar JJ, Baughman AL, Wise M, Morgan OW. Population incidence of Guillain-Barré syndrome: a systematic review and meta-analysis. Neuroepidemiology. 2011;36(2):123-33.

36. Sriwastava S, Kataria S, Tandon M, Patel J, Patel R, Jowkar A, et al. Guillain Barré Syndrome and its variants as a manifestation of COVID-19: a systematic review of case reports and case series. J Neurol Sci. 2021;420:117263.

37. Ashrafi MR, Azizimalamiri R, Shervin Badv R, Tavasoli AR, Nikkhah A, Montazerlotfelahi H, et al. Coronavirus, its neurologic manifestations, and complications. Iran J Pediatr. 2020;30(2):e102569.

38. Ashrafi MR, Mohammadi M, Zamani G, Khosroshahi N, Shervin Badv R, Tavasoli A, et al. We need well-designed multicenter studies to investigate neurologic manifestations of coronavirus disease 2019. Curr J Neurol. 2020;19(3):150-1.