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The Impact of the Omicron Variant in Pediatric COVID-19 Patients with Seizures

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Abstract

Introduction: *Late in the coronavirus disease 2019 (COVID-19) pandemic, there has been an upsurge in pediatric patients with seizures. This study was conducted to compare the demographic, laboratory, neurodiagnostic, and clinical characteristics of children with seizures infected with COVID-19 during the period when the Omicron variant of concern (VOC) was the predominant VOC with those of children with seizures infected with COVID-19 before the emergence of the Omicron variant.*

Methodology: *The population of this retrospective observational cohort study consisted of a total of 58 pediatric patients who had seizures and were diagnosed with COVID-19 between March 15, 2020, and August 31, 2022.*

Results: *The median frequency of seizures during the follow-up period was 2 (min. 1, max. 7). Focal seizures were observed in four (7%) patients. There was no significant difference between the Omicron and pre-Omicron VOC groups in the demographic-clinical characteristics and seizure findings ($p>0.05$). Excluding the patients with known neurological disease, the majority of the patients were under the age of six, and 84% were diagnosed with febrile convulsions. There was no significant difference between the groups in diagnosis types, treatment protocols, and clinical outcomes ($p>0.05$).*

Conclusion: *The rise in seizures reported in children infected with COVID-19 during the pandemic's last stages was linked to the Omicron VOC, which was the prevalent VOC at the time. Nevertheless, our findings indicated that Omicron VOC had similar outcomes to other COVID-19 variants in children with seizures.*

Keywords: *children, COVID-19, Omicron, SARS-CoV-2, seizures*

Running title: *Omicron Variant and Pediatric Seizures*

Introduction

The coronavirus disease 2019 (COVID-19) has a milder course in children and causes fewer deaths than adults [1]. Although it is usually asymptomatic, COVID-19 may be accompanied by signs of upper respiratory tract infection, such as fever, weakness, cough, sore throat, runny nose, and nasal congestion [2,3]. Apart from the respiratory system, COVID-19 may also involve gastrointestinal, urinary, cardiovascular, and neurological systems [4-6].

The studies conducted during the pandemic process revealed that approximately 36% of the COVID-19 patients had neurological signs and symptoms, i.e., central nervous system (headache, dizziness, acute cerebrovascular disease, seizures, ataxia, and altered consciousness), peripheral nervous system (taste, smell and visual impairment and neuralgia) and skeletal muscle involvements [7,8].

Seizures with diverse origins, including pathological causes and benign febrile seizures, are expected during the first few years of life and may subsequently diminish with age [9,10]. An increase in the number of pediatric COVID-19 cases with seizures has been observed since the last months of 2021. Most of these cases had simple febrile convulsions, which were accompanied in some cases by severe neurological

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events such as central nervous system infections, intracranial hemorrhage, epilepsy, acute disseminated encephalomyelitis, and Guillain-Barre Syndrome [11,12].

The objective of this study is to assess the impact of COVID-19 infection on neurological functions in exposed children with seizures by retrospectively reviewing and comparing their demographic, laboratory, neurodiagnostic, and clinical characteristics between the periods before and after the Omicron variant of concern (VOC) emerged.

Methodology

This retrospective observational cohort study was conducted in a tertiary healthcare center (Bursa Faculty of Medicine, City Training and Research Hospital, Turkey). The study population consisted of pediatric inpatients and outpatients under 18 diagnosed with COVID-19 infection between March 15th, 2020, and August 31st, 2022, based on the result of the reverse transcription polymerase chain reaction (RT-PCR) test and who had seizures.

After the local ethics committee approved the study protocol (Approval No: 2019-KAEK-140, Approval Date: 2022/11-09), the patient's medical records and hospitalization files were reviewed retrospectively. Patients above the age of 18 whose files could not be obtained or who lacked critical data were excluded from the study. Of the pediatric patients included in the study sample, the patients who applied to the clinic between January 1st, 2022, and August 31st, 2022, the period when the Omicron VOC was the dominant VOC, were included in the Omicron VOC group, whereas the patients who applied to the clinic between March 15th, 2020 and November 30th, 2021, the period prior to the emergence of the Omicron variant, were included in the pre-Omicron VOC group. Patients in the transition period of December 2021 were excluded from the present study.

Inpatients were evaluated clinically after admission to the emergency department and were followed up during their hospital stay until discharge. Outpatients were those who applied to the pediatric neurology outpatient clinic and whose follow-up was completed during this period.

Variables including age, gender, neurological disease history, familial neurological disease history, antiepileptic drug use, seizure characteristics, complaints before admission and the duration of these complaints, treatment characteristics, and treatment outcomes were recorded and analyzed comparatively between the groups. Seizures and epilepsies are categorized using the international league against epilepsy (ILAE)-revised terminology and concepts in our study [13].

Additionally, laboratory variables obtained from the laboratory tests carried out at admission were recorded and analyzed comparatively between the groups. These laboratory variables included the results of the complete blood count and serum biochemical tests (including renal and liver functions, lactate dehydrogenase, and electrolytes), myocardial enzyme levels, coagulation profile, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and procalcitonin (PCT) levels. In addition, the electroencephalography (EEG) and cranial magnetic resonance imaging (MRI) performed during the follow-up were reviewed and analyzed comparatively between the groups.

In the case of categorical variables, descriptive statistics were expressed as numbers (n) and percentage (%) values, while continuous variables were expressed as median and minimum-maximum values. Because no variable evaluated within the scope of the study was found to fit the normal distribution, mean and standard deviation data were not employed. Pearson's chi-square test was used to compare qualitative variables, whereas the Mann-Whitney U test was employed to compare two groups non-parametrically.

Statistical analyses were performed using the software package SPSS 22.0 (Statistical Product and Service Solutions for Windows, Version 22.0, IBM Corp., Armonk, NY, U.S., 2013). The probability (p) statistics of ≤ 0.05 were deemed to indicate statistical significance.

Results

Characteristics of the Study Group

The study sample consisted of 58 pediatric inpatients and outpatients admitted to the clinic with COVID-19 infection and who had concomitant seizures during the study period. Of the 58 pediatric patients included in the study sample, 37 (64%) applied to the clinic between January 1st, 2022, and August 31st, 2022, the period when the Omicron VOC was the dominant VOC (the Omicron VOC group), whereas 21 (36%) children who applied to the clinic between March 15th, 2020 and November 30th, 2021, the period prior to the emergence of the Omicron variant (the pre-Omicron VOC group). The median age of the sample, 38 males and 20 females, was 20 (min. 3, max. 196) months. The ratio of males to females in the sample was 1.90. Of the 58 patients, 14 (24%) were previously diagnosed with a neurological disease. Valproate, which was being used by 54% of the patients who were on antiepileptic drugs, was the most common antiepileptic drug used in the study sample.

The overall ratio of patients who had a prior seizure history, both with an underlying disease as above or benign seizures, was 52%. The median frequency of seizures during the follow-up period was 2 (min. 1, max. 7). Focal seizures were observed in four (7%) patients. The most common complaint at presentation was fever, which was the case in 85% of the patients, followed by fatigue or myalgia, which was present in 9% of the patients at presentation. There was no significant difference between the Omicron and pre-Omicron VOC groups in the demographic and clinical characteristics at admission and seizure findings ($p>0.05$) (Table 1).

Laboratory Characteristics

There was no significant difference between the Omicron and pre-Omicron VOC groups in laboratory characteristics except for ESR, which was significantly higher in the pre-Omicron VOC group ($p=0.022$). Table 2 shows the distribution of laboratory features per study group.

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Interictal EEG recordings of 28 (48%) patients were taken during the period they were infected. Of these EEG recordings, 23 (82%) were normal, whereas the remaining 2 (7%) and 3 (11%) indicated interictal epileptic discharges and nonspecific abnormalities, respectively. Cranial MRI was performed in 15 (26%) patients. Of the MRI findings, 65% were normal, while five indicated pathological findings (Table 3).

Clinical Outcomes

Of the patients included in the study, 12% were outpatients followed up in the pediatric neurology clinic. At least one new antiepileptic drug was added to the treatment regimen of 17% of the patients during the follow-up period. Febrile convulsion was diagnosed in the majority of patients (84%) when those with known neurologic disease were excluded. Two patients (5%) were diagnosed with febrile seizures, four (9%) with epilepsy, and one with *staphylococcus epidermidis* meningitis. In addition, one of the patients with abnormal MRI findings was diagnosed with acute disseminated encephalomyelitis and the other one with glutaric aciduria type 1 in a different center; both were followed to another center after the acute phase of their disease. The average length of hospital stay was 4 days (range: 1 to 23). Five (9%) patients required transfer to the intensive care unit (ICU), with a median ICU stay of 6 (min. 2, max. 21) days. There was no significant difference in diagnostic types, treatment regimens, or clinical outcomes between the Omicron and pre-Omicron VOC groups (p>0.05) (Table 4).

Table 1. Demographic and clinical features of convulsive pediatric patients with COVID-19

Variables	Total (n=58)	Omicron VOC era (n=37)	Pre-Omicron VOC era (n=21)	*P-value*
Demographics				
Age (months)	20 (3-196)	20 (4-156)	22 (3-196)	0.405[a]
< 1year	12 (21)	9 (25)	3 (14)	
1-5 years	39 (67)	25 (67)	14 (67)	
> 5 years	7 (22)	3 (8)	4 (19)	
Gender				0.159[b]
Girls	20 (34)	15 (40)	5 (24)	
Boys	38 (66)	22 (60)	16 (76)	
Prior history of neurological disease	14 (24)	7 (19)	7 (33)	0.495[b]
Epilepsy	7 (50)	3 (43)	4 (57)	
Cerebral palsy - Epilepsy	6 (43)	3 (43)	3 (43)	
Epilepsy syndrome (West)	1 (7)	1 (14)	0 (0)	
No. of family members with neurological disease	21 (36)	16 (43)	5 (24)	0.475[b]
Antiepileptic drug use*	13 (22)	6 (16)	7 (33)	0.247[b]
Valproate	7 (54)	2 (33)	5 (71)	
Levetiracetam	3 (23)	1 (17)	2 (29)	
Clobazam	3 (23)	1 (17)	2 (29)	
Carbamazepine	2 (15)	1 (17)	1 (14)	
Phenobarbital	1 (8)	1 (17)	0 (0)	
Topiramate	1 (8)	0 (0)	1 (14)	
Vigabatrin	1 (8)	0 (0)	1 (14)	
Seizure characteristics				
Prior history of seizure	30 (52)	17 (46)	13 (62)	0.185[b]
Average episode of seizures	2 (1-7)	2 (1-7)	2 (1-4)	0.918[a]
Duration of seizures (minutes)	2.5 (0.25-45)	3 (0.5-45)	2 (0.25-30)	0.361[a]
Type of seizures				0.460[b]
Focal	4 (7)	2 (6)	2 (10)	
Generalized	54 (93)	35 (94)	19 (90)	
Signs and symptoms				
Fever (body temperature > 37.3°C)	49 (85)	32 (86)	17 (81)	0.585[b]
Fatigue or myalgia	9 (16)	5 (14)	4 (19)	0.430[b]
Anosmia	8 (14)	3 (8)	5 (24)	0.445[b]
Vomiting	8 (14)	4 (11)	4 (19)	0.253[b]
No additional signs and symptoms	5 (9)	4 (11)	1 (14)	0.420[b]
Headache	1 (2)	0 (0)	1 (5)	0.625[b]

Data are presented as median (minimum-maximum values) or number (%).

COVID-19: coronavirus disease 2019, VOC: variant of concern.

*: The drugs were used concurrently in some patients. Percentages give the ratio among drug users.

[a]Mann Whitney-U test

[b]Chi-square test

Table 2. Laboratory findings of pediatric patients.

Parameter	Total (n=58)	Omicron VOC era (n=37)	Pre-Omicron VOC era (n=21)	*P-value* [a]
White blood cells ($x10^9$ per L)	9.19 (1.08-19.76)	9.37 (1.08-19.76)	9.16 (4.08-18.96)	0.788
Absolute neutrophil count ($x10^9$ per L)	5.31 (1.05-13.21)	5.40 (1.05-13.21)	5.31 (1.96-11.69)	0.829
Lymphocyte count ($x10^9$ per L)	1.96 (0.35-9.25)	1.64 (0.40-9.25)	2.42 (0.35-8.92)	0.148
Hemoglobin (g/dL)	11.50 (8.80-13.90)	11.60 (8.80-13.90)	11.40 (9.50-13.40)	0.472
Platelet count ($x10^9$)	269 (82-938)	268 (82-938)	272 (107-441)	0.436
Aspartat transferase (U/L)	35 (19-187)	55 (20-133)	34 (19-187)	0.950
Alanine amino transferase (U/L)	17 (8-128)	17 (8-47)	16 (10-128)	0.594
Lactate dehydrogenase (U/L)	286 (202-898)	301 (231-605)	272 (202-898)	0.227
Creatinine (µmol/dL)	0.32 (0.17-0.81)	0.31 (0.18-0.61)	0.32 (0.17-0.81)	0.597
Calcium (mg/dL)	9.40 (6.30-11.70)	9.50 (6.30-11.70)	9.20 (7.70-10.50)	0.099
Magnesium (mg/dL)	2.11 (1.82-2.36)	2.00 (1.91-2.36)	2.14 (1.82-2.21)	0.763
Creatine kinase MB (µg/L)	1.07 (0.39-3.83)	1.03 (0.44-3.19)	1.31 (0.39-3.83)	0.827
Prothrombin time (second)	9.70 (8.20-13.50)	9.76 (8.20-11.50)	9.70 (8.20-13.50)	0.964
D-dimer (µg/mL)	0.27 (0.20-1.07)	0.26 (0.20-0.86)	0.28 (0.20-1.07)	0.737
Erythrocyte sedimentation rate (mm/h)	**6 (2-62)**	**6 (2-21)**	**10 (2-62)**	**0.022**
C-reactive protein (mg/L)	3 (0-50)	4 (0-22)	2 (0-50)	0.866
Procalcitonin (ng/mL)	0.16 (0.04-3.36)	0.19 (0.04-0.85)	0.15 (0.07-3.36)	0.619

Data are presented as median (minimum-maximum values).
VOC: variant of concern.
[a]Mann Whitney-U test

Table 3. EEG and Cranial MRI features of patients.

Variables	Total n=58	Omicron VOC era n=37	Pre-Omicron VOC era n=21
EEG			
Performed	28 (48)	19 (51)	9 (43)
Normal	23 (82)	15 (79)	8 (89)
Nonspecific EEG abnormalities	3 (11)	3 (16)	0 (0)
Interictal Epileptiform Discharges	2 (7)	1 (5)	1 (11)
Cranial MRI			
Performed	15 (26)	7 (19)	8 (33)
Normal	10 (65)	6 (86)	4 (52)
Hyperintense lesion located in occipital lobe on T2 / FLAIR	1 (7)	0 (0)	1 (12)
Diffusion restriction in the bilateral basal ganglia on DWI	1 (7)	0 (0)	1 (12)
Hyperintense cortical lesions in different locations in both cerebral hemispheres on T2/FLAIR	1 (7)	0 (0)	1 (12)
Diffusion restriction in right temporal lobe cortex, left frontal lobe cortex, bilateral basal ganglia, bilateral middle cerebral peduncle on DWI	1 (7)	1 (14)	0 (0)
Enlarged perivascular distance in the basal ganglia on T2	1 (7)	0 (0)	1 (12)

Values are presented as numbers (%).
EEG: electroencephalogram, MRI: magnetic resonance imaging, VOC: variant of concern, DWI: diffusion-weighted imaging.

Table 4. Treatment and outcomes features of patients.

Variables	Total (n=58)	Omicron VOC era (n=37)	Pre-Omicron VOC era (n=21)	*P-value*
Treatments				
Treatment procedures				0.197 [b]
Outpatient	7 (12)	6 (16)	1 (5)	
Inpatient	51 (88)	31 (84)	20 (95)	
Antibiotics*	49 (85)	29 (78)	20 (95)	0.088 [b]
Ceftriaxone/Cefotaxime	40 (82)	25 (86)	15 (75)	0.265 [b]
Ampicillin sulbactam	9 (18)	5 (17)	4 (20)	0.545 [b]
Azithromycin	5 (10)	1 (3)	4 (20)	0.082 [b]
Vancomycin	1 (2)	1 (3)	0 (0)	0.592 [b]
Colistin	1 (2)	1 (3)	0 (0)	0.592 [b]
New antiepileptic drugs*	10 (17)	6 (16)	4 (19)	0.442 [b]
Valproate	6 (60)	4 (60)	2 (50)	0.370 [b]

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Levetiracetam	3 (30)	1 (15)	2 (50)	0.396 [b]
Lorazepam	2 (20)	0 (0)	2 (50)	0.189 [b]
Carbamazepine	1 (10)	0 (0)	1 (25)	0.711 [b]
Vigabatrin	1 (10)	0 (0)	1 (25)	0.450 [b]
Diagnosis				
Total	44 (76)	33 (39)	11 (52)	0.178 [b]
Febrile convulsion	37 (84)	29 (88)	8 (73)	0.141 [b]
Epilepsy	4 (9)	2 (6)	2 (18)	0.618 [b]
Acute symptomatic seizure	3 (7)	2 (6)	1 (9)	0.367 [b]
CNS infection	1 (2)	1 (3)	0 (0)	
Acute disseminated encephalomyelitis	1 (2)	0 (0)	1 (9)	
Glutaric aciduria type 1	1 (2)	1 (3)	0 (0)	
Outcomes				
Total duration of hospitalization, days	4 (1-23)	4 (2-23)	4 (1-16)	0.427 [a]
Intensive care requirement	5 (9)	4 (11)	1 (5)	0.340 [b]
Total duration in intensive care unit, days	6 (2-21)	6 (2-21)	4	0.800 [a]
Total duration of fever, days	0 (0-6)	0 (0-6)	0 (0-6)	0.602 [a]
Total duration of fatigue or myalgia, days	2(2-5)	2(2-5)	2 (2-3)	0.786 [a]
Total duration of anosmia, days	1(0-6)	1(0-3)	1(0-6)	0.625 [a]
Total duration of vomiting, days	0(0-6)	2(0-4)	0 (0-6)	0.912 [a]
Total duration of headache, days	0	NA	0	NA

Data are presented as median (minimum-maximum values) or number (%).
VOC: variant of concern, CNS: central nervous system, NA: not applicable.
*: The drugs were used concurrently in some patients. Percentages give the ratio among drug users.
[a]Mann Whitney-U test
[b]Chi-square test

Discussion

This study found that seizure frequency increased in the shorter omicron period, abnormal MRI findings were more frequent, and ESR was higher in the pre-omicron period, with no other significant differences.

Since the time the severe acute respiratory coronavirus (SARS-CoV-2) virus that caused the COVID-19 infection was identified, different variants have emerged. In parallel, numerous studies were conducted to identify these variants and determine how they affect the course of the disease [14]. The contagiousness of the Omicron variant (B.1.1.529) has been reported to be ten times that of the original SARS-CoV-2 and approximately two times that of the Delta variant [15]. It has also been reported that the number of cases infected with the Omicron variant doubled every two days after its emergence [16]. The majority of patients contaminated with the Omicron variant, on the other hand, were asymptomatic. In addition, the disease had a mild course in most of the symptomatic patients. Nevertheless, even though the Omicron variant is considered to be milder than other variants of SARS-CoV-2, further data are needed to draw conclusions about its severity [17].

There has been an increase in COVID-19 cases with seizures in the last stages of the pandemic [18]. Since the beginning of 2022, the dominant COVID-19 in Turkey has been the Omicron variant, as it is worldwide [19]. In the study conducted by Iijima et al. [20] the incidence of seizures after the emergence of the Omicron variant was found as 14.6% compared to 1.7% in the previous period of the pandemic. Even though 8.6 times more seizures were recorded, there was no significant difference in the clinical parameters investigated except for the dominant variations. In another recent study, seizures were observed in 19 (31%) of the 61 children admitted to the hospital due to COVID-19 during the Omicron VOC period [21]. Along these lines, Shoji et al. [22] reported a higher incidence of seizures in pediatric COVID-19 patients during the Omicron VOC period and stated that the

Omicron variant of COVID-19, albeit more contagious, had a milder course in these patients.

In a very recent study by Anastasopoulou et al. [23] with 229 pediatric patients with COVID-19 infection, the omicron period was emphasized as an important risk factor for increased seizure frequency. Mahmoudi et al. [24] evaluated the clinical outcomes of COVID-19 variants in Iranian children and found that seizure frequency was increased in the alpha and omicron variants compared to the delta variant. In parallel, the number of pediatric COVID-19 patients with seizures admitted to the clinic where this study was conducted, was seven, 16, and 35 in 2020, 2021, and 2022, respectively, indicating an increase in COVID-19 cases with seizures during the last stages of the pandemic. Of the 58 pediatric COVID-19 patients with seizures, 37 applied during the period when the Omicron variant was dominant, whereas the remaining 21 applied during the pre-Omicron period. In addition, the study findings revealed that the incidence of fever was higher, albeit not significantly, in pediatric COVID-19 patients with seizures during the Omicron period compared to the pre-Omicron period. The higher fever incidence observed during the Omicron period might have caused younger children to experience a higher incidence of seizures and the seizures to be experienced as febrile convulsions.

In a study conducted with 16 children who had seizures during the Omicron period, Apirada et al. [25] reported that eight (50%) patients presented with status epilepticus and six (38%) with focal seizures. Of the 16 patients, 14 (88%) presented with a seizure lasting>5 minutes or more than one seizure in 24 hours. In comparison, the most common type of seizures observed in this study was generalized tonic-clonic seizures, followed by focal seizures, which were observed at a rate of 7%. Of the 58 children who presented with seizures, 30 had a history of seizures. Of these 30 patients, 17 and 13 were admitted during the Omicron and pre-Omicron periods, respectively. In the vast majority of the patients, the seizures lasted less than 5 minutes.

It has also been stated that recurrent generalized tonic-clonic seizures can be observed in COVID-19 patients who do not have a history of seizures or a familial history of seizures [26]. In parallel, of the 58 pediatric COVID-19 patients with seizures included in this study, 16 patients with no history of seizures or familial history of seizures had seizures for the first time during the COVID-19 period, and these seizures were generalized tonic-clonic seizures. Of these 16 patients, nine had recurrent generalized tonic-clonic seizures. Febrile convulsions were observed in 84%, febrile seizures in 5% and epilepsy was diagnosed in 9% of the patients who had seizures during our study.

Several investigations found that the most prevalent abnormal laboratory results in pediatric patients with COVID-19 infection were leukopenia/lymphopenia and elevated creatine kinase. Furthermore, higher creatine kinase-myoglobin binding (CK-MB), lactate dehydrogenase (LDH), alanine aminotransferase (ALT)/aspartate aminotransferase (AST), ESR, PCT, and CRP levels have been documented in pediatric COVID-19 infection patients [27]. There was no significant difference in laboratory features between the Omicron and pre-Omicron VOC groups, except for ESR, which was considerably higher in the pre-Omicron VOC group but did not imply a pathological state, given that the median ESR score was 10.

In a study evaluating seven pediatric COVID-19 patients presenting with seizures, the EEG findings of the six patients indicated electrographic seizures, extremely sharp waves, intermittent frontal delta slowing in one patient each, and generalized slowing in two patients. The EEG of the remaining patient was normal [28]. In another study, Garcia Howard et al. [29] reported normal EEG and cranial MRI findings in a three-month-old girl with seizure attacks. Similarly, Bhatta et al. [30] reported normal EEG and cranial MRI findings in an 11-year-old patient who experienced generalized tonic-clonic seizures twice. The patients in the two studies mentioned above were asymptomatic during the follow-up period. In comparison, of the 58 pediatric COVID-19 patients with seizures included in this study, EEG was taken in 28 patients. The EEG findings were normal in 23 patients and abnormal in five patients, indicating epileptiform in two patients and dysrhythmic EEG in 3 patients. Two of these five patients had sharp waves in the frontal region, and another two had slow wave complexes in the frontotemporal region on EEG. The EEG indicated epileptic discharges in the remaining patient with abnormal EEG findings who had neurological findings but no abnormal findings in brain MRI. Of the 15 pediatric COVID-19 patients with seizures who underwent brain MRI, 10 had normal, whereas five had abnormal MRI findings. Of the five patients with abnormal MRI findings, four had normal EEG. On the other hand, MRI was not performed in three of the five patients with abnormal EEG findings, whereas the MRI of the two patients with abnormal EEG findings was normal.

Conclusion

During the Omicron VOC period, there was a dramatic increase in both COVID-19 cases and seizures in children infected with COVID-19. Although the small sample size for some analyses prevented us from drawing definitive conclusions, there was no significant difference in demographic, laboratory, and imaging characteristics, diagnosis types, treatment protocols, and clinical outcomes between the pediatric patients with seizures infected with COVID-19 during the Omicron and pre-Omicron periods in our study.

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Author contributions

Muhammet Furkan Korkmaz: Conceptualization; methodology; data curation; investigation; formal analysis; writing - original draft; supervision. Hatice Buket Özay: Data curation; writing - original draft. Rabia Tütüncü Toker: Conceptualization; data curation; writing - review & editing.

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