Research Article / Araştırma Makalesi

Brain MRI Findings In Children With Convulsions Secondary to Covid-19 Infection

Covid-19 Enfeksiyonuna Sekonder Konvülziyon Gelişen Çocuklarda Beyin MRG Bulguları

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Abstract

Background: The aim of the current study was to investigate magnetic resonance imaging (MRI) findings in children who developed convulsions after COVID-19 infection.
Materials and Methods: A retrospective screening was made of paediatric cases who presented at the COVID-19 pandemic clinic with suspected COVID-19 infection between March 2020 and June 2021 and were diagnosed with COVID-19 from a positive real-time polymerase chain reaction test (qRT-PCR). Non-contrast brain and diffusion MRI performed using a 3-Tesla device in all patients with convulsions. The demographic characteristics and brain MRI findings were recorded of cases with COVID-19 infection who developed convulsions.
Results: Evaluation was made of 6 cases who were diagnosed with COVID-19 and developed convulsions during the disease course. There was a history of convulsions in 3 patients and recurrent convulsion attacks developed despite anticonvulsant therapy. In the other 3 cases developed convulsion, there was no history of convulsions, or additional disease. Non-contrast brain MRI was taken for etiology in all patients. In all the cases, no signal changes of acute pathologies were detected on diffusion MRI.
Conclusion: COVID-19 infection can trigger convulsions even in patients with epilepsy and taking anticonvulsant therapy and may cause convulsions in previously healthy cases. Unlike in the adult patient population, COVID-19 infection was not seen to cause acute changes in brain MRI findings in the pediatric age group who developed convulsions due to COVID-19 infection.

Key Words: COVID-19, Convulsion, Child, MRI

Öz

Amaç: Bu çalışmanın amacı, COVID-19 enfeksiyonu sonrası konvülziyon gelişen çocuklarda manyetik rezonans görüntüleme (MRG) bulgularını araştırmaktı.
Materyal ve metod: Mart 2020 ile Haziran 2021 arasında COVID-19 pandemi kliniğine COVID-19 enfeksiyonu şüphesiyle başvuran ve pozitif gerçek zamanlı polimeraz zincir reaksiyonu testinden (qRT) COVID-19 tanısı alan pediatrik vakaların retrospektif taraması yapıldı. Konvülziyonlu tüm hastalara 3-Tesla cihazı kullanılarak kontrastsız beyin ve difüzyon MRG yapıldı. Konvülziyon gelişen COVID-19 enfeksiyonlu olguların demografik özellikleri ve beyin MRG bulguları kaydedildi.
Bulgular: COVID-19 tanısı konan ve hastalık seyri sırasında konvülziyon gelişen 6 olgunun değerlendirilmesi yapıldı. 3 hastada konvülziyon öyküsü vardı ve antikonvülzan tedaviye rağmen tekrarlayan konvülziyon atakları gelişti. Konvülziyon gelişen diğer 3 hastada konvülziyon öyküsü veya ek hastalık yoktu. Tüm hastalarda etiyoloji için kontrastsız beyin MRG çekildi. Tüm olguların difüzyon MRG'sinde akut patolojiye ait sinyal değişikliği saptanmadı.
Sonuç: COVID-19 enfeksiyonu, epilepsili ve antikonvülzan tedavi alan hastalarda dahi konvülziyonu tetikleyebilir ve önceden sağlıklı olan olgularda konvülziyona neden olabilir. Yetişkin hasta popülasyonundan farklı olarak, COVID-19 enfeksiyonuna bağlı konvülziyon gelişen pediatrik yaş grubunda COVID-19 enfeksiyonunun beyin MRG bulgularında akut değişikliklere neden olduğu görülmedi.

Anahtar Kelimeler: COVID-19, Konvülziyon, Çocuk, MRG

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Introduction

The devastating effects of the coronavirus pandemic caused by SARS-CoV-2 have been affecting the world since early 2020 (1).

Although it has been reported that the disease course in children is generally milder and mortality is rare, it has also been reported that the risk of COVID-19 disease may be higher in children with underlying conditions such as pulmonary dysfunction or immunosuppression. COVID-19 infection in children can cause fever, cough, respiratory distress, abdominal pain, diarrhea, vomiting and occasionally convulsions (2). Concerns have been raised over whether patients will experience acute seizures during COVID-19 infection (3). Viruses that affect the central nervous system in humans can cause viral encephalitis. Magnetic resonance imaging (MRI) findings may not be specific in the diagnosis of viral encephalitis. MRI offers information on both the diagnosis and possible causes of encephalitis. In addition, nonspecific findings supporting encephalitis can be seen on MRI. These are focal or diffuse cerebral variable signal intensity, hemorrhage, cerebral edema, and diffusion restriction (4,5).

The aim of this study was to investigate MRI findings in children who developed convulsions after COVID-19 infection.

Materials and Methods

A retrospective screening was made of pediatric cases who presented at our COVID-19 pandemic clinic with suspected COVID-19 infection between March 2020 and June 2021 and were diagnosed with COVID-19 from a positive real-time polymerase chain reaction test (qRT-PCR). This retrospective study was conducted following the ethical standards included in the Declaration of Helsinki and in accordance with our local ethics committee standards (decision no: 25, dated:18.10.2021). Permission for this study was obtained from the Turkish Ministry Health. All admissions diagnosed with seizure-related conditions were manually reviewed (6). Seizure-related emergency department presentations were noted. The patients were grouped as status epilepticus, febrile seizure, seizures in patients without a diagnosis of epilepsy, recurrence of seizures in patients with epilepsy, and paroxysmal movements (7). Patients with a diagnosis of psychogenic non-epileptic seizure (PNES) were not included in the study. Admission to hospital following emergency room presentation was recorded as clinical relevance and severity index. There was no any other neurological symptom other than convulsion.

All patients who developed COVID-19 infection were 3-10 days followed up in the hospital. Non-contrast brain MRI performed in the patients with convulsions during a 10-day period. When the control RT-PCR test became negative and the convulsions recovered, the patients were discharged.

In all children who developed convulsions after COVID-19 infection, cranial MRIs were obtained using a 3-Tesla powered MRI device (Magnetom Skyra, Siemens Healthcare, Erlangen, Germany) with a 64-channel head coil. The images used in the study were obtained using the same parameters for all patients; Axial T1A (weighted) spin echo (TR/TE/FA: 370/11/70), T2A turbo spin echo (TR/TE/FA: 4540/109/150), FLAIR (Fluid Attenuated Inversion Recovery); (TR/TE/FA:9140/81/150), Sagittal T1A spin echo (TR/TE/FA: 375/11/70), Coronal T2A turbo spin echo (TR/TE/FA: 4540/105/150) and diffusion MRI were obtained. The MRIs were examined twice in total at different times by a radiologist with at least 5 years of experience in neuroradiology and was unaware of the patients' clinical status. The cranial MRI findings were recorded.

Data obtained in the study were analyzed ststistically using NCSS (Number Cruncher Statistical System) Statistical Software (Utah, USA). Descriptive statistics were expressed as mean±standard deviation (SD) and median values, number (n) and percentage (%).

Results

Evaluation was made of 6 cases diagnosed with COVID-19, who developed convulsions during the disease course and the convulsion diagnosis was confirmed by a pediatric neurologist. These cases comprised 4 males and 2 females, aged 6 months, and 2, 3, 7, 11 and 12 years. There was a history of convulsions in 3 patients and recurrent convulsion attacks developed despite anticonvulsant therapy. In the other 3 cases, there was no history of convulsions or any additional disease (Table 1).

Table 1. Demographic Characteristics of Cases

Gender M/F, number (%)	4 (66,7%) / 2 (33,3%)
Age (years), min-max (median)	0,5-12(5)
Age groups	
<1 year	1(16,7%)
1-5 years	2(33,3%)
> 5 years	3(50%)

A 2-year-old patient had cystic encephalomalacia in the right cerebellar cortex (Figure 1), an 11-year-old patient had hydrocephalus, encephalocele, corpus callosum atrophy and cortical atrophy (Figure 2), and a 12-year-old girl who developed mortality had cortical atrophy and gliosis in the subcortical white matter on brain MRI. Axial non-contrast thorax CT shows bilateral diffuse parenchymal infiltrates secondary to COVID-19 in the same patient (Figure 3). There was no difference between previous MRI findings of these 3 patients with a history of positive convulsions.

On the brain MRIs taken at the time of COVID-19 infection, no pathology was observed in 3 patients aged 6 months, 7 and 3 years (Figures 4, 5 and 6, respectively). In all the cases, no signal changes of acute pathologies were detected on diffusion MRI.

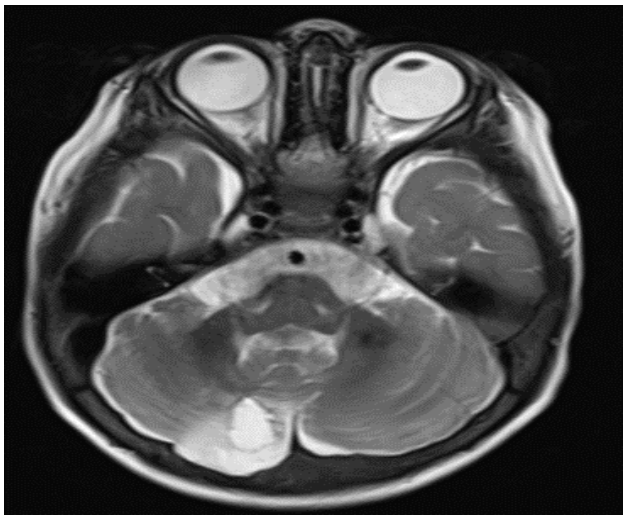

Figure 1. T2-weighted axial cranial MR image with cystic encephalomalacia in the right cerebellar cortex in a 2-year-old male patient.

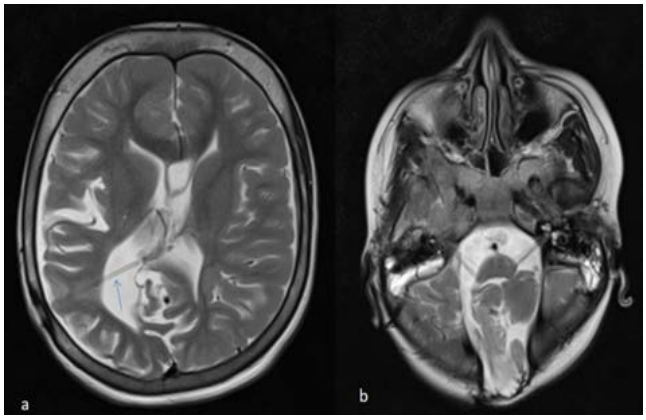

Figure 2. **a-** T2-weighted axial cranial MR image with shunt catheter of an 11-year-old female patient, shown by blue arrow, secondary to hydrocephalus, **b-** Encephalocele in the same patient.

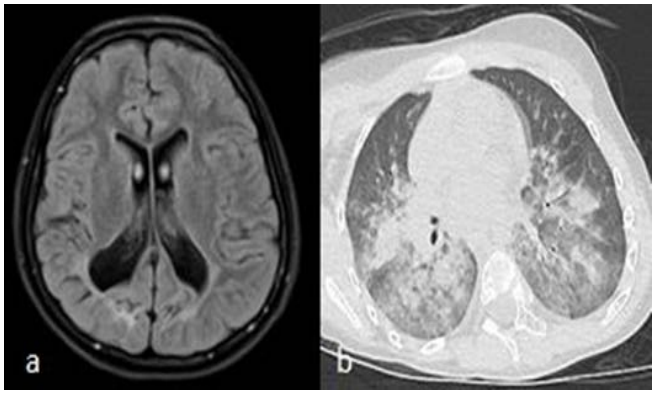

Figure 3. a- Cortical atrophy and gliosis in subcortical white matter in FLAIR sequence of a 12-year-old female patient, **b-** Axial non-contrast thorax CT shows bilateral diffuse parenchymal infiltrates secondary to COVID-19 in the same patient

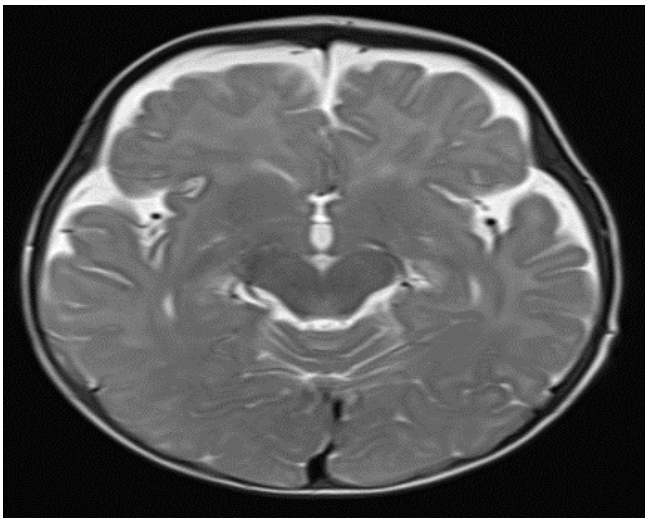

Figure 4. T2-weighted axial cranial MR image with normal brain in a 6-month-old baby boy.

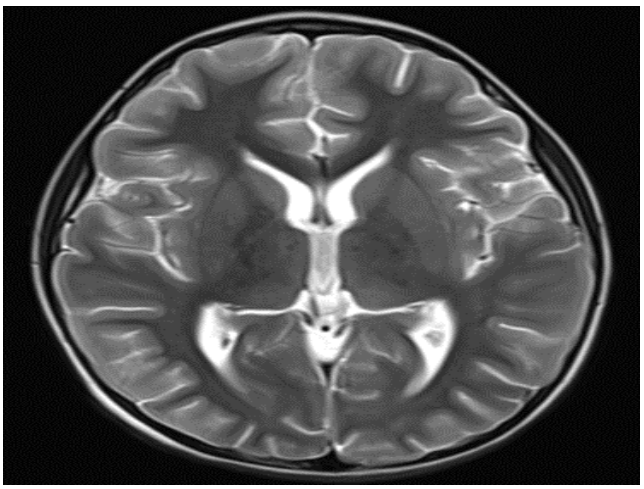

Figure 5. T2-weighted axial cranial MR with normal brain image of a 7-year-old male patient.

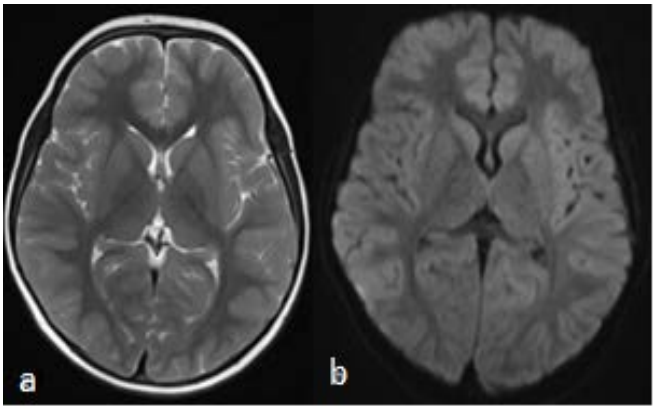

Figure 6. **a**- T2-weighted axial cranial MR image with normal brain of a 3-year-old male patient, **b-** Image of normal diffusion MR of the same patient

Discussion

The SARS-CoV-2 virus as the causative agent of the potentially fatal coronavirus 2019 disease (COVID-19) has resulted in a global pandemic. The neurotropic and neuroinvasive abilities of coronaviruses have been previously described in humans. Neurological problems found in patients with coronavirus infection include febrile seizures, convulsions, unconsciousness, encephalomyelitis and encephalitis (8).

Asadi-Pooya et al. (8) reported that patients with COVID-19 who had never been diagnosed with epilepsy, could have seizures for the first time. Convulsions may be seen in patients with COVID-19 due to reasons such as neuroinvasion, brain damage and hypoxia. In a study by Lu et al. (3), it was reported that COVID-19 causes minimal risk for convulsions during the acute phase.

In a study by Moriguchi et al. (5), specific SARS-CoV-2 RNA was detected in the cerebral spinal fluid (CSF) of a 24-year-old male patient. On the brain MRI of the same patient, there were hyperintense signal changes in the right mesial temporal lobe and hippocampus. This finding supported the possibility of SARS-CoV-2 meningitis. Many studies have reported that cerebrovascular events may develop in patients with COVID-19 (9,10).

Efe et al. (11) presented the first case of surgical treatment and histological confirmation of encephalitis in a 35-year-old female patient with COVID-19. Given the increasing number of infections worldwide, they have raised awareness of the severe neurological manifestations of COVID-19 and reported that, as in their case, COVID-19-associated encephalitis can mimic glial neoplasm.

Morassi et al. (12) reported that SARS-CoV-2 infection caused ischemic stroke in four patients (67%) and acute stroke in two patients (33%).

Poyiadji et al. (13) reported the MRI findings of an adult female patient who developed acute necrotizing hemorrhagic encephalopathy associated with COVID-19.

Rajbhandari et al. (14) reported that cerebral sinus vein thrombosis may develop as a complication of COVID-19 infection in young patients.

In a study of paediatric patients with COVID-19 infection, Sun et al. (15) reported clinical conditions such as septic shock, multi-organ failure, intussusception, toxic encephalopathy, status epilepticus and disseminated intravascular coagulation as complications.

Although it has been reported in the literature that COVID-19 infection poses a minimal risk for the development of convulsions during acute illness in adult patients (3), it may cause different clinical conditions ranging from acute ischemic or hemorrhagic stroke to meningitis, encephalitis and acute necrotizing hemorrhagic encephalopathy spectrum (5,11–13). In the pediatric age group, clinical conditions such as status epilepticus have been reported without MRI confirmation (15,16). In the current study, COVID-19 infection was found to trigger the development of convulsions in children with a history of convulsions, and cause convulsions in completely healthy children. Although the brain MRIs of adult patients have shown pathologies caused by COVID-19 infection, no acute brain damage was observed on the MRIs of the pediatric cases in this study.

The most important limitation of current study that the population of patients was small. Another limitation was that the control MRI was not performed.

Conclusion

COVID-19 infection can trigger convulsions even in patients with epilepsy and taking anticonvulsant therapy and may cause convulsions in previously healthy cases. Unlike in the adult age group, COVID-19 infection was not found to have caused acute changes on the brain MRI findings in the pediatric age group who developed convulsions due to COVID-19 infection.

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Ethical Approval: *Approval was obtained from the Harran University Clinical Research Ethics Committee before the study (Date: 18.10.2021, session no: 18, decision no: 25).*

Author Contributions:

Concept: F.E.
Literature Review: F.E., M.Z.Y.
Design : F.E., M.Z.Y.
Data acquisition: F.E.
Analysis and interpretation: F.E.
Writing manuscript: F.E., M.Z.Y.
Critical revision of manuscript: F.E., M.Z.Y.

Conflict of Interest: *The authors have no conflicts of interest to declare.*

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