Am J Neurodegener Dis 2022;11(3):46-54
www.AJND.us /ISSN:2165-591X/AJND0144146

Original Article

Prevalence, clinical, imaging, electroencephalography and laboratory characteristics of seizures in COVID-19

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Received May 14, 2022; Accepted October 10, 2022; Epub October 15, 2022; Published October 30, 2022

Abstract: Background: COVID-19 is the cause of the recent pandemic. Viral infections could increase the risks of neurological impairments, including seizures. Here, we aimed to evaluate the prevalence, clinical, imaging, electroencephalography and laboratory characteristics of seizures in COVID-19. Methods: This retrospective cross-sectional study was performed on cases of COVID-19 infection and seizure. The prevalence of seizures in patients with COVID-19 was calculated using the incidence of seizures in all patients. The collected data were age, sex, history of previous illnesses, the severity of COVID-19 disease, patients' medications, hospitalization, and the presence of electrolyte disorders in patients' tests and other tests such as blood gas. Those patients with their first seizure episodes were also divided into two groups of cases with COVID-19 associated seizures (N=38) and non-COVID-19 associated seizures (N=37) and the mentioned data were compared between the two groups. Results: We assessed data of 60 patients with COVID-19-associated seizures (group 1), 40 patients with seizures not related to COVID-19 (group 2) and 60 patients with COVID-19 infection and no seizures (group 3). The prevalence of hypertension and diabetes mellitus were significantly higher in group 3 compared to group 1 (P=0.044 and P=0.009, respectively). Still, patients in group 1 had a higher prevalence of cerebrovascular accidents (CVA) compared to group 3 (P=0.008). The prevalence of abnormal EEG was significantly higher in cases with COVID-19 infection compared to the other group (P<0.001). Cases with their first seizure episode associated with COVID-19 had significantly higher creatinine levels (P=0.035), lower blood pH (P=0.023), lower blood HCO3 (P=0.001), higher ALT (P=0.004), higher blood urea nitrogen (BUN) (P=0.001), lower hemoglobin (Hb) (P=0.017), higher ESR (P=0.001), higher CRP (P<0.001) and higher mortality rates (P=0.004). Conclusion: Patients with COVID-19 infection and seizure have higher mortality rates and disturbed laboratory data.

Keywords: COVID-19, seizure, pandemic, epilepsy

Introduction

COVID-19 (Coronavirus or SARS-CoV-2) is responsible for the latest pandemic [1, 2]. Coronaviruses could cause different symptoms in patients, but the most critical complication of COVID-19 is respiratory failure and acute respiratory distress syndrome (ARDS) [3]. Recent studies show that COVID-19 has higher mortality and morbidity rates than other viruses in their family [4].

Symptoms of COVID-19 pneumonia at the onset of the disease include fever, cough and fatigue. At the same time, other symptoms such as sputum production, headache, diarrhea, indigestion and lymphopenia appear approximately five days after incubation [5-7]. The time frame from the onset of COVID-19 symptoms leading to possible death varies from 6 to 41 days, with an average of 14 days [8].

Seizures can occur in the form of changes in mental state, level of consciousness, and tonic and clonic movements [9]. The leading causes of seizures are high-degree fever, stroke, low blood sugar, specific drugs or narcotics, lack of sleep, and low blood pressure [10]. Focal seizures include loss or alteration of consciousness [11]. In this case, the person may stare at a point and not respond to their natural environment or perform repetitive movements [12, 13].

Based on the evidence, one of the complications of COVID-19 is seizures. Viral infections can cause or provoke seizures in various people, especially those prone to epilepsy [14]. In children, fever for any reason (such as viral infections) can cause seizures or irritation [15, 16]. Currently, there is no evidence that the coronavirus can specifically cause seizures or irritation in susceptible individuals, such as those with epilepsy; and seizures are not a standard and specific clinical sign of the virus [17]. Based on previous research, clinical manifestations of novel coronavirus induced seizures may not be different from regular seizures and these episodes could be controlled effectively [16]. There are various data on the prevalence rates of COVID-19 induced seizures. These rates have been reported from 5-25% [16, 17]. Individuals prone to seizures, such as patients with epilepsy, should take their medications regularly and take protective and preventive measures against the virus. It has also been suggested that seizures in the context of COVID-19 infection can be caused by factors such as hypoxia, acidosis, or electrolyte disturbances in the hospital [18]. However, various studies are underway on the effect of COVID-19 disease on neurological diseases such as seizures [19]. However, no similar research has been done in Isfahan, Iran.

Therefore, considering the importance of COVID-19 disease and the possible association of this disease with neurological disorders such as seizures, as well as the need for long-term studies on the possible complications of this disease, we decided to examine the prevalence and characteristics of imaging, electroencephalography and laboratory seizures related to COVID-19.

Methods and material

Study design

This is a retrospective cross-sectional study performed in 2020-2021 in Al-Zahra hospital affiliated with Isfahan University of Medical Sciences. The current study was conducted on 60 cases of COVID-19 infection admitted to our medical center between September 2020 and September 2021 that had a seizure during the hospitalization course. The Ethics code of this study was IR.MUI.MED.REC.1401.055, provided by the Isfahan University of Medical Sciences.

Inclusion and exclusion criteria

The inclusion criteria were age more than 18 years, admission due to COVID-19 infection, diagnosis based on positive PCR test or radiologic findings, seizure during hospitalization, complete medical records, availability of the patient, and informed consent. Patients with incomplete data or lack of consent were excluded.

We included 60 patients based on the mentioned criteria using the census method. We also had 40 hospitalized patients with seizures and no COVID-19 infection and 60 hospitalized patients with COVID-19 and no seizure as control groups. The control group was matched with the other groups regarding age, gender and other demographic data.

Patient file information was thoroughly reviewed and information collected. The prevalence of seizures in patients with COVID-19 was calculated using the incidence of seizures in all patients admitted from September 2020 to September 2021.

Data gathering

The collected data were age, sex, history of previous illnesses, the severity of COVID-19 disease, patients' medications, hospitalization and the presence of electrolyte disorders in patients' tests and other tests such as blood gas. The severity of COVID-19 was determined by evaluating patient's chest CT scans and using CT severity score. The CT severity score was evaluated as described by Aalinezhad and colleagues in 2021 as follows [20]: CT severity score was calculated according to the anatomical structure of the lung. We divided 18 segments into 20 separate areas so that the apicoposterior segment of the left upper lung was divided into the apical and posterior regions and the antromediobasal segment of the left lung was also divided into the anterior and basal regions. The radiologists examined the presence and spread of opacity in all 20 areas and scored each area as 0, 1, and 2 for 0%, below 50%, and above 50%, respectively. The final score was obtained from the sum of po-

ints in each of the 20 areas and was considered a CT severity score with a range of 0-40.

These data were collected from documents of patients with a history of seizures: gender, age, medical history, first seizures, previous treatments, previous AED number, focal Seizures, abnormal EEG, status seizure, abnormal MRI, MRI Abnormality Type, ICU admission, length of stay and lab data.

Those patients with their first seizure episodes were divided into two groups of cases COVID-19-associated seizures (N=38) and non-COVID-19-associated seizures (N=37). The mentioned data were compared between the two groups.

Follow-up data

Patients were followed up for one year after discharge, and the outcome of patients' seizures were collected. The results included repeating seizures (with complete information such as the time of occurrence and the distance from the first episode of seizures) or occurring only once during hospitalization.

Statistical analysis

The data were analyzed by SPSS software, version 24, Chicago, IL. The Pearson Chi-square test and the t-test were used. *P*-value <0.05 was considered as the significance threshold.

Results

Study population

In this study, we assessed data of 60 patients with COVID-19-associated seizures (group 1), 40 patients with seizures not related to COVID-19 (group 2), and 60 patients with COVID-19 infection and no seizures (group 3). The study population comprised 98 males (61.2%) and 62 females (38.8%).

Clinical data

We observed no significant differences between the patients regarding gender (P>0.05). But we found that patients in group 1 had higher age than group 2 (P=0.01). Analysis of patient's data showed that the prevalence of hypertension and diabetes mellitus was significantly higher in group 3 than in group 1 (P= 0.044 and P=0.009 respectively). Still, patients in group 1 had a higher prevalence of cerebrovascular accidents (CVA) compared to group 3 (P=0.008). The history of epilepsy was also higher in group 1 compared to group 2 (P=0.001). It was also observed that patients in group 2 mainly had their first seizure episode compared to group 1 (P=0.001). Prevalence of abnormal EEG and status seizures and requiring ICU admission were significantly higher in group 1 compared to group 2 (P=0.001, P= 0.018, and P=0.002, respectively).

Laboratory analysis

Patients in group 1 had a longer hospitalization duration significantly (compared to both groups), lower blood pH (compared to group 2), lower blood HCO3 (compared to both groups), higher white blood cell (WBC) count (compared to group 3), and lower ferritin levels (P<0.05) (compared to group 3). Levels of lactate dehydrogenase (LDH), erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were significantly highest in group 3 and lowest in group 2 (P<0.05). No other differences were observed between the groups. These data are shown in **Table 1**.

Patients with first seizure

We also compared data of patients who had their first seizure episodes with (N=38) or without (N=37) COVID-19 infection. These data showed that the prevalence of abnormal EEG was significantly higher in cases with COVID-19 infection compared to the other group (P< 0.001). Furthermore, it was observed that cases with their first seizure episode associated with COVID-19 had significantly higher creatinine levels (P=0.035), lower blood pH (P= 0.023), lower blood HCO3 (P=0.001), higher ALT (P=0.004), higher blood urea nitrogen (BUN) (P=0.001), lower calcium levels (P< 0.001), higher potassium (K) levels (P=0.022), lower hemoglobin (Hb) (P=0.017), higher ESR (P=0.001), higher CRP (P<0.001) and higher mortality rates (P=0.004) (**Table 2**).

Discussion

This study aimed to determine the prevalence, clinical, imaging, electroencephalography and laboratory characteristics of seizures in patients with COVID-19. By evaluating data of 150 patients with seizures with or without COVID-19

Table 1. Comparison of demographic and laboratory data between patients

		Covid-19 Associated Seizures (Group 1) (N=60)	None Covid-19 related seizures (Group 2) (N=40)	Covid-19 without seizures (Group 3) (n=60)	*P*-value Group 1&2	*P*-value Group 1&3
Gender	Female	40% (24)	35% (14)	40% (24)	0.614	1.00
	Male	60% (36)	65% (26)	60% (36)		
Age		60.51±20.56	49.47±20.88	63.91±14.18	0.010	0.294
Past medical History	HTN	38.3% (23)	30% (12)	56.7% (34)	0.442	0.044
	DM	28.3% (17)	22.5% (9)	51.7% (31)	0.515	0.009
	CVA	18.3% (11)	12.5% (5)	3.3% (2)	0.436	0.008
	IHD	15% (9)	5% (2)	25% (15)	0.117	0.171
	HLP	8.3% (5)	10% (4)	10% (6)	0.775	0.752
	Hypothyroidism	6.7% (4)	7.5% (3)	11.7% (7)	0.846	0.343
	CKD	10% (6)	2.5% (1)	17.5% (10)	0.150	0.235
	Cancer	5% (3)	2.5% (1)	3.3% (2)	0.548	0.648
	Psychiatric Disease	13.3% (8)	5% (2)	-	0.174	-
	Brain tumor	6.7% (4)	10% (4)	-	0.547	-
	Developmental delay	5% (3)	0.0% (0)	-	0.162	-
	Epilepsy	35% (21)	7.5% (3)	-	0.001	-
First seizures		63.3% (38)	92.5% (37)	-	0.001	-
Previous treatment	Lacosamaide	0.0% (0)	0.0% (0)	-	-	-
	Phenytoin	3.3% (2)	2.5% (1)	-	0.800	-
	Phenobarbital	1.7% (1)	0.0% (0)	-	0.408	-
	Depakin	15% (9)	5% (2)	-	0.111	-
	Levebel	5% (3)	2.5% (1)	-	0.522	-
	Carbamazepin	1.7% (1)	0.0% (0)	-	0.408	-
	Lamotrigine	0.0% (0)	0.0% (0)	-	-	-
Previous AED number	0	76.7% (46)	92.5% (37)	-	0.235	-
	one	16.7% (10)	7.5% (3)	-		
	two	3.3% (2)	0.0% (0)	-		
	three	1.7% (3)	0.0.% (0)	-		
Focal Seizures		38.3% (23)	40% (16)	-	0.963	-
Abnormal EEG		45% (27)	25% (10)	-	0.001	-
Status		46.7% (28)	27% (11)	-	0.018	-
Abnormal MRI		23.3% (14)	20% (8)	-	0.661	-

MRI Abnormality Type	Acute Cortical Ischemic stroke	8.3% (5)	2.5% (1)	-	0.087	-
	Unknown lesion	0.0% (0)	2.5% (1)	-		
	Post-surgical change	1.7% (1)	7.5% (3)	-		
	CVT	0.0% (0)	2.5% (1)	-		
	MTS	0.0% (0)	5% (2)	-		
	Meningio-encephalitis	1.7% (1)	0.0% (0)	-		
	Cortical old infarction	5% (3)	0.0% (0)	-		
	SOL	3.3% (2)	0.0% (0)	-		
	Cortical Glial change	1.7% (1)	0.0% (0)	-		
	Cortical Cavernoma	1.7% (1)	0.0% (0)	-		
ICU admission		26.7% (16)	2.5% (1)	-	0.002	-
Length of Stay		10.67±13.01	3.65±2.44	6.85±4.64	0.001	0.034
Lab Data	BS mg/dL	140.81±62.04	142.00±78.11	177.61±102.16	0.933	0.020
	Cr mg/dL	1.30±0.74	1.14±0.32	1.68±1.57	0.201	0.104
	PH1	7.30±0.16	7.37±0.50	7.29±0.05	0.023	0.568
	Pco2 mmHg	40.91±12.35	39.23±8.017	39.91±12.60	0.496	0.664
	Hco3 mEq/L	20.29±5.78	23.23±4.21	25.07±10.18	0.014	0.002
	ALT U/L	50.31±52.60	24.98±19.51	51.43±50.74	0.008	0.906
	AST U/L	54.50±62.95	40.36±51.20	63.85±73.13	0.266	0.462
	BUN mg/dL	21.35±12.40	16.16±5.56	23.53±18.28	0.015	0.452
	Ca mg/dL	8.57±0.75	9.54±0.59	8.68±0.64	0.000	0.434
	CPK units/L	595.60±1597.95	556.71±1519.78	493.29±1355.31	0.916	0.718
	Ph mg/dL	3.23±0.88	3.22±0.92	3.23±1.06	0.972	0.973
	LDH U/L	700.64±298.88	661.46±464.60	928.25±546.90	0.646	0.008
	Mg Mg	1.97±0.33	2.04±0.19	2.01±0.25	0.405	0.444
	K mEq/L	4.52±0.66	4.23±0.44	4.71±0.52	0.015	0.088
	Na mEq/L	139.47±3.80	140.35±4.55	139.41±4.62	0.300	0.941
	WBC thousands per cubic milliliter	10262.88±5823.17	8422.50±2719.58	6933.89±3463.43	0.065	0.000
	Hgb g/dL	12.49±2.15	13.86±2.17	12.95±2.12	0.002	0.243
	PLT per microliter	197491.52±89661.50	213325.00±57109.15	188322.03±65726.82	0.325	0.528
	ESR mm/h	42.33±28.48	13.47±17.52	53.62±25.44	0.000	0.026
	CRP mg/L	46.04±41.320	10.09±15.79	88.15±43.97	0.000	0.000
	D-dimer μg/mL	2902.73±5726.24	2483.75±3038.59	1468.33±1539.43	0.886	0.064
	ferritin ng/mL	433.40±560.471	-	747.04±523.12	-	0.029
Seizures Free after 3 month		1.7% (1)	12.5% (5)	-	0.064	-
Mortality	In hospital	15% (9)	0.0% (0)	-	0.011	-
	Out hospital	5% (3)	2.5% (1)	-	0.548	-
	Total	20% (12)	2.5% (1)	15% (9)	0.011	0.471

-: missed data, HTN: hypertension, DM: diabetes mellitus, CVA: cerebrovascular disease, IHD: ischemic heart disease, HLP: hyperlipidemia, CKD: chronic kidney disease, AED: antiepileptic drugs, EEG: electroencephalogram, MRI: magnetic resonance imaging, CVT: Cerebral venous thrombosis, MTS: Mesial Temporal Sclerosis, SOL: space-occupying lesion, BS: blood sugar, Cr: creatinine, ALT: Alanine transaminase, AST: aspartate aminotransferase, BUN: blood urea nitrogen, CPK: Creatine Phosphokinase, ph: phosphorus, LDH: lactate dehydrogenase, Hg: magnesium, k: potassium, Na: sodium, WBC: white blood cell, Hgb: hemoglobin, PLT: platelet, ESR: erythrocyte sedimentation rate, CRP: C-reactive protein.

Table 2. Comparison of data between patients with first seizure

		Covid-19 Associated Seizures (Group 1) (N=38)	None Covid-19 related seizures (Group 2) (N=37)	*P*-value
Gender	Female	34.2% (13)	35.1% (13)	0.993
	Male	65.8% (25)	64.9% (24)	
Age		63.07±19.26	49.27±21.08	0.004
Focal Seizures		36.8% (14)	40.5% (15)	0.734
Abnormal EEG		52.6% (20)	21.6% (8)	0.000
Status		44.7% (17)	27% (10)	0.059
Abnormal MRI		23.7% (9)	18.9% (7)	0.615
MRI Abnormality Type	Acute Cortical Ischemic stroke	7.9% (3)	2.7% (1)	0.113
	Unknown lesion	0.0% (0)	2.7% (1)	
	Post-surgical change	0.0 (0)	8.1% (3)	
	CVT	0.0% (0)	2.7% (1)	
	MTS	0.0% (0)	2.7% (1)	
	Meningio-encephalitis	2.6% (1)	0.0% (0)	
	Cortical old infarction	7.9% (3)	0.0% (0)	
	SOL	0.0% (0)	0.0% (0)	
	Cortical Glial change	2.6% (1)	0.0% (0)	
	Cortical Cavernoma	2.6% (1)	0.0% (0)	
Lab Data	BS mg/dL	144.54±57.17	143.43±80.92	0.946
	Cr mg/dL	1.46±0.80	1.15±0.33	0.035
	PH1	7.29±0.19	7.37±0.04	0.023
	PCO2 mmHg	39.38±13.17	39.19±8.15	0.944
	HCO3 mEq/L	19.16±5.51	23.40±4.17	0.001
	ALT U/L	58.07±59.90	25.37±20.03	0.004
	AST U/L	65.24±75.33	41.05±52.69	0.129
	BUN mg/dL	24.00±13.38	15.90±5.30	0.001
	Ca mg/dL	8.53±0.73	9.56±0.60	0.000
	CPK units/L	848.12±2017.74	583.76±1575.95	0.589
	Ph mg/dL	3.26±0.96	3.21±0.91	0.850
	LDH U/L	783.81±320.17	664.84±481.64	0.265
	Mg Mg	1.98±0.31	2.07±0.14	0.272
	K mEq/L	4.53±0.69	4.21±0.42	0.022
	Na mEq/L	139.57±3.60	140.11±4.56	0.579
	WBC thousands per cubic milliliter	10713.42±6681.03	8418.91±2739.20	0.057
	Hgb g/dL	12.66±2.19	13.89±2.18	0.017
	PLT per microliter	182631.57±93413.18	211324.32±55994.07	0.112
	ESR mm/h	40.16±30.90	14.14±18.23	0.001
	CRP mg/L	49.91±42.86	10.46±16.00	0.000
	D-dimer μg/mL	3449.45±7061.68	2981.33±3516.25	0.911
Seizures Free after 3 month		2.6% (1)	13.5% (5)	0.148
Mortality	In hospital	21.1% (8)	0.0% (0)	0.004
	Out hospital	2.6% (1)	2.7% (1)	0.969
	Total	23.7% (9)	2.7% (1)	0.008

-: missed data, HTN: hypertension, DM: diabetes mellitus, CVA: cerebrovascular disease, IHD: ischemic heart disease, HLP: hyperlipidemia, CKD: chronic kidney disease, AED: antiepileptic drugs, EEG: electroencephalogram, MRI: magnetic resonance imaging, CVT: Cerebral venous thrombosis, MTS: Mesial Temporal Sclerosis, SOL: space-occupying lesion, BS: blood sugar, Cr: creatinine, ALT: Alanine transaminase, AST: aspartate aminotransferase, BUN: blood urea nitrogen, CPK: Creatine Phosphokinase, ph: phosphorus, LDH: lactate dehydrogenase, Hg: magnesium, k: potassium, Na: sodium, WBC: white blood cell, Hgb: hemoglobin, PLT: platelet, ESR: erythrocyte sedimentation rate, CRP: C-reactive protein.

infection and comparing their data with COVID-19 infected cases without a seizure, we observed that CVA and history of seizure, abnormal EEG, status seizures and requiring ICU admission were significantly more common in patients with COVID-19 induced seizers compared to other patients.

A comparison of laboratory data also revealed that cases with a seizure during COVID-19 infection had lower blood pH, lower blood HCO3, higher WBC, and lower ferritin levels compared to other patients. It was also indicated that in cases with their first seizure episode, those cases with COVID-19 had a higher prevalence

of abnormal EEG, higher creatinine levels, lower blood pH, lower blood HCO3, higher ALT, higher BUN, lower calcium, higher potassium, lower Hb, higher ESR, higher CRP, and higher mortality rates.

We also found that patients in the first group had higher ages compared to group 2. This issue could be explained by more frequent and broader laboratory and metabolic disturbances in patients with COVID-19 [21], and these disturbances are more frequently observed in older patients.

Frequencies of CVA were significantly higher in patients with COVID-19 infection and seizure compared to patients with COVID-19 disease and no seizure. CVA is considered a risk factor for seizure [22], so this issue could be justified.

It should be mentioned that the occurrence of seizures depends on various factors that could be divided into two groups of provoked and non-provoked seizures. Provoked seizures occur due to physical causes. These are single seizures that may result from trauma, low blood sugar (hypoglycemia), low blood sodium, high fever, or alcohol or drug abuse. An important point regarding the relationships between COVID-19 and seizure is that COVID-19 disease causes significant disturbance in various metabolites. COVID-19 infection is not associated with direct or indirect brain lesions.

Frequencies of status seizures were also higher in patients with COVID-19 and seizures could be a sign of more severe condition in patients. Therefore, it could be considered that patients with COVID-19 could suffer brain damage.

Various differences in laboratory data between groups could be due to COVID-19 infection and body inflammatory responses. Furthermore, blood sugar was lower in patients with COVID-19 and seizures. Low blood sugar could also trigger seizures. Along with these data, it should be mentioned that brain MRI and the presence of focal seizures were not significantly different between patients. These could be considered another reason that COVID-19 infection is associated with provoked seizures, mostly due to non-structural causes.

Another significant point in this study was significant differences between groups 1 and 2 regarding first seizure and epilepsy. This issue is because parents with epilepsy refer primarily to outpatient clinics, but patients with their first seizure episode refer mostly to the hospitals.

We also observed no significant differences between patients regarding seizure-free prognosis after three months. However, patients with COVID-19 associated seizures had higher mortality rates than other group, which could be due to higher age and more disturbed laboratory data.

All these data show a worse course of hospitalization and outcomes in patients with COVID-19 infection and seizure. Previous studies have also evaluated possible relationships between COVID-19 and seizures. It has been indicated that hypoxia, acidosis, or electrolyte disturbances in the hospital are the main causes of seizures in these patients. In a study by Narula and colleagues in 2020, they showed that infections with COVID-19 could significantly increase the chances of seizures and patients with previous histories of epilepsy are more prone to this condition [23]. We showed that patients with seizures and COVID-19 had more disturbed laboratory data than other cases and higher mortality rates.

Another point was that we evaluated data from cases with their first seizure episodes. In the present study, we observed that the patients with COVID-19 and seizures had higher mortality rates compared to other patients. Data have evaluated seizures as presenting manifestation of COVID-19. A study by Keshavarzi and others showed that seizures are among the presenting manifestations of COVID-19 in 0.8% of the patients who are admitted to the hospital due to a severe illness [24]. Therefore, special attention should be given to similar cases, especially due to their higher mortality rates.

A critical point of this study was disturbing laboratory data in COVID-19-infected patients with seizures. Kincaid and colleagues also reported that these cases could have rapidly deteriorating disease and more disturbed laboratory data than others [25]. Similar studies have also highlighted the course of seizures during hospitalizations due to COVID-19 [26, 27].

The limitations of this study were restricted study population and conducting it in a single

center. It is believed that multicentric studies on larger populations could reveal further data. We recommend that special care should be given to patients with COVID-19 regarding the development of neurological signs and prompt neurological consultations should be conducted in COVID-19 infected cases with histories of seizures. This study was conducted on patients' medical documents and our research team could not extract further detailed data. This issue could be considered as another limitation of our study. However, we believe that our research provides valuable data for neurologists. It is not yet apparent if COVID-19 increases the risks of seizure but this study, along with previous reports, highlights the importance of neurological care in infected cases, especially with disturbed laboratory data.

Conclusion

Patients with COVID-19 infection and seizure have higher mortality rates and disturbed laboratory data. In this study, it was indicated that most of the cases were symptomatic and had provoked seizures. Although there were no significant differences regarding seizure-free prognosis, patients with COVID-19-associated seizures had higher mortality rates than the other patients. It is believed that multicentric studies on larger populations could reveal further data.

Disclosure of conflict of interest

None.

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