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Clinical impact of COVID-19 on Turkish children with neurological and neuromuscular diseases

One center experience

Dicle Sener Okur, MD*

Abstract

This study aims to explore the effects of new type of coronavirus disease (COVID-19) in children with neurological and/or neuromuscular diseases

A retrospective study was conducted at State Hospital of Denizli. Pediatric patients diagnosed with COVID-19 who were hospitalized between March 18, 2020 and January 18, 2021 were included in the study. Children were divided into two groups: those with (group I) and without neurological and /or neuromuscular disorders (group II).

Male cases were more than female cases in group I. The difference between group I and group II was significant in terms of seizure (47.3%; 1.7%), dyspnea (36.8%, 6.2%) and number of days with fever (2.6 ± 1.9; 1.58 ± 1.42) ($P < .01$, $P < .01$, $P = .02$). Hypoxemia (7, 11; 36.8%, 4.5%) and abnormal auscultation findings (8, 44; 42.1%, 18.1%) were more common in children in group I, hypertension was more common in group II (0, 8; 0%, 3.3%). Lung involvement of COVID-19 was found to be more severe in group I ($P = .04$). The frequency of hospitalization in the intensive care unit ($P < .01$) and application of noninvasive mechanical ventilation (NIMV) ($P < .01$); the number of days followed-up in the intensive care ($P < .01$) and in the hospital ($P = .02$) of the patients in group I were higher than those in group II.

It is recognized that children with underlying neurological and/or neuromuscular diseases are severely affected by COVID-19.

Abbreviations: COVID-19 = new type of coronavirus disease, CT = computed tomography CT, IVIG = Intravenous immunglobuline, LMWH = low molecular weight heparin, NIMV = noninvasive mechanical ventilation, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

Keywords: cerebral palsy, children, COVID-19, epilepsy, neuromuscular diseases

1. Introduction

The new type of coronavirus disease (COVID-19), for which the causative agent is "Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)," emerged in Wuhan, China, late 2019 and had an impact all over the world.[1,2] The World Health Organization has described the outbreak on January 30, 2020 as a "Public Health Emergency of International Concern."[1–3] The first case in Turkey was seen by March 11, 2020, and the outbreak was declared a global pandemic.[1–4]

The respiratory system is the primary involvement site of the infection. However, SARS-CoV-2 affects other organs, especially those with high expression of the Angiotensin-converting enzyme 2 receptor as well.[5] Clinical features of SARS-CoV-2 are ranging from asymptomatic infection to fever and dry cough to multi-organ failure and death.[6,7] Mortality rate is higher in older people with comorbidities such as hypertension, diabetes, lung, and cardiac disease.[8]

The first child patient with SARS-CoV-2 infection was seen on January 20, 2020 in Shenzhen. Thereafter, pediatric cases and case series were reported. Although it has spread all over the world, clinical features of COVID-19 are still not clear in pediatric patients.[9] It has been reported that 1% of adolescents and 1% of children under 10 years old in China are affected.[10] From surveillance in Turkey, COVID-19 cases have been reported as mild (50.4%) and as severe (0.8%) in pediatric patients.[11] Preschool children and infants were more likely to have severe clinical pictures as reported from China.[9,10] Especially children with lung disease (asthma), cardiovascular diseases, immunosuppression (children who have undergone cancer-related chemotherapy, radiation therapy, hemapoietic cell or solid organ transplantation and received high dose cortisone), blood disease, chronic kidney disease, chronic liver disease, diabetes mellitus, neurological and neurodevelopmental disorders (cerebral palsy,

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Department of Pediatrics, Division of Pediatric Infectious Diseases, State Hospital of Denizli, Pamukkale, Denizli, Turkey.

** Correspondence: Dicle Sener Okur, Department of Pediatrics, Division of Pediatric Infectious Diseases, State Hospital of Denizli, Pamukkale University Faculty of Medicine Department of Pediatrics Division of Pediatric Infectious Diseases, 20180, Pamukkale, Denizli, Turkey (e-mail: diclesen71@yahoo.com).*

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epilepsy, intellectual disability, spinal cord injuries), neuromuscular diseases, and cases under 1 year of age have been reported to be more severe.[11,12]

There are reported cases of SARS-CoV-2 infection in which patients developed neurologic symptoms such as anosmia, headache, encephalopathy, stroke, seizures, epilepsy and confusion, myopathy and rhabdomyolysis, and even total paralysis.[6,13,15] The inflammatory and immune responses to SARS-CoV-2 result in immune system changes, enhancing lung injury and central nervous system complications. Importantly, patients hospitalized with COVID-19 and concurrent neurological problems have a higher risk of dying than other patients.[14] About 20% of patients admitted to the intensive care unit for COVID-19 reported neurological issues, and those with neurological problems have a higher mortality rate than other patients.[14] Although there are reports that COVID-19 affects neurological and neuromuscular systems, data on how it affects children with neurological and neuromuscular disorders such as cerebral palsy is limited.

State Hospital of Denizli has become the biggest health center for children in our city since the beginning of COVID-19 pandemic. In our study; pediatric patients who were followed up for neurological and neuromuscular disorders and hospitalized for COVID-19 were examined. This study aims to explore the effects of COVID-19 in children with neurological and neuromuscular disorders. The results of the study should contribute to the regulation of follow-up and treatment strategies of these patients during the pandemic.

2. Material and methods

2.1. Data collection

A retrospective study was conducted at State Hospital of Denizli, Department of Pediatric Infectious Disease, which was designated as the pandemic hospital of Denizli for children. Children were diagnosed COVID-19 according to the guideline developed by Turkish Republic Ministry of Health.[16] Diagnosis was done by detecting SARS-CoV-2 by polymerase chain reaction method in samples taken from the nasopharynx and oropharynx of children. Pediatric patients diagnosed with COVID-19 who were hospitalized between March 18, 2020 and January 18, 2021 were included in the study. Patients' information was obtained from their epicrisis and patient hospital files. Children were divided into two groups: those with (group I) and without neurological and /or neuromuscular disorders (group II). The demographic information of the two groups, sources of COVID-19 transmission, duration of symptoms before admission to the hospital, clinical and laboratory findings, treatments, length of stay in hospital and intensive care unit, and prognoses were compared.

Consent from the patient and from their parents to participate in the study was obtained at the time of their hospitalization. Before starting the study, approval of the health ethics committee (Ethical Committee of Pamukkale University Faculty of Medicine, date of approval 02/03/2021 and 05 approval number), the permission of the Ministry of Health and the chief physician of the hospital were obtained.

2.2. Statistical analysis

For the statistical analysis, Statistical Package for the Social Sciences 23.0 software (IBM SPSS Statistics, IBM Corporation) was used. For statistical analyses, the Chi-Squared test, Student t test, and Mann–Whitney U test were used; $P < .05$ was considered statistically significant.

3. Results

During the study period, 262 children were hospitalized with diagnosis of COVID-19 in State Hospital of Denizli. Nineteen of these children were being followed up by pediatric neurology due to neurological and/or neuromuscular disorders.

There was no difference between group I and group II in terms of demographic characteristics other than gender (Table 1). In the analysis of the age distributions, most patients in group I were in the age range of 4 to 12 years (n: 9, 47.4%), whereas most patients in group II were 4 years and older (n:151, 62.2%), especially above 12 years of age (n: 92, 37.9%). In addition, in Group II, the numbers of patients in the first 2 years of age (n: 79, 32.5%) and above 15 years of age (n: 61, 25.1%) (Table 2, Fig. 1) were the highest.

Male cases were more than female cases in group I; however female cases were more than male cases in the other group ($P < .001$) (Table 1)

Table 1

Demographic characteristics and house-hold contact.

		Group I		Group II		
		mean ± SD	Median (min–max)	mean ± SD	Median (min–max)	*P*
Age		97.21 ± 60.67	102 (2–201)	100.09 ± 76.95	110 (1–214)	.84
		n	%	n	%	
Sex	Male	17	89.5	113	46.5	<.001
	Female	2	10.5	130	53.5	
Region of city they live	City center	17	89.5	187	75.3	.12
	Town	2	10.5	37	15.2	
	Village	0	0	23	9.5	
Immigration	Immigrant	1	5.3	9	3.7	.53
	Non-immigrant	18	94.7	234	96.3	
House-hold contact	Yes	13	68.4	198	81.5	.22
	No	6	31.6	45	18.5	
Period of pandemic	First half	4	21.1	109	44.9	.04
	Second half	15	78.9	134	55.1	

Table 2

Age group distribution of children.

		Age groups (months of age)					
		≤24	24–48	≥48–144	≥144–180	≥180	Total
Group I	n	2	3	**9**	3	2	19
	%	10.5	15.8	**47.4**	15.8	10.5	100
Group II	n	**79**	13	59	31	**61**	243
	%	**32.5**	5.3	24.3	12.8	**25.1**	100
Total	n	81	16	68	34	63	262
	%	30.9	6.1	26	13	24	100

3.1. Demographic characteristics and house-hold contact

3.1.1. Age group distribution of children. It was found that the virus was transmitted to the children in both groups mostly from an individual in the home (13 vs 198; 68.4%, 81.5%). The source of the virus could not be found in (n:6) 31.6% of the children in group I and (n:45) 18.5% of children in group II. In addition, it was learned that (n:10) 52.6% of the patients in group I went to a health institution for a control mean 4, 40 ± 0.97 days before their symptoms started. Majority of children in group I (n:15, 78.9%) hospitalized at the second half of the pandemic in Turkey, however this difference was not observed in group II ($P = .04$). In group II the numbers of children hospitalized in both periods were almost similar (109 vs 134; 44.9% vs 55.1%) (Table 1).

When the symptoms of the groups were compared, there was no difference between group I and group II in terms of presence of symptoms (18 vs 208; 94.7% vs 85.6%) ($P = .27$). It was found that the patients in group I mostly presented complaints of fever (n: 17, 89.5%), cough (n:10, 52.6%), dyspnea (n:7, 36.8%), seizure (n:9, 47.4%), myalgia (n:3, 15.8%), diarrhea (n:3, 15.8%), and vomiting (n:3, 15.8%), and those in group II presented with fever (n:71, 71.2%), cough (n:88, 36.2%), myalgia (n:46, 18.9%), and diarrhea (n:30, 12.3%). Although there were no significant between-group difference in terms of fever ($P = .09$), cough ($P = .15$), myalgia ($P = 1.00$), diarrhea ($P = .71$), vomiting ($P = .42$), the difference between groups were significant in terms of seizure ($P < .01$), dyspnea ($P < .01$). In addition, number of days with fever was significantly different between groups. The number of days with fever of group I was 2.6 ± 1.95 days and the number of days with fever of group II was 1.58 ± 1.42 days ($P = .02$) (Table 3).

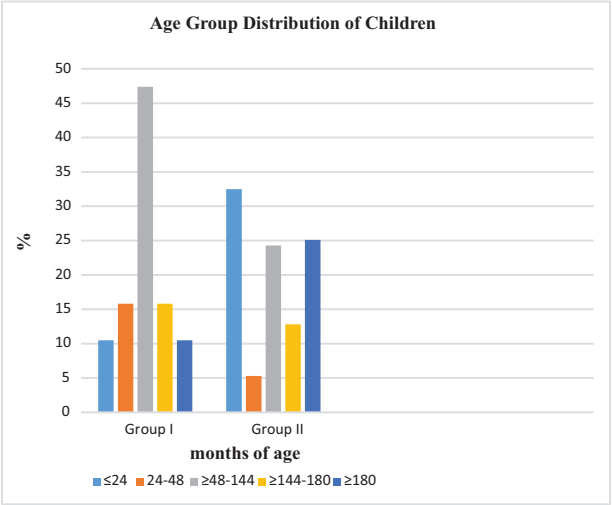

Figure 1. Age group distribution of children.

3.1.2. Symptoms and physical examination findings. When the physical examination findings were investigated, there was no difference between 2 groups in terms of weight ($P = .53$), height ($P = .58$), body temperature ($P = .98$), wheezing ($P = .15$), conjunctival hyperemia ($P = .41$), abdominal tenderness ($P = 1.00$). However; partial oxygen saturation with pulse oximeter ($P < .01$), blood pressure values ($P = .03$), auscultation sounds ($P = .01$) were significantly different between groups. Although weight and height values of groups did not differ, when we grouped children as underweight, normal weight and overweight, the difference between group I and group II was significant ($P = .02$) (Table 3).

In group I 7 (36.8%) of the children were hypoxemic on first admission to our hospital, however only 11 (4.5%) of the children in group II were hypoxemic on first admission ($P < .01$). None of the children in group I were hypertensive; in addition 2 (10.5%) of them were hypotensive. On the contrary none of the children in group II were hypotensive, and 8 (3.3%) of them were hypertensive ($P = .01$). With auscultation breathing sounds were abnormal in 8 (42.1%) of the children in group I and 44 (18.1%) of the children in group II ($P = .01$) (Table 3).

When the laboratory findings were examined, blood lymphocyte count ($P = .01$), serum albumin ($P < .01$) and serum total protein ($P = .01$) values of patients in group I were lower; and serum crp ($P = .01$), creatinin kinase ($P = .05$) values of patients in group I were higher than patients in group II, but there was no significant difference between the two groups in terms of other parameters (Table 4).

3.1.3. Laboratory findings and radiographic features. When chest radiographs were evaluated, lung involvement of COVID-19 was found to be more frequent and more severe in group I ($P = .04$), however there was no significant difference between groups when thorax computed tomography (CT) images evaluated ($P = .54$) (Table 4).

In group I, 10 (52.6%) of the patients were first hospitalized in intensive care unit, 6 (60%) of them were applied noninvazive mechanical ventilation (NIMV) and in group II 10 (4.1%) of patients were hospitalized in intensive care unit, 3 (30%) of them were applied NIMV ($P < .01$, $P < .01$). The mean number of days the patients in group I followed-up in the intensive care unit was 4.58 ± 6.07 days, and the patients in group II followed-up in the intensive care unit was 0,13 ± 0,84 days, the difference between groups were significant ($P < .01$). The length of stay of the patients in group I in the hospital was 8.21 ± 4.37 days, and of the patients in group II was 5.69 ± 2.42 days, the difference between groups was statistically significant ($P = .02$) (Table 5).

Table 3

Symptoms and physical examination findings.

		Group I		Group II		
		n	%	n	%	*P*
Symptom	Yes	18	94.7	208	85.6	.48
	No	1	5.3	35	14.4	
Fever	Yes	17	89.5	173	71.2	.86
	No	2	10.5	70	28.8	
Cough	Yes	10	52.6	88	36.2	.15
	No	9	47.4	155	63.8	
Myalgia	Yes	3	15.8	46	18.9	1.00
	No	16	84.2	197	81.1	
Diarrhea	Yes	3	15.8	30	12.3	.71
	No	16	84.2	213	87.7	
Dyspnea	Yes	7	36.8	15	6.2	<.001
	No	12	63.2	228	93.8	
Seizure	Yes	9	47.4	4	1.6	<.001
	No	10	52.6	239	98.4	
Duration of fever (day)	mean	2.63 ± 1.95		1.58 ± 1.42		.02
	median	2 (0–7)		1 (0–7)		
Saturation	Hypoxemic	7	36.8	11	4.5	<.001
	Not hpoxemic	12	63.2	232	95.5	
Blood pressure	Hypotension	2	10.5	0	0	.003
	Normotension	17	89.5	238	96.7	
	Hypertension	0	0	8	3.3	
Auscultation sounds	Normal	11	57.9	199	81.9	.006
	Abnormal	8	42.1	44	18.1	

3.1.4. Treatment and follow-up of patients. All of the patients in group I were given systemic antibiotics, 7 (36.8%) systemic steroid, 7 (36.8%) low molecular weight heparin (LMWH), 9 (47.4%) antiviral, 5 (26.3%) intravenous immunglobuline (IVIG). In group II; 209 (86%) of the patients were given systemic antibiotics, 13 (5.4%) systemic steroid, 7 (2.9%) LMWH, 52 (21.4%) antiviral, 2 (0.8%) IVIG (Table 4). Systemic steroid, LMWH, antiviral, IVIG usage were significantly different between 2 groups ($P < .01$, $P < .01$, $P = .02$, $P < .01$) (Table 5).

None of the patients in both group died, one of the patients in group I followed-up with mechanical ventilation, and referred to a tertiary education and research hospital for extracorporeal membrane oxygenation.

4. Discussion

Based on published literature and as far as we can determine, our study is one of the limited studies examining the course of COVID-19 in children with neurological and neuromusculer diseases in our country and globally.

In our study; male cases were more than female cases in group I; however female cases were more than male cases in the other

Table 4

Laboratory findings and radiographic features.

	Group I		Group II		
	Mean	Median	Mean	Median	*P*
Lymphocyte count(/mm^3)	1896.84 ± 1642.52	1500 (300–7100)	3165.48 ± 2288.86	2500 (450–12400)	.001
CRP* (mg/dL)	41.99 ± 63.9	8.6 (1–214)	11.64 ± 29.92	1 (1–241)	.01
Serum total protein	5.32 ± 2.08	5.4 (0.11–8)	7.04 ± 0.73	7.1 (4.9–8.5)	.002
Serum albumin	3.13 ± 1.15	3.3 (0.01- 4.3)	4.44 ± 0.36	4.5 (3.5–5.2)	<.001
Creatinin kinase (U/L)	11084.94 ± 35392.52	104 (8–142507)	98.67 ± 91.5	79 (5.1–969)	.04

		Group I		Group II		
		n	%	n	%	*P*
X-ray	Normal	12	63.2	190	78.2	.04
	Mild	0	0	6	2.5	
	Severe	7	36.8	47	19.3	
CT**	No CT	7	36.8	136	56	.262
	COVID-19	5	26.4	40	16.5	
	Other than COVID-19	7	36.8	67	27.5	

* CRP: C reactive protein.
** CT: Computed tomography.

Table 5

Treatment and follow-up of patients.

	Group I		Group II		
	n	%	n	%	*P*
ICU* admission	10	52.6	10	4.1	<.001
NIMV**	6	31.6	3	1.2	<.001
Antiviral (favipravir)	9	47.4	52	21.4	.02
Systemic streoid	7	36.8	13	5.4	<.001
IVIG***	5	26.3	2	0.8	<.001
LMAH****	7	36.8	7	2.9	<.001
	Mean	Median	Mean	Median	
No days in NICU	4.58 ± 6.07	2 (0–15)	0.13 ± 0.84	0 (0–9)	<.001
No days in hospital	8.21 ± 4,37	8 (2–16)	5.69 ± 2.42	6 (1–14)	.02

* ICU: intensive care unit.
** NIMV: noninvazive mechanical ventilation.
*** IVIG: intravenous immunglobulin.
**** LMWH: low molecular weight heparin.

group ($P < .01$). In studies conducted in our country and around the world, it has been reported that the number of male cases is higher than that of girls, and this data is supported by the data of our patients in group I.[17–21] However, pediatric patients without underlying neurodevelopmental and neuromuscular diseases did not support this data. This difference may be due to the fact that the gender of the patients was not examined according to their comorbidities in other studies or the number of patients with comorbidities was higher than our study.

Although there was no statistical difference between the 2 groups in terms of mean and median values of age ($P = .85$) when the age distributions were examined, it was found that the majority of the patients in group I were between the ages of 4 to 12, and in group II, the majority of them were 4 years and older, especially above 12 years of age. In addition, it was determined that the number of patients in Group II peaked in the first 2 years of age and above 15 years of age. In the literature, it is reported that the majority of patients in the pediatric age group are over 5 years old. Although the reported literature information in terms of age distribution is supported by group I, the same is not quite right for group II.[17,19,21] The peak of the number of patients over the age of 15 in Group II may be due to the excessive social activity of children in this age group and the increase in this activity with the closure of schools. Another reason may be that there were false opinions in the society, especially among adolescents, that the disease does not affect young people.

Although it was not statistically significant in our study, the household contact of the patients in group II was slightly higher than those in group I ($P = .22$). Another important point is that the source of the virus could not be found in 36% of the children in group I and 18.5% of children in group II. In addition, it was learned that 52.6% (n:10) of the patients in group I went to a health institution for a control mean 4.40 ± 0.97 days before their symptoms started. There was no health institution admission history in group II. As in the literature, in our study, it was determined that household contact is the most important factor in terms of virus transmission in children.[17–21] However, it is noteworthy that in patients with chronic diseases such as neurological or muscular diseases, health institutions can also be a source for transmission. The majority of children in group I (4 vs 15; 78.9% vs 21.1%) hospitalized at the second half of pandemic in Turkey, however this difference was not observed in group II (109 vs 134; 44.9% vs 55.1%) ($P = .04$). Since only emergency health services are provided within the scope of quarantine measures taken at the first peak of the pandemic in our country, patients in group I may not be brought to the hospital for their controls or when they have mild symptoms.

While there was no difference between the 2 groups in terms of symptomatic disease, the rate of symptomatic patients in group I (94.7%) was higher than the rates reported in the literature, the rate of symptomatic patients in the other group (85.6%) was almost the same as the other studies ($P = .49$). As we could determine; in literature the rate of symptomatic children varies between 77.3% and 84.2%, similar to our study.[17,20,21]

Similar to previous studies, the most common symptoms in our study were fever (89.5%; 71.2%) and cough (52.6%; 36.2%) in both groups.[17–19,21,22] Although not mentioned much in the literature, myalgia (15.8%; 18.9%) and diarrhea (15.8%; 12.3%) were symptoms that were reported frequently and at a similar rate in both groups in our study.[21,23,24–26] In addition, the difference between group I and group II was significant in terms of seizure (47.3%; 1,7%), dyspnea (36.8%, 6.2%) and number of days with fever (2.6 ± 1.9; 1.58 ± 1.42) in our work ($P < .01$, $P < .01$, $P = .02$). The difference in terms of seizures was not surprising as it was known that there were children with neurological disease in Group I. The underlying reasons for the higher incidence of dyspnea in group I can be explained by weak respiratory musculature, low mobility, and low respiratory capacity due to previous lung infections in these patients. However, longer duration of fever in Group I was a finding that needed clarification, and it is clear that more studies with these patients are needed.

When the physical examination findings were investigated, partial oxygen saturation with pulse oximeter ($P < .01$), blood pressure values ($P = .03$), auscultation sounds ($P = .01$) were significantly different between groups. While hypoxemia (7, 11; 36.8%, 4.5%) and abnormal auscultation findings (8, 44; 42.1%, 18.1%) were more common in children in group I, hypertension was more common in group II (0.8; 0%, 3.3%). It would be appropriate to predict that pneumonia and hypoxemia may develop more frequently in children with neurodegenerative and neuromuscular diseases, and to organize their follow-up and treatment according to these facts. On the other hand, it has been understood that the coexistence of COVID-19 and hypertension in children without an underlying disease is an important research topic.

When the laboratory findings were examined, blood lymphocyte count ($P=.01$), serum albumin ($P<.01$) and total protein values ($P=.01$) of patients in group I were lower; and serum crp ($P=.01$), creatinin kinase ($P=.04$) values of patients in group I were higher than patients in group II. When the laboratory findings of pediatric patients who had COVID-9 were reviewed in the literature; cytopenia, especially lymphopenia, and elevation in inflammatory markers are noteworthy.[17,19,21,23,26–30] Similar to the literature, the patients in group I had higher crp, lower lymphocyte counts and longer duration of fever compared to the other group, indicating that inflammation is more severe and lasts longer in these patients.

When chest radiographs were evaluated, lung involvement of COVID-19 was found to be more frequent and more severe in group I ($P=.04$), however there was no significant difference between groups when thorax CT images evaluated ($P=.26$). Although chest X-ray was performed in all children with respiratory symptoms, thorax CT was performed only in those with severe disease. Therefore, chest X-ray seems sufficient in children to show the severity of the disease and lung involvement. This situation coincides with the literature.[21]

In our study; the frequency of hospitalization in the intensive care unit ($P<.01$) and application of NIMV ($P<.01$); the number of days followed-up in the intensive care ($P<.01$) and in the hospital ($P=.02$) of the patients in group I were higher than those in group II. It has been reported in the literature that pediatric patients with an underlying disease are more prone to COVID-19 and even severe disease, and have a higher risk of hospitalization and follow-up in the intensive care unit; supported by our report.[19–23,31] However, there is not enough data about patients with neurological and neurological diseases.

When the treatments applied to our patients were examined in light of the COVID-19 follow-up and treatment guideline of the Ministry of Health of our country, we noticed that the need for IVIG ($P<.01$), systemic steroid ($P<.01$), LMWH ($P<.01$) and antiviral ($P=.02$) administration to the patients in group I was higher; however, this situation was not valid in terms of giving antibiotics.[16] This finding once again supports that inflammation is more frequent and severe in pediatric patients with underlying neurodegenerative and neuromuscular disease.

The main limitation of our study is the low number of cases with neurodegenerative and neuromuscular disease.

Since our center is the largest pandemic hospital for children in our city, the majority of paediatric patients were included in our study during the first 2 peak periods of the pandemic. However, the number of patients we could include in the study was small. The results of this study helped us recognize the need to organize a multicenter study. This study will also encourage other pandemic centers to investigate their patients especially in case they have neurological and neuromuscular diseases and to collaborate with other researchers in this field.

Another limitation is that the study is retrospective.

5. Conclusion

Based on published literature and as far as we can determine, our study is one of the few examining the course of COVID-19 in children with neurodevelopmental and neuromuscular diseases in our country and globally.

It is recognized that COVID-19 affects children. In addition, there are differences in the course of disease among children. In particular, children with underlying neurological and/or neuromuscular diseases are severely affected.

It is remarkable that; the peak of the number of patients without underlying mentioned diseases over the age of 15 may be due to the excessive social activity of children in this age group and false opinions in the society, especially among adolescents, that the disease does not affect young people. Therefore; studies are needed to reveal the causes of the increase in susceptibility to COVID-19 among adolescents.

It was learned that a significant number of the patients with neurological and neuromuscular disease went to a health institution for a few days before the onset of their symptoms. In light of this finding, in order to mitigate pandemic effects, the outpatient follow-up and treatment methods of these children should be reviewed, and strategies such as telemedicine and telerehabilitation to minimize transmission should be developed for future pandemics.

We noticed that the patients with neurological and neuromusculer disease had lower lymphocyte counts, longer duration of fever, higher inflammatory markers and higher need for anti-inflammatory and antithrombotic treatment compared to the other group. This indicates that inflammation is more severe and lasts longer in these patients.

While new information about the findings of COVID-19 in children is emerging day by day, the data obtained in our study should be supported by other studies.

In conclusion, patients with neurological and neuromuscular diseases had more severe and prolonged disease course. Moreover, health institutions were important sources for the transmission of infections to these patients. Therefore, we can emphasize that strategies such as telemedicine and telerehabilitation will reduce the clinical impact of the pandemic on children with neurological and neuromuscular diseases.

5.1. Ethics approval and consent to participate

This study was approved by the Ethical Committee of Pamukkale University Faculty of Medicine (date of approval 02/03/2021 and 05 approval number) and conducted in accordance with the Declaration of Helsinki. Written informed consent to participate in the study was obtained from the patients enrolled or their parents.

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Author contributions

Conceptualization: Dicle Sener Okur.
Data curation: Dicle Sener Okur.
Investigation: Dicle Sener Okur.
Methodology: Dicle Sener Okur.

Project administration: Dicle Sener Okur.
Software: Dicle Sener Okur.
Writing – original draft: Dicle Sener Okur.

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