Effects of Telerehabilitation Applied to Patients with Neurological Disorders Following COVID-19: A Pediatric Case Report

COVID-19 Sonrasında Ortaya Çıkan Nörolojik Bozukluk Sonucu Uygulanan Telerehabilitasyonun Etkileri: Bir Pediatrik Olgu Sunumu

Olgu Sunumu
Case Report

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DOI: 10.17942/sted.1592836

Geliş/Received: 29.11.2024
Kabul/Accepted: 13.11.2025

Summary
COVID-19 can affect people from mild symptoms to life-threatening symptoms. While only fatigue or weakness may occur after COVID-19, some patients may develop pulmonary complications such as respiratory failure, cardiovascular complications such as myocardial infarction, or neurological complications such as stroke/encephalitis. Although the literature draws attention to the neurological complications caused by COVID-19, there is not enough information about these complications and rehabilitation programs to improve them. In this case report, the 12-week effect of telerehabilitation applied to a girl with neurological impairment due to COVID-19 was evaluated. It was observed that a telerehabilitation program supervised by a physiotherapist contributed to the improvement of the patient's body structure and functions and provided improvements in criteria evaluating activity and participation. Longer-term follow-up is needed to determine how long these gains will continue.
Keywords: COVID-19; neurologic manifestations; telerehabilitation

Özet
COVID-19, hafif semptomlardan yaşamı tehdit edebilecek düzeyde semptomlara kadar insanı etkileyebilmektedir. COVID-19 sonrasında sadece yorgunluk veya halsizlik görülebilirken, bazı hastalarda solunum yetmezliği gibi pulmoner, miyokard enfarktüsü gibi kardiyovasküler veya inme/ansefalit gibi nörolojik komplikasyonlar gelişebilmektedir. Literatürde COVID-19'un neden olduğu nörolojik komplikasyonlara dikkat çekilse de, bu komplikasyonlar ve bunu iyileştirmeye yönelik rehabilitasyon programları hakkında yeterince bilgi bulunmamaktadır. Bu olgu sunumunda COVID-19'a bağlı ortaya çıkan nörolojik etkilenime sahip bir kız çocuğuna uygulanan telerehabilitasyonun 12 haftalık etkisi değerlendirilmiştir. Bir fizyoterapist tarafından denetimli telerehabilitasyon programının hastanın vücut yapı ve fonksiyonlarını iyileştirmesine katkı sunduğu, aktivite ve katılımı değerlendiren ölçütlerde iyileşme sağladığı görüldü. Elde edilen bu kazanımların ne kadar devam edeceğini saptamak için daha uzun süreli takibinin yapılması gereklidir.
Anahtar Sözcükler: COVID-19; nörolojik bulgular, telerehabilitasyon

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Introduction

The COVID-19 (2019-nCoV or SARS-CoV-2) infection caused by the New Type Coronavirus emerged in Wuhan, China, and quickly became effective all over the World. It was identified on January 7, 2020 as a novel Coronavirus not previously detected in humans (1). COVID-19, a multi-system viral sepsis syndrome, can range from mild to life-threatening symptoms and can affect different organ systems (2). In other words, while only fatigue or weakness may be observed following COVID-19, some patients may develop pulmonary complications such as respiratory failure, cardiovascular complications such as myocardial infarction, or neurological complications such as stroke/encephalitis (3-5). More specifically, neurological complications of COVID-19 may range from simple tremor and dystonia to encephalopathy. In a systematic review and meta-analysis study, the most common neurological findings in 13,480 patients with COVID-19 were reported to be myalgia (22%), dysgeusia (20%), anosmia (18%), headache (12%), dizziness (11%), encephalopathy (9.4%), and stroke (2.5%) (6). Although the exact pathophysiology underlying the severity and long-term effects of COVID-19 is not yet known, certain patient characteristics, including genetic factors, may predispose to these complications (7).

Immunodeficiency-74 (IMD74) is defined as an X-linked recessive immunological disorder that occurs due to COVID-19 infection. Evidence has been shown that the disease, which has a neurodegenerative character, is caused by a hemizygous mutation in the TLR7 gene, which plays an important role in the activation of the innate immune system (8). Therefore, a deficiency or defect in TLR function has been associated with increased infection (9) and TLR7 signaling has been implicated in the pathogenesis and antiviral response to COVID-19 (10).

IMD74, a rare neurological disorder associated with COVID-19, puts tremendous pressure on receiving rehabilitation services, given the potential disability. To systematically describe functioning, disability, and the impact of health conditions such as IMD74, the International Classification of Functioning, Disability and Health (ICF), developed by the World Health Organization (WHO), provides a standardized framework. The ICF allows healthcare professionals to evaluate body functions and structures, activities and participation, and environmental factors, thereby facilitating comprehensive assessment and individualized rehabilitation planning (11). Along with various rehabilitation services, physiotherapist-led telerehabilitation is effective in the context of a variety of health issues, including cardiorespiratory rehabilitation, musculoskeletal rehabilitation, and neurorehabilitation (12,13). Therefore, this report aimed to present the results of telerehabilitation based on the International Classification of Functioning, Disability and Health (ICF) in a pediatric case with IMD74 diagnosis characterized by neurological deterioration that developed after COVID-19.

Case Presentation

Case

A 12-year-old girl, who had no previous health problems, was admitted to the hospital with persistent cough, fatigue and headache for the last 6 months. The patient who was treated for sinusitis did not achieve results despite treatment. She applied to the hospital again due to increasing headache, loss of appetite, muscle weakness and balance disorder. During this period, the patient's increasing speech problems were noticeable. As a result of the evaluations made in the hospital, muscle weakness, balance disorder, fatigue and speech disorder were detected. There was a consanguineous relationship between the mother and father of the patient. However, there was no history of any chronic or neurological disease in her family history. According to the current clinical findings and laboratory evaluation results, the case was diagnosed with IMD74. The family of the child included in the study was informed about the details of the study (purpose, duration and application). Before

participating in the study, the "Informed Consent Form" was read and signed. It was stated that the exercises planned for 12 weeks would be done via telerehabilitation. For this, it was explained that exercises would be applied one-on-one with a physiotherapist's supervision via online video. Evaluations: (a) first session evaluation, (b) interim evaluation and (c) final evaluation were performed 3 times in total.

Outcome Measures

The tests applied under the ICF umbrella are shown in Table 1.

Pediatric Balance Scale: This scale consists of fourteen items that evaluate the functional balance of children in daily life. It provides the opportunity to evaluate balance status in positions including sitting and standing balance, transfers between positions, and leaning forward and standing (14).

5-Repetition Sit-to-Stand Test: This test involves the patient standing and sitting five times as quickly as possible while sitting in a chair with arms crossed over the chest. The patient was informed about the test and asked to do 1 trial before the test. They were asked to sit down and stand up quickly and without stopping 5 times. Timing includes the time it took for the patient to lift their hips off the chair and sit down after the 5th repetition. The temporal performance during the test was evaluated in seconds with a stopwatch (15).

Timed Up and Go Test: It is used to determine individuals' functional mobility, balance, walking and fall risks. In this test, individuals are asked to stand up from the chair as quickly and safely as possible (without the help of hands), walk 3 meters around the cone, turn around and sit back on the chair. The time spent during the performance is evaluated to get an idea about the functional mobility of the individual. 10 seconds or less; indicates that the patient is walking independently and the risk of falling is very low, while increasing the time indicates an increased risk of falling. The test was performed with 3 repetitions and the average time was calculated (16).

Functional Independence Measure for Children: Although it is generally used to evaluate the daily living activities of pediatric cases with brain damage, it is also used today in the evaluation of functionality in many pediatric pathologies. Evaluation is made in 6 sections: self-care, sphincter control, mobility, locomotion, communication and social communication. Scoring is evaluated between 1 and 7 (lowest score is 18, highest score is 126). While low scores are given in activities that can be done with assistance, increasing independence in the activity requires a high score (17).

Child and Adolescent Scale of Participation (CASP): It is a test that evaluates children's participation in home, school and social activities according to the information given by the family. The scale consists of four subsections. These subsections are: (a) Participation at Home, (b) Neighborhood and Community Participation, (c) School Participation and (d) Home and Community Life Activities. The items are rated on a five-point scale (0-4). This scoring corresponds to the answers appropriate for age (full participation), slightly limited, very limited, cannot do, not applicable (cannot be expected to participate in activities) (18).

Table 1. Scales and Tests Used Based on ICF

Body Structure-Function	Activity	Participation
PBS	WeeFIM	CASP
FRSTST		
TUG		

PBS: Pediatric Balance Scale; FRSTST: 5-Repetition Sit-to-Stand Test; TUG: Timed Up and Go Test; WeeFIM: Functional Independence Measure for Children; CASP: Child and Adolescent Scale of Participation

Intervention Procedures

Physiotherapy interventions

The exercises, which were performed using the online video conference method (via Whatsapp video call), were carried out one-on-one and under the supervision of a physiotherapist 3 days a week. Exercise sessions were planned to be every other day. Warm-up exercises were performed before starting the exercises, and cool-down exercises were performed afterwards. Stretching exercises were performed for the lower extremity, upper extremity and trunk muscles during the warm-up and cool-down exercises. In order for the patient not to have difficulty while doing the exercises, the physiotherapist also performed them to increase mutual harmony. The exercises were performed progressively and were advanced weekly throughout the telerehabilitation sessions (lasting 12 weeks). The patient was allowed to rest between movements during the exercises. The exercises were started with 5 repetitions and increased according to the patient's tolerance. The exercises used during the telerehabilitation sessions are as follows:

- Reciprocal shoulder flexion-extension
- Reciprocal shoulder abduction-adduction
- Scapular adduction, shoulder elevation, shoulder circumduction
- Reciprocal lateral flexion of the trunk in standing position
- Mini squat
- Extended forward reach in long sitting position
- Cross arm leg raise in crawling position
- Cat-Camel exercise
- Head flexion-extension-lateral flexion
- Chin-Tuck exercise
- Hip abduction-adduction in the supine position
- Reciprocal hip flexion-extension in supine position
- Straight leg raise in supine position
- Knee extension in sitting position
- Knee flexion in the prone position
- Ankle dorsi flexion-plantar flexion-circumduction in sitting position
- Bridge exercise
- Sit-ups (hook position)
- Trunk extension in prone position
- Hip extension in the prone position

Intervention outcomes

The changes in the active joint range of motion of the pediatric case after the telerehabilitation program are shown in Table 2. An increase in the upper extremity and lower extremity (right and left) range of motion was observed.

Table 2. Active Joint Range of Motion Assessment

	Initial assessment		Last assessment	
Upper Extremity	**Right**	**Left**	**Right**	**Left**
Shoulder abduction	130°/180°	125°/180°	160°/180°	160°/180°
Shoulder flexion	140°/180°	140°/180°	170°/180°	165°/180°
Shoulder extension	30°/60°	30°/60°	50°/60°	50°/60°
Elbow flexion	125°/145°	120°/145°	135°/145°	130°/145°
Lower Extremity	**Right**	**Left**	**Right**	**Left**
Hip abduction	10°/45°	10°/45°	20°/45°	20°/45°
Hip adduction	15°/30°	15°/30°	25°/30°	25°/30°
Hip flexion	45°/120°	40°/120°	80°/120°	70°/120°
Hip extension	5°/20°	5°/20°	10°/20°	10°/20°
Knee flexion	90°/140°	90°/140°	110°/140°	110°/140°
Foot dorsi flexion	5°/20°	5°/20°	10°/20°	10°/20°
Foot plantar flexion	15°/45°	15°/45°	25°/45°	25°/45°

The changes in muscle strength of the pediatric case after the telerehabilitation program are shown in Table 3. An increase in upper extremity and lower extremity (right and left) muscle strength was observed. The change in muscle strength was especially evident in the lower extremity.

The changes in the ICF-based criteria of the patient at the beginning, 6th week and 12th week are shown in Table 4. After the telerehabilitation program, it was observed that the patient gradually improved in body structure functions, activity and participation levels.

Discussion

This case study highlights the effectiveness of a supervised telerehabilitation program in the treatment of neurological disorders resulting from COVID-19. It was observed that the implemented telerehabilitation provided significant improvement in outcome measures. Improvements were observed in upper and lower extremity range of motion and muscle strength values. It was also observed that the patient benefited in outcome measures including functionality, activity and participation.

It has been reported that more than two-thirds of patients with COVID-19 have

Table 3. Muscle Strength Assessment

	Initial assessment		Last assessment	
Upper Extremity	**Right**	**Left**	**Right**	**Left**
Shoulder abduction	3/5	3/5	$3^+/5$	$3^+/5$
Shoulder flexion	3/5	3/5	4/5	4/5
Shoulder extension	3/5	3/5	$3^+/5$	$3^+/5$
Elbow flexion	3/5	3/5	4/5	4/5
Lower Extremity	**Right**	**Left**	**Right**	**Left**
Hip abduction	3/5	3/5	$3^+/5$	$3^+/5$
Hip adduction	3/5	3/5	$3^+/5$	$3^+/5$
Hip flexion	3/5	3/5	$3^+/5$	$3^+/5$
Hip extension	3/5	3/5	$3^+/5$	$3^+/5$
Knee flexion	3/5	3/5	4/5	4/5
Knee extension	3/5	3/5	4/5	4/5
Foot dorsi flexion	3/5	3/5	4/5	4/5
Foot plantar flexion	3/5	3/5	4/5	4/5

Table 4. Changes in Scales and Tests Used Based on ICF

Time Period	PBS	FRSTST (sec)	TUG (sec)	WeeFIM	CASP
Baseline	24	19.28	21.48	28	56
6th week	31	15.36	18.65	37	50
12th week	42	12.93	14.60	45	39

PBS: Pediatric Balance Scale; FRSTST: 5-Repetition Sit-to-Stand Test; TUG: Timed Up and Go Test; WeeFIM: Functional Independence Measure for Children; CASP: Child and Adolescent Scale of Participation

chronic disease comorbidities. In this respect, it is emphasized that managing comorbidities in this population is very important (19). In the early days of the pandemic, the severity and frequency of COVID-19 infection in children and adolescents were lower than in the adult population (20). However, studies have shown that some pediatric cases are seriously affected in the future. The situation can become quite severe with the immune, cardiovascular, pulmonary, neurological and gastrointestinal systems being affected (21). In our patient, the effects on body structure and functions limited the patient's activity and participation. However, the supervised telerehabilitation program implemented for 12 weeks contributed to the increase in the patient's functionality. In one study, it was reported that COVID-19 can affect the nervous system in both children and adults (22). It should not be forgotten that early detection of neurological involvement will increase the chance of success of the necessary rehabilitative interventions by making an early diagnosis.

The telerehabilitation approach can be used as a promising strategy to reduce the burden on patients and their caregivers by increasing treatment effectiveness and compliance. Telerehabilitation increases the accessibility of therapeutic interventions and helps the sustainability of rehabilitative approaches to meet the emerging needs of the patient. Therefore, its application, especially in children with neurological disorders, saves time and costs and contributes to presenting the rehabilitation process in a more ecological context at home (23). In our study, a 12-week telerehabilitation program yielded promising results in a pediatric patient with neurological disorders due to COVID-19. It is unclear how long these gains will be maintained. Therefore, it would be useful to evaluate the longer-term effects of the telerehabilitation program. Conducting the sessions one-on-one and under supervision facilitated the patient's motivational participation in the sessions. It has been emphasized in the literature that telerehabilitation cannot replace face-to-face therapy, but it can provide significant cognitive and functional improvements in children with neurodevelopmental disorders (24). In this respect, supervised telerehabilitation approach can be applied as an alternative in pediatric neurological patients who have difficulty with hospital-based rehabilitation program.

Conclusion

When current studies are examined, it is seen that the number of studies on telerehabilitation and tele-assessment has increased. With the development of technology, it is seen that healthcare systems are also shifting in this direction. This study has shown the effectiveness of the telerehabilitation program applied to pediatric patients who have neurological disorders due to COVID-19 and have difficulty participating in hospital-based exercise practices. Future studies examining the effectiveness of telerehabilitation in pediatric patients with a larger number and variety of neurological disorders will contribute to the literature.

The Ethical Aspect of Research

There are no personal details or identifying information in this study. Verbal and written consent was obtained from the patient's guardian for this case report. Since it is a case report, ethics committee approval was not required.

Conflict of Interest

There is no conflict of interest with any individual and/or institution.

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