Japanese Journal of Comprehensive Rehabilitation Science (2021)

Case Report

Improvement in activities of daily living and exercise tolerance in a patient with severe COVID-19 and femoral nerve palsy after Kaifukuki rehabilitation: a case report

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ABSTRACT

Yashiro T, Wada Y, Sugiyama M, Tateno H, Kasai F, Kawate N. Improvement in activities of daily living and exercise tolerance in a patient with severe COVID-19 and femoral nerve palsy after Kaifukuki rehabilitation: a case report. Jpn J Compr Rehabil Sci 2021; 12: 53–57.

Introduction: There have been many reports on rehabilitation techniques for patients with coronavirus disease 2019 (COVID-19). However, few have reported on the use of Kaifukuki rehabilitation for severe COVID-19 cases with complications of femoral nerve palsy after veno-venous extracorporeal membrane oxygenation (VV-ECMO) management.

Case: A male in his 50s who underwent VV-ECMO management during the course of his treatment for COVID-19 developed femoral nerve palsy due to iliopsoas hematoma. From day 120 after admission, he underwent Kaifukuki rehabilitation focusing on exercise therapy, activities of daily living (ADL) training, and respiratory rehabilitation to improve ADL and exercise tolerance. His respiratory function, functional independence measure scores, and 6-min walk test results improved. The patient was discharged on day 196. His recovery progressed without any further deterioration.

Discussion: Kaifukuki rehabilitation, focusing on respiratory rehabilitation, contributed to the improvement of ADL and exercise tolerance in a patient with severe COVID-19. In addition, attention should be paid to femoral nerve palsy after VV-ECMO.

Key words: COVID-19, VV-ECMO, femoral nerve palsy, exercise tolerance, convalescent rehabilitation

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 [1]. Patients with severe COVID-19 have long-term sequelae including fatigue and muscle weakness [2]. However, it has not yet been clarified how rehabilitation contributes to the improvement of long-term symptoms [3]. Here, we report that Kaifukuki rehabilitation for a patient with severe COVID-19 with femoral nerve palsy due to iliopsoas hematoma contributed to improvement in activities of daily living (ADL) and exercise tolerance. This study conformed to all specifications of the Case Report guidelines, which aim to standardize protocols for case report guidelines [4]. Informed consent was obtained from the patient for the publication of this case report.

Case

Patient: A male in his 50s.
Diagnosis: COVID-19.
Comorbidity: Hypertension.
Social history: He works as a company employee and lives alone in a two-story house. He has no history of smoking.

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Accepted: September 2, 2021.
Conflict of interest: There are no conflicts of interest to declare in this study.

doi.org/10.11336/jjcrs.12.53

History of present illness: The patient was diagnosed with COVID-19. Accordingly, fever and dyspnea were observed. He was admitted to an acute care hospital where he received ventilator support. Veno-venous extracorporeal membrane oxygenation (VV-ECMO) was performed from day 18 to day 36 after admission because his condition did not improve despite the application of prone positioning for respiration support. Physical therapy was initiated using a cycle ergometer at the bedside for upper limb training and low-frequency therapy with a general therapeutic electrical stimulator for the lower limbs. On day 33, he sensed pain on his right thigh, but the symptoms were relieved after performing femoral nerve block on day 34. After the end of VV-ECMO management, muscle weakness limited to the right limb appeared, and CT on day 37 revealed a hematoma (43 × 51.8 × 12.8 mm) in the right iliopsoas muscle, which was diagnosed as femoral nerve palsy based on clinical findings. He was then started on standing training with Total Lift-Bed™ (Vital Go Systems Ltd., Fort Lauderdale, Florida, USA), and sit-to-stand-and-hold training from the bed. After the end of ventilator management on day 56, occupational therapy was administered. Gait training, ADL training, and respiratory muscle stretching were performed. On day 67, he could sit upright and rise from the supine position independently using a handrail. On day 68, he could walk 10 m with a walker using a reservoir face mask set to deliver oxygen (flow rate: 10 L/min). On day 103, he could walk 80 m with a walker using the Oxymizer® with a flow rate of 5 L/min. However, his percutaneous arterial oxygen saturation (SpO_2) dropped to 70% when he moved around the ward with a walker. Consequently, for short distances he used a walker with the Oxymizer® (flow rate: 5 L/min), whereas for long distances he used a wheelchair. Regarding ADL capacity, he could independently dress himself on day 81 and required only light assistance in transferring position and toileting. He was transferred to the Kaifukuki rehabilitation ward on day 120.

The patient's condition and vital signs at the time of ward transfer were as follows: height, 168.0 cm; weight, 71.6 kg; blood pressure, 136/106 mmHg; and pulse rate, 112/bpm. His respiratory rate was 20/cpm, and SpO_2 was 97% at rest (Oxymizer® flow rate at 2 L/min) and 86% on exertion (Oxymizer® flow rate at 3 L/min). Thoracic mobility was poor, and sternocleidomastoid muscle hypertrophy was observed. Respiratory sounds were heard as fine crackles in both lungs at the end of inspiration. The modified British Medical Research Council shortness of breath scale was grade 5. Manual muscle testing (MMT) showed a score of 5/5 for the upper limbs, triceps and tibialis anterior; 2/5 for the iliopsoas and quadriceps; 4/4 for the gluteus medius; and 4/5 for the hamstrings. There was decreased sensation on the anterior surface of the right thigh and the medial surface of the lower leg. The total functional independence measure (FIM) score was 96: the motor items score was 61 (bathing: 3, toileting: 4, bed transfer: 4, toilet transfer: 4, shower transfer: 2, walk: 1, stairs: 1), and the cognitive items score was 35.

Blood test results showed that the white blood cell, hemoglobin, lactate dehydrogenase, C-reactive protein and Krebs von den Lungen-6 levels were at 7420/μL, 14.5 g/dL, 211 U/L, 0.12 mg/dL, and 1246 U/mL, respectively.

Chest and abdominal CT results showed ground-glass opacities in the bilateral lungs, traction bronchiectasis, and subpleural reticulation (Figure 1a). The right iliopsoas hematoma measured 17.2 × 11.9 × 49 mm (Figure 2a).

After admission to our hospital, rehabilitation (physiotherapy and occupational therapy) was started for his respiratory disorder, disuse syndrome due to long-term hospitalization, muscle weakness, gait disorder, and decline in ADL. Regarding respiratory rehabilitation, exercise therapy (abdominal breathing, thoracic range of motion training, and respiratory muscle stretching), ADL training, disease education, and nutritional guidance were provided. For right femoral nerve palsy, low-frequency therapy of the quadriceps muscle, muscle strengthening training, and gait training were performed to increase muscle strength. For thoracic range of motion training, manual mobilization of the shoulder girdle and thorax was performed. Respiratory muscle stretching was performed three times a day for the neck, shoulder girdle, upper limbs, and trunk. ADL training included simplification of movements, adjustment of movement speed, and training to synchronize breathing. Additionally, ADL training was performed in stages, from bed to sitting to standing, according to the degree of improvement in exercise tolerance. For muscle strengthening training, isometric contraction exercises were mainly performed in the MMT 2 stage of the quadriceps muscle, and as muscle strength improved, standing training and knee joint extension exercises using the anterior handrail were performed for three sets of 10 repetitions/set. During gait training, the patient tried to extend the walking distance while maintaining SpO_2 above 90%. Further, the 6-min walk test was performed periodically to adjust the amount of inhaled oxygen. Exercise therapy was discontinued when SpO_2 of 85%, pulse rate of 135/bpm, and respiratory rate of 30/cpm, which were resumed after recovery, were confirmed. On day 124, he could move from the room to the toilet with a walker using the Oxymizer® set (3 L/min), and on day 131, he could move around the ward. On day 156, he could ascend and descend the stairs using a handrail. On day 173, he could walk around the ward using a portable oxygen cylinder cart. Oxygen therapy was changed from Oxymizer® and nasal cannula (continuous) to nasal cannula (synchronized) with a flow rate of 0.75 L/min at rest and 4 L/min upon getting

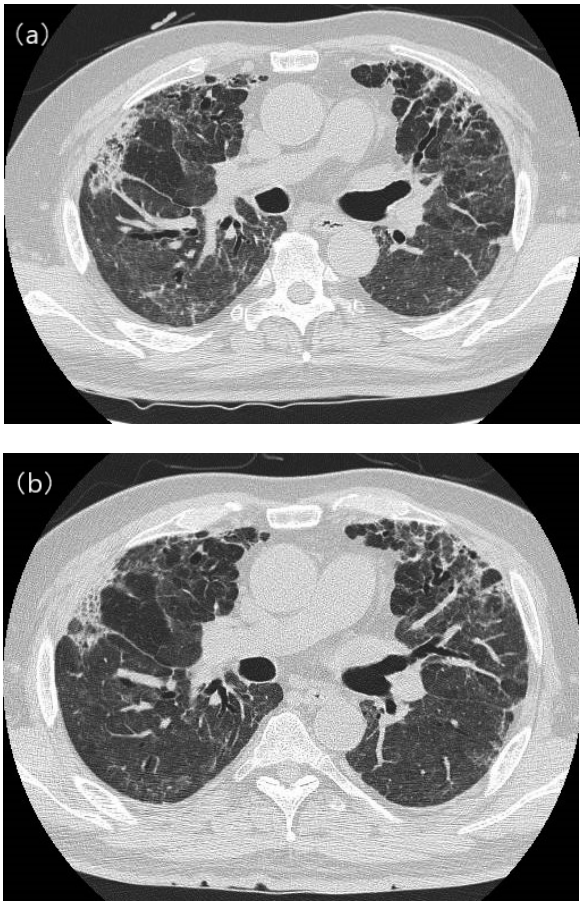

Figure 1. Progress of the lung condition on chest CT scan.
(a) Day of admission to our hospital (131st day), (b) Before discharge (176th day).

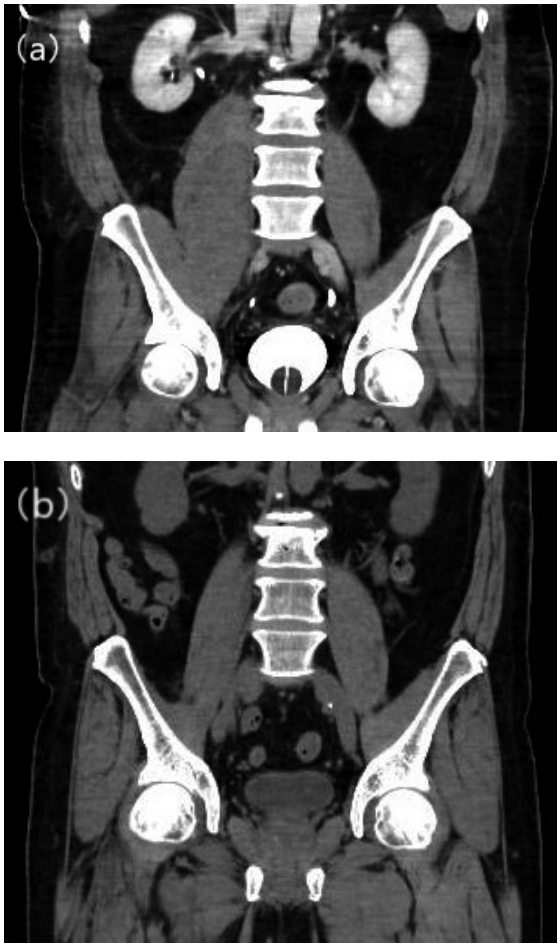

Figure 2. Course of the iliopsoas hematoma.
(a) During the previous hospitalization (37th day), (b) Before discharge (176th day).

Table 1. Conditions of the 6-min walk test at different points of the recovery period.

	Day 124	Day 156	Day 192
Oxygen condition	Oxymizer® 3 L/min	Nasal cannula (continuous) 3 L/min	Nasal cannula (synchronized) 3 L/min
Walking aid	Walker	Walker	Portable oxygen cylinder cart
Walking distance (m)	200	220	270
SpO_2 after 6-min walk test (%)	82	91	87
Modified Borg Scale (respiratory/lower limb)	4/3	3/3	4/2

out of bed. Thoracoabdominal CT on day 176 showed bronchiectasis and subpleural reticulation (Fig. 1b), but the right iliopsoas hematoma had disappeared (Fig. 2b). Spirometry (% lung capacity), arterial blood gas analysis: partial pressure of arterial oxygen, alveolar-arterial oxygen difference, 6-min walk test, and FIM (total score was 124, 89 points for the items and 35 points for cognitive factors) improved compared with at admission and discharge (Tables 1–3). Dyspnea remained unchanged on the modified Borg Scale 2 at rest and during exercise. Regarding right femoral nerve palsy, muscle weakness in the right lower limb (MMT scores were both 3/5 for right iliopsoas and right quadriceps) and sensory disturbance (decreased superficial sensation in the right anterior thigh and medial lower leg) remained. Home oxygen therapy was initiated because of marked hypoxemia during exercise. The patient was discharged on day 196.

Table 2. Trends in spirometry and arterial blood gas analysis.

	Spirometry		Arterial blood gas analysis (room air)		
	Day 140	Day 187		Day 140	Day 192
VC (L)	1.34	1.66	PaO_2 (mmHg)	49.8	58.1
%VC (%)	33.6	41.6	$PaCO_2$ (mmHg)	50.3	51.1
$FEV_{1.0}$% (%)	98.2	91.7	HCO_3 (mmol/L)	31.3	29.5
$\%FEV_{1.0}$(%)	32.7	47.4	A-aDO_2	37.0	27.8

VC, vital capacity; FEV1.0, percent of forced expiratory volume in 1 second; $\%FEV_{1.0}$, predicted forced expiratory volume in 1 second; PaO_2, partial pressure of oxygen in arterial blood; $PaCO_2$, partial pressure of carbon dioxide; HCO_3, bicarbonate ion; A-aDO_2, alveolar-arterial oxygen tension difference.

Table 3. Trends in Functional Independence Measure scores.

	Admission	Discharge
Self-care		
Eating	7	7
Grooming	7	7
Bathing	3	7
Upper body dressing	7	7
Lower body dressing	7	7
Toileting	4	7
Sphincter control		
Bladder management	7	7
Bowel management	7	7
Transfer		
Bed-to-chair	4	7
Toilet	4	7
Shower	2	7
Locomotion		
Walk	1	6
Stairs	1	6

Post-discharge course: The patient could perform instrumental ADL independently, drive (left foot gas pedal), and return to work, mainly teleworking. Right femoral nerve palsy did not change after discharge.

Discussion

In this case, the Kaifukuki rehabilitation focusing on respiratory rehabilitation was effective for this patient with severe COVID-19 who experienced a decline in ADL and exercise tolerance. It should be noted that femoral nerve palsy after VV-ECMO was an inhibitor of rehabilitation and ADL.

The Kaifukuki rehabilitation focusing on respiratory rehabilitation was effective for this patient with severe COVID-19 who had a decline in ADL and exercise tolerance. Although there is still no consensus on rehabilitation for COVID-19 [5,6], we considered that respiratory rehabilitation is as effective as when it was used for treatment of chronic obstructive pulmonary disease and interstitial pneumonia. In particular, the provision of a comprehensive rehabilitation program that included medical management, patient education, and environmental adjustment was useful in this case. In the future, we believe that a comprehensive rehabilitation program is required for patients with severe COVID-19 with a decline in ADL and exercise tolerance.

Femoral nerve palsy after VV-ECMO affects rehabilitation and ADL. The complication rate of iliopsoas hematoma in patients receiving VV-ECMO is 14.8% [7]. However, approximately 70% of femoral nerve palsy cases associated with iliopsoas hematoma can recover with conservative treatment [8]. In this case, muscle weakness and sensory disturbance remained at the time of discharge, approximately 7 months after the diagnosis of femoral nerve palsy. In addition to respiratory disorder and disuse atrophy due to prolonged hospitalization, femoral nerve palsy was a disincentive for rehabilitation in this case. Long-term rehabilitation should be planned for patients with femoral nerve palsy after VV-ECMO management.

In conclusion, we report a case of severe COVID-19 with femoral nerve palsy in which ADL and exercise tolerance were improved with Kaifukuki rehabilitation. In severe cases, it is necessary to pay attention to femoral nerve palsy caused by VV-ECMO, as well as respiratory function and ADL.

Acknowledgments

We would like to thank the staff of the Showa University Fujigaoka Rehabilitation Hospital for their assistance.

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