Case Study

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A Case Report of a Drop Foot After Veno Venous Extracorporeal Membrane Oxygenation for a Patient Diagnosed COVID-19

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Objective: To present a case study of a 69-year-old woman with COVID-19 who developed neurological complications due to Extracorporeal Membrane Oxygenation (ECMO) therapy and highlight the importance of daily neurological examinations and rehabilitation in the early detection and management of ECMO-related neurological complications in an isolation ICU.

Design: A case report

Methods: The patient received ECMO therapy, followed by neurological monitoring and rehabilitation in an isolation ICU. Daily neurological examinations were conducted to monitor the patient's neurological symptoms. Computed tomography was performed to confirm the presence of a hematoma in the left hamstring, which was identified as the cause of the neurological complication. Ultrasound-guided aspiration was immediately performed, and sciatic neuropathy predominantly involving the peroneal division was identified after aspiration.

Results: Successful recovery was made possible by the early detection of neurological complications and rehabilitation in an isolation ICU. Although electrodiagnostic tests were not performed due to limited access to the isolation ICU, the appropriate intervention time could be determined through daily neurological examinations and rehabilitation, thereby minimizing neurological sequelae.

Conclusions: ECMO-related neurological complications are well known, and their recognition in the ICU can be challenging. The presented case highlights the importance of daily neurological examinations and rehabilitation in the early detection and management of ECMO-related neurological complications in an isolation ICU, which can minimize neurological sequelae.

Key Words: COVID-19, Extracorporeal membrane oxygenation, Peroneal neuropathies, Rehabilitation, Intensive Care Units
Acknowledgment

Introduction

As countries have begun to move past pandemic restrictions and resign to living with the coronavirus disease 2019 (COVID-19), the number of patients admitted to hospitals with severe COVID-19 has not diminished, leading to a greater demand for extracorporeal membrane oxygenation (ECMO), especially in patients with acute respiratory distress syndrome (ARDS) [1]. ECMO is a useful approach for COVID-19 patients whose ARDS condition is critical; however, the treatment is not risk-free. Complications from ECMO include stroke, seizure, intracranial hemorrhage, vascular complications, compartment syndrome, ischemic neuropathy, femoral neuropathy, and muscle wasting [2]. Neurological complications stemming from ECMO can cause

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long-lasting or even permanent changes in a patient's life. Additionally, neurological evaluation is sometimes difficult to conduct on sedated patients in the isolation intensive care unit (ICU). Neurological evaluation and early rehabilitation in the ICU are important to minimize neurological impairment. Physiatrists play an important role in the multidisciplinary approach for critically ill patients [3]. In this study, we introduce a case in which neurological abnormalities were identified, and neurological sequelae were minimized through ICU rehabilitation.

Methods

Patient information

A healthy 69-year-old woman developed fever and dyspnea, and she was diagnosed with COVID-19 on December 27th, 2020. Her clinical frailty scale was 2, indicating that she had no symptoms of active disease. The patient's condition deteriorated rapidly after she was admitted to the ICU, where she received broad-spectrum antibiotics. The patient developed respiratory failure and was then transferred to a COVID-19-dedicated hospital on January 10th, 2021, where immediate intubation was performed. The patient's oxygen demand increased (PaO_2/FiO_2 ratio, 55), and she was diagnosed with ARDS. Chest computed tomography (CT) a detected a ground-glass opacity pattern in the left lower lobe. Veno-venous ECMO (VV-ECMO) was administered on the day of ICU admission. Since ECMO and ventilator weaning were difficult, the patient underwent tracheostomy on January 18th, 2021. The patient started ICU rehabilitation on the tenth day of ECMO support.

Examination

The initial Medical Research Council sum score (MRC-SS) was 28 points, and it is as follows: shoulder abduction 2/2, elbow flexion 2/2, wrist extension 3/3, hip flexion 2/2, knee extension 2/2, ankle dorsiflexion 3/3. A reduction in symmetrical deep tendon reflexes was observed in all limbs, but no pathological reflexes were observed. The MRC-SS was less than 48 points, consistent with ICU-acquired weakness (ICU-AW), where proximal weakness was dominant in this patient. The ICU rehabilitation consisted of 60 minutes of treatment sessions on weekdays, including an active assistive range of motion, mobilization, resisted exercise, and chest physiotherapy. The program avoided excessive pressure at the ECMO catheter insertion site. A physiatrist re-examined the MRC-SS before every rehabilitation session to evaluate muscle strength, and to determine the step of mobilization. After the ECMO catheter was removed (seven days after ICU rehabilitation), the physiatrist noticed swelling of the left leg, left foot drop, and ecchymosis of the patient's left thigh. At that time, left ankle dorsiflexion was graded as 1, using manual muscle testing (MMT). Chest CT and lower-extremity venography were performed to detect pulmonary thromboembolism (PTE) and deep vein thrombosis (DVT). There was no evidence of PTE or DVT, but a

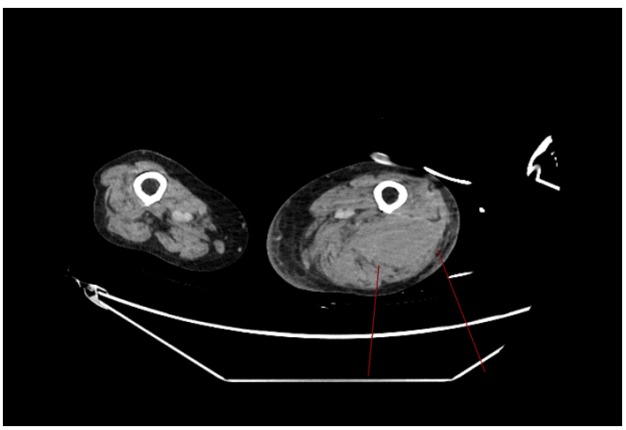

Figure 1. Extensive swelling with heterogeneity of left biceps femoris muscles

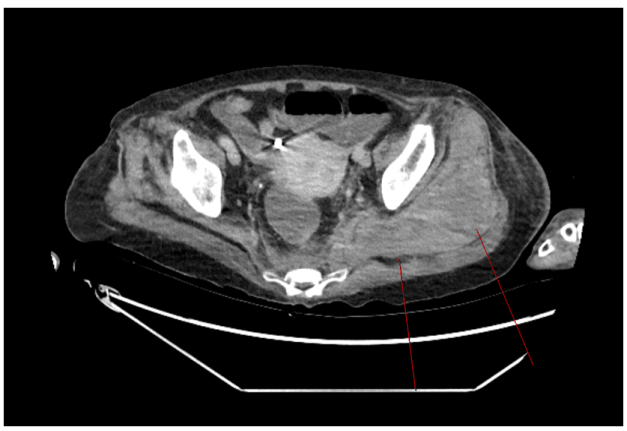

Figure 2. Extensive swelling with heterogeneity of left gluteus medius muscle

significant hematoma in the left gluteus medius and biceps femoris muscles was detected (Figure 1, 2). Aspiration of the hematoma was not done because of bleeding risk due to heparin-induced thrombocytopenia (HIT). The physiatrist observed no increase in hematoma size on ultrasonography (US), and the foot drop gradually improved during rehabilitation (left ankle dorsiflexion, grade 2+). However, neuropathic pain and neurological symptoms worsened after transferring to the general ICU. Although MRC-SS improved from 28 to 36, left ankle dorsiflexion was graded as 0. After US-guided aspiration of the hematoma, neuropathic pain showed rapid improvement.

Procedures

For electrodiagnostic (EDX) evaluation of foot drop, a nerve conduction study (NCS) and electromyography (EMG) were conducted on March 18th, 2021, approximately three weeks after hematoma aspiration. In the NCS, the left peroneal nerve compound muscle action potential (CMAP) from the extensor digitorum brevis muscle and left superficial peroneal sensory nerve action potentials (SNAP) showed decreased EMG amplitudes. The amplitudes of the left tibial nerve CMAP were lower than those of the right tibial nerve. In needle EMG, along with positive sharp waves and fibrillation potentials, decreased recruitment of polyphasic motor unit action potentials were seen in the left tibialis anterior and peroneus longus muscles. EMG findings in the biceps femoris short head and gastrocnemius muscles were also neuropathic features. Since EMG of the left tensor fascia lata and paraspinal muscles were normal, foot drop was likely not caused by L5 radiculopathy. The cause of the neurological symptoms was a left sciatic nerve lesion, predominantly in the peroneal division (Table 1). Combining the results of imaging and EDX with the clinical symptoms, the patient was diagnosed with compressive sciatic neuropathy due to hematoma.

Results

One and three month(s) after the initial EDX, the patient's neuropathic features showed a gradual improvement in follow-up EDX. Muscle strength also gradually recovered, and the MRC-SS was 53 upon hospital discharge (May 7th, 2021). The patient underwent various functional evaluations at an outpatient clinic on July 1st, 2021. In the MMT, except for ankle dorsiflexion of 4+ points, all muscle movements were graded as 5. The Timed Up and Go test took the patient 9.51 seconds to complete, and the patient came to a full standing position 11 times during the 30-second sit-to-stand test. The record of the six-minute walk test, done on the same day, was 309 m (58.8% predictive value). Muscle strength generally recovered to normal, but muscle endurance was still reduced.

Discussion

ECMO is used in patients facing life-threatening cardiopulmonary failure when no other treatment has been or is likely to be successful in improving oxygenation [4]. VV-ECMO may serve as a life-saving therapy for refractory respiratory failure, such as that induced by COVID-19 [5]. Complications associated with ECMO include internal bleeding, hemolysis, organ failure, ischemia, and thromboembolism. Neurological complications also occur in as many as 30% of adult patients treated with ECMO [6]. Complications such as sepsis and internal bleeding are typically identified in blood tests and can be treated relatively quickly; however, neurological complications may be overlooked because ECMO requires a deep sedation state to prevent cannula dislodgment [7]. Moreover, access to medical equipment and staff in the isolation ICU is restricted due to concerns about the transmission of COVID-19 to healthcare workers. The patient's neurological complication - her foot drop - was not related to the VV-ECMO catheter insertion but was induced by a hematoma in the hamstring. Compressive neuropathy due to hematoma caused foot drop, and this was a result of HIT [8]. HIT is presumably a result of anticoagulation management to prevent thromboembolism, ensuring optimal functioning of the circulatory system. Understandably, physicians may overlook such neurological complications, particularly in unstable patients; thus, thorough inspection and palpation are vital to detect neurological impairments

Table 1. Nerve conduction studies and Electromyographic findings

		Latency (sensory – peak, motor – onset)		amplitude		velocity	
		R	L	R	L	R	L
Sensory nerve	**Superficial peroneal**						
	03/18/2021	3.81 ms	3.88 ms	15.6 uV	7.2 uV	36.7 m/s	36.1m/s
	04/22/2021	NR	NR	NR	NR	NR	NR
	07/01/2021	3.13 ms	NR	10.2 uV	NR	44.7 m/s	NR
	Sural						
	03/18/2021	4.22 ms	3.50 ms	15.8 uV	14.1 uV	33.2 m/s	40.0 m/s
	04/22/2021	2.28 ms	NR	NR	NR	NR	NR
	07/01/2021	2.91 ms	NR	13.9 uV	NR	48.1 m/s	NR
Motor nerve (recording muscle)	**Common peroneal (EDB) - ankle**	**ankle / fibular head**	**ankle / fibular head**	**ankle / fibular head**	**ankle / fibular head**		
	03/18/2021	5.39 ms / 10.47 ms	7.58 ms / 13.75 ms	0.6 mV / 0.5mV	0.2 mV / 0.1 mV	47.2 m/s	40.5 m/s
	04/22/2021	5.16 ms / 11.33 ms	6.09 ms / 10.63 ms	0.6 mV / 0.6 mV	0.2 mV / 0.2 mV	43.8 m/s	49.4 m/s
	07/01/2021	5.31 ms / 11.09 ms	5.16 ms / 12.11 ms	0.7 mV / 0.6 mV	0.3 mV / 0.2 mV	45.8 m/s	40.3 m/s
	Tibial(AH) - ankle	**ankle / popliteal**	**ankle / popliteal**	**ankle / popliteal**	**ankle / popliteal**		
	03/18/2021	4.30 ms / 10.39 ms	4.69 ms / 11.02 ms	5.0 mV / 4.3mV	3.7 mV / 3.0mV	47.6 m/s	44.2 m/s
	04/22/2021	3.59 ms / 10.08 ms	4.14 ms / 10.63 ms	4.0 mV / 3.1mV	4.1 mV / 3.6mV	49.3 m/s	46.0 m/s
	07/01/2021	3.83 ms / 10.31 ms	3.75 ms / 10.86 ms	8.3 mV / 9.7mV	6.1 mV / 6.0 mV	51.7 m/s	46.4 m/s
H-reflex	03/18/2021	31.40 ms	34.84 ms				
	04/22/2021	28.27 ms	29.49 ms				
	07/1/2021	29.27 ms	28.38 ms				

Needle electromyography							
	Spontaneous activity			MUAP			Recruitment
	IA	Fib	PSW	Amp	Dur.	PPP	Pattern
Left biceps femoris, short head							
03/18/2021	NL	none	none	large	long	increased	reduced
04/22/2021	NL	none	none	NL	NL	NL	full
07/01/2021	NT	NT	NT	NT	NT	NT	NT
Left anteriortibialis							
03/18/2021	increased	1+	1+	large	long	increased	marked reduced
04/22/2021	NL	none	none	large	long	increased	marked reduced
07/01/2021	NL	none	none	large	long	increased	reduced
Left peroneus longus							
3/18/2021	increased	2+	2+	large	long	increased	marked reduced
4/22/2021	NL	none	none	large	long	increased	marked reduced
7/1/2021	NL	none	none	large	long	increased	reduced
Left gastrocnemius							
3/18/2021	NL	none	none	large	long	increased	reduced
4/22/2021	NL	none	none	large	long	increased	reduced
7/1/2021	NL	none	none	NL	NL	NL	full

* EDB: Extensor digitorum brevis, TA: Tibialis anterior, AH: Anterior hallucis, IA: Insertional activity, Fib: Fibrillation, PSW: Positive sharp waves, MUAP: Motor unit action potential, Amp: Amplitude, Dur: duration, PPP: Polyphasic pattern, NT: Not tested, NL: Normal

during or after ECMO. In addition, COVID-19 patients frequently experience diverse neurological complications, such as ischemic stroke, encephalitis, and critical illness polyneuropathy, due to long-term hospitalization [9]. Early detection of neurological problems can improve patient prognosis through early intervention. Evaluation and treatment of the cause of neurological damage can prevent neurological deterioration, and rehabilitation can help in the recovery of neurological impairment. Overall, a physiatrist can play an important role in a multidisciplinary approach to determine the appropriate treatment for patients who have neurological damage.

This case report had several limitations. Although a

clear rehabilitation goal can be obtained based on EDX for patients with suspected ICU-AW or peripheral neuropathy, implementing EDX in an ICU environment is always challenging, especially in an isolated ICU that is difficult to access. In this case, EDX was not initially used in the isolation ICU for this reason. The EDX was performed more than one month after the physiatrist first confirmed a neurological problem in the patient. Thus, EDX results did not sufficiently reflect the patient's initial condition. The use of a portable EMG machine in the isolation ICU would have yielded better results, revealing the patient's exact neurological issues that arose from ECMO. Despite this, changes in the hematoma were observed using US, and neurological abnormalities were evaluated daily to minimize neurological sequelae. As a result, the patient had a full recovery and was able to return to her daily routine without any problems, despite a severe COVID-19 infection. This case study demonstrates the importance of rehabilitation in shortening the length of hospital stay and return to normalcy after leaving the hospital, owing to the early detection and treatment of neurological complications.

Conclusion

Neurological complications induced by ECMO may adversely affect the quality of life. Early diagnosis of neurological complications and appropriate treatment interventions are important for positive prognoses in critically ill patients. To achieve positive prognoses, a multidisciplinary approach including neurological examination, EDX, and imaging evaluation is essential. Even in the isolation ICU, the role of physiatrists in a multidisciplinary approach is important not only in rehabilitation but also in diagnosis.

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