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Case Study

Effects of continuous rehabilitation on intensive care unit-acquired weakness after open-heart surgery: a case report

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Abstract. [Purpose] To assess the effects of continuous rehabilitation on intensive care unit-acquired weakness in a patient who underwent open-heart surgery. [Participant and Methods] This case report describes a 78-year-old female patient who developed intensive care unit-acquired weakness after open-heart surgery. She underwent cardiac surgery, via a thoracotomy, for valvular disease and angina pectoris. Her Medical Research Council sum score at the time of rehabilitative intervention was 28 points, indicating intensive care unit-acquired weakness. Rehabilitation was continued, and the patient's physical function was evaluated over time. [Results] Continuous rehabilitation improved the patient's grip strength, knee extension muscle strength, 6-minute walk test performance, and Short Physical Performance Battery score. [Conclusion] Although few reports have been published on rehabilitation for patients with intensive care unit-acquired weakness, our case suggests that appropriate rehabilitative intervention according to the severity of the condition and continuous rehabilitation may improve the patients' activities of daily living and physical function.

Key words: Intensive care unit-acquired weakness, Open-heart surgery, Exercise

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INTRODUCTION

Advances in cardiac surgery have been reported to improve survival, activities of daily living (ADL), and quality of life (QOL). However, a few patients experience delayed rehabilitation progression[1)]. In addition, intensive care unit-acquired muscle weakness (ICU-AW) complicates the development of generalized muscle weakness in the intensive care unit (ICU)[2, 3)]. ICU-AW is associated with a combination of rest, malnutrition, and hypercatabolism[4)]. Furthermore, it has been reported that complications associated with ICU-AW worsen short-term outcomes, such as delayed weaning from the ventilator and prolonged ICU stay, affect QOL, and increase rehospitalization rates[5, 6)]. Therefore, rehabilitation for ICU-AW is essential. Recently, ICU-AW interventions have been reported to improve ADL through early weaning and endurance training[7)]. However, rehabilitation in the general ward and after discharge from the hospital has not yet been established. Recovery from ICU-AW requires several months to 1 year to plateau. Thus, ICU-AW is a long-term issue, and rehabilitation should be continued during the acute phase and after discharge. We report a case in which continuous rehabilitation for ICU-AW improved physical function. This study demonstrates the potential effects of exercise therapy on long-term ICU-AW. The study was conducted in accordance with the Declaration of Helsinki; written and verbal informed consent was obtained from a patient, with attention to the protection of personal information. This study was approved by the ethics committee of Takanohara central hospital (ID: 2022008).

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PARTICIPANT AND METHODS

A 78-year-old female was hospitalized with weight gain and shortness of breath due to heart failure. The patient ADL could be completed independently. She was diagnosed with angina pectoris and aortic, mitral, and tricuspid regurgitation, and she underwent coronary artery bypass graft surgery, aortic valve replacement, mitral annuloplasty, and tricuspid valve replacement. Rehabilitation began on postoperative day 6.

Table 1 shows the patient's clinical observations during the early postoperative period. Echocardiography revealed a left ventricular ejection fraction (LVEF) of 19% and a brain natriuretic peptide (BNP) level of 400.5 pg/mL. Her Medical Research Council (MRC) score was 28 points, indicating ICU-AW (Table 2). The functional status score for ICU was one point as she could only turn over with full assistance. On postoperative day 42, the patient could stand up, and functional independence measure scores improved. However, malnutrition, weight loss, and muscle weakness continued to be observed. On postoperative day 90, the patient could walk, and her ADL improved further, but her grip strength and lower limb muscle strength remained weak.

The rehabilitation program was designed by focusing on the three major components of the patient's condition, namely acute cardiac failure (ACF), cachexia, and the recovery phase (Table 3).

During hospitalization, rehabilitation was performed six times a week for 40–60 minutes per session.

For ACF, ADL training was focused on turning over and bed movements.

For cachexia, attention was paid to the patient's hypercatabolism. The exercise program was designed on a Borg scale of 11–12 (light load). The exercise load was light, and fatigue was easy to control, focusing on resistance exercises using a Theraband. Aerobic exercise using a bicycle ergometer was also attempted but unsuccessful due to poor peripheral perfusion and shortness of breath. The bicycle ergometer was only started on the 90th postoperative day when these symptoms were no longer present for 10–20 minutes, starting at 10 watts and gradually increasing to 30 watts. The load was set at 11–12 on the Borg scale. After discharge from the hospital, resistance training and training on a bicycle ergometer were performed once a week for 1 hour. The patient nutritional status and physical function was considered when setting the exercise intensity, and a rehabilitation assessment was conducted over time. The following were evaluated: grip strength (Takei Physical Fitness Test, GRIP-D, TKK 5401, Niigata, Japan), knee extension muscle strength (HHD, ANIMA μTas F-100, Tokyo, Japan), short physical performance battery (SPPB), and 6-min walk test (6MD), which correlate with long-term prognosis post-open-heart surgery. Evaluation of HHD and SPPB began on postoperative day 42 when standing was possible. The 6MD was evaluated beginning on postoperative day 70 when walking was safe. Physical function was monitored from the early postoperative period to outpatient rehabilitation.

RESULTS

Changes in physical function and nutritional status over time are shown in Tables 4 and 5. The patient's physical function and nutritional status improved over time. Body weight showed improvement from 90 days after surgery without an increase in BNP (Fig. 1).

DISCUSSION

The present case was of an elderly patient who developed ICU-AW after open heart surgery. ICU-AW was observed, but physical function improved with prolonged light-load training.

The widely used diagnostic criteria for ICU-AW is an MRC score <48 points measured twice at an interval of at least 24 hours, as defined by Latronico and Bolton[8]. ICU-AW has also been associated with mortality, and it has been reported that patients with an MRC score ≤35 have an increased mortality rate compared to patients with an MRC score ≥48[9]. Therefore, this patient was ICU-AW with a high mortality rate due to MRC scale score of 28. In addition, previous studies

Table 1. Patient characteristics

Gender	Female
Age (years)	78
Body weight (kg)	52
FSS-ICU (point)	1
LVEF (%)	19
BNP (pg/mL)	400.5

FSS-ICU: the functional status score for the intensive care unit; LVEF: leftventricular ejection fraction; BNP: brain natriuretic peptide.

Table 2. MRC scale at the start of rehabilitation

	Right	Left
Shoulder	2	3
Elbow	2	2
Wrist	2	3
Hip	2	2
Knee	3	3
Ankle	2	2
Total (points)	28	

MRC: medical research council.

Table 3. Changes in rehabilitation programs

Day		30	60	90	120	240
ADL	Rolling	→	→	→	→	→
	Sitting on the edge of bed	→	→	→	→	→
	Stand up		→	→	→	→
	Walking (walker)			→		
	Walking (free hand)				→	→
FIM	Motor (points)	13	30	67	86	90
	Cognitive (points)	33	35	35	35	35
	Total (points)	46	65	102	121	125
Rehabilitation program	ROM	→	→	→	→	→
	Positioning	→	→			
	Portable ergometer		→			
	Thera band					
	• Hip flexion					
	• Hip abduction			→	→	→
	• Knee extension					
	Each 20×3					
	Calf raise			→	→	→
	Squat			→	→	→
	Ergo meter			→	→	→

ADL: activities of daily living; FIM: functional independence measure; ROM: range of motion.

Table 4. Changes of blood test data and nutritional data of the participant over time

Day	1	14	120	240
Albmin (g/dL)	3.2	3.2	3.4	4.6
BNP (pg/mL)	400.5	350.4	133.5	110.4

BNP: brain natriuretic peptide.

Table 5. Changes in physical function over time

Day		14	42	70	77	91	112	196	240
HHD (kgf/kg)		-	0.12	0.24	0.25	0.31	0.31	0.36	0.40
Grip (kg)		5.0	7.7	10.2	9.1	11.3	11.8	14.3	16.0
6MD (m)		-	-	180	330	400	400	500	500
SPPB	4 m gait	-	0	4	4	4	4	4	4
	5 stand up	-	0	0	0	1	2	4	4
	Balance	-	1	2	2	4	4	4	4
	Total score	-	1	6	6	9	10	12	12

HHD: hand held dynamometer; SPPB: short physical performance battery.

have shown that energy metabolism is greatly increased in heart failure patients with BNP >200 and left ventricular ejection fraction <55%[10]. The patient had LVEF of 19%, and BNP of 400.5 pg/mL at the time of intervention, requiring rehabilitation programs with attention to hypercatabolism. Rehabilitation for ICU-AW has been reported to include early rehabilitation therapy and electrical stimulation therapy[11, 12]. In particular, electrical stimulation therapy is known to improve muscle strength and mobility as an alternative therapy that can be performed even at rest[13]. On the other hand, it is rarely used long-term, and voluntary strength training is more effective when active training becomes possible. Recently, it has been reported that mild exercise therapy (Borg scale 4) improves exercise tolerance in ICU-AW patients with heart failure[11, 14]. Mild exercise therapy induces anabolism without increasing catabolism[11]. In this case, exercise intensity and content were set while paying attention to the loading dose. In addition, we evaluated the degree of fatigue after exercise and adjusted the load to manage the risk. Mild exercise therapy is considered to improve physical function without worsening heart failure because of risk management. The limitations of this study are that there was no external validity, as applied to other patients. In addition, because this was a case report, comparisons with other patients could not be drawn. However, as the number of

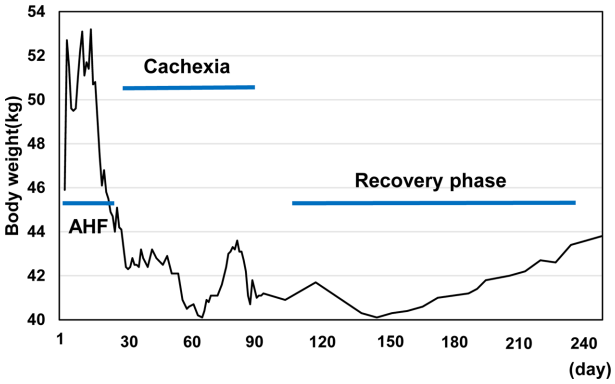

Fig. 1. Change in body weight.
Body weight was measured daily from on set and was observed for 240 days. Weight gain due to acute heart failure was observed on days 1–30. Weight loss due to cachexia was confirmed at about 30–90 days. Subsequently, weight loss showed improvement over time. AHF: acute heart failure.

ICU-AW patients is likely to increase with the improvements in emergency medicine, such a report is crucial for the future development of rehabilitation.

Conflict of interest

There is no conflict of interest to disclose in this study.

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