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Case Study

Effects of aquatic walking exercise using a walker in a chronic stroke patient

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Abstract. [Purpose] The aim of this study was to examine the usefulness of aquatic walking exercise using a walker for chronic stroke patients. We also examined the psychological effects on the study subject and the primary caregiver before and after aquatic walking exercise. [Subject and Methods] The subject was a 60-year-old male with bilateral paralysis after a cerebrovascular accident. The Fugl-Meyer Assessment (FMA) total score was 116 on the right and 115 on the left. The intervention combined aquatic and land walking exercise. A U-shaped walker was used for both water and land exercise. Continuous walking distance was the measure used to evaluate land walking ability. The psychological effects on the study subject and the primary caregiver were examined with the questionnaire. [Results] In aquatic walking, the mean time to walk 5 m showed an increase from the intervention after two months. After the aquatic walking and land walking combination, continuous walking distance also showed a prolonged trend. In the survey given to the main caregivers, improvements were observed. [Conclusion] Aquatic walking practice using a walker improved motivation in a chronic stroke patient, leading to improved walking ability, with a positive psychological influence on the participant and family caregiver.
Key words: Aquatic walking with a walker, Bilateral paralysis, Psychological benefit

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INTRODUCTION

Six months after a stroke, more than 30% of survivors remain unable to walk independently[1)]. A walking exercise program has reportedly been effective in rehabilitation after stroke[2)].

Some studies have reported that aquatic therapy for stroke patients provides motor and sensory stimulation that can improve static and dynamic balance[3, 4)]. Aquatic treadmill-walking can be used for task-specific training after stroke, and is also used as aquatic exercise to improve walking[5)]. However, an aquatic treadmill is not readily available or cost-effective for most aquatic facilities[6)].

Some patients find aquatic walking difficult without use of an underwater prosthetic device. For these cases, even underwater use of an ambulatory assistive device such as a walker may allow independent walking. However, there are few studies on aquatic walking exercise using a walker. In this study, we examined the usefulness of aquatic walking exercise using a walker for chronic stroke patients. We also examined the psychological effects on the study subject and primary caregiver before and after aquatic walking exercise. In this study, changes in the Activities of Daily Living (ADL) and physical function before and after the intervention were also included in the discussion.

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Table 1. ADL and physical functions score of the subject

	Item	Score
ADL	Barthel Index (BI)	30
	Functional Independence Measure (FIM)	66
Physical functioning	Brunnstrom Recovery Stage (BRS)	
	Right upper extremity (UE)	3
	Hand	4
	Lower extremity (LE)	4
	Left UE	2
	Hand	4
	LE	3
	Fugl-Meyer Assessment (FMA)	
	On the right	116
	On the left	115
	Grip strength measurement	
	On the right (kg)	10.2
	On the left (kg)	11.0

SUBJECT AND METHODS

The subject was a 60-year-old male with bilateral paralysis after a cerebrovascular accident; he developed right hemiplegia due to a cerebral infarction in 2004 and left hemiplegia due to cerebral hemorrhage in 2007. He was 170 cm high, weighed 66 kg, and had a body mass index of 22.83. He was referred for participation in daytime activities.

ADL (Barthel Index[7]) and Functional Independence Measure[8]) and physical functions score (Brunnstrom Recovery Stage[9], Fugl-Meyer Assessment[10]) and Grip strength measurement (ELECTRONIC HAND DYNAMOMETER EH-101, CAMRY) of the subject are shown in Table 1.

The purpose and methods of this study were fully explained to the subject and caregiver, and consent was obtained for participation. The caregiver is the wife who lives with the subject.

The intervention combined aquatic and land walking exercise. The intervention period was approximately 18 weeks, with aquatic walking exercise at a frequency of once every 2 weeks.

Aquatic walking exercise was performed for the first 9 weeks of the intervention, and combined aquatic and land-walking exercise was performed from weeks 10 to 18. Land walking exercises were performed once a week.

A U-shaped walker (SM-10, MATSUNAGA MANUFACTORY Co., Ltd.) was used for both water and land exercise.

Since gripping is difficult with the forearm in neutral position, we attached a PVC pipe to the top of the walker for gripping with the forearm in pronation. The task in aquatic exercise was to walk a 5-m straight course 10 times independently. The course was laid and walked from the same starting point each time. After walking, the subject was returned to the starting point with full assistance every time while facing the direction of travel. When the walking continuation distance is less than 5 m, the staff walking just behind the subject stopped. Weight belts (1.5 kg each) were sometimes added for stability. Pool floor walking was performed in an indoor swimming pool (I-Hope Suita), with 15-m length, 6-m width, and about 110-cm water depth; water temperature was set at 32°C and the test room temperature was set at 29.5°C.

Land walking was performed in a 35-m straight corridor, and practice was conducted using two patterns of assisted walking: with a U-shaped walker and with direct assistance of a physical therapist. A lower extremity orthosis was attached for evaluation of land walking.

Evaluations were performed for continuous walking distance in water (maximum 5 m) and on land, physical function, ADLs, and degree of subject satisfaction with aquatic walking exercise; separate questionnaire surveys were completed by the caregiver.

Continuous walking distance in water and on land was evaluated once every 2 weeks, and physical function and ADLs were evaluated at the beginning, and at 9 and 18 weeks of the program.

Degree of subject satisfaction with aquatic walking exercise was measured immediately after every session and a questionnaire survey of satisfaction was completed by the caregiver at the beginning and at 18 weeks.

Subject satisfaction with aquatic walking exercise was recorded using a Visual Analog Scale (VAS); the higher the value assigned by the subject, the greater the degree of satisfaction.

The questionnaire survey completed by the caregiver included a Zarit Burden Interview[11]; the caregiver VAS assessed recorded sleep time, nursing time, and the number of times the subject required night nursing care; scores for life motivation and health management awareness were also assessed, as were caregiver satisfaction with the water walking exercise and facility service. The goal was to achieve improved scores for all measures.

Table 2. The results of walking exercise

Practice day (phase)		0	1	2	3	4	5	6	7	8	9	10
Aquatic walk	5 times average reachable distance (m)		3.3	4.7	4.9	4.3	4.8	5.0	5.0	5.0	5.0	5.0
	5 m achievement success rate (%)		40	80	80	80	80	100	100	100	100	100
Land walk	continuous walking distance with only assistance (m)	6.0						5.0	8.5	12.0	11.0	18.0
	continuous walking distance with a walker (m)	10.0						11.0	14.0	15.0	21.0	26.0

Table 3. The results of the caregiver questionnaire survey

Item	Beginning	Final
Zarit Burden Interview (point)	25	23[a]
Sleep time (hour)	7	8[a]
Nursing time (hour)	2	1.5[a]
The number of times the subject required night nursing care (time)	1	1
Life motivation (point)	9	8
Health management awareness (point)	5	7[a]
Satisfaction with facility service (point)	8	7
Caregiver·satisfaction with the water walking exercise (point)	6	9[a]
Subject·satisfaction with the water walking exercise (point)	6	8.2[a]

[a]Improved items

RESULTS

Slight changes were observed in physical function and ADL measurements, with grip strength on the right increased from 10.2 to 11.2 kg, and from 11 to 12 kg on the left. FIM score increased from 66 to 67, and FMA score on the left side increased from 115 to 113. FMA on the right side, BRS, VAS, and BI did not show any differences.

The results of walking exercise are presented in Table 2. Continuous aquatic walking distance (average) was about 3 m at the beginning, 4 m at 2 weeks, and 5 m at 10 weeks; thereafter, 5 m was stably maintained; 5 m was attained 43/50 times (86%).

Continuous land walking distance with a walker increased from 11 m at the beginning (phase 1) of week 10 to 26 m at the end of the study (phase 10); distance with hand assistance increased from 5.0 m at the beginning to 18 m at the end.

The results of the caregiver questionnaire survey are presented in Table 3. The survey showed improvement by 6 out of 9 items.

DISCUSSION

This study examined the effect of aquatic walking exercise with a walker in a chronic stroke patient as well as the effect on the caregiver. The continuous walking distance gradually increased, and some benefit was observed in walking ability. Both patient and caregiver showed improved satisfaction levels with the aquatic walking exercise.

Ambulation with an aquatic treadmill is different from pool floor walking. Unlike stationary walking on an aquatic treadmill, pool floor walking requires movement of the trunk against water resistance while maintaining balance and negotiating drag force[6]. Walkers are used to improve balance and relieve weight bearing on a lower extremity, either fully or partially. They provide a wide base of support, improve anterior and lateral stability, and allow the upper extremities to transfer body weight to the floor[12]. The subject of this study had difficulty in walking on land; with the presumption that walking practice would be possible in water, we therefore applied walking exercise using a walker in a swimming pool.

Previous studies reported the usefulness of repetitive task training[13] and task-oriented training for rehabilitation in stroke survivors[14].

Walking exercise began with tasks of low difficulty; with improvement in walking ability, the difficulty level was adjusted by performing walking exercise with a higher degree of difficulty on land. Practice tasks comprised the same content by using a walker both underwater and on land, and repeated exercises were devised to make it easy to improve walking ability. Using motor–learning, in this case, it was possible to attain 5 m with steady underwater walking successfully, and this led to improved continuous walking distance on land.

In this study, subject satisfaction after walking exercise was higher in the latter half than in the first half of the intervention period. Viscosity and hydrostatic pressure can provide postural support for impaired balance with less fear of falling[15]; therefore, exercise in water can offer various psychological advantages, by motivating and supporting patients. These benefits can make it possible for post-stroke patients to initiate early gait rehabilitation[5]. The subject in the present study perceived little difficulty with aquatic walking, and the improved walking ability resulted in improved satisfaction with aquatic walking exercise.

The health-related quality of life score of family members providing home care for patients with higher degrees of disability was lower in the “Mental health” domain[16]. The questionnaire survey at the end of this study revealed that the caregiver had improved sleeping hours and awareness of health management. There is a lack of objective evidence for the benefit of water-based rehabilitation exercise after stroke; however, it has been shown that water-based exercise after stroke might help to reduce disability[17]. It was inferred that some influence might have been exerted at a level that could not be measured by the ADL scales used in the present study.

For these reasons, it was thought that aquatic walking practice using a walker improved motivation in a chronic stroke patient, leading to improved walking ability, with a positive psychological influence on the participant and family caregiver. Consequently, the findings showed the usefulness of a walker in aquatic walking rehabilitation of a chronic stroke participant.

A limitation of this study is that only one case was evaluated; thus, it is unknown whether other cases can obtain similar results. However, although statistical analysis was not performed, and the effect on improvement was unclear, it was possible to show that walking ability and psychological changes occurred using this method. Moreover, the study did not evaluate the carryover of improvement in walking ability or psychological benefit to the home environment. This will require further study.

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