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Original Article

Influence of rehabilitation combined with art devices on the number of sit-to-stand movements and resulting psychological effects

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ABSTRACT

Miyasaka H, Yoshioka K, Kawakami K, Tonogai Y, Hioki Y, Ogawa M, Kurotani E, Tanino G, Okamoto S, Sonoda S. Influence of rehabilitation combined with art devices on the number of sit-to-stand movements and resulting psychological effects. Jpn J Compr Rehabil Sci 2019; 10: 65–70.

Objective: To examine the effectiveness of art devices for lower limb exercises.

Methods: Patients admitted to comprehensive inpatient rehabilitation wards were assigned to either the art device (AD) group (11 patients) or the control group (17 patients) by randomized control trial (RCT) design. Sit-to-stand training was performed with a head mounted display (HMD) in the AD group and without the HMD in the control group. The training period was 10 min/day, 5 days/week for 2 weeks. The number of sit-to-stand movements was evaluated and a questionnaire about the device (feelings of pleasure and satisfaction graded on 7 levels) was administered.

Results: The number of sit-to-stand movements in the AD group significantly increased after 2 weeks ($p < 0.05$). However, the increase in the number of sit-to-stand movements was not significantly different between the two groups. The questionnaire regarding feeling of pleasure showed significantly improved results in the AD group during the first day of the trial; however, the improvement was not maintained until the last day of the training ($p < 0.05$).

Conclusion: The combination of rehabilitation and art devices may improve the initial motivation toward training and lead to an increase in the number of sit-to-stand movements.

Key words: virtual reality, art therapy, motivation

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Introduction

In rehabilitation exercises, tasks are performed repeatedly to improve motor function. French et al. [1] reported a low to moderate level of evidence for repeated training and found that it is clinically effective in improving function in stroke patients. Boukadida et al. [2] reported improvements in sit-to-stand duration, weight-bearing symmetry, and ability to stand independently in stroke patients in a review of sit-to-stand training which is a type of repeated training. In addition, it is reported that adding sit-to-stand training to conventional therapy significantly improves dynamic balance, extension strength of the knee joint, and the number of sit-to-stand movements in a day [3, 4].

Thus, the effectiveness of sit-to-stand training has been confirmed. However, since the movement is monotonous, it is difficult to maintain motivation for the duration of the training. Motivation is an important factor in rehabilitation [5, 6] and is known to be a component of motor learning theory [7, 8]. In order to enhance the effectiveness of motor learning, the factors of difficulty of training, transferability of skills, amount of training, feedback, and motivation are important. In particular, sufficient motivation in the early learning phase is required to develop new motor skills [9].

Game elements have been added to rehabilitation as a motivational tool [10]. In particular, training using virtual reality (VR) has been reported to be clinically

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useful when elements of the game were incorporated in a program that intuitively caused movement [11]. Moreover, Goršič et al. reported that rehabilitation using a game program linked to physical movement may enhance motivation [12].

In this study, sit-to-stand training was performed with a head mounted display (HMD), which provided a strong sense of immersion, and the number of sit-to-stand movements along with the psychological effects (feelings of pleasure and satisfaction) were examined.

Methods

1. Subjects

The subjects were 29 patients admitted to the comprehensive inpatient rehabilitation wards of Fujita Health University Nanakuri Memorial Hospital. Informed consent was obtained from all participants (Table 1). The inclusion criteria were as follows: (1) patients who could stand up from a chair independently or with partial assistance, and (2) patients without visual problems. Patients with a score of <20 in the total cognitive section of the Functional Independence Measure (FIM) [13] were excluded.

This study was approved by the ethics committee of Fujita Health University (No. HM17-041) and registered in the UMIN clinical trial registration system (UMIN ID: UMIN000027943).

2. Study design

In this study, subjects were divided into the art device (AD) group or the control (CT) group by randomized controlled trial design. The allocation was performed in order of entry according to a random number table created by a computer.

3. Training task and setting

The training task for all patients was sit-to-stand training from a chair 40 cm in height. Sit-to-stand training was carried out for 10 min/day, 5 days/week for 2 weeks in addition to 50 min a day of physical therapy for all patients. In the AD group, patients wore an HMD (Rift, Oculus VR, Inc.) during the training.

The mosaic on the VR images of the HMD became finer whenever the subject stood up from the chair. Once the VR images reached a predetermined limit, clear landscape photographs were completed (Figure 1). The patient selected one of five landscape photographs (Figure 2).

The system used in this research consisted of an HMD, monitor, and motion sensor. VR images were projected onto the monitor (Figure 3), and the monitor and motion sensor were placed in front of the patient. The VR images were programmed to be changed when the motion sensor sensed the patient's HMD movement [14] (Patented, Inventor: Kiyomi YOSHIOKA). A physiotherapist instructed the patients to ensure that the sit-to-stand training was performed appropriately in the correct standing position.

4. Setting the number of exercises in each group

In both groups, participants were instructed as follows: "Please repeat the sit-to-stand training, and if you get tired, please take a break." The participants in the AD group chose 30 or 50 sit-to-stand movements, and the landscape images were completed upon reaching the target count. If patients did not reach the target count, the landscape images remained coarse. In this study, the task was repeatedly performed for 10 min while the landscape photograph and the number of movements were freely selected.

Table 1. Patient characteristics.

Characteristic	AD	CT	*p*-Value
n	11	17	—
Age [year]	62.3 (15.9)	66.4 (13.4)	n.s.
Sex [Male / Female]	8 / 3	8 / 9	n.s.
Days from onset of stroke [days]	48.9 (10.7)	52.6 (19.5)	n.s.
Diagnosis			
Stroke	9	13	
Spinal cord injury	0	1	
Lower limb fracture	2	2	
Other	0	1	
FIM			
Motor item	77.0 (13.6)	76.9 (9.3)	n.s.
Cognitive item	31.6 (3.4)	30.1 (4.7)	n.s.

mean (standard deviation)
AD, Art Device group; CT, Conventional Therapy group; FIM, Functional Independence Measure; n.s., not significant.

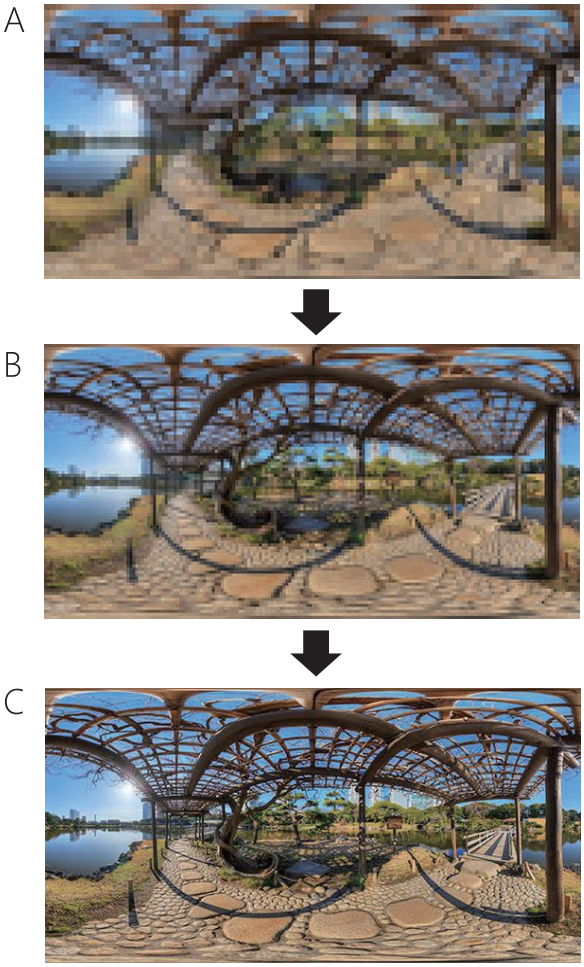

Figure 1. Change of mosaic of the landscape images.
An increase of the number of exercises makes the mosaic of the landscape image finer.
A. The landscape image is presented with rough mosaics due to a small number of movements.
B. The mosaics become finer in the landscape image as the number of movements increases.
C. A clear landscape photograph appears by completing the target exercise count.

Figure 2. Screen for selecting the landscape image.
The patient selects one of the five landscape photographs.

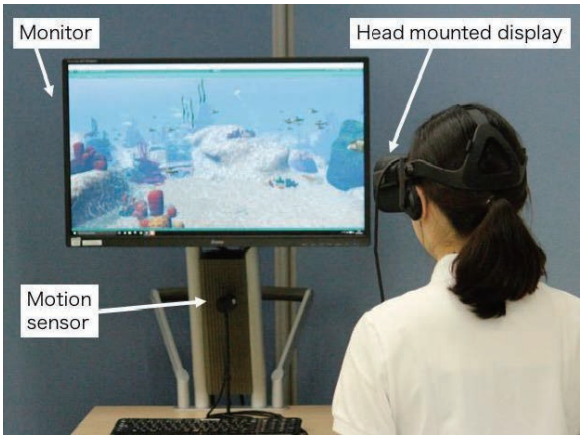

Figure 3. Appearance of the art device.
The system consists of a head mounted display, monitor, and a motion sensor. A VR image is projected on the monitor.

5. Evaluation items

The evaluation items were the number of sit-to-stand movements and the questionnaire (feelings of pleasure and satisfaction) for the device.

Physical therapists counted the number of sit-to-stand movements during the training. The questionnaire used a 7-step Likert scale at regular intervals on paper. Questionnaire findings were recorded by the physical therapists who conducted rehabilitation on the day and who asked about the feelings of pleasure and satisfaction by asking the question "How do you feel about rehabilitation of sit-to-stand now?"

The number of sit-to-stand movements was counted before the first day of training and after the end of the tenth day, and the questionnaire answers were evaluated before and after the first day and at the end of the tenth day.

6. Data analysis

Patient characteristics were compared between the two groups using Student's *t*-test for age and days since stroke onset and the Chi-square test for sex.

The Shapiro-Wilk test was used to determine data normality in this study. Since a normal distribution was confirmed in all groups, the paired *t*-test was employed for comparison of initial and final data in each group and the unpaired *t*-test was used for comparison of the initial, final, and difference in number of sit-to-stand movements between groups. The results of the questionnaire in each group were compared using the Chi-square test between pre- and post-training data of the first day (T1 and T2) to detect an immediate change and between post-training data of the first day (T1) and post-training data of the tenth day (T3) to check the retention effect. The significance level was set at 5%.

Results

One patient in the AD group was discharged during the intervention period; therefore, 28 patients (AD group: 11, CT group: 17) completed the task. The results for the number of sit-to-stand movements are shown in Table 2. The number of sit-to-stand movements significantly improved following intervention in the AD group ($p < 0.05$). On the other hand, there was no significant difference in initial, final, or difference in number of sit-to-stand movements between the two groups.

The results of the questionnaire are shown in Figures 4 and 5. The number of patients who answered "extremely pleasurable," "moderately pleasurable" or "slightly pleasurable" with regards to feeling of pleasure was 6 out of 11 at T1, and significantly increased to 9 at T2 ($p < 0.05$). However, the number of patients who answered "extremely pleasurable", "moderately pleasurable" or "slightly pleasurable" significantly decreased to 6 at T3 compared with T2 ($p < 0.05$).

Discussion

In this study, an art device was combined with sit-to-stand training; the number of sit-to-stand movements and the psychological effects were examined. The number of sit-to-stand movements before and after the intervention and the feeling of pleasure on the first day were significantly improved in the AD group compared with those in the CT group.

Li et al. [11] reviewed 16 papers regarding the

Table 2. Comparison of the number of sit-to-stand movements in both groups

	AD (n=11)			CT (n=17)		
	Pre	Post	Gain	Pre	Post	Gain
Number of stand-ups	80.1 [22.6]	110.7* [26.7]	29.8 [33.1]	101.9 [42.5]	115.8 [55.1]	13.9 [32.5]

mean (standard deviation).
AD, Art Device group; CT, Conventional Therapy group.
* Significant improvement at post-training compared to pre-training (*$p < 0.05$).

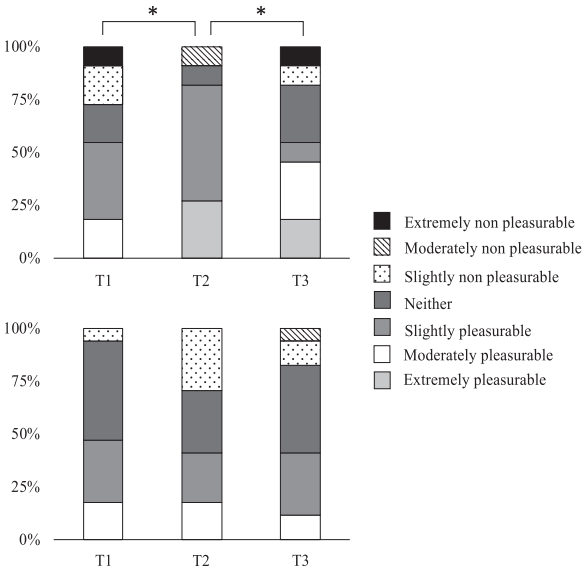

Figure 4. Results of the questionnaire on "feeling of pleasure."
The upper panel shows the AD group, the lower panel shows the CT group.
T1: before intervention of the first day
T2: after intervention of the first day
T3: after intervention of the last day
*There were significant differences between T1−T2 and T2−T3 in the AD group ($p < 0.05$).

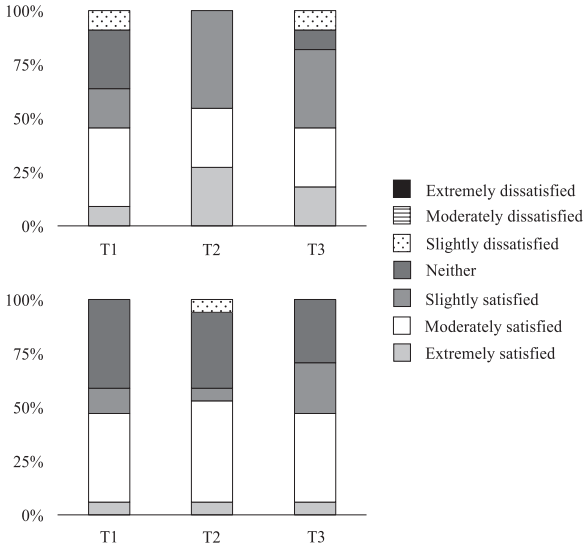

Figure 5. Results of the questionnaire on "feeling of satisfaction."
The upper panel shows the AD group, the lower panel shows the CT group.
T1: before intervention of the first day
T2: after intervention of the first day
T3: after intervention of the last day
There was no significant difference between T1−T2 and T2−T3 in both groups.

effects of balance function using VR in stroke patients. According to their report, balance training using VR improved the score of the Berg Balance Scale and Timed Up and Go test compared to conventional balance training. In addition, they also reported that intensive task-related activities provided by VR were more beneficial than conventional rehabilitation. Britton et al. reported that the addition of 30 min of daily sit-to-stand training to conventional training increased the number of daily standing movements as an effect of the sit-to-stand training [15]. The AD group in this study received the same amount of training and same training tasks as those of the CT group, however, the number of sit-to-stand movements in the AD group was significantly improved. Intensive practice of tasks using VR could lead to an increase in the number of exercises.

Intra-group comparison of the questionnaire results showed a significant improvement only in the feeling of pleasure before and after the intervention on the first day in the AD group. The VR content used in this study was art (a landscape photograph). Archer et al. reviewed the effects of art therapy on cancer patients, and found that art was one of the creative psychological interventions (CPI) and CPI was reported to be useful for anxiety, stress, anger, and mood in cancer patients [16]. Regarding the effect of art therapy on cerebrovascular patients, Kim et al. reported that drawing by the patients themselves was effective in improving motor function and motivation [17]. In the present study, we found that combining art elements with physical exercise enables patients to repeat the exercise while maintaining motivation. In addition, it is suggested that the amount of exercise can be increased by enhancing the patient's activity from the viewpoint of motor learning theory. Furthermore, although repeated training generally causes fatigue, it has been reported that training using VR results in less fatigue than normal practice [18]. The patients in the AD group in this study would have been less fatigued than those in the CT group, and this could have led to an increase in the number of exercises performed. On the other hand, since the number of sit-to-stand movements was measured for only 10 min, the training might have ended before fatigue occurred in some patients. Thus, the difference in effect would become clearer by setting the endpoint of measurement as the fatigue level.

The feeling of pleasure was not maintained until the last day in this study. Five types of landscape photograph were used in this study. Providing various landscape photographs in accordance with the patient's interests would enhance motivation. It would be possible to continue rehabilitation while increasing the level of activity by combining art devices with rehabilitation in the early stage of rehabilitation when patients are unaccustomed to exercise or have low motivation.

Acknowledgements

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