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Original Article

Effects of a standard transfer exercise program on transfer quality and activities of daily living for transfer-dependent spinal cord injury patients

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Abstract. [Purpose] The objective of this study was to analyze the effect of a standard transfer exercise program on the transfer quality and activities of daily living (ADL) in wheelchair-dependent spinal cord injury patients. [Subjects and Methods] We randomly divided 22 patients into 2 groups. During the intervention period, one group received treatment with both conventional physical therapy and a standard sitting pivot transfer exercise program (experimental group, n=12) and the other group was managed solely with conventional physical therapy (control group, n=10). The standard transfer exercise program comprised of an independent and a dependent program. Exercises were conducted 30 minutes daily, 3 times per week, over a period of 6 weeks. All subjects were tested using a transfer assessment instrument (TAI) and spinal cord independence measure (SCIM) before and after the intervention. [Results] Compared to the control group, the intervention group scored higher on both the transfer assessment instrument (TAI Part 1, Part 2, TAI total score) and spinal cord independence measure tests (SCIM mobility room and toilet score; SCIM total score). [Conclusion] In conclusion, the standard transfer exercise program is an effective tool which improves transfer quality and the ability of wheelchair-dependent spinal cord injury patients to carry out their ADLs.

Key words: Spinal cord injury, Dependent transfer, Motor imagery

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INTRODUCTION

Patients with spinal cord injuries who are wheelchair dependent use the strength and function of their upper limbs to aid manual wheelchair propulsion and to perform functional activities such as transferring out of their chair and moving paralyzed areas of the body, for example, to prevent the development of pressure sores[1)]. Transfer is performed by spinal cord injury patients during their activities of daily living (ADLs), such as during transfer to and from the bed, car seat and bath chair. Pivot transfer is the most typical movement method[2)], and should be performed for about 15 to 20 times a day[3, 4)].

Transfer is an essential element of the spinal cord injury patient's life, and when these patients cannot perform transfer, or when they find it increasingly difficult to transfer due to pain and damage to the musculoskeletal system, their functional activity decreases[1)].

There has been a lot of interest in the transfer technique and its ability to optimize functional activity for patients with disabilities and minimal residual function.

Malouin & Richards[5)] have focused on investigating the role of motor image training as a method to optimize motor function. The validity of motor imagery has been proven in numerous studies which have investigated this technique and its neurophysiological basis in patients with spinal cord injuries[5–11)]. Grangeon et al.[10)] showed that motor image training and general rehabilitation training in cervical injury patients improved their score in the performance of hand function tasks and

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also shortened performance time, thus demonstrating that motor image treatment and general rehabilitation treatment are effective when conducted together. However, because study of Grangeon et al.[10] has been conducted case study of cervical patients, it is a difficult to generalize.

Therefore, the purpose of this study was to investigate the effects of a standardized transfer exercise program based on motor learning and motor image training on the ability of patients with randomized spinal cord injuries to transfer and to perform their ADLs.

SUBJECTS AND METHODS

Study participants were recruited from rehabilitation centers through bulletin board notices posted at local hospitals. Twenty-two patients with spinal cord injuries were recruited from R. Hospital in Gyeonggi-do. All patients provided written informed consent. This study was conducted after approval from the institutional review board (IRB) of S. University.

All selected patients had spinal cord injuries, but specific criteria included 1) patients whose neurological function had plateaued over eight months from the start of the study[12]; 2) patients who were moving for >4 hours mainly using a manual wheelchair[13]; 3) patients who had been using a manual wheelchair for more than six months; 4) patients who were performing dependent pivot transfer; 5) patients who could receive training for more than 30 minutes; 6) patients whose muscle tension in all four limbs was below stage 3 of the Modified Ashworth Scale (MAS)[14]; and 7) patients who had not participated in a study similar to our own within the past year.

Exclusion criteria included 1) progressive spinal cord injuries (ie, myelitis); 2) comorbidities; 3) secondary damage (ie, bedsores); 4) inability to stand up without a support; 5) inability to receive training due to pain; 6) limited visual or auditory function, or limited joint range of movement; and 7) a history of any orthopedic surgery on the upper limbs, and in particular on the wrist.

The general characteristics of the study participants are shown in Table 2. After the selected subjects were divided based on restrictive and independent transfer, two groups were generated using the pseudo-random allocation method, and included 12 members in the experimental group and 10 members in the control group. The experiment was conducted for six weeks, and patients were orientated to the test method and the training method before the start of the study.

The experimental group and the control group conducted pre-checks related to transfer and ADL performance prior to the start of the experiment. Both groups received general physical therapy for six weeks (five 60-minute sessions per week), while the experimental group also followed a standardized transfer exercise program (three 30-minute sessions per week). Post tests were conducted for both groups after six weeks.

One week before the experiments and analyses, patients were educated about the training and measurement method during a session which lasted for one hour and occurred twice weekly.

The standardized transfer exercise program[13] is based on a clinical practice guideline (CPG) which describes a protocol that should be followed in order to preserve upper limb function for the therapist and wheelchair user. Therapist has provided transfer training for intervention group. The image training used in this study was based on this CPG (Table 1).

The standardized transfer exercise program process included image training for 1–2 weeks which was based on the motor learning method theory. In order to facilitate learning, participants were placed in a quiet environment without interruptions. Prior to image training, they were encouraged to sit in their wheelchair and assume the most comfortable posture to relax their bodies and minds. At the same time, they were presented with a 20-minute educational video which described the standardized biomechanical transfer posture related to upper limb damage, as well as the transfer technique, including information on the transfer working direction, joint angle, and move order. For the image education, training was repeated for ten minutes[15].

From weeks 2–4, a standardized transfer exercise program was conducted together with image training, and repeated 4 or 6 times, respectively. Patients underwent a 10-minute preparatory exercise, aviation exercise and wind-up exercise. If patients experienced any difficulties in learning and acquiring a specific technique, the transfer parts were visualized and the exercises were repeated and compensation strategies were presented. To facilitate learning, difficult parts were exercised first, then whole movements were connected, and feedback was provided based on motor learning theory[13].

As for the difficulty level of transfer practice, the height of the arrival point was adjusted, and based on studies of the real environment[16]. In order to adjust the level of difficulty, the environment was rearranged to include a mat, an undulating table, and a bench, and uneven transfer was performed according to the performance conditions with the points of arrival at 40 cm (bathroom height), 50 cm (mat height) and 60 cm (car height). If necessary, a push bar was used[13, 17]. No slide boards were used due to limited hand function and the possibility of causing pain[18].

From weeks 5–6, real transfer practice was conducted in conjunction with the standardized transfer exercise program (4 times) and image training (6 times). Patients performed 10 minutes of preparatory exercises, aviation exercises and wind-up exercises. The patients were recorded as they attempted to perform these exercises, and individual feedback based on motor learning theory was provided regarding how well the motions were performed[18].

During the arbitration period, if any subjects complained of dizziness, low blood pressure, or pain, they were allowed to rest until the symptoms disappeared.

General physical therapy was performed at R. Hospital using the principles of spinal cord injury treatment in both the experimental group and control group. Therapy was guided by physical therapists with clinical experience of 2 to 7 years,

Table 1. Standardized transfer exercise program

Stage	Weeks (of 6)	Position	Method	Time (min)
Image training	1–2	wheelchair sitting	Transfer seated operation (Pilot Education)	30
Dependent /Independent Transfer Seated exercise	3–4	wheelchair sitting and mat sitting	Preparatory exercise (10 min) Aviation exercise (10 min) Wind-up exercise (10 min) (Transfer Seated exercise + Image training)	30
Dependent /Independent Transfer Seated exercise	5–6	wheelchair sitting and mat sitting	Preparatory exercise (10 min) Aviation exercise (10 min) Wind-up exercise (10 min) (Transfer Seated exercise + Image training)	30

min: minutes

Table 2. General characteristics of dependent transfer seated exercise (n=22)

	Experiment group (n=12)	Control group (n=10)
Gender		
Male	8 (66.7%)[a]	8 (80%)
Female	4 (33.3%)	2 (20%)
Impairment level		
C4–C6 ASIA A	3 (25%)	4 (40%)
C7–C8 ASIA A	5 (41.7%)	5 (50%)
T1–T6 ASIA A	1 (8.3%)	0 (0%)
Cervical ASIA C	3 (25%)	1 (10%)
Age (years)	45.08 ± 13.81[b]	43.90 ± 15.22
Height (cm)	167.25 ± 8.49	170.10 ± 9.55
Weight (kg)	64.00 ± 9.34	60.50 ± 7.60
Duration (months)	25.75 ± 9.40	31.50 ± 9.50
MAS (stage)		
Upper extremity	0.58 ± 0.67	0.40 ± 0.70
Lower extremity	1.17 ± 0.83	0.70 ± 0.82

MAS: modified Ashworth scale,
[a]Number of subjects (percentage); [b]mean ± standard deviation

and occurred for 60 minutes 5 times a week, over a six-week period[19]. In order to examine transfer in this study, a Transfer Assessment Instrument (TAI) was used.

The TAI was developed by McClure et al.[20] and is an instrument which is used to assess the quality and quantity of transfer performance in wheelchair users. All patients are capable of receiving 10 points regardless of their injury level or amount of assistance required during transfer. The TAI is not biased based on subjects' age, disability type, gender, weight, muscle, balance, shoulder pain, period of wheelchair use or the number of times of transfer. In addition, the TAI does not require any expensive or highly technical equipment, and is an economical instrument which can easily and quickly be used in the clinic[20]. The score ranges of intra-rater reliability for TAI Part 1, Part 2 and Total 3 were r=0.81 to 0.85, and the score ranges of inter-rater reliability for TAI Part 1, Part 2 and Total 3 were r=0.74 to 0.88, which shows that the score has high reliability[21].

The TAI consists of two parts and three scores. Part 1 consists of 15 items, which are indicated by 'Yes', 'No' and 'N/A'. The score ranges from 0 to 10, and is calculated by adding up the score of each transfer performed, multiplying by 10 and dividing by the number of items applied. Part 2 consists of 12 items ranked on a Likert scale from 'Strongly disagree' (0) to 'Strongly agree' (4). The score ranges from 0 to 10 and is calculated by adding up the score of each transfer performed, multiplying by 2.5 and dividing by the number of items applied. The Total 3 score is calculated as the mean score of Parts 1 and 2[21].

In this study, the spinal cord independence measure (SCIM) was used in order to examine patients' ADLs.

SCIM is an instrument to assess spinal cord injury patients' daily life, and was developed by Catz et al[22]. This instrument

Table 3. Changes in transfer ability of Dependent transfer subjects (n=22)

	Test	Experiment group (n=12)	Control group (n=10)	t (p)
TAI part 1 (score)	Pre	5.74 ± 1.84[a]	5.92 ± 2.57	
	Post	7.82 ± 1.19	6.49 ± 2.06	
	Pre-Post	−2.09 ± 1.61	−0.57 ± 1.03	−2.561 (0.019)
	t (p)	−4.490 (0.001)	−1.758 (0.113)	
TAI part 2 (score)	Pre	4.93 ± 1.83	5.14 ± 2.32	
	Post	6.85 ± 1.23	5.27 ± 2.01	
	Pre-Post	−1.92 ± 1.09	0.14 ± 0.47	−4.828 (0.000)
	t (p)	−6.126 (0.000)	−0.917 (0.383)	
TAI total 3 (score)	Pre	5.33 ± 1.58	5.54 ± 2.40	
	Post	7.34 ± 1.07	5.89 ± 1.95	
	Pre-Post	−2.00 ± 1.15	−0.35 ± 0.71	−3.977 (0.001)
	t (p)	−6.052 (0.000)	−1.544 (0.157)	

TA: transfer assessment instrument
[a]mean ± standard deviation

Table 4. Changes in daily life performance of dependent transfer subjects (N=22)

	Test	Experiment group (n=12)	Control group (n=10)	t (p)
SCIM III room and bathroom item (score)	Pre	3.17 ± 2.69[a]	2.40 ± 1.35	
	Post	4.25 ± 2.60	2.40 ± 1.35	
	Pre-Post	−1.08 ± 1.00	0.00 ± 0.00	−3.425 (0.003)
	t (p)	−3.767 (0.003)	(1.000)	
SCIM III movement item (score)	Pre	7.17 ± 2.59	5.20 ± 2.53	
	Post	8.83 ± 3.35	5.20 ± 2.53	
	Pre-Post	−1.67 ± 1.30	0.00 ± 0.00	−4.029 (0.001)
	t (p)	−4.432 (0.001)	(1.000)	
SCIM III Total (score)	Pre	29.58 ± 7.37	23.50 ± 8.78	
	Post	31.33 ± 7.44	23.70 ± 8.94	
	Pre-Post	−1.75 ± 1.29	−0.20 ± 0.63	−3.463 (0.002)
	t (p)	−4.706 (0.001)	−1.000 (0.343)	

SCIMIII: spinal cord independence measure
[a]mean ± standard deviation

consists of three domains (self-activity, 20 points; breathing and sphincter control, 40 points; and movement, 40 points), and the total score is 100 points. the spinal cord independence measure (SCIM) is able to sensitively reflect changes in the spinal cord injury patients' function[23)].

The rate of concordance between two testers of SCIM was over 67% in 19 sub-items; over 80% in 16 items except sphincter control-bladder, indoor movement and outdoor movement, and between 83–96% on the items of room and bathroom[24)]. The internal consistency Cronbach's alpha was 0.847 to 0.849, and the reliability between the testers was r=0.745–0.962[25)]. The concurrent validity was r=0.779 to 0.790[25)] while the concurrent validity of the Korean SCIM was r=0.972 to 0.975, which showed a high correlation[24)]. Statistical analysis was performed using SPSS ver. 21.0. Data are presented as mean and standard deviation. The response sample t test was conducted in order to examine changes before and after each motor image. The independent samples t-test was conducted in order to examine the difference between groups. P values ≤0.05 were considered statistically significant.

RESULTS

The general characteristics of the study participants are shown in Table 2. The subjects' transfer was measured, and the changes in dependent transfer subjects in the experimental group and the control group after six weeks of training are shown in Table 3. The control group did not show any significant improvement after training as determined by TAI Part 1 score, Part 2 score and Part 3 score. The experimental group showed significant improvements after training ($p<0.05$). In a comparison of the difference between the two groups after training, there were more statistically significant differences in the experimental group than in the control group ($p<0.05$). The subjects' ADL performance was measured, and the changes in dependent transfer subjects in the experimental group and the control group before and after six weeks of training are shown in Table 4. The control group did not show any significant improvement after training in the SCIM room and bathroom item score, movement item score and total score. The experimental group showed significant improvements in SCIM scores after training ($p<0.05$) compared to the control group.

DISCUSSION

There was a significant effect on the quality of transfer in the dependent transfer experimental group compared to the control group. Rice et al.[13] conducted standardized transfer training based on the results of the existing transfer and assessed transfer at different times after discharge from hospital (six weeks, six months and one year). They found that there were no significant differences between groups among patients who performed independent transfers. However, in the assisted transfer group, patients who received the intervention performed higher quality transfers one year later compared to patients in the control group, which is in keeping with the results of this study. There were some limitations in the design of the study described, as patients were provided with at-home educational materials and assessed after discharge, thus making it difficult to control for environmental exposure. This limitation was avoided in our study as patients followed specific training times under the supervision of qualified physical therapists.

Compared to the control group, the dependent transfer experimental group showed significant improvements in a number of areas including 1) the room and bathroom items; 2) respiratory muscle and sphincter control; 3) motions for the prevention of bedsores; 4) transfer ability to the car seat, toilet and bath; and 5) wheelchair movement on the bed. All of these changes contributed to an improvement in functional independence. One limitation of this study is that the assistant's help ranged widely between 1% and 100%. However, we believe that the differences observed between the two groups in this study are still meaningful, because the SCIM takes into account whether or not patients are aided by an assistant. For patients who require only a little assistance, There are three very important factor in transfer technique. They are moment, muscle compensation, and head & hip joint relationship along with the level of neurologic damage[19]. The standardized transfer exercise program increased the understanding of biomechanical mechanisms, wheelchair preparing techniques and proficiency in learning compensation movements.

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