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Original Article

Effect of self-managed training of the paretic upper limb in stroke patients in the convalescent phase: application of the Transfer Package, an element of CI therapy

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ABSTRACT

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Objective: Transfer package (TP) is one of the elements of constraint-induced movement therapy (CI therapy). This study evaluated the effectiveness of implementing TP as self-training in addition to occupational therapy for the upper paretic limb in the convalescent phase after stroke.

Methods: Twelve patients at 8 to 16 weeks after onset of primary stroke were recruited in the study. A comparative study was conducted by dividing the subjects into two groups: a group that implemented self-training consisting of TP in addition to routine occupational therapy (TP group) and a group that implemented self-training including stretching and self-assisted exercise in addition to routine occupational therapy (non-TP group). In both groups, self-training was conducted for approximately 30 min a day, everyday for three weeks. At the beginning and three weeks after intervention, the patients were evaluated using the manual function test (MFT) and the motor activity log (MAL). Wilcoxon signed rank test was used to evaluate the changes in various evaluation parameters before and after intervention.

Results: The MFT score improved significantly in both groups. For the MAL evaluation, the Amount of Use and Quality of Movement improved significantly in the TP group compared to the non-TP group.

Conclusion: The present study indicates that self-training incorporating TP in the convalescent phase of stroke is effective in improving the amount of use and quality of movement of the paretic upper limb at the level of daily life.

Key words: convalescent phase of stroke, paretic upper limb function, self-training.

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Introduction

In rehabilitation for upper limb hemiparesis after stroke, training involving repetition of specific movements (including goal-oriented exercise, repetitive upper limb exercise, mirror therapy, and repetitive facilitation exercise), constraining use of the non-paretic upper limb, and therapy that forces use of the paretic upper limb in daily life are strongly recommended [1]. As a therapy that constrains use of the non-paretic upper limb and forces use of the paretic upper limb, constraint-induced movement therapy (CI therapy) has been validated by evidence obtained from large-scale randomized studies [2]. Moreover, report has shown that the CI therapy is also useful for sensory ataxia [3].

However, the addition of a transfer package (TP) to the above-mentioned concentrated training has attracted attention in recent years. The TP is a behavioral strategy with the goal to promptly transfer the new functions gained from training of the paretic upper limb to the patient's daily life. The strategic approach of TP is that through concentrated training and use of the paretic upper limb in activities of daily living, the occupational therapist explains to the patient the state of his/her paretic upper limb and the problems, and instructs the patient techniques that can overcome the problems. Through these procedures, the objective of TP is to improve the frequency of use and quality of movement of the patient's paretic upper limb in daily life, consequently to achieve behavioral modification of the paretic upper limb. In other words, TP is a method to modify the subject's behavior by helping the patient learn how to use the paretic upper

limb in daily living [4, 5]. The TP consists of three elements: "promotion of self-monitoring of the paretic upper limb," "behavioral contract to use the paretic upper limb in daily life," and "problem-solving technique." First, the patient will self-monitor the status of use of his/her paretic upper limb by feedback of the use situation from observation of daily life or by using the motor activity log (MAL). Next, the patient will make a contract regarding use of the paretic upper limb in daily life. He/She will list up around 10 goals of using the paretic upper limb in daily life and plan the training to achieve these goals. Apart from the 10 goals, the patient will simulate as many other situations as possible which involve use of the paretic upper limb and practice to use the limb. As problem-solving technique, the occupational therapist will work with the patient to identify roles of the paretic upper limb and the methods of use in various movements.

In the kaifukuki ward of our hospital, although patients are often asked vaguely to "make more efforts to move the arm and hand," due also to the large number of elderly subjects, many patients do not satisfy the indications for CI therapy [6] and many are not capable of implementing training for long periods of time. In addition, during the limited period of hospitalization, interventions for patients who aim to return home or return to work tend to center on essential tasks for activities of daily living (ADL), instrumental activities of daily living (IADL), work resumption support, and leisure activity support. For this reason, there is an impression that CI therapy that constrains the non-paretic upper limb aiming to overcome learned non-use of the paretic upper limb is an important strategy to improve ADL and IADL performed by bilateral upper limbs.

Due to the difficulty to implement intensive training specifically for the paretic upper limb to achieve the goal during the limited hospitalization period, our hospital therefore aims to improve the frequency of use and quality of movement of the paretic upper limb by incorporating bilateral limb movements during ADL and IADL training.

The studies reported previously used TP exclusively as one element of CI therapy, and there is no report of using TP in combination with routine occupational therapy including upper limb function training and ADL training, without constraining the non-paretic limb [4, 5]. In the present study, we examined the effect of self-training incorporating TP in addition to occupational therapy in patients in the convalescent phase of stroke.

Table 1. Indications for constraint-induced movement therapy.

- Capable of walking independently.
- Capable of independent self-care.
- Wrist extension of paretic side: active 20° or above.
- I to III finger MP joint extension of paretic side: active 10° or above.
- No subluxation and no shoulder-hand syndrome, mild pain permitted.
- Mini Mental State Examination (MMSE): 20/30 or above.
- No remarkable higher brain dysfunction (aphasia, agnosia, apraxia).
- No psychiatric disease and no dementia.
- No medically uncontrolled serious comorbidities.
- Markedly high risk of falling.

Subjects

Twelve stroke patients who were hospitalized at the kaifukuki ward of our hospital between April and November 2014 were studied. The subjects were selected with reference to the indications for CI therapy reported by Domen et al. (Table 1), according to the criteria established independently in our hospital (Table 2). Before participation in the study, each subject was given explanations of the study according to the contents approved by the ethical committee of the hospital, and each gave written informed consent.

The subjects were divided into two groups by the intervention method: a group that implemented self-training including TP in addition to occupational therapy (TP group), and a group that implemented self-training including stretching and self-assisted exercises in addition to occupational therapy (non-TP group). The effects of interventions were compared between two groups.

The subjects were assigned to the two groups by the time of admission. Six patients admitted from April 2014 who satisfied the indications (Table 2) were assigned to the TP group. Six patients admitted from August 2014 who satisfied the indications (Table 2) were assigned to the non-TP group.

The TP group (n=6) consisted of 2 men and 4 women aged 69.5±7.4 years, with right-sided hemiparesis in 2 patients and left-sided hemiparesis in 4 patients. The duration from stroke onset to initiation of self-training including TP was 86.0±15.8 days (Table 3). The non-TP group (n=6) consisted of 4 men and 2 women aged 65.8±11.8 years, with right-sided hemiparesis in 3 patients and left-sided hemiparesis in 3 patients. The duration from stroke onset to initiation

Table 2. The indications at our hospital.

- Degree of paresis in upper limb and fingers: both Brunnstrom Stage IV or above.
- No shoulder-hand syndrome, mild pain permitted.
- No remarkable higher brain dysfunction (aphasia, agnosia, apraxia).
- No psychiatric disease and no dementia.
- No medically uncontrolled serious comorbidities.

Table 3. The group of subjects who underwent occupational therapy incorporating transfer package (TP).

ID	Gender	Age	Time from stroke onset (days)	Paretic side	Br. Stage (upper limb /fingers)	Manual function score (MFS)	Amount of use (AOU)	Quality of movement (QOM)
A	Female	78	93	Right	IV/IV	34.3	0.63	0.99
B	Male	58	58	Left	IV/V	40.6	0.63	1.25
C	Female	75	87	Left	IV/IV	62.5	0.90	0.33
D	Female	69	101	Left	IV/IV	28.1	1.23	1.07
E	Female	73	79	Right	IV/IV	50.0	0.43	0.50
F	Male	64	98	Left	IV/IV	28.1	0.43	0.29
	Average	69.5±7.4	86.0±15.8			40.6±13.5	0.70±0.30	0.73±0.41

Maximum score: MFS; 100, MAL-AOU and -QOM; 5.0.

Table 4. The group of subjects who underwent occupational therapy without incorporating transfer package (TP).

ID	Gender	Age	Time from stroke onset (days)	Paretic side	Br. Stage (upper limb /fingers)	Manual function score (MFS)	Amount of use (AOU)	Quality of movement (QOM)
G	Male	58	92	Right	IV/IV	21.8	0.41	0.25
H	Female	80	95	Right	IV/V	43.7	2.25	1.83
I	Male	81	137	Left	IV/IV	43.7	0.00	0.00
J	Male	64	68	Right	IV/IV	21.8	0.33	0.33
K	Female	51	54	Left	IV/IV	53.1	1.37	1.25
L	Male	58	76	Left	IV/IV	53.1	1.71	2.00
	Average	65.8±11.8	87.0±28.8			39.4±14.3	1.01±0.89	0.94±0.86

Maximum score: MFS; 100, MAL-AOU and -QOM; 5.0.

of self-training excluding TP was 87.0±28.8 days (Table 4).

Methods

The occupational therapists who conducted evaluation and intervention were given explanations on the implementation of the study, but were not given detailed explanations about the objective and design of the study. They were also not given explanation on the assignment of groups.

1. Intervention methods

During the period of hospitalization, both groups underwent routine occupational therapy for 60 to 80 min a day. Routine occupational therapy included range of motion exercise, muscle strengthening exercise, upper limb function training, ADL training, IADL training, and leisure activity support. In additional to the routine occupational therapy, both groups implemented self-training 30 min a day for 3 weeks.

The contents of self-training were as follows. In the TP group, the patients self-monitored the status of use of their paretic upper limb by feedback of the use situation from observation of daily life or by using the MAL. Next, the patients made a contract regarding use of the paretic upper limb in daily life. Each patient set around three goals that were meaningful to him/her, such as “wishing to cook with assistance from the affected arm” and “wishing to use the spoon with the affected hand.” The level of difficulty of the goal was graded into “goal can be achieved soon,” “goal can be achieved with effort,” and “goal can be achieved somehow if given enough effort,” considering that acquiring a sense of achievement would motivate patients to adhere to self-training. Apart from the goals, self-training was conducted for around 10 simulated situations in the ward which involved using the paretic upper limb. Some examples of bilateral upper limb tasks frequently implemented were “drinking water by holding the cup with both hands” and “wiping the face by holding the towel with both hands.” The occupational therapist and the patient worked together to set the goals and to decide items of using the paretic upper limb in daily life, and prepared a table of self-training toward achieving the goals. The self-training table contained task-oriented type (including task-specific type) upper limb function training, bilateral hands training, and ADL training. The training table was self-checked by the subject during training, and was therefore a self-managed type

training. During occupational therapy session, the occupational therapist confirmed whether the patient was able to do the tasks in actual situations, and in case of any problem, the occupational therapist worked with the patient to solve the problem.

In the non-TP group, in addition to routine occupational therapy, the subjects underwent self-training including self-assisted exercise and stretching.

2. Evaluation methods

In both groups, the function of the paretic upper limb as well as the frequency of use and quality of movement were observed before and after intervention.

As indicator of the paretic upper limb function, the manual function test (MFT), which is an upper-limb function assessment measure for hemiparetic patients after stroke, was used. The MFT has a full score of 32. To convert to 100, the measured MFT score was multiplied by 3.125 to give the manual function score (MFS). As indicators of frequency of use and quality of movement of the paretic upper limb, the Amount of Use (AOU) and Quality of Movement (QOM) of the MAL were used.

3. Statistical analyses

The pre-intervention MFT score (MFS) as well as AOU and QOM of the MAL were compared between two groups using Mann-Whitney test. The changes in MFT score (MFS) as well as AOU and QOM of the MAL before and after intervention were analyzed using Wilcoxon signed rank test. Statistical analyses were conducted using SPSS 12.0J for Windows. The significant level for all analyses was less than 5%.

Results

The pre-intervention MFT score (MFS) as well as AOU and QOM of the MAL were not significantly different between the TP group and non-TP group (MFS; p=1.000, AOU; p=1.000, QOM; p=0.872).

The MFT score (MFS) improved significantly after intervention in both groups (TP group: p=0.042. Non-TP group: p=0.043).

Comparing MAL evaluation before and after intervention, AOU and QOM were significantly improved only in the TP group (TP group: AOU; p=0.027, QOM; p=0.028. Non-TP group: AOU; p=0.197, QOM: p=0.068). (Figures 1−3).

Discussion

From the results of this study, although both groups showed similar improvement at functional level, the TP group showed significant improvement in AOU and QOM of the paretic upper limb at daily life level.

The graded repetitive arm supplementary program (GRASP) is currently the Canadian stroke rehabilitation guideline. GRASP is an upper limb exercise program based on self-managed training and consisting of graded and repetitive tasks. The program is designed for subacute stroke patients. In addition to 3 or 4 h of physiotherapy and occupational therapy per week, patients perform self-managed (task oriented) training of around 30 min for 4 weeks. GRASP has been reported to have equivalent effects on MAL (AOU and QOM) as CI therapy [7].

Furthermore, by increasing the frequency of use of the paretic upper limb in daily life, TP may induce

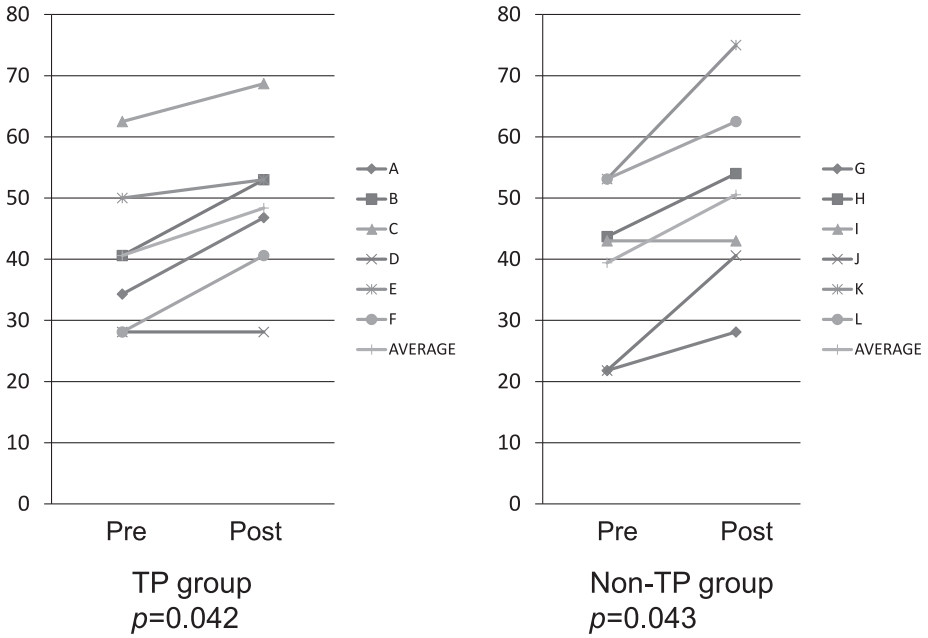

Figure 1. Manual function score (upper limb function) of two groups before (Pre) and after intervention (Post).

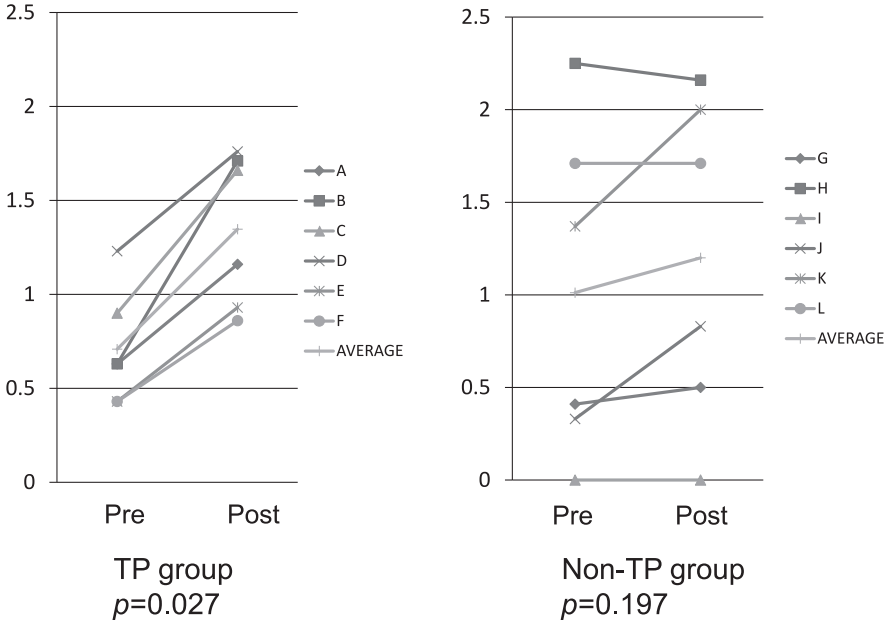

Figure 2. Amount of use (AOU) of two groups before (Pre) and after intervention (Post).

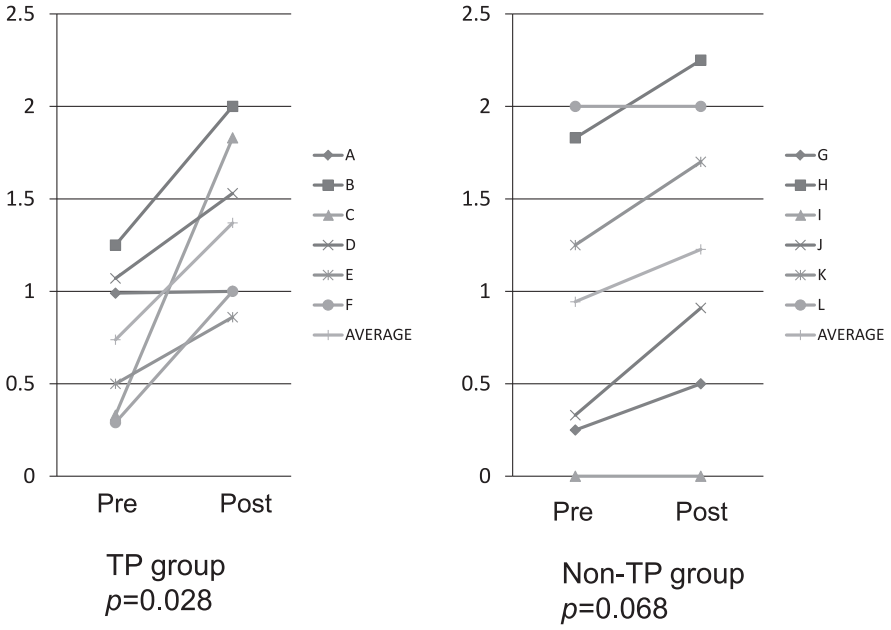

Figure 3. Quality of movement (QOM) of two groups before (Pre) and after intervention (Post).

behavioral modification of patients based on motor learning [4, 5].

As in previous studies, implementation of self-managed training for approximately 30 min a day in our kaifukuki ward successfully induced patients to actively use the paretic upper limb in daily life, causing behavioral modification in the subjects based on motor learning and consequently improving AOU and QOM.

The GRASP study recruited subacute stroke patients, and the mean duration from stroke onset to beginning of self-training was 20±7.1 days [7]. In the present study, the duration from stroke onset to initiation of self-training incorporating TP was 86±15.8 days. The recovery plateau of the paretic upper limb has been reported to be 1 month, with a maximum of 3 months [8]. The subjects in our study were confirmed to be near the plateau state. Among these patients, both groups showed the same degree of improvement at functional level, but AOU and QOM of the paretic upper limb at daily life level were improved significantly only in the TP group. These findings indicate that even in the convalescent phase,

self-managed training is a useful technique that improves the frequency of use and quality of movement of the paretic upper limb. The convalescent phase is a phase of transition to daily life. It is necessary to establish self-managed training while being hospitalized in the kaifukuki ward, for the patient him/herself to plan training tasks for the paretic upper limb, to simulate the situations of using the paretic upper limb in real life, and to review and adjust the methods of using the paretic limb. The convalescent phase is also the course toward natural recovery. Learning self-managed training, experiencing improvement of not only function but also frequency of use and quality of movement of the paretic upper limb, and actually achieving success during this period will promote meta learning, and further improvement after discharge from the kaifukuki ward can be expected.

In the kaifukuki ward of our hospital, although patients are often asked vaguely to "make more efforts to move the arm and hand", partly because of the large number of elderly subjects, many patients do not satisfy the indications for CI therapy as shown in Table 1 [6] and many are not capable of implementing training for long periods of time. Furthermore, it is difficult to conduct interventions concentrating only on the paretic upper limb during the limited hospitalization period. For this reason, as a means to achieve the primary goal of returning home and improving quality of life by acquiring ADL and IADL, as well as to achieve the secondary goal of acquiring role and pleasure, it is important to incorporate bilateral upper limb exercises to improve the function, frequency of use and quality of movement of the paretic upper limb.

Most of the movements conducted by humans are bilateral. Even though a movement is performed with the intention of using unilateral upper or lower limb, somehow the contralateral upper or lower limb becomes involved in the movement subconsciously. When the arms on both the "good side" and "bad side" are moving simultaneously, the "bad side" shows better movement than usual. In other words, when moving both upper limbs symmetrically, the quality and accuracy of the paretic limb are improved [9].

In addition, meaningful task-specific training in daily life, such as holding a cup with the paretic upper limb and using the non-paretic upper limb to assist with moving the cup to the mouth, and wiping the face with a towel held by two hands, has been reported to result in greater brain plasticity compared to meaningless task-specific training [10].

In the present study, without constraining the non-paretic upper limb but only incorporating activities conducted by bilateral upper limbs and activities conducted only by the paretic upper limb during life in the hospital, the repetitive training gradually habituated the movement facilitating motor learning, which probably resulted in the improvement of the frequency of use and quality of movement of the paretic upper limb. In this study, the patients used the paretic upper limb not only to acquire hospital ADL, but also in interventions aiming to acquire roles and pleasure, such as "using the paretic hand to assist in cooking." Incorporating bilateral upper limb movements in exercises that are meaningful to the subjects and experiencing the success of achieving the graded goals may have contributed to improving the frequency of use and quality of movement of the paretic upper limb.

Conclusion

The GRASP study reported that subjects voluntarily continued GRASP after the 4-week intervention period, and further improvement was observed in a large number of cases [7].

In the present study, although the follow-up after intervention has not been completed, further study on a larger number of cases is required to validate the present results, and to examine the possibility of long-term functional improvement of the paretic upper limb including after discharge from hospital.

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