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Effects of the TrainingBIG[™] and Task specific concepts on turning over 180 degrees in patients with Parkinson's disease

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Abstract

Background: Difficulty in turning is problematic for patients with Parkinson's disease (PD) and is found to be associated with the risk of fall and hard to be remedial.

Objective: To investigate the effects of physical therapy on turning over 180 degrees in patients with PD.

Methods: Thirteen patients with PD were randomized into 2 groups which were the treatment (n=7) and the control (n=6) groups. All participants were assessed demographic data, severity by Modified Hoehn and Yahr Scale, and Unified Parkinson's Disease Rating Scale. At pre- and post-assessments, the participants were tested their turning characteristics over 180 degrees by using a gait mat synchronized with video camera. For the treatment group, they received physical therapy program. Both groups of participants continued their earlier medical treatment and having stable medical status. The treatment group received training for 3 times a week over 4 weeks. Turning step and turning time were compared between pre- and post-assessments in each group, and between the treatment and control groups.

Results: Significant difference of turning step was found between pre- and post- assessments (p=0.041) in the treatment group. In addition, turning step was found to be significant difference between the treatment and the control groups (p=0.010) at post- assessment. For the turning time, no significant difference was found neither between pre- and post- assessments in each group nor between the treatment and the control groups.

Conclusion: The present findings indicated that physical therapy would be beneficial to improve turning step in patients with PD.

Keywords: Parkinson's disease, Turning, TrainingBIGTM, Task specific

1. Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder, leading to gradual loss of the neurotransmitter dopamine in the brain. Four motor symptoms considered as cardinal features in patients with PD are bradykinesia, rigidity, resting tremor, and postural instability (1). Other motor symptoms frequently presents in patients with PD include gait dysfunction, abnormal posture, speech and swallow disturbance, mask-like face expression, and fine movement impairment. For non-motor symptom, patients may present autonomic dysfunction, neurobehavioral problem, impairments of cognition, perception and sensation, and sleep disturbance depending on severity of individuals (2). In addition, difficulty in performing a complex task as turning is extremely considered in practice (3, 4) and reported to be related with a greater risk of fall in patients (4). Possible factors of difficulty in turning come from loss of trunk rotation capability, loss of intersegmental flexibility, interlimb coordination, postural instability, and bradykinesia (5, 6). When the disease progresses, some patients express difficulty in gait initiation and termination, diminished step length and speed prior a plan to start and stop the steps during turning (4, 7). Rotation of the head toward the travel direction followed by rotation of the trunk in normal was replaced by nearly simultaneous of the head and the trunk instead (8).

Physical therapy is one of the major parts of rehabilitation for patients with PD. Many studies reported the positive outcomes of various types of exercise in patients with PD (9-15). Ellis and colleagues in 2005 (11) investigated the effects of physical therapy program in 68 patients with PD. After training for 6 weeks, greater improvement was shown in the treatment group than the control group. Scandialis and colleagues in 2001 (15) found that muscle strength and functional capacity of walking were improved after training the leg muscles for 8 weeks. In addition, comparative study on different intensive exercises established that higher intensity of exercise had better improvement for functional ability and movement quality in patients with PD (16).

Nowadays, concept of large amplitude training for patients with PD was applied in speech training by using the Lee Silverman Voice TreatmentTM (LSVTTM) (17). Given the success of LSVTTM and general nature of speed–amplitude phenomenon, training is extended to the limb movement which is called the TrainingBIGTM following the same principle in speech therapy (18). The principle keys of this concept are multiple repetitions, high intensity, and complexity for contributing neuroplasticity and brain reorganization in animal models (19). The trainingBIGTM had been developed and was used as a novel rehabilitation approach for correcting mobility impairment in patients with PD (18, 20)

However, evidences supported about the efficacy of physical therapy treatment on turning in patients with PD are still limited. Therefore, the present study aimed to investigate the effects of physical therapy treatment on turning characteristics in patients with PD based on the TrainingBIGTM and task-specific concepts.

2. Materials and Methods

2.1 Participants

Participants were the patients who had been diagnosed as an idiopathic PD by neurologists. They were recruited from March 2011 to July 2011 from Movement Disorder Clinic, Division of Neurology, Faculty of Medicine Siriraj Hospital, Mahidol University. They were randomly allocated into 2 groups; the treatment and the control groups. The age, gender, and severity of both groups were similar. All participants were asked to sign an informed consent approving by the ethical committee of Mahidol University Institutional Review Board, Mahidol University (MU-IRB 2011/072.2503).

Inclusion criteria for all participants were having the modified Hoehn and Yahr Stage 2.5-3, stable PD medication at least 1 month without wearing-off phenomenon, able to walk independently without using assistive device, able to follow commands and instructions, having right leg dominant, and the age ranged from 60-75 years. Exclusion criteria were clinical diagnosis of dementia, having other neurological, cardiopulmonary, or other musculoskeletal problems such as fracture, severe pain, arthritis which influenced the test performance, attending other exercise programs during participation, having high blood pressure (more than 140/90 mmHg), hemodialysis, and visual problems which could not be adjusted by lens or glasses.

All patients with PD were assessed the demographic data and motor skill by the Unified Parkinson's Disease Rating Scale (UPDRS) items III and IV. Thirteen patients with PD who participated in this study were divided into 7 patients with PD for the treatment group and 6 patients with PD for the control group. They were 6 males and 1 female for the treatment group and 5 males and 1 female for the control group. There were no significant differences in the age, severity, UPDRS score (items III and IV), and number of freezing in gait as demonstrated in Table 1.

	Treatment (n=7)	Control (n=6)	. a
Variables	Mean ± SD	Mean ± SD	<i>p</i> -value [*]
Sex (male/female)	6/1	5/1	-
Age (years)	67.71 ± 5.02	68.78 ± 5.47	0.613
Modified Hoehn and Yahr Stages	2.50 ± 0.00	2.50 ± 0.00	1.000
PD onset (years)	5.29 ± 2.06	4.67 ± 4.03	0.614
Items III and IV of the Unified Parkinson's Disease Rating Scale (UPDRS) (scores)	21.43 ± 10.55	19.00 ± 3.22	0.885
Number of freezing in gait (times/day)	2.57 ± 0.79	2.33 ± 0.82	0.430

Table 1. Characteristics of p	patients with PD.
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a = p-value Mann-Whitney U test

2.2 Turning assessment

Both the treatment and the control groups were assessed their turning characteristic at the same period (pre- and post-assessments). All assessments were evaluated at the Postural Control and Balance Laboratory, Faculty of Physical Therapy, Mahidol University. For turning assessment, participants were asked to standing approximately at middle of platform in a relax position. Video camera was placed perpendicular to the front of participants. Participants were instructed to initiate turning over 180 degrees with their right leg and completed the task when they faced on oppositely to the starting position. Light signal was set in front of the participants. Instruction of the turning task was "Please turn to see the picture on the wall behind you when see the light signal". Five minutes break between each trial were allowed during performing the task for 3 trials. Turning step and turning time were averaged from three performing trials for the next step of analysis.

2.3 Physical Therapy Program

Both groups of participants continued their earlier medical treatment and having stable medical status and were recorded their daily activities by phone once a week. Only the treatment group received physical therapy program with the physical therapist at Faculty of Physical Therapy, Mahidol University. Exercise duration was set approximately 45 minutes per round, 3 times per week. Five minutes break or until the patients' readiness were allowed between each of training program. The exercise program was based on the TrainingBIGTM and task specific concepts. It composed of breathing exercise and chest mobilization, stretching exercise, and training of alternative arm swing, and turning.

- Breathing exercise and chest mobilization

Deep breathing and chest mobilization exercises were performed in the beginning of program for 2 sets. Participants performed 3 repetitions for each set. Instruction for deep breathing exercise and chest mobilization were "Deeply inhale through your nose. Your stomach inflated and pushed the hands upward. Then exhale long through your mouth. Your stomach deflated, and the hands moved downward" and "Deeply breathe and let your chest moved as much as possible while spreading your arms as much as possible. Then exhale while lowering your arms to the hypogastrium".

Stretching exercise

Upper and lower trunks, hip flexor, and plantarflexor muscles were stretched with an assistant from physical therapist based on the TrainingBIGTM concept (18). During perform stretching, physical therapist always asked stretch feeling from patients as the perceptual feedback for preventing pain and injury. Each stretching was held for 15 seconds and performed 10 repetitions or until the muscles were relaxed.

- Alternate arm swing training

Participants were trained to swing the arms alternatively following the beat of a metronome at 1.8 Hz for 1 minute and were performed the arm swing for 3 sets (21). Instruction for the alternate arm swing training was "Swing both arms alternately by raising and stretching them as high as you can, following the pace of sound."

- Balance training

Locomotor balance training was performed by marching. They were allowed to hold the back rest of the chair for safety. Then, they were asked to lift the left and right legs as high as possible alternatively following the beat of metronome at 1.8 Hz for 1 minute and performed for 3 sets (21).

Turning over 180 degrees training

Participants practiced how to turn over 180 degrees by stepping on the marks which was classified into 3 patterns according to the task difficulty (Figure 1). Degree of turning was set at 30, 45, and 60 degrees corresponding to each participant's performance. Participants practiced turning over the left and right sides for 5 times per each side. They were allowed to catch the back rest of the chair during turning for preventing fall. Resting period was set at around 5 minutes between each set.



Figure 1. Three patterns of turning training (30, 45, and 60 degrees).

2.4 Statistical Analyses

Due to number of patients with PD who met inclusion and exclusion criteria was small, Mann-Whitney U test was used to compare the variables between the treatment and the control groups. Wilcoxon Signed-Rank test was used to compare the variables between pre- and post- assessments.

All data were analyzed by using the SPSS version 18.0, S/N 5082368 NY, US. The statistical significance level was set at *p*-value less than 0.05.

2.5 Sample size calculation

Sample size was analyzed for between and within groups comparisons from the pilot study (n = 4 subjects) in primary outcome (turning step) at the alpha level of 0.05 (22). Number of subjects was 8 per each group was sufficient for discriminate the mean values in between and within groups comparisons.

3. Results

3.1 Within group (pre- and post- assessments) comparison

As demonstrated in Table 2, significant difference of turning step is found between pre- and post- assessments only in the treatment group (p=0.041), but not in the control group (p=0.456). There is no significant difference of turning time between pre- and post- assessments in neither the treatment group (p=0.128) nor the control group (p=0.735).

3.2 Between groups (the treatment and the control) comparison

Comparisons of turning step and turning time between the treatment and the control groups at pre- and post- assessments are demonstrated in Table 2. At pre-assessment, there is no significant difference of turning step and turning time between the treatment and the control groups. At post-assessment, only the turning step was found to be significant difference between group comparison.

Variables	Groups	Pre	Post	<i>p</i> -value ^a
Turning step (step)	Treatment	4.95 ± 1.78	3.62 ± 0.78	0.041*
	Control	7.33 ± 4.98	7.56 ± 4.16	0.456
	<i>p</i> -value ^b	0.352	0.010*	-
Turning time (sec)	Treatment	5.07 ± 1.00	4.59 ± 1.18	0.128
	Control	5.91 ± 2.43	5.71 ± 1.65	0.735
	<i>p</i> -value ^b	0.886	0.253	-

Table 2. Comparisons of turning step and turning time within and between groups (treatment and control)

^a = *p*-value Wilcoxon Signed-Rank test

b = p-value Mann-Whitney U test

* = significant difference (p-value < 0.05)

4. Discussion

The present study tried to correct the patients' movement based on the TrainingBIGTM and the task specific concepts (18, 23). As demonstrated in the participants characteristics, we tried to control the confounding factors such as the age, gender, and severity which could affect the findings (2, 16, 24). Thus, the improvements in patients with PD were likely to come from the exercise program. Previous studies presented positive effects of physical therapy on an improvement of motor performance related to changes in posture and rigidity (10-12, 16). Correction of the movements and physical activities may break immobility cycle and encourage the patients to have a good quality of the movement when performing the task (3, 11, 14).

Turning step was found to be significantly improved as a reduction of turning step at post-assessment in the treatment group. Significantly decreased of turning step was found in the treatment group when compared to that of the control group. An improvement of turning step comes from several considerations. Firstly, the exercise program included stretching of upper trunk, lower trunk, hip flexor, and ankle plantarflexor muscles. This stretching exercise was shown to be a strategy to facilitate changes in turning task and prepare the muscle for action (25). It could be helpful for patients with PD by improving muscle flexibility, joint range of motion, posture due to enhancement of trunk mobility, and activating the extensor muscles (26). Secondly, application of the TrainingBIGTM encourages the patients to focus on movement and learns how to use more effort to perform the task (18). In addition, this principle empowers the patients to move bigger, reduces bradykinesia symptom, induces brain reorganization to learn movements, and increases the step length during turning over 180 degrees (23). Thirdly, task specificity may improve turning performance by inducing learning how to step when performing the task repeatedly (27). Patients with PD were able to memorize the step during turning following the marks and hence had tendency of decreased turning step due to the task specific training. In contrast, the control group demonstrated tendency of increased turning step at the post-assessment.

For the turning time, minimal reduction of this variable was found in the treatment group. Even

the turning time was not shown significant difference between pre- and post-assessments in both the treatment and the control groups. The declination of turning time was corresponding to the reduction of turning step in the treatment group. Likewise the turning step, an improvement in turning time may result from the exercise program which included muscle stretching (25), TrainingBIGTM (18, 23), task specificity (27), and cues used during facilitating the turning task (28). Similar to a previous study, Willems and colleagues (29) reported that auditory cue was able to use for improving turning task in patients with PD. Patients with PD who were in the non-cue condition took more time and more step in turning than the cue condition. Moving the arms alternatively following auditory rhythm coincided with the improvement of movement's coordination, increased transverse thoracic and pelvic rotation, and increased stride length. For the control group, the present study demonstrated that the averaged turning time was slightly decreased at post-assessment.

Limitation of the study

The present study was limited by a small number of participants and could not generalize to other (4) stages of patients with PD. In addition, the consequent in follow-up period was not assessed.

5. Conclusion

This study provided the effects of physical therapy treatment on turning over 180 degrees in patients with PD. After training over 4 weeks, the findings demonstrated tendency of turning performance improvement in the treatment group while the control demonstrated tendency of worsening. Thus, exercise program used in present study may promote turning performance in patients with PD.

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