Effects of Home Exercise on Physical Function and Activity in Home Care Patients with Parkinson’s Disease

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Abstract. [Purpose] The aim of this study was to clarify the effects of guidance in home exercise on physical function and the amount of activity in home care patients with Parkinson’s disease (PD). [Subjects and Methods] A 2-month home exercise intervention consisting of self-administered exercise by patients (self-exercise) and home visit exercise therapy guided by a physical therapist (home visit exercise) was conducted in 10 home care patients with PD to compare changes in physical function, activities of daily living, and postural status between before and after the intervention. [Results] A decreased number of chief complaints and alleviation of fear of falling were observed after the intervention. In terms of physical function, a significant increase in flexibility and muscle strength were observed, although no significant changes were found in activities of daily living, gait, and balance. Although there was no significant change in the total amount of daily physical activity, the analysis of daily posture changes revealed a significant reduction in the percentage of time spent lying down and a significant increase in the percentage of time spent sitting after the intervention. [Conclusion] Guidance in home exercise in home care patients with PD can be effective in making self-exercise a habit, improving range of motion and muscle strength, and reducing the time spent in a supine position.

Key words: Exercise therapy, Home care patients with Parkinson’s disease, Physical activity

INTRODUCTION

Parkinson’s disease (PD) is a neurodegenerative disease of the extrapyramidal system. A curative therapy has not been established for PD, and a combination of drug therapy, surgical treatment, and physical therapy is recognized as the standard treatment1, 2).

The estimated incidence of PD in Japan is 50 per 100,000 in the overall population and 200 per 100,000 in the population aged 64 or older3). The number of patients with PD is expected to additionally increase with the aging of the population in the future4). Rates of discharge to home in patients with PD are high despite heavy dependence on medical treatment5), and 85.4% of all patients are under care at home6). Accordingly, any support system or intervention to maintain physical function in home care patients is important. In Japan, the nursing care insurance service seems to play a major role under the current social security system in regard to health insurance and nursing care insurance. One survey of outpatients with PD revealed that 75% of PD have been certified as being in need of care, and that the use of ambulatory care and ambulatory rehabilitation services by PD patients has increased by 38% and 23%, respectively, compared with a survey conducted 8 years previously7). The number of users of nursing care insurance is also increasing, although the service contents do not satisfy their needs8); tailored intervention is necessary because of great variations in symptoms and severity among patients2, 8). In addition, in our study of exercise therapy in home care patients with PD7), we found that a demand existed for intervention tailored to symptoms and their severity, because the rehabilitation service provided by nursing care insurance is centered on group exercise and exercise therapy using machines.

Intervention by guidance or by personal or group exercise therapy in patients with PD has been reported in several studies to improve activities of daily living (ADLs)9), increase exercise capacity and improve gait10, 11), extend range of motion12), and improve balance13). However, few reports are available on the effectiveness of home visit guidance on home exercise performed voluntarily by home care patients with PD. In addition, it is not known how interventions in which home visit guidance is provided affect aspects of daily living in home care patients with PD, a disease that is characterized by daily fluctuations such as the on-off phenomenon and wearing-off phenomenon.

Our aim was to clarify the effect of home exercise con-
sitting of daily self-administered exercise by patients (self-exercise) and weekly home visit exercise therapy guided by a physical therapist (home visit exercise) on physical function, ADLs, and postural status in home care patients with PD.

SUBJECTS AND METHODS

This cohort study design was based on the performance of a 2-month home exercise intervention in home care patients with PD and a comparison of physical function and physical activity between before and after the intervention. Fourteen home care patients with PD who belonged to the Miyagi Branch of the Japan Parkinson Disease Association participated in the study. The inclusion criteria for the PD group were as follows: patients with no change in antiparkinsonian drugs for ≥2 months who were in stage II or III of the Hoehn and Yahr severity scale and were capable of independent locomotion and participation in the intervention program. The study was divided into three periods to take account of seasonal affects on conditions: the first period was from January to February and included two patients, the second was from February to March and included seven patients, and the third was from May to June and included five patients. One patient in the second period and three patients in the third period withdrew from the study because of hospitalization during the intervention period, difficulty in conducting the home exercise because of aggravation of low back pain, or other reasons; a total of four patients were thus excluded from the study. Accordingly, the final analysis set included 10 patients (two male and eight female patients). In the PD group, the mean duration of disease was 12.6 years (SD, 5.6) and the mean number of oral antiparkinsonian drugs being taken was 3.9 (SD, 1.2).

The home exercise consisted of daily self-exercise by patients and weekly home visit exercise guided by a physical therapist (the first author); the intervention period was 2 months. Self-exercise was composed of the following five types of exercises: 1. stretching; 2. balancing in a four-points-kneeling position, with muscle strengthening; and 3. postural change movements from sitting for a long time to a four-points-kneeling position. At the beginning of the intervention, the physical therapist (the first author) provided guidance on practice of self-exercise in the form of a self-made booklet with photographs, and the patients were challenged to perform self-exercise at least three a week. We asked the patients to keep a record of their daily training and falls on a calendar to confirm that they had done the exercise and monitor any falling events during the intervention period. In order to improve the motivation for self-exercise, guidance of self-exercise by the physical therapist was provided to the patients during a visit in the presence of their family. In addition, the status of implementation of self-exercise was checked weekly. The home visit exercise consisted of 30 min of exercise including 1. active-assistive and passive stretching, 2. strengthening of the extensor muscles in a prone position, 3. movement from a sitting to a standing position, 4. balancing in a standing position, and 5. stepping in a standing position. The physical therapist (the first author) visited patients weekly to conduct the home visit exercise. Patients performed self-exercise with no fixed schedule, and the home visit exercise was conducted 1 to 2 h after treatment with antiparkinsonian drugs.

Home exercise was conducted with the approval of the physician attending each patient. The study was planned in accordance with the Declaration of Helsinki and was conducted with the approval of the Ethics Committee of the Graduate School of Health Sciences, Hirosaki University. Prior written informed consent was obtained from the patients, and an encoding process was used during the analyses to avoid identifying individuals.

An interview and assessment of physical function and physical activity were conducted before and after the intervention. The assessment of physical function was always conducted 1 to 2 h after treatment with antiparkinsonian drugs.

We interviewed patients regarding basic issues, including current medical history and medications, and the following items:

Implementation of self-exercise: Before the intervention, we interviewed patients regarding their self-exercise habits and the average number of times they had exercised during the week preceding the study. After the intervention, the number of self-exercise sessions and the daily average duration of self-exercise (in min) were calculated from the written records of the patients.

Chief complaints regarding aspects of daily living: The number of chief complaints regarding 37 aspects of daily living in relation to the symptoms and signs of PD, ADLs, and instrumental ADLs (IADLs; see below) was surveyed in a multiple-answer manner, in accordance with previous studies.

Falls: Patients were asked to state the number of times they had fallen in the past month and to assess their fear of falling during that time. The Modified Falls Efficacy Scale (MFES; scores) developed by Hill et al. was used to measure fear of falling. The MFES scores 14 activities on a 0 (not confident) to 10 (completely confident) scale. The maximum total score is 140 points, and higher scores indicate greater self-efficacy in falling incidents.

Parkinson’s Disease Rating Scale (PDRS): The PDRS is a scale developed by Webster that is used to score the severity of symptoms in patients with PD. It consists of 10 items, including rigidity, postural regulation impairment, tremor, and self-care activities. Each item is scored on a scale of 0 to 3. The maximum total score is 30 points, and a higher score indicates a greater level of severity.

Instrumental Activities of Daily Living (IADLs): The Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG Index of Competence) was used as an indicator of the performance of IADLs, which are non-fundamental ADLs, such as shopping, laundering, telephoning, and medication management, that enable an individual to live independently in the community. The maximum total score for this assessment is 13 points.

The following seven items were selected as indicators of physical function:

Range of motion: The ranges of motion of shoulder flex-
ion, trunk extension, and trunk rotation (shoulder flexion angle, trunk extension angle, and trunk rotation angle, respectively, in degrees) were measured according to criteria established by the Japanese Orthopedic Association and the Japanese Association of Rehabilitation Medicine.

Muscle strength: The isometric maximum muscle strengths of the hip flexors and knee extensors were measured with a handheld dynamometer (μTas F-1; Anima Corporation, Tokyo, Japan); a sensor of the handheld dynamometer was held in the hand to impose manual resistance in accordance with the posture required for measurement in Daniel's & Worthington's Muscle Testing (Hislop22). Measurements were taken three times, including practice runs, and the maximum value (N) was used in the analysis. Because no statistical difference between the sides of the body was observed in the results, measurements from the dominant leg (the right foot in all patients) were used as representative values.

Activities of daily living (ADLs): The Functional Independence Measure23 (FIM) was used as an indicator of the ability to perform basic ADLs such as feeding, going to the toilet, putting on clothes, grooming, and bathing. The FIM consists of 13 physical items and five cognitive items, totaling 18 items. The maximum total score for the assessment is 126 points.

Gait: The time and number of steps required to walk 5 m at an optimum speed were measured, and the walking speed (m/min) and cadence (steps/min) were calculated. Patients walked in the principal walking style normally they used at home (with or without a cane). All patients could walk without a cane.

Timed Up and Go (TUG) test: In the TUG test, the time required for an individual to stand up from a seated position in a chair, walk toward a mark 3 m ahead at their optimum walking speed, make either a clockwise or counterclockwise turn around the mark, walk back at their optimum walking speed, and sit down was measured twice, and the mean value was used in the analysis.

Functional Reach Test (FRT): With the patient standing in a comfortable position with the legs spread approximately shoulder-width apart and with the shoulder on the side of the dominant arm flexed 90 degrees and the elbow joint completely extended, the distance moved by the third metacarpal bone from its original position to when the individual reached forward as far as possible was measured twice, and the mean value was used in the analysis.

Functional Balance Scale (FBS): For the FBS, the Berg Balance Scale24, a 14-item scale with a total score of 56 points, was used for assessment. In addition, a 20-cm stool was used to test movement requiring a foot to be placed on a stool. The assessment was conducted in the order of movements listed on the test sheet.

As indicators of daily physical activity status, we measured the amount of physical activity on the basis of the movements of a site near the center of the body. We also recorded the changes in postural state, including the percentages of time spent per 24 h lying down, sitting, standing, and walking and the number of postural changes.

A high-capacity triaxial accelerometer (MVP-A3-05A-SD; MicroStone Corporation, Nagano, Japan), which had the capacity to record continuously for up to 30 h, was used to measure the amount of physical activity. The accelerometer was set with a sampling time of 200 ms and a low-pass filter of 35 Hz. Considering the impact of rhythmic segmentation of the head, limbs, and other body parts, the device was placed at the middle of the abdomen near the center of the body to quantitatively assess movement ability in terms of full body motion. According to the methods proposed by Iwashita25, the resultant acceleration was calculated from the left-right (x axis), front-back (y axis), and up-down (z axis) acceleration. Furthermore, the sum of all impulse values for a 24-h period was obtained through integration with respect to time (total impulse, kg m/h) and used as an indicator of the amount of physical activity.

A behavior recorder (A-MES; Solid Brains Co., Ltd., Kumamoto, Japan) consisting of two 3-dimensional position and acceleration sensors (sampling time: 200 ms) attached to the chest and thigh was used to measure the percentages of time spent per 24 h in the four movements of lying down, sitting, standing, and walking and the numbers of postural changes. In addition, the time spent lying down was further categorized into the percentages of time spent per 24 h in a supine, side-lying, or prone position. The high-capacity triaxial accelerometer and behavior recorder were attached together to give measurements for 24 h for 2 consecutive weekdays, when average levels of activity were expected. Statistical analyses were conducted using SPSS 18.0 for Windows. The Wilcoxon signed-rank test was used to compare data from before and after the intervention, and the statistical significance level was set at 5%.

**RESULTS**

Of the 10 study patients, four had been engaged in self-exercise before the intervention; the remaining majority had not. Five patients were users of ambulatory services provided by nursing care insurance. Two patients had neither been engaged in self-exercise nor used ambulatory services. Changes between before and after the 2-month self-exercise and home visit exercise intervention are shown in Table 1.

In the interview survey, a significant change was observed after the intervention compared with before in the number and duration of self-exercise sessions; significant increases were seen in these items after the intervention. In addition, there was a significant decrease in the number of chief complaints and a significant improvement in the MFES after the intervention. However, there was no significant change in the PDRS (which indicates the severity of PD symptoms) or the TMIG Index of Competence, an indicator of IADL.

In the physical function tests, a significant difference was observed in shoulder flexion angle, trunk extension angle, hip flexion muscle strength, and knee extensor muscle strength between before and after the intervention. No significant changes were observed in FIM, walking speed, cadence, TUG, FRT, or FBS.

In the physical activity status testing, a significant
change was seen only in the percentages of time spent lying down (percentage time decreased) and sitting (percentage time increased). No significant change was observed in total impulse (an indicator of the amount of physical activity), number of postural changes, or other parameters.

**DISCUSSION**

Four of the 10 patients had been engaged in self-exercise on a regular basis; their main exercises were stretching and walking. Significant increases in the number and duration of self-exercise sessions per week were observed after the intervention compared with before. It seemed that this was due to the effects of guidance in self-exercise and of management of its implementation by using a self-exercise record book. These results are the same as those reported by Montgomery et al.\(^{26}\), who found an increase in the number of exercise hours after the provision of daily living and exercise guidance. In addition, our data on the number and duration of self-exercises before the intervention highlight a problem: the duration of self-exercise each day in home care patients with PD is insufficient, even if they are in the habit of performing self-exercise; patients may not have the chance to exercise, except when they use ambulatory services.

Meanwhile, the number and duration of self-exercise
sessions were increased by the intervention. Accordingly, it seems that guidance and management to promote habitual self-exercise in home care patients with PD are effective and are needed.

In the interview surveys, no marked changes were observed between before and after the intervention in terms of the number of falls, the PDRS, or the TMIG Index of Competence. In other words, the intervention seemed less effective at treating the number of falls in the month before the survey, less effective at reducing the severity symptoms of PD, or the performance of IADLs. However, a decrease in the number of falls\(^1\) and the absence of improvement in primary functional impairment\(^27,28\) in response to exercise therapy has also been reported. In this respect, further discussion of the content and duration of our home exercise intervention is needed. In contrast, the number of chief complaints and the MFES scores were significantly improved. In the chief complaint survey, patients were interviewed about how many items were true of their PD symptoms and made their ADL difficult; the numbers of items decreased after the intervention. It seemed that this was because the patients’ awareness of the effects of guidance on exercise led to subjective changes\(^30\). Furthermore, the improved MFES scores showed that fear of falling was alleviated. This appeared to result from the patients’ increased awareness of the effectiveness of exercise guidance\(^30\) and from the improvement in fall risk scores because of the exercise intervention\(^30\).

In the physical function testing, shoulder flexion angle, trunk extension angle, hip flexion muscle strength, and knee extensor muscle strength significantly increased after the intervention. This is likely because the intervention improved flexibility and muscle strength\(^1\). The trunk rotation angles in our patients were close to the normal reference range of motion, even before the intervention. This is apparently the reason why no significant difference in this parameter was observed between before and after the intervention.

In relation to ADL, gait, and balance, no significant difference was observed between before and after the intervention in FIM, an indicator of ADL. Some previous studies have found an improvement in ADL after an intervention consisting of exercise therapy\(^41,31\), whereas others have reported otherwise\(^32\). Opinions are thus not unified. The following factors were considered to be the reasons why the results of this study showed no significant differences in FIM before and after the intervention: most of the study patients performed ADL independently; the intervention period of two months was too short and insufficient; and the program of the intervention focused on stretching, muscle strengthening, and postural change. Further study will be required for the reference. Interventional effects using treadmills or external cues such as visual and auditory stimulation during gait\(^23,37\) have been reported. However, it seems that we observed no significant differences in these parameters because neither a treadmill nor external cues were used concurrently in the self-exercise and home visit exercises. Moreover, our patients had relatively good walking ability and could walk at an optimum speed of 50 m/
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REFERENCES