Hirosaki Med. J. **65**：190―198，2014

ORIGINAL ARTICLE

COMPARISON OF PHYSICAL FUNCTION AND ACTIVITY IN HOME-CARE PATIENTS WITH PARKINSON'S DISEASE AND HEALTHY ELDERLY PEOPLE

Hideyuki Nakae[1, 2)]，and Hitoshi Tsushima[2)]

Abstract Objective: To compare physical function and 24-h activity in home-care patients with Parkinson's disease with those in healthy elderly people.
Methods: Physical function（range of motion, muscle strength, activities of daily living, gait, and balance）was measured in 10 home-care patients with Parkinson's disease（PD group）and 10 healthy elderly subjects（healthy group）. As an indicator of the amount of physical activity per day, a triaxial accelerometer was used to measure the 24-h total impulse value; simultaneously, behavior recorders were used to measure 24-h posture.
Results: The healthy group scored significantly higher in activities of daily living, walking speed, and balance. No significant difference was observed between groups in terms of range of motion, muscle strength, cadence, amount of physical activity per day, and number of postural changes. However, the PD group spent significantly more time per day standing and in a supine position.
Conclusion: In the PD group, the amount of physical activity per day was comparable to that in the healthy elderly group, despite the decreased levels of activity caused by their impaired performance in activities of daily living. Range of motion and muscle strength may have been maintained by these patients' self-training and by training at day-care centers. Our results suggest the importance of practicing postural transfers from the standing and supine positions and of intervention and guidance that aim to improve impaired performance in daily living.
Hirosaki Med. J. **65**：190―198，2014

Key words: activity; home-care patients with Parkinson's disease; physical function.

原　著

在宅パーキンソン病患者と健常高齢者における身体機能と活動状況の比較

中　江　秀　幸[1, 2)]　　對　馬　　均[2)]

抄録　目的：在宅パーキンソン患者の身体機能と24時間の活動状況の特徴を健常高齢者との比較から明らかにする．
対象と方法：在宅パーキンソン患者(PD群)10名と健常高齢者(高齢者群)10名を対象として，身体機能については関節可動域，下肢筋力，日常生活活動，歩行能力，バランス能力を測定した．一日の活動量については三軸加速度計を用いて24時間の総力積値を測定し，指標とした．同時に行動記録計を用いて24時間の姿勢動態を測定した．
結果：日常生活活動，歩行速度，バランス能力は高齢者群の方が有意に上回っていた．関節可動域，下肢筋力，歩行率，一日の活動量と姿勢変換回数については両群間に有意差を認めなかった．しかし，１日の姿勢で立位及び背臥位の占める割合はPD群が有意に高かった．
結語：PD群では生活場面での動作障害により活動能力は低下するが，１日の活動量は高齢者群と同等であり，関節可動域や下肢筋力は自主トレーニングやディケアの訓練により維持できることが明らかとなった．これらのことから，立位や背臥位からの姿勢変換練習や生活場面の動作生涯の改善を目的とした介入や指導の重要性が示唆された．
弘前医学　**65**：190―198，2014

キーワード：在宅パーキンソン病患者；身体機能；活動状況．

1) Course of Physical Therapy, Department of Rehabilitation, Faculty of Health Sciences, Tohoku Fukushi University
2) Division of Health Sciences, Graduate School of Health Sciences, Hirosaki University
Correspondence: H. Nakae
Received for publication, December 13, 2013
Accepted for publication, December 27, 2013

1) 東北福祉大学健康科学部リハビリテーション学科理学療法学専攻
2) 弘前大学大学院保健学研究科保健学専攻
別刷請求先：中江秀幸
平成25年12月13日受付
平成25年12月27日受理

Introduction

Parkinson's disease (PD) is a chronic progressive disease, the 4 major signs of which are rest tremor, muscle rigidity, akinesia/bradykinesia, and postural reflex impairment[1]. With the addition of distinctive gait disorders such as frozen gait and short-stepped gait[2], individuals with PD tend to experience difficulty in movements such as walking, standing up, and rolling over[3], and they are likely to lead sedentary lifestyles. Additionally, with the progression of such symptoms, levels of independence in activities of daily living[2], as well as levels of physical activity, decline. This can lead to secondary disorders such as decreased muscle strength[4].

Treatment for PD is based on drug therapy and surgical therapy such as deep brain stimulation[5]; however, the effectiveness of these treatments is poor for postural reflex impairment and gait disorders. Furthermore, aspects of daily living may also be affected by daily fluctuations[6], such as the on-off phenomenon and wearing-off phenomenon, which are caused by long-term administration of drugs. Therefore, it is important to provide daily life guidance and home-care rehabilitation in line with the individual's symptoms and impairment[8], not only through regular assessments and understanding of symptoms, but through understanding of everyday symptoms and characteristics in the context of the structure of daily life[7].

In view of the above, we investigated physical features such as the amount of physical activity per day, as well as posture and physical function, in home-care patients with PD in a daily life setting. We compared these characteristics with those in healthy elderly people to reveal points to consider in the physical therapy of home-care patients with PD.

Methods

1. Subjects

Ten home-care patients with PD (PD group) who belonged to Japan Parkinson's Disease Association Branch A participated in this study. Selection criteria for the PD group were no change in antiparkinsonian drugs for ≥2 months, as well as Hoehn and Yahr severity scale[9] stage II or III and independent locomotion ability (stage II: 3 subjects, stage III: 7 subjects). In the PD group, the mean duration of disease was 11.1 years (Standard Deviation 5.6) and the mean number of oral antiparkinsonian drugs being taken was 3.9 (Standard Deviation 1.2). The control group had 10 healthy elderly people (healthy group) who lived locally and had volunteered via a recruiting process run by the Senior Citizens' Club of City B. The demographic characteristics of the PD group and the healthy group are shown in Table 1. Our study was conducted with the approval of the ethics committees of Hirosaki University Graduate School of Medicine.

2. Measurement methods

1) Physical function

The following 8 items, including range of motion, muscle strength, activities of daily living, gait, and balance, were selected as indicators of physical function:

i) Range of motion

The ranges of motion of shoulder flexion, trunk extension, and trunk rotation were measured according to the criteria established by the Japanese Orthopaedic Association and the Japanese Association of Rehabilitation Medicine.

ii) Muscle strength

The isometric maximum muscle strength of hip flexors and knee extensors was measured with a hand-held dynamometer (μTas F-1, manufactured by Anima Corporation, Tokyo).

Table 1 Age and physical size of subjects

		PD group (n = 10)		Healthy group (n = 9)		
		Mean	*(SD)*	*Mean*	*(SD)*	
Age	(years)	70.3	(5.6)	73.6	(3.1)	ns
Body height	(cm)	153.8	(8.8)	155.8	(5.1)	ns
Body weight	(kg)	48.7	(10.7)	57.5	(7.8)	*

ns: non-significant; * $P < 0.05$

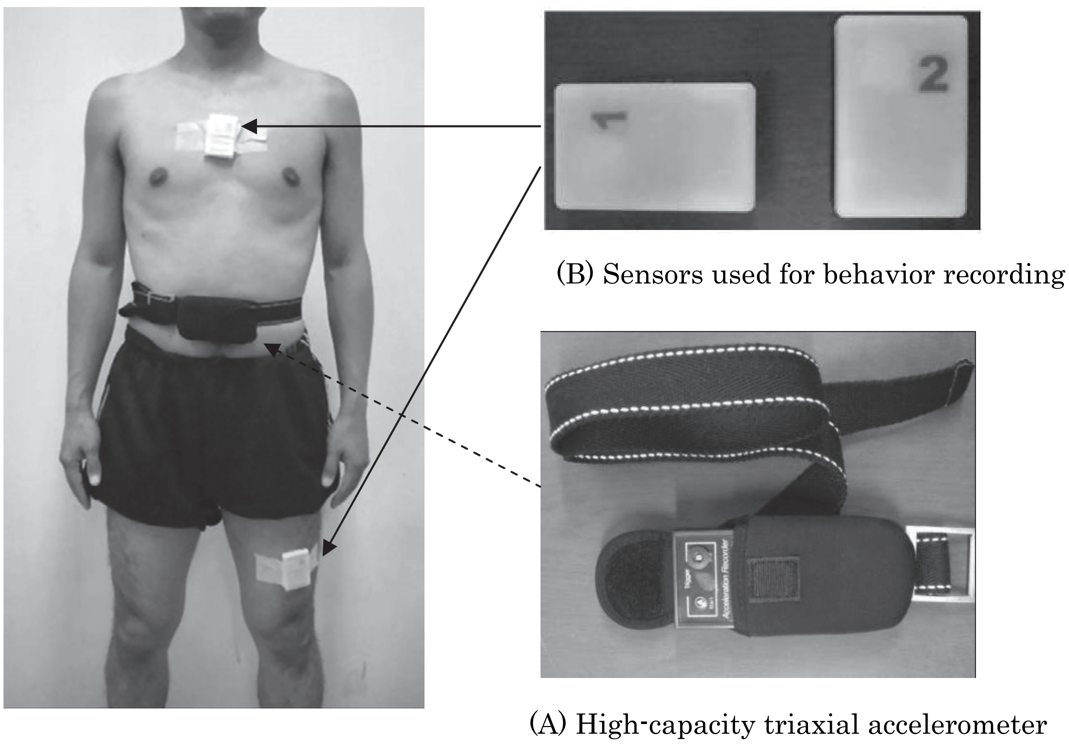

Figure 1 System used to measure activity
(A) The high-capacity triaxial accelerometer was placed on the abdomen
(B) The sensors of the behavior recorder (A-MES) were attached to the sternum and thigh

Measurements were taken 3 times (including practice runs), and the maximum value (N) was used for the analysis.

iii) Activities of daily living (ADL)

The Functional Independence Measure (FIM)[10] was used as an indicator of ability to perform basic activities of daily living, such as feeding, going to the toilet, putting on clothes, grooming, and bathing. The total score for the assessment was 126 points.

iv) Instrumental activities of daily living (IADL)

The Tokyo Metropolitan Institute of Gerontology (TMIG) index of competence[11] was used as an indicator of the ability to perform instrumental activities of daily living, namely activities that were not fundamental for functioning but enabled the subject to live independently (e.g. shopping, laundry, telephoning, and medication management). The total score for the assessment was 13 points.

Table 2 Measurements of physical function and activity in the two groups

		PD group (n = 10)		Healthy group (n = 9)		
		Mean	*(SD)*	*Mean*	*(SD)*	
Range of motion						
shoulder flexion	(degrees)	154.5	(10.4)	154.0	(10.8)	ns
trunk extension	(degrees)	14.5	(5.0)	17.0	(6.3)	ns
trunk rotation	(degrees)	44.0	(2.1)	43.5	(6.3)	ns
Muscle strength						
hip flexors	(N)	114.0	(28.4)	121.8	(17.5)	ns
knee extensors	(N)	151.0	(49.0)	169.5	(41.7)	ns
Activities of daily living						
FIM	(points)	118.5	(9.9)	126.0	(0.0)	**
TMIG index of competence	(points)	9.8	(2.2)	13.0	(0.0)	**
Gait						
walking speed	(m/min)	49.0	(8.3)	62.2	(11.4)	*
cadence	(steps/min)	135.1	(17.0)	130.1	(12.6)	ns
TUG	(s)	11.3	(1.6)	8.3	(2.1)	**
Balance						
FRT	(cm)	24.1	(8.3)	30.9	(4.4)	ns
FBS	(points)	53.4	(3.1)	55.5	(1.1)	*
Amount of physical activity						
total impulse	(kg･m/h)	479.1	(102.2)	520.8	(173.2)	ns
Posture						
lying/day	(%)	37.3	(9.2)	41.7	(7.2)	ns
sitting/day	(%)	25.2	(8.8)	32.1	(10.9)	ns
standing/day	(%)	17.1	(9.1)	8.2	(5.4)	*
walking/day	(%)	20.3	(6.4)	18.0	(7.3)	ns
supine/total lying	(%)	78.9	(17.0)	63.1	(18.2)	*
side lying/total lying	(%)	21.0	(17.1)	33.7	(17.3)	ns
prone/total lying	(%)	0.1	(0.2)	6.6	(11.9)	ns
number of postural changes	(times)	450.7	(212.7)	420.3	(121.8)	ns

ns.: non-significant; * $P < 0.05$; ** $P < 0.01$

v) Gait

The time and number of steps required to walk 5 m at optimum speed were measured, and the walking speed (m/min) and cadence (steps/min) were calculated.

vi) Timed Up and Go (TUG) test[12)]

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, turn around the mark, walk back, and sit down, was measured twice, and the mean value was used for the analysis.

vii) Functional reach test (FRT)[13)]

Standing in a comfortable position with the legs spread approximately shoulder-width apart, and with the dominant arm raised 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 as far forward as possible was measured twice, and the mean value was used for the analysis.

viii) Functional balance scale (FBS)

The Berg Balance Scale[14], a 14-item scale with a total score of 56 points, was used for this assessment. In addition, subjects were tested for their ability to put their foot on a 20-cm stool. The assessment was conducted in the order of the movements listed on a test sheet.

2) Physical activity status

As an indicator of physical activity, the amount of physical activity per day, posture, and the number of postural changes were measured on 2 consecutive weekdays, 24 h a day, during which time the subjects planned to have average levels of activity. As discussed below, 2 types of measurement device were used for recording.

i) Amount of physical activity

A high-capacity triaxial accelerometer (MVP-A3–05A-SD, manufactured by MicroStone), which had the capacity to continuously record for up to 30 h, was used to measure the amount of physical activity (Figure 1-A). The accelerometer was set at a sampling time of 200 ms and had a low-pass filter of 35 Hz. To quantitatively assess movement ability in terms of full body motion, the device was placed on the middle of the abdomen, near the center of the body. According to the methods proposed by Iwashita[15], the resultant acceleration was calculated from left–right (x axis), front–back (y axis), and up–down (z axis). 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 was used as an indicator of the amount of physical activity.

ii) Posture and number of postural changes

A behavior recorder (A-MES, manufactured by Solid Brains Co., Ltd) (Figure 1-B) was used to measure posture and the number of postural changes made by each subject in a daily setting. This device recorded the percentage of time spent per 24 h (%) lying down, sitting, standing, and walking, as well as the number of postural changes. The data were based on information received from two 3-dimensional position and acceleration sensors (sampling time: 200 ms), one attached to the chest and one to the thigh. The time spent lying down was further categorized into a supine, side-lying, or prone position. Then the percentage of these positions per total lying time (%) was calculated respectively.

3. Data processing

For measurements obtained with the above procedures, comparisons between the PD group and elderly group were made by using a Mann-Whitney U test. In addition, Data were analyzed using SPSS 13.0J for Windows, and the statistical significance level was set at 5%.

Results

The mean and standard deviation of each variable in the PD and elderly groups are shown in Table 2. Statistically significant differences between the groups were observed in the variables of FIM ($p<0.01$), TMIG index of competence ($p<0.01$), walking speed ($p<0.05$), TUG ($p<0.01$), and FBS ($p<0.05$); the healthy group scored superior for these variables. No significant differences were observed for range of motion, muscle strength, cadence, or FRT.

With regard to physical activity, no significant differences were observed for total impulse (an indicator of the amount of physical activity) or for the number of postural changes; however, the percentages of time spent standing and in a supine position were significantly higher in the PD group than in the healthy group.

Discussion

1. Physical function

The values of gait-related variables such as walking speed and TUG were significantly limited in the PD group than in the healthy group. Previous reports have noted that frozen gait in PD patients occurs, in association with disease duration and severity, as initiation hesitation in 86% of patients and as block on turning in 45%[16, 17]. Additionally, occurrence of arm swinging during walking decreases from a relatively early stage in PD patients, and the decrease in the occurrence of arm swinging is negatively correlated with walking speed and length of stride[18]. Furthermore, PD patients tend to have impaired TUG movements such as standing up, initiating walking, turning, and sitting down[19]. The lower gait scores observed in the PD group than in the healthy group may have been caused by such gait disorders characteristic of PD. Sofuwa et al.[20] reported that PD patients score significantly lower than healthy adults of a similar age on walking speed and length of stride, but not on cadence or double support time. Our results support this finding, because both groups scored about 130 steps/min for mean cadence, and no significant difference was observed in this parameter.

No significant difference was observed between the groups in terms of variables related to range of motion, muscle strength, and FRT. Apart from the fact that our PD patients had fairly mild disease (stage II or III), these findings may have occurred because 7 of the 10 PD patients were receiving functional training during their day care. Chuma[3] has pointed out the importance of providing PD patients with motion training such as trunk rotation and of practicing postural maintenance. Additionally, Okubo et al.[21] suggest that exercise therapy has an interventional effect on PD patients by improving muscle strength, flexibility, and dynamic balance; the treatment guidelines[22] give this a grade A recommendation (i.e. strongly recommended on the basis of scientific evidence). In a survey conducted by Okoshi et al.[23] and including 192 outpatients and inpatients, 71.9% of respondents were reported to be involved in some sort of exercise.

2. ADL status

In general, the ability to perform ADL and IADL is said to decline in PD patients[2, 25] for reasons such as the need for increasingly more time to perform ADL as symptoms progress[24]. Consistent with this point, during the assessment of ADL in our PD group, points were deducted in the FIM scoring because the patients needed longer than healthy subjects to get dressed and to deal with food dropped while eating and with toileting issues. Additionally, during our assessment of the TMIG index of competence in the PD group, points were deducted for items related to locomotion, such as "Traveling alone using buses and trains," "Depositing/withdrawing money from one's bank/postal savings," and "Visiting a friend's home." However, the fact that all of the subjects in the healthy group had full scores in the FIM and the TMIG index of competence assessment may have been the reason for the significant difference on these items observed between the groups.

3. Physical activity status

No significant difference was observed between the groups in terms of total impulse (an indicator of the amount of physical activity) or number of postural changes. The PD group scored significantly higher than the healthy group in terms of the percentages of time spent in a standing and a supine position.

We hypothesized that the amount of physical activity in the PD group would be lower, in view of reports that PD patients lead sedentary lives with low levels of daily activity[4]. We also hypothesized that, in comparison with healthy people of a similar age, patients with disease of

Hoehn and Yahr severity scale stages II to IV would have significantly more leisure time (as opposed to the time allotted to physiological or compulsory activities), and that this leisure time would be occupied by passive activities[26]. However, the physical strength of PD patients is comparable to that of normal healthy people when activities of daily living are maintained[27]. In patients with disease of Hoehn and Yahr severity scale stage I or II, the degree of functional impairment is mild, and employment and housework are possible[11]. For patients with stage III disease and above, there will be fewer opportunities for standing and walking because of the higher risk of falling; and patients with stage V are confined to bed with prolonged bed rest[7]. The patient population in our study was at disease stage II or III, and., in terms of FIM, the individuals were at an independent level (*mean* points 118.5 Standard Deviation 9.9); these factors might explain why the activity levels of the PD group were as high as those in healthy elderly people, and they may have been the reason why no significant between-group differences were observed in the amount of physical activity or the number of postural changes.

The percentages of standing position per 24 h and the percentages of supine position per time spent lying down were both significantly higher in the PD group than in the healthy group. The high percentage of time spent standing may have been caused by the inability to transfer one's position/movement from standing to another position/movement because of deterioration of gait and balance. Previous reports have pointed out that around 70% of PD patients notice the occurrence of frozen gait and difficulty in changing direction[2, 28], and that patients are prone to impairment of movements such as standing, initiation of walking, turning and sitting down[19]. Our finding is therefore likely to be the result of the influence of gait disorders characteristic of PD patients. Additionally, the reason why a high proportion of time was spent in a supine position while lying down was likely because individuals experienced difficulty in rolling over owing to postural reflex impairment and akinesia or bradykinesia, which are also characteristic of PD patients.

Conclusions

In PD patients, gait ability, as assessed by walking speed and TUG, is reduced because of the influence of characteristic gait disorders. Our results demonstrated that, in PD patients with Hoehn and Yahr disease stage II or III, the amounts of time spent lying down and sitting were comparable to those in healthy elderly people. However, because of the influence of characteristic PD signs such as postural reflex impairment and akinesia/bradykinesia, the time spent standing was longer, and there was difficulty transferring from a supine position to other positions. Our results also imply that, through exercise therapy, it is possible to maintain range of motion, muscle strength, and standing balance abilities, even in home-care patients with PD. The above-mentioned points are important when considering physical therapy intervention in home-care patients with PD. In future, we need to perform an investigation and verification similar to those used here but in patients with Hoehn and Yahr stage IV or V disease who require maximum assistance with locomotion.

Acknowledgments

The authors thank the participants for their contribution to this study. This work was supported by JSPS KAKENHI Grant Number 22390099.

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