Strength and Functional Capacity of a 70-Year-Old Patient Diagnosed with Parkinson Disease Following 1 Year of Combined Supervised Progressive Resistance Training and Home-Based Training: A Case Report

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Terje Gjøvaag[1,2] and Hilde Sylliaas[1]

[1]Department of Physiotherapy, Oslo and Akershus University College of Applied Sciences, Oslo, Norway. [2]Department of Occupational Therapy, Prosthetics and Orthotics, Oslo and Akershus University College of Applied Sciences, Oslo, Norway.

ABSTRACT: The value of resistance training (RT) for people with Parkinson disease (PD) is disputed, but recent research shows promising results regarding effects of intensive RT. The main aim of this case report was to develop a combined model consisting of home-based training (HT) and supervised RT as a 1-year follow-up to evaluate changes in functional capacities of a patient with PD. The intervention consisted of 8 weeks of supervised progressive RT, followed by 12 weeks of individual HT. This sequence was then repeated, for a total follow-up of 12 months. Functional capacities were assessed between all training periods with a battery of clinical measures. During the second HT period, functional outcomes and muscle strength were better preserved compared with the first HT period. These results are important regarding how to design and implement efficient exercise regimens for patients with PD and show that progressive RT twice a week for 2 months combined with home training in periods is effective in improving muscular strength and functional capacities.

KEYWORDS: Parkinson disease, strength training, principle of overload, 1-year follow-up, case report

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CORRESPONDING AUTHOR: Terje Gjøvaag, Department of Physiotherapy, Oslo and Akershus University College of Applied Sciences, PO Box 4, St. Olavs plass, NO-0130 Oslo, Norway. Email: terje.gjovaag@hioa.no

Introduction

Maximum muscle strength, power, and rate of force development decrease with aging, even in highly trained master athletes.[1] This age-dependent reduction in muscle strength means that older people are more likely to face problems performing their daily activities and experience increased risk of falling.[2-4] The health care is in need for methods that allow the increasing proportion of older people to live safely in their own home, be independent in activities of daily living (ADL), and experience fewer falls.[3]

Resistance training (RT), and particularly high-intensity RT, is effective for improving strength among older adults, and regular resistance exercise is considered a viable strategy to prevent generalized muscular weakness associated with aging.[5] However, it is challenging to develop interventions that are time efficient for clinicians and at the same time is beneficial for the participants. Hence, new models for implementing combinations of supervised training and home-based training (HT) must be developed.[5]

To improve strength in elderly, the principle of progressive overload is important.[6] Generally, throughout the RT program, the training volume and/or training intensity performed must be periodically increased to continuously overload the muscle and to ensure that the exercising person is able to make further improvements in strength.[7,8] There are several guidelines for progressive RT programs, but guidelines for developing strength and hypertrophy for elderly persons recommend 1 to 3 sets per exercise with 60% to 80% of 1 repetition maximum (1RM) for 8 to 12 repetitions, 2 to 3 days per week.[9] The value of strength training for people with Parkinson disease (PD) is, however, disputed,[10,11] but recent research shows promising results regarding effects of intensive RT on the physical capacity of patients with PD.[12]

There is, however, no studies regarding how persons with PD disease respond to several periods of intensive RT interspaced by periods of general home-based physical activity. Hence, this case study reports on how the functional capacity of a person with PD respond to a regime of combined home-based training and supervised RT at an outpatient clinic and a new model for implementing combinations of supervised training and HT for this patient group.

Methods

Patient history

We report on a 70-year-old man and his 12 months follow-up at an outpatient clinic. He reported taking medications for Morbus Parkinson (Mb Parkinson) and for moderate hypertension but needed no assistance in ADL. The patient lived with his wife in an apartment. The patient was active; he was competent in outdoor walking without walking aids and participated in social relationships with other people and his family. He did not participate in any organized training but went on a daily walk alone or together with his wife for about 30 minutes. After reporting to the outpatient clinic, the patient was initially examined clinically by a physiotherapist.

The patient was not severely affected by the disease. He was not characterized by tremor or rigidity. Furthermore, he had stiffness in the thoracic part of the column, compatible with both age and Mb Parkinson. He was not fearful of falling but reported that he sometimes kicked his foot in the uneven ground during walking. Furthermore, he reported that his wife often told him not to bend forward while he was walking. He was aware that this could be a part of the clinical picture of Mb Parkinson.

He was considered to be a good candidate to determine whether progressive strength training could improve his functional status, improve his activity level, and reduce his impairments and disabilities. He was motivated to improve his current level of functioning and improve posture and reduce stumbling by progressive RT exercises.

Intervention and outcome measurements

The patient assessment, RT intervention, and all tests were performed at an outpatient clinic. The intervention consisted of an 8-week supervised progressive RT program (RT Period 1), followed by a 12-week individual, unsupervised home-based exercise program (first HT period [HT Period 1]). This exercise sequence was subsequently followed by a new 8-week period of supervised progressive RT (RT Period 2) and then 12 + 8 weeks of unsupervised home-based exercise (HT Period 2 + 8 weeks). Outcome measurements and tests were obtained the same week the intervention started, then after 8 weeks of RT, furthermore, after 12 weeks of HT, 8 weeks of RT, 12 HT, and finally after 8 more weeks of HT. The person performing the measurements and tests was not the same person as the intervention therapist.

The supervised RT intervention was provided twice a week for the first 8 weeks, and each exercise sessions lasted 45 to 60 minutes, depending on the participant's ability and tolerance. The participant was supervised by a physiotherapist during all RT sessions. The intervention was targeted toward improving strength of the main muscle groups in the upper and lower body, and the following exercises were included in the RT program: leg press, knee extension, chest press, sitting leg press, sitting pull down, sitting chest press, and sitting rowing.

Following a warm-up sequence on a stationary cycle for 10 to 15 minutes with a load corresponding to 12 to 13 on the Borg Rating of Perceived Exertion scale,[13] the patient performed the RT exercises in various training machines (Technogym, Cesena, Italy). The workload was determined individually for each exercise, and for all exercises, the patient performed 3 sets of 10 repetitions. The load was modified continuously by the physiotherapist if the participant was able to lift the workload for 1 or 2 repetitions above the desired number.

In addition, the exercise program also included standing lunges.

For the lunges, the participant was instructed to place each leg forward alternately with 90° of flexion in the hip and knee joint. Support was given initially and gradually reduced to no support. Eventually, a 2 kg weight in each hand was used for the last 3 weeks of the training period. The participant was gradually encouraged to increase the flexion in the hips and knees to 90°. The first 8-week RT period started with an introductory phase extending over 3 to 6 sessions to become familiar with both the equipment and the exercises. Progression in resistance and repetitions was noted in a training diary, as well as their position at the training equipment. He attended all training sessions at the outpatient clinic, ie, compliance was 100%.

For the unsupervised HT, the participant was required to perform daily walks and to perform lunges and squats twice per week for 12 weeks in his home environment. For both the lunges and the squats, the participant was instructed to do the exercises with 90° of flexion in the hip and knee joints. The training program was the same as during supervised training, ie, the patient performed 3 sets of 10 repetitions of each exercise, but these exercises were performed without the external loading as in the supervised RT. Compliance in home training was not registered.

Test battery

Functional tests were the Timed Up-and-Go (TUG) test, the 2-minute step-in-place (2MSIP) test, the 6-minute walk test (6MWT), and the Sit-to-Stand (STS) test. In addition to the function tests, maximum strength (1RM) was measured in the leg press exercise (Technogym) and in the knee extension exercise (Technogym).

The TUG test is a functional mobility test used in the clinic to evaluate dynamic balance, gait, and transfers.[14] The tester measures the time it takes for a person to rise from a chair and walk 3 m at a comfortable pace, turn, and walk back to the chair and sit down. The test was performed without the use of a walking aid. Mean TUG score for elderly persons with PD is 14.8 ± 5.8 seconds (confidence interval [CI]: 12.3-17.3).[15]

The STS test measures lower body muscle strength. We applied the performance measure, the 30-second chair stand, as described by Jones et al.[16] A 46-cm-high chair was placed against the wall to prevent it from tilting. The participants were asked to perform as many stands as possible during 30 second, and the score was the total number of stands performed. There is no information on STS scores from a patient population with PD, but the normal range for healthy men, 70 to 74 years of age, is 12 to 17 times.[17]

The 2MSIP test is a test to assess aerobic endurance and balance.[18] Numbers of steps are counted. The test person has to

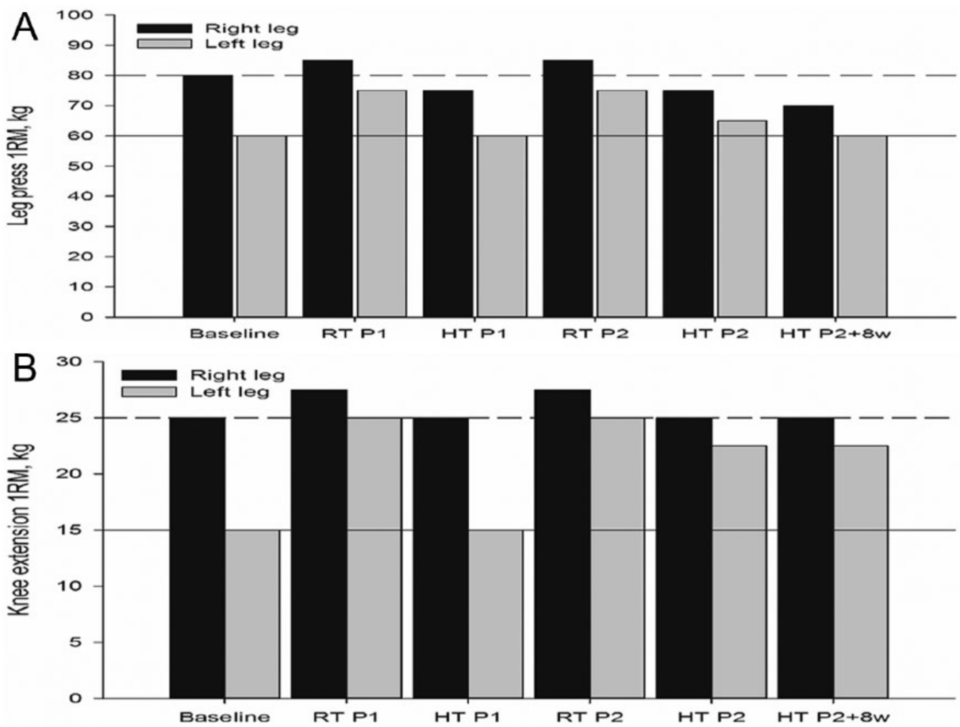

Figure 1. Maximum strength of (A) leg press exercise following supervised resistance training and unsupervised home-based training and (B) knee extension exercise following supervised resistance training and unsupervised home-based training. RT P1 and P2 = resistance training periods 1 and 2. HT P1 and HT P2 = home-based training periods 1 and 2. Dotted and solid lines are 1 repetition maximum (1RM) values for right and left legs, respectively. Baseline measurements of maximum strength were performed prior to the first RT period. All other measurements are performed at the end of each RT period and HT period, respectively. In addition, measurements were performed 20 weeks after the start of HT P2 (HT P2 + 8 weeks).

lift the knee in height with the pelvis. On the signal "go," the participant starts stepping in place, alternating lifting the right and left legs. The knees must be lifted to the correct height to be counted, and the tester only counts the number of times the right knee reaches correct height. The 2MSIP data are not reported for PD, but Jones and Rikli[17] report that the normal range of healthy men, 70 to 74 years old, is 80 to 110 steps.

The 6MWT measures walking capacity, walked distance (m),[19] and allows calculation of gait velocity ($m\,s^{-1}$).[20] The test is often used as an expression for submaximal aerobic capacity, although in some patients with heart failure, it appears to be a maximal test.[19] The 6MWT is also used to assess exercise tolerance, thus measuring the functional exercise capacity. Data for 6MWT are not reported for PD, but the normal range for older healthy men was reported to be 498 to 621 m.[17] In relation to this, Brusse et al[15] reported that the comfortable walking speed of patients with PD was $0.91 \pm 0.21\,m\,s^{-1}$ (CI: 0.82-1.01) and that their fast walking speed was $1.24 \pm 0.33\,m\,s^{-1}$ (CI: 1.10-1.38).

Results

Maximum strength, 1RM

As shown in Figure 1A and B, the patient increased in 1RM in both leg press and knee extension exercises during both RT periods. For both exercises, the right leg is stronger than the left leg. For leg press, the left leg has about 75% of the strength of the right leg, and for knee extension exercise, the corresponding relationship is about 60%. The left leg was the leg most affected by the disease. In general, during the periods of RT, the strength of the left leg increased to about the same strength as the right leg. Strength of the right leg increased about 6% to 10% during the RT periods, whereas the weaker left leg increased between 25% and 67% for leg press and knee extension exercises, respectively. Following HT Period 1, strength was better preserved in the right leg, whereas the left leg strength dropped to baseline values. During HT P2, knee extension strength in the left leg was better preserved compared with HT P1 but were still lower compared with RT P2 measurements. In summary, during the time from RT Period 2 to the last follow-up (HT period 2 + 8 weeks), there was a reduction in the level of strength, but at the last follow-up, the level was higher than at baseline (except for right during leg press exercise) and satisfactory for his age. By the end of the training period, the patient reported that he had little or no difficulty doing his usual hobbies and recreation, performing heavy activities around the home and using public transport.

Functional capacities

As shown in Table 1 and Figure 2, the patient improved his results at all functional test following periods of RT. Improvements from baseline (0 weeks) in STS, TUG, 6MWT, walking speed, and 2MSIP following RT Period 1 were 33.3%, 16.4%, 14.5%, 14.4%, and 8.1%, respectively.

Table 1. Progression of functional capacities during supervised resistance training and unsupervised home-based training.

TESTS	BASELINE, 0WK	RT P1, 8WK	HT P1, 12WK	RT P2, 8WK	HT P2, 12WK	HT P2+8WK
STS, times	12	16	11	17	15	13
TUG, s	8.5	7.1	10.4	7.0	7.3	7.2
6MWT, m	484	554	501	584	561	534
Walk speed, s^{-1}	1.34	1.54	1.39	1.62	1.56	1.48
2MSIP, steps	86	93	81	100	98	96

Abbreviations: 2MSIP, 2-minute step in place; 6MWT, 6-minute walk test; HT, home-based training; P1 and P2, Period 1 and Period 2; RT, supervised resistance training; STS, Sit to Stand; TUG, Timed Up and Go; walking speed, average walking speed during the 6MWT.
Baseline measurements were performed prior to the first RT period. All other measurements are performed at the end of each RT period and HT period, respectively. In addition, measurements were performed 20 weeks after the start of HT Period 2 (HT P2 + 8 weeks).

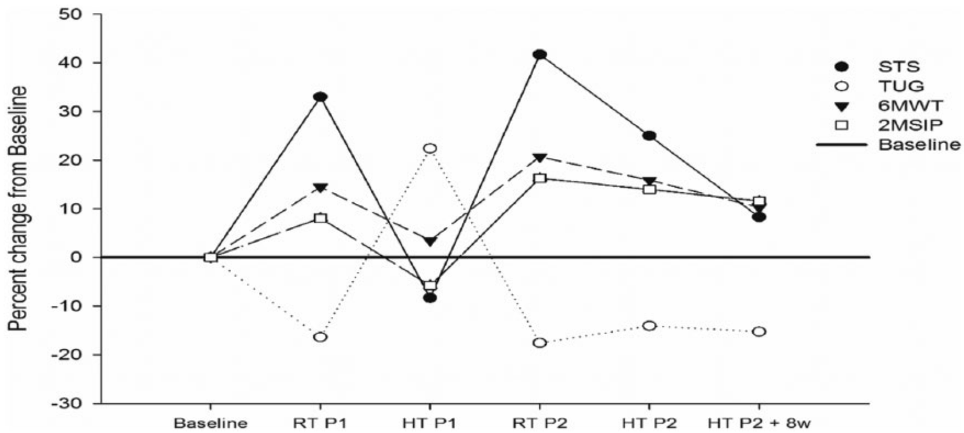

Figure 2. Changes in functional capacity during supervised resistance training and unsupervised home-based training Baseline measurements were performed prior to the first RT period. All other measurements are performed at the end of each RT period and HT period, respectively. In addition, measurements were performed 20 weeks after the start of HT Period 2 (HT Period 2 + 8 weeks). 2MSIP, 2-minute step in place; 6MWT, 6-minute walk test; HT P1 and P2, home-based training periods 1 and 2; RT P1 and P2, resistance training periods 1 and 2; STS, Sit-to-Stand; TUG, Timed Up and Go.

At follow-up after his HT Period 1, the results for all measurements decreased with about the same magnitude as the increase in the previous training period. Improvements from baseline in STS, TUG, 6MWT, walking speed, and 2MSIP following RT Period 2 were 41.6%, 17.1%, 20.5%, and 16.3%, respectively.

At follow-up after HT Period 2 and HT Period 2 + 8 weeks, all functional measurements still were about 10% better than at baseline; hence following RT Period 2, functional capacities seem to be better preserved than following RT Period 1. Average walking speed at HT Period 2 and HT Period 2 + 8 weeks was about 16% and 10% faster than at baseline and similar to data from a healthy population.

Discussion

The main aim of this case report was to evaluate how a combined model consisting of unsupervised HT and supervised RT at an outpatient clinic affected functional capacity of a person with PD during a 1-year follow-up. A recent systematic review and meta-analysis demonstrate that an RT intervention improves muscular strength of persons with PD, but information is limited regarding the outcome of functional capacities of patients with PD when they, in periods, are left to perform HT on their own.[21]

Treatment of chronic illnesses, such as PD, puts a large burden on the health and welfare system if patients having these illnesses continuously need physiotherapy or other health care services for follow-up. In this perspective, it is important to establish interventions that, at least in periods, enable people to take larger responsibility for their own health. This is also important considering that independent living is a key factor for health-related quality of life.[22] People with PD retain the ability to participate in many forms of exercise and generally respond to exercise interventions similar to age-matched persons without PD. Among different treatments, exercise is currently at the forefront for PD,[23,24] and in this perspective, the RT for patients with PD may be an important supplement to their treatment regime.

In this study, there is clear effect of supervised RT on muscle strength and functional outcomes, both following the first and the second training periods. In the first RT intervention period, functional outcomes improved by about 8% to 30% compared with baseline, and in the second RT period, the improvement ranged from about 16% to 40% (Figure 2).

Improvements of this magnitude may be significant for maintaining the level of independence which active living persons with PD actually desire. The functional performance of the patient with PD in this study prior to start of the RT interventions was generally in the low end of normal values for healthy men of similar age. After the second RT period, his performance had improved greatly and was generally in the upper range of values for healthy men of similar age.[15,17] Consequently, one may safely judge that repeated RT interventions and HT periods promote meaningful clinical changes for this patient with PD.

During HT, however, there is a gradual decline in strength and physical capacity, especially in this case, during the first training period. During the second HT period, functional outcomes and muscle strength are better preserved, and at the end of the follow-up period, most outcome variables still showed 10% to 20% improvement compared with baseline recordings. These results are important regarding how to design and implement exercise regimens for patients with PD.

The improvements in outcome measurements in this study are in line with other studies.[12,25] In addition, a systematic review by Roeder et al[21] summarizes that RT interventions are effective in improving muscular strength in persons with PD compared with no RT exercise. Furthermore, this meta-analysis advocates that interventions which combine RT with other types of exercises (eg, balance training) are the more effective.[21] Muscle weakness may be a primary symptom of PD and contributes to postural instability and gait difficulties.[21,26] Hence, RT may be very important for improving functional outcomes related to mobility in this population.[27]

Following bouts of intensive physiotherapy treatment, it may not be economically feasible for many patients with PD to continue seeing a physiotherapist throughout the year. Thus, to lessen the burden on municipal health and welfare services, and to promote independent living, we suggest that people with PD are relegated to supervised RT 2 to 3 times a year and that they perform home-based exercises in the interregnum between supervised training. With increasing proficiency in performing RT, the patients with PD may gradually need less supervision and gain independence also when performing these exercises.

Conclusions

The clinically most important findings of this case study are that individually tailored progressive RT may be a suitable intervention to make a patient with PD more independent. Furthermore, a program of home-based maintenance training seems to be effective in partially maintaining functional capacities.

Author Contributions

HS wrote the first draft of the manuscript. TG contributed to the writing of the manuscript and made critical revisions. HS and TG agree with manuscript results and conclusions, reviewed, and approved the final manuscript.

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