Application of LSVT BIG Intervention to Address Gait, Balance, Bed Mobility, and Dexterity in People With Parkinson Disease: A Case Series

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Background and Purpose. Lee Silverman Voice Treatment Big (LSVT BIG) is characterized by intensive exercising of high-amplitude movements to overcome bradykinesia and hypokinesia in patients with Parkinson disease (PD). The aim of the present case series was to explore possible beneficial effects of LSVT BIG training on gait, balance, bed mobility, and dexterity.

Case Description. Three patients with mild to moderate PD (all male; aged 52, 54, and 70 years; Hoehn & Yahr stages I–III) completed a 4-week LSVT BIG training program (16 individual 1-hour sessions) and an intensive home training program in accordance with the LSVT BIG protocol. Two certified LSVT BIG physical therapists delivered the LSVT BIG training sessions.

Outcomes. The outcome measures for gait and balance included the Functional Gait Assessment (FGA), Functional Reach Test (FRT), Timed "Up & Go" Test (TUG), Freezing of Gait Questionnaire (FOGQ), and motor score on part III of the Unified Parkinson's Disease Rating Scale (UPDRS III). Bed mobility was addressed using the Lindop Parkinson's Disease Mobility Assessment (LPA). The Nine-Hole Peg Test (9HPT) was used to measure dexterity. The 3 patients performed better on balance and gait assessments, as indicated by increased scores on the FRT and FGA (all 3 patients) and decreased scores on the TUG, FOGQ, and UPDRS III, of which scores of the FRT and UPDRS III achieved the minimal detectable change. Furthermore, the patients were quicker in tasks related to bed mobility (LPA). The patients' dexterity skills did not improve for their dominant (right) hand (9HPT).

Discussion. This case series suggests that the LSVT BIG may be beneficial for gait, balance, and bed mobility. Future work is needed to ascertain the effectiveness by means of randomized controlled trials.

Parkinson disease (PD) is a progressive neurodegenerative disorder that affects both motor and nonmotor basal ganglia circuitry.[1] The degeneration of dopaminergic neurons in the substantia nigra leads to the clinical manifestation of the cardinal motor features of PD: bradykinesia, muscle rigidity, tremor at rest, and impairment of postural reflexes.[2] Patients with PD experience increasing difficulties with walking, balance, and bed mobility. Furthermore, they often report clumsiness in activities of daily living (ADL), such as cutting food and tying shoelaces.[3] The effectiveness of physical therapy has been shown in PD, for which a wide range of techniques are used to improve gait, balance, and ADL.[4] Most of these techniques use compensatory movement strategies or external cueing in order to bypass basal ganglia dysfunction. Other treatment protocols focus on retraining the deficient function by repetitive, high-intensity exercises.

The recently developed LSVT BIG treatment, derived from the Lee Silverman Voice Treatment (LSVT), belongs to the latter approaches aiming to restore normal movement amplitude by recalibrating the patient's perception of movement execution.[5,6] The treatment focuses on intensive exercising of large-amplitude movements. The high intensity of LSVT BIG is predefined by a training mode of 16 individual 1-hour sessions for 4 weeks and an independent home training program. Also, every exercise is repeated at least 8 times and performed with an effort of 80% of the maximal workload.[5] (See video of the therapeutic approach, available at ptjournal.apta.org.) Two studies on the effectiveness of LSVT BIG in people with PD have been reported so far. A randomized trial, including 60 participants, demonstrated improved motor performance after intensive LSVT BIG: cardinal symptoms, such as bradykinesia, hypokinesia, were reduced, as assessed by the motor score on part III of the Unified Parkinson's Disease Rating Scale (UPDRS III).[5] One noncontrolled trial, including 18 participants, showed positive effects on walking speed and reaching movements.[6] However, the effects of LSVT BIG on gait (ie, freezing of gait), balance, bed mobility, and dexterity still remained to be established.[5] All of these factors have been shown to be strongly related to quality of life in individuals with PD[7,8]; therefore, improving these functions is important. The aim of the present case series was to examine the potential benefits of LSVT BIG on gait and balance, bed mobility, and dexterity in 3 patients with mild to moderate PD.

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- Video of the LSVT BIG therapeutic approach.

Patient History and Systems Review

For this case series, 3 patients were selected who met the following inclusion criteria, based on prior recommendation[6]: idiopathic PD, diagnosed by expert neurologists according to the criteria of the United Kingdom Brain Bank[9]; Hoehn & Yahr stages I–III, and Mini-Mental State Examination (MMSE) score >25. The patients did not show any severe depression, disabling dyskinesia, or comorbidity affecting mobility or ability to exercise. Patients 1 and 2 were selected from a neurologist's practice, and patient 3 was selected from a rehabilitation center. All 3 patients were identified by an expert neurologist through diagnosis according to the aforementioned criteria. After an informative consultation between patient and physical therapist, each patient agreed to participate in the 4-week LSVT BIG program. Furthermore, they all signed an informed consent statement. The patients' neurologist was encouraged to keep antiparkinson medications stable unless there was significant worsening of motor function.

The 3 patients described here lived independently in their communities and walked without assistive devices. Patient 1 was diagnosed with PD, with first PD symptoms (tremor of the right hand, rigidity and bradykinetic symptoms also predominantly right-sided) appearing 4 years previously. The previous year, he experienced a slight worsening in body posture and balance. During his daily routine, he further noticed that his slowness of movement and muscle stiffness negatively influenced his piano playing, writing skills, and jogging. While jogging or walking uphill, he often was short of breath. He defined the main goals for his upcoming physical therapy sessions as: (1) to reduce his slow behavior while playing the piano, (2) to improve his writing skills, and (3) to walk uphill with less effort.

Patient 2 was diagnosed with PD 5 years previously. He reported tremor of the right hand, general muscle stiffness, and slowness of movement. He also described some difficulties with writing skills. In addition, while getting in and out of bed, he experienced difficulty (slow and small movements) in turning over left and right in bed. He formulated his personal goals as: (1) to become more mobile again, (2) to improve his mobility when getting in and out of bed, and (3) to be able to drive his car again. His past medical history further revealed chronic low back pain and polyarthritis.

Patient 3 was diagnosed with PD 12 years previously. In addition to his

Table 1.
Patient Characteristics and Clinical Description[a]

Characteristic	Patient 1	Patient 2	Patient 3
Age (y)	52	54	72
Sex	Male	Male	Male
Time since diagnosis (y)	1	4	12
H&Y stage	I	II	III
Disease onset and predominant symptoms	Right	Right	Right
UPDRS III	10	29	34
MMSE	30/30	28/30	30/30
Medication (levodopa equivalent, mg/d)	800	800	1,300
Profession	Teacher	Taxi driver until 2011	Retired cabinetmaker
Main therapy goals	Writing Playing piano Walking uphill	Stepping up onto bus Getting in and out of bed Lifting heavy objects	Improving posture Reaching-grasping Turning while walking
Comorbidity	Dyspnoeic when walking upwards, no cardiovascular pathology	Low back pain L3–L5 polyarthritis	Carpal tunnel syndrome, right and left

[a] H&Y=Hoehn and Yahr Scale; UPDRS III=part III of the Unified Parkinson's Disease Rating Scale, motor examination in "on" state; MMSE=Mini-Mental State Examination.

general muscle stiffness and small and slow body movements, he reported a more stooped posture and experienced balance difficulties (incertitude, predominantly during dual tasking). His medical history further revealed carpal tunnel syndrome of both hands, for which he was treated intensively at that time. His personal goals were to improve his body posture, to walk greater distances, to better perform certain dual tasks (eg, standing secured while performing manual tasks), and to achieve better reach toward certain objects and improve their handling. The patients' primary impairments and clinical characteristics identified during the physical examination are specified in Table 1.

Clinical Impression 1

Based on the described data collected so far, the 3 patients were eligible candidates for the LSVT BIG program. Furthermore, none of the patients revealed a medical history that prevented them from participating in the LSVT BIG program. All patients reported slowness of movement and muscle stiffness, which they experienced as the main reason for their loss of body function and difficulties performing ADL. We hypothesized that the rigidity as well as the bradykinetic and hypokinetic symptoms played an important role in their reported difficulties. Also, all patients reported light to moderate changes in gait, balance, and dexterity skills, which were the main outcomes in this case series. Patient 2 additionally mentioned problems in getting out of bed. Further standardized measurements for gait, balance, dexterity, and bed mobility were needed to objectify reported difficulties before training. These measurements are described in detail in the following section.

Examination

Patients were videotaped while performing all behavioral tests. The performances were rated by an experienced therapist (A.S.), who was blinded with respect to clinical information of the patients. To eliminate possible "on-off" differences, all patients were tested in the on phase, which was about 2 hours after dopaminergic medication intake. Follow-up measurements were taken at the same time point after 4 weeks of LSVT BIG training. All measures were performed within 1 hour.

Gait and Balance Measures

Gait and balance problems are common in individuals with PD, influenced by their change in body posture as well as by bradykinesia, freezing of gait, and dual tasking,[10] often resulting in increased risk for falling. Therefore, multiple tests are recommended in diagnosing gait and balance problems in people with PD.[11] We combined the Functional Gait Assessment (FGA), Functional Reach Test (FRT), Timed "Up & Go" Test (TUG), Freezing of Gait Questionnaire (FOGQ), and the motor score on UPDRS III to ensure a comprehensive evaluation of gait and balance.

The FGA is a 10-item, reliable and valid tool to assess balance during various walking tasks in people with PD. Each item can be scored between 0 and 3 points, with a maximum score of 30 points. A higher total score signifies better balance.[12] A minimal detectable change (MDC) of 4.2 points has been established.[13]

To identify high or low risk for falling in people with PD, the use of multiple tests, such as the TUG and FRT, has been recommended.[12] The FRT measures the maximum distance that a person can reach forward with one arm while standing. The mean of 3 reaching trials was used in the current study. It has an MDC of 9 cm for patients with PD.[14] A score below 31.75 cm indicates a high risk for falling.[15] The TUG measures basic walking mobility skills in individuals with mild to moderate PD.[16] On the command "go," the patients were instructed to rise from the chair, walk 3 m at a comfortable and safe pace, turn, walk back to the chair, and sit down. An MDC of 3.5 seconds has been considered to be a true change in PD.[16] A score above 7.95 seconds indicates a high risk for falling.[15]

The FOGQ is a valid, self-administered, 6-item survey instrument designed to assess the severity of freezing of gait in individuals with PD.[17] Each item is rated on a 5-point ordinal scale. The total score ranges from 0 ("absence of symptoms") to 24 ("most severe symptoms"). Until now, no MDC has been established.

The UPDRS III quantifies motor symptoms of PD, reports good test-retest reliability,[18] and has an MDC of 5 points.[19] The subscale III contains 14 items, of which each item can be rated between 0 ("normal performance") and 4 ("severe impairment") points.

All patients demonstrated balance problems measured by the FGA (patients 1–3: 27, 25, and 26 points, respectively) and a high risk for falling detected by the FRT (20, 24, and 19 cm, respectively). In addition, patient 2's and patient 3's TUG performance was 11.5 and 7.7 seconds, respectively, further underscoring their risk for falling. All patients demonstrated light to moderate freezing of gait (patients 1–3: 2, 12, and 8 points, respectively, on the FOGQ). Their UPDRS III score was 10, 29, and 34 points, respectively.

Bed Mobility

The Lindop Parkinson's Disease Mobility Assessment (LPA), part B, is a reliable and valid measure of bed mobility in individuals with PD.[20] It measures the time and support needed to perform 4 tasks (sitting to lying down, turning over right and left in bed, and sitting up from a supine position). Each item is scored on a 3-point ordinal scale, where a score of 0 indicates "unable to perform or needing help of 2 people," and a score of 3 indicates "unaided, with ease (in less than 5 seconds)." A total score of 12 indicates no difficulties in bed mobility.

Patients 1, 2, and 3 scored 12, 12, and 11 points out of 12, respectively, on the LPA. Patient 2 reported some difficulties getting out of bed. Therefore, we additionally reported the time needed to perform the items of the LPA.

Dexterity

All 3 patients described difficulties with dexterity (dominant or nondominant hand, or both hands). We decided to include the Nine-Hole Peg Test (9HPT), which is a standardized test to assess hand dexterity. For this test, the time needed to displace 9 pegs was recorded. It has known normative value,[21] and its reliability and validity have been proven in individuals with PD.[22] Minimal detectable changes of 2.6 seconds and 1.3 seconds, for the dominant and nondominant hands, respectively, have been established for individuals with PD.[22] Patients 1 to 3 needed 20.4, 22.6, and 26.4 seconds, respectively, with their dominant hand, to perform the 9HPT. For their nondominant (left) hand, they needed 16.5, 21.4, and 26.5 seconds, respectively.

Clinical Impression 2

In each patient, light to moderate balance and gait problems were assessed, underscoring their subjective reported difficulties. All patients showed an increased risk of falling (FRT score $<$31.75 cm). Motor examination on the UPDRS III indicated typical bradykinesia and hypokinesia in the upper and lower extremities in all 3 patients. We expected that all patients would improve on gait and balance, with a lower risk for falling, after 4 weeks of LSVT BIG.

Reported difficulties of dexterity skills were confirmed by the results of the 9HPT, in particular for patient 3. We hypothesized that the rigidity as well as bradykinesia and hypokinesia mainly reduced dexterity in both hands. Reported impairments in dexterity were more present on the dominant (right) side for patients 1 and 2. Because LSVT BIG contains exercises, such as spreading out of fingers, we expected improved performance in dexterity skills of both the dominant and nondominant hands.

The LPA did not reveal any deficits in 2 patients, although patient 2 clearly mentioned such difficulties in bed mobility. We hypothesized that his difficulties in bed mobility were related to his bradykinetic and hypokinetic symptoms. Therefore, we expected that after the LSVT BIG intervention, his bed mobility would be performed easier and, consequently, faster.

All patients were determined to be appropriate to participate in the LSVT BIG program due to the pres-

Table 2.
LSVT BIG description of Tasks 1 Through 3[6]

Task	Exercises
Task 1: maximum sustained movements: seated	Exercise 1: 8 repetitions, sustain big "stretch" floor to ceiling Exercise 2: 8 repetitions, sustain big "stretch" side to side
Task 2: repetitive/ directional movements: standing	Exercise 1: 16 repetitions, big step forward (8 repetitions each leg) Exercise 2: 16 repetitions, big step sideways (8 repetitions each side) Exercise 3: 16 repetitions, big step backward (8 repetitions each leg) Exercise 4: 20 repetitions, forward big rock and reach (10 repetitions each side) Exercise 5: 20 repetitions, sideways big rock and reach (10 repetitions each side)
Task 3: functional component movements	Patient identifies 5 movements he or she does in functional everyday living (eg, sit-to-stand). Clinician and patient select one simple component of each of these movements. There are 5 repetitions for each of the component movements: "Do your movement with the same effort/bigness that you do during daily exercises."

ence of bradykinetic and hypokinetic symptoms, which negatively influenced their performance on gait, balance, dexterity and bed mobility.

Intervention

All participants were engaged in a 4-week training program, supervised by 2 certified LSVT BIG physical therapists (J.J. and K.M.). The program consisted of 16 one-hour sessions of supervised training (4×/week) and an additional home training program, which included a repetition of the exercises of the supervised training sessions. The 1-hour session is a one-to-one, supervised training session in which patients are constantly encouraged to focus on how it feels and what it looks like to move big and to work with an effort of at least 80% of the maximal workload (defined by visual analog scale [VAS]; 80% corresponds to 8/10 on the VAS). This high intensity aims to overcome bradykinesia and hypokinesia and, therefore, corrects and recalibrates the sensory perception of small movements into big movements.

Supervised Training (Weeks 1–4)

The supervised training is divided into 3 tasks. Tasks 1 and 2 represent 50% of the exercises and consist of standardized whole-body movements with maximal-amplitude, repetitive, multidirectional movements (eg, stepping and reaching forward, sideward, and backward), and stretching. The other 50% of the exercises are described as task 3, which includes individual goal-directed ADL.

Task 1 is called "maximum sustained movements" and contains 2 seated exercises. Task 2 is called "repetitive directional movements" and consists of 5 exercises. Three exercises are multidirectional, balancing movements, involving interlimb coordination and whole-body mobilization. For the other 2 exercises, patients have to swing both arms alternately forward or sideways. Task 3 is called "functional component movements," in which one component of each selected movement (eg, sit-to-stand, moving the trunk forward when standing up) is chosen and repetitively performed with big amplitude. In task 3, big movements are trained in real-life or carryover activities (ie, sit-to-stand, getting out of bed) to complete sensory recalibration (for more details about tasks 1–3, see Tab. 2).

The training was adapted weekly by increasing either the workload or the repetitions of exercises. Furthermore, they were improved by shaping techniques. A shaping technique is a tactile or visual aid to improve the quality of movement and its amplitude. Tactile aid means a hands-on correction by the physical therapist of the position without verbalizing the errors. Visual aid means that the patient imitates the therapist's performance ("Watch me, and do what I do").

Patients received a booklet containing all exercises of tasks 1 and 2. Furthermore, they had a diary that allowed them to document the amount of training sessions and the exercise frequency.

Home Training (Weeks 1–4)

Besides the supervised training, patients were encouraged to do their home training, consisting of repetitions of the supervised training. They trained once a day on days with supervised training and twice a day on days without supervised training. The LSVT BIG program for each patient is described in detail in Table 3.

Outcomes

Data of outcome measurements were obtained before training started and after 4 weeks of LSVT BIG training. Results of all outcome measures are listed in Table 4.

Gait and Balance

After 4 weeks of LSVT BIG training, all patients demonstrated increased FGA and FRT scores and showed decreased TUG scores. For the FGA, the scores increased 2 to 3 points but did not reach MDC values (4.2 points). Regarding the FRT, patient 1's and patient 3's outcome performance (both 31 cm) exceeded the MDC of 9 cm. All 3 patients nearly achieved the cutoff score of 31.75 cm, suggesting decreased risk for

Table 3.
Training Progress, Shaping Techniques, Sensory Calibration, and Main Problems[a]

Week 1	Patient 1	Patient 2	Patient 3
Task 1: 2 ex seated	8 reps, VAS 8.5	8 reps, VAS 8.5	8 reps, VAS 8.5
Task 2: 5 ex standing	8 reps, VAS 8.5	8 reps, VAS 8.5	8 reps, VAS 8.5
Task 3: Functional component movements	Standing up: 8 reps, VAS 7 Walking big: 8 reps, VAS 8.5	Standing up: 8 reps, VAS 8 Walking big: 8 reps, VAS 8	Standing up: 8 reps, VAS 8 Walking big: 8 reps, VAS 8
Shaping techniques: optimize movement bigness through tactile or visual aid	Only small amount of tactile help was necessary to optimize amplitude	A lot of tactile and visual help was necessary for each ex to optimize amplitude	A lot of tactile and visual help was necessary for each ex to optimize amplitude
Sensory calibration: movement bigness in carryover activities	Big writing on blackboard in front of the classroom, big walking going upward, playing the piano with big finger movements	Walking big, going outside	Walking big, going into the forest
Main problems	Prior to the training start, it was a challenge for patient 1 to plan and combine work and social life with this highly intensive (4×/wk for 4 wk) program	Problems copying tasks 1 and 2 without supervision. Low back pain persisted during big walking and clearly reduced his motivation. Therefore, we tolerated walking with a smaller amplitude to avoid the pain.	Patient mentioned problems in performance despite the booklet with the pictured exercises. A videotaped demonstration of the exercises (visualizing therapist and patient) helped him for his home training during the next 3 weeks. Balance problems during task 2: the handrail was used for security. Two days without supervised training due to the flu.
Week 2	**Patient 1**	**Patient 2**	**Patient 3**
Task 1: 2 ex seated	10 reps, VAS 7	8 reps, VAS 8.5	10 reps, VAS 7
Task 2: 5 ex standing	10 reps, VAS 8	8 reps, VAS 8.5	10 reps, VAS 8
Task 3: functional component movements	Standing up: 8 reps, VAS 7 Walking big: 8 reps, VAS 8.5 Writing ex: 8 reps, VAS 6 Finger-tapping: 8 reps, VAS 6	Standing up: 8 reps, VAS 8 Walking big: 8 reps, VAS 8	Standing up: 10 reps, VAS 7 Walking big: 10 reps, VAS 8.5 Turning while walking: 10 reps
Shaping techniques: optimize movement bigness through tactile or visual aid	Small amount of tactile help was necessary to avoid scapular pain during task 1 (ex 1) and task 2 (ex 1)	A lot of tactile and visual help was necessary for each ex	A lot of tactile and visual help was necessary for each ex, giving additional video feedback as in week 1
Sensory calibration: movement bigness in carryover activities	Identical to week 1	Getting in and out of a bus, getting in and out of bed with big movements	Walking big going out, big reaching and grasping, standing big (upright position)
Main problems	Due to a cold (3 d), reps were reduced (only 5 reps for tasks 1 and 2). Scapular pain during task 1 (ex 1) and task 2 (ex 1): 10 minutes of costal mobilization and kinesiology taping were given 2 times a week, which reduced the pain.	Problems copying tasks 1 and 2 without supervision Reduced home training on days with low back pain. This pain also reduced the amplitude in tasks 1 and 2; frequent breaks were needed. Tasks 1 and 2 took 50 min to complete; therefore, only 10 min remained for task 3 Movement bigness was barely used in carryover activities	Patient reported pain during grasping due to carpal tunnel syndrome: grasping exercises with imaginary objects instead of heavy objects reduced the pain

(Continued)

Table 3.
Continued

Week 3	Patient 1	Patient 2	Patient 3
Task 1: 2 ex seated	10 reps, VAS 8	10 reps, VAS 8.5	10 reps, VAS 8
Task 2: 5 ex standing	10 reps, VAS 8	10 reps, VAS 8.5	10 reps, VAS 8
Task 3: functional component movements	Standing up: 10 reps, VAS 8 Walking big: 10 reps, VAS 8.5 Writing ex: 10 reps, VAS 7 Finger-tapping: 10 reps, VAS 7 Piano-like ex (finger extension with prone hand): 10 reps, VAS 7	Standing up: 8 reps, VAS 8 Walking big: 8 reps, VAS 8 Stepping up big: 8 reps, VAS 8	Standing up: 10 reps, VAS 8 Walking big: 10 reps, VAS 8.5 Turning while walking: 10 reps Reaching and grasping: 10 reps
Shaping techniques: optimize movement bigness through tactile or visual aid	Tasks 1 (ex 2) and 2 (ex 2) with 5 reps of spikes (rhythmically opening and closing the hand as big as possible)	Visual help, especially for big movements in both hands, was necessary	Tasks 1 (ex 2) and 2 (ex 2) with 5 reps of spikes (rhythmically opening and closing the hand as big as possible.). Visual feedback improved movement bigness as in week 1: home training with mirror.
Sensory calibration: movement bigness in carryover activities	Identical to week 1	Getting in and out of a bus, getting in and out of bed with big movements, lifting movement with TheraBand (The Hygenic Corp, Akron, Ohio) and big amplitude	Identical to week 2
Main problems	Finger ex were performed big but did not reach an effort of VAS 8	Patient reported sustained low back pain, which reduced the amplitude of standing up	Identical to week 2
Week 4	**Patient 1**	**Patient 2**	**Patient 3**
Task 1: 2 ex seated	10 reps, VAS 8	10 reps, VAS 8.5	10 reps, VAS 8
Task 2: 5 ex standing	10 reps, VAS 8	10 reps, VAS 8.5	10 reps, VAS 8
Task 3: functional component movements	Standing up: 10 reps, VAS 8 Walking big: 10 reps, VAS 8.5 Writing ex: 10 reps, VAS 6.5 Finger-tapping: 10 reps, VAS 6.5 Piano-like ex: 10 reps, VAS 6.5	Standing up: 8 reps, VAS 8 Walking big: 8 reps, VAS 8 Stepping up big: 8 reps, VAS 8	Standing up: 10 reps, VAS 8 Walking big: 10 reps, VAS 8.5 Turning while walking: 10 reps Reaching and grasping: 10 reps
Shaping techniques: optimize movement bigness through tactile or visual aid	Tasks 1 and 2: 5 reps of spikes (rhythmically opening and closing the hand as big as possible) with video feedback to visualize and confirm good performance	Visual help, especially for big movements in both hands, was necessary	Tasks 1 and 2: 5 reps of spikes (rhythmically opening and closing the hand as big as possible) with mirror in front or video feedback to improve movement bigness, confirm and visualize good performance as in week 1
Sensory calibration: movement bigness in carryover activities	Identical to week 1	Identical to week 3	Identical to week 2
Main problems	Identical to week 3	Identical to week 3	Identical to week 2

[a] ex=exercises, reps=repetitions, VAS=visual analog scale (maximal effort is 10/10).

falling. Decreased scores on the TUG were found in all 3 patients but remained below the MDC of 3.5 seconds.

Patient 2, who had most severe freezing of gait before training, showed a striking improvement on the FOGQ. He experienced less freezing of gait. Concerning the UPDRS motor scale, the mean improvement over all 3 patients was 5.6 points, which exceeds the MDC of 5 points.[19] This improvement was most prominent for patients 2 and 3.

Bed Mobility

With respect to bed mobility, 2 patients already had a maximum score of 12 points on the LPA before training. Therefore, no further improvements could be expected on that scale. However, patients 1 and 3 performed the 4 tasks much quicker after LSVT BIG training. Patient 2

Table 4.
Pretraining-Posttraining Outcome Measurements for Patients 1 Through 3[a]

Measure	Patient 1		Patient 2		Patient 3	
	Pretraining	Posttraining	Pretraining	Posttraining	Pretraining	Posttraining
Gait and balance						
FGA (0–30)	27	29	25	28	26	29
FRT (cm)	20	31[b]	24	31.5	19	31[b]
TUG (s)	5.4	5.0	11.5	10.3	7.7	5.8
FOGQ (0–24)	2	2	12	4	8	9
UPDRS III	10	8	29	23[b]	34	25[b]
Bed mobility						
LPA (0–12)	12	12	11	12	12	12
Sit-to-lie (s)	3.0	1.5	2.9	4.4	3.5	1.3
Lie-to-sit (s)	2.0	1.5	5.6	4.4	2.6	1.3
Turning left (s)	2.9	1.1	2.7	2.2	3.5	1.7
Turning right (s)	2.6	1.1	2.7	1.9	2.9	2.0
Dexterity						
9HPT, right hand (s)	20.4	19.4	22.6	23.5	26.4	26.3
9HPT, left hand (s)	16.5	15.1[b]	21.4	23.9	26.5	24.2[b]

[a] FGA=Functional Gait Assessment, FRT=Functional Reach Test, TUG=Timed "Up & Go" Test, FOGQ=Freezing of Gait Questionnaire, UPDRS III=Unified Parkinson's Disease Rating Scale III, motor examination, LPA=Lindop Parkinson's Disease Mobility Assessment, 9HPT=Nine-Hole Peg Test.
[b] Exceeded the minimal detectable change.

demonstrated no more difficulties in sitting up from a supine position and achieved a maximum score of 12 points.

Dexterity

Patients 1 and 3 demonstrated some improvements in dexterity. Although exceeding the MDC,[22] these improvements were only for their nondominant (left) hand. No improvements could be found for their dominant hand, which demonstrated the strongest bradykinesia, hypokinesia, and rigidity. Patient 2 did not improve in performance of dexterity skills and even showed some minor deterioration.

Personal Goals

Patient 1 reported improvement when walking uphill, being less dyspnoeic. Patient 2 passed his driving test after 4 weeks of training and reported getting in and out of bed easier. Patient 3 mainly improved his daily walk in the forest and reported having a better posture.

Discussion

Our patients in this case series showed improvements on several outcome measures, including gait, balance, and bed mobility, after 4 weeks of LSVT BIG training. However, the level of improvements differed among the 3 patients and varied on some outcome measurements. These discrepancies may be explained by the fact that the patients described distinct main problems in body functions and activities, also related to their differing stages of PD, although they had in common that they noticed bradykinetic and hypokinetic symptoms, being either mild or moderate. These cardinal motor symptoms typically affected their performance in motor tasks. In line with the Berlin LSVT BIG study,[5] our patients demonstrated similar decreased motor scores on the UPDRS III (mean improvement of 5.6 points), supporting the positive effect of LSVT BIG training on bradykinesia and hypokinesia. These positive changes in motor scores have previously been explained—by focusing on amplitude, movements are expected to be bigger, faster, and more precise.[23–25] Furthermore, it is known that patients with PD are often unaware of producing small movements and often lack appropriate feedback mechanisms to correct "small" behavior.[5] The LSVT program incorporates feedback mechanisms, such as shaping techniques and, therefore, aims to improve the self-perception of patients with PD, leading them to habitually move with bigger movements.[5]

Possible effects from bigger movements on balance, bed mobility, and dexterity skills were not addressed in the previous LSVT BIG studies.[5,6] Increased FGA scores were found in all patients, suggesting better balance. However, the increment did not exceed the MDC; therefore, the changes cannot be interpreted as a real change. With regard to risk for falling, patients 1 and 3 in this case series demonstrated clinically relevant improvements on the FRT. All 3 patients nearly achieved the normal cutoff score of 31.75 cm after 4 weeks of LSVT BIG training. This finding suggests a reduced risk for falling. However, this explanation is not supported by the performance on the TUG. In all 3 patients, TUG scores did not exceed the MDC, possibly explained by the fact that patients 1 and 3 already had TUG scores indicating low fall risk prior to the intervention. Another explanation could be that the duration of intervention (ie, 4 weeks) was not enough to obtain a clinically relevant change on the TUG, which has been shown previously.[6]

Patient 2 experienced less freezing of gait after 4 weeks of LSVT BIG training. This finding may have been due to the combination of specific balance exercises (task 2), which are integrated into the daily routine, possibly stimulating generalization effects, and the focus on large-amplitude movements. However, in contrast to patient 2, the other 2 patients did not show any changes in freezing of gait. This finding suggests that LSVT BIG training does not reduce freezing of gait in all patients with PD, which also has been shown for some patients with PD who received cued gait training.[26] In any case, LSVT BIG training may be an alternative, besides cued gait training,[27] to reduce freezing of gait in some patients with PD.

Another main focus of this case series was to examine possible beneficial effects of LSVT BIG training on bed mobility. We could demonstrate that our 3 patients were quicker performing bed mobility tasks (eg, to sit up from a supine position). These outcomes, however, were not identifiable by the bed mobility subscale of the LPA for patients 1 and 3, possibly due to ceiling effects. Interestingly, patients 1 and 3, who did not train for bed mobility in particular, also benefitted from LSVT BIG training. This finding raises interest in possible effects of LSVT BIG from trained to nontrained tasks.

Finally, possible benefits of LSVT BIG training on dexterity skills also were examined. Our case series demonstrated no improved performance of dexterity skills for the dominant (right) hand in all patients. Furthermore, none of the patients reported improved writing skills. Patients 1 and 3 showed some improvements with their nondominant (left) hand, even exceeding the MDC. These improvements could have been due to spikes in performance of task 2, which consisted of rhythmic exercises focusing on high-amplitude hand and finger movements. However, patient 2 did not show any benefits of LSVT BIG training on dexterity. We hypothesize that the lack of meaningful improvement can be explained by the fact that LSVT BIG does not specifically stimulate the coordination of small muscle movements, which are imperative for dexterity. Another explanation may be that deficits in dexterity in patients with PD are not only explained by the underlying bradykinesia but also by an apraxic disorder called "limb kinetic apraxia" (LKA).[28] This higher-order motor disorder typically affects dexterity, which is not explained by elementary motor symptoms, and has been suggested to be present in patients with PD.[28]

It is clear that our case series limits the ability to generalize our observations to other patients with PD, especially with those in the most advanced stages (ie, IV and V). Furthermore, we did not include a control group, nor did we record any follow-up measurements. Therefore, we do not have information concerning long-lasting effects of LSVT BIG training on gait, balance, bed mobility, and dexterity. Finally, one has to keep in mind that the intensive LSVT BIG program requires a lot of physical effort and adherence from the patients due to its high frequency (16 hours in 4 weeks) and intensity (continuously training with an effort of 80%). Future studies will be needed to explore alternative dosages of LSVT BIG, tailored to physical resources of the patients.

In conclusion, the present case series is the first report describing possible beneficial effects of LSVT BIG training on gait, balance, and bed mobility in patients with mild to moderate PD. Future well-designed, randomized studies will be needed to ascertain the effectiveness and long-term improvements of LSVT BIG training on these functions.

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