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Improved mobility, cognition and disease severity in Corticobasal Degeneration of an African-American male after 12 weeks of Adapted tango: a case study.

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Abstract

Corticobasal degeneration (CBD) has no available treatment to slow disease progression and generally resists drug therapy. CBD has symptoms and decreased quality of life similar to Parkinson's disease. Adapted Tango, a successful rehabilitation for Parkinson's, may address CBD. A 63-year-old African-American male with CBD (alias: YD; CBD duration=2 years) was evaluated for motor, cognitive and psychosocial function before, immediately after, one-month after and six-months after 12 weeks of 20, bi-weekly 90-minute AT lessons. After intervention, disease-related motor symptoms improved and YD reported fewer problems in non-motor experiences of daily living, which include mood, cognition, pain, fatigue, etc. Motor symptoms remained above baseline at six-month posttest. YD's balance confidence improved post-intervention, but declined below baseline at six-month posttest. Quality of life was maintained despite worsened depression. YD improved or maintained executive function, and visuospatial function and attention at posttest and one-month posttest. At posttest, YD maintained mobility and improved on dynamic balance. At one-month posttest, most mobility measures had improved relative to baseline. Yet, YD showed executive function and overall motor decline six months post-intervention. AT may have temporarily slowed disease progression, and improved or maintained mobility and cognition. Gains were poorly maintained after six months. Further study is warranted.

Keywords

Corticobasal Degeneration; Dance; Exercise; Atypical Parkinson Syndrome; Rehabilitation; Case Report

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Conflict of Interest

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Introduction

Effective diagnostic treatment options are limited for Parkinson's disease (PD) and atypical Parkinson syndromes, which are increasing in diagnoses on a global scale.¹ Corticobasal degeneration (CBD), an atypical Parkinson syndrome, is a rare, rapidly progressing tauopathy involving neuronal loss of cerebral cortex and basal ganglia affecting an estimated 0.62–0.92 per 100,000 people.^{2,3} CBD has comorbidities and symptoms in common with PD (e.g. tremor, rigidity, bradykinesia and postural instability), making diagnosis extremely difficult.⁴ CBD is characterized by cortical dysfunction, asymmetric rigid syndrome, sensory loss, impaired cognition, social behavior and reduced quality of life (QOL). The age of CBD onset is typically 60 to 70 years old, but ranges from 45 to 77.²

No effective, established or disease-modifying treatment or pharmaceutical therapeutic option currently exists for CBD.^{5,6} The best treatment options available for CBD patients are enrollment in clinical neuroprotective trials.⁷ Little literature exists on exercise effects on tauopathies other than PD, although exercise-based interventions benefits for PD are well documented. Exercise-based CBD case reports suggest efficacy of frequent exercise to prolong longevity and maintain function in patients. One-month of repetitive facilitation exercise prevented neuronal and circuitry loss in an individual with mixed features of CBD and progressive supranuclear palsy. This individual had greater ability to perform daily activities, fewer falls, slowed rate of brain volume loss and maintained balance and endurance.⁸ Another 10-yearlong study showed regular and aggressive exercise (i.e. biweekly, 60-minute sessions) comprised of stretching, strength training and treadmill walking decreased falls and promoted stability function in an individual with CBD.⁹

Dance, a socially-supportive exercise and rehabilitation method for postural instability, incorporates continual adjustment to and awareness of environmental demands while maintaining balance. One form of dance, Adapted tango (AT) improves mobility, QOL and cognition, particularly spatial cognition, in older adults with PD improve mobility¹⁰ and may address CBD symptoms. A systematic review and meta-analysis of dance versus exercise interventions in PD found that dance was favored over exercise for balance and QOL and for teaching compensatory movement strategies.¹¹ Furthermore, there is increased basal ganglia activity, normally impaired by CBD, when tango is rhythmically performed.¹² Compared to Dance for Parkinson's, a community-based mixed dance style PD intervention, a tango group scored better on static and dynamic mobility, and motor symptoms of CBD.¹³ Compared to other ballroom dances, e.g., Waltz/Foxtrot, AT benefitted freezing of gait, motor control, forward and backward gait, balance and six minute walk test distance more.^{14,15} AT is unique because it involves problem-solving and motor goal communication through tactile connection. Given evidence supporting AT's effects and success of exercise in prior case reports, we believed AT would benefit YD's CBD-related symptoms.

Methods

The institutional review board at Emory University School of Medicine and the R&D committee of the Atlanta VA approved this work. YD provided written informed consent

before participating. This study conforms to all CARE guidelines and reports the required information accordingly (see Supplementary Checklist).

Case Description

CBD is extremely difficult to diagnose, because of its similarity with other neurodegenerative disorders, especially PD. Clinical diagnosis is based on thorough neurological examination. Individuals with CBD exhibit myoclonus, and Levodopa is ineffective.¹⁶ The study included individuals with diagnosed Parkinsonism and PD who could walk 3 or more meters unassisted. As such, YD was a 63-year-old African-American man working part-time as a funeral director, with a two-year right-side onset CBD diagnosis and two falls in the previous six months. YD was diagnosed by a board-certified neurologist with specialty training in movement disorders, 2 years before participating in the study. YD's Movement Disorders Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS) scores indicated moderate to severe Parkinson's; YD had right upper extremity myoclonus, and Levodopa was ineffective for him, consistent with a CBD diagnosis. His OFF-medication MDS-UPDRS motor-subscale III (UPDRS-III), a clinical motor examination on the effects of PD, score was 63 out of 108, which exceeds the established norm of 36.8 for moderate severity PD patients,¹⁷ indicating severe CBD-related motor symptoms. YD reported difficulty rising from a chair, but no freezing of gait. Although YD did not use an assistive device, he reported a low score of 8/24 on the Composite Physical Function (CPF) index, a participant-completed questionnaire that asks whether or not they can do, can do with difficulty or help, or cannot do a range of important and basic activities of everyday living (ADL).¹⁸ Lower scores on the CPF indicate one's risk of loss of function to perform ADLs. As such, YD's wife regularly assisted him in ADLs, such as assisting with personal needs like dressing and bathing, light and heavy housework, climbing up and down stairs and carrying objects over 10lbs. YD had no dance experience before the study and it was unclear whether he could participate meaningfully given his mobility limitations. However, he stood to potentially benefit from the AT classes given positive results seen in multiple PD participants.

Data on medications were collected at each time point in the study. At pretest, YD reported that he was prescribed 25–100 tab Carbidopa Levodopa and 2mg Trihexyphenidyl for his CBD, and 300mg Diltiazem and 4mg Doxazosin for high blood pressure diagnosed 10 years earlier. At the 6-month posttest, YD reported adding 0.5mg of Clonazepam to his prescribed medication regimen to treat myoclonus.

Dance Therapy Intervention

YD attended 20, 90-minute AT classes with older adults with PD over the course of 12 weeks. Classes were led by an experienced and qualified instructor, and consisted of a 20-minute warm-up, 10 minutes practicing skills from previous classes, and 60 minutes learning and practicing new skills and rhythms. Warm-ups consisted of breathing exercises, attention to postural alignment, limbering and increasing range of motion. Instructors and assistants monitored all participants for their safety. AT was created specifically for older adults with balance problems and/or PD to accommodate musculoskeletal and balance problems. AT requires frequent movement initiation and cessation, multi-directional perturbations and

varied rhythms. AT requires participants to focus on trunk control, coordination and stepping strategies, kinesthesia, their partner and trajectory, step aesthetics and multirhythmic step patterns. After warm-up, the instructor introduced novel step elements each class. Participants practiced new steps with a healthy partner in place before traveling around the dance floor. Toward the end of class, the new steps were reviewed and incorporated with previously learned steps and rhythms, allowing participants to travel around the room dancing step combinations. Participants spent equal time leading and following dance steps, regardless of sex, in a “closed practice” position. Adapted from the traditional ballroom frame, the “closed practice” position factors in potential mobility restrictions of participants, and provides a more stable way to support the participant and reduce fall risk. The position consists of partners facing one another and holding hands/forearms with bent elbows and forearms parallel to the floor. YD danced with healthy volunteers from the community and student research assistants from local universities, who were trained in spotting techniques. YD sometimes danced with his wife, who was very supportive. More details about adapted tango are given in the supplemental material section for this case report (See Supplemental Material).^{19,20}

Examination

YD was examined two weeks before (pretest), within two weeks after (posttest), 4–6 weeks after (1-month posttest) and 6 months after (6-month posttest) completing 20 AT classes. Intervention was discontinued within two weeks before posttest. Between posttest and 6-months posttest, YD resumed daily activities without AT or other instruction from the research team. Data were collected at six months posttest, because we wanted to determine whether improvements from AT would be maintained and to track progression given rapid CBD progression. The comprehensive battery used to assess YD included physical function measures (i.e., mobility, endurance, balance, and gait function), cognition (memory, planning, processing speed) and psychosocial function (QOL, depression, balance confidence). Motor, cognitive and psychosocial function is critical to ADL performance, social interaction and living an unhindered and safe life. All outcome measures were tested while YD was “OFF” medications, defined as at least a 12-hour period since the last anti-parkinsonian medication intake, to avoid dyskinesia and medication fluctuations that hinder functional activity. Trained and blinded raters followed standard protocol.

Outcome Measures

No normative data on CBD exist for the outcome measures, so we employ PD normative data and minimal detectable changes (MDC) as available for each outcome measure.

Mobility

Four Square Step Test: a valid test of mobility that measures movement initiation, planning and coordination²¹ requires participants to initiate multidirectional movement in a challenging sequence, while stepping over 2.5cm diameter rods arranged in a cross. Participants are given three trials and their best time (i.e. lowest time) is used for analyses. The PD-specific cut-off score, >9.68 seconds, indicates increased fall risk. MDC has not been determined for this task.

6-Minute Walk Test:²² a test of endurance measured in meters. Participants, accompanied by a trained administrator, walk up and down a corridor for 6 minutes at a self-determined pace. The distance walked is measured, and the PD-specific MDC is 82 meters.²³

Timed-Up-and-Go Baseline (TUG-B), TUG Cognitive (TUG-C) and TUG Manual (TUG-M): These tests measure balance, mobility and fall risk.²⁴ In TUG-B a participant stands up from a chair, walks 3 meters, turns around and comes to sit back down in the chair. To measure dual-task ability, the same TUG task is performed while counting backwards by threes from a random number (TUG Cognitive, TUG-C), and while carrying a cup of water (TUG Manual, TUG-M). For the dual tasks, YD was instructed to pay equal attention to walking and the secondary task. The MDC for TUG tasks has not been established. However a PD cut-off score for TUG-B is set at >11.5 seconds, which indicates increased fall risk.

Habitual, backward and fast-as-possible (fast) gait speeds (m/s) were measured with a stopwatch over a 20 foot distance using established methods. Slower gait speeds are associated with disease severity, worse mobility and increased fall risk.²⁵ The MDC for forward gait speed in PD patients is 0.22m/s and for fast gait speed is 0.23m/s.²⁶

Disease Severity

The MDS-UPDRS-III has been used previously in CBD studies.⁴ Higher MDS-UPDRS scores indicate greater impact of PD symptoms. The **MDS-UPDRS** quantifies and evaluates the burden and extent of PD. Part I, comprised of interview and a questionnaire completed by the participant, measures the effects of PD on non-motor ADLs, including cognition, mood, anxiety, apathy and several autonomic issues. Part II is a self-administered questionnaire about the effects of PD on motor ADLs, including saliva, eating, dressing, bed mobility, gait, balance and fine motor skills. Part III, graded by a trained rater, is a clinical motor examination. Part III's examination includes speech, facial expression, tone, the speed and amplitude of gross and fine motor movements, tremor, posture, reactive balance, and functional mobility. The score ranges for each section are: Part I range=0–16, Part II range=0–52, Part III range=0–108, Part IV range=0–24. The established normative data for mean scores on the MDS-UPDRS are: Part I=11.5, Part II=16.0, Part III=36.8.¹⁷ The MDC are: Part I MDC=2, Part II MDC=4, Part III MDC=11.²²

Parkinson's Disease Questionnaire-39 (PDQ-39):²⁷ a self-report questionnaire that assesses PD-specific QOL over the past month, comprised of eight domains: mobility, ADLs, emotional well-being, stigma, social support, cognition, communication and bodily discomfort. PDQ39-Summary index (SI) scores, expressed as a percentage of the sum of all 39-items, range from 0 (the lowest possible score) to 100 (the highest possible score). The normative PDQ39-SI score is 33.01. While each domain has its own MDC, the average MDC is 19.57. Higher scores indicate worse QOL as a result of PD-related symptoms.

Cognition

Trail Making Test Parts A&B (Trails B-A) is an extensively-used test of visuospatial processing speed, attention, executive function and set switching.²⁸ A short practice example is given before each Trails task. Participants are asked to connect a series of 25 dots

containing numbers in ascending order as quickly as they can for Trails A. In Trails B, participants are asked to connect 25 dots containing either a number or a letter by going from a number to a letter in ascending order as quickly as they can. The Trails B-A score is (the time it took to complete Trails B) – (the time it took to complete Trails A). Slower Trails B-A times are associated with cognitive impairment and impaired executive functioning.

The Tower of London Total Achievement Score²⁹ measures executive functioning, specifically organization and planning ability, a cognitive function often impaired by CBD. The test consists of nine different towers which range in difficulty, from simple towers completed in 1–3 moves to more difficult towers requiring up to 26 moves minimum. Participants are asked to complete each tower in the fewest number of moves possible. The total achievement score (maximum score=30) is a sum of each individual tower's achievement score – a measure that awards more points to towers completed with the fewest moves. The MDC has not been established and a worse (i.e. lower) score indicates impaired executive functioning and planning.

The **Montreal Cognitive Assessment (MoCA)** is a rapid screen for cognitive abilities that can indicate mild dementia. With 16 items and 11 categories, MoCA assesses visuospatial and executive functioning, language, orientation, attention, memory, naming and abstraction. The highest score is 30. An extra point is given to participants with less than 12 years of education. The PD-specific norm for MoCA is 25; scores below 25 indicate PD-MCI.

Reverse Corsi Blocks (Corsi)³⁰ is a validated visuospatial attention and working memory task in which participants must reproduce sequences of blocks in the reverse order touched by the examiner. The examiner begins with two moves and progresses to a maximum of nine moves, with two trials per level. Participants continue to the next level if at least one trial is correctly performed. The task ends when the participant fails both trials in a level. The product score is calculated by multiplying span (highest level achieved +1) with the number of correct trials completed. The maximum product score is 144. A worse (i.e. lower) score indicates impaired visuospatial attention and working memory.

The **D-KEFS Color Word Interference Test (CWIT)**³¹ measures executive function and consists of four conditions. Condition 1 (color naming) and Condition 2 (word reading) provide a baseline, while Condition 3 (Inhibition) and Condition 4 (Inhibition/Switching) provide more challenge and test inhibition and switching. The inhibition/switching test can indicate possible impairment as well as cognitive flexibility capabilities. Scaled scores for each condition range from 1 (the lowest/worst score) to 19 (the highest/best score), with 10 being the “average” score. The MDC has not been established for this task. A lower score indicates impaired executive function in inhibition and switching domains.

Psychosocial Questionnaires

The **Beck Depression Inventory (BDI-II)** is a self-reported questionnaire concerning overt behavioral characteristics of depression.³² BDI scores range from 0 to 63. Higher scores indicate more symptoms of depression, with a PD-specific cut-off score established as 13/14

to screen for depression. Total BDI scores can indicate minimal (0–13), mild (14–19), moderate (20–28) and severe (29–63) depression. The MDC for the BDI is 8.7.³³

A valid³⁴ **Single-item QOL** measure asked, “how would you rate your overall quality of life?” and was measured on a 7-point Likert scale (1: lowest QOL, 7: highest QOL).

Activities-Specific Balance Confidence scale (ABC),³⁵ is a self-assessed level of self-confidence in performing activities without losing balance. ABC is highly sensitive and a specific predictor of fall risk. The highest possible score is 100%, indicating complete confidence in balance during various activities ranging from normal walking to walking on ice. For PD, the mean ABC score is 73.6% with a cut-off score of 69% that is predictive of recurrent falls.³⁶

Results

Pretest, posttest, 1-month posttest and 6-month posttest measures are summarized in Table 1. YD demonstrated variable performance over the study. Improvements at posttest were not all maintained in the 1-month posttest- and 6-month posttest-intervention. YD improved at posttest in balance confidence, maintained at 1-month posttest, but declined below baseline at 6-month posttest. Health-related QOL was maintained throughout the study, but YD became more depressed at posttest (going from minimal to mild depression), which was not resolved at 6-month posttest. At posttest, YD demonstrated clinically important improvement in executive function and maintained visuospatial function and attention, maintained at 1-month posttest. At 6-month posttest, YD declined in set switching and cognitive flexibility. At posttest YD improved four square step test time with no other changes. At 1-month posttest, mobility measures had improved from baseline, with overall declined motor performance at 6-month posttest. Although YD improved on disease-related motor symptoms, reported fewer non-motor symptoms (MDS-UPDRS-I) and reported maintained ability in motor ADLs (MDS-UPDRS-II) at posttest, he returned to baseline or worsened at 6-month posttest, save for UPDRS-III.

Satisfaction

At the immediate posttest following intervention YD was given an exit questionnaire to determine his satisfaction with the program. YDX's exit questionnaire indicated enjoyment and benefit from AT. He reported the classes, assessments and questionnaires were mentally stimulating; “The tango and the questionnaires had me thinking. The [Tower of London test] too. [The program] had me thinking and it helped me with my balance.” YD strongly agreed with statements that he enjoyed participating, his balance, walking and endurance improved, and that he had been more physically and mentally active. He indicated he would continue participating if possible. YD reported difficulty in the warm-up, “I think the warm-up is good, but I couldn't do the things they were doing.” He reported AT was excellent.

Discussion

This is the first case report demonstrating benefits of AT for an individual with CBD, and underscoring the rapid progression of CBD with collection of data at 6-month posttest

following intervention. AT may target CBD-related motor and cognitive impairments. Short-term results were variable and variably maintained at subsequent time points. YD improved balance confidence, mobility, coordination, disease severity, planning and visuospatial processing speed immediately after intervention. However, most of these improvements were not maintained, and some declined below baseline at 6-months posttest. As there are no effective medications for CBD,^{5,6} the prescribed regimen of medications for YD may not have impacted the results. The relentlessly rapid progression of CBD, unhindered by medication and the absence of clinical neuroprotective intervention may have led to declines observed at 6-month posttest, which may even have been attenuated by YD's participation in AT.

Depressive symptoms are very common in patients with neurodegeneration; at least 51 percent of CBD patients present depressive symptoms during the disease course.² Similarly, YD initially screened for mild depression and showed further depressive signs at post assessments. AT has improved QOL scores in PD patients;³⁷ however, YD's QOL scores remained constant. His depression relative to QOL was potentially offset by his increased mobility and cognitive functioning post-intervention.

YD reported that his non-motor ADLs were less affected by his CBD and the research team reported significant improvement on motor skills affected by CBD. His significantly improved MDS-UPDRS-III score could result from having more room to benefit given the initial severity of his CBD,⁴ seeing as CBD patients have significantly higher MDS-UPDRS-III scores than PD patients.⁴ The physical demands of AT may have been effective in targeting CBD-related motor impairments, such as bradykinesia, rigidity and muscle control. Further, YD's maintained PDQ39 SI score is consistent with previous AT literature on PD patients.¹⁰

AT may have slowed YD's clinical progression of motor decline; YD improved motor function, possibly from practicing AT's unique sequence of motor skills. Many CBD patients report decreased endurance;³⁸ however, YD maintained endurance at 6-month posttest suggesting that the walking, standing and moving in AT classes may have aided this aspect of function. Balance, coordination and mobility (static and dynamic) improved and fall risk declined immediately after intervention, as per posttest ABC score, and Four Square Step Test time, and the 1-month posttest increases in gait speed. These motor skills are inherent to AT and YD regularly practiced them in AT class.

Seventy percent of CBD patients manifest cognitive impairment during disease course.² YD initially screened for some cognitive impairment, but improvements were noted after intervention. YD improved on measures of visuospatial abilities and executive functioning, normally impaired by CBD.³⁹ In addition to aerobic exercise, which has been shown to improve cognition in PD patients,⁴⁰ AT requires recalling steps and directions while maintaining awareness of spatial relationships.¹⁰ YD's consistent decline in CWIT Inhibition/Switching task indicates decreased cognitive flexibility. Contemporary dance therapy with comprehensive improvisation has increased cognitive flexibility in normally aging adults.⁴¹ AT shares some improvisational components, within the rules of tango. The contemporary dance improvisation focused on producing new movements while AT

improvisation focused on creating new patterns with previously learned steps, potentially accounting for YD's lack of improvement in cognitive flexibility. In contrast, YD improved in planning and organization required by the Tower of London.

YD could have benefited from other forms of dance or exercise intervention for people with PD; however, AT is a unique intervention that involves standard aerobic exercise, skill learning and motor repertoire development. This intervention is a partnered dance which, in comparison to non-partnered dance interventions, might be especially helpful for someone with balance impairments and motor control difficulties. AT, while structured around motor functioning, calls upon cognition in addition to motor skills.

Study is warranted to determine if adding a more comprehensive improvisation component to AT would increase cognitive flexibility in CBD individuals. AT benefited disease severity, and motor and cognitive functioning, with best results seen immediately after intervention. Results are tempered by psychosocial measures that largely worsened although YD appeared to appreciate the class experience.

Study Limitations and Conclusions

This study is limited because it describes one male participant with CBD and most benefits were not maintained at 6-month posttest, suggesting sustained intervention is needed for long-lasting benefit. YD enjoyed the program and even the assessment process, reported increased balance confidence and a lesser impact of CBD on non-motor ADL. AT may benefit others with CBD. Future work with larger samples and longer-term intervention is warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Case Performance during Study Observation.

The AT intervention may have helped YD maintain cognitive and motor function despite the rapid progressive nature of CBD. However, in the 6 month absence of intervention by the study team, YD experienced decline, but this expected decline may have been attenuated by the intervention.

Table 1.

Pretest, posttest, 1-month post and 6-month post measures.

Assessment	Pre	Post	1-Month Post	6-Month Post
Psychosocial				
Activities-Specific Balance Confidence (ABC), Total Score (%)	51.86	(+) 61.25	(+) 60.63	(-) 49.38
Parkinson's Disease Questionnaire, Summary Index Score (PDQ-39 SI) [*] (/100)	31.5	31.5	31.5	(-) 34.48
Quality of Life (QOL) Score (/7)	4	4	4	4
Beck Depression Inventory (BDI-II) Score (/64)	9	(-) 15	(-) 15	(-) 16
Cognitive				
Trails Difference (B-A), (sec)	85.38	(+) 43.46	(+) 77.06	(-) 225.78
Tower of London, Total Achievement Scaled Score (/19)	12	(+) 19	(+) 19	(+) 15
MOCA, Total Score (/30)	23	(+) 27	(+) 25	(+) 25
CWIT, Color Naming SS (/19)	1	1	1	1
CWIT, Word Reading SS (/19)	1	1	1	1
CWIT, Inhibition SS (/19)	7	(-) 6	7	(-) 2
CWIT, Inhibition/Switching SS (/19)	9	(-) 7	(-) 3	(-) 1
Corsi Product	12	12	(+) 20	(+) 16
Motor				
Four Square Step Test, Best Time (sec)	20.87	(+) 17.91	(+) 18.59	(-) 33.69
6 Minute Walk Test (m)	289.56	274.32	(+) 350.52	304.8
TUG Baseline (sec)	12.06	11.47	14.4	(-) 19.87
TUG Cognitive (sec)	14.40	14.50	(-) 15.92	(-) 20.60
TUG Manual (sec)	20.09	19.97	(-) 19.56	(-) 24.53
Average Forward Gait Speed (m/s)	1.07	1.03	(+) 1.36	(-) 0.84
Average Backward Gait Speed (m/s)	0.62	0.61	(+) 0.84	(-) 0.40
Average Fast Gait Speed (m/s)	1.35	(-) 1.28	(+) 1.75	(-) 1.05
MDS-UPDRS				
Part 1 (/16)	9	(+) 6	(+) 5	9
Part 2 (/52)	21	22	22	(-) 28
Part 3 (/108)	63	(+) 51	(+) 57	(+) 57

YD's performance before and after AT training.

^{*} Higher scores for BDI, PDQ-39 SI, Trails B-A, Four Square Step Test, all TUG tests and all MDS-UPDRS sub-tests indicate decline.

Coded as per clinical judgment of maintenance (no code), improvement (+) or decline (-) rather than using pure magnitude of change.