Case Report

# Application of Adapted Tango as Therapeutic Intervention for Patients With Chronic Stroke

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**ABSTRACT**

**Background and Purpose:** Dance has demonstrated beneficial effects on mobility in older individuals with movement disorders; yet, effects of partnered dance remain unexamined in individuals with chronic stroke. The purpose of this study was to describe the effects of adapted tango classes on balance, mobility, gait, endurance, dual-task ability, quality of life (QOL), and enjoyment in an older individual with chronic stroke and visual impairment.

**Case Description:** D.L. was a 73-year-old African American man, 13 years poststroke with spastic hemiplegia, visual impairment, and multiple comorbidities.

**Intervention:** D.L. attended 20 1½-hour tango classes adapted for older individuals with sensory and motor impairments over 11 weeks.

**Outcomes:** Measures of balance, mobility, gait, endurance, dual-task ability, and QOL were evaluated before and after the intervention and at 1-month follow-up. D.L. improved on the Berg Balance Scale, 30-s chair stand, Timed Up and Go (single, manual, and cognitive conditions), 6-Minute Walk Test, and backward gait speed. Not all measures improved: balance confidence decreased, and there was no change in forward and fast gait speed or QOL, as measured by the Short Form-12 and the Visual Function Questionnaire–25. Some gains were maintained at one-month follow-up. D.L. reported enjoying the classes, noted improvement in physical well-being, and wanted to continue the program.

**Discussion:** Thirty hours of adapted tango lessons improved balance, mobility, endurance, and dual-task ability in a participant with chronic stroke. The participant enjoyed the classes, was adherent, and wished to continue. This is the first reported use of adapted tango dance as rehabilitation for an individual with chronic stroke and low vision.

**Key Words:** chronic stroke, dance, exercise, low vision, rehabilitation

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A stroke event occurs every 40 seconds in the United States, often resulting in severe disability, and associated costs of approximately $74 billion, while the total cost of stroke from 2005 to 2050 is projected to be more than $1 trillion.[1] Individuals with chronic stroke engage in fewer activities and have reduced cardiovascular fitness compared with age-matched sedentary individuals.[2] Among those older than 65 years, 50% of stroke survivors have hemiparesis while 30% are unable to walk without assistance.[1] Balance and mobility issues resulting from chronic stroke contribute to difficulty with activities of daily living (ADL) and severely impact health-related quality of life (QOL).

Exercise interventions that improve mobility, balance, and QOL are needed for individuals recovering from chronic stroke with residual movement impairments because of impaired balance due to hemiplegia.[3] Rehabilitative programs for postural instability are most effective if they incorporate dynamic balance practice and continual adjustment to environmental demands,[4] which may be provided by exercise programs like tai chi[5,6] and potentially dance, an enjoyable, motivating, and engaging activity for older adults.[7]

Dance may be an effective way to address motor impairments associated with chronic stroke because of the additional opportunity for social integration, which may positively impact health poststroke.[8] Previous studies showed that older, movement-impaired adults who danced were more motivated to pursue healthy, exercise-related behaviors, while also demonstrating improved balance and functional mobility.[9] Recent research employing an adapted program of Argentine tango showed improved balance, mobility, and QOL in individuals with Parkinson's disease (PD) with moderate mobility impairments.[10,11] Novel and rich in sensory cues, adapted



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tango involves frequent movement initiation and cessation, a range of speeds, rhythmic variation, and spontaneous multidirection changes. The partner may provide balancing assistance, which could allow those requiring walking aids to challenge their limits of stability in a safe and monitored way.

To date, no studies have examined the effects of partnered dance on individuals with chronic stroke and sensory impairment. Previous work has demonstrated the efficacy of adapted tango for improved mobility and balance in individuals with PD. Although PD and stroke have different pathophysiological processes and impairments, individuals with either condition often experience mobility limitations, balance instability, gait disorders, increased fall risk, decreased endurance, and unilateral impairment. As such, the purpose of this case report was to describe the effects of a similar adapted tango program on balance, mobility, gait, endurance, dual-task ability, and QOL for a 73-year-old man, 13 years poststroke, with hemiplegia and visual impairment.

## METHODS

Emory University's institutional review board and the Atlanta VAMC Research & Development committee approved the protocol. D.L. provided written informed consent before participating.

### Case Description

The case reported here is from an individual who participated in a study of adapted tango for older individuals with sensory and motor impairment. From a query performed on the Veterans Health Information Systems & Technology Architecture, D.L. matched criteria for potential eligibility for the study. He was mailed a letter telling him about the study, and the principal investigator called him 10 days later to verify interest. He was interested in participating in the class because he wanted to improve his mobility and balance, while participating in a group exercise program for additional social interaction. In addition to a diagnosed visual impairment (ie, best eye acuity better than 20/70), a mental status score 8 or more points on the Short Portable Mental Status Questionnaire[12] was required for inclusion. Thus, after he agreed to participate, his mental status was assessed over the phone with this instrument. As D.L. matched inclusion for mental status, an appointment was made for his first visit 2 weeks later. At this visit, he was additionally screened for general health, evaluated for visual acuity and stereoacuity, and observed for performance on gait and lower body strength (detailed in the "Tests and Measures" section).

D.L. was a 73-year-old African American man and former environmental engineer who was 13 years post–cerebrovascular accident. He lived with a supportive, unmarried daughter, who was involved with his health care (eg, she prepared his medications for him daily). Immediately after the stroke, he spent 6 months in rehabilitation receiving intensive treatment and felt that "he would never walk again"; however, following completion of therapy, he could walk without the cane for short distances of 10 feet or less and with a single point cane, for longer distances, as was the case during observation for this report. He was then transferred to a less-intense, but supervised yearlong program, which involved upper extremity rehabilitation and walking daily.

When D.L. came for his initial evaluation, he had spastic hemiplegia in lower and upper left extremities, wore orthopedic shoes with an orthotic double upright ankle-foot orthotic on his left ankle for foot drop, and was able to bear weight unsupported during single-leg stance for only very short intervals of less than 1 second, measured with a stop watch. He demonstrated hemiparetic gait. His left foot was toed out approximately 20° as measured by GAITRite walkway (CIR Systems, Inc, Havertown, Pennsylvania), and he dragged his left foot. In spite of this difficulty, D.L. habitually ambulated independently and unsupervised with a cane both indoors and outdoors and appeared to do so safely. After being asked, he reported no use of his left upper extremity limb, which was flaccid in appearance and upon manual investigation. D.L.'s body mass index was 30.3, indicating that he was obese.

D.L. had diabetic retinopathy and age-related macular degeneration, with moderate visual impairment and limited stereoacuity (World Health Organization, International Classification of Diseases-10, 2006). When asked about his vision with a standardized questionnaire, the National Eye Institute Visual Function Questionnaire–25 (VFQ-25),[13] he reported that his eyesight was "good." He reported some difficulty reading street signs and matching his clothes, moderate difficulty reading newspapers, and extreme difficulty noting objects in his periphery. While D.L. appeared to have adapted successfully to reduced visual ability and had sought out low-vision resources offered by the VA, his gait and mobility might have been adversely impacted by visual impairment, given that two thirds of those with age-related macular degeneration have motor impairments driven by limited vision and balance deficits, which often result in greater fall risk.[14]

D.L. had the following comorbidities for which he was actively treated: arthritis, diabetes, hypertension, anemia, and stage IV kidney failure. He had experienced one fall the previous year. Despite health issues, he left his house every day, walked daily, regularly spent time at the local senior center visiting with friends, was involved with veterans' activities, traveled at least once per year, and rated his general health as "good." He scored 23/24 on the Composite Physical Function index, in which participants are asked to rate whether they are limited a lot, a little, or not at all on a range of basic and instrumental activities of daily living (ADL).[15] D.L.'s score of 23/24 on the Composite Physical Function index indicates that he did not perceive limitations in his ability to perform ADL (eg, bathing, dressing himself, grocery shopping, walk a half mile, climb stairs, and complete household chores). He reported being limited a little only while doing strenuous activities (eg, bicycling, vigorous calisthenics, and moving heavy furniture). When asked, D.L. reported that he could safely navigate steps by always using 2 feet per stair and the railing.

### Clinical Impression 1

Given D.L.'s hemiplegia, visual impairment, previous fall history, and other comorbid conditions, we expected to observe



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at baseline: balance impairment, decreased lower body strength and endurance, slowed gait speed, and increased time to complete dual tasks indicating deficits in mobility compared to healthy older adult norms. Evidence shows that improved health and fitness can be achieved among individuals with chronic stroke, in a manner similar to that of age-matched individuals without stroke.[8,16-19] Therefore, we believed that D.L. would need an exercise program targeted at improving balance, mobility, and gait deficits. Given his preferences for socialization, we thought that he would benefit from a group format. Group programs like tai chi have been successful for improving postural control in individuals with chronic stroke and older adults[5,6,20] so we believed an adapted program of tango, which, similar to tai chi, involves careful attention to weight placement and shifting, would be beneficial. However, he was 13 years poststroke, had previously received intensive rehabilitation, and was already habitually active; thus, the extent to which he could continue to benefit from rehabilitative treatment was in question.

## Examination

A comprehensive battery of measures was used to perform a functional assessment of D.L.'s abilities in terms of physical function (eg, lower body strength, gait function, endurance, balance, mobility) and psychological function (eg, balance confidence, QOL, depression). All these aspects of function affect the ability of a stroke survivor to perform ADL, move safely and adaptively throughout his environment, and interact successfully with friends and family.

## Tests and Measures

D.L. determined an optimal performance time of day for the first visit (screening), which took place 1 month before training began. D.L. was evaluated with a more comprehensive battery at the same time of the day on 3 separate occasions: 1 week before training began (pretest), within the week following completion of 20 lessons (posttest), and again 4 weeks after posttesting (follow-up).

## Lower Body Strength

Lower body strength is associated with the ability to perform lifestyle tasks such as climbing stairs and getting in and out of a vehicle or bath and was measured with the 30-second chair stand (chair stand) test,[15] in which the participant rises from a chair to full standing as many times as possible in 30 seconds.

### *Gait function*

Spatiotemporal parameters of habitual, backward, and fast-as-possible (fast) walking speed were assessed by a 6-m instrumented, computerized GAITRite walkway. Preferred and fast walking speed have excellent test-retest reliability ($r$ = 0.90 and 0.91)[21] and have been found to be valid and reliable in individuals with hemiparesis after stroke.[22] Variables of interest included walking speed, walking speed variability, step length variability, and single support time. All reported variables are the average of 3 trials (computed by GAITRite) for each condition (forward, backward, and fast). D.L. began walking approximately 1 m before the mat and stopped walking 1 m off the mat. GAITRite computed gait speed for each trial by dividing distance traveled on the mat (from first footfall to last footfall) by ambulation time upon the mat. Gait speed variability is computed by GAITRite as the standard deviation of the range of stride velocities during a trial, which were computed as stride length divided by stride time (respectively, the distance and the time elapsed between 2 consecutive footfalls of the same foot).

### *Endurance*

Endurance was measured with the 6-Minute Walk Test (6MWT), a valid and reliable measure of overall mobility and physical functioning in individuals with chronic stroke.[22] D.L. was asked to walk as far as possible in 6 minutes in an unobstructed hallway.

### *Balance*

Balance was assessed with the Berg Balance Scale (BBS). The BBS has excellent inter- and intrarater reliability (0.98-0.99) and is a psychometrically sound measure of balance impairment poststroke,[23-25] with a maximum score of 56 possible points. The BBS assesses balance during common daily activities, such as turning, stepping, and picking up objects. D.L. did not use an assistive device during evaluations.

The Functional Reach Test (FRT) is an indicator of limits of stability, an aspect of balance. Test-retest reliability of the FRT is 0.89. FRT has adequate construct validity with performance on walking speed ($r$ = 0.71) and mobility skills ($r$ = 0.65).[26] D.L. was instructed to use his right arm to reach as far as possible without taking a step.[26] As reach decreases, the chance of falling increases.[27]

### *Mobility*

A measure of functional mobility, the Timed Up and Go (TUG),[28] has demonstrated validity and reliability in individuals with stroke.[22] TUG requires the participant to rise from a chair, walk 3 m as quickly as possible, turn around, and return to the chair. The time needed to complete the test is reported. Participants are given one practice trial and one official trial.

### *Dual-task ability*

Dual-task ability was measured with the TUG cognitive (TUGc) and manual conditions (TUGm). Test-retest reliability is good for both TUGc ($r$ = 0.98) and for TUGm ($r$ = 0.97).[29] In TUGc the participant counts backward by 3 seconds from a random number between 20 and 100. The time taken to complete each task and the number correct and errors made are reported in Table 1. In TUGm, the participant carries a full glass of water. Time 15 or more seconds for TUGc and time 14.5 or more seconds for TUGm indicate impaired dual-task ability and increased fall risk.[28]

### *Balance confidence, QOL, and depression*

Using self-report questionnaires, balance confidence, physical, mental and visual QOL, and depression were assessed to gain valuable information related to D.L.'s own perception



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**Table 1. Outcome Measures of Balance, Endurance, Mobility, and Dual-Task Ability[a]**

| Measures | Pretest (Within 1 Wk Before the Intervention) | Posttest (Within 1 Wk After the Intervention) | Follow-up (4 Wk After the Posttest) | % Change pre to post | % Change Pre to Follow-up |
|---|---|---|---|---|---|
| Balance | | | | | |
| Berg Balance Scale (/56) | 41 | 49 | 50 | 19.5 | 22.0 |
| Functional Reach Test, m[b] | 0.14 | 0.18 | 0.33 | 28.6 | 135.7 |
| Endurance | | | | | |
| 6MWT, m | 213.4 | 243.8 | 268.2 | 14.3 | 25.7 |
| Mobility | | | | | |
| TUG baseline, s | 11.0 | 10.0 | 9.3 | −8.8 | −15.7 |
| Dual task | | | | | |
| TUG manual, s | 16.8 | 14.9 | 16.8 | −11.4 | 0.4 |
| TUG cognitive, s | 16.2 | 12.5 | 12.5 | −23.0 | −23.0 |
| TUG cognitive % correct[c] | 100 | 100 | 100 | 0 | 0 |

Abbreviations: 6MWT, Six-Minute Walk Test; TUG, Timed Up and Go.
[a]Higher scores on the Berg Balance scale indicate greater balance function.
[b]Scores less than 0.15-0.18 m on the FRT indicate limited functional balance.
[c]D.L. was allowed to practice counting backward for 3 trials, before completing the TUGc. While only counting for 15-second intervals, D.L. made no errors, giving 11.7 correct answers at pretest, 11.7 correct answers at post test, and 12 correct answers at follow up. During the TUGc, D.L. enumerated 8 figures during pre-test, 9 figures during post-test and 7 figures during follow up, and made no errors. Note that negative changes on the TUG, TUGc and TUGm indicate faster performance.

of his abilities, disabilities, and mood across a range of function, before and after treatment. The interviewer, a trained research assistant, verified whether D.L. understood the questionnaires before administration by explaining their purpose, providing instructions, asking whether he had questions, repeating anything that seemed unclear to D.L. (based on his response delay), and using examples. D.L. was asked to verify his comprehension of each scale by repeating this information to the interviewer.

### *Balance confidence*

Balance confidence was assessed with the Activities-specific Balance Confidence scale, which is both valid and reliable for measuring balance confidence in older adults across a continuum of activities.[30,31]

### *Quality of life*

Physical and mental QOL were determined using the Physical Component Summary and the Mental Component Summary scores, respectively, that were calculated from the 12-Item Short Form Health Survey,[32] which has demonstrated reliability in patients with cerebral aneurysm.[33] Visual health-related QOL was assessed with the VFQ-25, with psychometric properties that are unaffected by type or severity of eye condition.[13]

### *Depression*

The Geriatric Depression Scale–Short Form evaluated depression and has demonstrated test-retest stability and internal consistency among older African Americans.[34]

### *Participant satisfaction*

To determine participant satisfaction with adapted tango, an Exit questionnaire was administered at posttesting. This instrument has been used previously to evaluate satisfaction with tango and exercise programs for people with PD, healthy older adults, and people with severe and persistent mental illness.[10,11,35-37] The questionnaire contains 9 items regarding whether the participant enjoyed the classes and would continue and whether improvements in aspects of physical well-being were noted. Agreement is indicated on a 5-point Likert scale (1 = *strongly agree* to 5 = *strongly disagree*). Three questions requested open-ended responses regarding what the participant liked best, least, and any recommendations for improving the program. This case report represents the first use of this Exit questionnaire for someone with stroke and visual impairment. We are not aware of an established and standardized instrument for this purpose. Psychometrics have not been analyzed; however, the purpose of administering the questionnaire was to request important information about the perceptions of the participant regarding the physical activity and whether improvements were noted in physical well-being after participating. Given the importance of patient satisfaction with treatment as an aspect of outcome of utmost concern to therapists, patients, and families, obtaining and reporting information related to D.L.'s perceptions were considered of value and a standardized questionnaire that captures this information does not exist; therefore, we developed and administered the questionnaire described earlier. D.L.'s responses are provided in the "Outcome" section.



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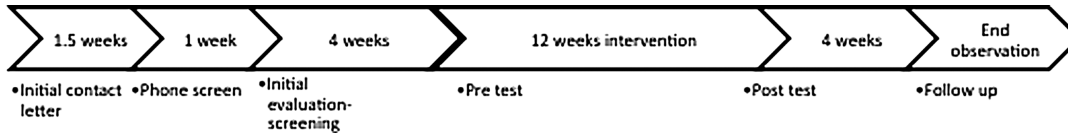


**Figure 1.** Timeline of patient observation. This timeline depicts the amount of time that elapsed between points of contact from initial contact (recruitment letter) to the final observation.

### *Testing order*

All outcome measures were instrumented or completed by D.L., except BBS, which was videotaped for a qualified rater, not involved with the project otherwise. The following outcome measures were administered on *4 separate occasions, including the first screening visit*: chair stand, forward, backward, and fast gait. All other measures were administered *only* at pre-, post-, and follow-up observations (Figure 1). The order of testing was as follows: chair stand, gait, TUG battery, 6MWT, BBS, FRT, and then questionnaires, with rest breaks throughout.

### *Initial examination data*

Considering his baseline performance, D.L. had substantial fall risk. Although his performance during chair stand (12 full rises to standing during screening, 13 during pretest) was in the low normal range[15] for healthy men in his age group, D.L. demonstrated a score of less than 6 to 7 inches (0.15-0.18 m) on the FRT, which indicates that he had a limited ability to perform ADL and increased risk of falls[27] (Table 1). His TUG single condition score did not indicate fall risk (time to perform ≥13.5 seconds indicates fall risk), although both TUGm and TUGc revealed increased fall risk (Table 1). His baseline 6MWT performance was also substantially less than that of community-dwelling, healthy older men,[15] as he was only in the 1st percentile, although his performance largely matched those of individuals poststroke.[38] At the first observation, D.L. also had slow forward gait speed compared with those of community-dwelling older adults (Table 2), and his balance was impaired, based on his BBS score (Table 1). In spite of these impairments, D.L. had high balance confidence, and his physical, mental, and visual QOL measures were within norms or better for his age group[13,32] (Table 3).

**Table 2. Measures of Forward, Backward, and Fast-As-Possible Gait Before and After the Intervention**

| Measures | Screen (4 Weeks Before the Pretest) | Pretest (Within 1 Week Before the Intervention) | Posttest (Within 1 Week After the Intervention) | Follow-up (4 Weeks After the Posttest) | % Change Pre to Post | % Change Pre to Follow-up |
|---|---|---|---|---|---|---|
| Forward (preferred) gait | | | | | | |
| Gait speed, m/s | 0.70 | 0.90 | 1.10 | 0.70 | 20.7 | −16.1 |
| Gait speed variability, m/s | 0.09 | 0.06 | 0.08 | 0.06 | −36.4 | 0.09 |
| Step length variability, m | 0.06 | 0.04 | 0.04 | 0.04 | 0.0 | 0.06 |
| Single support time L | 0.34 | 0.35 | 0.33 | 0.36 | 5.7 | −2.9 |
| Single support time R | 0.40 | 0.42 | 0.38 | 0.47 | 9.5 | −11.9 |
| Backward gait | | | | | | |
| Gait speed, m/s | 0.20 | 0.20 | 0.30 | 0.20 | 20.8 | -8.3 |
| Gait speed variability, m/s | 0.04 | 0.04 | 0.04 | 0.05 | 0.0 | −25 |
| Step length variability, m | 0.05 | 0.04 | 0.07 | 0.06 | −75 | −50 |
| Single support time L | 0.32 | 0.37 | 0.46 | 0.46 | −24.3 | −24.3 |
| Single support time R | 0.23 | 0.29 | 0.24 | 0.24 | 17.2 | 17.2 |
| Fast gait | | | | | | |
| Gait speed, m/s | 0.80 | 1.10 | 1.10 | 1.10 | 0.0 | 0.0 |
| Gait speed variability, m/s | 0.08 | 0.06 | 0.04 | 0.05 | 36.4 | 9.1 |
| Step length variability, m | 0.05 | 0.05 | 0.04 | 0.03 | 11.1 | 44.4 |
| Single support time L | 0.31 | 0.30 | 0.29 | 0.29 | 3.3 | 3.3 |
| Single support time R | 0.37 | 0.40 | 0.34 | 0.38 | 15.0 | 5.0 |



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**Table 3. Self-reported Quality of Life, Balance Confidence, and Depression Measures Before and After the Intervention[a]**

| Measures | Pretest (Within 1 Wk Before the Intervention) | Posttest (Within 1 Wk After the Intervention) | Follow-up (4 Wk After the Posttest) | % Change Pre to Post | % Change Pre to Follow-up |
|---|---|---|---|---|---|
| SF12 PCS[b] | 52.4 | 49.7 | 48.8 | −5.2 | −6.9 |
| SF12 MCS[b] | 62.7 | 57.6 | 64.6 | −8.1 | 3.0 |
| Visual Function Q25 composite score | 82.6 | 75.3 | 77.7 | −8.8 | −5.9 |
| Activities-specific Balance Confidence | 93.1 | 73.8 | 75.0 | −20.7 | −19.4 |
| Geriatric Depression Scale | 1 | 0 | 0 | −100.0 | −100.0 |

Abbreviations: MCS, Mental Component Summary; PCS, Physical Component Summary.
[a]On the Visual Function Questionnaire-25, SF12-PCS and SF12-MCS, lower scores indicate worse vision, physical or mental-related quality of life, respectively. Higher scores on the ABC indicate greater activities-specific balance confidence. Lower scores on the Geriatric Depression Scale–Short Form indicate less depression.
[b]The norms for the individuals with serious physical impairments are as follows: PCS: 38.8 (11); MCS: 52.5 (10).[32]

## Clinical Impression 2

In agreement with initial observations of D.L.'s physiological state, D.L.'s baseline performance on the outcome measures demonstrated need for balance and mobility rehabilitation. D.L.'s challenges in regaining motor function were very pronounced, because he was both older and dealing with visual impairment; therefore, he displayed age-related deficits, such as reduced balance stability and more cautious gait.[39,40] In addition, D.L. likely lacked the ability to compensate fully for his visual loss using somatosensory and vestibular systems.[40] Given D.L.'s habitual reliance on his cane, we believed that he could potentially benefit from the adapted tango program previously mentioned, and recently shown to be effective in people with PD who regularly used assistive devices.[11] This program has even been shown to be effective for a severely limited individual with PD after 20 hours of adapted tango over 10 weeks.[36] Furthermore, partnered dance has 3 distinct advantages that may enhance training for stroke participants: (1) requires steps in all directions at various amplitudes, a necessary skill for accomplishing ADL; (2) a balance aid, in the form of the dance partner, is provided, such that those who need support can still participate; (3) the exercise intensity (speed) can be modified.[8] Hackney and Earhart[11] demonstrated that partnered dancing did not attenuate any balance benefits by providing a balance aid in the form of a partner. Thus, we chose adapted tango as an appropriate treatment for mobility, gait, and balance impairments secondary to chronic hemiplegia. This study's protocol called for 1.5 hours per class, 2 times per week over 12 weeks, because a meta-analysis demonstrated that only high dosage exercise programs 180 or more minutes/week are likely to affect habitual gait speed significantly in older adults.[41] Hackney and Earhart[42] previously demonstrated the feasibility of an intensive dance program in which people with moderate PD and substantial gait, balance, and mobility impairments participated in 1½-hour-long partnered dance lessons 5 d/wk for 2 weeks. When considering the intensity of training planned and D.L.'s sensory-motor impairment, the degree to which he could participate in dance lessons was uncertain. Also, given the many years since his stroke, whether he would benefit from the program was unclear.

If the intervention were effective, in keeping with previous studies in other populations,[10,11,42] we would expect similar outcomes: improved gait, balance, endurance, mobility, and QOL. The exact mechanisms of improvement with adapted tango are unknown. However, an investigation into mechanisms associated with improvement in tai chi indicates that there was a tighter coupling between the center of pressure and the center of mass during gait initiation after training in a group of older adults, compared with age-matched controls.[20] Other potential mechanisms underlying reduction in falls with tai chi include (1) improved balance[43] (2) reduced fear of falling,[44] or (3) enhanced neural and biomechanical mechanisms associated with balance recovery.[45] We hoped that adapted tango would similarly benefit D.L.'s function, and expected the intervention to be effective via 1 or more of the mechanisms described earlier.

### *Adapted tango intervention*

D.L. was told that he was participating in a study to learn about the effects of 20 1½-hour-long adapted tango classes on balance and mobility in visually impaired older adults. He was instructed not to change habitual exercise regimens during the study. To attend classes, D.L. used public transportation provided for individuals with handicaps. Classes were held in the dining room of a senior independent housing community. The instructor, certified as a personal trainer by the American Council on Exercise, and to teach ballroom dance, had several years' experience working with older and mobility- and balance-impaired individuals.

The instructor taught progressive adapted tango lessons to 6 to 12 visually and motor-impaired older adults with adequate numbers of healthy partners for each class period. As participants arrived for class, they were encouraged to



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work on previously learned material, while music played in the background, in pairs, and with volunteer assistants (volunteers), who were healthy graduate or undergraduate students recruited from Emory University. Volunteers were instructed in methods for monitoring postural instability and prevention of falls before beginning classes. The ratio of participant to volunteer was 1:1.

After 5 to 10 minutes of practice, the partner classes would begin to upbeat Latin, jazz, or pop music with 15-minute standing warm-ups, which included whole-body movements designed to increase joint range of motion, attention to postural alignment, and entrainment to rhythmic beats. Specifically, these movements included shoulder and head rolls, punching, "swimming," knee bends, foot tapping, isolations, and upper-lower limb oppositional movements. The movements were designed to prepare the body for the motor demands of the dance class by increasing blood flow to muscles and joints, a common practice for dance classes. The instructor also took advantage of the opportunity to introduce new rhythms to the class during the movements of the warm-up, because of the relative simplicity of these moves, that is, one joint moving, compared with those learned as tango choreography. After warm-up, novel tango step elements were introduced at each class and were practiced in pairs.

Listening and dancing to commercial tango music, D.L. moved around the room, using tango steps in various rhythms while partnered. Toward the last third of class, the new step of the day was reviewed and combined with previously learned steps. New steps would be learned during 4 classes and the steps would be reviewed on the fifth class, using a periodization technique. This was repeated 4 times until the 20th lesson. During therapeutic dance, a prime goal for individuals with balance impairments is to move with dynamic balance, a hallmark of dance training. This involves moving the center of mass beyond the base of support, an inherently unstable position, and then reachieving balance with the next step. Dance movements were progressed in difficulty by increasing balance challenge, the number of steps joined together, and rhythmic complexity and musicality. Also, participants were expected to learn and retain step patterns through the program, increasing their motor repertoire. Steps involved coordination with one's partner in forward, backward, and side directions, rocking actions, turns, and embellishments, which often involved single-leg support. See Table 4 for a comprehensive list of steps (A) and terms (B) of adapted tango used through the 20-lesson program. More details on the structure of adapted tango are provided elsewhere.[46]

D.L. and his dance partners spent equal time leading and following dance steps, performed in a "closed practice" position, an adaptation of the traditional ballroom frame in which participants hold elbows facing one another, maintaining forearms parallel to the floor. D.L. was enthusiastic and attempted to perform every activity with the help of volunteers. He was very attentive in class and confident in his understanding of the dance steps, as he would correct the instructor if he believed she had erred in an explanation. Although many exercises could be done in a chair, he stood through most of warm-up. The instructor estimated that he practiced dance approximately 90% of the 1½-hour-long classes, meaning that he walked around the room for at least 1 hour every class. The instructor provided D.L. with appropriate modifications when necessary, for example, the "cruzada," in which one crosses a foot tightly next to the other. D.L. was instead instructed to bring his foot in front of the other, approximating a tandem stance with more weight on the front foot. Also, he could successfully lead steps by moving his torso, as tango steps are signaled by rotations from the hips and waist. He adequately conveyed the "lead," despite the compromised "frame position" posed by the hemiplegic left arm, which was held by the volunteer.

## OUTCOME

D.L. attended 20 lessons in approximately 12 weeks. Screening (1 month before), pre- (within 1 week before the intervention), post- (within 1 week following the intervention), and follow-up (1 month after the intervention) measures are summarized here and in Tables 1 to 3. Changes were noted from pre- to posttest. D.L. improved on chair stand (screening: 12 rises to full standing, pre: 13, post: 15, follow-up: 14), which was a 15.4% change from pre to post and maintained 7.7% from pre to follow-up. D.L. also improved on the BBS, FRT, TUGc, TUGm, and the 6MWT (Table 1). Some gains were retained at follow-up 1 month after completing the intervention. He improved slightly in backward walking velocity but he improved only minimally on forward and fast gait, which were highly variable from observation to observation (Table 2). Self-reported physical and mental health and visual QOL changed little, while balance confidence decreased (Table 3.) D.L.'s responses on the Exit questionnaire indicated that he strongly agreed with statements that he "enjoyed the classes," "would continue if possible," and "was more physically active." He also strongly agreed with statements that as a result of participation he had improved in walking, coordination, strength, endurance, and mood. He agreed with the statement that he noted improvement in balance. In open-ended responses, D.L. commented that he appreciated the instructor's and volunteers' patience, felt that the group was a "family," and looked forward to classes. He wished the classes could have continued beyond the 30 hours.

## DISCUSSION

This is the first case report to demonstrate potential benefits of adapted tango dance for an older individual with chronic, hemiplegic stroke and visual impairment. After 30 hours of partnered dance, D.L. expressed enjoyment of the program while demonstrating improvements in measures of balance, mobility, endurance, and dual tasking. Some gains were maintained 1 month after completing the intervention, which was also noted after participation in a similar program of adapted tango in a group of people with PD with balance instability.[36]



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**Table 4. Steps and Terms of Adapted Tango**

**(a) Lesson Plan of Adapted Tango[a]**

| Part | Lesson | Steps | Embellishment | Rhythms |
|---|---|---|---|---|
| Part 1 | 1 | Steps forward, backward and side; walk like "cat" | Taps to side | Ss, Qs, QQS |
| | 2 | Step side and forward, step side and back to R and L; rock steps | Taps to side | SSQQ |
| | 3 | Introduce OP | Rapid taps in place | QQS, SSQQ |
| | 4 | "Rumba step": 6 weight shifts: forward, side, feet together; back, side, feet together | Click one heel to other | Mix of Ss and Qs |
| | 5 | Review & synthesize | | |
| Part 2 | 6 | "Rock the baby": Rock steps turning R and L | Click heel | SSQQS, QQS |
| | 7 | Parallel breaks | Lift toe to knee | SSQQS, introduce Tango Pause |
| | 8 | Walks forward, lift leg in pause, in single leg support; introduction to Promenade | Lift toe to knee | SSQQS |
| | 9 | Introduction to voltas and cruzada | Dibujo | Mix of Ss and Qs |
| | 10 | Review and synthesize | | |
| Part 3 | 11 | OP, Cruzada from side step R & L; rock steps | Taps to side | SSQQ |
| | 12 | Side, forward, "collect feet"; Cruzada R and then L | "Wing" | QQS, Tango Pause |
| | 13 | Walks forward; lead backward step for follower into cruzada | Dibujo | SSQQ, Tango Pause |
| | 14 | OP to cruzada; step and collect in 8 directions | Collect in wing | Mix of Ss and Qs |
| | 15 | Review and synthesize | | |
| Part 4 | 16 | 3 Steps and collect in 8 directions; Clamshell | Wing, dibujo | Any rhythm, Tango Pause |
| | 17 | Cross system: side by side facing same direction, then facing one another side by side, and then with overlap of torsos and leg | Lift toe to knee | Same as earlier |
| | 18 | Step and collect; grapevine to center and to wall; slow pivots: arrangement by leader | Any of the above | Same as earlier |
| | 19 | Review: Rock steps, slow pivots, clamshell | Any of the above | Same as earlier |
| | 20 | Review: Cruzada, promenade, clamshell, cross system, slow pivots | Any of the above | Same as earlier |

Abbreviations: L, left; OP, outside partner; Q, quick beat; R, right; S, slow beat.
[a]Given that adapted tango derives from Argentine Tango, an improvisational dance, step order, and repetition rate are ultimately determined by the leader from dance to dance.

**(b) Terms of Adapted Tango**

| Term | Definition |
|---|---|
| Rock steps | Shifting weight from 1 foot to other without collecting feet during the swing phase |
| Outside partner (OP) | OP: Walking slightly offset to partner's side but turning torso to align in parallel with partner |
| Parallel breaks | Maintaining torso facing partner; foot of one partner crosses diagonally forward while foot of other crosses diagonally backward |
| Cruzada | A "signature" tango step involving crossing 1 foot tightly over the other while typically moving backward; done to get back in front of leader after an OP move |
| Volta | Crossing a foot over another repeatedly in a "limping" or "rocking" action and traveling to the side |
| Promenade | Moving sideways with partner; feet are pointed in direction of travel, but torsos face one another |
| Dibujo | Drawing a circle on floor with foot—decorative, but encourages single-leg support |
| Quick | Faster beat of music |
| Slow | Twice as long as quick, slower beat of music |
| Tango rhythm | Slow, slow, quick, quick, slow |

(*Continues*)



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**Table 4. Steps and Terms of Adapted Tango (*Continued*)**

| (b) Terms of Adapted Tango | |
|---|---|
| **Term** | **Definition** |
| Cross system | Any point in which leader and follower are on the same foot, rather than on opposite feet; this is distinctive of the Argentine tango and can be used to travel in any direction |
| Parallel system | Any point in which leader and follower are on opposite feet—more common to partnered dance |
| Collecting feet | Bringing "free" foot to other foot under the center of mass, but without putting weight on foot, in preparation for next step |
| Clamshell | Adaptation of the "ocho," in which the leader turns their torso, leading the follower to walk around him or her in a figure 8 motion to L or to R |
| Contra body movement | Turning the upper body against the moving the leg, ie, turning R side of the body against the L moving leg, typically used preceding rotation |
| Slow pivots | One partner rotates in place, moving their feet under them, while the other partner revolves around them, by walking around them. Torsos remain facing one another, encouraging contra body movement |
| Molinete | Adaptation of the step, "molinete," one partner does a grapevine action of the feet while revolving around their partner, who is stationary |
| Tango pause | Variable length of time in which partners "hold" a movement, by remaining still on single leg support; used for dramatic effect |
| 8 Directions | Forward, backward, right, left, right forward, right backward, left forward, left backward |
| Wing | Drawing in inner ankle, and "winging" toe out slightly to side |

Adapted tango, being derived from a dancing art, is administered such that whatever approach the participant takes with the choreography, his or her attempts to perform the steps are considered "successful"; therefore, we were not able to determine which aspects of training included in Table 4 were more responsible for success of the therapy. Characteristics of adapted tango may target stroke-related movement impairments, such as mobility and postural instability. While dancing tango, participants focus on trunk control and voluntary stepping strategies, whole-body coordination, and somatosensory awareness, which is similar to the approach during other mind-body exercise forms like tai chi. In addition, participants attend to their partner, the movement path, other dancers, and aesthetic qualities. Multiple auditory, tactile, and visual cues provided in tango may facilitate movement. In D.L.'s case, the enhanced motor control and increased attention to movement he practiced in his tango class may have carried over into daily activities, leading to increased mobility and additional functional improvement 1 month after cessation of classes.

## Lower Body Strength and Endurance

Although dance was new to D.L.'s exercise regimen, he was already walking daily; thus, his ability to improve in strength and endurance was uncertain. As compared to healthy older men, aged 70 to 74 years, D.L. began in the 35th percentile and improved to the 55th percentile on the chair stand, which indicates progression from low normal to high normal range.[15] This represented a 15.4% increase after training, demonstrating improved lower body strength. In contrast, D.L.'s 6MWT was well below normal for his age and indicated that he was at risk for loss of functional mobility.[15] The 6MWT is a measure of endurance, which is strongly correlated to overall function and to risk of recurrent stroke.[8] D.L.'s 6MWT performance was below the 1st percentile for men aged 70 to 74 years, but his performance largely agrees with the data found on a group of individuals poststroke who were reported to walk an average of 216 m in the 6MWT.[38] D.L. improved 14% on the 6MWT from pre- to posttest (increased to 26% at follow-up). This may be significant because the small real difference, the amount indicating clinical change in a measure for a single individual with mild-moderate hemiparesis,[47] is 13% for the 6MWT.[22] However, D.L.'s performance remains far less than the 500 m achieved by healthy older men, in the low normal range.[15] The findings of this case study are in agreement with previous studies that demonstrated improved physical function (eg, long walking distance and cardiovascular fitness) long after traditional rehabilitation had been completed for individuals with chronic stroke.[8,19]

## Balance

Individuals with both balance and vision impairments have fall rates nearly 3 times greater than those without either impairment,[48] thus identifying interventions to improve balance, such as adapted tango for D.L., is important. His 8-point change on the BBS exceeded the minimal detectable change of 6 points.[25] Previously individuals with PD improved approximately 4 points on the BBS after adapted tango,[11] also a significant clinical difference in the



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PD population. On the FRT, D.L. improved to a score of 0.33 m, which matches norms for healthy men aged 70 to 87 years.[26] These positive changes in balance further indicate that D.L. could continue to improve in balance, 13 years poststroke, through novel training, and in agreement with other studies in which stroke survivors continued to improve.[16-19]

### Mobility and Dual-Tasking Ability

D.L. demonstrated slight improvement in mobility with faster performance on the single-condition TUG (9% change improved to 16% at follow-up). D.L. improved on the TUGc (23% change, maintained at follow-up), and to a lesser degree on TUGm (11% change, not maintained). The 23% change on the TUGc matches the small real difference.[47] The improvement in cognitive dual-tasking is encouraging because individuals with hemiparetic stroke demonstrate decrements in gait performance under dual-task conditions[49] with times that indicate increased fall risk.[28] D.L. improved to being at lower risk for falls, based on TUGc and TUGm; however, he maintained this improvement only in TUGc. Because of its multitask nature, tango practice may improve dual-task performance because participants must attend to their partner, the music, other dancers, as well as current and future step patterns, while making decisions and effecting action throughout. Thus, tango may be an effective treatment intervention for individuals with impaired ability to dual-task while walking.

### Gait Function

Much literature has been devoted to the prognostic value of walking speed for health outcomes, including fall incidence, mortality, and cognitive decline.[50-53] In fact, walking speed may be a reasonable "vital sign" for clinicians to consider during evaluations of older adults.[51,54] Clinical assessment of walking speed has ecological validity for the assessment of functional status in older adults, in terms of limitations in community activities.[55] Walking speed of 1 m/s or less is associated with limitations in performing community and home-based activities,[55] while speed of less than 0.6 m/s is associated with increased likelihood of hospitalization.[56] Immediately after the intervention, D.L. had achieved speed approximating the 1 m/s threshold, but at follow-up D.L.'s performance on forward gait speed (Table 2) indicates that he was likely to have limited community ambulation.

The change in forward gait performance from the first (screening) to the second (pre) baseline observation exceeded the improvements noted from pre- to posttest (Table 2). The double pretest may have served as acclimatization to gait measures for D.L., because preferred walking speed variability, observed because it increases with greater age and risk of falls in older adults[57,58] appeared to decrease considerably after the first observation (Table 2). Walking speed measures a discreet and specific aspect of mobility and may have limited value to document stroke recovery.[59] For individuals undergoing stroke rehabilitation, a change of greater than 0.3 m/s is necessary to exceed measurement error and patient variability,[60] magnitude of change that was not observed in D.L.'s performance. To date, no improvements of this magnitude have been noted with adapted tango programs in other populations.[11,61] Potentially, there are other more relevant outcome variables of gait for stroke (eg, stance time on the paretic leg). D.L. did demonstrate slightly improved backward walking speed (not maintained at follow-up), which could have resulted from regular backward walking in tango.

We lack repeated baselines from some of the most compelling results (eg, BBS, 6MWT, TUGc, and TUGm). Therefore, we cannot be sure that variability inherent in these measures was not greater than changes noted in functional performance. Importantly, we demonstrated the need for repeated baseline measurements in evaluating the efficacy of intervention for rehabilitative purposes. D.L., coping with multiple morbidities, might demonstrate fluctuating levels of disability and recovery, previously noted among older adults,[62,63] which may explain the variability in the gait measures.

### Subjective Measures

Possibly D.L.'s positive self-reported health contributed to the favorable changes noted after the intervention, as his physical and mental QOL scores were slightly better than norms from the general adult population[32] (Table 3) throughout the observational period. His visual-related QOL, measured by the VFQ-25, was also high for an individual with his level of visual impairment. In contrast, D.L. demonstrated less balance confidence after the intervention, (standing on a chair to reach something, and walking on icy sidewalks: both dropped from 100% confident to 0% confident), possibly because of increased awareness of his specific balance impairments from consistent practice of challenging balance exercises during the testing and intervention. Given D.L.'s impairments, his ability to reassess his confidence in performing challenging activities in unmonitored settings may have been prudent for his safety, but also manifested as a lower confidence score. Importantly, D.L.'s subjective impressions of the tango program, as per the Exit Questionnaire (see the "Outcome" section), suggest that he wanted the program to continue because of perceived benefits for his mobility, balance, and QOL.

### Limitations and Conclusions

While this work is limited to describing a single participant, it demonstrates that an individual with chronic, hemiplegic stroke and multiple comorbidities can derive benefits in balance, dual-tasking, and endurance while also experiencing satisfaction and strong interest in continuing classes. Satisfaction is a critical element that may suggest an intervention is viable with regard to motivation, initiation, adherence, and performance. Dance could be an effective and enjoyable long-term physical activity for individuals with chronic stroke, who have ambulatory activity levels less than those of sedentary adults with disability, or who have cardiovascular fitness levels less than that needed to



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complete ADL.[2] Effective interventions are especially needed for African Americans with chronic stroke, who have greater activity limitations and first stroke occurrence rates twice that of whites.[1] Future work with larger samples of individuals with chronic stroke and longer-term interventions is warranted.

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