Tai Chi and Postural Stability in Patients with Parkinson's Disease

“It isn’t every day that an effective new treatment for some Parkinson’s disease symptoms comes along. Especially one that is safe, causes no adverse side effects, and may also benefit the rest of the body and the mind. That’s why I read with excitement and interest a report in the New England Journal of Medicine showing that tai chi may improve balance and prevent falls among people with Parkinson’s disease.”

Peter Wayne
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New England Journal of Medicine

“This degenerative condition can cause many vexing problems. These range from tremors and stiffness to a slowing or freezing of movement, sleep problems, anxiety, and more. Parkinson’s disease may also disrupt balance, which can lead to frightening and damaging falls.

BACKGROUND

Patients with Parkinson's disease have substantially impaired balance, leading to diminished functional ability and an increased risk of falling. Although exercise is routinely encouraged by health care providers, few programs have been proven effective.

METHODS

We conducted a randomized, controlled trial to determine whether a tailored tai chi program could improve postural control in patients with idiopathic Parkinson's disease. We randomly assigned 195 patients with stage 1 to 4 disease on the Hoehn and Yahr staging scale (which ranges from 1 to 5, with higher stages indicating more severe disease) to one of three groups: tai chi, resistance training, or stretching. The patients participated in 60-minute exercise sessions twice weekly for 24 weeks. The primary outcomes were changes from baseline in the limits-of-stability test (maximum excursion and directional control; range, 0 to 100%). Secondary outcomes included measures of gait and strength, scores on functional-reach and timed up-and-go tests, motor scores on the Unified Parkinson's Disease Rating Scale, and number of falls.

RESULTS

The tai chi group performed consistently better than the resistance-training and stretching groups in maximum excursion (between-group difference in the change from baseline, 5.55 percentage points; 95% confidence interval [CI], 1.12 to 9.97; and 11.98 percentage points; 95% CI, 7.21 to 16.74, respectively) and in directional control (10.45 percentage points; 95% CI, 3.89 to 17.00; and 11.38 percentage points; 95% CI, 5.50 to 17.27, respectively). The tai chi group also performed better than the stretching group in all secondary outcomes and outperformed the resistance-training group in stride length and functional reach. Tai chi lowered the incidence of falls as compared with stretching but not as compared with resistance training. The effects of tai chi training were maintained at 3 months after the intervention. No serious adverse events were observed.

CONCLUSIONS

Tai chi training appears to reduce balance impairments in patients with mild-to-moderate Parkinson's disease, with additional benefits of improved functional capacity and reduced falls. (Funded by the National Institute of Neurological Disorders and Stroke; ClinicalTrials.gov number, NCT00611481.)

STUDY DESIGN

We designed a randomized clinical trial to compare the effects of exercise at 6 months in a group of patients assigned to tai chi classes with the effects in groups assigned to resistance-training or stretching classes. Each group participated in a 60-minute class that met twice weekly for 24 weeks. An expanded description of the methods is provided in the Supplementary Appendix, available with the full text of this article at NEJM.org. The trial protocol, also available at NEJM.org, was approved by the institutional review board of the Oregon Research Institute, and written informed consent was obtained from all participants. All authors vouch for the completeness and accuracy of the data and attest to the fidelity of the trial to the protocol.

STUDY PARTICIPANTS

Study participants were recruited from four Oregon cities (Eugene, Corvallis, Salem, and Portland) by means of newspaper advertisements, referrals from neurologists or physical therapists, and information distributed to local support groups for persons with Parkinson's disease. Eligibility criteria included a clinical diagnosis of Parkinson's disease, with a disease severity rating of stage 1 to 4 on the Hoehn and Yahr scale (which ranges from 1 to 5, with higher scores indicating more severe disease)[4]; an age of 40 to 85 years; at least one score of 2 or more for at least one limb for the tremor, rigidity, postural stability, or bradykinesia items in the motor section of the Unified Parkinson's Disease Rating Scale (UPDRS) III)[18]; stable medication use; ability to stand unaided and walk with or without an assistive device; medical clearance for participation; and willingness to be assigned to any of the three interventions. Exclusion criteria were current participation in any other behavioral or pharmacologic study or instructor-led exercise program, a Mini–Mental State examination[19] score lower than 24 (indicating some degree of cognitive impairment), debilitating conditions or vision impairment that would impede full participation in the study, and unavailability during the study period.

SCREENING AND RANDOMIZATION

Research staff screened patients by telephone. Those who met prescreening criteria underwent an in-person evaluation and baseline assessment. Eligible participants were randomly assigned to one of the interventions, in a ratio of 1:1:1, without stratification, with the use of permuted-block randomization once eligibility was confirmed and baseline assessments were completed. Outcome assessors were unaware of group assignments.

EXERCISE INTERVENTIONS

Tai Chi

The protocol consisted of six tai chi movements[17] integrated into an eight-form routine (see the Supplementary Appendix for more details).[20,21] Because the goal was to maintain balance through postural control, the protocol was specifically designed to tax balance and gait by having participants perform symmetric and diagonal movements, such as weight shifting, controlled displacement of the center of mass over the base of support, ankle sways, and anterior–posterior and lateral stepping. The first 10 weeks emphasized the mastery of single forms through multiple repetitions; later weeks focused on repetitions to enhance balance and increase locomotion. Natural breathing was integrated into the training routine.

Resistance Training

The protocol, developed from the exercise literature,[11,22-25] focused on strengthening the muscles that are important for posture, balance, and gait. Resistance (with weighted vests and ankle weights) was introduced at week 10. Weighted-vest resistance was initially set at 1% of body weight and was increased by approximately 1 to 2% of body weight, depending on each participant's tolerance, every fifth week until 5% of body weight was achieved. Ankle weights started at 0.45 kg (1 lb) per limb and were gradually increased to 1.36 kg (3 lb). The routine involved 8 to 10 exercises, including forward and side steps, squats, forward and side lunges, and heel and toe raises, performed in 1 to 3 sets of 10 to 15 repetitions. Progression was modified for participants with physical limitations. Natural breathing was emphasized during the training routine.

Stretching

This control condition was designed to provide a low-intensity exercise program with the social interaction and enjoyment inherent in the two other interventions but without similar training benefits in lower-extremity weight bearing, strength, or balance.[13,20] The core activities encompassed a variety of seated and standing stretches involving the upper body (neck, upper back, shoulders, chest, and arms) and lower extremities (quadriceps, hamstrings, calves, and hips), with the use of gentle joint extension and flexion and trunk rotation. Abdominal breathing, with an emphasis on inhaling and exhaling to maximum capacity, and relaxation of major muscles were also included.

PRIMARY OUTCOMES

Primary outcomes consisted of two indicators of postural stability — maximum excursion and directional control — as measured by computerized dynamic posturography (Balance Master System, NeuroCom). Maximum excursion is an assessment of the limits of self-initiated movements as patients shift or lean their center of gravity, without falling, toward the theoretical limit (100%) in each of eight target directions. Directional control, a measure of movement accuracy, is calculated by comparing the amount of movement toward the target with the amount of extraneous movement. Scores on both measures range from 0 to 100%, with higher percentages indicating better balance or control.

SECONDARY OUTCOMES

Gait (stride length and walking velocity) was quantified with the use of a computerized 4.3-m (14 ft) walkway (GAITRite, CIR Systems). Participants were instructed to walk at their normal pace for four trials; the results were averaged to derive a score for each measure, with higher scores indicating better gait ability. Strength of bilateral knee extensors and flexors was measured at an angular velocity of 60 degrees per second with the use of an isokinetic dynamometer (Biodex System 3, Biodex Medical Systems). Summary peak torque values (in Newton meters [Nm]) of five cycles of maximal extension and flexion were calculated from the average of measurements of both limbs. The functional-reach test[26] assessed the maximal distance a participant could reach forward beyond arm's length while maintaining a fixed base of support in a standing position, with higher scores indicating better balance. The timed up-and-go test[27] measured the time (in seconds) taken to rise from a chair, walk 3.1 m (10 ft), return, and sit down, with a shorter time indicating better mobility. Participants' motor symptoms were assessed with the 14-item UPDRS III[18]; scores range from 0 to 56, with lower values indicating less motor disability. Assessors were trained by a board-certified neurologist according to the standard protocol.[28] Interrater reliability was 0.96. Falls were monitored by means of daily “fall calendars” that were maintained by the study participants[13] and collected monthly throughout the intervention or until a participant withdrew from the study.

TEST PROCEDURES

Outcome measures were assessed at baseline, at 3 and 6 months, and 3 months after completion of the intervention. Participants were instructed to follow their normal schedules for physical activity and medication during the 6-month intervention period. Assessments were conducted during times when participants were in “on” periods (i.e., when medication was working and symptoms were controlled). The participants' antiparkinsonian medications were monitored by means of a self-reported measure.[29]

STATISTICAL ANALYSIS

All primary and secondary analyses were conducted on an intention-to-treat basis. Between-group differences in demographic and baseline variables were tested with a chi-square test for categorical variables and a one-way analysis of variance for continuous variables.

Intervention effects on primary and secondary continuous outcome measures were compared by means of mixed repeated-measures analysis of variance, with and without adjustment for baseline and time-varying covariates (e.g., age, sex, disease stage, health status, medication use and change, and level of physical activity). Pairwise comparisons between the tai chi group and the two other groups were conducted only if the omnibus F-test statistics indicated that the null hypothesis should be rejected. Independent-sample t-tests (with 95% confidence intervals) were used to compare group means. Paired t-tests were used to examine within-group changes from baseline to 6 months. Negative binomial regression was used to model data on falls and to derive incidence-rate ratios (with 95% confidence intervals). The same analytic procedures were used to examine the sustainability of the intervention effects.

We calculated that a sample of 45 participants per group would provide at least 80% power to detect a between-group difference of 6 percentage points in maximum excursion and 10 percentage points in directional control from baseline to 6 months, assuming a 15% attrition rate, at a two-tailed alpha level of 0.05. These predicted percentage-point differences equate to a medium effect size of 0.30 or greater (the difference between two means divided by the pooled standard deviation for the data). For the primary outcomes, a two-tailed alpha level of 0.01 (for four corrected comparisons by the Bonferroni method) was considered to indicate statistical significance. Statistical analyses were performed with the use of SPSS software, version 17 (IBM), and Stata software, version 11 (StataCorp).

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Oregon Research Institute

KEY FINDINGS

In an original article published in the February 9, 2012 issue of the *New England Journal of Medicine (NEJM)*, ORI scientist Fuzhong Li, Ph.D. and colleagues reported that a tailored program of twice-weekly Tai Chi training resulted in improved postural stability and walking ability, and reduced falls in the participants.

The results of the study showed that the Tai Chi group performed consistently better than the stretching group in how far they could lean in any direction without losing balance as well as demonstrating better levels of directional control of the body and walking ability (i.e., longer stride length). Tai Chi participants also outperformed those in the resistance training group on the balance and stride length measures. Finally, Tai Chi training was shown to significantly lower the incidence of falls compared to stretching and to be as equally effective as resistance training in reducing falls.

Impaired movement, especially the loss of ability to maintain standing balance, adversely affects function and quality of life in patients with Parkinson's disease. With progression of the disease, patients lose stability and have trouble walking, difficulty managing activities of daily living, and experience frequent falls. Exercise is an important part of the management of Parkinson's disease because physical activity has been shown to retard the deterioration of motor function and to prolong functional independence. However, research on alternative forms of exercise, such as Tai Chi, that could improve balance, gait, and function in patients with Parkinson's disease is scarce.

The Tai Chi program developed by Dr. Li consisted of six Tai Chi movements integrated into an eight-form routine that focused on weight-shifting, controlled-displacement of the center of gravity over the base of support, ankle sway, and front-to-back and sideways stepping. Natural breathing was integrated into the training routine.

"There are a number of practical advantages to using Tai Chi to improve motor dysfunction of Parkinson's disease - it is a low cost activity that does not require equipment, it can be done anywhere, at any time, and the movements can be easily learned. It can also be incorporated into a rehabilitation setting as part of existing treatment. Similarly, because of its simplicity, certain aspects of this Tai Chi program can also be prescribed to patients as a self-care/home activity," Dr. Li added.

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