Published in final edited form as:
Gait Posture. 2008 October ; 28(3): 456–460. doi:10.1016/j.gaitpost.2008.02.005.

Tai Chi Improves Balance and Mobility in People with Parkinson Disease

Madeleine E. Hackney[1] and **Gammon M. Earhart**[1,2,3]

1*Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO 63108*

2*Department of Anatomy and Neurobiology, Washington University School of Medicine, St. Louis, MO 63108*

3*Department of Neurology, Washington University School of Medicine, St. Louis, MO 63108*

Abstract

This pilot study examines the effects of Tai Chi on balance, gait and mobility in people with Parkinson disease (PD). Thirty-three people with PD were randomly assigned to either a Tai Chi group or a control group. The Tai Chi group participated in 20 one-hour long training sessions completed within 10–13 weeks; whereas, the control group had two testing sessions between 10 and 13 weeks apart without interposed training. The Tai Chi group improved more than the control group on the Berg Balance Scale, UPDRS, Timed Up and Go, tandem stance test, 6-minute walk, and backward walking. Neither group improved in forward walking or the one leg stance test. All Tai Chi participants reported satisfaction with the program and improvements in well-being. Tai Chi appears to be an appropriate, safe and effective form of exercise for some individuals with mild-moderately severe PD.

Introduction

Parkinson disease (PD), a progressive neurodegenerative movement disorder that affects more than 1 million people in the United States, causes falls and hip fractures costing approximately $192 million annually[1, 2]. Strategies to improve balance may help reduce falls and disability from hip fractures. Tai Chi, a martial art that involves slow controlled movement and the maintenance of various postures, may be an effective means of addressing balance problems. Five days of Tai Chi training improved the 50-foot speed walk, the Timed Up and Go and the Functional Reach test[6] in 17 people with mild PD. Similarly, 12 Tai Chi sessions enhanced physical aspects of well being and balance in 8 people with PD[7]. Qi Gong, a martial art similar to Tai Chi, enhanced scores on the UPDRS motor subscale 3 and reduced the rate of progression across a one-year period in PD[5]. While these studies highlight the feasibility and potential benefits of Tai Chi, none employed a control group.

The purpose of this pilot study is to quantify the effects of Tai Chi on functional mobility, gait and balance in people with mild to moderate PD compared to a matched untreated control group with PD. We hypothesized that TC would result in improvements not seen in the control group.

Corresponding Author Gammon M. Earhart, PhD, PT, Program in Physical Therapy, Washington University School of Medicine, Campus Box 8502, 4444 Forest Park Blvd., St. Louis, MO 63108, (314) 286-1425.

Methods

CONSORT guidelines were followed in the conduct and reporting of this study. This work was approved by the Human Research Protection Office at Washington University in St. Louis (protocol # 06-0280). All participants provided written informed consent prior to participation.

Participants

Participants were at least 40 years of age, could stand for 30 minutes, could walk independently for at least 3 meters with or without an assistive device, had Hoehn & Yahr scores ranging from 1.5-3, and each had a diagnosis of idiopathic PD. PD diagnostic criteria were those used for clinically defined "definite PD" based upon published standards[8–10]. Participants all demonstrated clear benefit from levodopa and were tested on medications. Testing was performed at a standardized time during the medication cycle to reduce the effects of medication-related fluctuations in performance. Participants were excluded if they had: 1) a serious medical problem, or 2) history or evidence of neurological deficit other than PD that could interfere, such as previous stroke or neuromuscular disease. Participants were recruited from the St. Louis community through advertisement at local support groups and local American Parkinson Disease Association community events, as well as through the Washington University Movement Disorders Center. While some participants self-identified, most were directly recruited via telephone.

Thirty-three participants with PD took part in this study. See Table 1 for participant demographics. Participants were randomly assigned to participate either in Tai Chi (TC) or in a Control group. Simple random assignment was performed by the first author using a coin toss. At the start of the study there were 17 TC participants and 16 controls. Note that while the first author was not blinded to group assignment, all participant evaluations were videotaped for scoring by a blinded rater.

Intervention

The TC participants received structured, progressive lessons from an experienced instructor. They were taught the first and second circles of the Yang Short Style of Cheng Manching. Participants attended twice weekly one hour lessons, completing 20 lessons within 13 weeks. Those in the control group received no intervention.

Pre and Post Testing Protocol

Assessments of TC participants were conducted the week prior to initiation of training and the week following completion of 20 training sessions. Assessments of Control participants were conducted at the same time interval as the TC participants. All assessments were videotaped and data files were coded for blinded ratings. During each assessment, participants were first evaluated using the Unified Parkinson's Disease Rating Scale Motor Subscale 3 (UPDRS) [11,12]. Balance was evaluated using the Berg Balance Scale (BBS) [13], the tandem stance test (TS), and the one leg stance test (OLS) [14]. Functional mobility was assessed using the Timed Up and Go test (TUG) [15,16] and gait was assessed by examining standard forward and backward walking along an instrumented, computerized GAITRite walkway (CIR Systems, Inc., Havertown, PA). Finally, gait endurance was measured using the six minute walk test.

During the post-testing session, TC subjects also completed a questionnaire asking them to rank items on a scale of 1–5 (1 = strongly agree, 2 = somewhat agree, 3 = neither agree nor disagree, 4 = somewhat disagree, 5 = strongly disagree.) Item 1 asked if participants enjoyed participating in Tai Chi and items 2 through 7 asked if participants noted improvement in particular aspects of physical well-being since beginning the Tai Chi classes.

Kinematics

Spatiotemporal features of walking were measured using a 5m instrumented, computerized walkway. Subjects were asked to walk both forward and backward on the walkway at their normal pace, performing three trials in each direction. Results from the three trials of each direction were averaged. The primary variables of interest were gait velocity, stride length, and functional ambulation profile (FAP). The FAP is a single, numerical representation of gait performance[17] that is valid, reliable, and can discriminate between people with and without PD when walking at preferred speeds[18].

Analyses

For each individual, pre-test values were subtracted from post-test values to obtain individual change scores. Absolute change scores were compared between groups using independent t-tests when appropriate. Mann Whitney Rank Sum tests were used when data were not normally distributed. A Bonferroni correction was applied to account for the use of multiple tests. Overall significance level was $P = 0.05$, and each test had a significance cutoff of $p \leq 0.004$.

Results

Four participants in TC did not complete the study: one withdrew at week 4 upon being hospitalized for unrelated issues, one withdrew after week 5 citing that the exercise was not sufficiently intense, and two who had transportation issues attended sporadically over the course of the entire study but did not complete the required 20 lessons in 13 weeks. Three controls were unable to complete post-testing during the required time interval due to an ankle injury, a hospitalization, and a death in the family. Thus, in each group there were 13 participants who completed the study. Only data from these 26 individuals were analyzed.

At baseline, the two groups were not significantly different with respect to age, UPDRS scores, H&Y values, or duration of PD. At post-testing, however, several differences in change scores were noted between groups with the TC group showing greater improvement than the Control group in all cases (Table 2). Improvement in Berg Balance scores was significantly greater for the TC than the Control group. The TC group also improved on the UPDRS motor subscale 3, tandem stance, Timed Up & Go, and the six minute walk while the Control group showed little change on these measures. Improved FAP, stride length and velocity for backward walking indicated improved backward walking in the TC but not the Control group. Forward walking and one leg stance did not improve in either group.

In addition to the quantitative changes noted above, TC participants reported that they enjoyed participating and noted improvements in their physical performance. Median and interquartile values are reported for questionnaire responses. Participants reported having enjoyed the class (median = 1(25%:1.0, 75%: 2.0)), and somewhat agreed with the statements “my balance has improved” (median = 2.0 (25%: 1.8, 75%: 3.0)), “my walking has improved” (median = 2.0 (25%: 1.0, 75%:3.0)), “my coordination has improved” (median = 2.0(25%: 2.0, 75%: 3.0)), “my endurance has improved” (median =2.0 (25%: 1.8, 75%: 3.0), and “my mood has improved” (median = 2.0 (25%: 2.0, 75%: 3.0)). Participants neither agreed nor disagreed with the statement “my strength has improved” (median, 3.0 (25%: 2.8, 75%: 3.0).

Discussion

This pilot study compared changes in functional mobility in people with PD who participated in Tai Chi to a matched control group who received no intervention. The TC group demonstrated improvements in Berg balance scores and TUG performance similar to those reported previously for elderly individuals with and without PD who practiced Qigong or Tai

Chi [5,6,19,20]. The lack of improvement in one leg stance for the TC group contrasts with a study of more than 100 seniors who participated in Tai Chi three times weekly for three months. They showed improvements of more than 3 seconds in one leg stance time[20]. The lack of improvement in forward walking in the present study was consistent with a previous study of more than 150 elders without PD who showed no changes in gait velocity after participating in a year of Tai Chi[20]. However, several other studies have reported improvements in gait with TC, including an improvement of 2.3s in the 50 foot speed walk in persons with PD[6]. Improved gait performance was also noted in 28 elderly people following 48 weeks of Tai Chi[22] and in a group of vestibulopathic participants who practiced Tai Chi for ten weeks[23]. The lack of effects on one leg stance and gait in our study may be related to the small sample size and short duration of Tai Chi training.

This is the first study to examine six minute walk performance before and after Tai Chi. The improvement noted in the TC group may reflect improved balance. Alternatively, the improvement may reflect increased endurance, as Tai Chi has been shown to reduce systolic blood pressure, total cholesterol, heart rate and low-density lipoprotein cholesterol levels after as little as 10 weeks[24,25].

This study has several limitations including small sample size and a short duration of training. Longer training may increase the benefit from Tai Chi. Tj\his is supported by the fact that long-term Tai Chi practitioners exhibit smaller increases in postural sway in the antero-posterior direction in response to perturbation[26], an effect not seen in individuals who had practiced Tai Chi for only 3 months[27]. However, this apparent long term benefit may reflect incorporation bias, as those able to participate in Tai Chi for a longer term may be healthier than those that cannot endure.

To conclude, participants with PD who participated in twice weekly Tai Chi lessons demonstrated improvements in gait, balance and functional mobility. Although this pilot study is limited by a relatively small sample size and short training duration, the results suggest that Tai Chi may be an effective and safe form of exercise for some individuals with mild to moderately severe PD.

Acknowledgements

We would like to acknowledge Josh Funk, Minna Hong, Ruth Porter, Mike Falvo, Lauren Mehner, Tiffany Chung, Ba Huynh, Jeff Becket, Kyleen Albert, Laura Cohen, Patricia Engel, Callie Chen, Svetlana Kantorovich, Ryan Choi and Marghuretta Bland, for their assistance with this project. We also thank Joel Perlmutter for assitance with revision of this manuscript. A grant from the American Parkinson Disease Association funded this work. The study sponsors played no role in the study design, in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication.

References

1. Melton LJ III, Leibson CL, Achenbach SJ, Bower JH, Maraganore DM, Ober AL, Rocca WA. Fracture risk after the diagnosis of Parkinson's disease: influence of concomitant dementia. Mov Disord 2006;21(9):1361–1367. [PubMed: 16703587]
2. Bacon WE. Secular trends in hip fracture occurrence and survival rate: age and sex differences. J Aging Health 1996;8:538–553. [PubMed: 10182385]
3. Gatts SK, Woollacott MH. Neural mechanisms underlying balance improvement with short term Tai Chi training. Aging Clin Exp Res 2006;18(1):7–19. [PubMed: 16608131]
4. Voukelatos A, Cumming RG, Lord SR, Rissel C. A Randomized, Controlled Trial of tai chi for the Prevention of Falls: The Central Sydney tai chi Trial. J Amer Geri Soc 2007;55:1185–1191.
5. Schmitz-Huebsch T, Pyfer D, Kielwein K, et al. Qigong exercise for the symptoms of Parkinson's disease: a randomized, controlled pilot study. Mov Disord 2006;21(4):543–548. [PubMed: 16229022]

6. Li F, Harmer P, Fisher K, Xu J, Fitzgerald K, Vongjaturapat N. Tai Chi-based exercise for older adults with Parkinson Disease. J Aging Phys Act 2007;15(2):139–151. [PubMed: 17556781]
7. Klein PJ, Rivers L. Taiji for Individuals with Parkinson Disease and their Support Partners: Program Evaluation. J Neuro Phy Ther 2006;30(1):22–27.
8. Racette BA, Rundle M, Parsian A, Perlmutter JS. Evaluation of a screening questionnaire for genetic studies of Parkinson's disease. Am J Med Genet 1999;88(5):539–543. [PubMed: 10490713]
9. Calne DB, Snow BJ, Lee C. Criteria for diagnosing Parkinson's disease. Ann Neurol 1992;32:S125–S127. [PubMed: 1510370]
10. Hughes AJ, Daniels SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. J Neurol Neurosurg Psychiatry 1992;55:181–184. [PubMed: 1564476]
11. Fahn, S.; Elton, RL. UPDRS program members. Unified Parkinson's disease rating scale. In: Fahn, S.; Marsden, CD.; Goldstein, M.; Calne, DB., editors. Recent developments in Parkinson's disease. vol. 2. Florham Park, NJ: Macmillan Healthcare Information; 1987. p. 153-163.
12. Movement Disorder Society Task force on Rating Scales for Parkinson's Disease. The Unified Parkinson's disease rating scale (UPDRS): status and recommendations. Mov Disord 2003;18(7): 738–750. [PubMed: 12815652]
13. Berg K, Wood-Dauphinee S, Williams JI. The Balance Scale: reliability assessment with elderly residents and patients with acute stroke. Scand J Rehabil Med 1995;27:27–36. [PubMed: 7792547]
14. Vellas BJ, Wayne SJ, Romero L, Baumgartner RN, Rubenstein LZ, Garry PJ. One-leg balance is an important predictor of injurious falls in older persons. J Am Geriatr Soc 1997;45:735–738. [PubMed: 9180669]
15. Mathias S, Nayak U, Isaacs B. Balance in elderly patients: the "Get-up and Go" test. Arch Phys Med Rehab 1986;67:387–389.
16. Morris S, Morris ME, Iansek R. Reliability of measurements obtained with the Timed "Up & Go" test in people with Parkinson disease. Phys Ther 2001;81:810–818. [PubMed: 11175678]
17. Nelson AJ. Functional Ambulation Profile. Phys Ther 1974;54(10):1059–1065. [PubMed: 4424703]
18. Nelson AJ, Zwick D, Brody S, Doran C, Pulver L, Rooz G, Sadownick M, Nelson R, Rothman J. The validity of the GaitRite and the Functional Ambulation Performance scoring system in the analysis of Parkinson Gait. NeuroRehabilitation 2002;17(3):255–262. [PubMed: 12237507]
19. Taggart HM. Effects of Tai Chi Exercise on Balance, Functional Mobility, and Fear of Falling Among Older Women. Applied Nursing Research 2002;15(4):235–242. [PubMed: 12444582]
20. Li F, Harmer P, Fisher KJ, McAuley E, Chaumeton N, Eckstrom E, Wilson NL. Tai Chi and Fall Reductions in Older Adults: A Randomized Controlled Trial. J of Gerontology: Medical Sciences 2005;60A(2):187–194.
21. Yeh SH, CHuang H, Lin LW, Hsiao CY, Eng HL. Regular Tai chi chuan exercise enhances functional mobility and CD4CD25 regulatory T cells. Br J Sports Med 2006;20(3):239–243. [PubMed: 16505081]
22. Hass CJ, Gregor RJ, Waddell DE, Oliver A, Smith DW, Fleming RP, Wolf SL. The influence of Tai Chi training on the center of pressure trajectory during gait initiation in older adults. Arch Phys Med Rehabil 2004;85:1593–1598. [PubMed: 15468016]
23. McGibbon CA, Krebs DE, Parker SW, Scarborough DM, Wayne PM, Wolf SL. Tai Chi and vestibular rehabilitation improve vestibulopathic gait via different neuromuscular mechanisms: Preliminary report. BMC Neurology 2005;5:3. [PubMed: 15717934]
24. Ko GTC, Tsang PCC, Chan HCK. A 10-week Tai-Chi program improved the blood pressure, lipid profile and SF-36 scores in Hong Kong Chinese women. Med Sci Monit 2006;12(5):CR196–CR199. [PubMed: 16641875]
25. Wolf SL, O'Grady M, Easley KA, Guo Y, Kressig RW, Kutner M. The Influence of Intense Tai Chi Training on Physical Performance and Hemodynamic Outcomes in Transitionally Frail, Older Adults. J. of Gerontology: Medical Sciences 2006;61A(2):184–189.
26. Tsang WW, Hui-Chan CW. Standing balance after vestibular stimulation in Tai Chi–practicing and nonpracticing healthy older adults. Arch Phys Med Rehabil 2006;87:546–553. [PubMed: 16571396]
27. Fong S-M, Ng GY. The effects on sensorimotor performance and balance with Tai Chi training. Arch Phys Med Rehabil 2006;87:82–87. [PubMed: 16401443]

A. Tai Chi	Gender (M/F)	Age (years)	Time with PD (years)	Total UPDRS Motor Subscale Score	H&Y Score	Daily Dosage of PD Medications
TC1	M	69	5	25.5	2	Sinemet 187.5/750mg Mirapex 0.5mg
TC3	M	53	9	25	3	Sinemet 200/800mg Amantadine 100mg Pramipexole 2mg
TC4	M	68	11	29	1.5	Sinemet 75/300mg
TC5	M	65	6	40.5	2	Sinemet 100/400 mg Mirapex 0.05 mg Comtan 200 mg
TC6	M	52	14	24	2.5	Sinemet 350/1400mg
TC7	M	70	6	12	1.5	Sinemet 125/500mg
TC8	M	51	1	22	1.5	Sinemet 187.5/150mg Propanalol 60mg
TC9	M	73	14	26	2	Sinemet 350/1400mg Entacapone 1400mg Pramipexole 4mg
TC10	F	60	4	11.5	1.5	Sinemet 250/1000mg Pramipexole 2mg
TC12	F	73	6	20	2	Sinemet 237.5/950mg Tolcapone 600mg Amantadine 200mg
TC14	M	70	17	39	2	Sinemet 112.5/450mg Tolcapone 600mg Pramipexole 1mg
TC15	M	74	13	32	2.5	Sinemet 275/1100mg
TC17	M	66	7	35	2	Sinemet 412.5/1650mg Tolcapone 600mg
Mean ± SD or Median; Interquartiles	11M/ 2F	64.9±8.3	8.7±4.7	25.5 (25%: 21.5, 75%: 32.8)	2.0 (25%: 1.5, 75%:2.1)	

B. Control	Gender (M/F)	Age (years)	Time with PD (years)	Total UPDRS motor subscale 3 score	H&Y score	Daily Dosage of PD Medications
C1	M	78	7	30.5	2	Sinemet 187.5/750mg
C2	M	66	3	27	2	Sinemet 112.5/450mg
C3	M	67	3	23	2	Sinemet 200/1000 mg Neurontin 300 mg
C5	M	59	4	18	2	Sinemet 75/300mg
C6	M	55	3	13	1.5	Sinemet 37.5/150mg
C7	M	52	5	13	1.5	Sinemet 1187.5/4750mg Ropinirole 1mg
C8	M	64	4	27.5	2	None
C9	F	47	10	26.5	2	None
C10	F	69	5	24	2	Sinemet 75/300mg
C11	F	69	1	23	2	Sinemet 100/400 mg
C13	M	45	4	46	2.5	Sinemet 150/600 Amantadine 400mg Entacapone 600mg
C14	M	69	12	37.5	2	Sinemet 150/600mg Amantadine 100mg Entacapone 600mg

B. Control	Gender (M/F)	Age (years)	Time with PD (years)	Total UPDRS motor subscale 3 score	H&Y score	Daily Dosage of PD Medications
C15	M	74	10	17	2	Sinemet 187.5/750mg
Mean ± SD or Median; Interquartiles	10 M/3 F	62.6 ±10.2	5.5±3.3	24.0 (25%: 17.8, 75%: 28.3)	2.0: (25%: 2.0, 75%: 2.0)	

Table 2

Changes in Gait Variables, TUG and OLS

	Tai Chi	Ctrl	P value
UPDRS	−1.5 ± 6.6 (−5.6% ± 0.3)	4.3 ± 5.6 (17.2 % ± 0.2)	p = 0.025
Berg Balance Scale	3.3 ± 3.0 (7.0% ± 0.1)	−0.5 ± 2.1 (−1.0% ± 0.0)	p = 0.001*
Timed Up & Go (sec)	−1.0 s ± 0.1 (−10.2%± 0.0)	−0.1 s ± 1.1 (−1.15%± 0.1)	p = 0.093
Tandem Stance (sec)	8.3 ± 14.1 (34.8 % ± 0.6)	−11.6 ± 24.5 (−26.7% ± 0.6)	p = 0.018
One Leg Stance (sec)	−0.2s ± 13.1 (−1.2%± 0.8)	−0.6 s ± 20.2 (−3.1%± 1.1)	p = 0.918†
Backward FAP	6.5 ± 7.6 (10.9% ± 0.1)	0.8 ± 8.8 (1.2% ± 0.1)	p = 0.096
Backward stride length	0.1 m ± 18.7 (18.3%± 0.3)	−.03 m ± 26.5 (−3.2%±0.3)	p = 0.085
Backward velocity	0.2 m/s ± 19.6 (25.1%± 0.3)	−0.0m/s, ± 25.7 (−0.4%± 0.3)	p = 0.067
Forward FAP	1.8 ± 10.1 (1.9%± 0.1)	−1.3 ± 6.3 (−1.4%± 0.1)	p = 0.939†
Forward stride length	−0.1 m ±22.8 (5.8 %± 0.2)	0.0 m ± 6.6; (1.4 %± 0.1)	p = 0.151†
Forward velocity	0.01 m/s ±20.8 (6.2%±0.2)	0.1 m/s ±10.8 (5.4%± 0.1)	p = 0.838
Six Minute Walk (m)	44.4 ± 65.9 (10.3 % ± 0.2)	0.8 ± 43.4 (0.2% ± 0.1)	p = 0.046

Values are means ± SD for absolute change and in parentheses these scores are expressed as a percentage of baseline performance ± SD. The p values are reported for between-group comparisons of change scores using t-tests unless otherwise noted.

* Significant difference Tai Chi vs. Ctrl.,

† Mann-Whitney Rank Sum Test