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Tai Chi Exercise for Patients With Chronic Obstructive Pulmonary Disease: A Pilot Study

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Abstract

OBJECTIVE—To determine the feasibility of a randomized controlled trial of the effect of a tai chi program on quality of life and exercise capacity in patients with COPD.

METHODS—We randomized 10 patients with moderate to severe COPD to 12 weeks of tai chi plus usual care (n = 5) or usual care alone (n = 5). The tai chi training consisted of a 1-hour class, twice weekly, that emphasized gentle movement, relaxation, meditation, and breathing techniques. Exploratory outcomes included disease-specific symptoms and quality-of-life, exercise capacity, pulmonary function tests, mood, and self-efficacy. We also conducted qualitative interviews to capture patient narratives regarding their experience with tai chi.

RESULTS—The patients were willing to be randomized. Among 4 of the 5 patients in the intervention group, adherence to the study protocol was excellent. The cohort's baseline mean ± SD age, percent-of-predicted FEV_1, and ratio of FEV_1 to forced vital capacity were 66 ± 6 y, 50 ± 12%, and 0.63 ± 0.14, respectively. At 12 weeks there was significant improvement in Chronic Respiratory Questionnaire score among the tai chi participants (1.4 ± 1.1), compared to the usual-care group (−0.1 ± 0.4) (P = .03). There were nonsignificant trends toward improvement in 6-min walk distance (55 ± 47 vs –13 ± 64 m, P = .09), Center for Epidemiologic Studies Depression Scale (−9.0 ± 9.1 vs −2.8 ± 4.3, P = .20), and University of California, San Diego Shortness of Breath score (−7.8 ± 3.5 vs −1.2 ± 11, P = .40). There were no significant changes in either group's peak oxygen uptake.

CONCLUSIONS—A randomized controlled trial of tai chi is feasible in patients with moderate to severe COPD. Tai chi exercise as an adjunct to standard care warrants further investigation.

Keywords

tai chi; quality of life; exercise capacity; chronic obstructive pulmonary disease; COPD; patient narratives; depression

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Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality, both in the United States and internationally. In 2000, COPD was the fourth most common cause of death in the United States, and the only major disease among the top 10 that continues to increase in prevalence.[1–3] Despite pharmacologic and surgical advances, many patients continue to suffer from dyspnea and substantial limitations in daily activities.

The importance of exercise in the management of COPD has been well studied. Current recommendations have been incorporated into pulmonary rehabilitation guidelines, although there is ongoing debate regarding the optimal types, intensity, and duration of exercise.[4–6] Conventional programs improve exercise endurance, shortness of breath, and quality of life, even in patients with severe COPD and poor exercise tolerance.[7] Importantly, both low-intensity and high-intensity exercise produces clinical benefits. In addition to aerobic activity, lower-extremity exercise, and strength training, studies suggest that unsupported upper-extremity exercise may offer additional benefits and may be a more effective way to train patients in activities similar to those required in daily living.[6]

Although exercise and pulmonary rehabilitation have been shown to be beneficial, the literature suggests that only a small percentage of eligible patients actually participate. The presence of comorbidities, including chronic heart failure and depression, correlates with poor adherence to pulmonary rehabilitation.[8] Of those who do complete exercise programs, maintenance of activity is universally problematic, and clinical benefit declines dramatically after 1 year.[9] Other exercise options that are easily implemented, low-cost, and promote exercise self-efficacy among patients with COPD are still needed.

Tai chi (also known as tai chi chuan or taijiquan) is a gentle, meditative exercise that employs detailed regimens of flowing circular movements, balance and weight shifting, breathing techniques, and cognitive tools such as visualization and focused internal awareness.[10–12] Studies have investigated tai chi as an intervention for a wide variety of health concerns, including chronic cardiovascular conditions,[13–21] cardiorespiratory fitness and functional status,[22–26] and balance and musculoskeletal disease.[22,23,27–40] The physical activity of tai chi is estimated to be about 1.6 – 4.6 metabolic-equivalent-of-task units (METs) and 50–74% of maximum heart rate, depending on the age of the individual and the intensity of practice.[41–44] Thus, tai chi may be a suitable exercise option for patients with COPD, as it provides mild to moderate aerobic activity, and lower-extremity, unsupported upper-extremity, and core-strength training. It also contains elements of breathing and respiratory muscle training and stress management that are important aspects of COPD management. Further, studies suggest that tai chi is safe, accessible, enjoyable, and has a high adherence rate.[29,45–49]

Our objective was to determine the feasibility of a randomized controlled trial of tai chi for patients with COPD, and to explore preliminary estimates of tai chi's effect on quality of life and exercise capacity.

Methods

Study Design

Ten patients were recruited from the ambulatory pulmonary practice at Beth Israel Deaconess Medical Center in Boston, Massachusetts. The patients were randomly assigned to receive either 12 weeks of tai chi in addition to their usual care, or to usual care alone. Usual care included pharmacologic therapy and general exercise advice, per the American College of Chest Physicians guidelines for patients with COPD, but did not include a formal

supervised exercise protocol. Patients receiving usual care were offered tai chi at the conclusion of the study. All the patients had either previously completed a pulmonary rehabilitation program or otherwise had declined participation in pulmonary rehabilitation. We used a computer-generated randomization algorithm to generate treatment assignments. All patients provided written informed consent. Our institution's human subjects review board approved the protocol. Figure 1 shows a flow diagram of the type recommended by the Consolidated Standards of Reporting Trials (CONSORT).

We selected subjects based on the following criteria:

- Physician diagnosis of COPD
- FEV_1 < 65% of predicted, and ratio of FEV_1 to forced vital capacity (FVC) < 0.70
- ≥ 45 y of age

We excluded subjects who had:

- A COPD exacerbation that required systemic steroids, antibiotics, emergency-department visit, or hospitalization within the past month
- Any planned major pulmonary intervention in the coming 3 months (eg, lung-volume-reduction surgery)
- Severe peripheral vascular disease and claudication or other physical condition that would preclude a 6-min walk test
- Inability to perform bicycle ergometry
- Severe cognitive dysfunction (Mini Mental State Examination score ≤ 24)
- Inability to speak English
- Current participation in a conventional pulmonary rehabilitation program or regular practice of tai chi

Intervention

The intervention consisted of 1-hour group tai chi classes customized for patients with respiratory disease, and held twice weekly for 12 weeks. We used a standard protocol that we have used in prior trials in patients with heart failure[16] (Table 1), with additional emphasis on meditative breathing. The original program development was guided by similar interventions used in prior tai chi trials with elderly patients and those with limited mobility.[29] The protocol included traditional warm-up exercises, followed by 5 simplified tai chi movements taught by 2 certified and experienced instructors (average experience of 20 y). Warm-up exercises included weight shifting, arm swinging, gentle stretches of the neck, shoulders, spine, arms, legs, visualization techniques, and traditional breathing methods (ie, dan tien breathing and whole body breathing). These exercises focus on releasing tension in the physical body, incorporating mindfulness and imagery into movement, increasing awareness of breathing, and promoting overall relaxation of body and mind. The core tai chi movements were adapted from Master Cheng Man-Ch'ing's Yang-style short form,[10] and performed repetitively. Chairs were provided for resting, and patients were allowed to progress at their own comfort and pace. We provided a 35-min instructional videotape that outlined the exercises presented in class. Patients were encouraged, although not required, to practice at home at least 3 times per week. Class attendance was monitored, and adherence to practice was tracked via self-report logs, which obtained the weekly frequency and duration of home tai chi practice.

Outcome Measures

All measures were obtained at baseline and 12 weeks. Questionnaires and functional assessments were also obtained at 6 weeks, in the event that 12-week data were unavailable. Cardiopulmonary tests and functional assessments were performed by staff blinded to subject assignment.

Exercise Capacity and Functional Status

The patients performed a symptom-limited exercise test with a bicycle ramp protocol to determine peak oxygen uptake and cycling endurance. Testing was done on an electronically calibrated upright bicycle, with expired gas analysis and continuous electrocardiographic monitoring. Breath-by-breath respiratory gas analysis was performed with a metabolic cart (Vmax 229, SensorMedics, Yorba Linda, California). Peak values were averaged from the final 20 seconds of the test. In addition, patients underwent a 6-min walk test[50] and the standard timed Up-And-Go assessment, according to the method of Podsiadlo and Richardson.[51]

Health-Related Quality of Life, Symptoms, Mood, and Psychosocial Functioning

We used the self-administered, standardized version of the Chronic Respiratory Disease Questionnaire (CRQ), which is validated and commonly employed in patients with COPD.[52,53] To measure dyspnea we used the University of California, San Diego Shortness of Breath Questionnaire[54] and the Modified Medical Research Council Dyspnea Scale. We also used the COPD Self-Efficacy Scale[55] and the Center for Epidemiologic Studies Depression Scale score.[56] We used the Holistic Complementary and Alternative Health Questionnaire to measure attitudes toward complementary therapies and holistic health beliefs.[57]

Pulmonary Function Tests

A minimum of 3 acceptable spirometry efforts were performed, with a rolling-seal volume-displacement spirometer (GS or CPL, Collins, Braintree, Massachusetts), following the American Thoracic Society standards for quality and reproducibility. Lung volumes, including total lung capacity, functional residual capacity, and the ratio of inspiratory capacity to total lung capacity were measured via plethysmography.

Physical Activity

In addition to monitoring home tai chi practice via self-report logs, to keep track of patients' level of other physical activity outside of classes we used the Community Healthy Activities Model Program for Seniors (CHAMPS) Physical Activity Questionnaire,[58] which captures weekly frequency and total time spent in different activities and allows estimation of caloric expenditure.

Qualitative Interview

Among the tai chi participants we performed 30-min semi-structured qualitative exit interviews to further explore areas not captured in our standardized instruments, such as candid assessments (positive, negative, and neutral) of various aspects of the tai chi intervention. Each interview session was audio taped, transcribed verbatim, and analyzed with inductive methods to identify common themes.

Healthcare Utilization and Adverse Events

At each follow-up visit we collected data on medications and healthcare utilization (hospitalization, emergency department, and out-patient visits). We also asked about

medical illnesses, such as COPD exacerbation, and other adverse events that may not have resulted in a medical visit.

Statistical Analysis

All statistical analyses were performed on an intention-to-treat basis. The patients' baseline characteristics were compared with *t* tests for continuous variables and Fisher's exact test for nominal variables. We used 2-sample Wilcoxon rank-sum tests, adjusted for baseline scores, to compare the distribution of change after 12 weeks between the treatment and control groups. Differences were considered statistically significant when $P < .05$.

Results

Feasibility, Adherence, and Safety

The patients were willing to be randomized. In 4 of the 5 tai chi participants, adherence to the study protocol was excellent. One tai chi participant had poor adherence and attended only one class, due to family medical circumstances unrelated to the study, but did complete all testing. The remaining 4 tai chi patients attended an average of 22 of the 24 (91%) class sessions, and they all reported home tai chi practice. No adverse events occurred during the class sessions. No patients in either group were hospitalized during the study period for COPD exacerbation, and there were no deaths.

Baseline Characteristics

Table 2 describes the cohort's baseline characteristics. The baseline mean ± SD age, percent-of-predicted FEV_1, and FEV_1/FVC were 66 ± 6 y, 50 ± 12%, and 0.63 ± 0.14, respectively, and the median ± SD GOLD stage was 2.5 (range 2–3). There were no significant differences between the groups in demographics, clinical classification of pulmonary disease severity, or rate of reported comorbidities. The 2 groups scored similarly on the Holistic Complementary and Alternative Health Questionnaire (43 in the tai chi group vs 44 in the control group, $P > .99$, range 11–66), in which a higher score denotes a more positive attitude toward holistic health. However, due to the small sample size, there were baseline differences in physical activity and CRQ score: the tai chi participants were initially more active, yet reported worse quality of life.

Change in Outcomes After 12 Weeks

Table 3 presents the baseline and week-12 measurements. Compared to the controls, the tai chi group showed significant improvements in quality-of-life scores (CRQ total score and CRQ emotion domain). Nonsignificant trends in improvement were seen with tai chi, as compared to usual care, in 6-min walk distance, Center for Epidemiologic Studies Depression Scale score, University of California, San Diego Shortness of Breath score, and COPD Self-Efficacy Scale scores. There were no significant changes in spirometry or peak oxygen uptake, although both groups increased exercise duration in the bicycle stress test. At 12 weeks the mean weekly caloric expenditure had increased in both groups, to 3,570 kcal/wk and 1,483 kcal/wk in the tai chi and control groups, respectively ($P = .09$).

Qualitative Analyses

The exit-interview data suggest that the tai chi patients found the program valuable and enjoyable. All the tai chi patients rated the tai chi sessions highly, many expressed interest in additional instruction, and 4 of the 5 patients planned to continue with tai chi on their own after the study. Further, an attention to mind-body breathing was noted to be one of the most important aspects. Below is an example of a representative quote:

> I think the thing that changed the most was understanding my breathing better—breathing patterns and breathing deep. I'm one who is used to shallow breaths rather than the whole thing, and now I try to be much more aware of that. And if I'm having a bad day, I try to give myself some time to rest and get my breathing back "in sync." I like the idea, the pace of tai chi, the gracefulness of it. I like the idea that it's non-stressful. If you're doing other forms of exercise, you often have more on your mind. If you're on the treadmill or the bike, you're watching to see how long you're on, the speed you're going at, and so forth, whereas with tai chi it's nothing—it's just you—and I like that idea.

Discussion

Our preliminary data show that a randomized controlled trial of tai chi exercise is feasible and safe in patients with moderate to severe COPD. As a complement to standard medical care, tai chi may enhance quality of life, psychosocial function, and possibly exercise capacity, and warrants further investigation.

In patients with comparable COPD severity, improvements with conventional exercise have been shown. In a recent study by Maltais et al, both out-patient and home-based pulmonary rehabilitation (including aerobic cycling and strength training) improved CRQ dyspnea score at 12 weeks (0.7– 0.8-unit change), although changes in the other subdomains were not clinically relevant.[59] With tai chi we preliminarily report improvements of greater magnitude (approximately a 1.5-unit change of CRQ score). Maltais et al also reported small changes (8–11 m) in 6-min walk distance in both exercise groups; however, that change is less than the minimum clinically relevant change of 35 m or 10% of baseline.[60] Here we report a trend of about 55 m or 14% baseline, which is comparable to other pulmonary exercise trials.[5]

Tai chi may be a safe adjunct or alternative to conventional exercise training in patients with COPD. We observed no serious adverse events in this small pilot study, although further study is needed. Overall, the adverse event rate in conventional exercise trials is low. However, cases of COPD exacerbation, cardiovascular events, and minor musculoskeletal injuries have been reported.[59] In contrast, tai chi encourages patients to move fluidly, with less strain,[39,61] and has been reported safe in various deconditioned populations of persons with cardiovascular disease.[13,19]

Limitations

As our main goal was to determine feasibility, the study sample was small and did not afford adequate statistical power to detect differences in our exploratory outcomes measures. Because of our small sample size, there were baseline differences between the groups, which limits the interpretation of some results. In addition, with a usual-care control group, the patients could not be blinded to treatment, and time/group effects of the intervention could not be matched. Nonetheless, this first study provides valuable preliminary information about a novel meditative exercise that may be an option for patients with COPD.

Conclusions

Given the suggestive trends we observed, larger-scale investigations may be warranted. Future studies may begin to elucidate possible mechanistic pathways, to better understand the important components of the intervention (eg, physical activity vs meditation/relaxation or slow breathing), to evaluate adherence and persistence of benefit, to explore the role of tai chi in relation to conventional exercise (eg, as a possible maintenance strategy after pulmonary rehabilitation), and to address cost-effectiveness.

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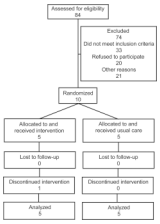

Fig. 1.
Flow diagram of eligibility assessment, exclusion, inclusion, and analysis.

Table 1

Tai Chi Intervention for Patients With COPD

Week	Activities	Approximate Duration (min)
1	Introductory Session: Overview of Program	
	Tai chi principles, philosophies	15
	Demonstration of tai chi form	10
	Expectations of participants	10
	Description of class format	5
	Participation in warm-up exercises	30
2–5	Warm-up Exercises (Repeated During All Sessions)	
	Standing	
	"Drumming the Body"	6
	"Swinging to Connect Kidney and Lungs"	3
	"Washing the Body With Qi"	3
	Standing meditation and breathing	3
	Sitting	
	Neck/shoulder stretches	6
	Arm/leg stretches	3
	Sitting meditation and breathing	6
	Total average warm-up time	30
	Tai Chi Movements	
	"Raising the Power"	5–10
	"Withdraw and Push"	5 per side
	Warm-up and Movements 1 and 2	
	"Grasp Sparrows Tail"	5 per side
	"Brush Knee Twist Step"	5 per side
10–12	Warm-up and Movements 1–4	
	"Wave Hands Like Clouds"	5–10
	Total average time for tai chi movements	30

Table 2

Baseline Characteristics

	Tai Chi (*n* = 5)	Control (*n* = 5)
Demographic Factors		
Age (mean ± SD y)	65 ± 6	66 ± 6
Male, No. (%)	3 (60)	3 (60)
Race		
Black	1 (20)	2 (40)
White	4 (80)	3 (60)
Baseline Clinical Factors		
FEV_1 (mean ± SD % predicted)	53 ± 7	47 ± 7
GOLD stage (mean ± SD)	2.4 ± 0.5	2.6 ± 0.5
BODE index (mean ± SD)	3.8 ± 2.2	4.0 ± 1.7
Medications, No. (%)		
Inhaled corticosteroids	5 (100)	5 (100)
Anticholinergics	4 (80)	4 (80)
Long-acting β-agonists	4 (80)	5 (100)
Physical Activity		
Caloric expenditure per week (kcal/wk)*	3,423	804
Self-Report of Comorbidities, No. (%)		
Coronary artery disease	0 (0)	1 (20)
Arrhythmia	1 (20)	1 (20)
Hypertension	1 (20)	2 (40)
Asthma	2 (40)	2 (40)
Gastrointestinal condition	1 (20)	0
Cancer	1 (20)	3 (60)
Anxiety	2 (40)	2 (40)
Depression	2 (40)	1 (20)
Arthritis	1 (20)	0
High cholesterol	2 (40)	4 (80)

*Calorie expenditure per week was the only measurement for which there was a statistically significant difference between groups.

GOLD = Global Initiative for Chronic Obstructive Lung Disease
BODE = body mass index, airflow obstruction, dyspnea, exercise capacity

Table 3

Comparison of the Effects of Tai Chi Versus Usual Care on Change in Outcomes After 12 Weeks

Outcome	Tai Chi Group (*n* = 5) median (range)		Control Group (*n* = 5) median (range)		*P*
	Baseline	Week 12	Baseline	Week 12	
Chronic Respiratory Questionnaire*					
Total score†	3.5 (3.2–5.2)	5.4 (4.1–6.4)	5.7 (4.6–6.5)	5.3 (4.5–6.4)	.03
Emotion domain†	4.4 (1.8–4.8)	5.0 (4.1–6.1)	5.8 (4.4–7.0)	4.7 (4.1–6.7)	.04
Mastery domain	4.2 (3.5–5.5)	6.5 (3.7–7.0)	6.0 (4.0–7.0)	5.7 (4.2–7.0)	.07
Dyspnea domain†	4.4 (1.8–6.0)	5.7 (4.4–6.7)	6.0 (5.4–7.0)	6.4 (5.2–6.8)	.29
Fatigue domain	3.7 (2.7–5.2)	5.2 (4.0–6.0)	5.0 (4.0–6.2)	5.7 (3.7–6.0)	.17
6-min walk test (m)*	401 (240–575)	428 (379–624)	422 (121–526)	381 (121–522)	.09
Peak oxygen uptake (mL/kg/min)*	9 (8–18)	9 (7–15)	11 (6–14)	11 (7–14)	.57
Exercise duration (min)*	7 (5–10)	8 (6–11)	6 (5–8)	7 (7–10)	.91
FEV_1/FVC*	73 (48–87)	69 (53–85)	54 (42–73)	54 (43–72)	.99
FRC‡	124 (79–244)	106 (87–109)	146 (81–181)	125 (85–137)	.67
Timed Up and Go (s)‡	10 (7–13)	8 (5–9)	9 (7–20)	8 (6–17)	.44
UCSD SOB Questionnaire‡	39 (23–69)	27 (19–58)	20 (6–50)	22 (12–37)	.40
CES Depression score‡	14 (11–46)	5 (1–27)	12 (2–17)	8 (0–17)	.24
COPD Self-Efficacy score*	105 (87–149)	135 (102–137)	135 (129–143)	137 (111–144)	.20

*Higher score more favorable.

†Significant baseline differences between groups.

‡Lower score more favorable.

FVC = forced vital capacity
FRC = functional residual capacity
UCSD = University of California, San Diego
SOB = shortness of breath
CES = Center for Epidemiologic Studies

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